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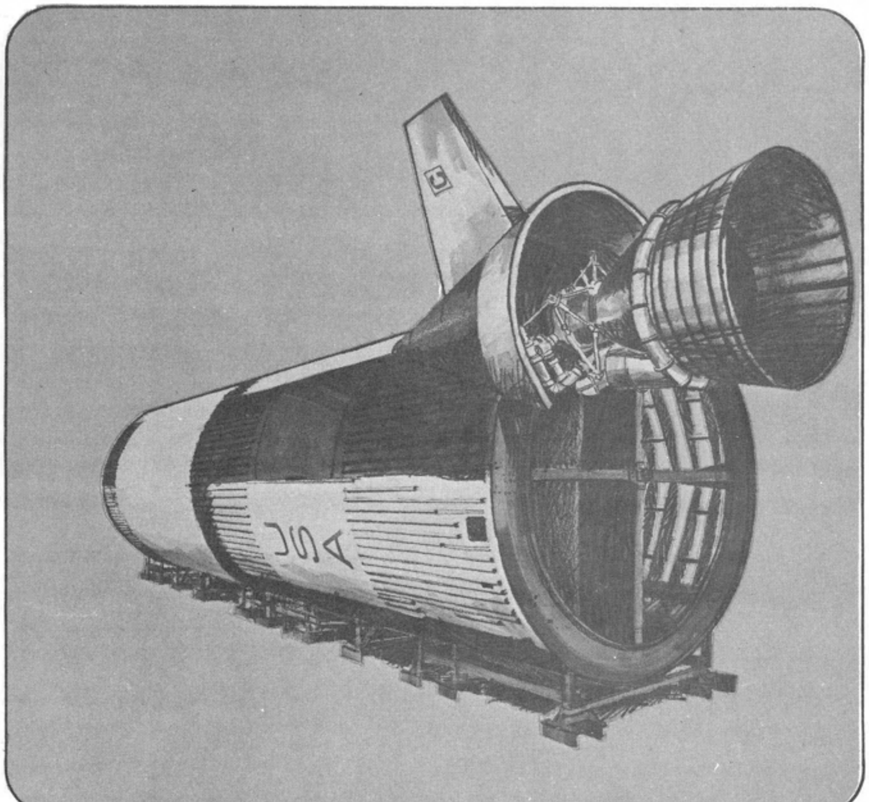

SATURN S-IC

FISCAL YEAR 1964 ANNUAL PROGRESS REPORT

Aug 14, 1964

D5-12601-1 [redacted]

LAUNCH SYSTEMS BRANCH

AERO - SPACE DIVISION

THE BOEING COMPANY

THE BOEING COMPANY

LAUNCH SYSTEMS BRANCH, AERO-SPACE DIVISION · P. O. BOX 26088, NEW ORLEANS, LA. 70126

July 2, 1964

National Aeronautics and Space Administration
George C. Marshall Space Flight Center

IN REPLY REFER TO

Fiscal year 1964 progress of the Saturn V/S-IC Stage Program has reflected a significant transition from primarily a conceptual to an implementation phase of program activity.

The developmental nature of the S-IC Stage Program has resulted in changes to the program requirements. The most significant change was the change to program schedule Plan VII. Numerous contract modifications have been received which have significantly expanded the scope of the work assigned to The Boeing Company. At the close of FY '64, The Boeing Company capabilities are focused on implementing these new program requirements.

The release of S-IC and GSE/MSE basic design was behind schedule at the beginning of this fiscal year period. Combined action by NASA/MSFC and Boeing in such areas as approval of GSE design criteria and establishment of a streamlined approval release system has significantly improved our schedule position relative to release of design documentation.

Throughout the reporting period, the assembly and manufacturing effort was greatly affected by program changes. At the outset of the fiscal year, the assembly and manufacturing activity was primarily involved with structural component activity per Plan V requirements. Program changes such as the NASA/MSFC redirection from schedule Plan V to Plan VII, the impact of Boeing intertank redesign and the transfer of thrust structure tooling and assembly from NASA/MSFC to Boeing at Michoud has required changes in planning and program phasing. It was a period which saw many adjustments to tool loading schedules and procurement activities. As of the end of June 1964, the Launch Systems Branch had realigned its stage assembly effort in support of the new customer schedule requirements. Launch Systems Branch Michoud-assembled S-IC stages and GSE/MSE for all locations are currently predicted to be delivered per the NASA/MSFC Plan VII schedule requirements. At the same time, an all-out effort is in progress by NASA/MSFC and the Launch Systems Branch to ensure that critical problems affecting the completion of the S-IC-T stage were being properly dealt with.

Behind-schedule activation of various facilities in the Michoud complex created problems during the past year. The use of partial and interim facilities in addition to other work-around techniques has allowed Launch Systems Branch to minimize schedule impact. Permanent facility activations commenced during the fourth quarter of calendar year 1963 and continued through the end of June 1964. The remaining facilities are predicted to be completed during fiscal year 1965.

Many new and varied developmental problems will undoubtedly arise during the next fiscal year. I am confident that Boeing and NASA/MSFC management will overcome these challenges with the same team spirit demonstrated in the past.

THE BOEING COMPANY
Aero-Space Division

R. C. Dunigan

R. C. Dunigan
S-IC Program Executive
Launch Systems Branch

SATURN S-IC

FISCAL YEAR 1964 ANNUAL PROGRESS REPORT

D5-12601-1 ■ AUGUST 14, '64

LAUNCH SYSTEMS BRANCH
AERO - SPACE DIVISION
THE BOEING COMPANY

FOREWORD

This Annual Progress Report has been prepared by The Boeing Company to fill the requirement under Article XXXI, Paragraph C, of Contract NAS8-5608 as modified by Modification 100. It encompasses the progress made by The Boeing Company on the Saturn S-IC Program for the fiscal year 1964 (from July 1, 1963 through July 2, 1964). The main objective of this report is to serve as an historical presentation stressing Boeing accomplishments and present capabilities under Contract NAS8-5608.

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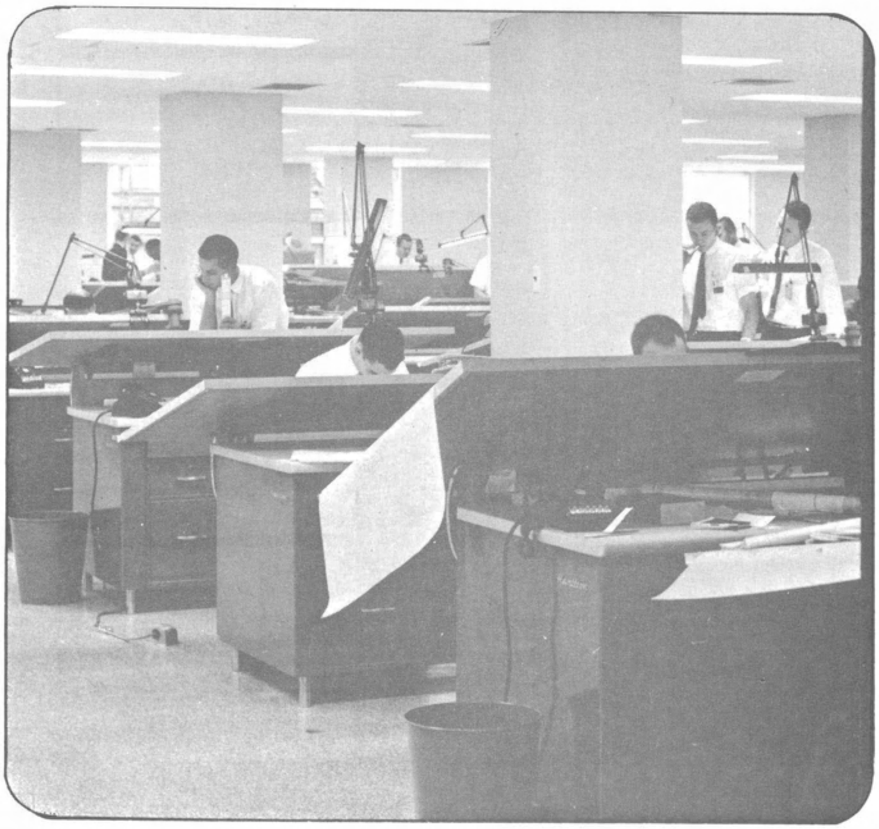
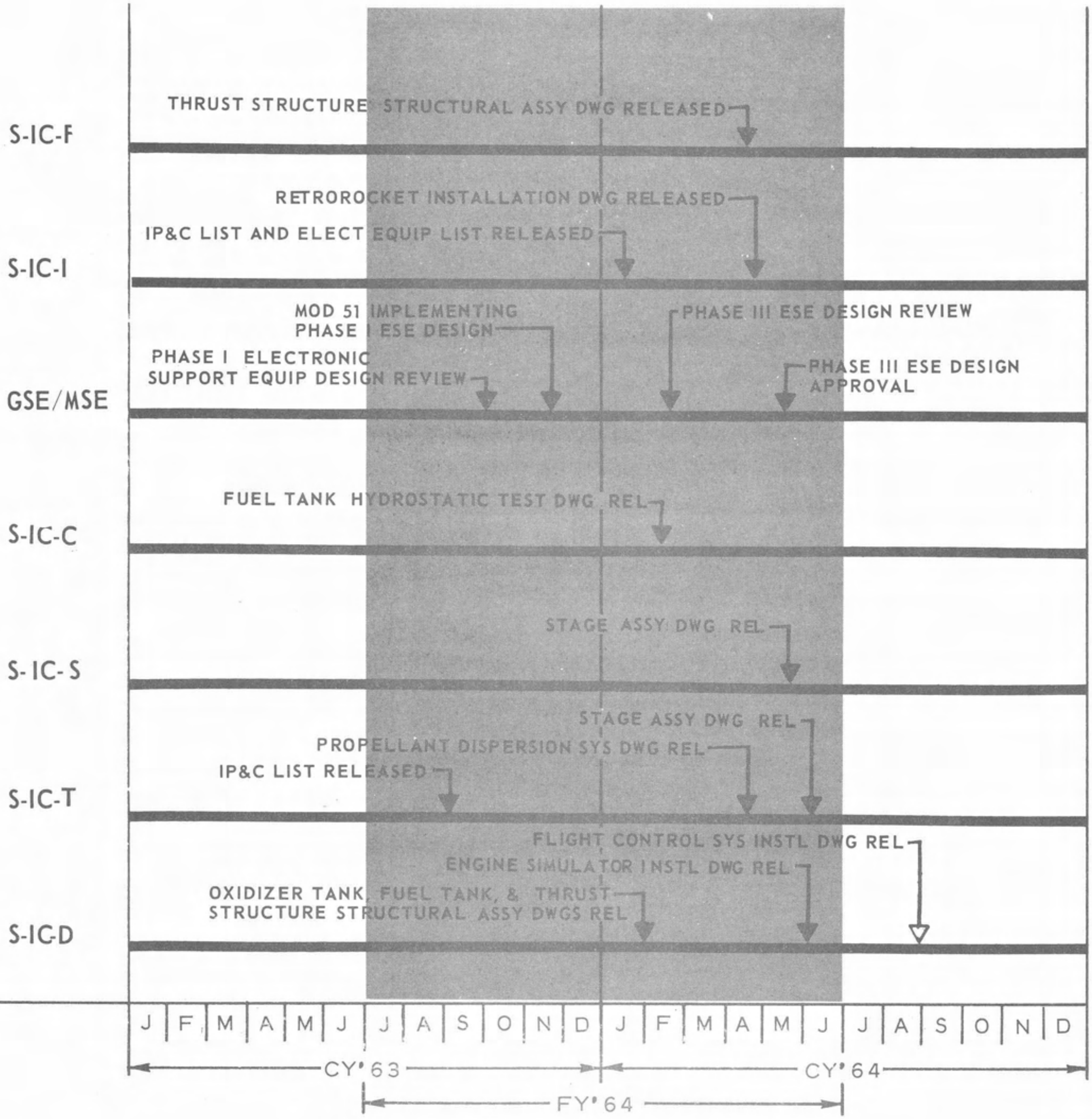


DESIGN AND ENGINEERING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During Fiscal Year (FY) 1964, two major program redirections (NASA/MSFC Plan V and VII) from NASA/MSFC resulted in S-IC stage program schedule changes. This rescheduling reflected changes in phasing as well as an interchange of certain task assignments. Little relief was afforded to the Engineering documentation release schedule, since the S-IC-T release requirements remained unchanged in order to provide early capability for test firings.

The S-IC stage basic design documentation, lagging at the beginning of FY '64, is currently on schedule. The recovery, which was accomplished during the last quarter of the fiscal year, is the result of concentrated effort on the factors that delayed design activity and the streamlining of the design approval process.

On June 4, 1964, the release of the S-IC-T stage assembly drawing completed the basic releases for that test stage. The basic design releases of all major structural elements for subsequent vehicles were also completed during the year.

Change action against released basic design became a substantial design effort during the year. During the last quarter of the reporting period, there was also increased emphasis in technical assistance rendered in solving fabrication problems encountered by NASA/MSFC, Boeing, and the various vendors.

Early in FY '64, release of GSE/MSE drawings was slow because of delays in design criteria approvals. These delays were offset in part by a more detailed design review during the Pre-Phase I and Phase I reviews, making it possible to proceed more accurately and quickly to Phase III or production design releases. This has enabled Boeing to maintain on-schedule status at FY'64 year end.

S-IC STAGE DESIGN

Several variations of the S-IC are being designed by Boeing under specifications and technical direction provided by NASA/MSFC. The configurations being designed and their primary purposes are listed below:

Model	Purpose
S-IC-T	Static test of F-1 engines and engine systems.
S-IC-C	Fuel Tank only—for structural testing.
S-IC-S	All major structural components—for use in structural testing of assembled stage.
S-IC-D	For use in dynamic testing of the assembled Saturn V vehicle. This configuration is further defined under Electrical and Instrumentation Section.
S-IC-F	Facilities checkout at MILA.
S-IC-1 through S-IC-10	Flight vehicles

The progress made on S-IC design and development throughout FY'64 is discussed in the following sections.

DOCUMENTATION

Release of basic design documentation, at the start of the fiscal year, was substantially behind the schedule required to meet hardware program schedules. This documentation was returned to schedule during the second half of the year (Figure I-1). Schedule position was regained by (1) recovery on the design schedule, and (2) reduction of release processing flow time. The design schedule was recovered by concentrated effort in areas where design criteria had caused delayed effort. Release processing time was shortened in March 1964, by reducing flow-time for the approval process, as authorized by Contract Modification 76. Although there were S-IC program schedule changes during the year, there was little effect on documentation release schedules as the S-IC-T schedule was not altered.

Change action against released basic design became a substantial design effort during the year. At the close of FY'64, change documentation release, with only minor exception, was being made in accordance with change commitments established by the joint NASA/MSFC-Boeing Change Board. Documentation has been completed for approximately 200 changes since inception of change action against the S-IC stages. Changes have resulted from design criteria revision, adverse structural test results (intertank), instrumentation requirement additions, and weight saving.

WEIGHT STATUS

There was increasing emphasis during the year on S-IC vehicle weight control and reduction. The first major weight reduction — approximately 4500 pounds — was accomplished during the first quarter through use of a computerized analytical model study of the S-IC thrust structure. The resulting design documentation was issued under Change Action Memo (CAM) 72. Deletion of the requirement for the in-flight LOX dome purge system (CAM 112) shortly thereafter, eliminated 1200 pounds of system weight.

A joint NASA/MSFC-Boeing weight reduction team was established in September 1963, to review and implement weight saving ideas. Under this weight reduction program, eight weight saving changes have been approved by NASA/MSFC to effect an additional total weight reduction of approximately 7000 pounds. The effects of these weight changes are detailed in Figure I-2. Program schedule impact has been minimized by committing the changes to later flight vehicles; however, all presently committed weight reduction changes will be incorporated on vehicles on which payload weight capability will become critical.

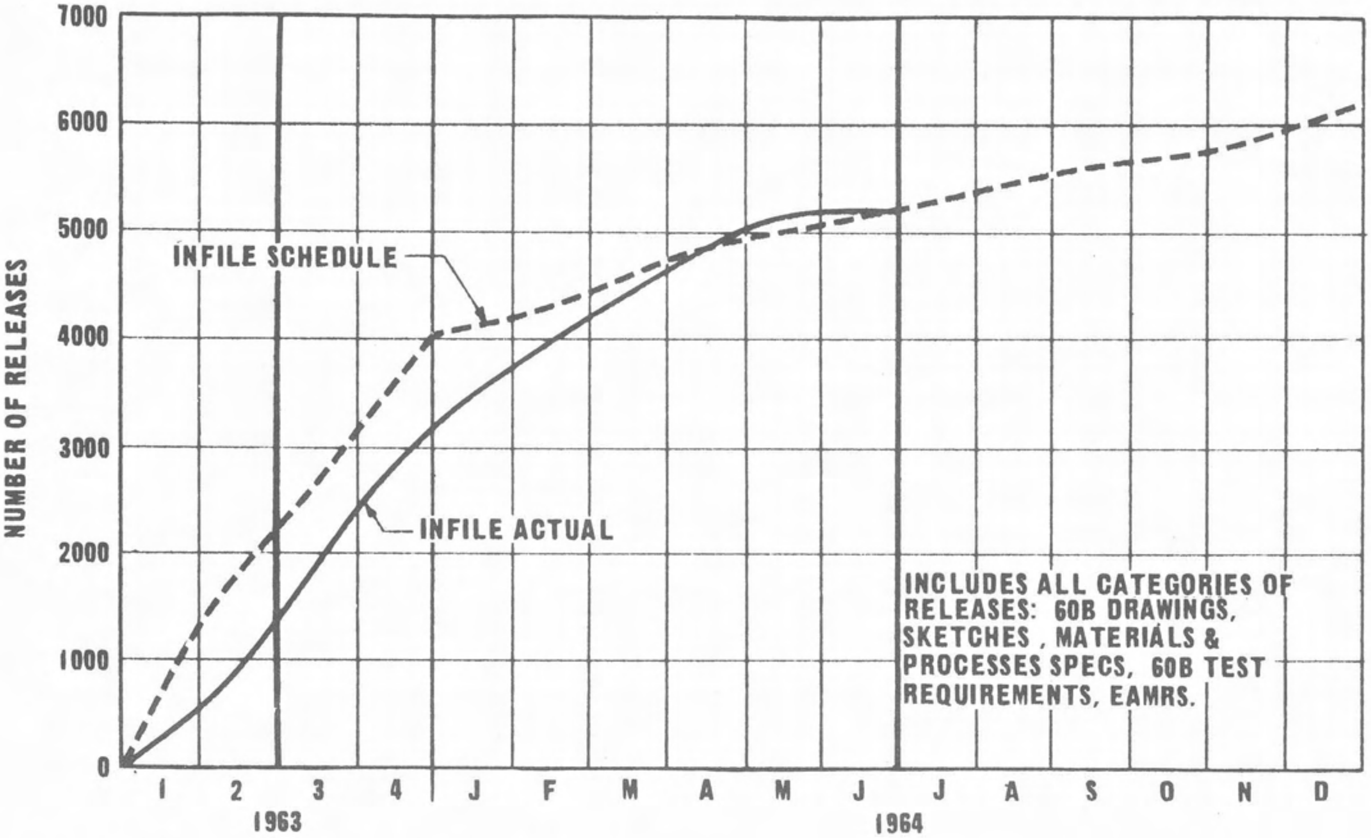
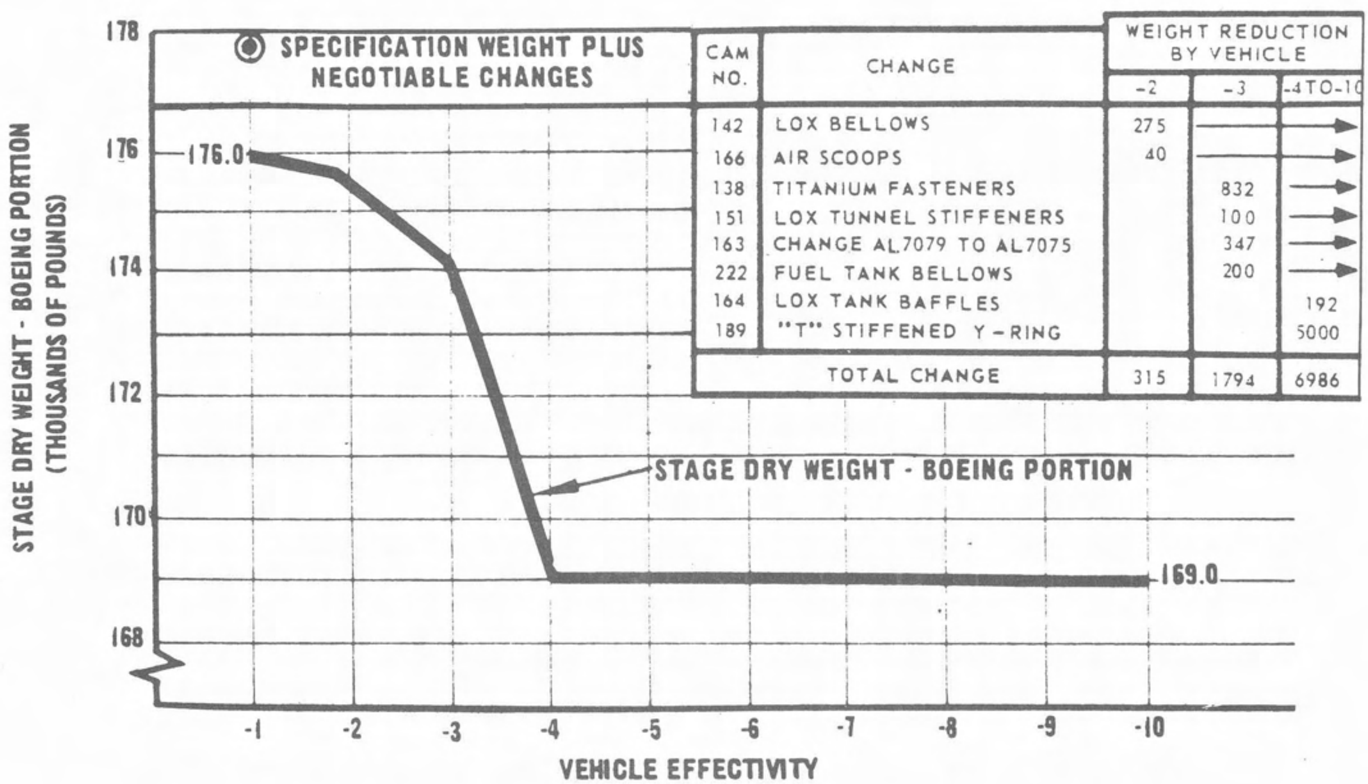


Figure 1-1 - S-IC Stage Basic Release Schedule -- Plan VII



CAM NO.	CHANGE	WEIGHT REDUCTION BY VEHICLE		
		-2	-3	-4 TO -10
142	LOX BELLOWS	275	→	→
166	AIR SCOOPS	40	→	→
138	TITANIUM FASTENERS		832	→
151	LOX TUNNEL STIFFENERS		100	→
163	CHANGE AL7079 TO AL7075		347	→
222	FUEL TANK BELLOWS		200	→
164	LOX TANK BAFFLES			192
189	"T" STIFFENED Y-RING			5000
	TOTAL CHANGE	315	1794	6986

Figure 1-2 - S-IC Weight Reduction Program

The only weight originally specified in Contract NAS8-5608 was the total stage dry weight of 287,000 pounds. To provide a direct basis for evaluation of Boeing weight control performance, a specification allowance for the Boeing-controlled portion of the S-IC was established as 174,282 pounds at a NASA/MSFC-Boeing meeting in March 1964. The specification allowance and the general definition of Boeing responsibility were formalized by Contract Modification 109. The calculated weight for the Boeing-controlled portion of the S-IC at the time of establishment of specification allowance was 172,285 pounds. The weight history of the S-IC-1 is shown in Figure I-3. The effect on weight of changes considered to be negotiable is carried in the specification allowance line subsequent to formal definition of Boeing responsibility.

STRUCTURAL DESIGN

Basic release of documentation for the S-IC-T was completed in early June with the release of the stage assembly drawing. Basic release of all major structural elements for subsequent vehicles was also completed during the last quarter of the fiscal year. The heat shield installations remain to be released, and the stage assembly drawings for S-IC-D and subsequent vehicles will be released following completion of electrical and instrumentation design early in CY'65.

With the completion of most of the basic design activity, emphasis has shifted to change design and technical support of manufacturing, vendors, and the various test activities affecting S-IC structure.

Significant structural design problems were encountered and resolved during the year. The most important of these were a dynamic loading problem and an intertank structural problem.

Early in the fiscal year, analytical studies of stage dynamic loads indicated a possibility that a direct dynamic coupling of transient engine thrust buildup and vehicle release loads would substantially exceed specified load factors for stage structural design. After further study, it was recommended that the stage holddown release mechanism be changed from an instantaneous release device to a system in which holddown restraint is released gradually to avoid sudden application of release loads. This solution was agreed to, and subsequent study, including revised estimates of engine thrust buildup rates, indicated that the holddown mechanism change would eliminate the problem.

A second major problem was encountered during development testing of 1/8-scale models of the intertank structure. The intertank structure consists of a longitudinally corrugated skin with circumferential stiffener rings. Design of the intertank was based on the very

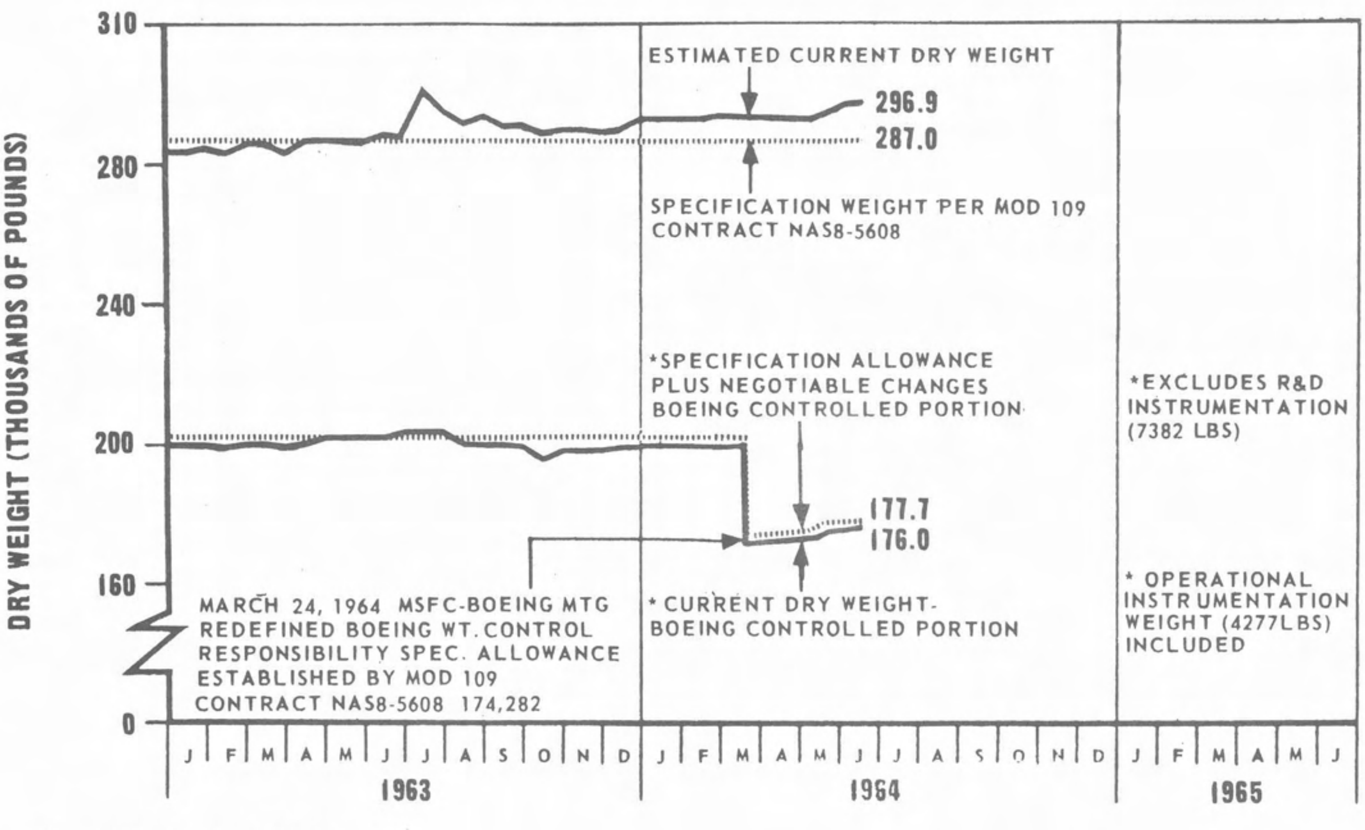


Figure I-3 - S-IC Dry Weight Status

limited experimental data available for this type of structure under compression loading; however, because of the limited data available and because of its questionable applicability to large structures, such as the S-IC intertank, scale-model development testing was essential.

Initial tests during the second quarter of the year resulted in failures at substantially less than the expected load (as applicable to the scale model). Subsequent testing confirmed the early test results.

A change (CAM 207) has been initiated to redesign the intertank in accordance with NASA/MSFC Technical Directives 180 and 211. The intertanks for the S-IC-T, -D, and -S will use the existing design, since these units will not be subjected to flight vehicle loads. The S-IC-1, -2, and -3 intertanks will be a heavier (approximately 2600 pounds) "minimum risk" unit with thicker skins and stronger ring frames. Such an approach is necessary to avoid program schedule delays, since substantial testing is required to establish a minimum weight design of adequate strength.

As presently planned, the S-IC-4 will incorporate a lighter weight design. One intertank of the present configuration and one intertank of the heavy S-IC-1 configuration will be loaded to destruction to provide data for correlation of full-scale and sub-scale tests, and additional sub-scale tests will be utilized to determine S-IC-4 design. An S-IC-4 configuration intertank will also be loaded to destruction to verify its design.

PROPULSION AND MECHANICAL EQUIPMENT DESIGN

Basic release of documentation for the S-IC-T was completed during the last quarter of the year, with the exception of the F-1 engine conversion drawings, which are scheduled for release early in calendar year 1965. Release of all basic drawings for the S-IC-D, -F, -S, and -1 has also been completed. All component, assembly, and subsystem qualification test requirements have also been released.

As with structural design, emphasis has shifted to change design and technical support of manufacturing, vendors, and the test activities affecting propulsion and mechanical equipment.

ELECTRICAL AND INSTRUMENTATION DESIGN

This S-IC-T basic design was completed during the last half of FY '64. Basic release of S-IC-D test instrumentation, cables, and equipment mass simulators was begun following definition of the S-IC-D configuration in February. Approximately 1100 electrical/instrumentation basic drawings remain to be released for the S-IC-D. The remaining release breakdown includes cable assemblies, equipment and cable installations, mass-simulated equipment, brackets, connectors, and other installation details. The general configuration definition to which S-IC-D basic release is being made is described below:

a) The electrical configuration will be the same as the S-IC-1, except that electrical/electronic equipment and transducers will be omitted. Dummy equipment simulating the mass of the actual equipment will be installed for all items weighing over 20 pounds, and for all shock-mounted equipment.

b) Installation provisions will be made for all instrumentation equipment.

c) All electrical cabling will be installed.

d) Except for the engine servo-actuators, propulsion components weighing over 20 pounds will be simulated by dummies. All flight hardware mounting provisions will be included.

During the latter half of the fiscal year the highest priority was assigned to release of documentation for CAM 177, which provides the Systems "A" Basic and the Research and Development Measurement systems for the S-IC-T vehicle. System "A" measurements are defined by NASA/MSFC Document SK10-1596 Revision A, "S-IC-T Static Firing Measurement Requirements." Measurement Systems "A" is a system of transducers which will be wired directly to recorders as the primary instrumentation for data gathering during ground test firings. Over 700 items of electrical and instrumentation documentation have been required by CAM 177. Design work was completed on all items by the first of June and all remaining documentation was completed and in release process at the end of the year.

Responsibility for releasing S-IC-1 through S-IC-10 measurement instrumentation program was transferred from NASA/MSFC to Boeing following NASA/MSFC approval of the S-IC-1 Instrumentation Program and Components (IP&C) list late in the second quarter of the fiscal year. Approval of the IP&C list permitted identification of the instrumentation and electrical configuration for the S-IC-1. Instrumentation program and electrical equipment lists will be released individually for S-IC-2 through S-IC-10, with the various releases scheduled through January 1966. Any change between the instrument list for S-IC-1 and subsequent lists will be implemented by change action to revise affected structures, propulsion, and electrical documentation.

Direction to proceed with design and development of a visual instrumentation installation was received late in the third quarter of the fiscal year by Modification 75 to the contract. The visual instrumentation consists of two television cameras viewing the engine turbo pumps and four ejectable and recoverable movie cameras, two to record liquid movement in the oxidizer tank and two to record stage separation (separation view cameras will be omitted from the S-IC-T). Development was well under way at the end of the fiscal year, with preliminary drafts of procurement drawings for the LOX tank optical system (fiber optics bundles, lenses, etc.) and the photo-optics timer specification distributed to potential suppliers. Preliminary drafts of procurement drawings for other components are nearing completion. The NASA/MSFC breadboard of the photo-optics strobe light has been received at Michoud and is under test.

Some difficulties and delays were encountered during the year in the development of the various propellant measuring systems for the S-IC. These systems consist of the fuel and LOX loading probes (for determination of loading completion), the LOX and fuel engine cutoff sensors, and the R&D instrumentation for liquid level and fuel slosh measurement. All of these systems are to be installed in the S-IC-T. Despite the delays encountered, all are expected to be delivered in time to be installed in the S-IC-T, and all parts are expected to be qualified before the S-IC-T is placed on the test stand.

GSE/MSE DESIGN

Simulated flight tests and static firing tests of the S-IC stage will be accomplished primarily through application of automatic digital programing and evaluation techniques. Ground support equipment (GSE) will evaluate the performance and integrity of a completely assembled stage at R-Qual and R-Test. Manufacturing support equipment (MSE) will accomplish the same goals at Michoud and the Mississippi Test Operations (MTO). Tests conducted on the S-IC stage will be fully automated except when automation is impractical for economic or technical reasons. Automated testing is the goal to which engineering design effort is being directed. Boeing design concepts developed early in the program were reviewed during the first half of the reporting period; subsequent redirection culminated in Modification 51 to Contract NAS8-5608 on November 21, 1963.

DOCUMENTATION RELEASE

Early in FY '64, release of drawings was slowed as a result of delay in the approval of the design criteria. These delays were offset, in part, by a more detailed design review. By achieving greater definition of detail during the Prephase I and Phase I (System Design Concept) reviews, it was possible to proceed more accurately and quickly to Phase III (Production Design) releases and maintain schedule (Figure I-4). Contract Modification 51 directed incorporation of the Phase I design changes. This was followed by the Phase III design submittal on February 25, 1964. NASA/MSFC gave approval on May 15, 1964 based on incorporation of comments resulting from the design review. The majority of comments fell within the contract scope and did not significantly affect overall design. Action has been initiated to incorporate all items which were within the scope of the contract. Change Action Memos have been initiated for nine recommended design improvement items which are beyond the scope of the contract.

On June 2, 1964, Boeing was given limited direction to resume work on the MTO design, temporarily suspended in December 1963. Interim funding was provided until Modification 102 officially became part of the

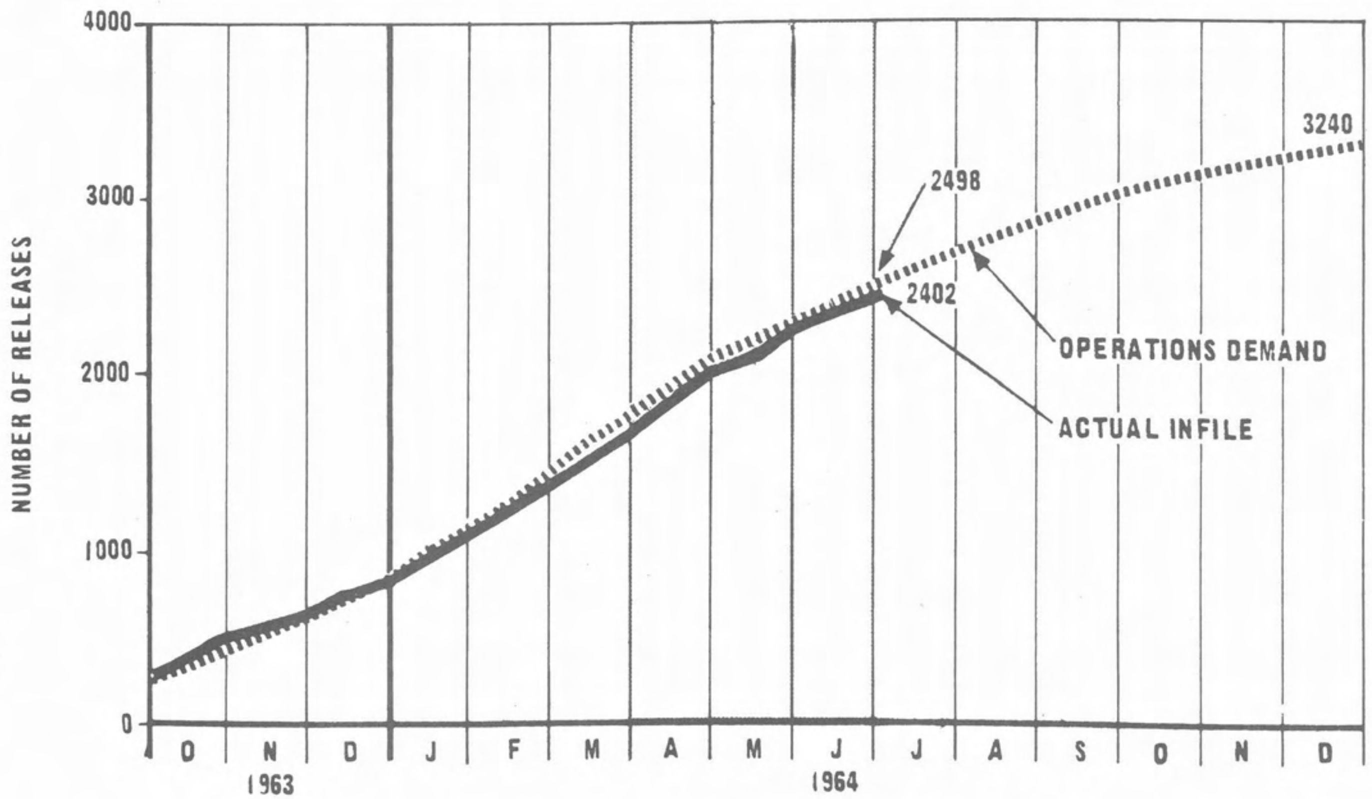


Figure I-4 - Engineering Basic Release Schedule-- GSE/MSE

contract. Work is now in progress detailing the design requirements for the MTO test and checkout complexes.

TEST AND CHECKOUT EQUIPMENT DESIGN

Substantial changes have been made to the original concept of the test and checkout complexes during the year. These changes resulted from the Prephase I and Phase I design reviews and had a major impact on the degree of automation and capability of the test and checkout complexes. Some of these changes are described briefly below.

The original test and checkout equipment concept called for centralized control of testing. This has been modified to add provision for switching test control to test operators at the individual test stations within the test and checkout complex.

Another expansion of capability has been incorporated in the area of data recording. Originally, records were to be stored within the computer for printout later. The new design retains computer storage and adds the ability to store data in direct writing recorders.

Capability of the mechanical test control equipment has also been increased. In the original concept, testing could be conducted on a limited one-at-a-time basis. The expansion of equipment adds flexibility and permits simultaneous testing of components.

Equipment sharing has been eliminated. At the Michoud complex, instead of using one computer plus a switching distributor to control testing on two vehicles, inidividual computers will be used in the testing of each vehicle. These are representative of the Prephase I and Phase I design changes. In general, test and checkout capabilities have increased with a necessary accompanying increase in equipment design effort.

The test and checkout complexes (Figure I-5) are composed of a control and monitor station, a computer station, a mechanical test station, a data systems test station, the related interconnection equipment, checkout calibration, and maintenance equipment. Test personnel direct and control the execution of tests performed by the digital computer. Computer codes allow full automatic and semi-automatic operations as well as local control from the test stations. Each test station contains the stimuli generators and control circuitry necessary to test the stage system with the computer. Error detection and fault isolation techniques are employed to make more effective usage of the test equipment and to reduce operating time on stage systems.

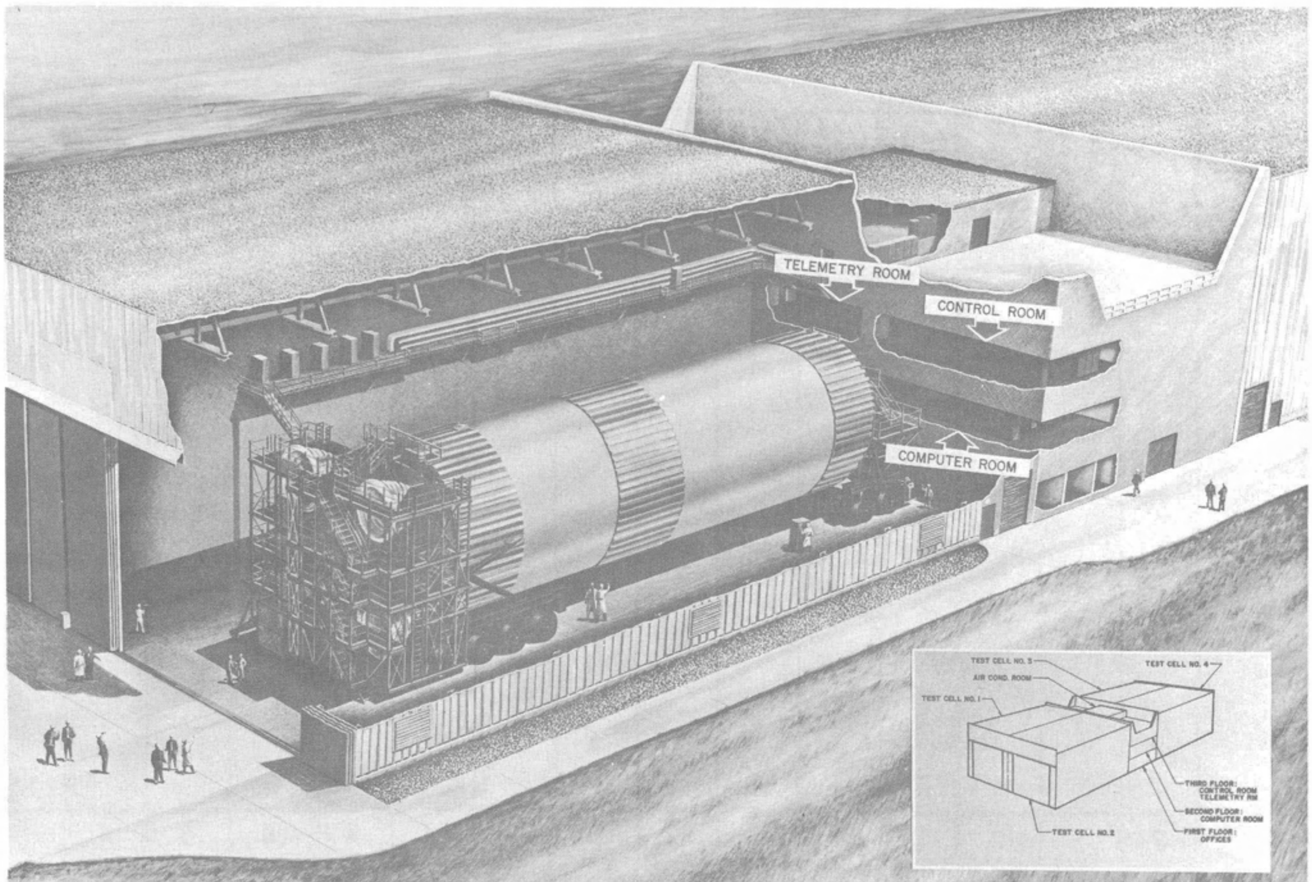


Figure I-5 - Test and Checkout Complex

Control and Monitor Station

The Control and Monitor Station (Figure I-6) includes the control and monitor console, the audio communication equipment, the closed-circuit TV equipment, and the cathode ray tube (CRT) interface and control logic equipment. The console provides control of the computer-directed test system and furnishes stage and test system status information. Design of all portions of the console has been completed, with assembly drawings and wiring schematics released for procurement of equipment.

The CRT display incorporated in the console, provides display capability for subsystem testing, troubleshooting, maintenance, and for presentation of supplementary information during normal testing (Figure I-7). Preliminary design of the CRT was completed during the first quarter of this reporting period along with construction of a feasibility model. Since then, checkout of the model has been completed and demonstrations of its capabilities have been made to NASA/MSFC personnel on several occasions. Late in April, authorization to proceed with the Boeing-Raytheon CRT display system was received for the NASA/MSFC Quality Division and Michoud Test and Checkout Complexes, and a contract was let to Raytheon on June 3, 1964, to proceed with production of five units.

The audio communications systems consist of the general area paging system, local area paging system, and the intercommunications system. Design of each of these systems has been completed, specification drawings have been released, and equipment is now beginning to arrive at Michoud from suppliers.

A closed-circuit TV system is provided for each test cell to enable the test engineers to monitor activity on and around the stage. Design in this area is 95 percent complete, with some equipment already received, functionally tested, and prepared for storage until ready for assembly into the system.

Computer Station

The Computer Station (Figure I-8) utilizes the RCA-110A digital computer. Under control of its internal program and guided by the test conductor, the computer generates digital words, analogs, and discretes as required to program the individual test stations and stage under test.

Design of the Computer Station, including the equip-

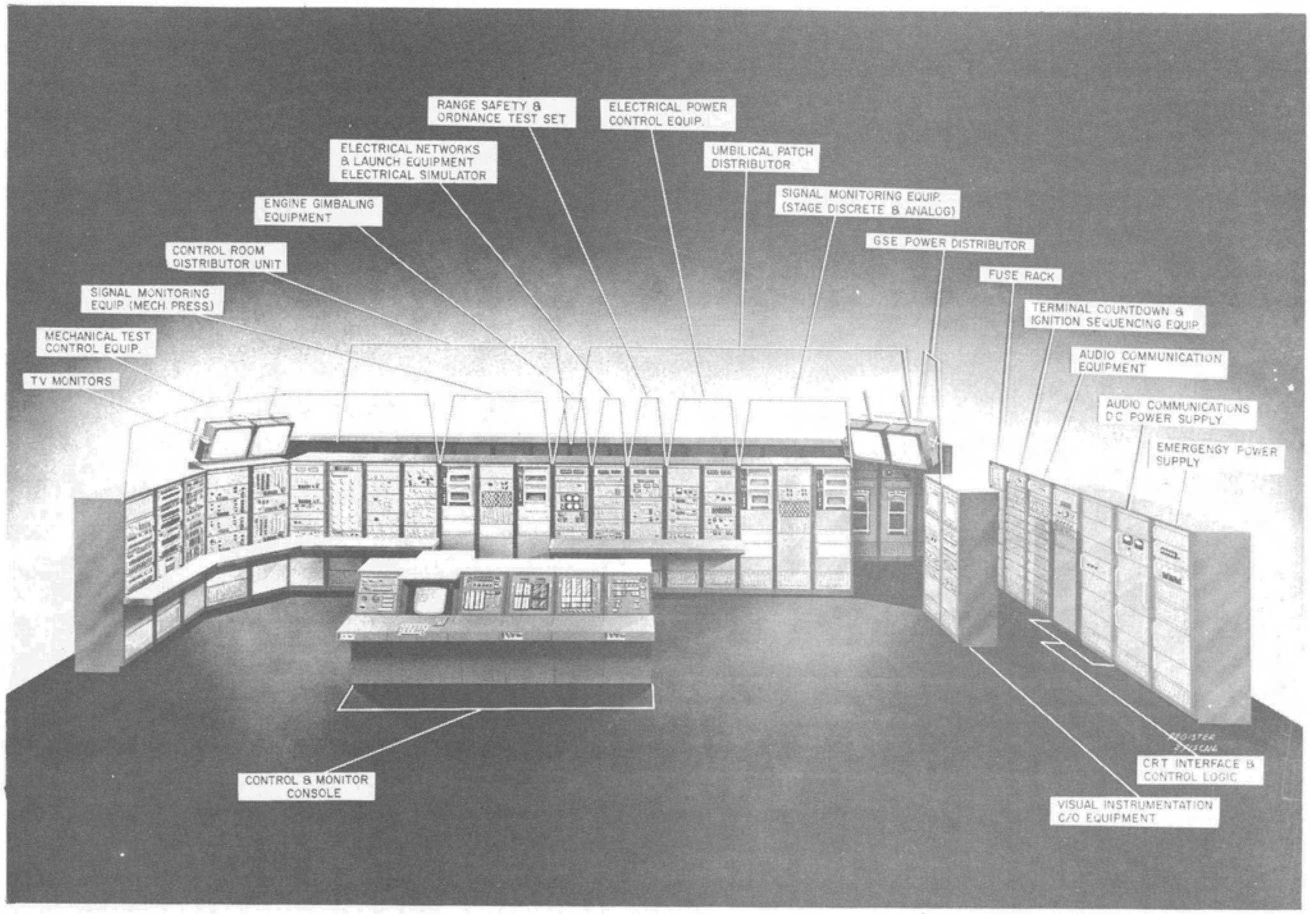


Figure I-6 - Control and Monitor Station

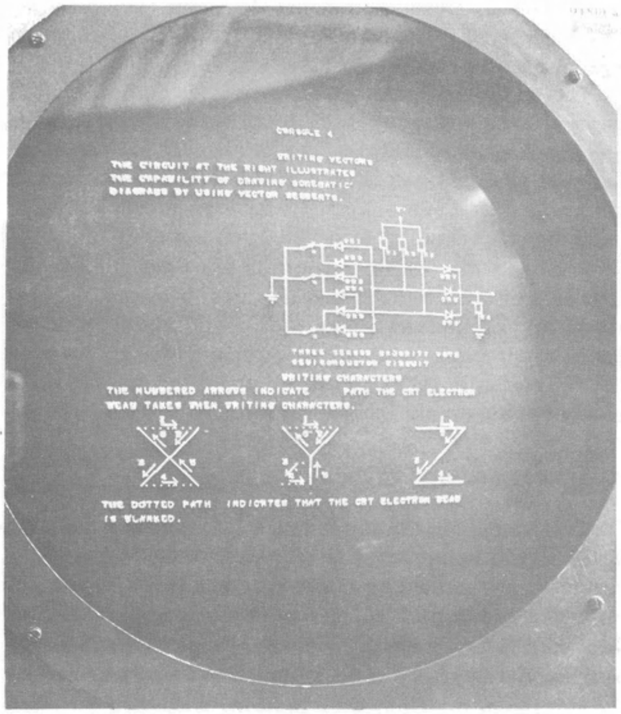


Figure 1-7 - Typical CRT Presentation

ment necessary to generate special inputs required by the ground computer system and that equipment necessary to ensure computer interface compatibility with other test and checkout equipment, has been completed. Information recently received from RCA reveals significant differences in the 110A computer interface. Modifications are necessary to include additional interface circuits. Redesign will be initiated as soon as firm data is obtained from RCA. Specification and assembly drawings have been released for some of the associated equipment, and procurement is under way.

The Boeing Company has been using NASA/MSFC computer facilities a few hours each week for program development, training, and coding of automatic test procedures and processors including the MSFC specified Acceptance Test or Launch Language (ATOLL) translator . Use of the NASA/MSFC facilities has been an interim measure necessitated by the lack of an RCA 110A computer. NASA/MSFC has since supplied an RCA 110 computer which was installed at the Boeing Engineering Evaluation Laboratory in Huntsville. Installation took place in late May and checkout continued through early June. On June 11, the computer became operational. Shortly after that, the CRT display feasibility model was interfaced with the computer for continued developmental research.

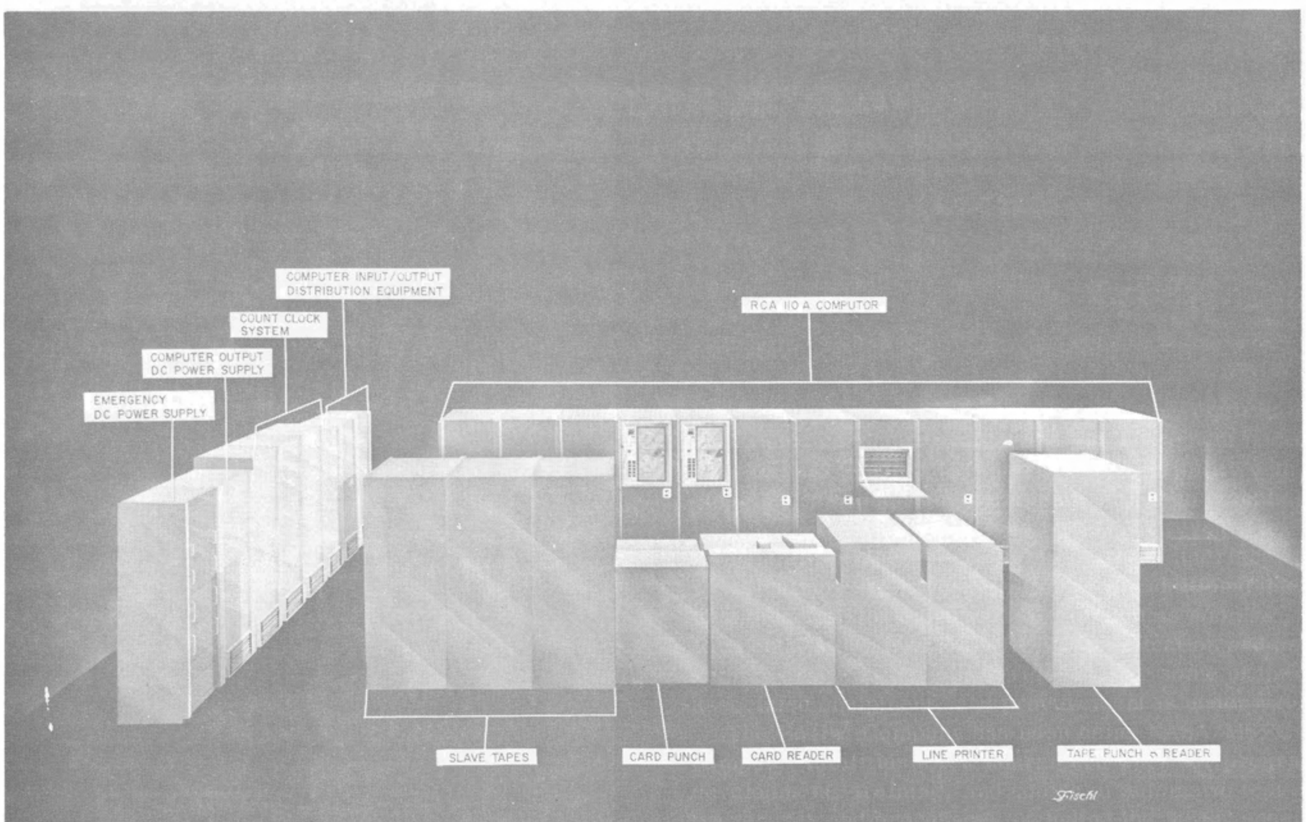


Figure 1-8 - Computer Station

In December 1963, Modification 59 was incorporated, adding timing equipment for the Michoud computer stations. The NASA/MSFC design has been completed and the Boeing revised drawings are in process of being released.

Electrical Power Station

The Electrical Power Station consists of the 60-cycle AC ground power supply, the stage DC ground power supplies, the overall test battery supply, emergency DC power supplies, the GSE DC power supply, the computer output DC power supply, and the audio communication equipment power supply. The overall test battery supply provides ground power to the stage battery bus in lieu of vehicle battery power during test and checkout. In the event that power from a DC ground supply is lost, an emergency DC power supply will provide power to the stage and to essential test and checkout control equipment necessary to place the stage in a safe condition and proceed with an orderly shutdown. The GSE DC power supply provides the 28-volt DC power required by the test and checkout equipment for switching, indication, display, and control functions necessary to program the electrical and the mechanical test stations, either in the manual or automatic mode. The computer output DC power supply provides the minus 28-volt DC power required to operate relays in the computer discrete output distribution rack. Power required by the audio communication equipment for the entire test complex is provided by the audio communication equipment power supply.

Design for the Electrical Power Station has been completed. Specification drawings have been released and contracts have been let for all power supplies. Acceptance test procedures are being prepared, with the first of the tests beginning at the end of June 1964. Design of the 400-cycle AC ground power supply was cancelled with the decision to substitute an ignition system, operating from a 750-volt AC system, for the S-IC-F, -D, and flight stages. The S-IC-T will use a 28-volt DC pyrotechnic ignitor.

Electrical Test Station

The Electrical Test Station consists of the range safety and ordnance test rack, the range safety transmitting antenna equipment, the exploding bridge wire (EBW) pulse sensor equipment, the electrical networks test sets, the electrical power control equipment, the signal monitoring equipment, and the terminal countdown and ignition sequencing equipment.

The stage range safety and ordnance systems are tested after they are installed in the fully assembled S-IC stage. The EBW pulse sensor equipment analyzes the voltage output of the EBW firing units, and determines if the firing unit is acceptable. The electrical networks test rack consists of the local control panel, the upper stage electrical networks substitute, the switch selector control equipment, the launch equipment electrical simulator, the emergency detection system checkout equipment, the engine gimballing equipment, and the portable engine gimballing equipment. The upper stage electrical networks substitute provides all the necessary terminations and control signals normally provided to the S-IC stage by the upper stages. Switch selector control equipment provides signals to program the stage switch selector. Simulation of various launch functions which are not available as part of the factory and pre-static firing checkout procedure is provided by the launch equipment electrical simulator. The emergency detection system checkout equipment checks out the emergency detection system of the S-IC stage. The engine gimballing equipment, both rack mounted and portable, provides signals for testing the engine servo-actuators on the S-IC stage, the stage hydraulic system, and the associated stage electrical wiring. Central control for all major GSE power and GSE stage power is provided by the electrical power control equipment. Signal monitoring equipment is provided to record selected stage pressures and analog signals. The terminal countdown sequencer provides signals, in the proper sequence and time relationships to control the launch functions required during countdown and static firing. The ignition sequencer provides signals in the proper sequence and time relationships to control the ignition and shutdown of the five engines of the S-IC stage.

Design for all portions of the Electrical Test Station has been completed. The major portion of specification and assembly drawings have been released, and procurement of equipment has begun.

Mechanical Test Station

The Mechanical Test Station consists of test and test-related equipment and its control equipment, to provide control and monitor functions for propulsion testing. The station is controlled by the computer to perform mechanical tests which normally consist of the following:

1) Application of turbo-pump heater power, allowing the thermostat to cycle, and evaluation of the results;
2) Performance of all valve operation, timing, and sequencing;
3) Activation of pressure switches, and evaluation of results;
4) Application of pneumatic and hydraulic pressures to the stage, in the sequence necessary to perform overall performance tests, such as simulated launch, cutoff, and abort.

The mechanical test control equipment consists of control and display equipment (switches, indicator lights, sequential displays, and communications equipment) to control the Mechanical Test Station.

The test display and control panel indicates the system under test, test status, malfunction indication,

and control mode. Certain major test parameters are also displayed, such as hydraulic pressure and flow rates, pneumatic supply pressure, and station power supply voltage. Controls include those required for manual control tests and certain emergency or panic stop controls.

The pneumatic supply unit, pneumatic pressure test racks, and flowmeters, provide and control high-pressure helium, nitrogen, or dry air to pressurize and test the fuel and LOX feed systems, the fuel and LOX tanks, and the ullage systems. Design has been completed for the pneumatic equipment, and drawings have been released for procurement and assembly.

The hydraulic power supply units provide hydraulic fluid to the S-IC to provide flow to both the engine start valves and the engine gimballing system. Design for all the hydraulic equipment has been completed, critical design reviews have been held, and the majority of drawings have been released. Design has also been completed on the hydraulic control interconnection equipment.

Data System Test Station

The Data System Test Station (Figure I-9) consists of the digital data acquisition system (DDAS), integrated telemetry ground equipment, RF terminal equipment, remote automatic calibration unit, DDAS tape recorder, instrumentation calibration equipment, telemetry digitizing equipment, and the visual instrumentation checkout equipment. A relatively new technique is being employed in the test and checkout of the Saturn V stages. This is the use of the airborne telemetry system as a ground test tool. The DDAS, a development of NASA/MSFC, makes use of airborne pulse-code-modulation telemetry system components for sampling and encoding data which is then transmitted over a coaxial link via a carrier frequency. This data is used for prelaunch checkout and sent by the DDAS ground equipment to the computer and to various test stations for evaluation. The integrated telemetry ground equipment receives, demultiplexes, and decodes telemetry signals from the stage during factory checkout. The RF terminal equipment serves as a distribution center for all telemetry RF and video signals arriving from the test cells. The stage and its associated ground support equipment incorporates a remote automatic calibration of instrumentation transducers. This system provides a capability to test the measuring transducers required for monitoring functional readiness of the vehicle from a remote position. The instrumentation calibration equipment provides and controls power and calibration signals to the telemetry equipment on the stage. The telemetry digitizing equipment receives the analog out-

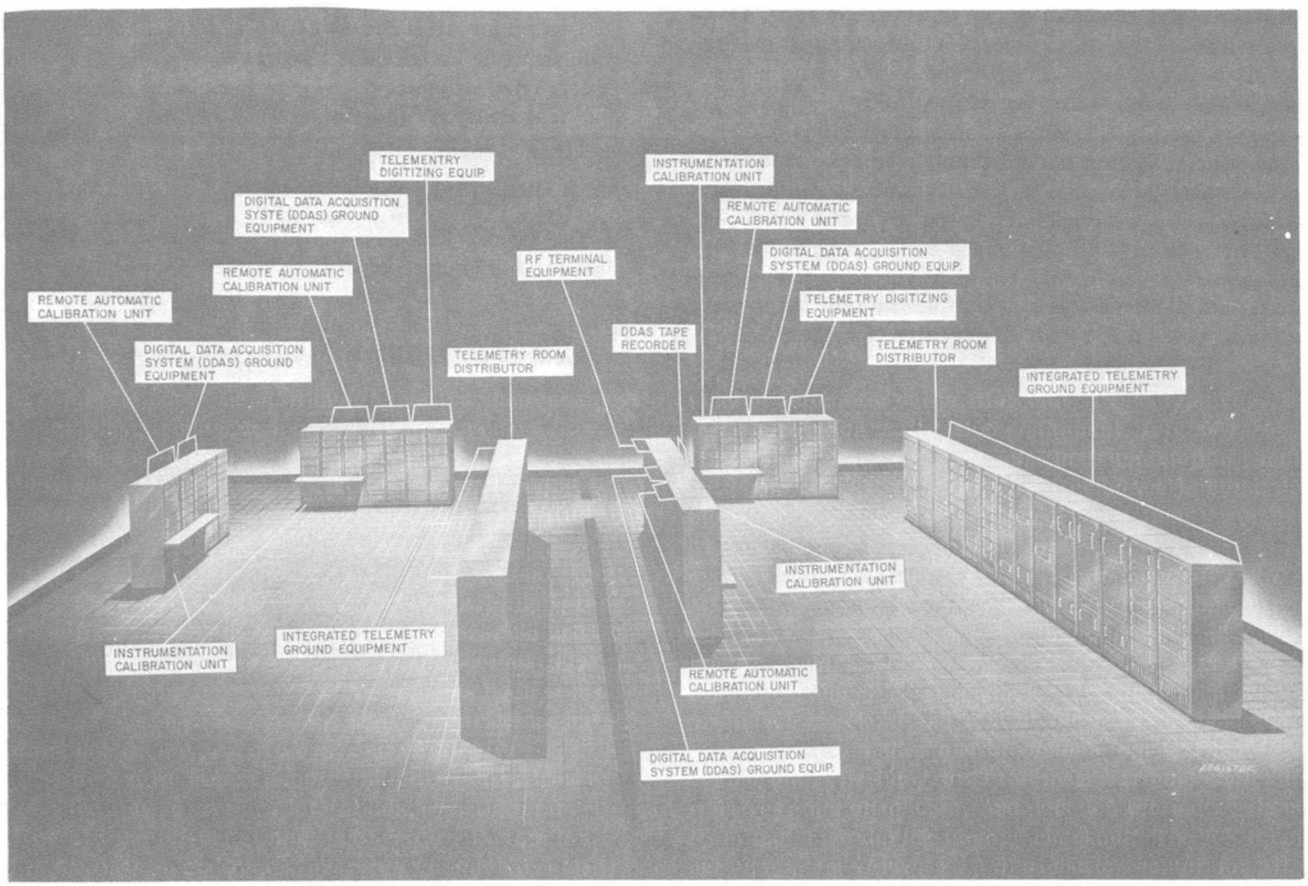


Figure I-9 - Data System Test Station

puts of the telemetry discriminators for digitizing and programing into the stage DDAS format. This permits computer analysis of identical data transmitted via the DDAS and the telemetry measurement links. The TV instrumentation and film camera checkout equipment controls and monitors the application of power and control signals, and evaluates TV picture quality.

Design for the Data System Test Station has been completed. Specification and assembly drawings have been released and vendors have been selected for all items. Fabrication is already in progress at the vendor locations and at Michoud for the Boeing-made items.

Interconnection Equipment

Equipment to interconnect the test and checkout equipment to itself and to the stage provides the capability of transferring electrical power, test instrumentation data, hydraulic power, and pneumatics to and from the S-IC stage during test and checkout. Design of this equipment has been completed and specification and fabrication drawings have been released to initiate procurement and manufacture of parts.

Checkout Auxiliary Equipment

The checkout auxiliary equipment is that equipment which is not a part of the automated test complex, but which is also required to checkout a completely assembled stage. This includes the pneumatic leak detection set to detect pneumatic leaks in the stage propulsion system, an antenna checkout set, stage weighing equipment, area contamination detection equipment to detect RP-1, RJ-1, and trichloroethylene vapors and monitor the content of oxygen in specific locations, internal access equipment, and other assorted equipment for sensing and measuring. Boeing design in this area is in progress and is expected to be complete in the near future. In addition, Modification 36 directed Boeing to design and fabricate two sets of work platforms and bulkhead protection equipment for use at MILA. Design of this equipment is currently in progress.

HANDLING AND TRANSPORTATION EQUIPMENT

Equipment required to move and position the stage and its components during assembly and test consists of the forward handling ring, the stage attach fittings, the fin and fairing cradles, retrorocket handling equipment, and component handling equipment. The forward handling ring (Figure I-10) provides a method for raising or lowering the S-IC stage to the vertical or horizontal position, and enables the assembled stage to be towed on the stage transporter. Final assembly of the initial forward handling ring was begun during the first quarter, with completion and testing occurring during the second quarter. Testing revealed inadequacies in the towing beam, necessitating redesign of that portion. The modified version of the handling ring, incorporating the redesigned towing beam, completed all testing satisfactorily, and was shipped to NASA/MSFC in the early part of February 1964. A second handling ring has since been completed and shipped to NASA/MSFC for use with the weight simulator (Figure I-11) and handling of the S-IC stages to be assembled and tested there. Design for the stage attach fittings and the fin and fairing cradles has been completed, with design of the retrorocket handling equipment and component handling equipment to be completed in the near future. Design is also in progress for the stage pressure control and monitor system that will maintain positive pressure in the fuel and LOX tanks during transportation of the stage.

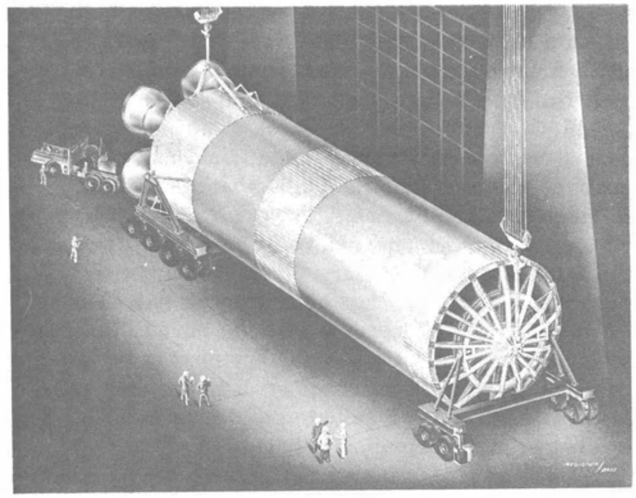


Figure I-10 - Forward Handling Ring With Stage

A listing of the major handling and transportation equipment of Boeing design is shown in Part VIII of this report.

OPERATING AND SERVICE EQUIPMENT

Basic release on all umbilical assemblies including umbilical plates, ground carriers, simulators, and substitutes was completed in April 1964. Shortly after,

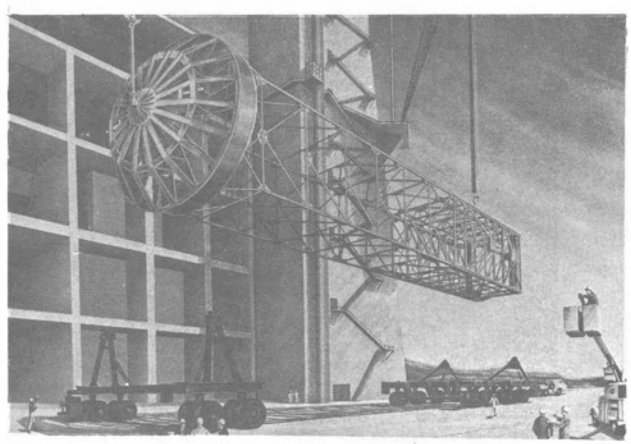


Figure I-11 - Forward Handling Ring With Weight Simulator

on May 26, 1964, the unqualified first article aft No. 1 ground carrier assembly, the aft vehicle skin panel assembly, and the aft flight assembly were delivered to NASA/MSFC.

During the reporting period, Modifications 34 and 35 were received for umbilical equipment to be used at the Merritt Island Launch Area. Modification 34 called for Boeing to design and build four sets of pneumatic equipment for the Saturn V launcher umbilical tower. Phase I approval has been granted by NASA/MSFC, and work is proceeding with the Phase III portion. Modification 35 required the design of umbilical carriers, plates, and associated equipment. Design in this area has been completed, and drawings have been released for fabrication of parts.

MECHANICAL AUTOMATION BREADBOARD (MAB)

During the second quarter of this reporting period, Boeing received Modification 52, calling for design of the MAB (Figure I-12). Modification 94 directed Boeing to manufacture the MAB. The MAB is intended to prove out the automated mechanical checkout concept, and to provide a checkout of the stage peculiar mechanical GSE for the S-IC stages. By utilizing flight equipment, including one F-1 engine, a complete fuel and LOX delivery system, a control pressure system, and limited purge system components, stage systems are duplicated for checkout of the associated GSE. The F-1 engine and four electrically simulated engines will be gimballed and subjected to simulated flight loads. The engine will also be capable of accepting all automated prestart and testing operations. Fuel and LOX tank ullage space will be simulated, and pressurization will be effected as necessary during fuel and LOX loading checkout and launch. Fill and drain functions will be simulated by timing devices in conjunction with operational hardware.

Design of the fuel, LOX, and control pressure/purge subsystem were released to NASA/MSFC for review and approval. Also released were preliminary data on the F-1 engine, hydraulic subsystem, and interconnection equipment Design comments have been received from NASA/MSFC and are being incorporated into the hardware design.

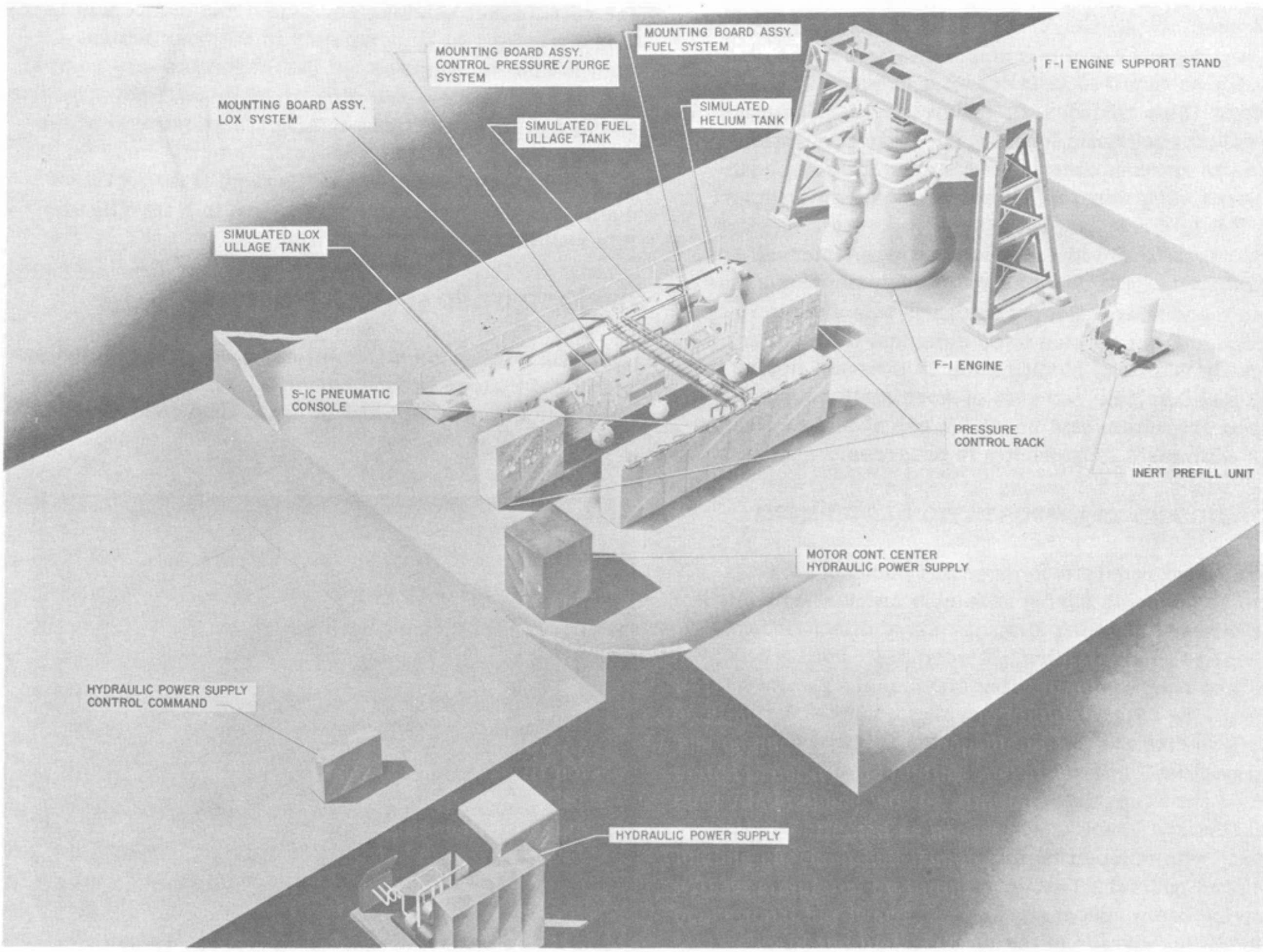
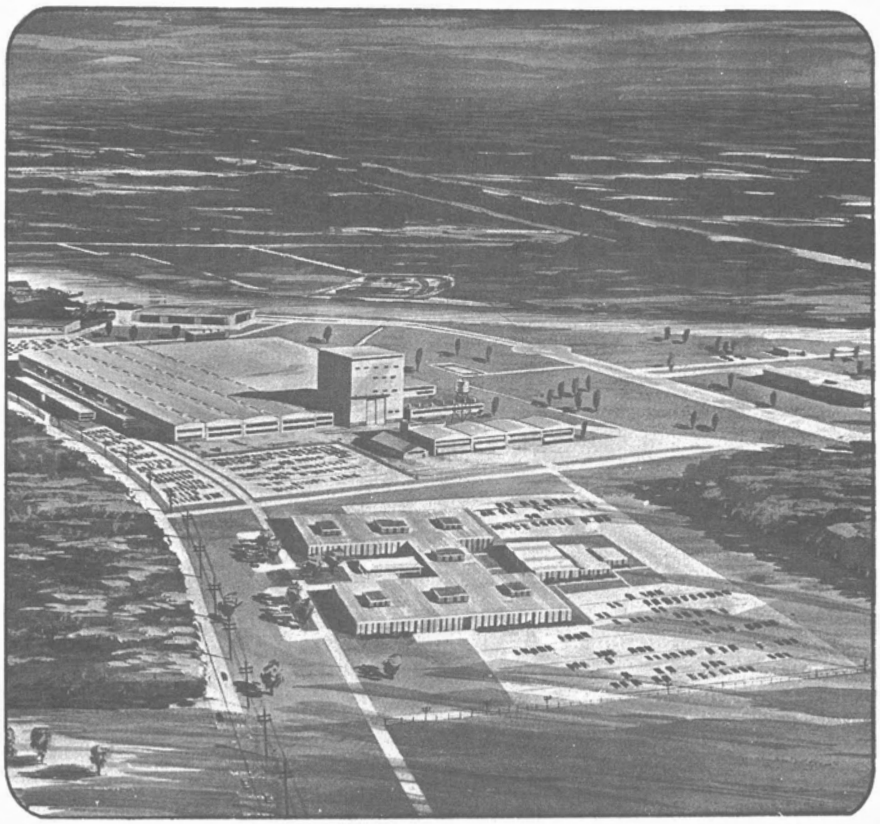
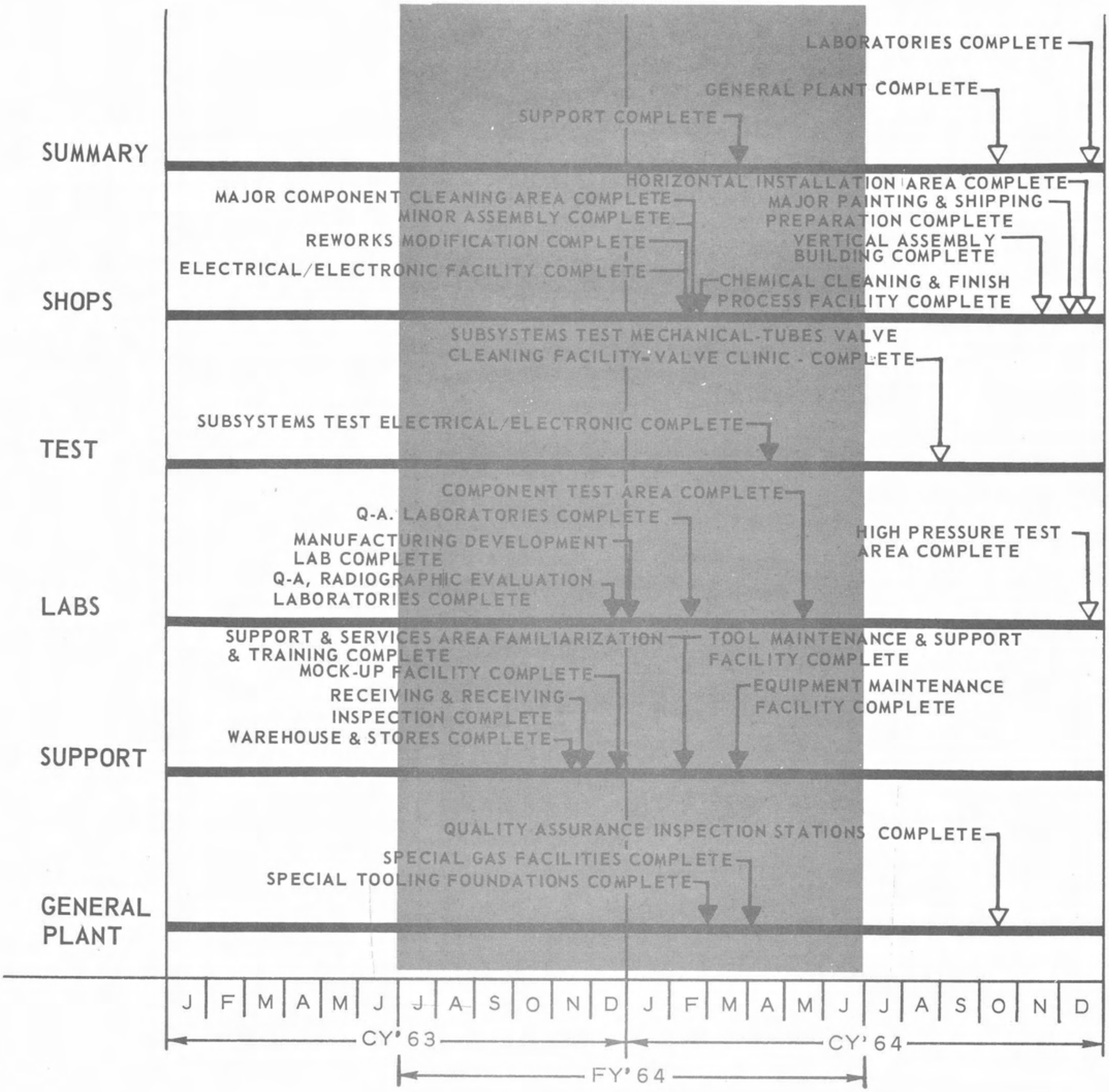


Figure I-12 - Mechanical Automation Breadboard Mockup

II



FACILITIES PLANNING AND ACTIVATION


LABORATORIES COMPLETE
GENERAL PLANT COMPLETE
SUPPORT COMPLETE
SUMMARY
HORIZONTAL INSTALLATION AREA COMPLETE
MAJOR COMPONENT CLEANING AREA COMPLETE
MAJOR PAINTING & SHIPPING PREPARATION COMPLETE
MINOR ASSEMBLY COMPLETE
REWORKS MODIFICATION COMPLETE
VERTICAL ASSEMBLY BUILDING COMPLETE
ELECTRICAL/ELECTRONIC FACILITY COMPLETE
CHEMICAL CLEANING & FINISH PROCESS FACILITY COMPLETE
SHOPS
SUBSYSTEMS TEST MECHANICAL-TUBES VALVE CLEANING FACILITY-VALVE CLINIC - COMPLETE
SUBSYSTEMS TEST ELECTRICAL/ELECTRONIC COMPLETE
TEST
COMPONENT TEST AREA COMPLETE
Q-A. LABORATORIES COMPLETE
MANUFACTURING DEVELOPMENT LAB COMPLETE
HIGH PRESSURE TEST AREA COMPLETE
Q-A, RADIOGRAPHIC EVALUATION LABORATORIES COMPLETE
LABS
SUPPORT & SERVICES AREA FAMILIARIZATION & TRAINING COMPLETE
TOOL MAINTENANCE & SUPPORT FACILITY COMPLETE
MOCK-UP FACILITY COMPLETE
EQUIPMENT MAINTENANCE FACILITY COMPLETE
RECEIVING & RECEIVING INSPECTION COMPLETE
WAREHOUSE & STORES COMPLETE
SUPPORT
QUALITY ASSURANCE INSPECTION STATIONS COMPLETE
SPECIAL GAS FACILITIES COMPLETE
SPECIAL TOOLING FOUNDATIONS COMPLETE
GENERAL PLANT
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

Significant progress toward total activation of the facilities complex at Michoud was made during fiscal year 1964, in preparation for full-scale assembly of both ground test and flight stages.

NASA/MSFC and Boeing personnel held discussions during the initial portion of the reporting period to establish mutual agreement on the use of interim and partial facilities in addition to other workaround techniques required to support Plan Va schedule.

Boeing subcontractors experienced an electricians strike during the third quarter of CY '63. This hampered facilities activation efforts but the use of partial and interim facilities lessened program impact and allowed Boeing to continue its support of NASA/MSFC ground test requirements in an orderly manner. The completion of Phase V of special tooling foundations was accomplished during this quarter.

During this fourth quarter of CY '63, six facilities were activated. They included: the Receiving and Receiving Inspection, Quality Assurance Radiographic Evaluation Laboratories, mockup facility, tank farm, warehouses and stores, and special tooling foundations—Phase VI. The activation of such facilities reduced the need for interim and partial facilities.

The change in program schedules from NASA/MSFC Schedule Plan V to Plan VII highlighted the commencement of the first quarter (CY '64). The change from Plan V to Plan VII as related to facilities activation impact consisted of changes in demand dates and resulted in subsequent schedule revisions for some facilities.

The user demand dates of five facilities were changed as a result of the transition from Plan V to Plan VII. This resulted in revisions to facilities activation schedule requirements.

Facility	Demand Dates Plan V	Demand Dates Plan VII
Major Component Cleaning Facility	10-15-63	2-17-64
Engine Buildup	8-3-64	11-1-64
Horizontal Installation	11-16-64	1-14-65
Major Painting & Shipping Preparation	7-1-64	9-15-64
Stage Test Positions 1, 2, 3, and 4	8-1-64	10-1-64

Significant progress was realized during the first quarter of CY '64, with the continuing activation of complete facilities and the corresponding reduction in partial and interim facilities. Through the combined efforts and discussions between NASA/MSFC and Boeing, funding problems were overcome on the stage test facility and Phase II construction activities for this facility were initiated. The Tool Maintenance and Support facility, Familiarization and Training area, Support and Services areas, and the Equipment Maintenance Facility were completed during this period, thereby completing the support areas activation for the Michoud Complex. In addition, five facilities in the Shop category were completed. They include Chemical Cleaning and Finish Process Facility, Major Component Cleaning Area, Electrical/Electronic Facility, Rework and Modification Facility, and Minor Assembly. The following facilities within the Lab category were also completed: Manufacturing Development Lab, the remaining Quality Assurance Labs, and the Component Test Materials and Process Lab. During this same period, Phases VII and VIII of Special Tooling Foundation were also completed.

Late in the first quarter of CY '64, NASA/MSFC and Boeing concentrated on eliminating potential stage delivery impact items which were resulting from funding problems on the completion of construction of the Vertical Assembly Building, and problems of definition of criteria for the Major Painting and Shipping Preparation facility.

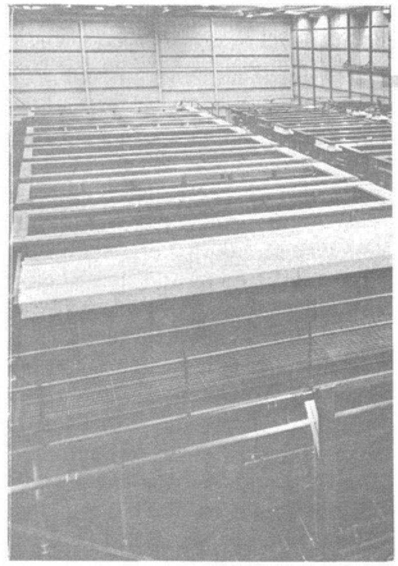
During the second quarter of CY '64, the funding problem for the completion of the Vertical Assembly Building was resolved and construction work was started on May 5, 1964, with a scheduled completion of November 18, 1964. A firm definition of criteria was established for the Major Painting and Shipping Preparation Facility and the design is scheduled to be complete on August 7, 1964 with the total facility completion scheduled for December 11, 1964.

Nine construction contracts were completed during the second quarter of CY '64, with eight contracts continuing in work and four contracts pending NASA/MSFC approval as of July 2, 1964.

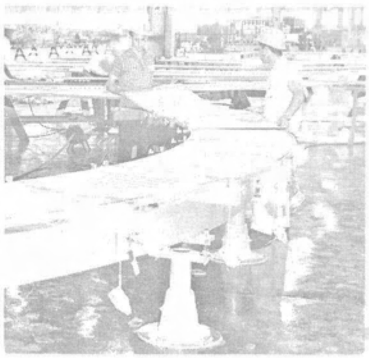
Facilities activated during the same quarter include Subsystems Test Electrical/Elctronic Facility, and Phase I of the Stage Test Facility under the Test category. Component Test Propulsion and Mechanical Lab and Structural Test were completed in the Laboratories category. In the General Plant Area, Special Gas Facilities was also completed. These achievements have reduced the use of interim and partial facilities and accomplished another milestone toward total completion of the Michoud Complex

It has been established that the impact to stage deliveries has been minimized by the use of interim and partial facilities in operation or work-around methods. The cumulative effect of utliizing interim and partial facilities, and a large number of work-around methods, could delay scheduled deliveries of S-IC stages.

During fiscal year 1965 it is predicted that the remaining facilities will be completed: Horizontal Installation Facility, Engine Buildup Facility, and the Major Painting and Shipping Preparation Facility and the Vertical Assembly Building in the Shops category. Also the High-Pressure Test Facility and Quality Assurance Inspection Stations in the Laboratories area will be completed. Subsystems Test Mechanical, and Stage Test Facility Phase II are the remaining facilities to be completed in the Test category.

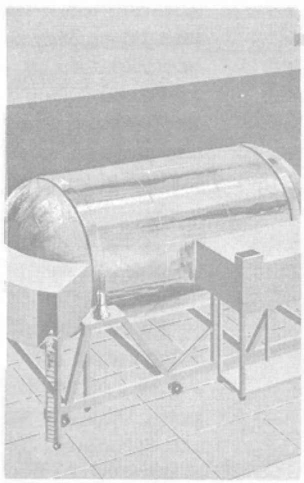


Chemical Cleaning and Finish Process Facility

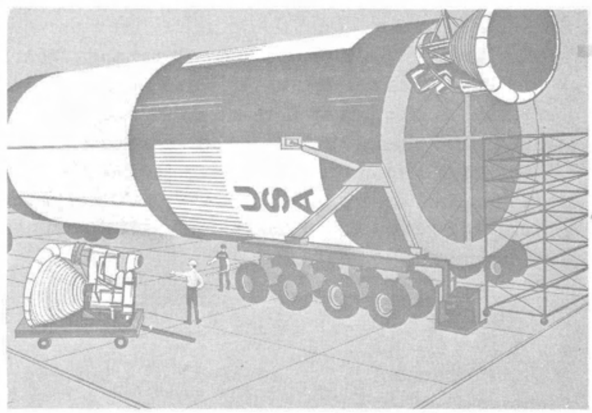


Minor Assembly

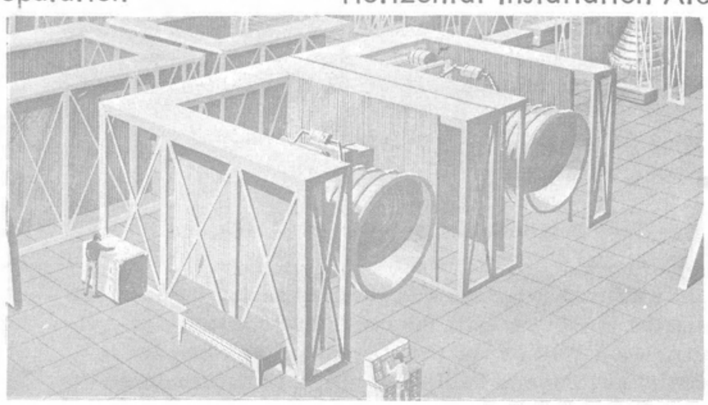
FACILITIES/SHOPS



Major Painting and Shipping Preparation

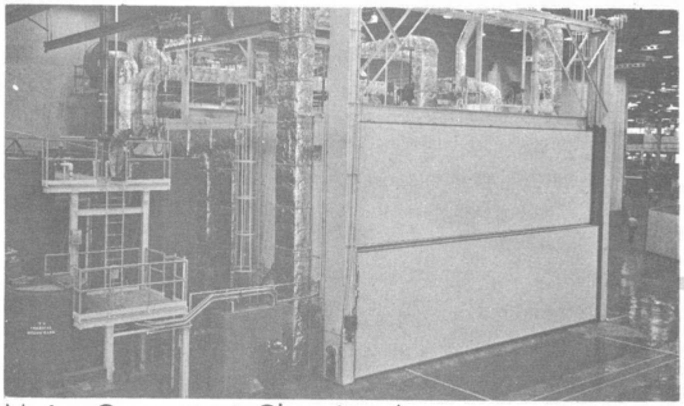


Horizontal Installation Area

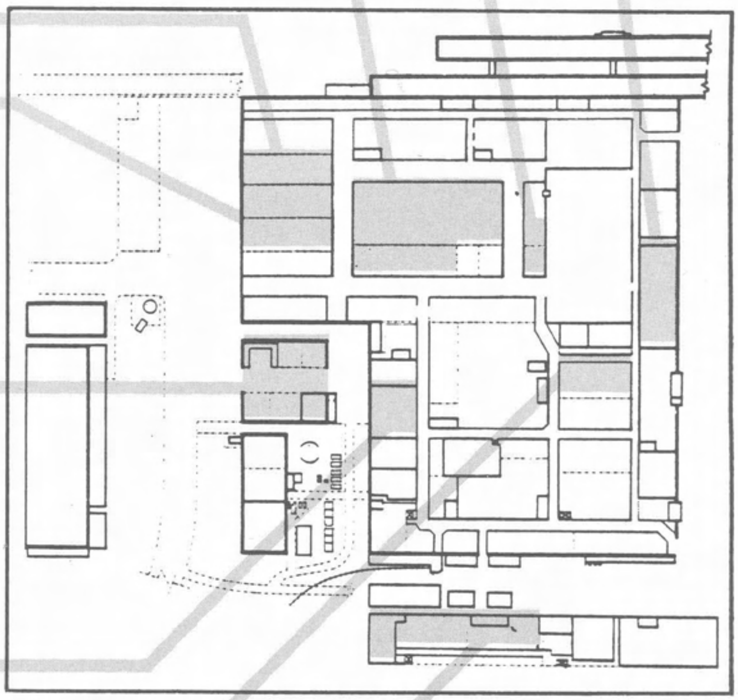


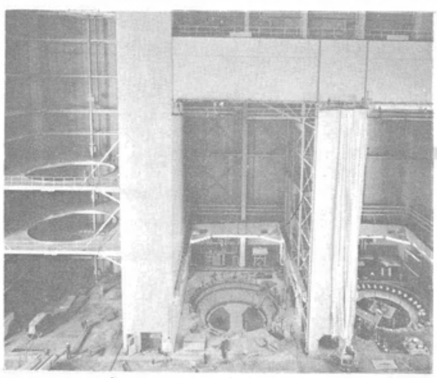
Engine Build-up Facility

Electrical/Electronic Facility



Major Component Cleaning Area





Vertical Assembly Building

Rework
and Modification

ELECTRICAL/ELECTRONIC FACILITY

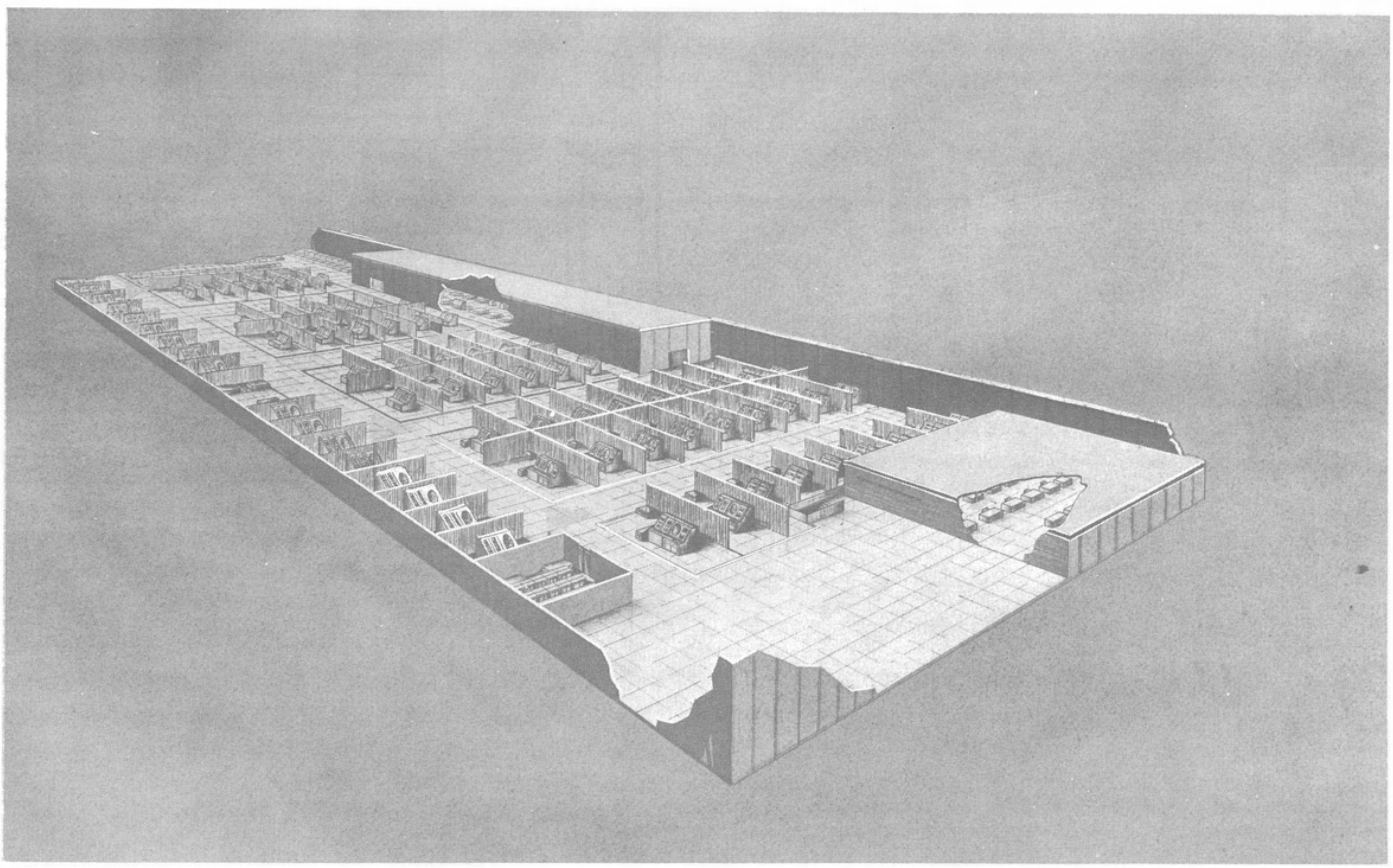
Function - The Electrical/Electronic facility is used to fabricate, assemble and rework electrical and electronic components and assemblies for the S-IC stage and GSE. The facility consists of the following areas: 1) Electrical Fabrication; 2) Electronic Fabrication; 3) GSE Console Assembly.

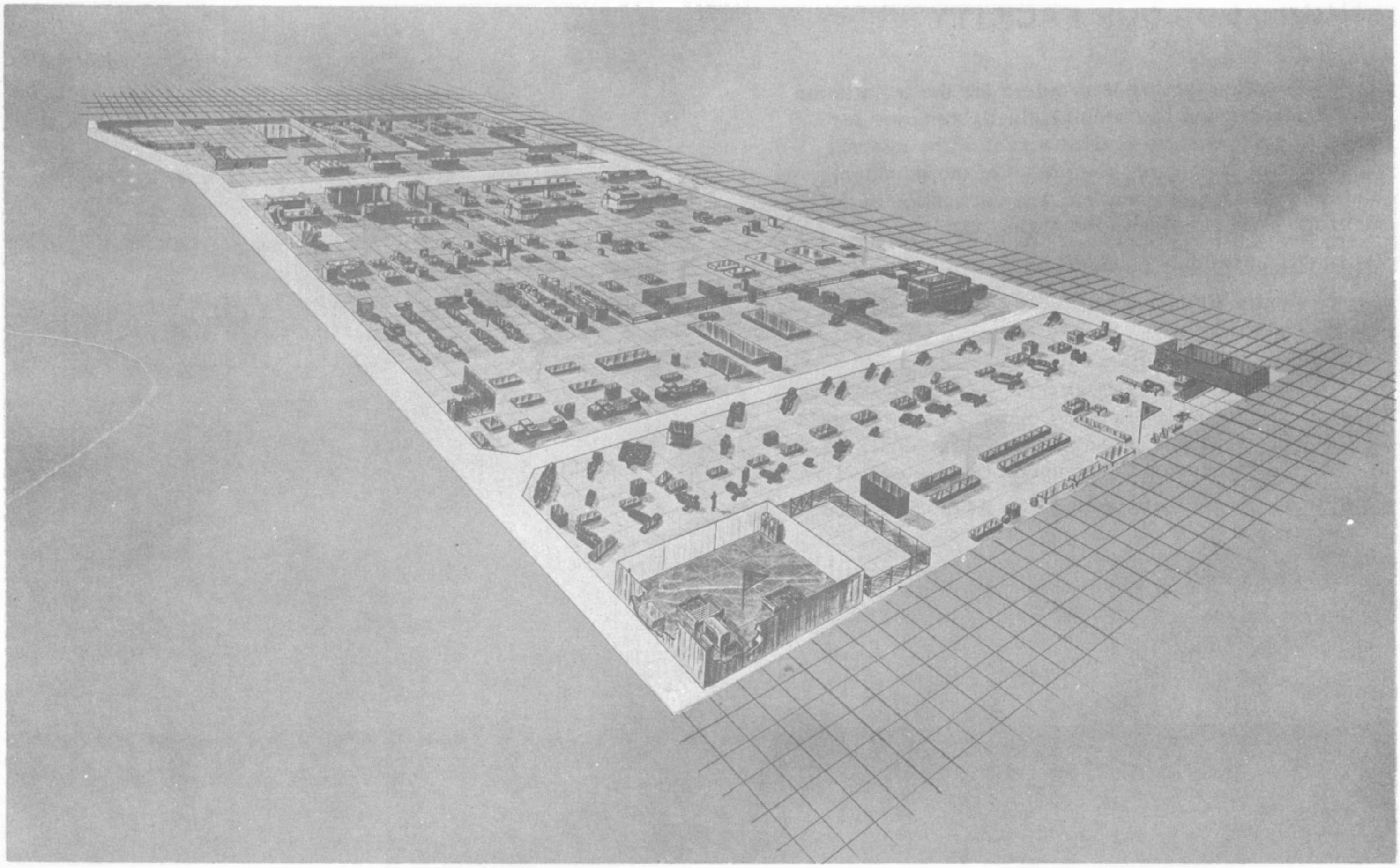
Using Organization - Manufacturing

Area - Electrical/Electronics facility - 51,000 sq. ft.

Milestones - Design Complete ------- 6-21-63
Construction Started ---- 7-18-63
Construction Complete -- 1-3-64

Contracts - 63-24 -- A&E
63-47 -- Construction





REWORK & MODIFICATION – TOOL MAINTENANCE

Function -- This area consists of a "blue streak" type shop which is capable of producing small parts as required for program changes, late or misplaced items, and emergency repairs as required to support both the S-IC booster production and tool maintenance programs This area consists of the following:

1. Rework and Modification facility consisting of the following areas: a) Tube Bending; b) Sheet Metal; c) Machining; d) Fixture Bore; e) Heat-Treat and Non-Metals; f) Woodwork and Plaster; and g) GSE/MSE Assembly and Maintenance.
2. Tool Maintenance and Support Facility composed of the following areas: a) Welding; b) Bench Assembly; and c) Fixture Maintenance.

Using Organization - Manufacturing

Area - Rework and Modification -- 75,844 sq. ft.
Tool Maintenance -------- 21,672 sq. ft.
TOTAL ----------------- 97,516 sq. ft.

Milestones - Design Complete ------------7-12-63
Truss Modification ----------7-8-63
Construction Started ---------7-22-63
Truss Modification Complete--9-20-63
Construction Complete -------2-14-64

Contracts - 62-4 --- A&E
62-9 --- Construction
63-6 --- Construction
63-40 -- Construction
63-48 -- Construction
63-59 -- Construction
63-62 -- Construction

ENGINE BUILDUP FACILITY

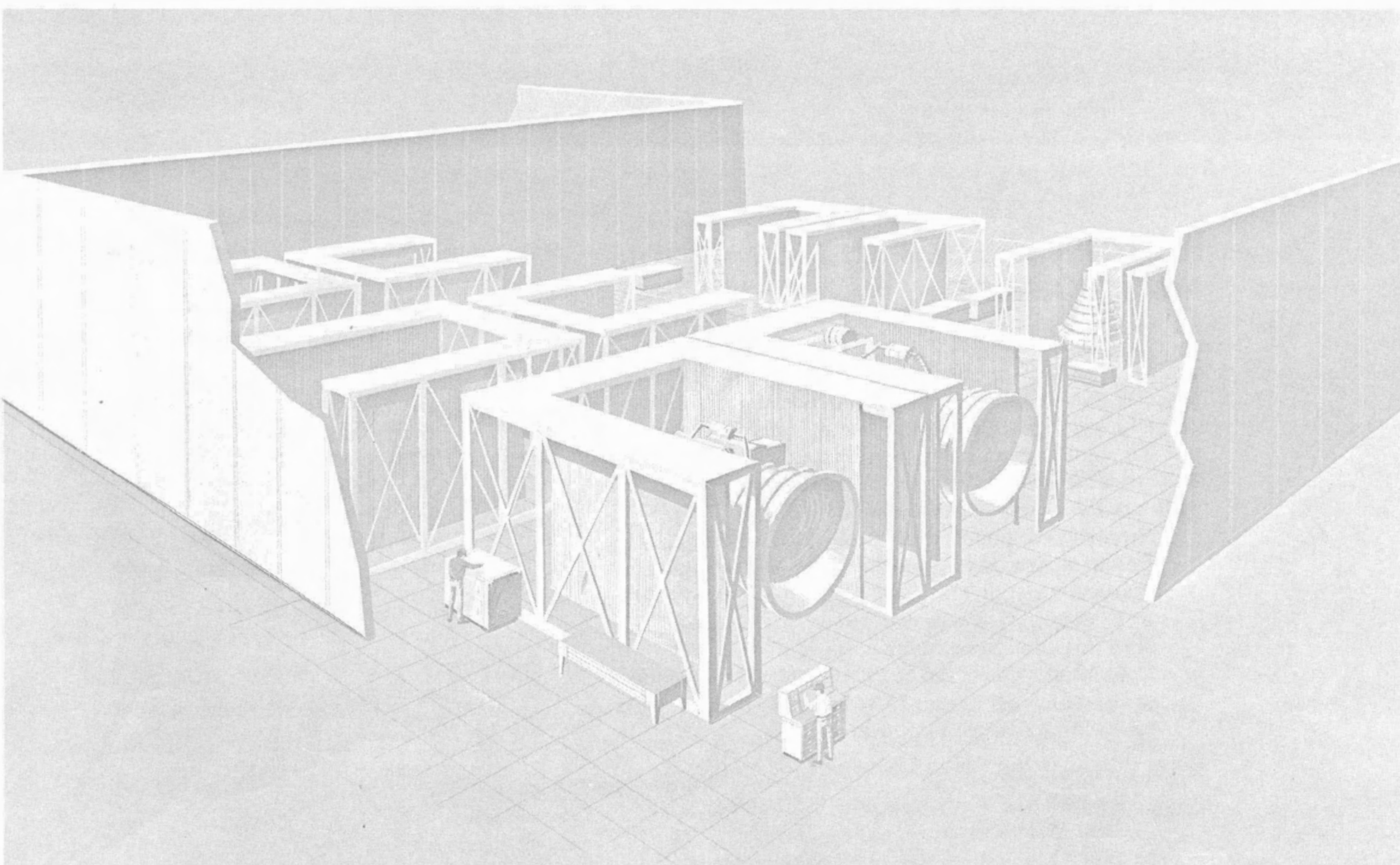
Function - This facility is required for the installation of components that had been originally removed for shipping purposes, re-establishment of the internal alignment of the engine, the preset of the actuator, and the assembly, inspection, and verfication of the fit of the skirt relative to the engine nozzle.

Using Organization - Manufacturing

Area - Engine Buildup Facility -- Approximately 12,960 square feet

Milestones - (Boeing effort only)
Scheduled Design Start --------- 8-21-64
Scheduled Design Complete ----- 11-9-64
Scheduled Construction Start ---- 12-22-64
Scheduled Construction Complete -3-23-65

Contracts - No numbers assigned to A&E or Construction Contracts



VERTICAL ASSEMBLY AREA

Function - This facility is required to assemble the complete S-IC stage in a vertical position. In addition, the area will be used to assemble tanks, install baffles, assemble tank connection sections, perform hydrostatic testing, clean flight vehicle LOX piping and RP-1 fuel tanks.

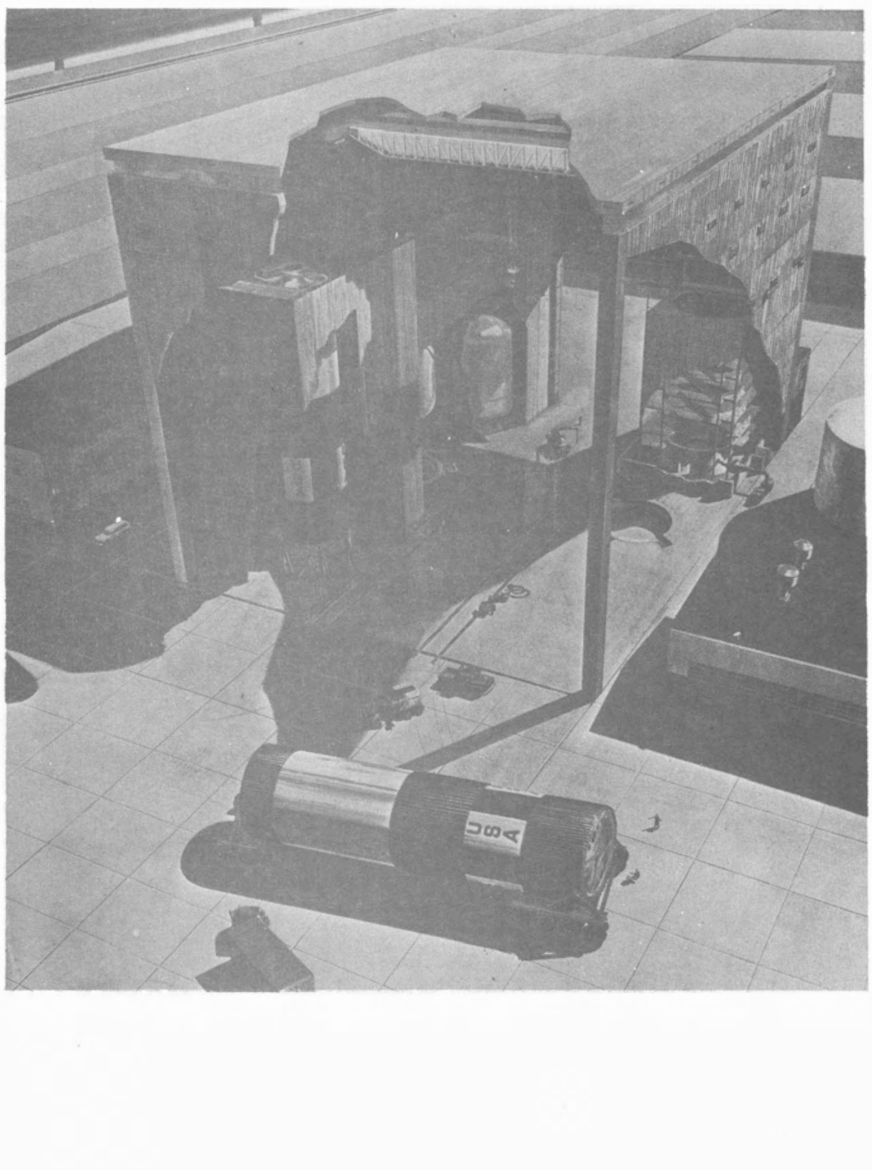
Using Organization - Manufacturing and In-Plant Test

Area - 44,414 square feet

Milestones

63-4 Tank Farm --	Design Started ------ 9-15-62 Design Complete ---- 3-1-63 Construction Started--4-27-63
63-64 Phase I ---- (Tank Assembly Position 1 & 2 including structural 90 ft. & 155 ft. towers)	Design Started ------ 8-9-63 Design Complete ---- 10-28-63 Construction Started--12-10-63 Construction completion scheduled for 6-8-64, but due to schedule slide anticipated completion early in the third quarter, CY '64
64-8 Phase II ----- (Tank Farm Distribution, Complete 155 ft. Tower, Hydrostatic Test Tower, Hydrostatic Test Position)	Design Started -------- 6-3-63 Design Complete ------ 2-6-64 Construction Started ---5-4-64 Construction Complete--10-19-64

Contracts - 63-64 -- A&E
62-12 -- Hydrostatic Test Position and Final Assembly Construction
64-8 --- Tank Positions 1 & 2 Construction
63-4 --- Tank Farm Construction



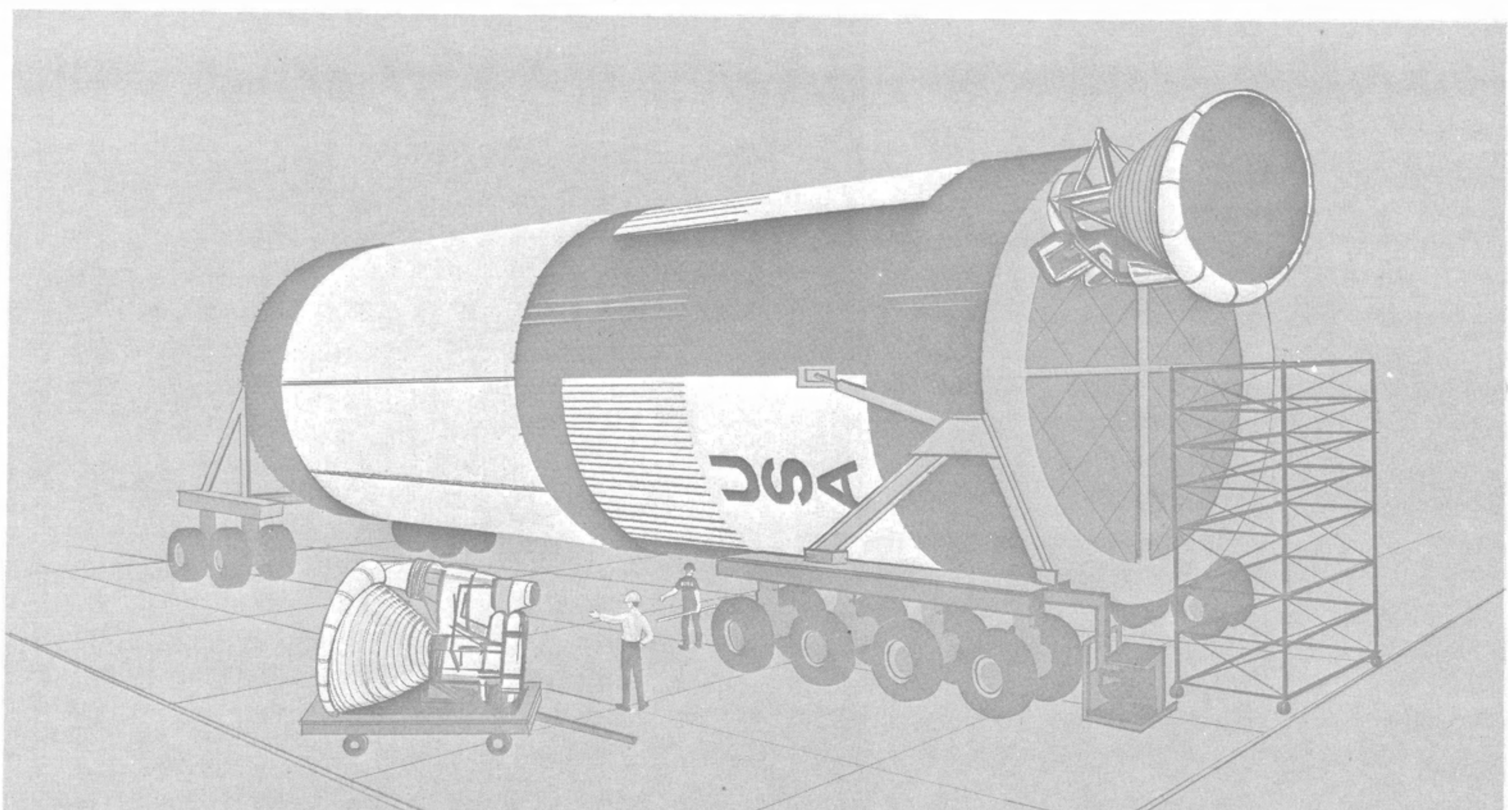
HORIZONTAL INSTALLATION AREA

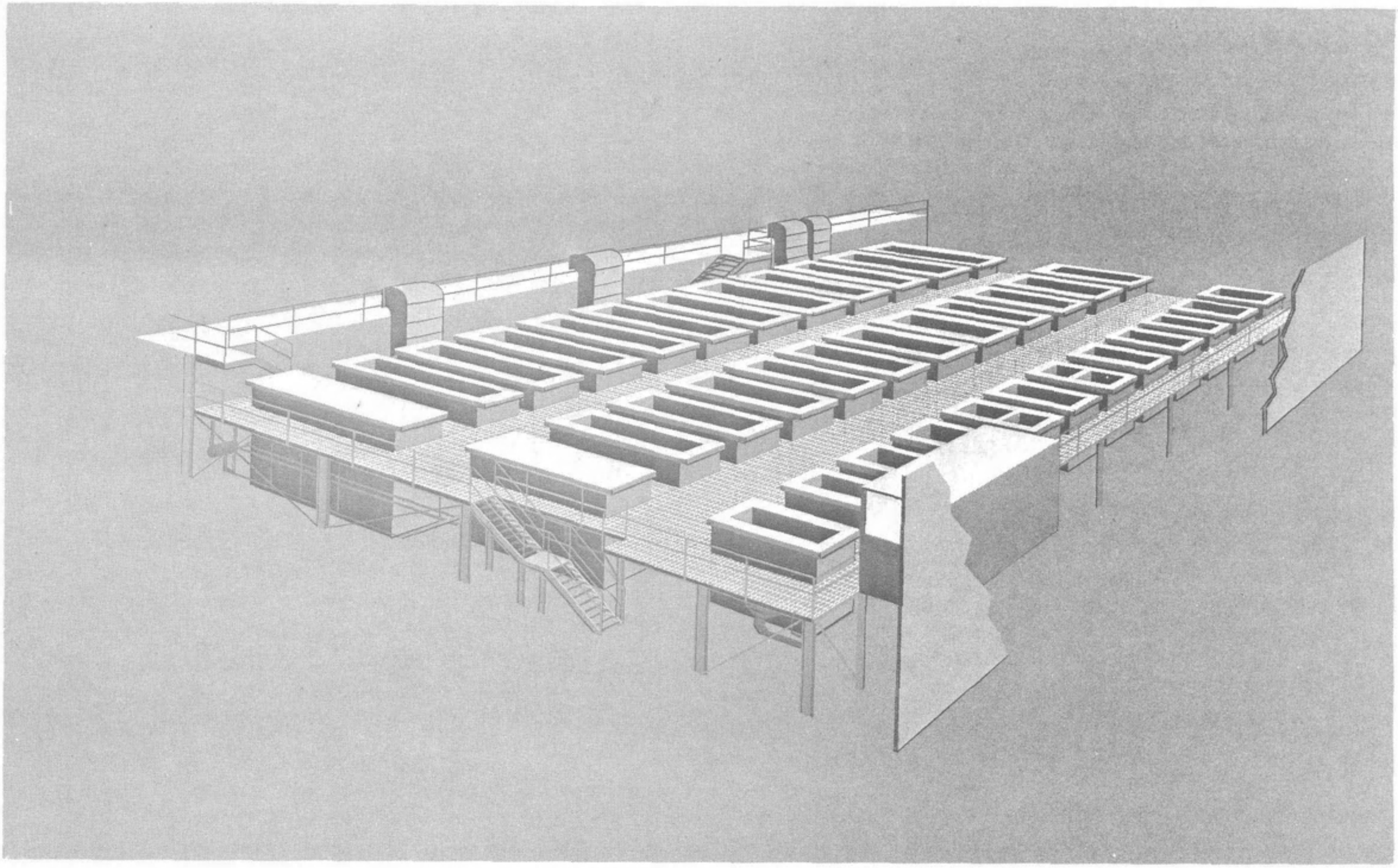
Function - This facility will be used to install the F-1 engines and associated hardware on the S-IC stage in the horizontal position and to refurbish the engines after static testing.

Area - 51,976 square feet

Milestones - Scheduled Design Start -------- 6-22-64
Scheduled Design Complete ---- 8-14-64
Scheduled Construction Start --- 9-16-64
Scheduled Construction Complete-12-21-64

Contracts - 64-18 -- A&E





CHEMICAL CLEANING AND FINISH PROCESS FACILITY

Function - This facility provides the capability for chemical cleaning of aluminum and steel segments in unfinished and semi-finished form. In general, this applies to all stage and ground support equipment components not considered contamination sensitive.

This area is a manual, semiautomatic facility consisting of an aluminum cleaning line of 10 tanks and a steel cleaning line of 11 tanks.

Using Organization - Manufacturing

Area - Chemical Cleaning and Finish Process facility -- 25,100 square feet

Milestones - Tank Design Started -------------3-19-63
Aluminum Line Design Complete --7-8-63
Steel Line Design Complete -------8-1-63
Aluminum Line Construction Complete ------------------------2-26-64
Steel Line Construction Complete--2-26-64

Contracts - 63-31 -- A&E
63-15 -- Tank Fabrication
63-46 -- Tank Fabrication
63-44 -- Construction Aluminum Clean Line
63-54 -- Construction Steel and Plating Line
63-11 -- Crane Fabrication and Erection

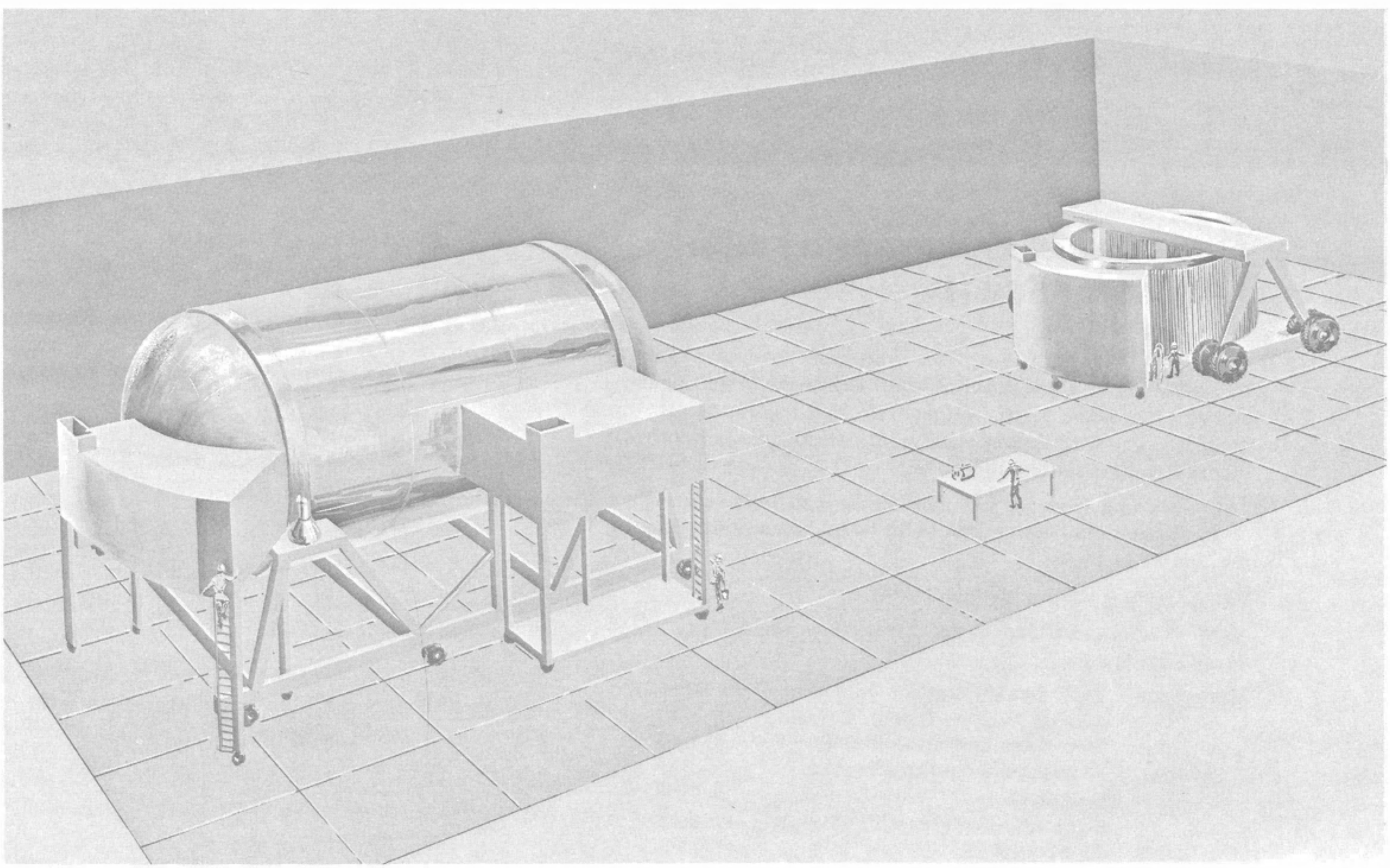
MAJOR PAINTING AND SHIPPING PREPARATION

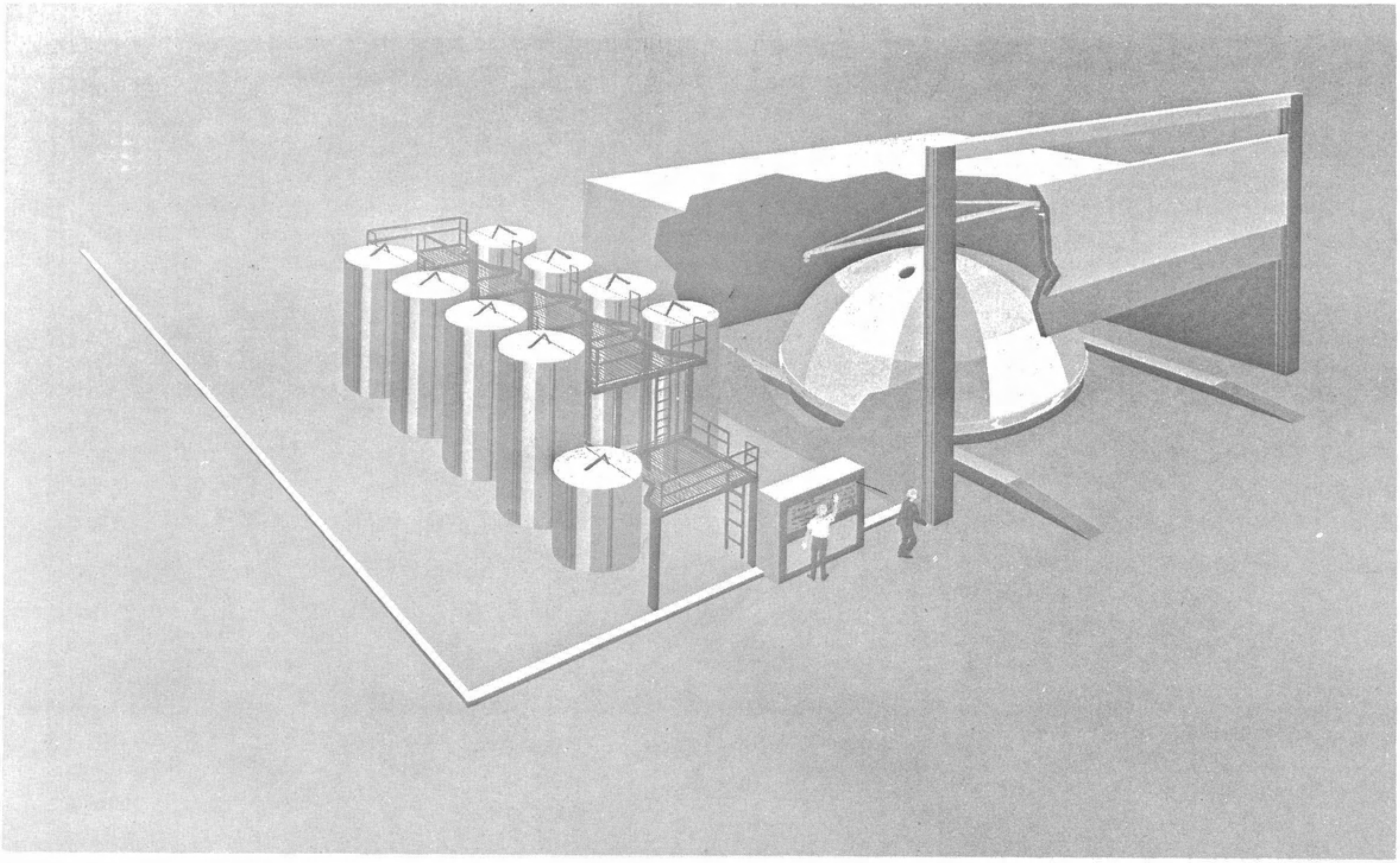
Function - This facility is required for final preparation of the booster for shipment. This preparation includes painting, decal application, protective coating, dust sealing and systems draining.

Area - 16,800 square feet

Milestones - Design Started ---------------- 6-10-64
Scheduled Design Complete ----- 8-7-64
Scheduled Construction Started - 9-8-64
Scheduled Construction Complete-12-11-64

Contracts - 64-19 -- Design





MAJOR COMPONENT CLEANING AREA

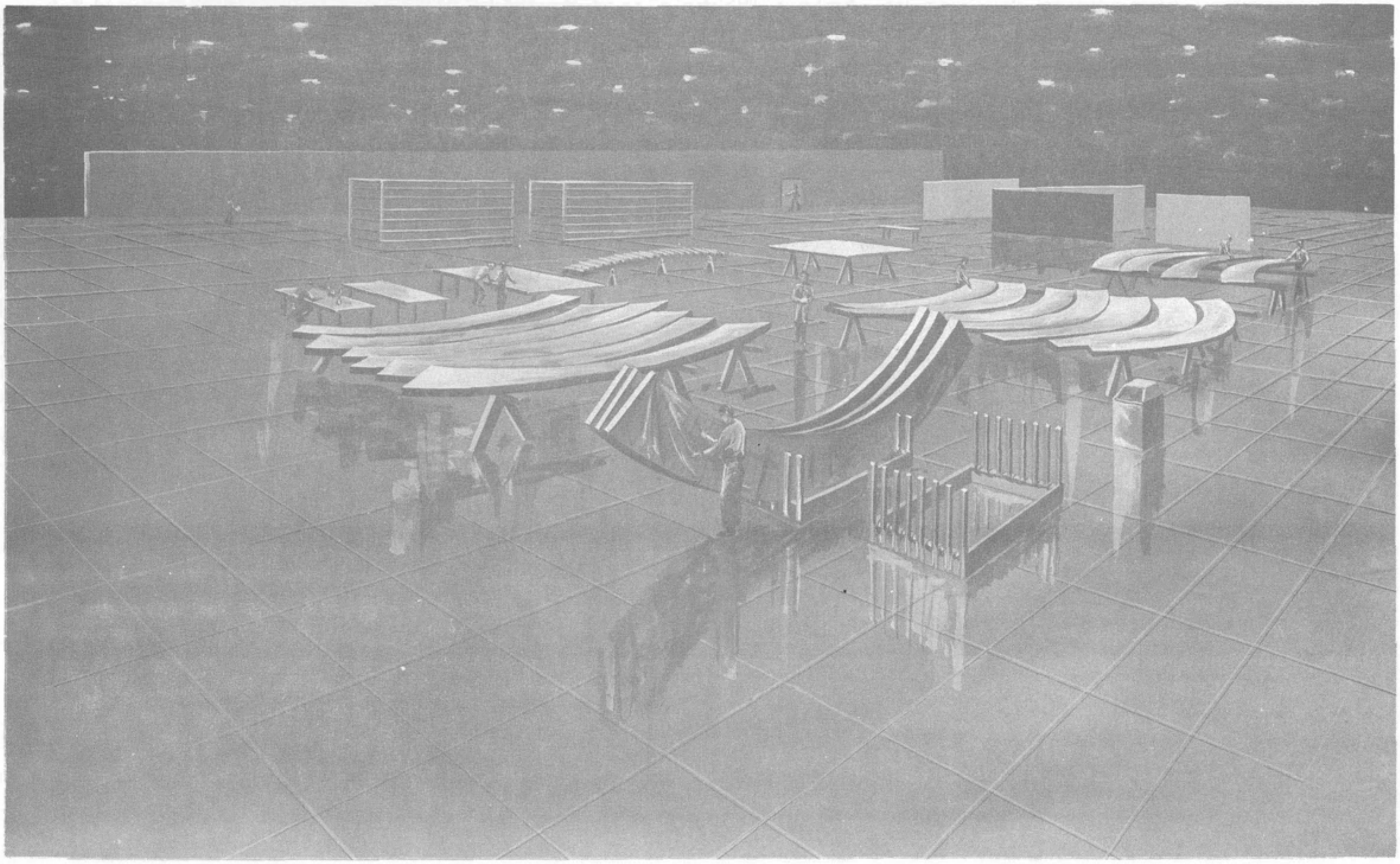
Function - This area is used for the cleaning and conversion coating of bulkheads, baffles, and other tank components too large for the immersion cleaning line. Skin sections and Y-rings are also cleaned in this area. Systems required to perform the cleaning and coating operations include: trichloroethylene, alkaline cleaning solution, deodorizer, iridite, and demineralized water distribution.

Using Organization - Manufacturing

Area - Major Component Cleaning facility -- 4,560 sq. ft.

Milestones - Design Started ------------- 4-15-63
Design Complete ----------- 8-7-63
Construction Started -------- 10-10-63
Tank Fabrication Complete -- 1-21-64
Construction Complete ------ 2-19-64

Contracts - Design -- In-house
63-41 --- Pile Driving
63-46 --- Tank Fabrication
63-57 --- Construction



MINOR ASSEMBLY AREA

Function - The Minor Assembly Area provides facilities to assemble vehicle components prior to major assembly. This includes provisions for welding, machining and mechanical fabrication.

Using Organization - Manufacturing

Area - 238,516 square feet

Milestones

63-40 Truss Mod ----- Started ---- 1962
Complete -- 10-31-63

63-11 Cranes -------- Started ---- 4-9-63
Fabrication & Installation Complete -- 2-21-64

63-62 Crane Access -- Started ---- 10-25-63
Platforms Complete -- 11-20-63

Special Tooling Foundations Phases 5, 6, 7 & 8

63-35 -- Started ---- 1963
Complete -- 9-27-63

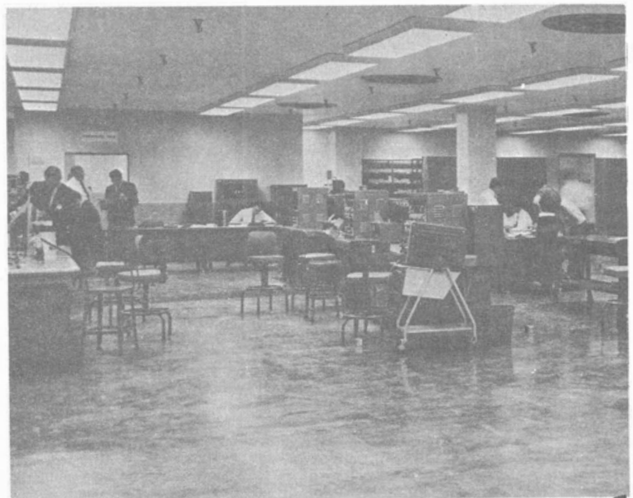
63-55 -- Started ---- 1963
Complete -- 10-31-63

63-61 -- Started ---- 1963
Complete -- 2-29-64

63-67 -- Started ---- 1963
Complete -- 3-1-64

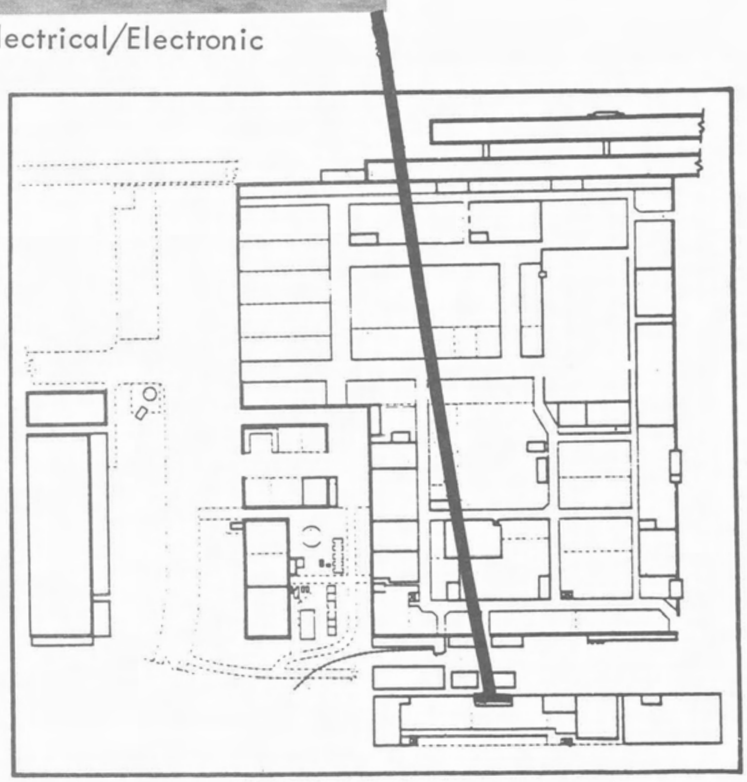
Contracts - 62-4 --- A&E Gray Box
63-40 -- Truss Mod
63-11 -- Cranes Fabrication & Installation
63-33 -- Y-ring Weld Area
63-62 -- Crane Access Platforms
63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8

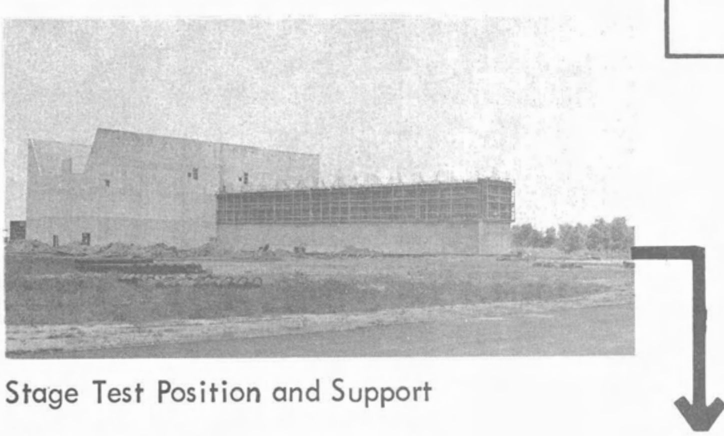
(The illustration shows a typical area)



Subsystems Test Electrical/Electronic

FACILITIES/**TEST**





Stage Test Position and Support

SYSTEMS TEST

ELECTRICAL/ELECTRONIC

Function - All electrical and electronic components, and subsystems of Ground Support Equipment and Saturn S-IC flight electrical and electronic systems are tested in this area. The subsystems Test electrical/electronic area is comprised of the: 1) Instrument Test Area; 2) Bench Test Area; 3) Telemetry Ground Station; 4) RF and TV Test Area; 5) Development and Special Test Area. These areas provide the capability for performing the following: testing of sensing devices, printed circuit cards, electronic chassis, various electrical and electronic components, subsystems, telemetry systems and electromagnetic radiating devices.

In addition, the facilities will provide the capability for: 1) developing special test equipment; 2) performing component and subsystems test; 3) compatibility testing between GSE and flight instrumentation and the resolution of any discrepancies disclosed in such testing.

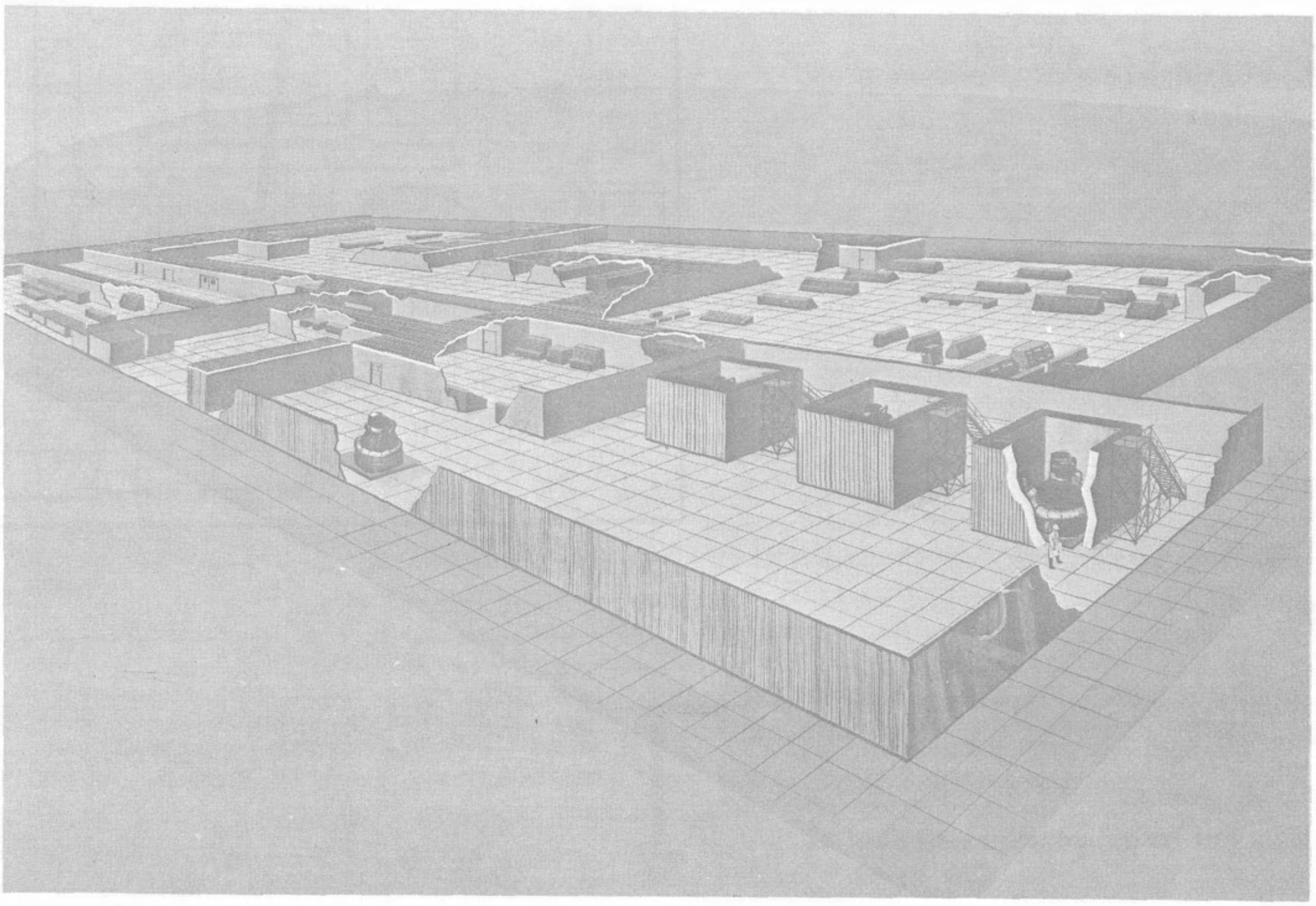
Using Organization - In-Plant Test

Area - Subsystems Test Electrical/Electronic - 14,252 square feet.

Milestones - Design Start ----------- 9-18-63
Design Complete ------- 10-23-63
Construction Start ------ 12-6-63
Construction Complete -- 4-17-64

Contracts - In-House -- Design
63-69 ----- Construction

(The artist concept depicts the electrical/electronic area of subsystems test.)



Electrical/Electronic Area of Subsystems Test

SUBSYSTEMS TEST

MECHANICAL

Function - The Mechanical Subsystems Test area shall provide the capability of testing S-IC vehicle mechanical subsystems and components, vendor furnished items, and subsystems which have failed in static-firing or upper-level checkout. This shall include testing and measuring instruments, testing components and subassemblies that must operate at extremely low temperatures, test and proof of pressure pneumatic system components, check valve cracking pressures, and testing the LOX and fuel systems flight hydraulic components and subassemblies of the F-1 engine. Shops included in this area are: 1) Engine Test Cell; 2) Hydraulic Test Area; 3) Cryogenic Test Area; 4) Pneumatic Test Area; 5) Tool Crib; 6) Testing Staging Area, and 7) Hydrostatic Test Area.

Using Organization - In-Plant Test

Area - 27,192 square feet

Milestones - Design Start ------- 6-10-63
Design Complete --- 12-27-63
Construction Start -- 6-17-64
Anticipated completion early in the third quarter CY '64.

Contracts - 62-13 -- A&E
64-1 --- Construction

VALVE CLINIC

Function - The Valve Clinic is used for dismantling and reassembling valves. All inoperable valves, orifices, regulators, etc., are to be dismantled as required and inspected to determine the cause and extent of damage or malfunction.

Using Organization - Manufacturing

Milestones — Design Started------------6-10-63
Design Complete----------12-27-63
Construction Started ------2-11-64
Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design

TUBE AND VALVE CLEANING FACILITY

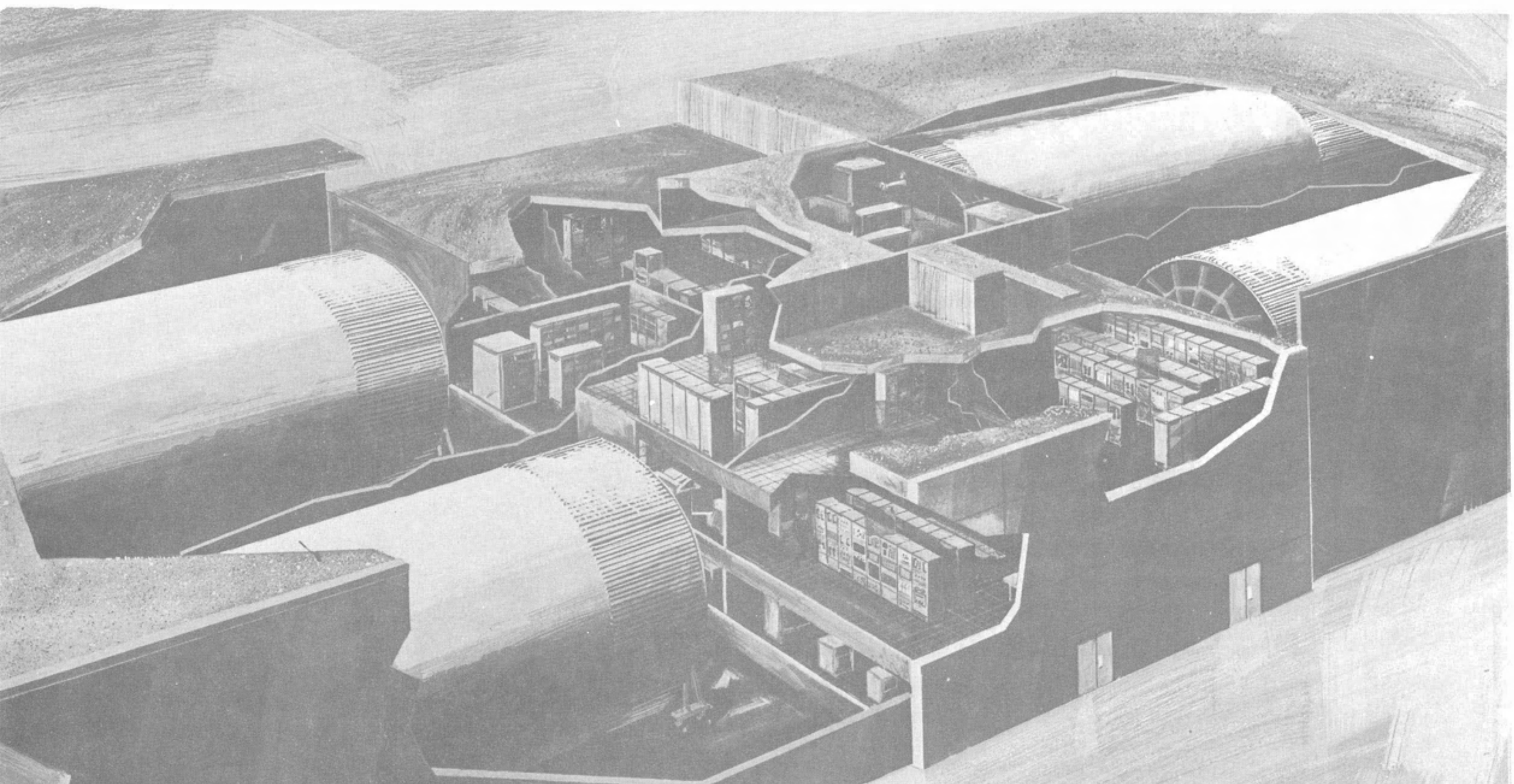
Function - The Tube and Valve Cleaning facility is required for the cleaning of fuel, LOX, and pneunatic components to the cleanliness levels required for the system. Tubing will be flushed with the proper cleaning agents, dryed, and packaged at this location. Valves and components are to be cleaned and rinsed in ultrasonically energized fluids, placed in vacuum ovens for drying, and flushed to certify the cleanliness levels.

Using Organization - Manufacturing

Area - 6,670 square feet

Milestones - Design Started ---------- 6-10-63
Design Complete -------- 12-27-63
Construction Start -------2-7-64
Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design



STAGE TEST POSITION AND SUPPORT

Function - The Stage Test Position is necessary to fulfill requirements of the final stage checkout program of the S-IC stage. This will be accomplished in four stage test positions for performing various tests on the pneumatic, hydraulic, mechanical, telemetry and electrical systems of the S-IC stage to ensure system integrity.

Using Organization - In-Plant Test

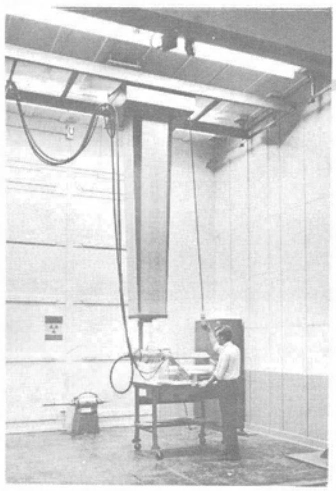
Area - 114,432 square feet (66,120 Test Cells; 48,312 support facility).

Milestones - Contract 63-71 Phase I
Design Started ----------5-24-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Construction Complete ---Is basically completed except for seeding and secondary road work which cannot be accomplished until November 1, 1964.

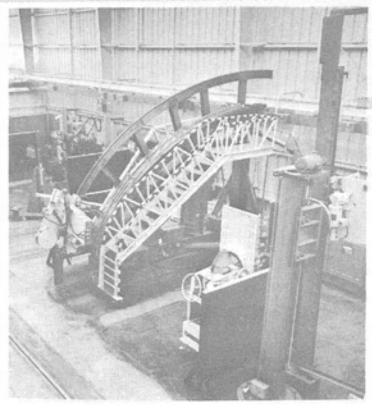
Contracts — 63-71 -- Phase I Construction
64-9 --- Phase II Construction
63-29 -- A&E

Contract 64-9 Phase II
Design Started ----------10-2-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Scheduled Construction Completion -------------1-4-65

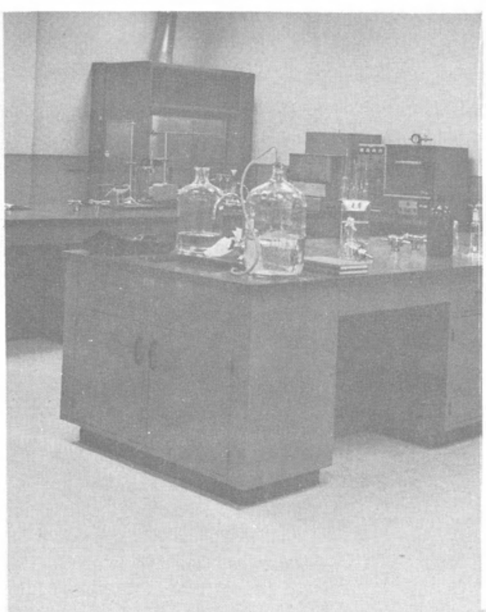
FACILITIES/LABORATORIES



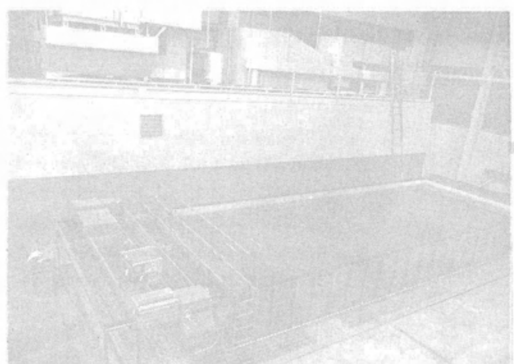
Quality Assurance
Radiographic Evaluation Laboratories



Manufacturing Development Laboratory

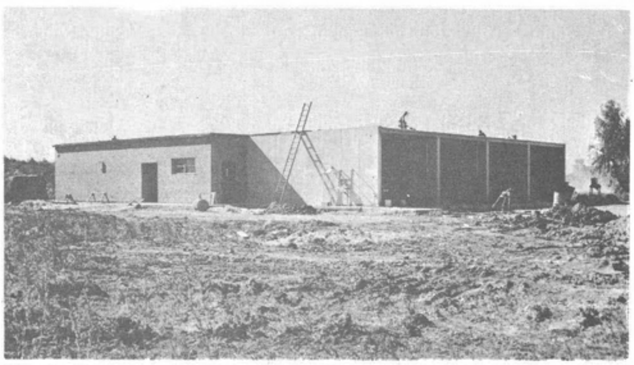


Measurement Control Laboratories

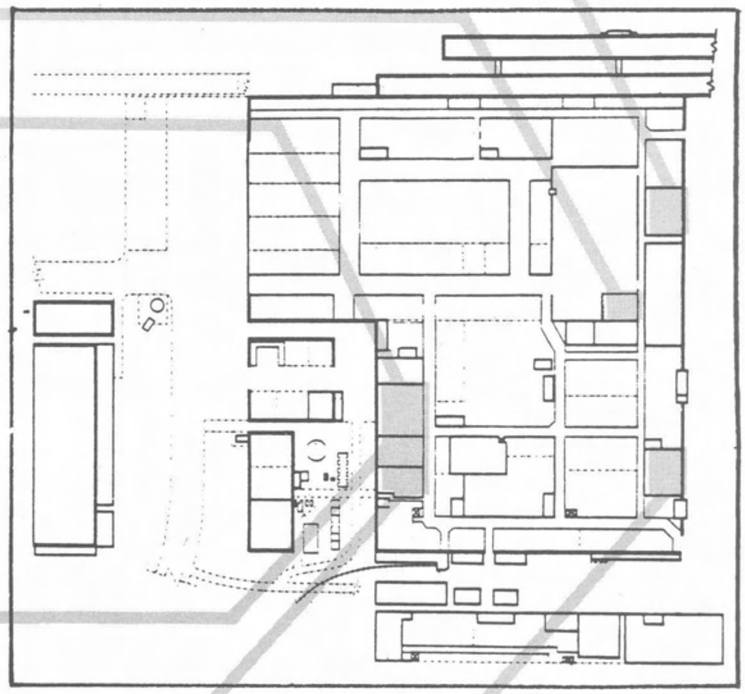


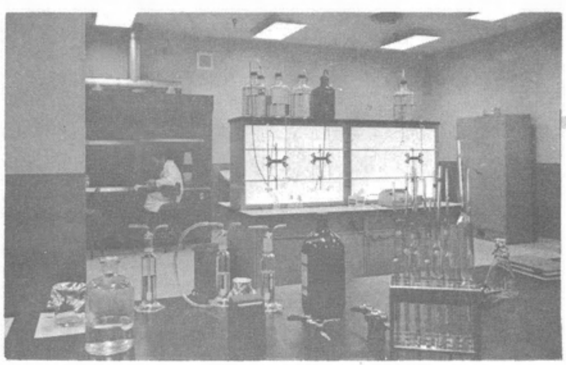
Non-Destructive Test Laboratory

Component Test Area
(Material and Processes Laboratory)



High Pressure Test Area (Remote from Plant)





Quality Evaluation Laboratories

MANUFACTURING DEVELOPMENT LABORATORY

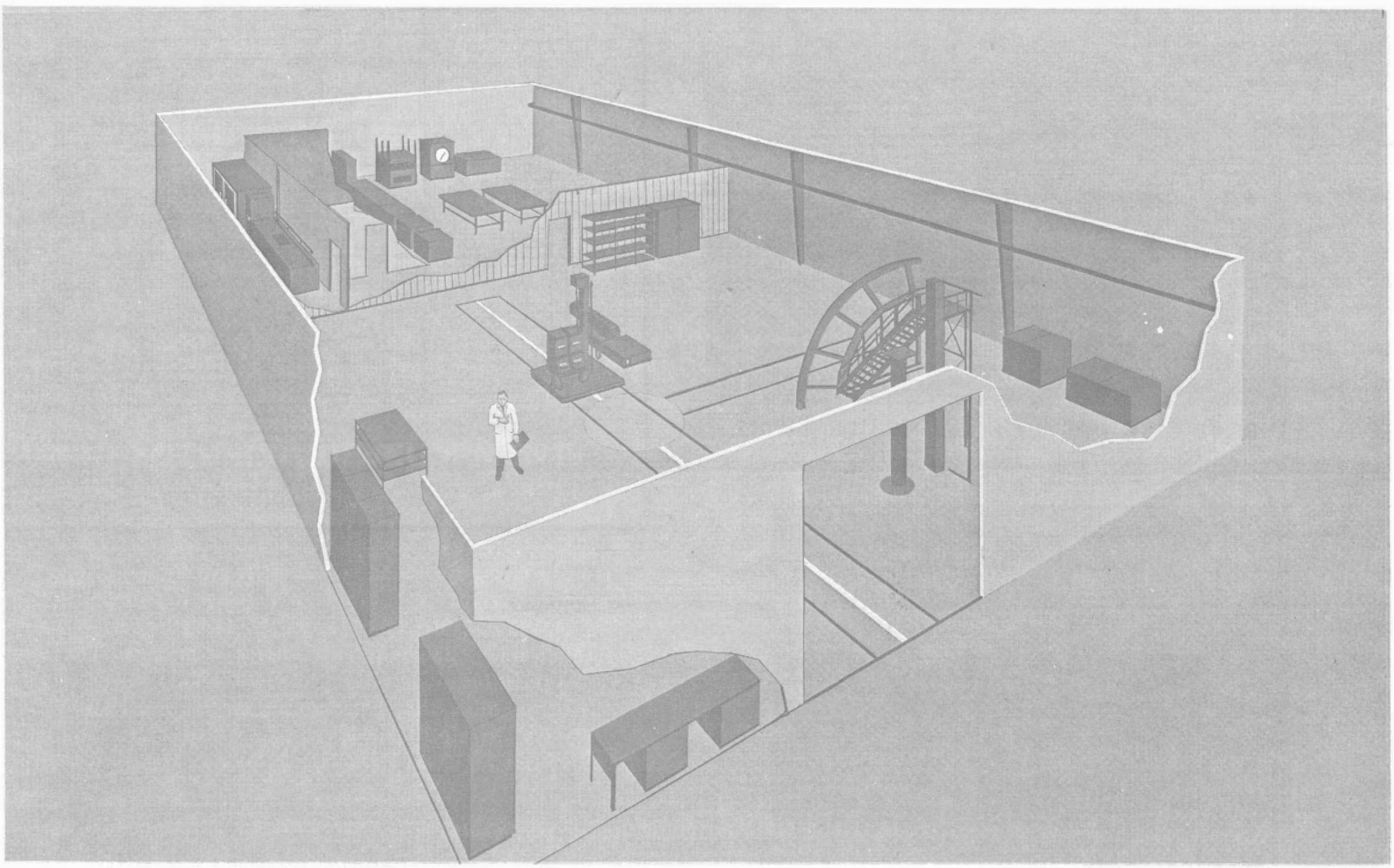
Function - This area is used for the development of new production processes, refining of existing techniques and to eliminate production problems. It also serves to train personnel in new welding methods. This laboratory is subdivided into five totally enclosed sections: 1) Welding Area, 2) Radiation Area, 3) Specimen Preparation Shop, 4) Wire and Instrument Control, and 5) NASA Office.

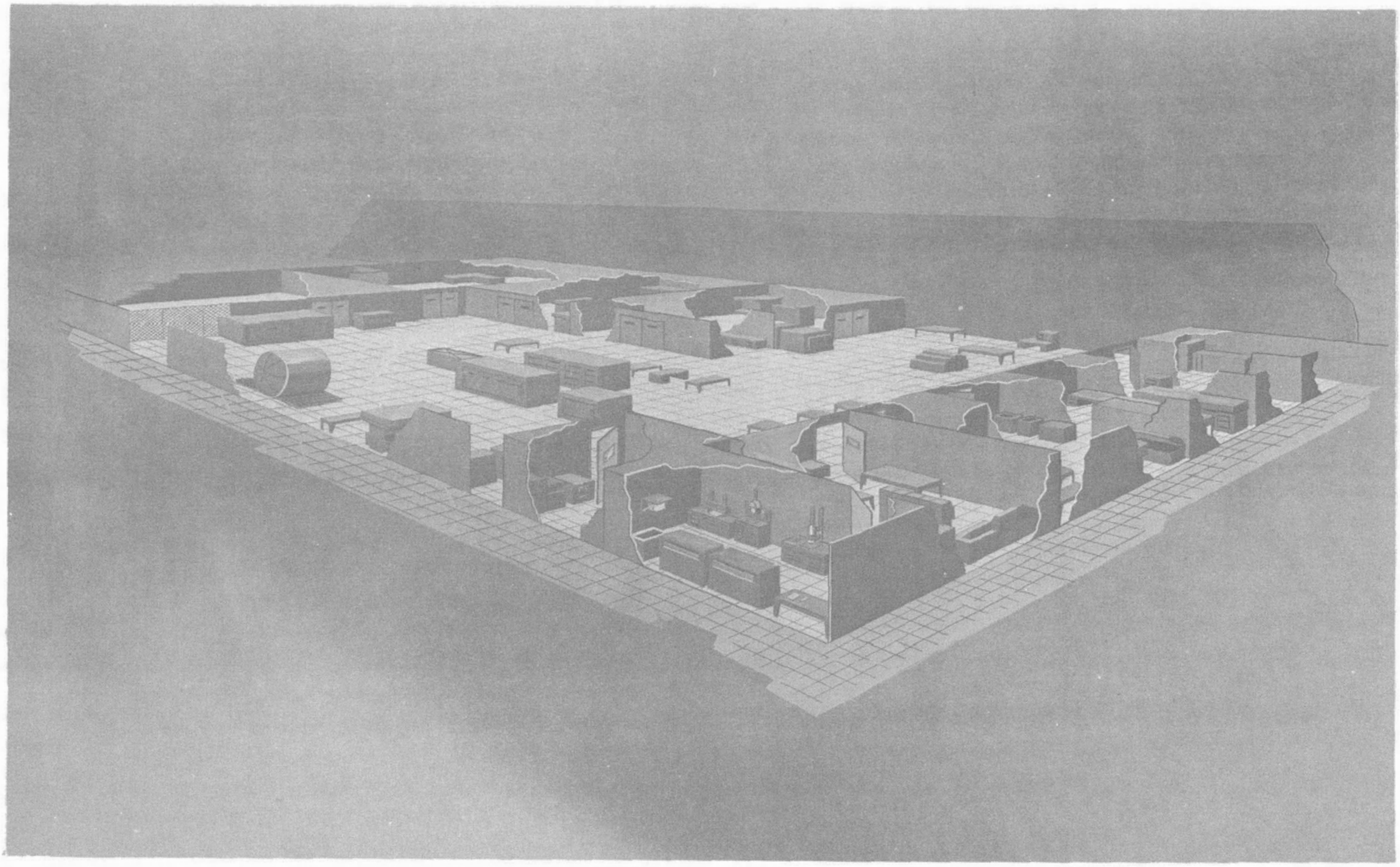
Using Organization - Manufacturing

Area - Manufacturing Development Laboratory -- 6,600 square feet.

Milestones - Design Complete ------- 6-13-63
Construction Start ------ 6-25-63
Construction Complete -- 1-3-64

Contracts - 62-15 -- A&E
63-20 -- Interim Construction
63-25 -- A&E
63-41 -- Construction
63-56 -- Construction





The above illustration shows the Material and Processes Laboratory-Component Test Area

COMPONENT TEST AREA

Function - This area is used to test various mechanical, electrical, and hydraulic components of the S-IC booster to establish and substantiate the design concepts and manufacturing techniques employed. This component testing also provides reliability assurance. Test equipment here is capable of producing, sensing, and recording simulated flight and ground handling conditions (e.g., acceleration, force, vibration, pressure, and temperature environments) to establish the high degree of reliability necessary for the first firing.

Using Organization - Engineering

Area - Component Test Areas -- 73,504 square feet

Milestones - Design Start ----------- 5-15-63
Design Complete ------- 9-26-63
Construction Start ------ 8-12-63
Construction Complete -- 6-15-64

Contracts - 63-32 -- A&E
63-55 -- Construction (Pilings)
63-58 -- Construction
63-66 -- Construction
63-68 -- Construction

HIGH PRESSURE TEST

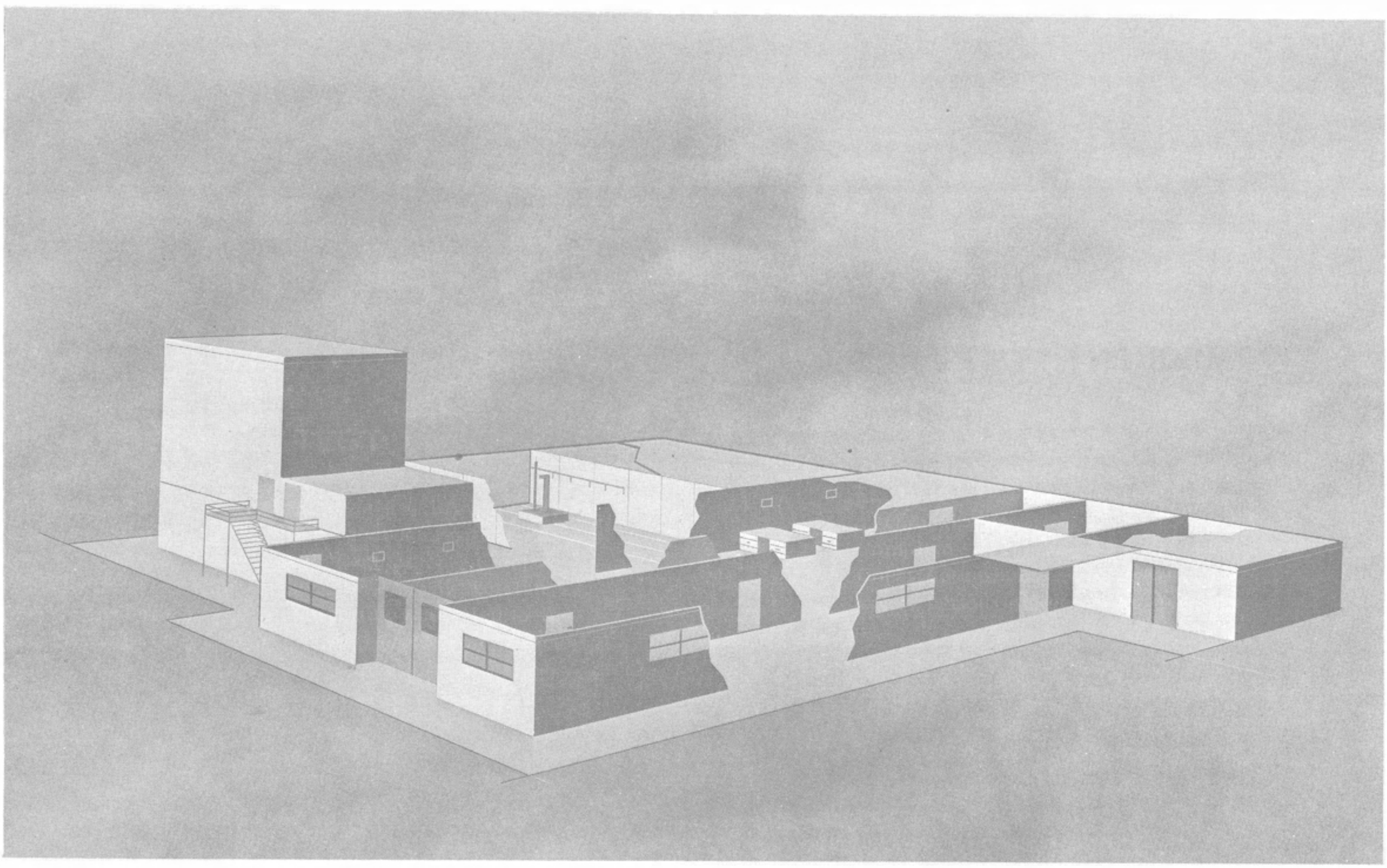
Function - The High-Pressure Test facility will be used to conduct all testing of a hazardous nature for both booster and ground support equipment. Components, subassemblies, subscale test hardware, tanks, and ground support equipment will be subjected to various pressure flow and burst tests to ensure compliance with design requirements under normal and emergency environment and operating conditions.

Using Organization - Engineering

Area - 5,020 square feet

Milestone--

High-Pressure Test:	Design Start ----------	6-12-64
	Design Complete ------	8-3-64
	Construction Start -----	9-8-64
	Construction Complete -	12-22-64
Liquid-Level Test:	Design Start ----------	2-6-64
	Design Complete ------	6-10-64
	Construction Start -----	6-29-64
	Construction Complete -	8-13-64
Helium & Nitrogen Modification:	Technical Support Start -----------------	1963
	Technical Support Complete -------------	4-21-64
	Construction Start -----	5-8-64
	Construction Complete -	10-1-64



QUALITY ASSURANCE LABORATORIES

Function--Quality Evaluation Laboratory - These laboratories are used by the Quality and Reliability Assurance organization to ensure the quality levels of all products and assemblies. Laboratories included in the Quality Evaluation Laboratories are are: 1) Chemical; 2) Metallurgical; 3) Spectro-Analysis; 4) Physical Test; 5) Equipment Quality Analysis; 6) Contamination Control.

Nondestructive Test Laboratory - Nondestructive testing equipment and techniques are maintained and used for such areas as fabrication control and special investigations, in addition to the primary receiving-inspection demands. The equipment and instrumentation of this laboratory is used by technical personnel to perform services such as examination of surface defects, internal defects, discontinuity and porosity in metal parts and welds; and also the detection of cracks and defects in both ferrous and nonferrous materials.

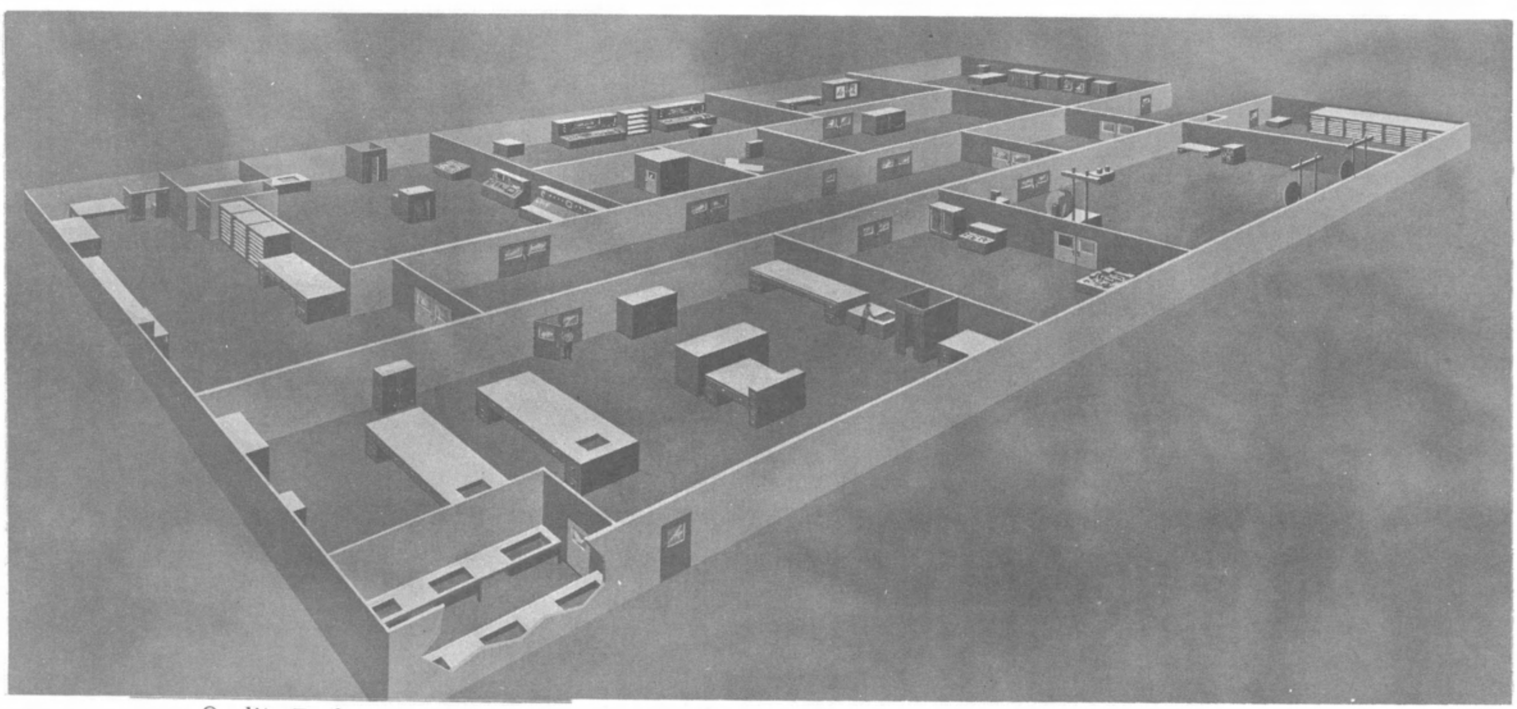
Measurement Control Laboratory - The Measurement Control Laboratory provides the capability to perform initial and periodic calibration and accuracy certification of all measuring and testing equipment used in the Boeing-Saturn Operations at Michoud. In addition, calibration-certification services for transfer standards are performed in this area in accordance with the present agreements between Boeing, Chrysler, and NASA. Laboratories included in the Measurement Control Laboratory area are: 1) Measurement Receiving Area; 2) Micorwave-Electronic Electrical Laboratory; 3) Precision Measurement Laboratory; 4) Pyrometry-Pressure Flow Laboratory; 5) Measurement Office Area.

Using Organization - Quality Assurance

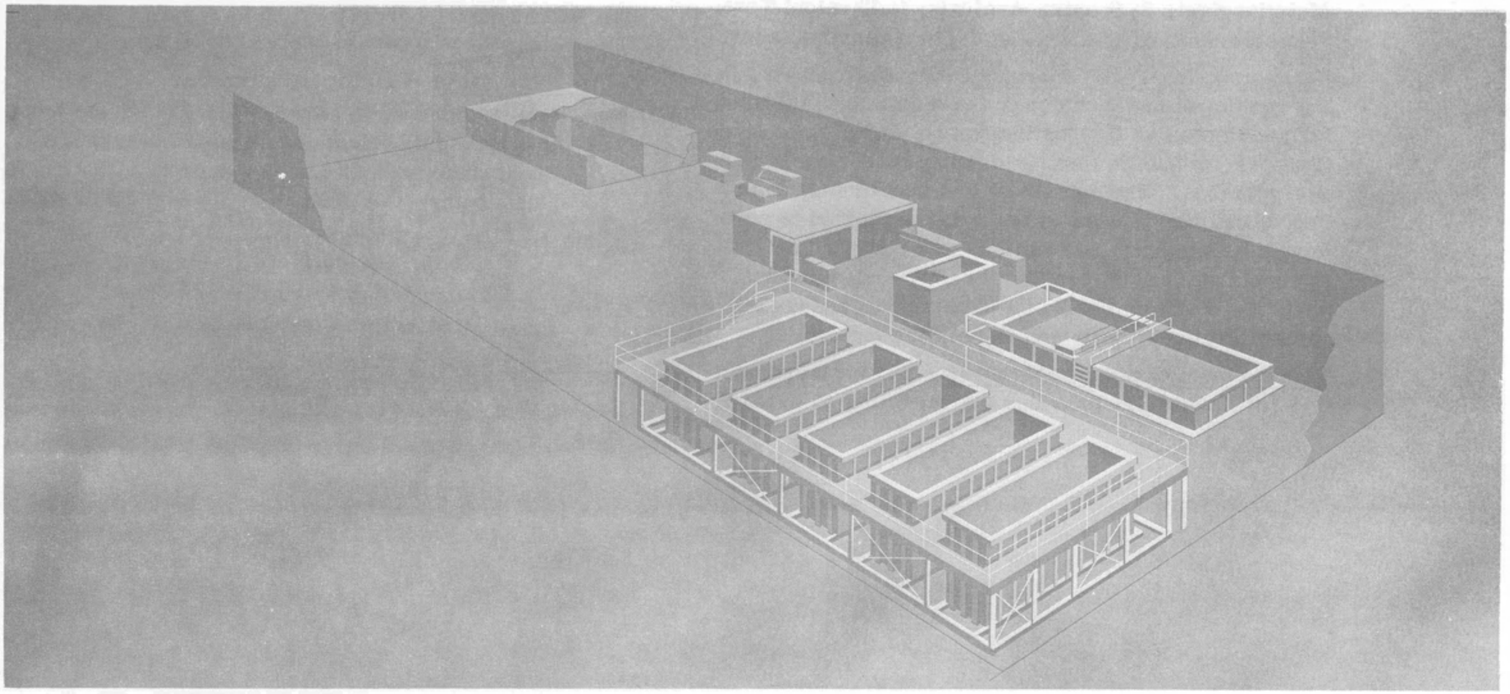
Area - Quality Assurance Labs---- 28,714 square feet
Qualification Evaluation Lab-approx. 8,970 sq. ft.
Nondestructive Test Lab---- approx. 8,000 sq. ft.
Measurement Control Lab---approx. 9,660 sq. ft.

Milestones - Design Started --------- 1-1-63
Design Complete ------- 6-5-63
Construction Started ---- 7-30-63
Construction Complete -- 5-15-64

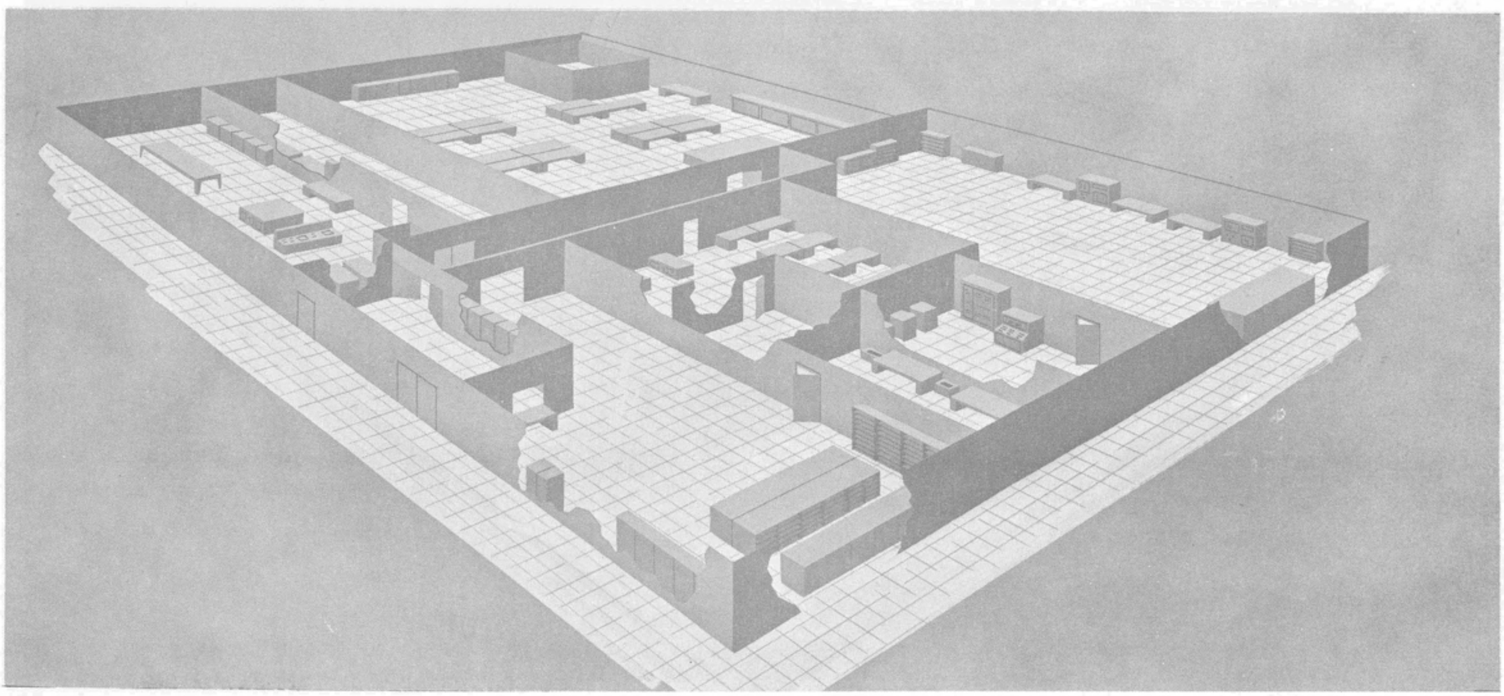
Contracts - 62-11 -- A&E
63-3 --- Construction



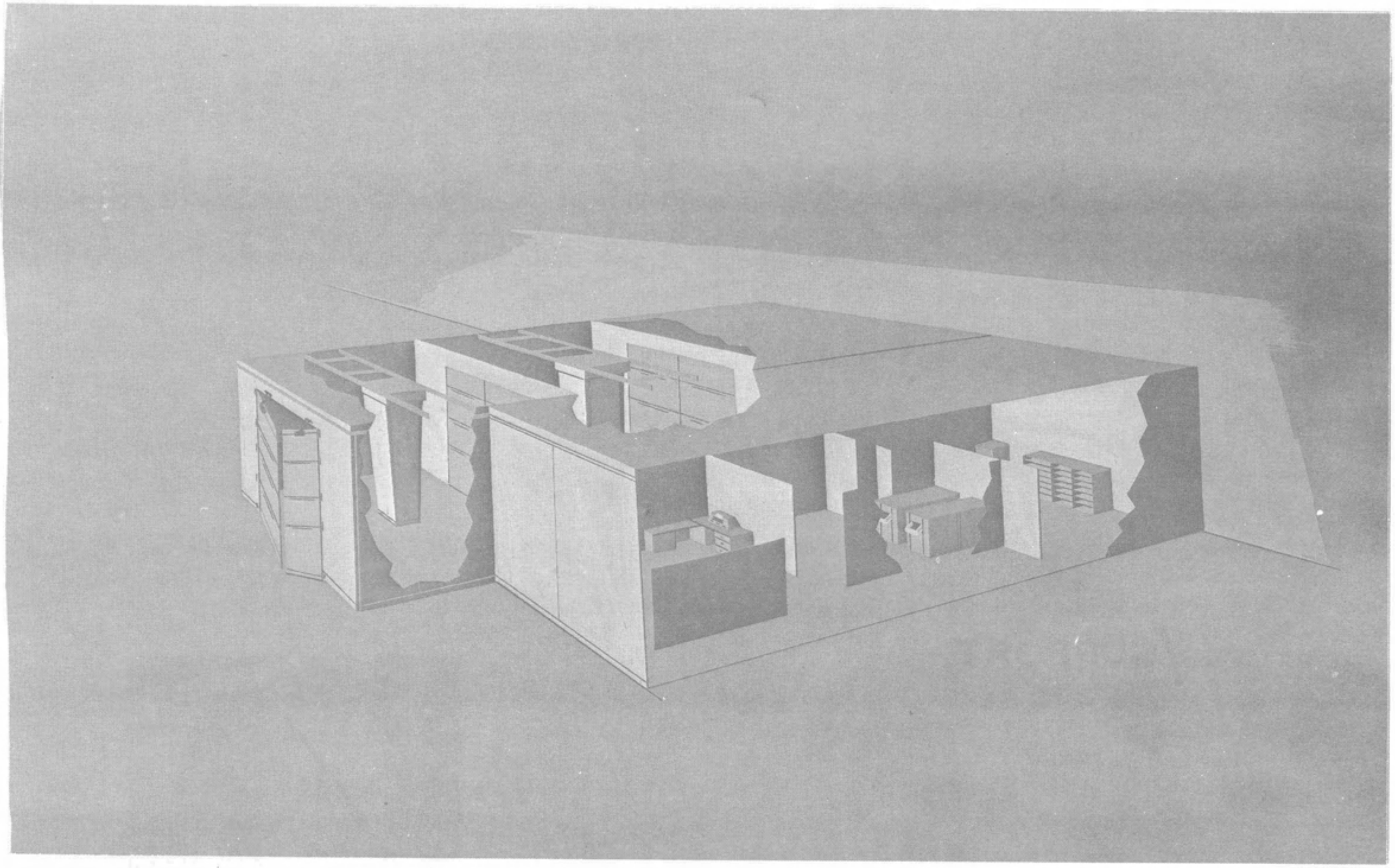
Quality Evaluation Laboratory



Non-Destructive Test Laboratory



Measurement Control Laboratories



QUALITY ASSURANCE RADIOGRAPHIC EVALUATION LABORATORIES

Function - The Centralized Radiographic Evaluation Laboratory provides both X-ray and radio-chemical evaluation support for weld development, weldor certification, and weld and raw material inspection. This laboratory is equipped to detect, evaluate, and record surface and subsurface discontinuities in welds and materials. It also provides for the developing and storage of the permanent X-ray film records for the total S-IC fabrication program.

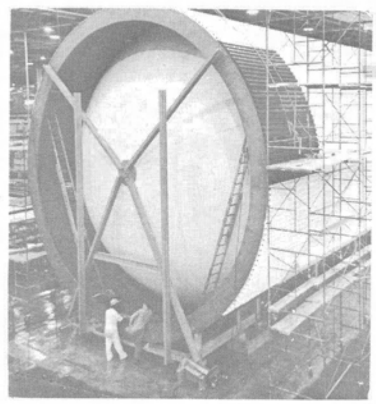
Using Organization - Quality Assurance

Area - Quality Assurance Radiographic Laboratory -- 3,443 square feet.

Milestones - Start Redesign ----------- 2-27-63
Partial No. 34 Complete -- 4-10-63
Design Complete --------- 5-29-63
Construction Started ------ 6-19-63
Construction Complete ----12-6-63

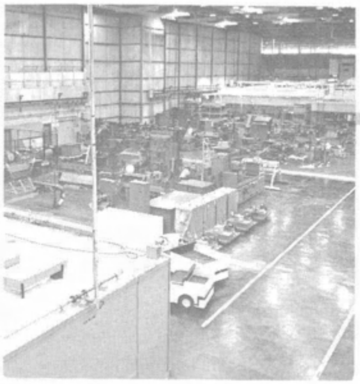
Contracts - 62-7 --- A&E and In-house Design
63-45 -- Construction

FACILITIES/SUPPORT



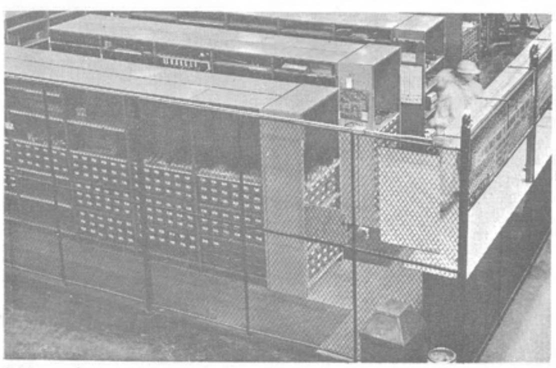
Mockup Facility

Support and Services Area – Familiarization and Training

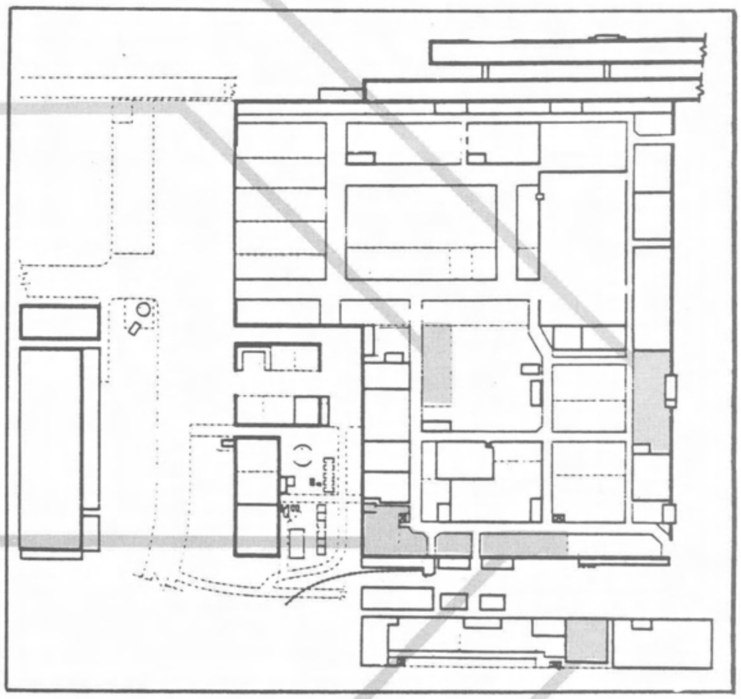


Equipment Maintenance Facility

Receiving and Receiving Inspection Facility



Warehouse and Stores



RECEIVING AND RECEIVING INSPECTION FACILITY

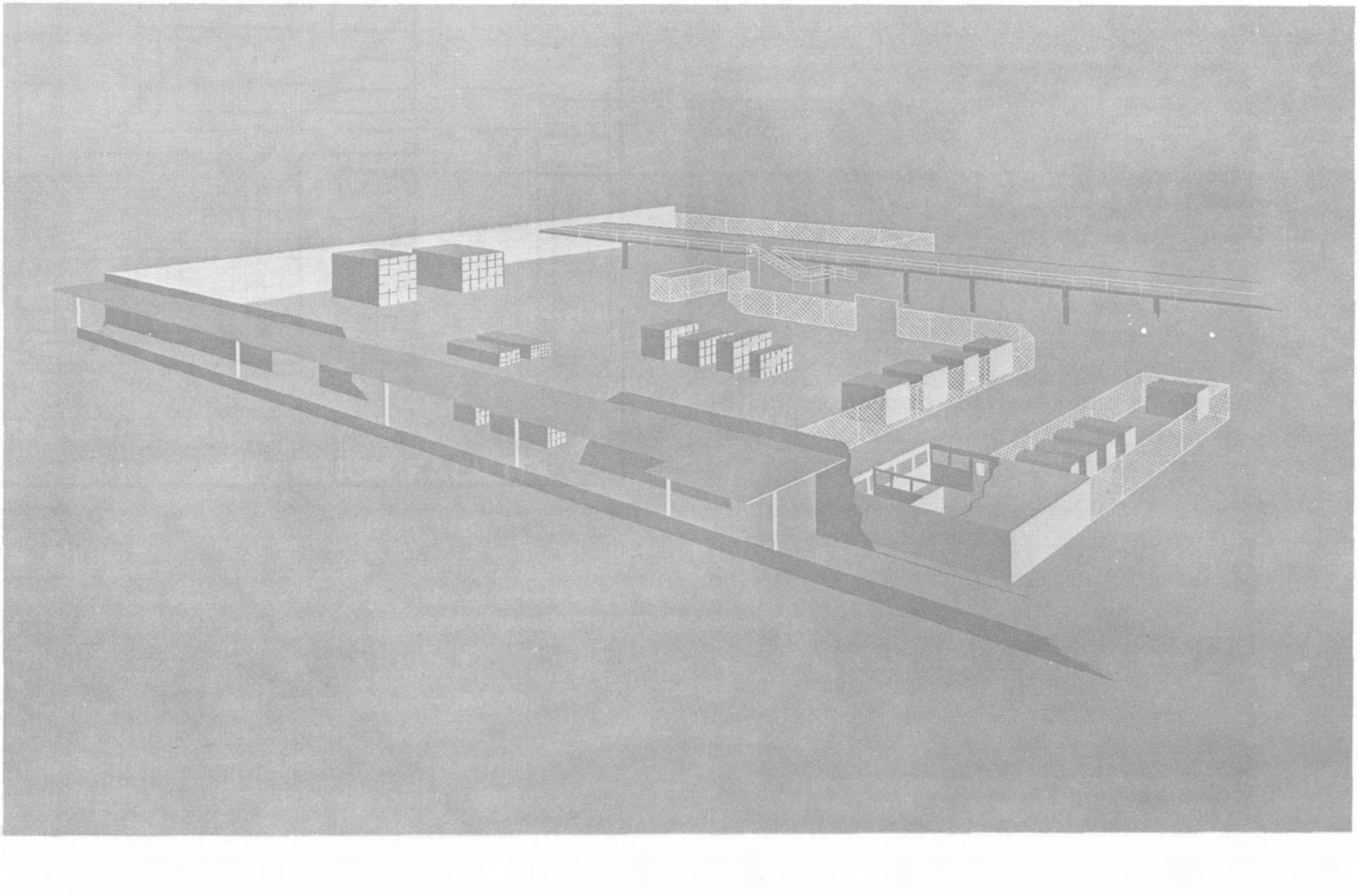
Function - The Receiving-Inspection area receives those components supplied by vendors, subassemblies, raw materials, and test equipment from the general receiving area. These items receive a planned inspection to verify compliance with specifications and general acceptance requirements. Visual and dimensional inspections are performed here with support from the Quality Evaluation Laboratories.

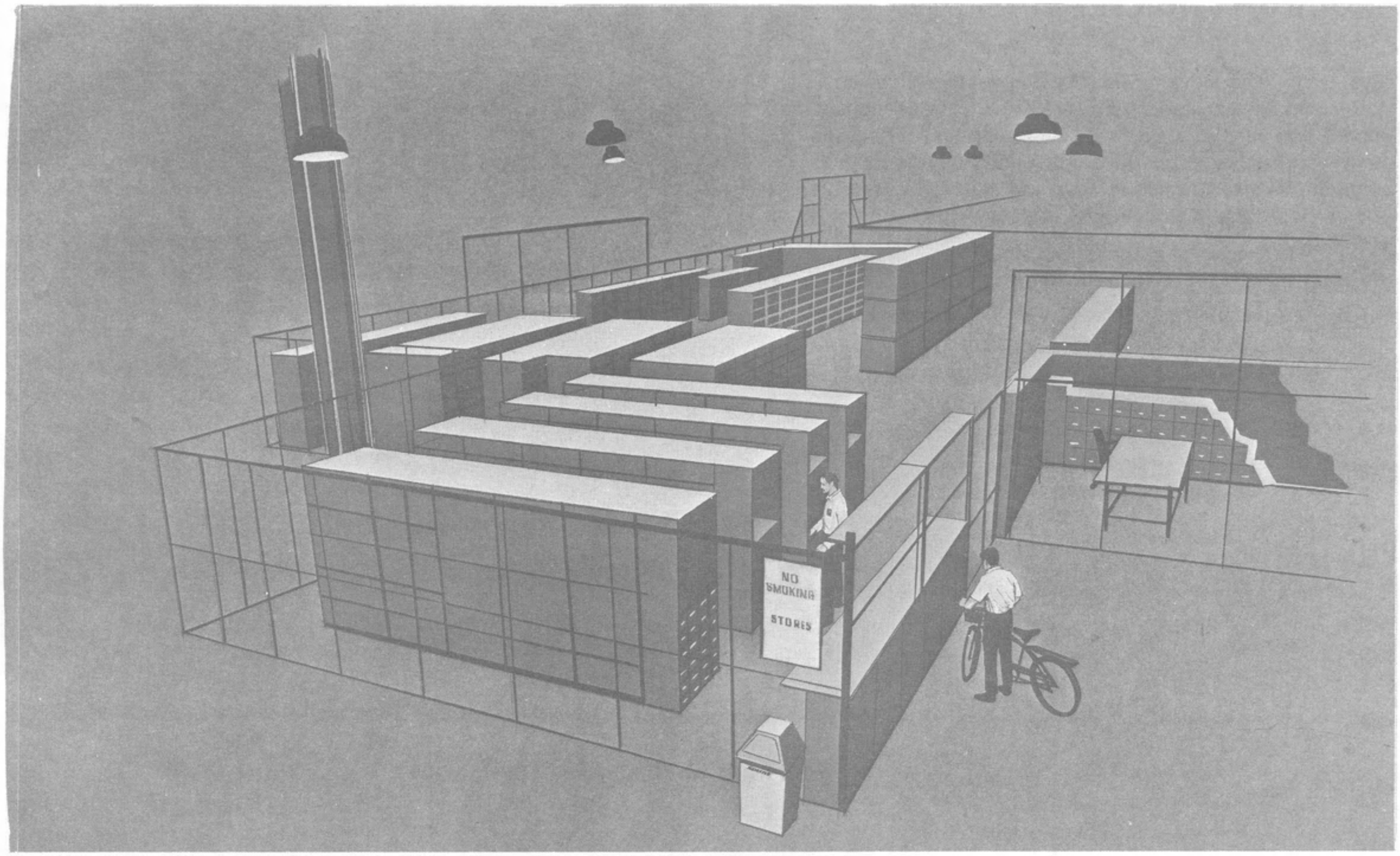
Using Organization - Finance and Quality Assurance

Area - Receiving and Receiving-Inspection Facility -- 24,506 square feet.

Milestones - Design ---------------- 6-20-63
Design Complete --------8-1-63
Construction Start ------ 9-10-63
Construction Complete -- 11-26-63

Contracts - 62-4 -- A&E
63-56 - Construction





WAREHOUSE AND STORES

Function - Foundations must be provided for special tool- the capability to store raw materials and subcontractor supplied items as required to support the manufacture of the S-IC booster.

Using Organization - Materiel

Area - 122,779 square feet

Milestones - Equipment Installation Started - 8-20-63
Equipment Installation Complete - 11-14-63

Contracts - 62-4 -- A&E

MOCKUP FACILITY

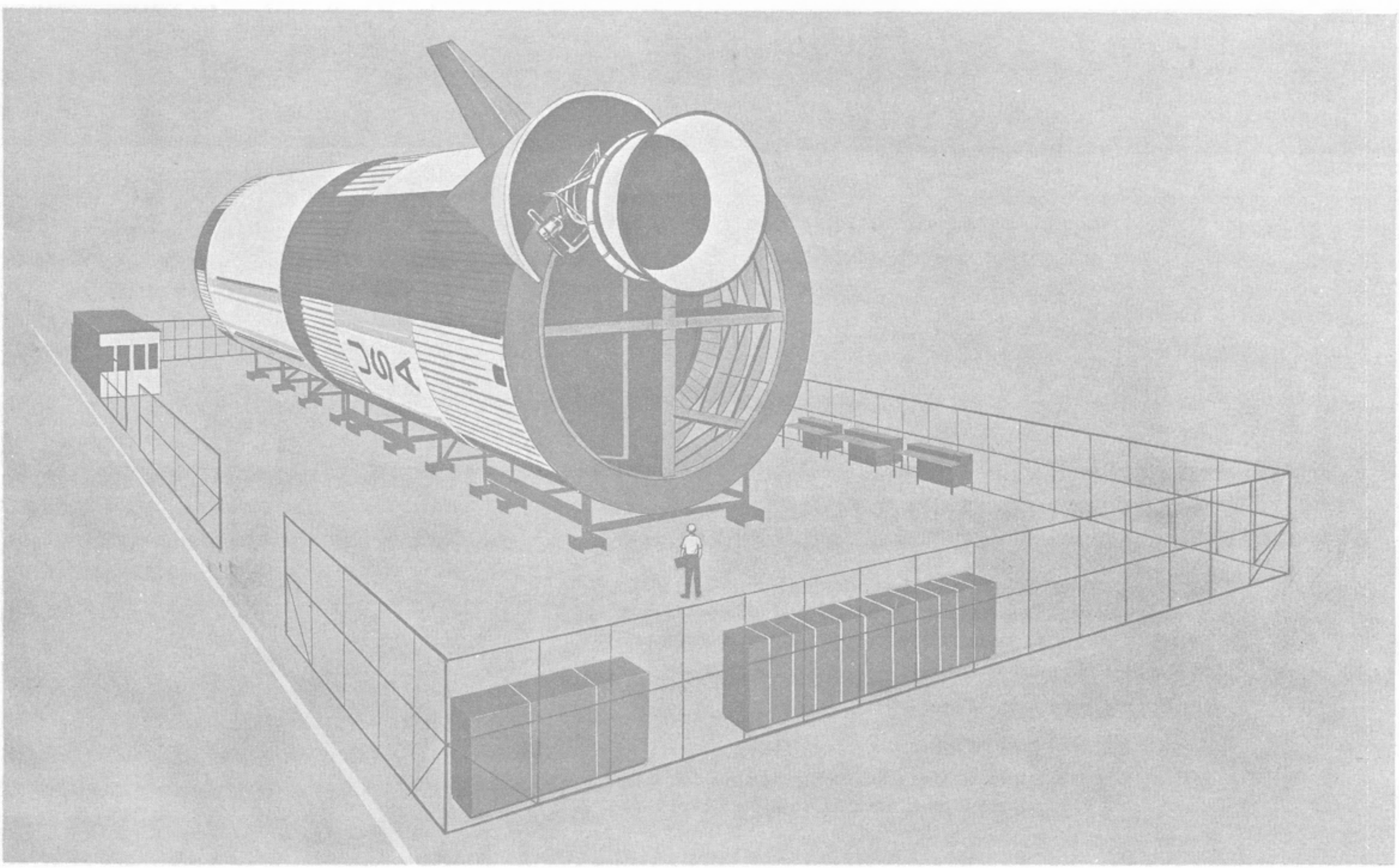
Function - The Mockup Facility houses the Michoud full-scale S-IC manufacturing model. This horizontal model was built to a Class III configuration. It serves as a forming board for developing and fabricating propulsion, electrical, astrionics, and hydraulic systems; for critical tank contours; and for component assembly locations.

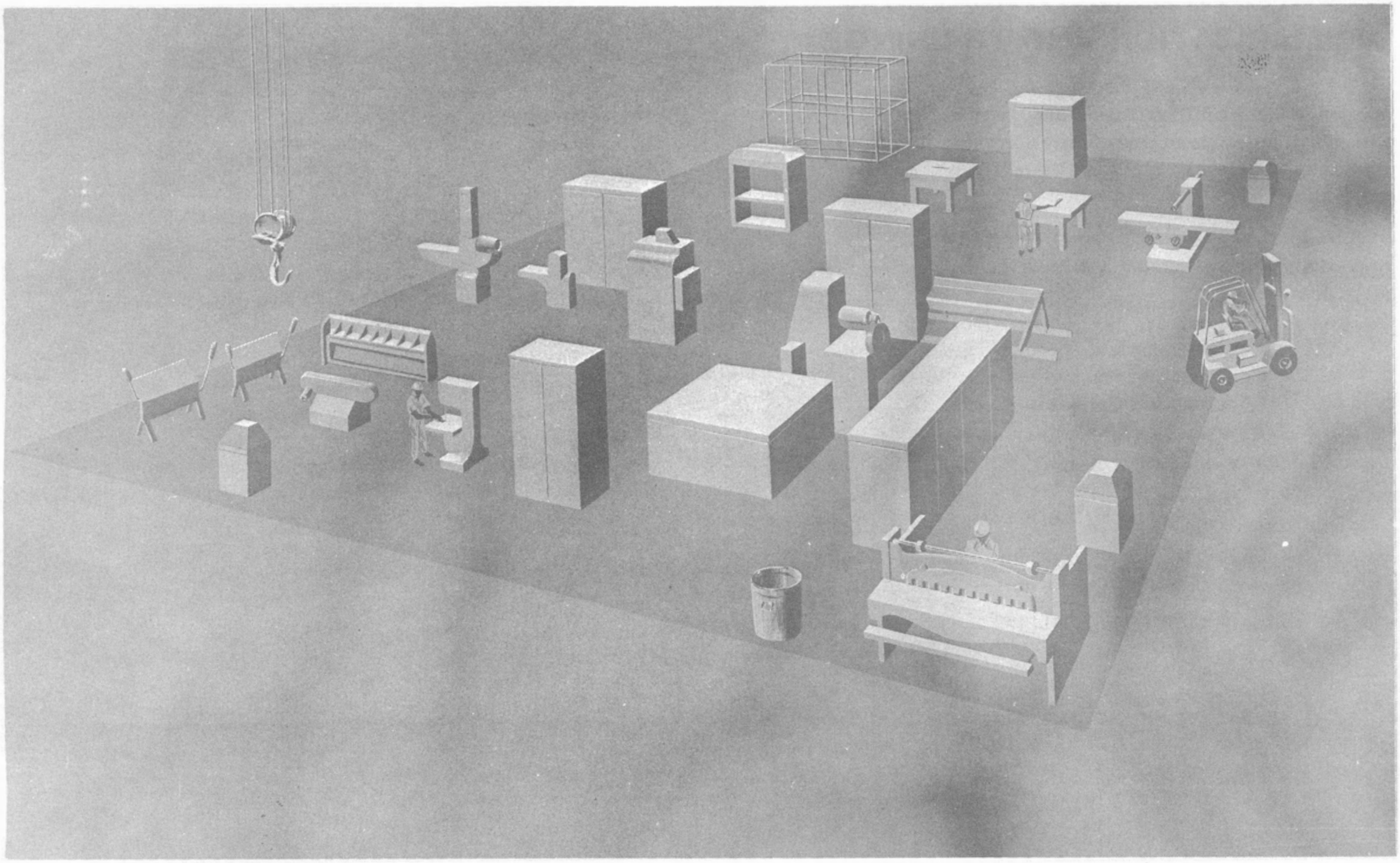
Using Organization - Manufacturing

Area - Full-Scale Model Facility -- 14,400 square feet

Milestones - Design Start ----------- 5-1-63
Design Complete ------- 10-8-63
Construction Start ------ 10-25-63
Construction Complete -- 12-27-63

Contracts - Design -- In-house
63-63 --- Construction





EQUIPMENT MAINTENANCE FACILITY

Function - The Equipment Maintenance facility is required to provide maintenance for general factory and office equipment. It affords the capability of fabricating items that, because of economy or scheduling, are not purchased from vendors; and provides for maintenance of production machine tools, fixtures and other accessory equipment, air-conditioning equipment and systems, metal office equipment, production welders, and general plant items. The facility is capable of housing and providing for maintenance of mobile equipment and consists of the following:

1) Machine Shop
2) Sheet-Metal
3) Woodwork Shop
4) Electrical Shop
5) Paint Shop
6) Transportation
7) Facilities Checkout Equipment
8) Filter Cleaning Facility

Using Organization - Facilities

Area - Equipment Maintenance facility — 23,678 square feet.

Milestones - Design Start ----------- 6-26-63
Design Complete ------- 9-30-63
Construction Start ------ 10-25-63
Construction Complete -- 3-26-64

Contracts - Design -- In-house
63-61 --- Construction

SUPPORT AND SERVICES AREAS
FAMILIARIZATION AND TRAINING

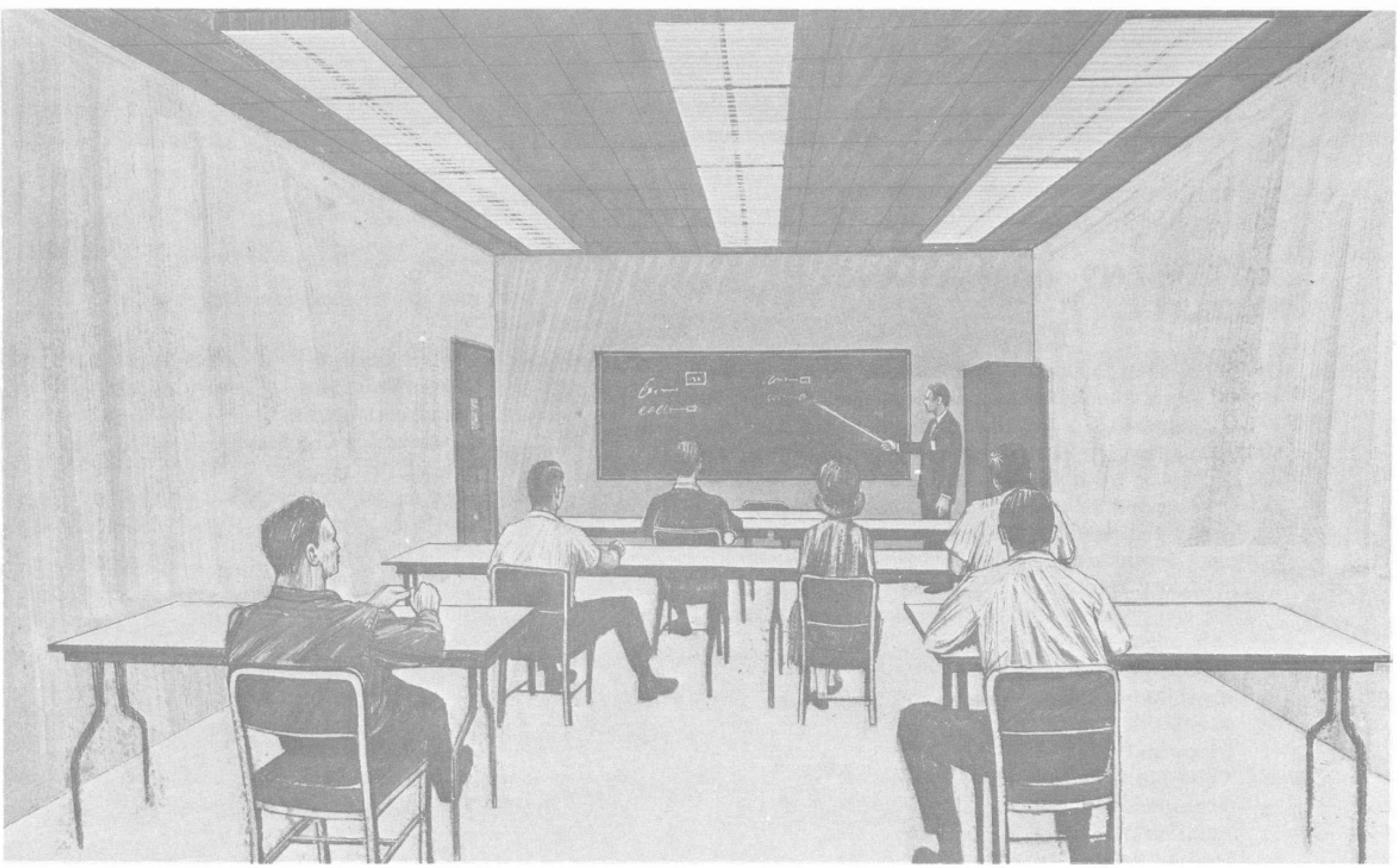
Function - The Familiarization and Training area will be used to train, orient, and certify personnel in sheet-metal assembly work, electrical fabrication, and optical tooling.

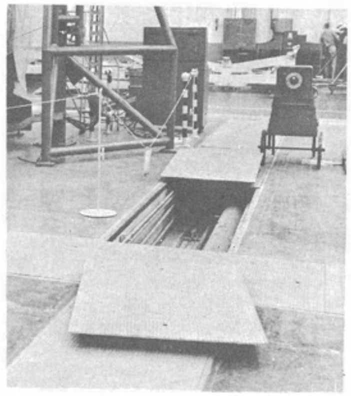
Using Organization - Industrial Relations Organization

Area - Familiarization and Training Facility -- 11,660 square feet.

Milestones - Design Start ----------- 9-15-63
Design Complete ------- 10-28-63
Construction Start ------ 10-28-63
Construction Complete -- 2-14-64

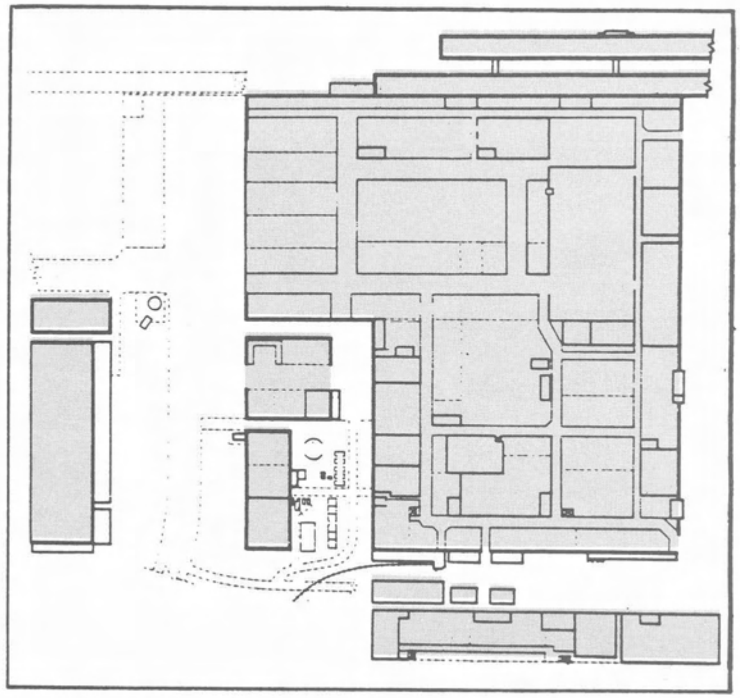
Contracts - 63-27 -- A&E
63-47 -- Construction

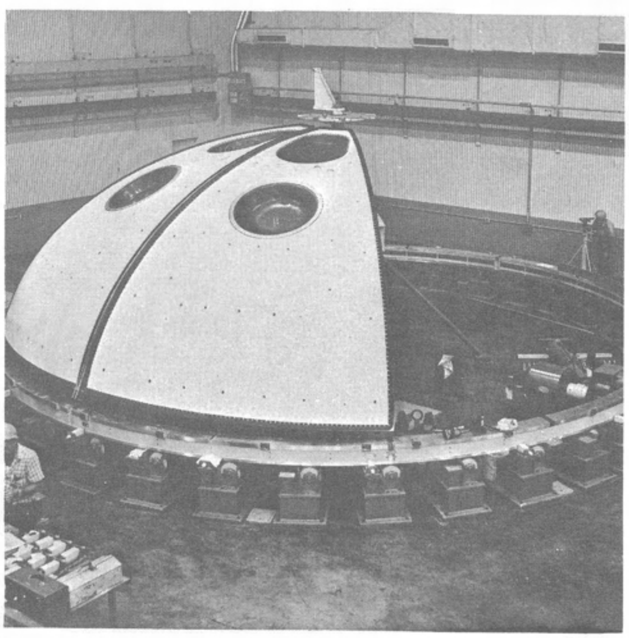




Special Gas Facilities

FACILITIES/GENERAL PLANT





Special Tooling Foundations

SPECIAL GAS FACILITIES

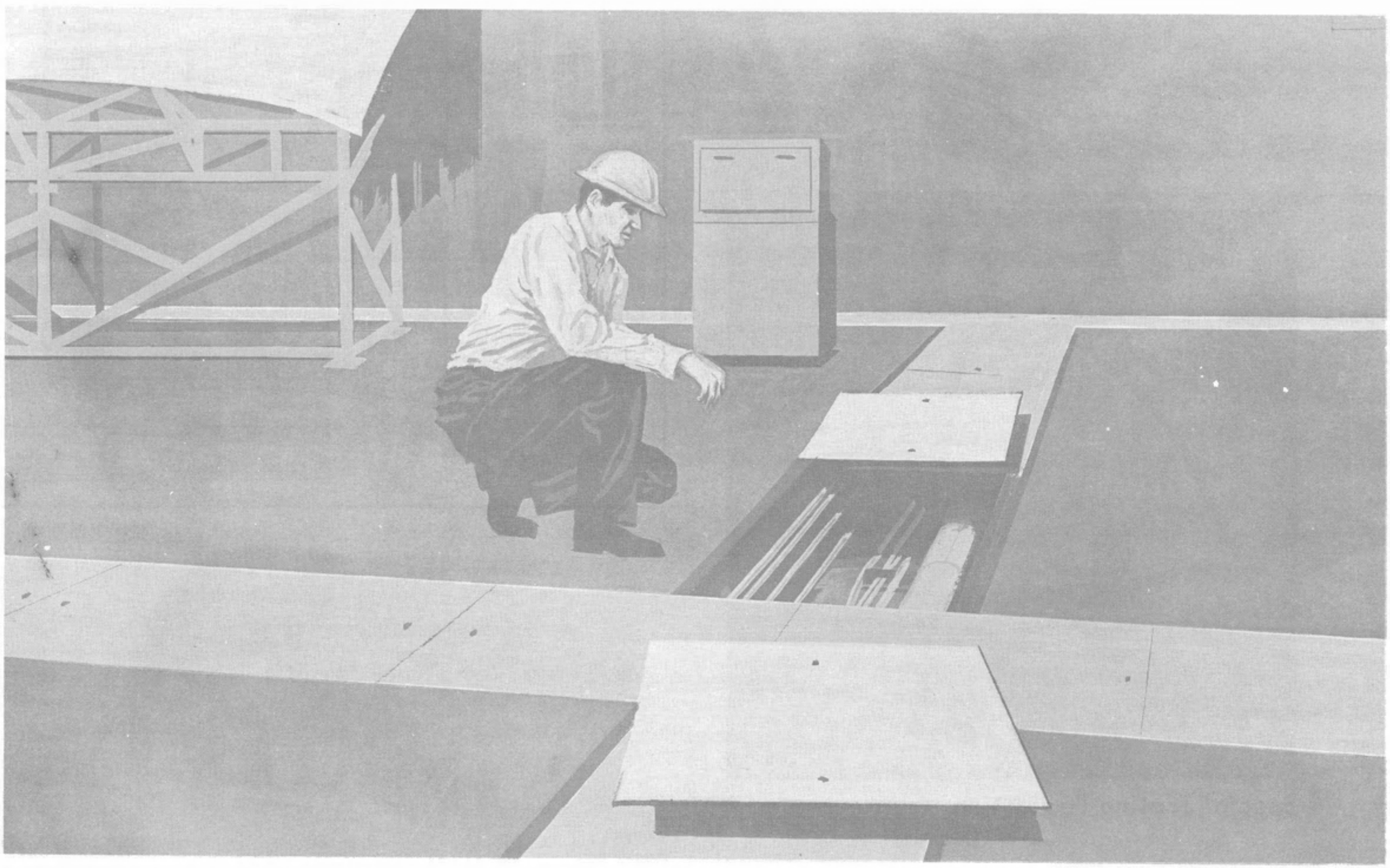
Function - The Special Gas facility will handle piped gaseous nitrogen (GN_2), helium, and argon; and liquid nitrogen (LN_2) stored in pressure vessels. Nitrogen will be used for testing, drying, packaging and purging. Helium will be used for pressurization and to create an inert atmosphere for certain welding processes. The principal use of argon is to be for weld shieldings. Small amounts of bottled CO_2 and CCl_2F_2 (Refrigerant 12) will also be used, primarily for instrumentation testing and other laboratory functions.

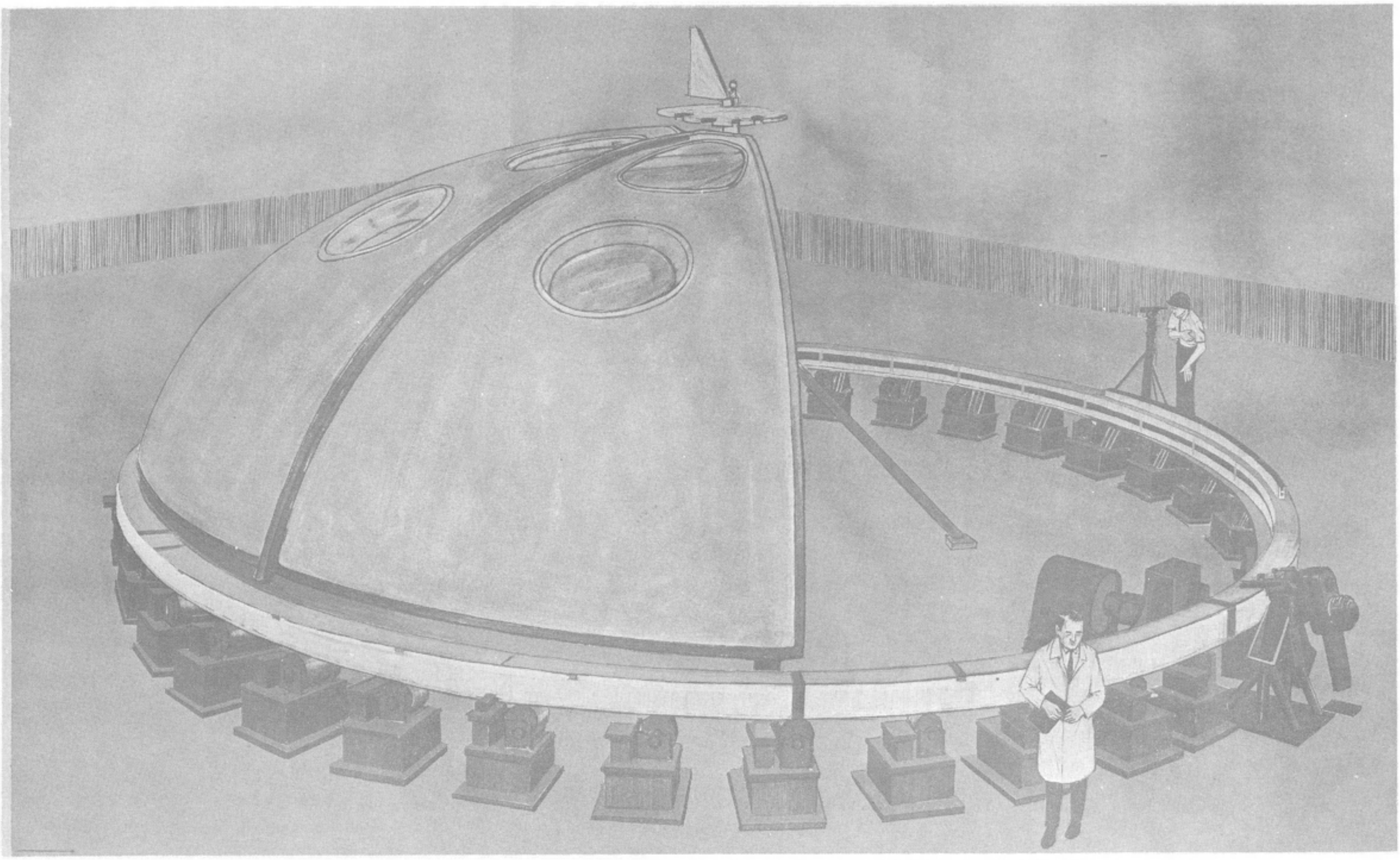
Using Organization - Manufacturing

Area - Not applicable

Milestones - Design Started --------- 1-1-63
Design Complete ------- 8-13-63
Construction Started ---- 12-21-63
Construction Complete -- 4-3-64

Contracts - In-house -- Design
63-53 -----Construction





SPECIAL TOOLING FOUNDATIONS

Function - Foundations must be provided for special tooling required in the assembly and manufacture of the S-IC booster and GSE/MSE.

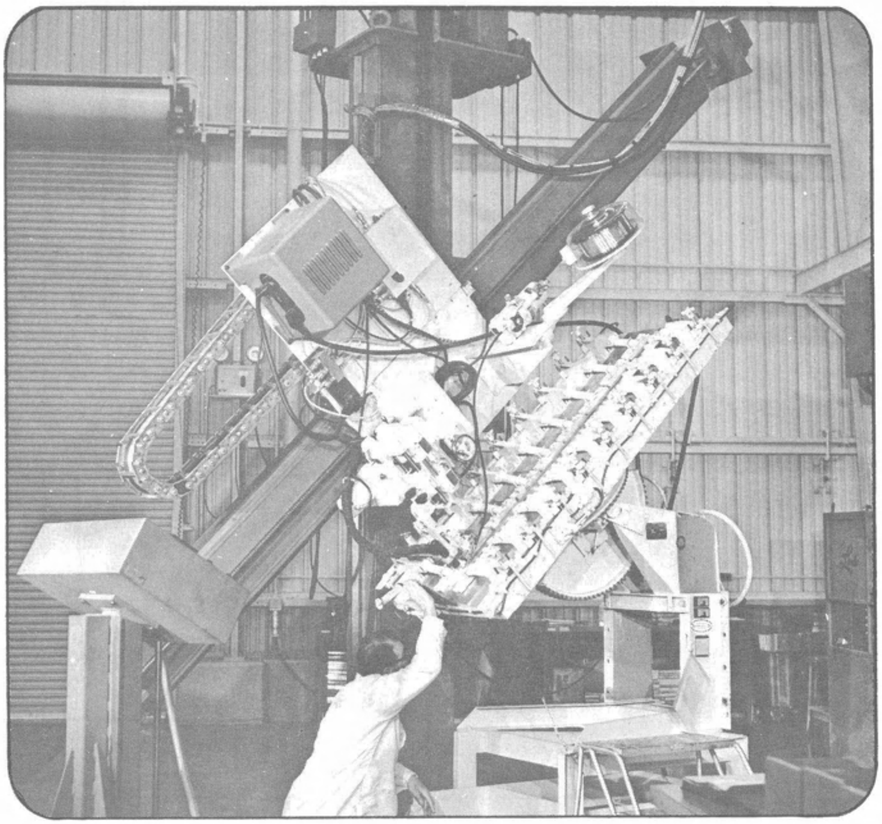
Using Organization - Manufacturing

Area - Not applicable

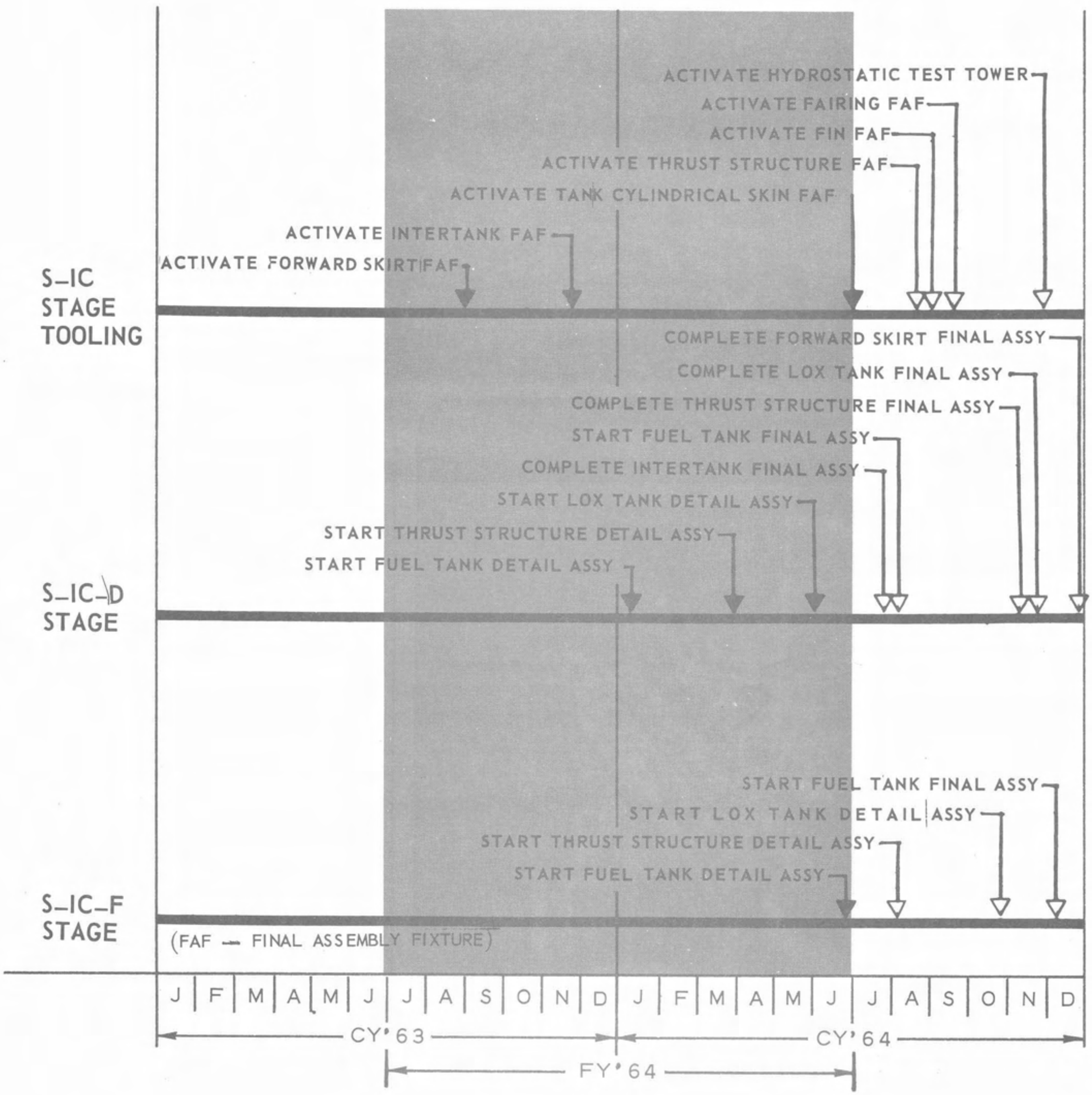
Milestones - Special Tooling Foundations Phases 5, 6, 7, and 8.

Phase 5 Started ---- 1963
Phase 5 Complete -- 9-27-63
Phase 6 Started ---- 1963
Phase 6 Complete -- 10-31-63
Phase 7 Started ---- 1963
Phase 7 Complete -- 2-29-64
Phase 8 Started ---- 1963
Phase 8 Complete -- 3-1-64

Contracts - 63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8



ASSEMBLY AND MANUFACTURING


ACTIVATE HYDROSTATIC TEST TOWER
ACTIVATE FAIRING FAF
ACTIVATE FIN FAF
ACTIVATE THRUST STRUCTURE FAF
ACTIVATE TANK CYLINDRICAL SKIN FAF
ACTIVATE INTERTANK FAF
ACTIVATE FORWARD SKIRT FAF
S-IC STAGE TOOLING
COMPLETE FORWARD SKIRT FINAL ASSY
COMPLETE LOX TANK FINAL ASSY
COMPLETE THRUST STRUCTURE FINAL ASSY
START FUEL TANK FINAL ASSY
COMPLETE INTERTANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-D STAGE
START FUEL TANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-F STAGE
(FAF — FINAL ASSEMBLY FIXTURE)
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

SUMMARY

S-IC stage assembly and manufacturing activity at the beginning of this reporting period was primarily oriented to structure component manufacture in support of the NASA/MSFC ground test program, and the fabrication and erection of stage tooling at Michoud. During the last three months of 1963, the scope of work was expanded to include increased procurement of stage systems specialty hardware, and components for test and checkout equipment. Ground support equipment (GSE) requirements for the NASA/MSFC ground test program were also defined during the same period, permitting Boeing to assess their capability to deliver equipment for R-Test and R-Qual laboratories at MSFC. By the end of June 1964, firm delivery dates were established for R-Test GSE, and the requirements were formally established for one set of test and checkout equipment to be installed at Mississippi Test Operations.

On January 22, 1964, the program schedule changed from NASA/MSFC Plan V to NASA/MSFC Plan VII. (See Part X of this report for a discussion of this change.) This changed The Boeing Company's responsibilities from providing the S-IC-F stage, and the S-IC-2 through S-IC-10 stages to providing the S-IC-D, the S-IC-F and the S-IC-3 through S-IC-10 stages. In conjunction with these program revisions, assembly and manufacturing activities were rephased to the new Plan VII schedule requirements. By the end of the first quarter of CY'64, Boeing had incorporated Plan VII schedules into its stage production schedules, established a GSE/MSE manufacturing program that supported the defined requirements of both MSFC and Michoud operations, and had made substantial progress in manufacturing development.

At the end of the first quarter of CY'64, delay of construction on the hydrostatic test facility for the Michoud vertical assembly building suggested a slippage in completion of the S-IC-D stage. However, by the end of the reporting period, the condition had been lessened and was no longer considered a problem affecting delivery of the S-IC-D. Other major problems during March 1964, were: indications of major rework to intertank tooling resulting from potential structural changes to intertank hardware; and incompatabilities between Boeing production requirements and delivery schedules proposed by NASA/MSFC for government-furnished F-1 engines, beginning with the S-IC-3 stage. The requirement for redesigned intertank hardware became firm in the second quarter of CY'64 and Boeing assembly and manufacturing schedules were adjusted to absorb two additional intertank assemblies, plus the necessary rework of the assembly tooling. Resolution of the NASA/MSFC-Boeing F-1 engine schedules was still being studied at the close of the reporting period.

At the end of June 1964, The Boeing Company's Contract NAS8-5608 assembly and manufacture activity included assembly operations on S-IC-D hardware and GSE/MSE for all locations. Minor behind-schedule conditions existed in several areas; however, recovery is predicted and all GSE/MSE and S-IC stages are forecast to be delivered per the NASA/MSFC Plan VII schedule requirements.

S-IC-D STAGE

The Boeing Company activity for the S-IC-D stage, Plan V requirements, was directed toward assisting NASA/MSFC in a role similar to that of the S-IC-T stage; namely, that of supplying NASA/MSFC specific assemblies, major components, and hardware items as required. NASA/MSFC Plan VII effected the realignment of The Boeing Company responsibilities to include assembly of the S-IC-D stage at the Michoud facility.

Under Plan VII, the S-IC-D stage is to be delivered to MSFC on August 20, 1965. Assembly and manufacturing activities were rephased to the new Plan VII requirements, and by the end of March 1964, Boeing had completed the incorporation of Plan VII into its production schedules.

Actual production of the S-IC-D stage was initiated during the third quarter of CY'63 with the fabrication of fuel-tank skin ring segments (Figure III-1). In November 1963, procurement activity started with the placing of purchase orders for long lead items. The first quarter of CY'64 was highlighted by an increase in component fabrication for the S-IC-D stage. By the end of the second quarter of 1964, components were available at Michoud for tank assembly. Fittings were being welded in bulkhead gore segments, and weld operations on the S-IC-D fuel tank skin rings were performed. Parts were available for the thrust structure and center-engine support structure (Figures III-2 and III-3), and were scheduled for assembly in the early part of July 1964.

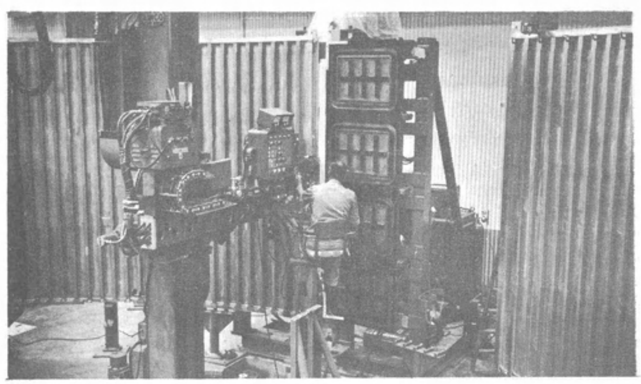


Figure III-1 - Boeing Technician Routing an S-IC-D Tank Skin Ring Segment Prior to Welding in the Environmentally Controlled Minor Assembly Area at Michoud

At the close of the first quarter of CY'64, construction of the hydrostatic test facility in the Michoud Vertical Assembly Building was being delayed. This con-

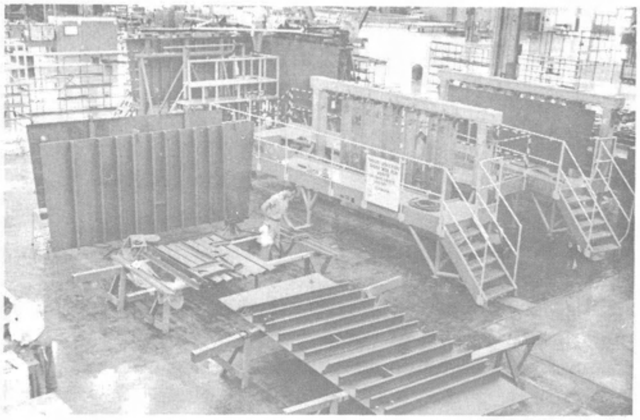


Figure III-2 - Shear Web Panels for the Center Engine Support Assembly (Background) are Being Completed at Michoud

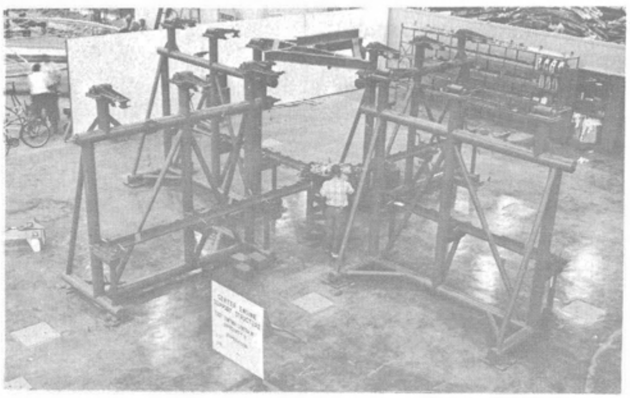


Figure III-3 - Assembly Fixture Used For the Center-Engine Support Nears Completion.

dition threatened completion schedules for the S-IC-D fuel and LOX tanks and resulted in a predicted late delivery of the S-IC-D stage. Close cooperation between NASA/MSFC and Boeing in resolving funding problems allowed Phase II vertical assembly building construction to proceed in April 1964. Although a 17-day behind schedule condition still exists on this construction, the use of work around methods has alleviated this condition and hydrostatic testing is no longer considered a major problem area. Construction progress at this time is shown in Figures III-4 and -5.

As a result of findings derived from tests conducted on a scale model intertank during the early months of 1964, a second problem was discovered. Failure of the scale-model intertank under some loading conditions suggested certain modifications to the intertank structural hardware, which in turn required modification of the intertank assembly tooling. At first, this indicated that the S-IC-D intertank assembly schedule would be adversely affected. Subsequent studies on intertank assembly fixture loadings indicated that both the hardware and tooling could be modified without impairing S-IC-D intertank completion schedules.

At the close of the reporting period Boeing activity in support of the S-IC-D stage was generally supporting NASA/MSFC Plan VII schedules. Delivery of the S-IC-D stage to MSFC on August 20, 1965, is currently expected to occur on schedule.

S-IC-F STAGE

At the outset of the reporting period, Boeing emphasis on the S-IC-F stage was centered on stage tooling design and fabrication requirements. Boeing had completed approximately 60 percent of the tool design and 35 percent of the tool fabrication for the total S-IC-F stage requirements by the end of September 1963.

Working to Plan V schedules, Boeing began fabricating S-IC-F detail parts at Boeing/Wichita, during the fourth quarter of CY'63. Assembly operations were then due to start at Michoud during the first quarter of CY'64. However, when NASA/MSFC Plan VII schedules became effective in January 1964, a revision of S-IC-F stage production schedules was necessary to meet a new NASA/MSFC on-dock delivery date, January 21, 1966, to the Merritt Island Launch Area. Under the new schedule requirements, major assembly activities are to start at Michoud in August 1964. Component fabrication is on schedule in support of this assembly requirement, and the S-IC-F stage is forecast to be completed on schedule.

S-IC-3

Michoud assembly activities in support of the S-IC-3 stage are scheduled to start late in the fourth quarter of CY'64. Plan VII requires delivery of this stage to Mississippi Test Operations on August 1, 1966, for static

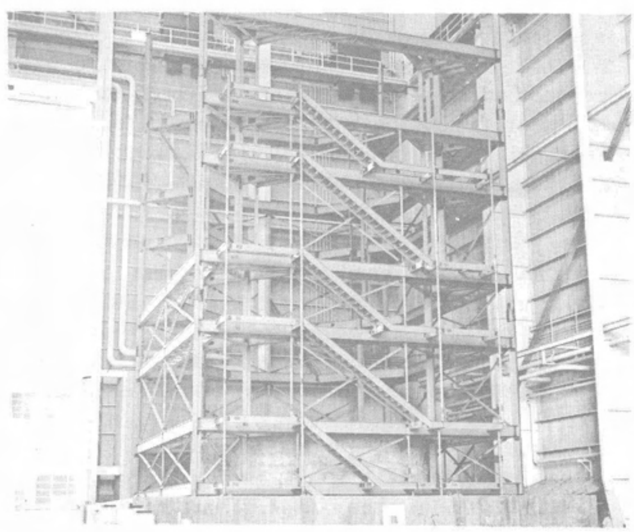


Figure III-4 - Construction Progress on the Hydrostatic Test Tower in the Vertical Assembly Building at Michoud

testing. Following this, the stage is to be returned to Michoud for refurbishment, checkout, and eventual delivery to MILA on February 21, 1967.

Hardware orders for the S-IC-3 were released during the fourth quarter of CY'63, and by the end of the first quarter of CY'64 the fabrication of detail components was underway. By the close of the reporting period, approximately 90 percent of the known structural hardware components had been placed on order.

The only item of concern relative to the S-IC-3 stage is the availability of F-1 engines from Rocketdyne. During the first quarter of CY'64, it became apparent that the NASA/MSFC proposed availability dates of these government furnished engines were not compatible with Boeing engine buildup schedules in support of the S-IC-3 stage assembly. This is currently under study by both NASA/MSFC and Boeing. Although progress is being made, the problem has not been completely resolved. It is anticipated that a satisfactory solution will be effected by either acceleration of engine deliveries to Michoud or the authorization of workaround techniques, so that the Plan VII schedules for delivery of the S-IC-3 stage will be met.

S-IC STAGE TOOLING

Fabrication and erection of tooling for Michoud started during the early months of 1963 and continued through the reporting period. Significant tooling activated during the fiscal year were the intertank, forward skirt, and thrust structure final assembly positions (Figures III-6, III-7, and III-8) along with the necessary supporting subassembly and minor assembly tooling. The LOX and fuel-tank minor assembly tooling, used to assemble bulkheads and cylindrical tank skins (Figure III-9), was certified for the assembly of production hardware. By the end of the reporting period, tank tooling was being installed in the tank final assembly area in the Michoud Vertical Assembly Building.

The change from NASA/MSFC Plan V to Plan VII in January caused considerable adjustments to Boeing tool loading schedules. These adjustments were incorporated into the Boeing schedules by the end of March 1964. During the second quarter of CY'64, it was necessary to further realign tool loading for both the intertank and thrust-structure assemblies.

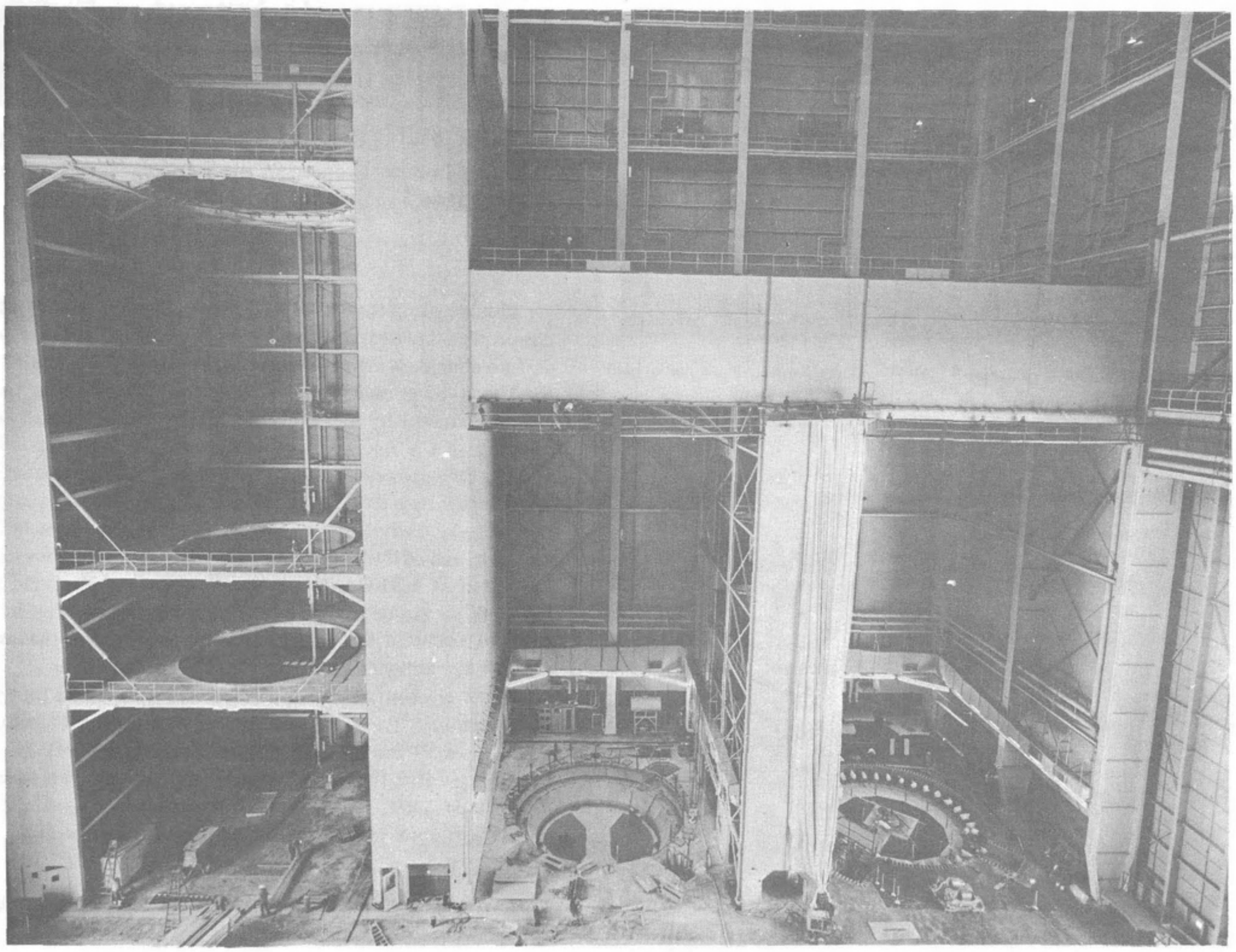


Figure III-5 - Construction Progress on the Vertical Assembly Installations in the Vertical Assembly Building at Michoud.

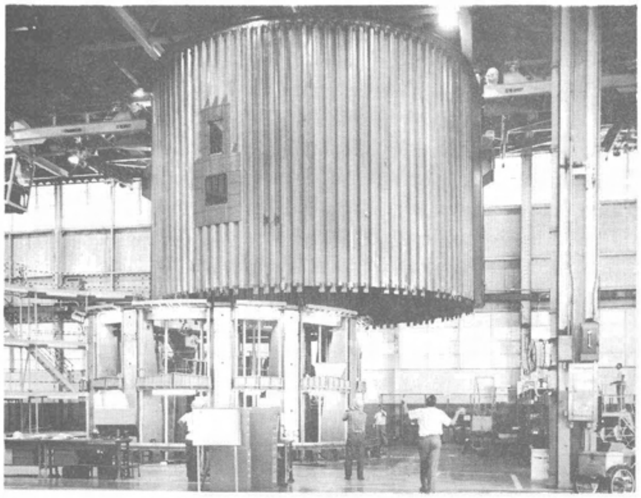


Figure III-6 - Two Overhead Cranes Swing Away the Completed S-IC-S (1) Intertank Assembly at Michoud. The Upper Structure of the Fixture was Removed to Facilitate the Removal.

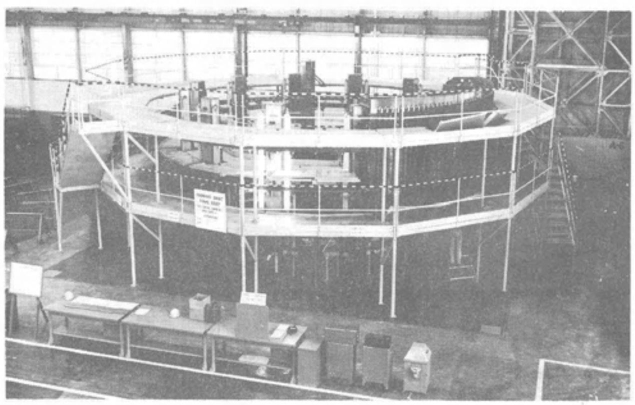


Figure III-7 - Forward Skirt Final Assembly Fixture with S-IC-S Skin Panels

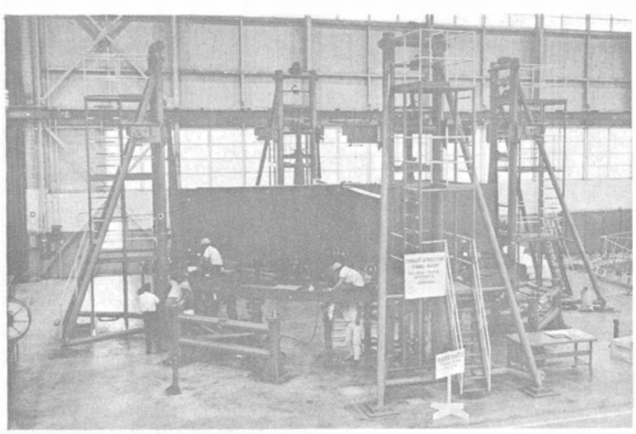


Figure III-8 - First Loading Operation of the No. 1 Thrust-Structure Final Assembly Fixture at Michoud. Lower Thrust Ring, Hold-Down Posts, and Center Engine Support Assemblies are seen Positioned in Fixture

The rearrangement of loading for the intertank resulted from the requirement for two additional intertanks for the S-IC-S stage. These additional intertanks were introduced as a result of engineering recommendations following tests conducted on a scale model intertank. The schedule has been adjusted to allow assembly of the additional intertanks and modification to the intertank tooling. Modification will occur during the third quarter of CY'64, and will not impair Boeing's ability to meet delivery commitments supporting the Plan VII schedule.

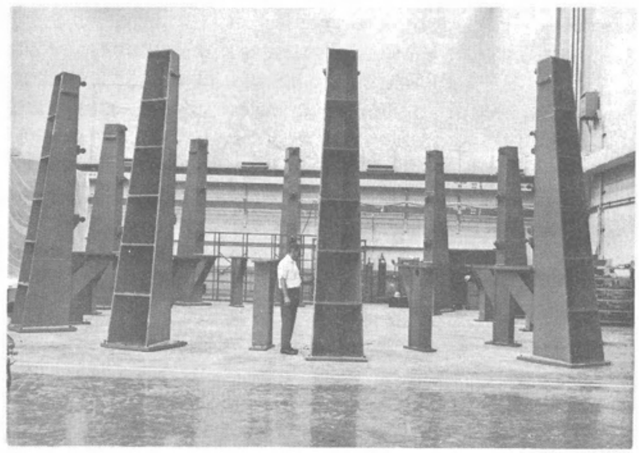


Figure III-9 - Tool Erection of a Tank Cylindrical Skin Assembly Fixture Located in the Environmentally-Controlled Bulkhead Subassembly Area at Michoud

Thrust structure tool erection (Figure III-10) at Michoud was accelerated and tool loading schedules amended so that S-IC thrust structures could be assembled for the S-IC-S and follow-on stages. This was a major change caused by a NASA/MSFC decision, in the second quarter of CY'64, to stop assembling thrust structures at MSFC/Huntsville and transfer both the responsibility and the tooling to Boeing/Michoud for assembly of the S-IC-S, -1, and -2 stage thrust structures from MSFC. At the close of the reporting period, the tooling previously installed at MSFC was being relocated at Michoud while the S-IC-S stage thrust-structure hardware was being used to activate the initial assembly position that was a part of the original tooling plan.

Work is continuing on the tooling still remaining to be activated. Tank assembly will be started in August 1964, as will the fin and fairing (Figure III-11) tooling.

Hydrostatic test will be activated late in the fourth quarter of 1964, and assembly of the S-IC-D stage will activate the vertical assembly position in January 1965.

MANUFACTURING DEVELOPMENT

Manufacturing development effort was moved from

the interim location to the permanent Manufacturing Development Laboratory facility in December 1963. The manufacturing development effort is oriented along: (1) weld development, weld equipment checkout and certification; and (2) process and production technique development and certification. Particular emphasis has been placed in the development of chemical milling production techniques.

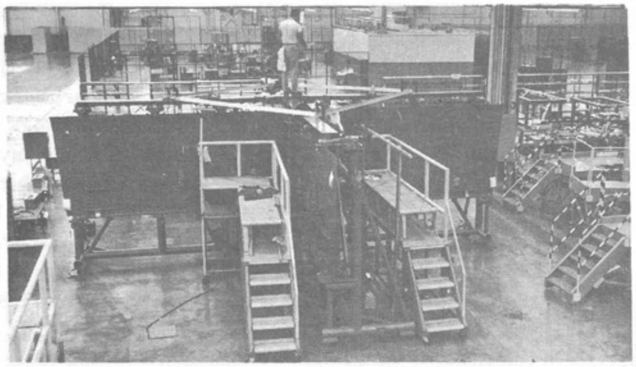


Figure III-10 - Center Engine Support Assembly Fixture at Michoud Showing Shear Web Subassemblies Loaded in the Fixture

Figure III-11 - Engine Fairing Tooling at Michoud

The completion of weld certification activity on bulkhead fitting welds, apex-to-base welds, and actuator supports are typical of weld certification efforts during the period.

Weld development activity (Figures III-12 through III-17) has continued at a high rate in areas such as inert-gas-shielded tungsten-arc (TIG) spot welding, oscillated inert-gas-shielded metal (MIG) arc welding, weld planishing and gore-to-gore welding.

Completing the chemical cleaning and finish process facility in the first quarter of CY'64 allowed process certification to be completed in all operations of the aluminum cleaning and conversion coating line except conversion coating, during March 1964. Certification of conversion coating application was completed in April.

Process and production technique development acti-

Figure III-12 - Shrink Fitting--Temperature Inspection During Freezing of Bulkhead Fitting Prior to Welding Operation

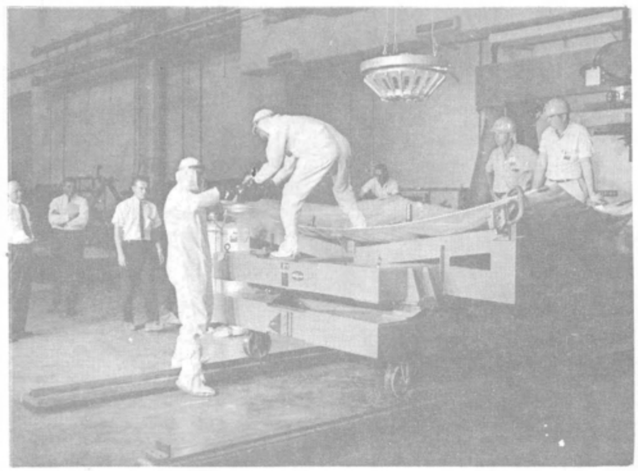


Figure III-13 - Shrink Fitting--Frozen Bulkhead Fitting Being Positioned for Welding to Gore Base

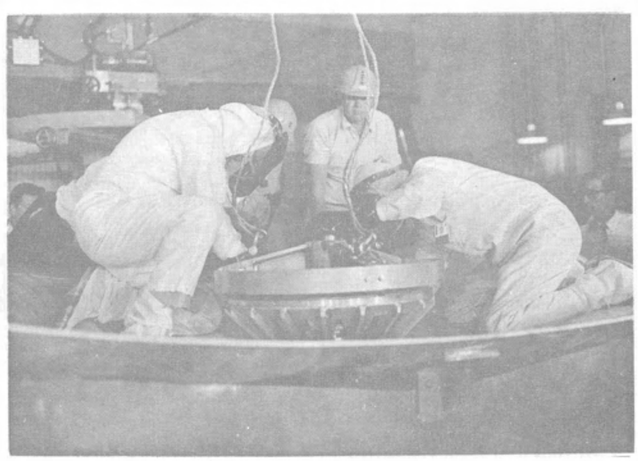


Figure III-14 - Shrink Fitting--Technicians Clamping Frozen Fitting into Place for Welding to Gore Base

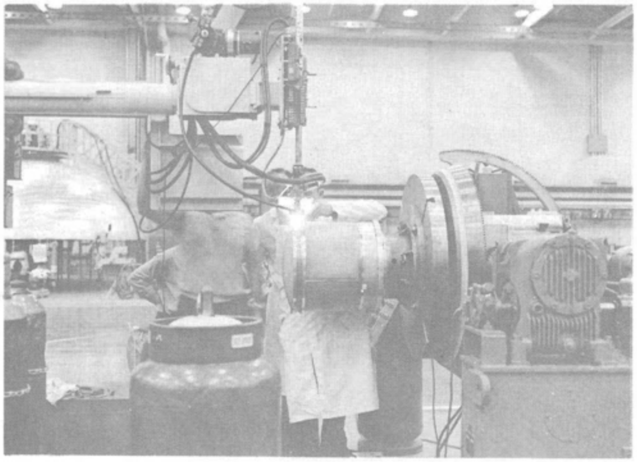


Figure III-15 - Technicians Perform a Weld Operation on a Helium Distributor, in the Bulkhead Minor Assembly Area at Michoud

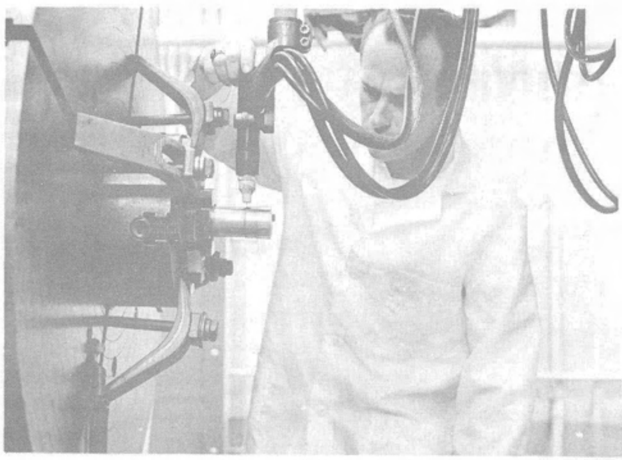


Figure III-16 - A Test Weld Set-Up on Weld Lathe in the Manufacturing Developmental Laboratory at Michoud

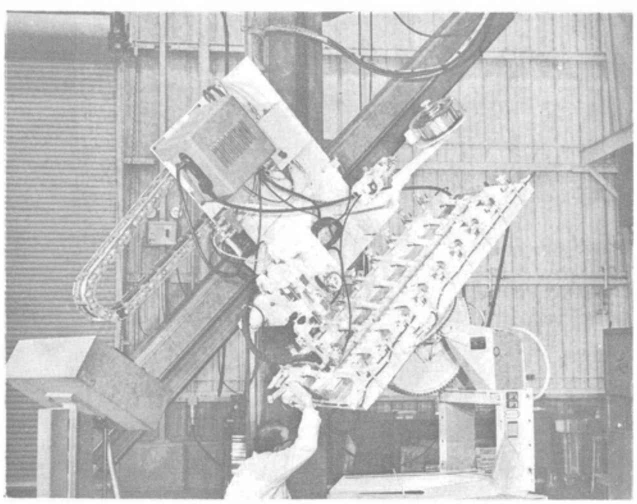


Figure III-17 - Technician Runs Weld Tests Using Inert Gas Process in the Manufacturing Development Laboratories at Michoud

vity was in evidence in such areas as mold dies, thermocouple welding, and stage wiring identification.

The establishment of sufficient chemical milling capability to support program schedules and reliability requirements has accounted for a considerable degree of activity in combined efforts between NASA/MSFC and Boeing. Chemical milling problems have been attributed basically to non-uniform chemical milling etch rates peculiar to 2219-T37 aluminum.

Chemical milling conferences have been held throughout the reporting period with NASA/MSFC, Boeing, prime aluminum fabricators, and nearly all present and potential chemical milling suppliers being represented. Techniques and courses of action to resolve this problem are being discussed and decided upon at these meetings. To date the non-uniform etch-rate problem is being investigated along two lines: (1) improvement of metallurgical homogeneity; and (2) development of a chemical milling etch not sensitive to metallurgical inconsistencies.

Additional developmental effort was expended in the investigation of ram flaring techniques, bonding adhesive, and machining and fastener applications.

In the area of weight reduction, a manufacturing process for pocket milling T-sections in machined Y-rings was under development as part of a 5000-pound-per-vehicle weight reduction proposal.

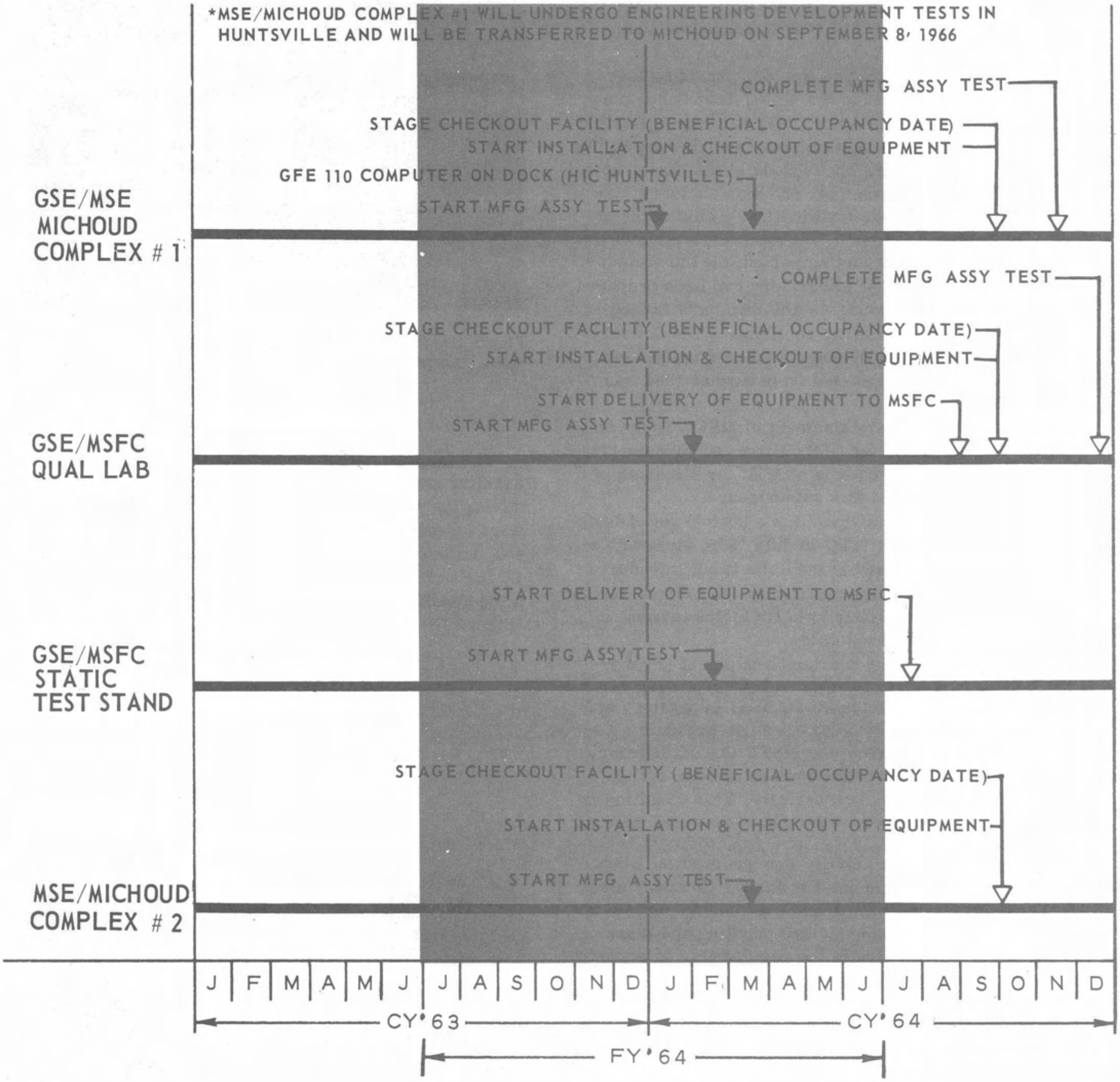
Extensive coordination between The Boeing Company and the Parsons Corporation of Traverse City, Michigan, was conducted to eliminate problems encountered in manufacturing the one-piece LOX tunnel assemblies.

Two major process modifications in the second quarter of 1964 resulted in manhour savings and increased reliability:

1) Conversion Coating Plan for Bulkhead Assemblies--the conversion coating of detail parts was changed to conversion coating of the entire bulkhead by use of the major component cleaning facility. This procedure eliminated the manhours previously required for stripping conversion coating prior to each welding operation;
2) Electrical Conductive Coatings--the process call-out on ground support equipment drawings was changed from abrasive cleaning prior to conversion coating to less costly chemical cleaning, resulting in increased reliability.

GSE/MSE

Fabrication of GSE items was hampered during the third quarter of CY'63, pending the result of deliberations between NASA/MSFC and Boeing on GSE Pre-Phase I submittals. Subsequent to these discussions in the following quarter, NASA/MSFC issued authorization to proceed. The agreement on the definition of the functional and physical characteristics of the equipment involved, allowed Boeing to establish delivery capability through an assessment of the required manpower and workloads. As a result of this assessment, Boeing was predicting ability of meeting delivery requirements on


*MSE/MICHOUD COMPLEX #1 WILL UNDERGO ENGINEERING DEVELOPMENT TESTS IN HUNTSVILLE AND WILL BE TRANSFERRED TO MICHOUD ON SEPTEMBER 8, 1966
GSE/MSE MICHOUD COMPLEX # 1
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
GFE 110 COMPUTER ON DOCK (HIC HUNTSVILLE)
START MFG ASSY TEST
GSE/MSFC QUAL LAB
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
GSE/MSFC STATIC TEST STAND
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
MSE/MICHOUD COMPLEX # 2
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START MFG ASSY TEST
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

the R-Qual Laboratory set by the end of the fourth quarter of CY'63; however, delivery of several items of the Test Division GSE were predicted to be later than required. During the fourth quarter of CY'63, fabrication of subassembly and parts test equipment was initiated. Modification No. 67 to Contract NAS8-5608, which effected NASA/MSFC Plan VII Schedule, called for the simultaneous installation of test and checkout equipment at both the MSFC Quality Laboratory and at Michoud. Since Modification No. 53, providing test and checkout equipment to the MSFC Test Laboratory, was being negotiated in April 1964, it was not possible to determine the full effect on manufacturing capability or schedule adherence. The outlook at that time, however, indicated that assembly and manufacturing activity in support of both modifications would occur at the same time.

By the end of the reporting period, the list of equipment for the MSFC Test Laboratory had been prepared, on-dock date requirements established, and Boeing Company delivery capability confirmed. The delivery of this equipment, finally negotiated as Modification No. 106, will span the period from August 1964 into October 1965.

In addition to the establishment of MSFC Test Laboratory requirements for GSE, a firm requirement for the first of two proposed sets of MSE for Mississippi Test Operations (MTO) was authorized.

An anticipated requirement for a second set of equipment to be available at MTO in July 1966, along with an additional set at Michoud at the same time, introduces the necessity of obtaining contract go-ahead from NASA/MSFC early in the third quarter of 1964 if the equipment is to be available on those dates.

Four sets of test and checkout equipment (Figure III-18) were in work at the close of the reporting period. The equipment for the MSFC Test Laboratory and for the Michoud MSE Complex 2 was on schedule. Assembly and manufacture of the MSFC Qual Laboratory and Michoud MSE Complex 1 equipment were 3 and 6 weeks behind schedule, respectively. This condition is expected to be alleviated by the end of the third quarter of 1964.

Concurrent with the activity in support of the stage test and checkout equipment The Boeing Company also was assembling subsystems test equipment, subassembly and parts test equipment, and handling and transportation equipment. Due to the requirement to perform testing on specialty hardware items for the S-IC-T, it was necessary to activate interim test facilities. At the close of the reporting period the construction of the permanent test facility was not complete; however, the continued use of the interim facility provided the testing required to support S-IC-T schedules.

Twenty-one stations, composed of subassembly and parts test equipment, were scheduled for activation by the end of the reporting period. Only three permanent stations and four of an interim nature were activated at that time, but testing schedules were supported with approved workaround equipment and procedures which will accommodate test activities until the qualified test stations become available.

Figure III-18 - GSE/MSE Drawer and Rack Assemblies Shown Nearing Completion and also Ready for Shipment

The forward handling ring was the major item of handling and transportation equipment to be in work during the reporting period. The first unit of the forward handling ring completed assembly and test, and was delivered to MSFC during the first quarter of 1964. By the end of the second quarter of 1964 a second forward handling ring had been delivered and a third unit (Figure III-19) was being assembled.

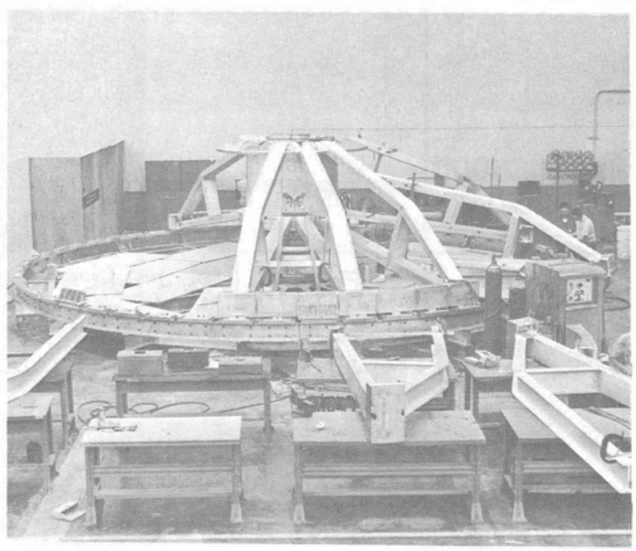
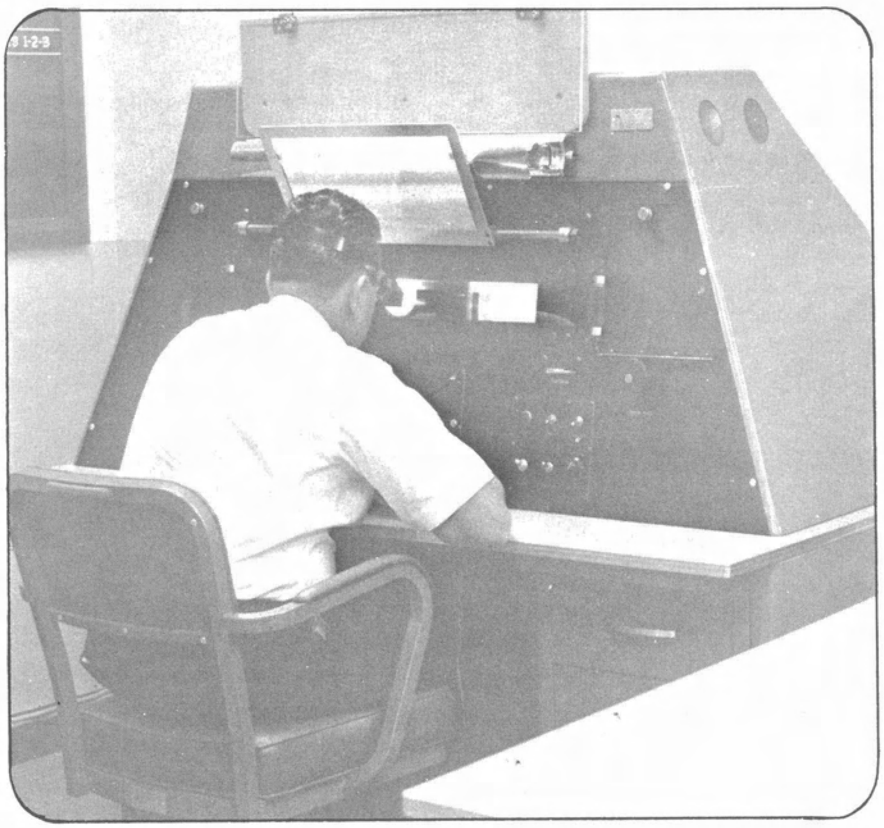


Figure III-19 - Tooling Mechanics Installing Radial Trusses on Third Forward Handling Ring Assembled at Michoud



QUALITY ASSURANCE

Fiscal year 1964 was characterized by significant progress in all basic functions of quality and reliability assurance. In July 1963, interim facilities were in use and numerous workaround measures were used to perform required tasks. Systems, procedures, and techniques were basically conceptual at the beginning of FY 64. By the year's end, they had become operational. Permanent facilities had been activated and refinements had been made in systems, procedures, and techniques as initial deliveries were accomplished on the S-IC-T vehicle components..

QUALITY ASSURANCE CAPABILITY

Significant progress was made during FY 64 in expanding inspection and test capabilities consistent with accelerating hardware schedules. During the early part of FY 64, interim facilities such as those shown in Figures IV-1 and IV-2 were still in use. In January

Figure IV-1 - Interim Quality Assurance Development Laboratory in Use at Michoud in Early FY 64

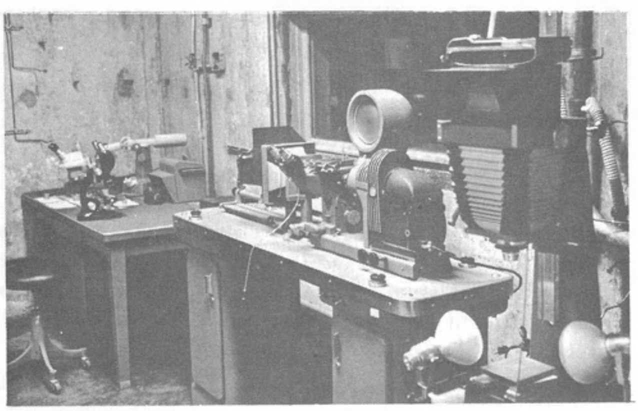


Figure IV-2 - Interior View of Interim Quality Assurance Development Laboratory Facility

1964, final activation of the permanent Quality Evaluation Laboratories was initiated. Figure IV-3 shows the early construction of the laboratory and Figures IV-4

Figure IV-3 - Construction Progress of Permanent Quality Evaluation Laboratories at Michoud

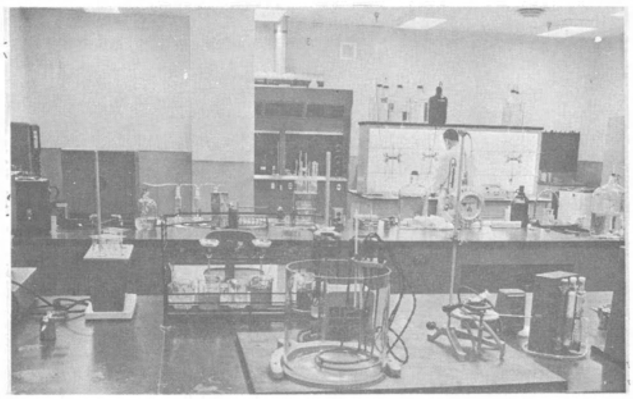


Figure IV-4 - Interior of the Permanent Quality Evaluation Laboratories at Michoud

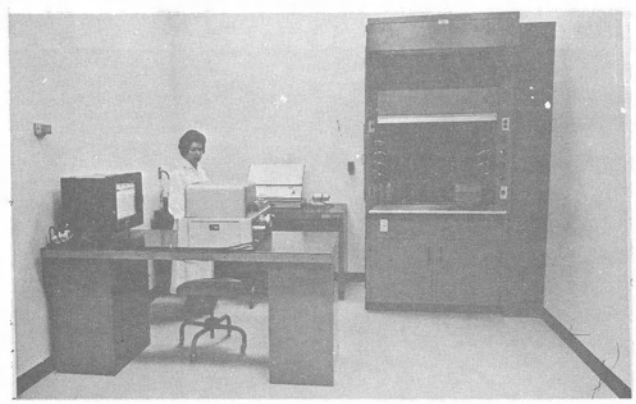


Figure IV-5 - Densitometer Used in Conjunction With Emission Spectrometer in Obtaining Qualitative and Quantitative Analyses of Inorganic Material

through IV-7 show the laboratory at the end of CY '63. Figure IV-8 shows the electrical and electronics area of the permanent Measurement Control Laboratory during initial activation in December 1963. At the close of CY 63, approximately 80 percent of all equipment required had been received. A view of the present laboratory is shown in Figure IV-9. Interim facilities

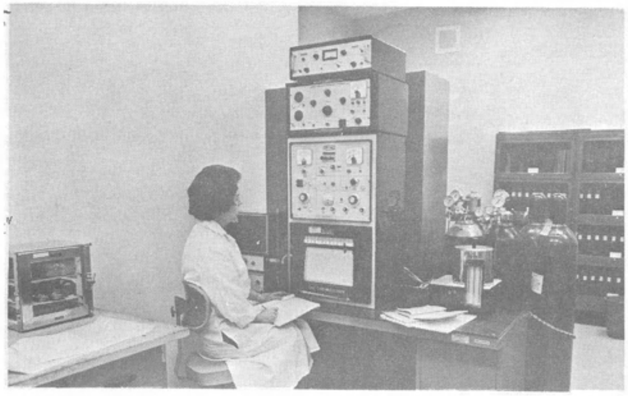


Figure IV-6 - Gas Chromatograph Used in Obtaining Quantitative Analysis of Organic Material

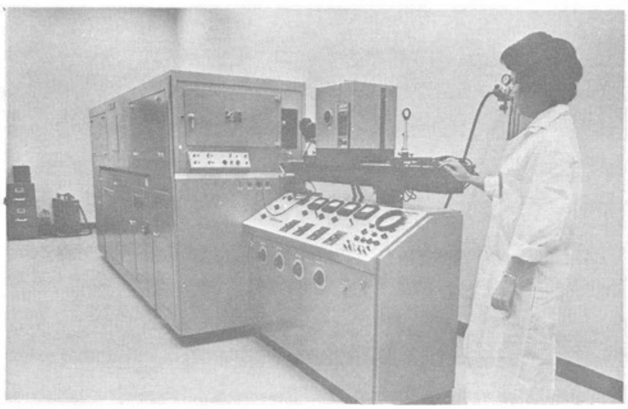


Figure IV-7 - Three-Meter Grating Spectrograph in Quality Evaluation Laboratory

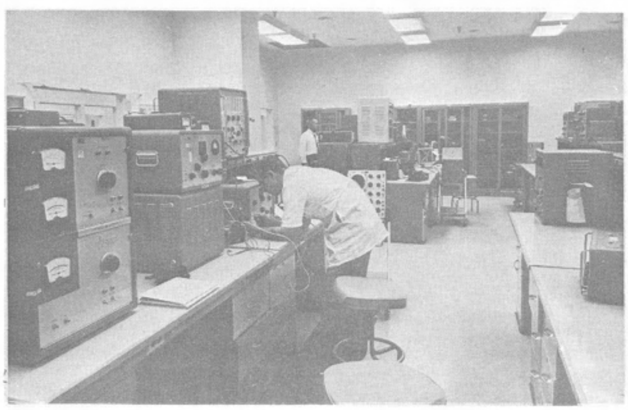


Figure IV-8 - Electrical/Electronics Area of Measurement Control Laboratories at Michoud

such as portable vans (Figure IV-10) that had represented primary capability had been replaced by permanent facilities at the close of CY 63. It is important to note, however, that many interim facilities will continue to be used on a secondary basis to supplement and enhance primary capability in permanent facilities. Following is a brief summary of notable progress:

Figure IV-9 - Pressure, Vacuum Flow, and Mass Area of Measurement Control Laboratories

CENTRAL RADIOGRAPHIC EVALUATION LAB

This laboratory was completed during the early part of FY'64 and its associated mechanized X-ray tooling was activated. In conjunction with mechanized X-ray tooling, this laboratory provides extensive inspection coverage of all stage weldments. It has automatic film processing and mechanized viewing capabilities, three detail inspection vaults, and ancillary processing equipment. At the end of the reporting period, the workload approximated 5,000 X-ray exposures per month. An increase to a peak load in excess of 10,000 feet of film per month is anticipated.

Items of inspection tooling and equipment were developed and activated during the fiscal year that substantially increased radiographic capabilities. Most noteworthy are the gore apex to gore base, bulkhead to Y-ring, polar cap, Y-ring dollies, LOX tunnel and skin ring tools, film paper stripper unit, film viewing console and status board, X-ray suspension system, 300 KV suspension system, 300 KV suspension X-ray machine, and 150 KV suspension X-ray anode machine.

QUALITY EVALUATION AND MEASUREMENT CONTROL LABORATORIES

Brick-and-mortar construction for permanent laboratory facilities was completed in December 1963, and initial activation followed. This acquisition allowed an orderly transition to the operational stage and paved the way for elimination of some workaround measures and retirement of interim facilities to a secondary status.

During the first half of FY '64, flow time for incoming material analysis was excessive because preparation equipment was not available. The transition to permanent facilities, accompanied by acquisition of equipment, enabled a reduction in flow time, and, in many instances, decreased manhour requirements. An example is the lathe (Figure IV-12) necessary for test specimen preparation. Prior to acquisition of this equipment, the Boeing Manufacturing organization assisted in the preparation of test specimens.

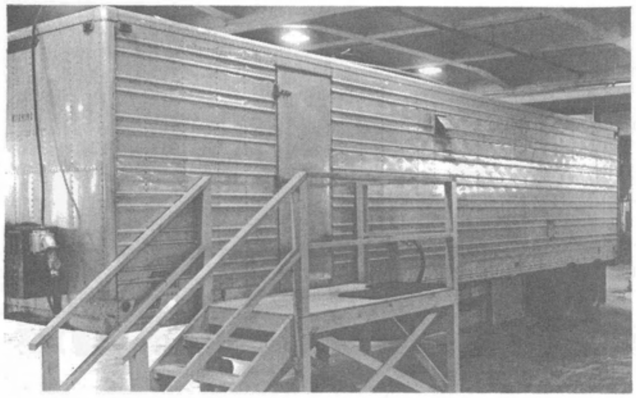


Figure IV-10 - Typical Interim Facility--Pyrometric Van

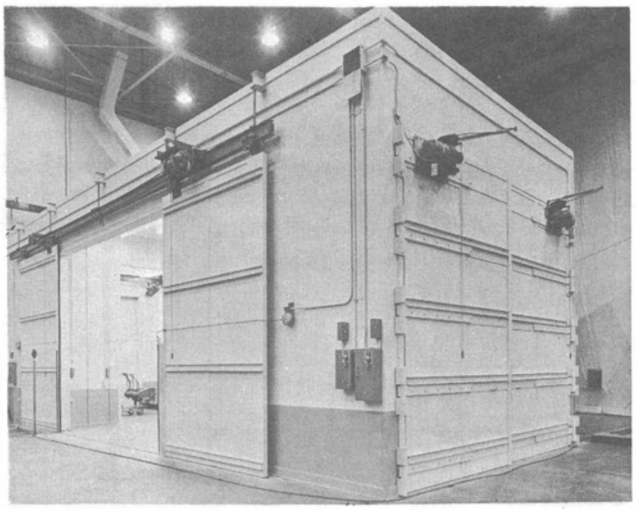


Figure IV-11 - Central Radiographic Evaluation Laboratory Activated in Early FY'64

In January 1964, workaround methods were required to support penetrant inspection of gore segments because the permanent Non-Destructive Test Laboratory was not completed. Portable spray equipment has been used. It is anticipated that automatic spray equipment will be installed early in FY '65.

A LOX impact test facility is being installed to enable appropriate test of components and is expected to be fully integrated during the first half of FY '65.

Capabilities in the Measurement Control Laboratory increased consistent with program demands. New equipment was added each month, and at the close of FY '64, was approximately 80 percent complete. Figure IV-13 shows the Optical Rotary Surface Plate and associated equipment, and the Optical Comparator.

The volume of activity in the Quality Evaluation and Measurement Control Laboratories experienced a significant increase. Orders increased from 1100 to 2900 per month during FY'64. Total orders for the year were about 25,600.

DIMENSIONAL INSPECTION

Dimensional inspection requirements for bulkheads, thrust structures, and intertank assemblies dictated the need for a 34-foot rotary turntable. During FY '64, an area was allocated and the foundation and plans for its installation were completed. At the close of FY '64 Boeing personnel were completing final checkout of the equipment at the vendor's plant.

The rotary turntable will be located in the factory area as shown in Figure IV-14. This turntable, the first

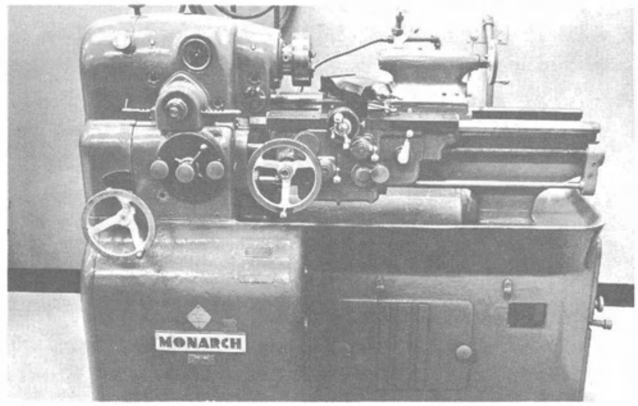


Figure IV-12 - Specimen Preparation Equipment--Monarch Lathe

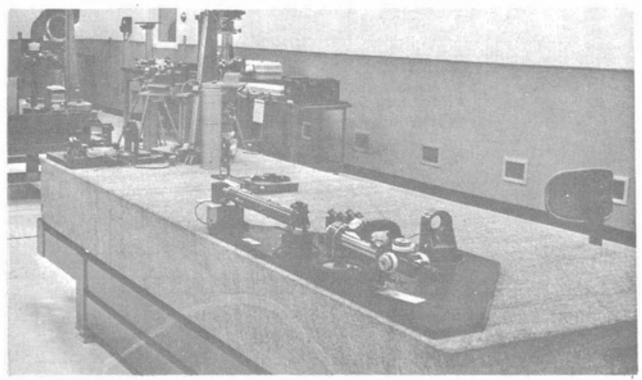


Figure IV-13 - Optical Rotary Table in Measurement Control Laboratories

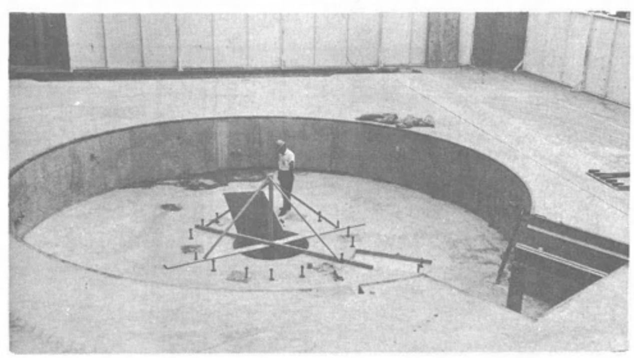


Figure IV-14 - Construction Work Area for 34-Foot Rotary Turntable

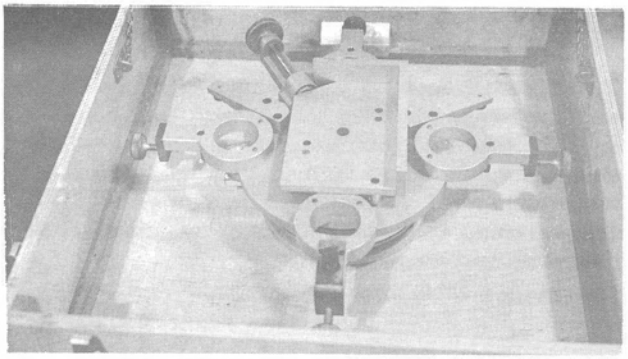


Figure IV-15 - Fitting Optical Target Used for Inspection of Fuel Suction Fittings

Figure IV-16 - Tooling Bars and Associated Optical Tooling Equipment in Use in Michoud Plant

unit of this size with design features necessary to perform precise optical dimensional measurements, will become an integral part of the in-process inspection plan.

Inspection capability for determining critical dimensions increased significantly during the fiscal year. The fitting optical target shown in Figure IV-15 was developed and placed in use. This equipment will be used in inspection of fuel suction fittings.

Tooling bars and associated optical tooling equipment (Figure IV-16) were placed in use during the reporting period.

Unavailability of sufficient tooling equipment during the early part of the FY required some workaround measures. However, at the close of FY'64, the required equipment had been obtained and in -process inspection was being accomplished as planned.

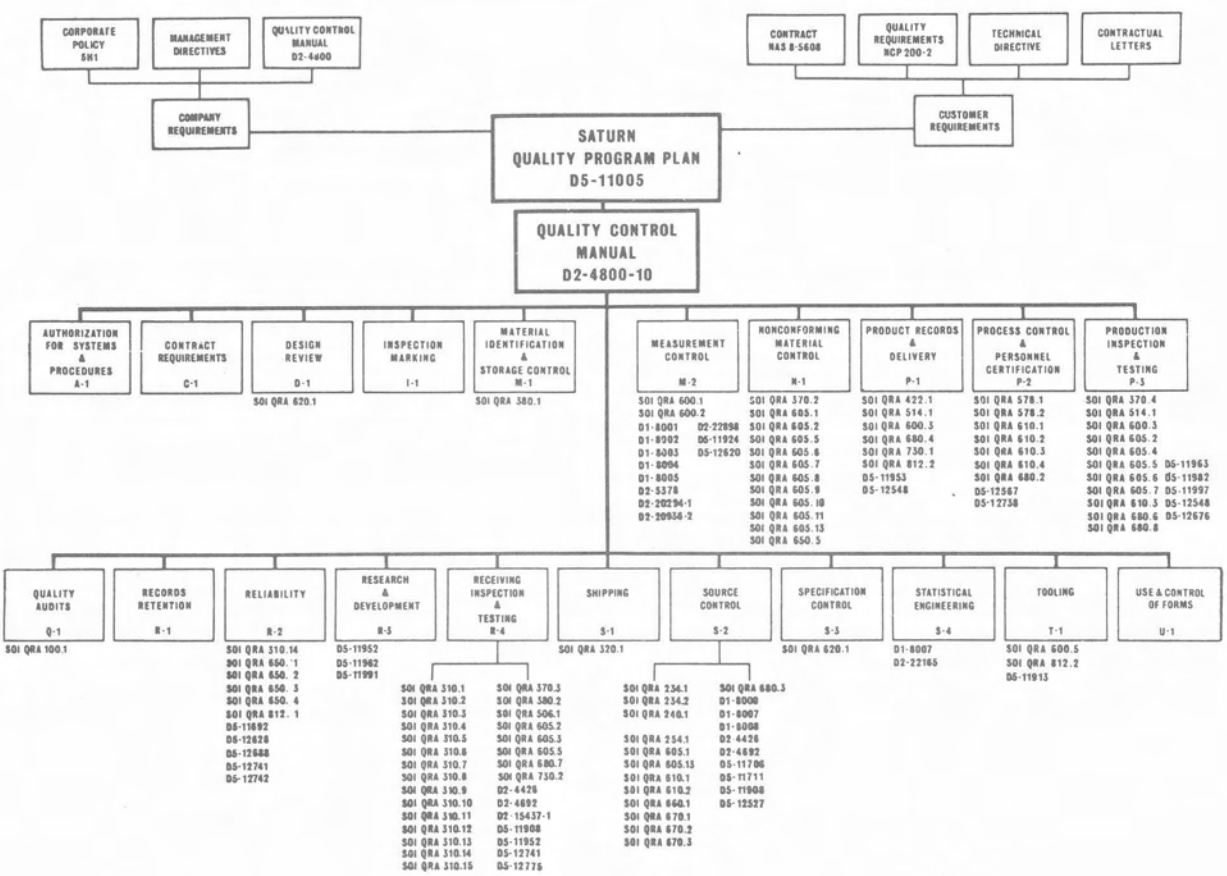


Figure IV-17 - Quality Assurance Program Documentation

QUALITY ASSURANCE SYSTEMS

Fiscal year 1964 saw the evolution of basic systems from a conceptual to an operational stage. Systems involving Quality Engineering, subcontractor control, in-process inspection, and audit reviews were analyzed and refined consistent with product integrity and program schedules.

QUALITY ENGINEERING

The volume of engineering releases increased significantly during FY 64. During the last quarter 4600 releases were reviewed to ensure compliance with NPC 200-2. Coordination with the Engineering organization improved communication of requirements, and, at the end of FY 64, more than 80 percent of the requests submitted had been accepted for incorporation.

Emphasis was placed on quality performance reporting during the year. A system for bi-weekly analysis of stage nonconformances was initiated. A report tabulating nonconformance in Receiving Inspection and major assembly areas is issued to appropriate management.

SUBCONTRACTOR CONTROL

In early July 1963, an interdivisional source control meeting was held to refine the corporate system and ensure full use of resources. As a result of this meeting, the Launch Systems Branch was assigned the responsibility for the survey and surveillance of processing facilities in the states of Alabama, Florida, Kentucky, Louisiana, Mississippi, South Carolina, Tennessee, and Texas.

Numerous surveys of supplier performance were conducted during the FY to ensure compliance with the requirements of NPC 200-3. A notable example was the visit of a combined NASA/MSFC and Boeing team to Los Angeles area suppliers during the latter part of FY 64. Major problems requiring immediate action were multiple inspection by government source inspectors, and misinterpretation of the cleaning requirements of NASA/MSFC Specification 164. Action items were assigned to both MSFC and Boeing personnel to resolve these problems.

The vendor rating system was refined during the FY. All experience is now integrated in the Boeing Aero-Space Division system, ensuring a more complete and

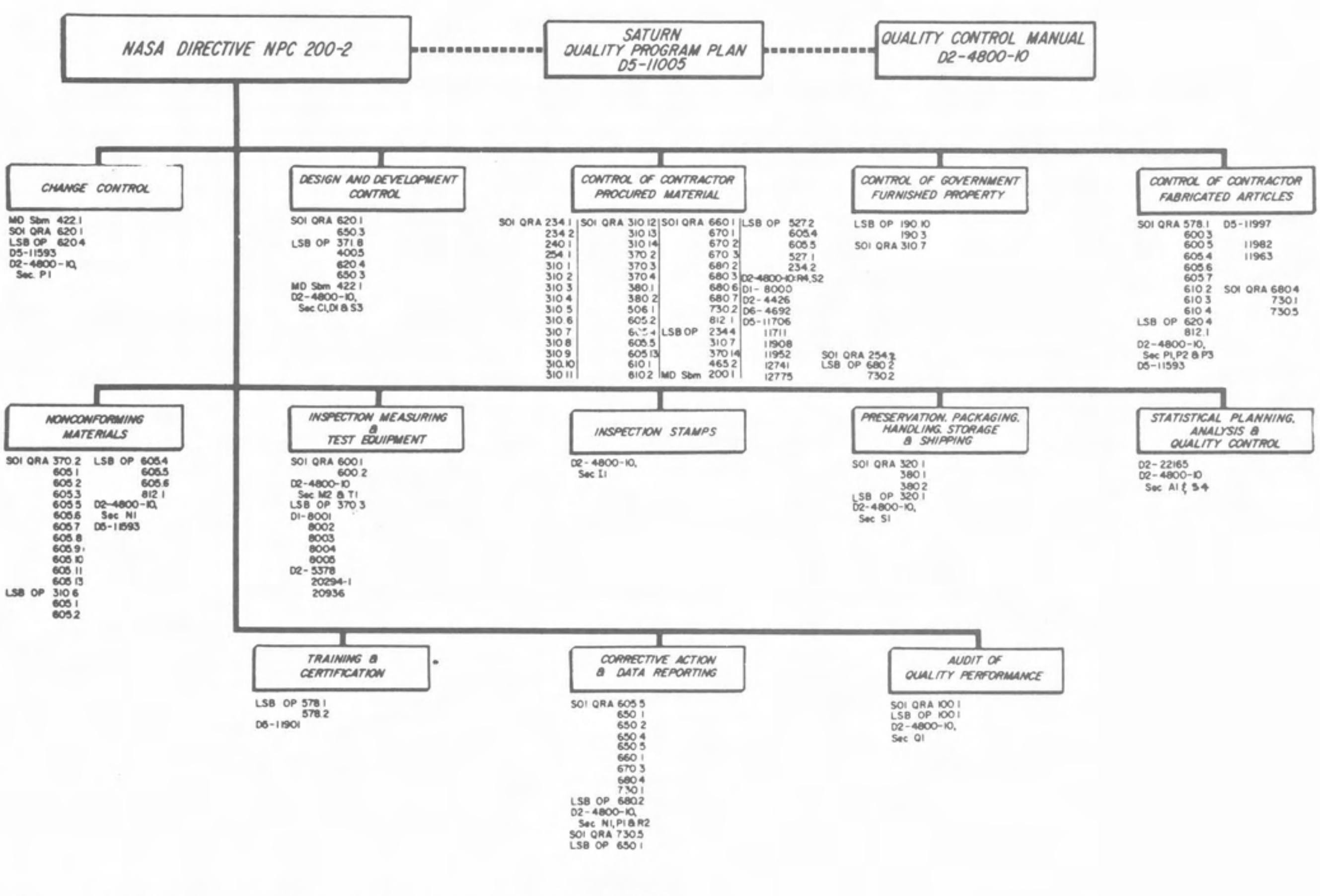


Figure IV-18 - Quality Program Documentation--NPC 200-2

accurate evaluation of all vendor performance data. This, in turn, assures validity of the acceptance sampling system.

During FY '64, 409 proposals involving 102 procurements were evaluated.

A vendor performance reporting system was initiated at Boeing/Huntsville and is being maintained on a current basis. The system is used for items delivered to MSFC and denotes any outstanding problem areas related to tooling items.

IN-PROCESS INSPECTION, TEST, AND DELIVERY

Emphasis of development and refinement of the In-Process inspection system, paced by initial deliveries of S-IC-T stage hardware, was increased during the FY'64. Special inspection processes involving fabrication and assembly operations were reviewed throughout the year.

Interim clean rooms for test inspection of small hydraulic pneumatic and electrical components were activated during the early part of the FY. The first electrical/electronic test inspections were also initiated.

Initial deliveries of hardware allowed refinement of the basic delivery system. Early in the reporting period, coordination with NASA/MSFC Technical Liaison and Contract Administration resulted in the reduction of delivery forms required to accompany stage hardware and tooling items shipped from Boeing/Wichita and Boeing/Seattle. A system to control nonconformance items shipped from outplant areas was also initiated.

QUALITY ASSURANCE TECHNIQUES

Consistent with the transition from a concept to an operational stage, notable progress was made in the development and application of inspection techniques during the year. Following is a brief summary of this progress:

PENETRANT INSPECTION

Considerable progress was made in developing and refining penetrant inspection techniques. A notable example is the extended use of portable spray equipment originally developed for penetrant inspection of Y-rings. This equipment is now being used to inspect gore segments, cylindrical skins, polar caps, and other miscellaneous parts.

OPTICAL TOOLING

The equipment acquisition phase of the Optical Tooling Program neared completion during the FY. Surface tables, tooling bars, alignment scopes and clinometers were obtained and placed in operation. This equipment and techniques were combined to establish an optical tooling program capable of meeting inspection requirements on assemblies completed to date.

RADIOGRAPHIC DEFECT LOCATION AND DEFINITION

Adaptations to mechanized X-ray equipment were accomplished to permit the same accurate three-dimensional location of weld defects as was obtained in manual X-ray systems. The capability was developed to apply this technique to such welds as apex to base, gore to gore and bulkhead to Y-ring.

DIMENSIONAL VERIFICATION

Inspection of large assemblies for dimensional verification was accomplished during the year on such items as a complete intertank, thrust structure components and head assembly components. Experience gained in these areas will be applied to alignment inspection of larger assemblies such as fuel and LOX tanks and a complete stage.

QUALITY ASSURANCE PROCEDURES

Considerable effort was devoted to the development and refinement of operation procedures. Following are specific examples:

SPECIAL INSPECTION PROCEDURES (D5-11982)

This document was completely revised during the year to broaden its scope. D5-11982 will eventually become a multi-volume document encompassing all the unique inspection techniques utilized on the Saturn Program. At the end of FY '63, ten categories of hardware oriented procedures had been written and incorporated into D5-11982.

NON-DESTRUCTIVE TEST APPLICATION TECHNIQUE DEVELOPMENT PLAN (D5-11962)

The Non-Destructive Test Application Technique Development Plan was developed during the year and was being reviewed as the year ended. This document describes the development of application techniques for various non-destructive tests.

DOCUMENTATION

Implementing documentation developed during the year included Standard Operating Instructions, Operating Procedures, and Technical Documents. The need was recognized for a visibility media to portray the documentation released to incorporate the provisions of the Quality Program Plan. Three documents trees were subsequently developed to provide this visibility. These were: 1) Q&RA Program Documentation (Figure IV-17), 2) Reliability Program Documentation, and 3) NPC 200-2 Documentation (Figure IV-18).

QUALITY ASSURANCE AUDITS

Periodic quality assurance audits of all Quality and Reliability Assurance functions and the Launch Systems Branch Training Program were initiated during FY'64. Several special audits were also conducted during the year and included audits of the factory drawing service, inspection stamp control, Saturn records system, and Wichita and Seattle quality functions. Results of audits were documented in the Launch Systems Branch Quarterly Audit Reports and forwarded to the contracting officer in accordance with NASA publication NPC 200-2.

SPECIAL INSPECTION TECHNIQUE DEVELOPMENT

The need was recognized for several specialized inspection tools during 1964 and significant progress was made in developing and acquiring this equipment. Following are notable examples of this specialized equipment.

SUPPLEMENTARY INSPECTION

A supplementary inspection technique was needed to determine actual fusion diameter of spot welds. To do this, an ultrasonic recording scanner was designed. This equipment was initially used to support hardware inspection of bulkhead assemblies.

A proposed new ultrasonic hand scanner was subsequently developed and submitted to NASA for procurement during the latter part of the year. In addition, an improved scanning system for both the hand scanner and the ultrasonic recording scanner was tested and approved for use in both systems. This improved system uses the pulse echo single transducer instead of the double transducer required for the "Pitch and Catch" method.

CONTOUR EVALUATOR PACKAGE

The bulkhead contour evaluator was received from the vendor in June 1964. This equipment will be used with a contour template for final inspection of bulkhead assemblies.

OPTICAL TARGET PACKAGE

This package was completed by the vendor and received June 26, 1964. This equipment will be used for dimensional inspection of fittings and also in conjunction with the 34-foot rotary table during final dimensional inspection of the bulkhead assemblies.

MICROWAVE THICKNESS MEASURING EQUIPMENT

Developmental work was completed during the year on equipment to measure the thickness of gore segments during chemical milling and subsequent operations. The equipment has been ordered and the vendor will deliver it during the first quarter of FY '65.

PREDICTIONS

Quality and Reliability Assurance anticipates continued acceleration of activity consistent with the program demands of FY '65. Fabrication, assembly, and test developmental activity will be particularly significant. Activation of remote sites will also receive considerable attention.

Quality Assurance capability is expected to increase. Specifically the following will be accomplished:

1) The 34-foot rotary table will be installed, checked out, and placed in use to perform critical optical dimensional inspection of bulkheads, thrust structures, and intertank assemblies;
2) The Technical Development Laboratory is expected to be completed and activated. The purpose of the laboratory is to develop non-destructive test techniques, design inspection equipment and perform technical liaison with Manufacturing Development and MSFC;
3) Permanent penetrant inspection facilities, using automatic spray equipment, will be activated and integrated in the inspection plan.

V

SYSTEM AND SUBSYSTEMS TEST

DEVELOPMENT, QUALIFICATION, AND RELIABILITY TESTING

"S-IC Contractor Test Program Summary," Document D5-11928-1, listing development qualification, and reliability testing considered to be Boeing responsibility, was prepared and submitted to NASA/MSFC for comment during the second quarter of the fiscal year (FY). The document was subsequently revised in accordance with NASA/MSFC comments, resubmitted early in February, and made a contractual document by Contract Modification 92, received April 15, 1964.

Development testing, which began during FY'63, continued throughout FY'64, most of the work being accomplished at the Boeing-Seattle and Wichita facilities because of the lack of test facilities and equipment at Michoud. While development testing was substantially behind schedule at the end of the fiscal year, no serious program schedule impact is foreseen, since those tests crucial to design development have been scheduled to provide required information at the time needed.

The qualification and reliability test programs have recently been rescheduled to coincide with late availability of laboratories and test equipment at Michoud. The new schedules are to be provided in the next issue of Document D5-11928-1, and at present still allow for meeting the Plan VII schedule end dates for qualification and reliability testing.

TEST PARTICIPATION-MSFC

Boeing personnel at MSFC have participated in F-1 engine static firings, LOX and fuel systems loading and unloading, and F-1 engine setup and dismantling. Other participation effort during the year, has included the preparation of documents, plans and procedures, and data acquisition planning support; the preparation of installation drawings, wiring diagrams, and operation and maintenance procedures; and design reviews and construction surveillance.

The purpose of this effort is to prepare Boeing personnel to assume full responsibility for the S-IC static firing program at MTO.

MTO ACTIVATION

A June 2, 1964 letter from the NASA/MICHOUD Contracting Office to the Boeing Launch Systems Branch Contract Administration Office gave Boeing limited authorization to proceed with the activation of MTO in an amount not to exceed $570,000 pending receipt of formal NASA Headquarters approved supplemental agreement, "MTO Activation Authorization," Modification No. 102 to Contract NAS8-5608.

Major activities during the reporting period were con-

EVENT	ACTION	DATE
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Submitted to NASA	February 19, 1964
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Modification 92 Received	April 10, 1964
PARTICIPATE IN CHECKOUT OF MSFC TEST STAND	Participation by Boeing	November 9, 1964
MTO ACTIVATION	Go-Ahead	June 2, 1964
MTO ACTIVATION	MTO Activation Plan Complete (D5-11071-3)	August 1, 1964
GOVERNMENT FURNISHED FACILITIES, EQUIPMENT AND SERVICE REQUIREMENTS FOR MTO	Document D5-11061 Complete	July 1, 1964
GENERAL TEST PLAN	Submitted to NASA	November 1, 1964
TEST DATA ANALYSIS	Flight Test Evaluation and Reports Plan Complete (D5-11056)	January 2, 1965

Figure V-1 - Documentation Status

centrated on planning and documentation. Document D5-11071-3, "Plan for Activation and Operation of S-IC Complex at MTO," is in process and scheduled for completion August 1, 1964. The status of significant documentation necessary for the activation program is shown in Figure V-1. At the close of the period, efforts were continuing in design and specification reviews on the S-IC complex and technical systems, and GSE design and installation liaison. Interface common to MSFC and MTO in the brick-and-mortar and equipment areas were also in process.

TEST PLANNING

Major emphasis was placed on the General Test Plan document during this reporting period. The General Test Plan document defines development, qualification, reliability, production, acceptance, prelaunch, flight and special tests for the S-IC stage and GSE from development of components through operational flights. It provides objectives, test descriptions, test progression, concepts, policies and responsibilities. The original effort was started early in the reporting period and resulted in a preliminary draft which was distributed late in December 1963.

Subsequent to joint NASA/MSFC-Boeing reviews the first coordination copy was released on March 26, 1964. The NASA/MSFC comments were reviewed June 4 and 5, 1964, at a joint meeting. The comments are being incorporated into a second coordination copy which is scheduled for release on July 24, 1964.

FLIGHT EVALUATION

TEST ANALYSIS & EVALUATION

A Boeing S-IC Flight Test Evaluation Committee, made up of members from all technical organizations, has been instrumental in defining Boeing analysis requirements for external data submitted for inclusion in the "Engineering Instrumentation Requirements" document.

The committee is presently developing detailed techniques for providing calibration data required by Technical Directive 170, and specifications of calibration data to be used for the linearization of flight test data at Slidell.

CENTRALIZED DATA REDUCTION

On October 4, 1963, formal announcement was made by NASA/MSFC of the establishment of a "Joint Usage Laboratory" at Slidell and Michoud for Boeing and Chrysler test data reduction. Boeing was asked to participate in the establishment of equipment specifications. As a result, the Boeing Data Reduction Steering Committee was established, with the Saturn Booster Test organization manager as the Boeing senior member.

Subsequent to the request from NASA/MSFC for Boeing participation in the establishment of equipment specifications for the Centralized Data Reduction Facility, the Data Reduction Steering Committee established a joint system description and specification which was completed and submitted to NASA/MSFC on January 1, 1964.

By November 26, 1963, the scope of the Centralized Data Reduction activities was defined. The recommendation submitted to NASA/MSFC called for third-party operations at Slidell and Michoud with data user (Boeing or Chrysler) surveillance.

Test Data Reduction facilities will be provided at the Computer Operations Office, Slidell, Louisiana, and the Michoud Engineering Building, New Orleans, Louisiana. The Slidell facility will reduce the various raw telemetry data records, as received from Merritt Island Launch Area (MILA), to a common digital tape format for IBM7094 computer entry. The data records to be reduced will be direct analog wideband FM PAM/FM/FM telemetry tapes, PCM/FM telemetry tapes and predetection recorded magnetic tapes.

The Michoud Data Reduction facility will receive data in recorded form from the various data acquisition sites and from the Slidell facility and will process the data to satisfy the requirements of quick-look preliminary analysis, detailed test analysis, data evaluation and analysis, and test reporting. This facility will also be used quite extensively for vibrational and acoustical analysis.

The vibration and acoustical analysis system will give support in the areas of component test, static test, and flight test data reduction. This system is capable of reducing direct analog magnetic tapes, wide-band FM magnetic tapes, and SS/FM telemetry tapes.

S-V SYSTEMS SUPPORT

SYSTEMS STUDIES

Engineering support under technical assistance orders has steadily increased in scope during the past year. Saturn V studies in aerodynamics, systems design, flight control and test data analysis, mission abort analysis structural design, and wind tunnel testing were conducted. Support to Astrionics and P&VE Laboratories has continued and a number of new tasks has been added. System studies conducted and pertinent results are discussed in the following paragraphs.

SATURN V FLIGHT CONTROL SYSTEM ANALYSIS

Document D5-11240-1, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis," released April 6, 1964, contains an evaluation and comparison of slosh stability, structural coupling, dynamic loads, and vehicle transient responses for various control laws and feedback parameters considered for application to the Saturn V. Control system analysis and specifications for the 4106 configuration of the Saturn vehicle are contained in Document D5-11290-2, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis--Vehicle 4106."

FLIGHT TEST DATA ANALYSIS SYSTEM

Development work was completed on the flight test data analysis system. Significant developmental and supporting documents released were:

a) D5-11247-1, "Saturn Flight Test Data Analysis System Definition";
b) D5-11247-2, "Data Source Comparison Computer Program";
c) D5-11249, "Saturn Flight Test Report Vehicle (I, II, III, and IV) Data Source Comparison," Vol. 1-4;
d) D5-13029, "The Mathematical Development for the AMR Range Data Reduction Computer Program";
e) D5-13025, "Coordinate System Definition in Saturn Flight Test Data Analysis System."

D5-11247-1 defines basic system concepts for the Saturn flight test data analysis system, and D5-11247-2 contains the mathematical and statistical techniques for post-flight data comparison. Four volumes of D5-11249 give tracking data comparisons for flight data obtained from SA-1, SA-2, SA-3, and SA-4 and demonstrate system development. D5-13029 and D5-13025 present the mathematical formulations for conversion of AMR tracking information from tracking station format to vehicle position with respect to station, launch, and inertial coordinates. Portions of this development work were used in Boeing presentations at the NASA/MSFC Flight Evaluation Working Group Meeting and to the Saturn data reduction sub-group panel.

SATURN V FLIGHT PERFORMANCE

Studies and presentations of mission abort were conducted for the powered and unpowered modes. The ability of the vehicle to complete developmental missions after an engine had been shut down was also determined. Significant analyses, with recommendations for mission and abort criteria, are contained in Document D5-11392, "Saturn V Vehicle Abort Analysis and Criteria." Presentations were given to the Aero-Astrodynamics Laboratory and to the MSC/MSFC crew safety panel. Results of a study to define Saturn V flight performance reserve for the LOR mission were presented at the second guidance and performance sub-panel meeting at MSC April 28, 1964.

LAUNCH ESCAPE SYSTEM

A study was conducted to evaluate the capability of the Launch Escape System (LES) to provide protection from booster explosions. It was determined that the Apollo capsule would be subjected to damaging overpressure if the LES is initiated simultaneously with the explosion of the booster. Prior warning time of approximately two seconds is required for the astronaut to escape. Results of this study were presented to the MSC/MSFC crew safety panel.

ASSISTANCE TO LAUNCH SUPPORT EQUIPMENT OFFICE

Technical assistance to the Launch Support Equipment Office, Huntsville, Alabama, and to KSC, includes engineering studies, analysis, and report writing as applicable to: Coordination for Saturn V launch support equipment; Engineering for design, budgeting, and scheduling in the launch equipment area, the propellant area, and the launch system and umbilical equipment reliability area.

MTO ACTIVATION

During this reporting period, on-dock dates for all contractor furnished test and checkout equipment were determined.

Support was provided to NASA/MSFC for the S-IC Complex (MTO) design review. A major revision to Document D5-11061, "Government Furnished Facilities, Equipment and Services for Mississippi Test Operations," was completed. Document D5-11071-2, "Plan for Activation and Operation of the S-IC Complex at MTO," was prepared and released as the work statement to support a request for estimate (RFE) which was issued to cover the MTO Activation Plan. The RFE meeting was held in New Orleans, November 6, 1963, and a presentation to NASA/MSFC was made on December 9, 1963.

Documentation was developed for the Saturn records system procedure, manpower plan, test evaluation and reports plan, activation static firing and special test data plan, and the safety plan.

This resulted in a significant contribution to the Saturn program in that the initial overall requirements for Mississippi Test Operations were defined through this work effort.

EQUIPMENT MANAGEMENT SYSTEM

The establishment and documentation of an equipment management system to cover all ground support equipment (GSE) for the Saturn V program, the development and documentation of an initial Saturn V program elements list, and the development of a preliminary Saturn V GSE list was completed in December 1963.

An S-IC equipment data support group, consisting of full-time representatives from the Launch Systems Branch was organized on September 16, 1963, in Huntsville. This group was assigned the task of reviewing and updating the equipment listed in the data bank established as a result of the task force effort. The first updated S-IC equipment list was completed on October 11, 1963, and a computed version of the S-IC equipment list was completed on November 8, 1963. An outline of the proposed Saturn V equipment management system was documented and was submitted to the Saturn V Project Office for comment on September 24, 1963.

This effort represented an important contribution to the program since it provided program visibility of known equipment requirements and responsibilities, assistance in identifying duplicated or omitted equipment, a basis for equipment accountability, data to identify contract deficiencies, a basis for equipment status reporting, and data for development of installation and checkout packages.

TAO 6 was released December 31, 1963 to ensure continuity of the Saturn V Equipment Management support effort following the expiration of TAO 30.

TAO 6 provides for 20 Boeing technical personnel to support the Saturn V Project Office at NASA/MSFC, for implementation, maintenance and future development of the equipment management system. Specifically, this support consists of follow-on studies for further application of the management system and assistance in the maintenance and further development of:

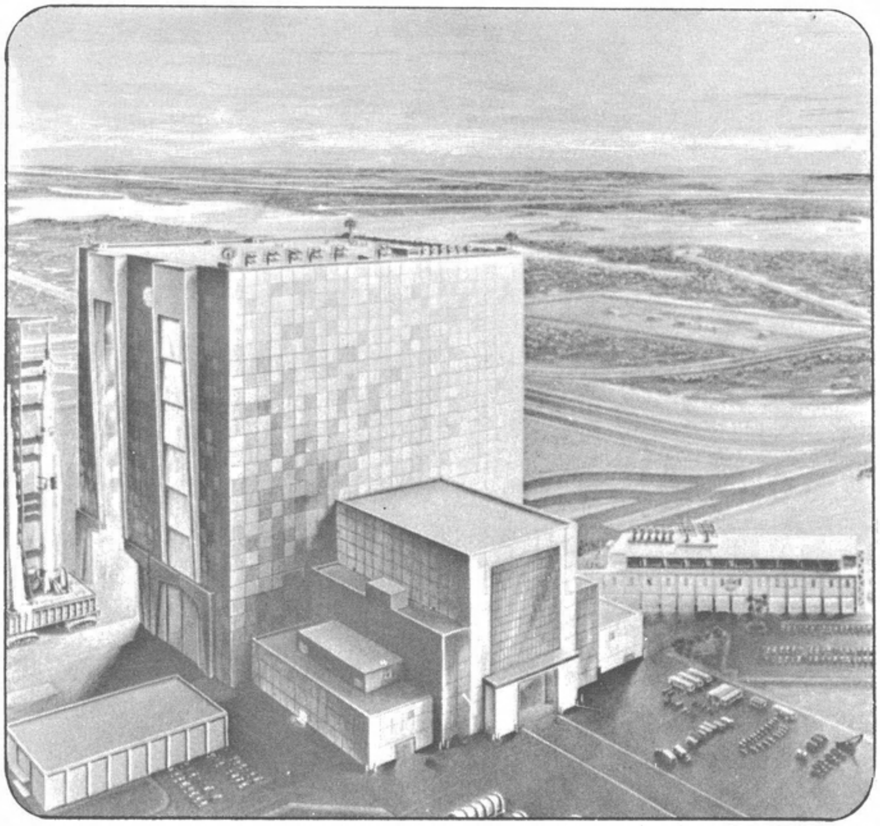
1) Saturn V Program Elements List;
2) Saturn V Master Equipment List;
3) Equipment Allocation Techniques;
4) Problem Resolution Schedules.

The Saturn V/S-IC master equipment list has been placed into computer format and is now stored in the Michoud Computer Office. Updating of this data bank occurs on a monthly basis.

Development of report requirements and planning of computer programming is now in progress.

Responsibility for work covered by TAO 6 was transferred from Boeing Booster Test to Boeing Engineering in March 1963; however, Booster Test is providing support.

VII



LAUNCH OPERATIONS SUPPORT

MERRITT ISLAND LAUNCH AREA LIAISON

The Boeing activities in the Cape Kennedy area were consolidated into one organization during February. Mr. A.M. Johnston was appointed Manager of the Boeing Atlantic Test Center (BATC) reporting directly to Mr. G.H. Stoner, Vice President and General Manager, Launch Systems Branch of the Aero-Space Division, The Boeing Company. Mr. H.W. Montgomery was appointed Manager of Saturn S-IC activities at BATC.

Document D5-11058, "MILA S-IC/Saturn V Checkout and Test Plan," was revised to reflect the Kennedy Space Center (KSC) planning for a fifty eight day cycle of Launch operations. Document D5-11059, "S-IC MILA Equipment List," was released and served as the first guide for MILA use requirements.

Liaison activities included the preparation of document D5-11830, "MILA S-IC Launch Operations Record Systems." The system provides a method of fulfilling the Saturn V vehicle record requirements while maintaining a high degree of compatibility with Boeing records at other locations.

Document D5-11816, "Launch Operations Support Plan S-IC/Saturn V," was prepared during this report period. The plan presented the BATC concept of the Boeing effort to be performed under Part VII of Contract NAS8-5608. The document became the basis for negotiation of task orders to authorize Boeing support effort for KSC for FY '65. The approved task orders will allow for a growth of 100 persons for a total of 123 under this part of the contract.

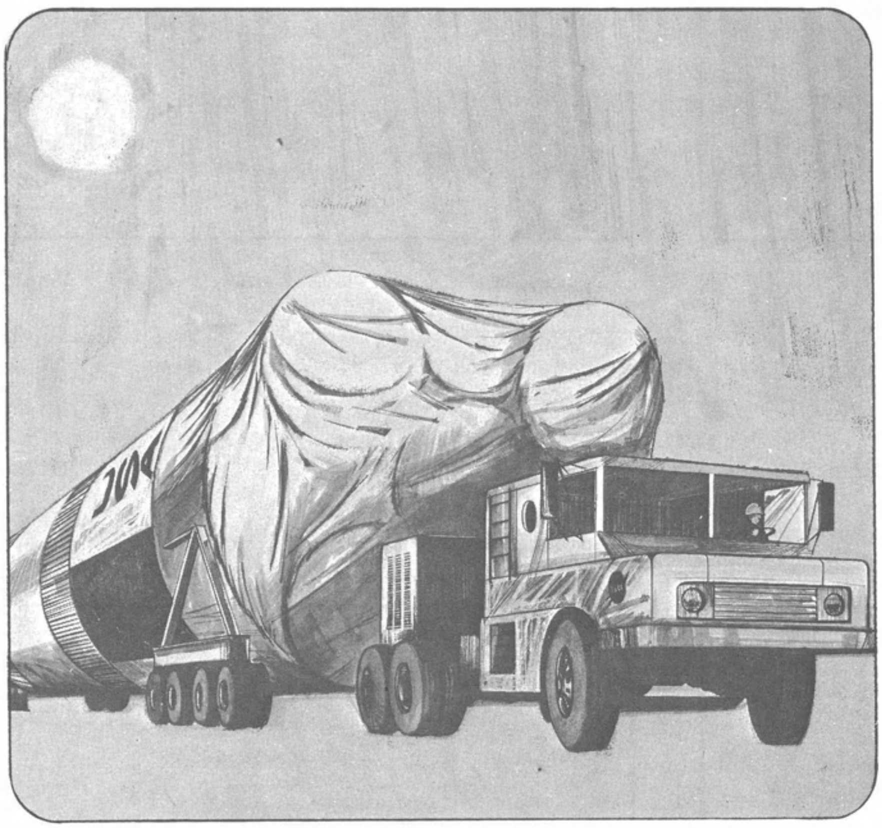
The "BATC Training Plan" is in process with initial release scheduled for October 1, 1964. This plan will serve as the basis for negotiations regarding off-site personnel training and will ultimately support the KSC training plan.

A compilation of all tests to be performed on the S-IC-F stage at MILA is also in process. The initial release, scheduled for August 15, 1964 will be in document form—"S-IC-F Catalog of Tests - MILA."

LAUNCH OPERATIONS PARTICIPATION

Twenty-three BATC personnel are currently assigned to support NASA/KSC Launch Vehicle Operations Activities. Assignments vary with the individual organization supported but cover S-V/S-IC MILA program planning, and participation in Saturn I test activities for familiarization and training purposes. Numerous working-group meetings and design reviews were attended by support personnel during the reporting period. These included meetings of the Instrumentation Working Group reviews covering S-IC transporter and pneumatic systems, Saturn V propellant loading system, propellant dispersion system, RCA 110 computer networks, and thrust-vector control system.

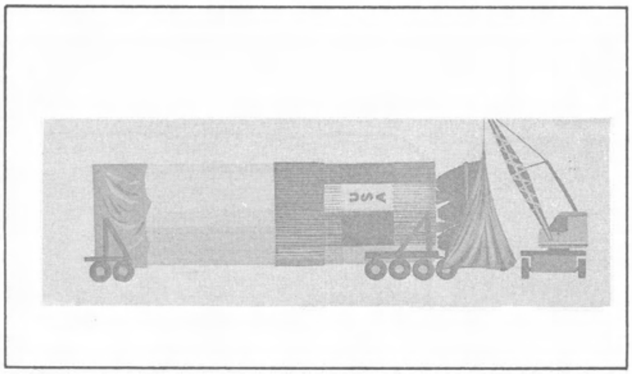
VIII



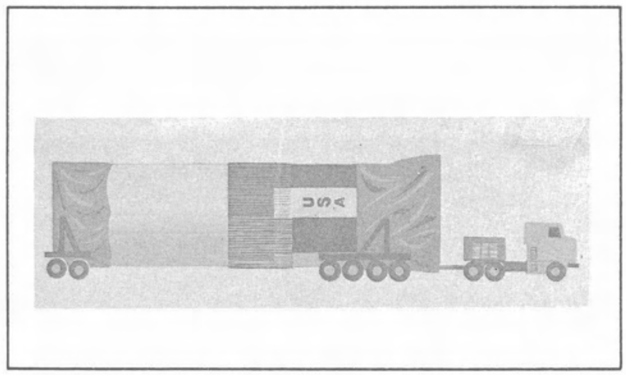
STAGE TRANSPORTATION

STAGE PREPARATION
EQUIPMENT:

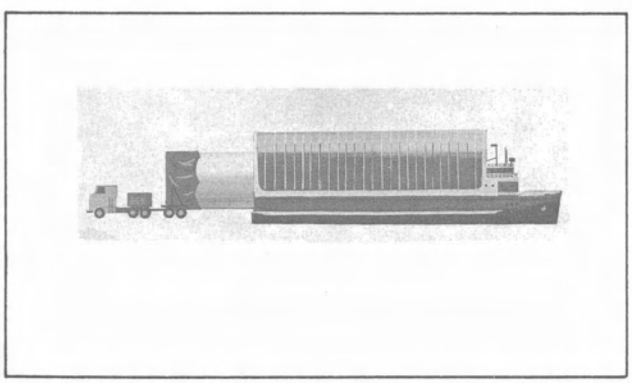
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings



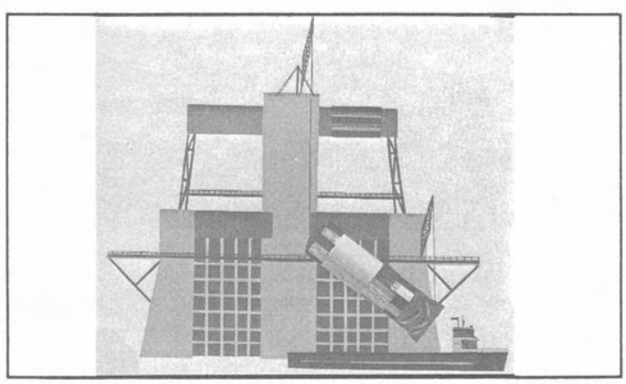
HANDLING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



LAND TRANSPORTATION
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

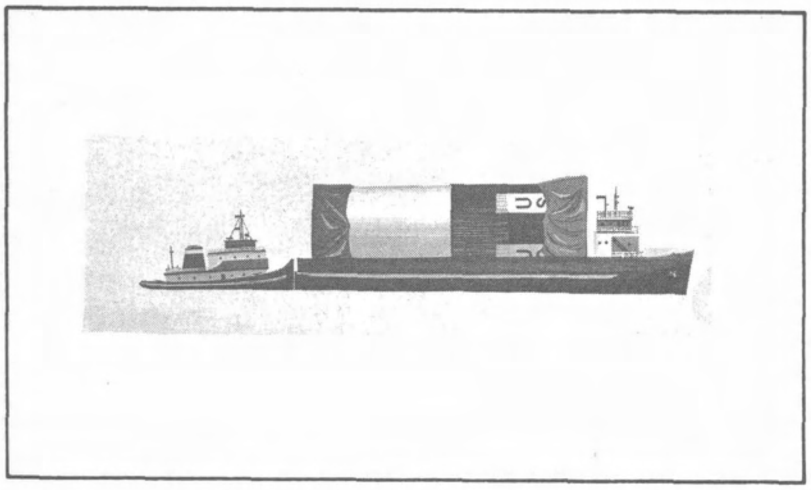


LOADING-UNLOADING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

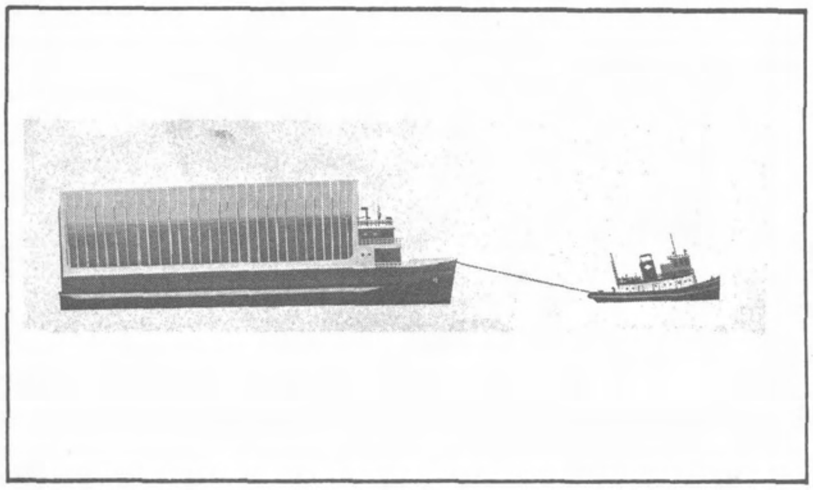


* THE PROTECTIVE COVERS AND PLUGS ARE JOINT BOEING-NASA DESIGNED ITEMS.

WATER TRANSPORTATION — OPEN
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Transportation Accessory Kit
Forward Handling Ring
Stage Attach Fittings



WATER TRANSPORTATION — CLOSED
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



STAGE TRANSPORTATION SEQUENCE

A complete revision to Document D5-11053, "Saturn V S-IC Stage Transportation Plan," has been the prime order of business during this reporting period. This revision encompasses all phases of transportation, identifies the Boeing organizations responsible for each of the transportation functions, and contains the latest schedules and equipment requirements. This document is scheduled for release in September 1964.

Document D5-11763, "Saturn V S-IC Stage Transportation Requirements," is also in process and is a compilation of the detailed requirements for transporting the S-IC Stage in accordance with the above Transportation Plan. This document is scheduled for release in January 1965.

The first barge movement (S-IC-D to MSFC transport sequence shown) is scheduled for August 1, 1965, with no problems anticipated at this time.

IX

MANUFACTURING SUPPORT TO MSFC

S-IC-C TEST FUEL TANK

Boeing support of the ground test program for the S-IC-C test fuel tank involved the fabrication and delivery of stage hardware details and assemblies and fabrication and erection of the tank support structure.

Fabrication and delivery of minor stage hardware, such as tank ring baffles continued during the third quarter of CY'63. During August 1963, the assembly of the one-half intertank was completed in support of the NASA/MSFC test fuel tank requirements. The one-half intertank was delivered to MSFC by barge (Figures IX-1 and -2) on November 16, 1963. Stage hardware deliveres were completed during the last quarter of CY'63.

Effort during the first quarter of CY'64 was directed toward completion of the tank support structure. This activity culminated March 11, 1964 with the installation of the test fuel tank on the support structure.

Figure IX-1 - The Michoud Plant and the Partially Completed Vertical Assembly Building are a Backdrop for the One-Half Intertank Being Towed to the Slip for Shipment to MSFC

S-IC-T STAGE

The Boeing effort on the S-IC-T static test stage encompasses the fabrication of structural hardware details and assemblies (thrust structure, intertank, and tank components), and the procurement and delivery of specialty hardware in support of NASA/MSFC.

Figure IX-2 - The Half Intertank is Carefully Loaded on the Barge at the Dock and Secured by Boeing Mechanics

STRUCTURAL HARDWARE

S-IC-T structural hardware deliveries to MSFC began during the second quarter of CY'63 with the delivery of the fuel tank lower-head apex gores. Deliveries of this hardware (Figures IX-3 and -4) continued through the second quarter of CY'64 with the final major structural hardware deliveries having been completed in May.

The last of the basic structural subassemblies delivered during the reporting period included the GOX and helium distributors, and the LOX tank ring baffles and cruciforms (Figure IX-5). At the close of FY 64, there were 656 items remaining to be delivered to MSFC by Boeing in support of the S-IC-T stage. Delivery of these items, such categories as minor tooling, specialty hardware, and minor structure components (Figure IX-6), will continue through January 15, 1965.

SPECIALTY HARDWARE

Specialty hardware deliveries began in November 1963, and were continuing at the close of FY 64. These deliveries consist of both items to be shipped directly from suppliers to MSFC, and items routed through

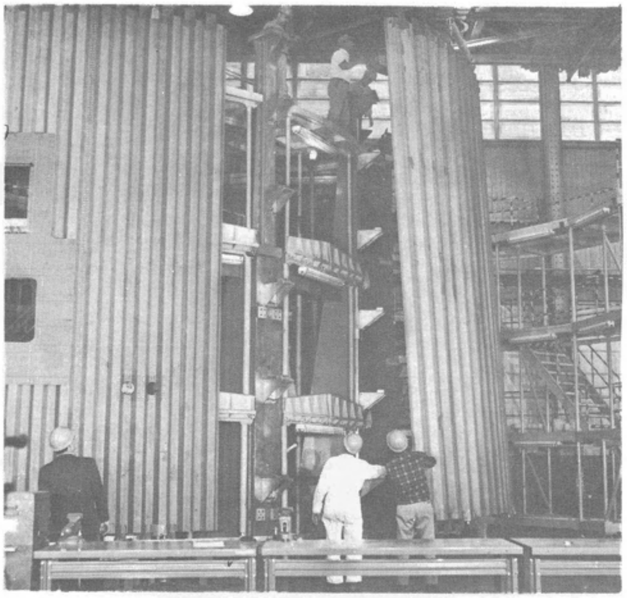


Figure IX-3 - An S-IC-T Intertank Panel is Removed from the Intertank Assembly Fixture

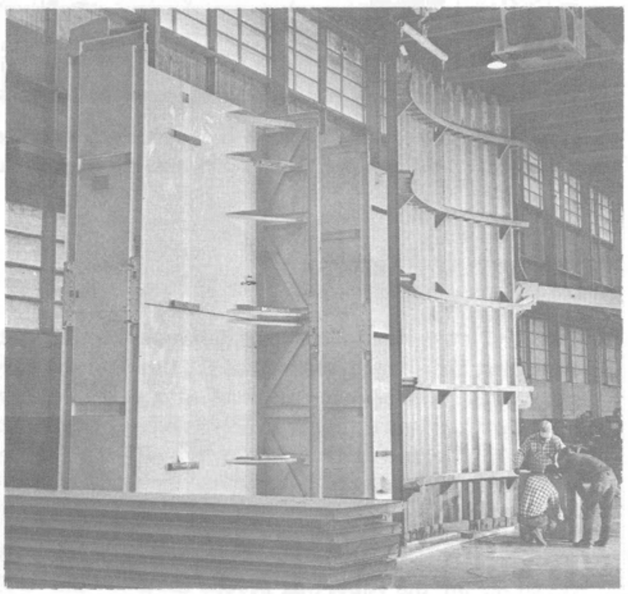


Figure IX-4 - The -T Intertank Panels are Placed in the Shipping Case Vertically

Figure IX-5 - A Cruciform Baffle Segment is in its Assembly Fixture at the Left. Another Baffle Segment is on a Stand.

Figure IX-6 - Segments of Anti-Slosh Cantilever Circumferentials Await Shipment in the Michoud Tank Ring Baffle Pick-up Area for the S-IC-S and -T

Boeing/Michoud for test and calibration. A need for increased delivery rates during the latter part of FY 64 resulted in concerted efforts by Boeing Management to attain better adherence to delivery schedules by suppliers for critical items. Key members of both NASA/MSFC and Boeing Management were maintaining close liaison through such media as the monthly MSFC/Boeing S-IC-T stage meetings. These meetings were held to ensure that critical areas affecting completion of the S-IC-T stage would receive the proper attention.

Typical of the conditions affecting hardware deliveries were changes in design criteria; revised vibration/shock testing requirements; supplier design deficiencies; and over-optimistic delivery capability quotations. Corrective actions initiated by Boeing included overtime authorization; negotiation of unqualified hardware deliveries and direct shipment authorization; establishing resident personnel at supplier locations to expedite design decisions; assistance in resolving production and quality problems; and periodic Boeing Management visits to ensure continuing management awareness of problems and follow-up of remedial action.

S-IC-S STAGE

Boeing support to NASA/MSFC major structural component hardware (S-IC-S) requirements were initially oriented to fabrication, assembly, and delivery of stage hardware details and assemblies to support the assembly of an equivalent structural stage at MSFC. Hardware deliveries from Boeing were to be provided so that the stage could be assembled in two major sections. The first section (upper structural

stage) would include a LOX tank, an intertank, and a forward skirt. The second section (lower structural stage) would include an intertank, fuel tank, thrust structure, fin and fairing assemblies, engine actuator supports, and propellant line supports. Boeing effort is directed toward final delivery of components to MSFC for the lower structural stage by November 31, 1964, and for the upper structural stage by December 14, 1964.

STRUCTURAL HARDWARE

Thrust Structure

Structural components were being fabricated for the thrust structure (Figure IX-7) of the S-IC-S stage during the fourth quarter of CY 63. By the end of the first quarter of CY 64, the fabrication of structural components for the entire S-IC-S stage was about 87 percent complete. They were scheduled to be 92 percent complete but were slightly behind schedule because the fabrication of the S-IC-T stage had priority.

During the first quarter of CY 64, deliveries were made to MSFC for the S-IC-S thrust structure, with the majority of items being scheduled for delivery during the quarter ending July 2, 1964.

Shortly after the beginning of the second quarter of CY 64, Boeing was requested to assume responsibility for complete assembly of the S-IC-S, S-IC-1, and S-IC-2 thrust structures. These structures will be assembled at Michoud, necessitating transfer of previously delivered thrust structure subassemblies and assembly fixtures from MSFC to Michoud. At the close of the reporting period, the S-IC-S stage thrust structure was in the final assembly operation at Michoud. Minor assembly activities are in phase with final assembly requirements. Present status indicates the completed S-IC-S thrust structure will be delivered to MSFC by September 30, 1964, as scheduled.

Intertank

Intertank assembly activities during the fiscal year included two units of the original configuration for the S-IC-S. The first -S intertank assembly was completed, removed from the final assembly fixture, and shipped to MSFC on June 18, 1964. Delivery of this intertank differed from the S-IC-T in that the structure was removed from the assembly fixture in one piece, and shipped as a single unit rather than in sections as occurred on the -T. The second intertank for S-IC-S was then loaded onto the final assembly fixture and is expected to be completed and removed by July 14, 1964. No major problems have been encountered in the assembly of these two units. Current planning calls for two additional intertanks of a revised configuration for S-IC-S to be assembled in the fourth quarter of 1964.

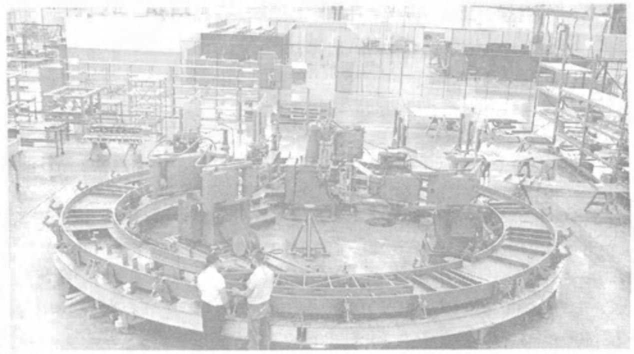


Figure IX-7 - S-IC-S Thrust Ring being Loaded into the Lower Thrust Ring Subassembly Fixture

Forward Skirt

Final assembly of the S-IC-S forward skirt (Figure IX-8) was started in the last week of the reporting period. Assembly activity is progressing on schedule and is to be completed by September 8, 1964.

Figure IX-8 - Skin Panels for the S-IC-S are Assembled in the Fixture at the Left and Held for Shipment as shown

LOX and Fuel Tank

Boeing support of the S-IC-S LOX and fuel tank assemblies consisted of assembly of the forward bulkhead (Figure IX-9) for the LOX tank at Michoud and the delivery of detail tank components to MSFC for subsequent assembly by NASA/MSFC at Huntsville. By the end of the second quarter CY 64, over 500 tank components for the S-IC-S had been delivered to MSFC. At the end of the first quarter of CY 64, the forecast for completion of S-IC-S tank component deliveries was the end of June. Subsequent redirection by NASA/MSFC, altering both quantities and delivery demand dates, has necessitated a re-evaluation of delivery capability. LOX tank component deliveries that were outstanding on July 2, 1964, included 16 ring-baffle segment assemblies, four panel assemblies, four cruciform baffle assemblies, three covers, and one GOX distributor. Fuel tank components still to be delivered included 40 ring-baffle bearings, two cover assembl-

ies, a helium distributor assembly, and a helium cover assembly. Delivery dates through August 17, 1964, have been cited.

The assembly of the forward LOX tank bulkhead at Michoud was to be delivered to MSFC on June 22, 1964, but is behind schedule and is presently forecast for delivery on August 11, 1964. This schedule position is caused by an accumulation of technical problems encountered during the assembly process. Fitting-to-gore welds developed excessive warpage and shrinkage. The gore segments had to be returned to Wichita for rework. Difficulties were then encountered during the gore-to-gore weld operation, and following this the polar cap was determined to be overformed, and a new polar cap had to be fabricated. While this was being produced, the bulkhead was successfully welded to the Y-ring and brackets were welded onto the assembly out-of-sequence in an effort to reduce down time. Assembly completion is predicted for July 25, after which the bulkhead must be prepared for shipment. The bulkhead will then be loaded on a barge and routed to MSFC.

Fin and Fairing

Fin and fairing assembly operations for the S-IC-S are presently scheduled to begin in July 1964. Delivery of the completed assemblies is forecast for the fourth quarter of CY 64.

SPECIALTY HARDWARE

Specialty hardware required of The Boeing Company for the S-IC-S stage is included under four part numbers, which represent a total of twenty parts. The last part is forecast to be on-dock at MSFC by July 28, 1964, which supports MSFC delivery requirements.

S-IC-1 AND S-IC-2 STAGES

Structural component fabrication dominated Boeing efforts in support of the S-IC-1 and the S-IC-2 stages. However, by the end of the reporting period, bulkhead gores were being assembled at Michoud for the S-IC-1 and the assembly for the S-IC-1 base heat shield was about to start. Further assembly activities at Michoud on the S-IC-1 will be paced by the availability of tooling, which is currently loaded with S-IC-S and S-IC-D hardware. Hardware deliveries to MSFC for S-IC-1 and S-IC-2 stages were limited to components for LOX and fuel tanks. Michoud assembly activities and deliveries to MSFC will continue to accelerate as program emphasis swings to the first flight stages, and on-schedule performance is predicted.

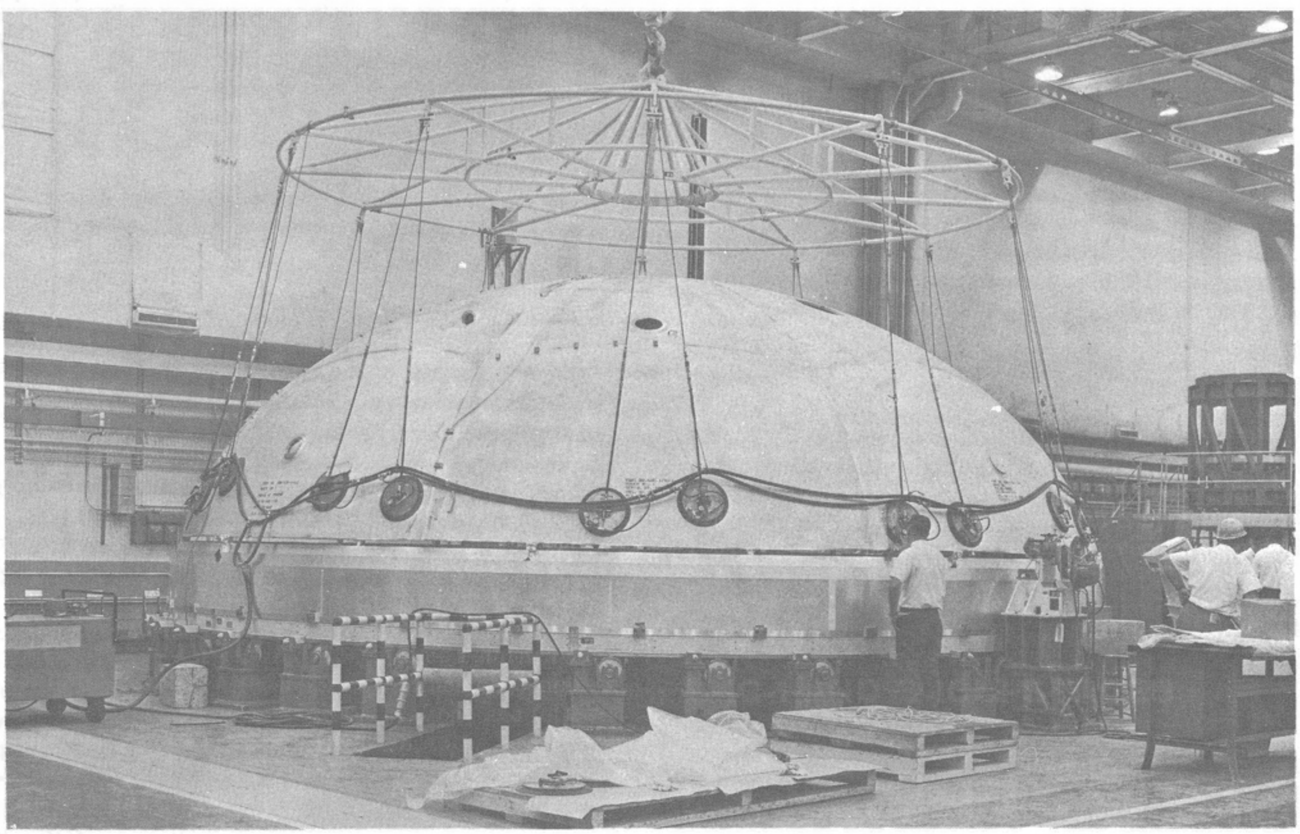
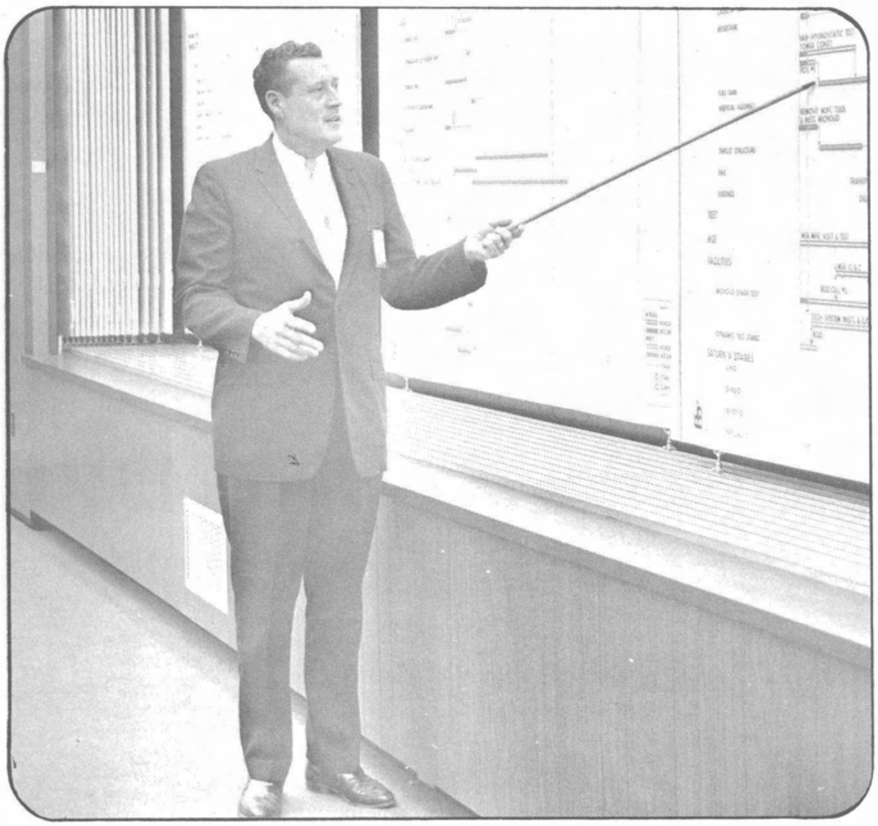


Figure IX-9 - S-IC-S Forward LOX Bulkhead was moved from the Polar Cap Weld Fixture to this Bulkhead-to-Y-ring Weld Turntable by means of the Vacuum Handling Tool shown still Attached



PROGRAM MANAGEMENT

CONTRACTING ACTIVITIES

GENERAL

During FY 64, The Boeing Company was actively engaged in the following Saturn V/S-IC stage program contracts with NASA/MSFC:

Contract NAS8-5608--"Long Range Saturn S-IC Stage Program."

Contract NAS8-2577--"Preparatory Effort Leading to a Project for Engineering, Fabrication, Assembly, Checkout, Static Testing, Transportation, and Launch of the Saturn S-IC Stages"

Contract NAS8-5606(F)--"Facilities Required for Saturn S-IC Stage Program."

Contract NAS8-13002--"Saturn V/S-IC Full-Scale Tail-Section Mockup."

The prime contract, Contract NAS8-5608, effective January 1, 1963, was based on Schedule Plan IV. Through negotiations in late 1962 and in early 1963, Boeing's work base was expanded significantly and because of this, official Schedule Plan V was established in May 1963. In late June 1963, in anticipation of FY 64 funding limitations, NASA/MSFC directed Boeing not to add additional personnel to the S-IC program. This restriction was later removed and a manpower schedule recommended by Boeing was substituted.

In December 1963, Schedule Plan VI, consistent with FY 64 funding, was established. A major program redirection in January 1964, necessitated a change from Schedule Plan VI to Schedule Plan VII. Plan VI was never completely negotiated or implemented because of its short duration, (December 20, 1963 through January 22, 1964). Schedule Plan V and the subsequent modifications to it, served as a baseline for the negotiated transition to Plan VII.

Schedule Plan VII was compared to Schedule Plan V (Figure X-1), to reflect program slides in stage deliveries and in completion of Ground Support Equipment and Manufacturing Support Equipment (GSE/MSE). The responsibility for assembly of the S-IC-D dynamic test stage was transferred from MSFC to Boeing/Michoud, and the assembly of the S-IC-2 flight stage was transferred from Boeing to MSFC.

As of January 1, 1964, sufficient Construction of Facilities funds had been obligated to Contract NAS8-5608 to satisfy all construction requirements through FY 64 with the exception of the stage test facility, the high-pressure test facility, and the Vertical Assembly Building. Funding for these facilities was provided by subsequent modifications received prior to FY end.

CONTRACT NAS8-5608

Modification No. 30, effective August 2, 1963, completed negotiation of Schedule Plan V program redirection and substantially increased the contract value. Modification No. 60, dated December 20, 1963, directed a change to the Plan VI delivery schedule. Modification No. 67, dated January 22, 1964, redirected the program to Plan VII, which revised the delivery dates for stages S-IC-D, S-IC-F, S-IC-3 through S-IC-10,

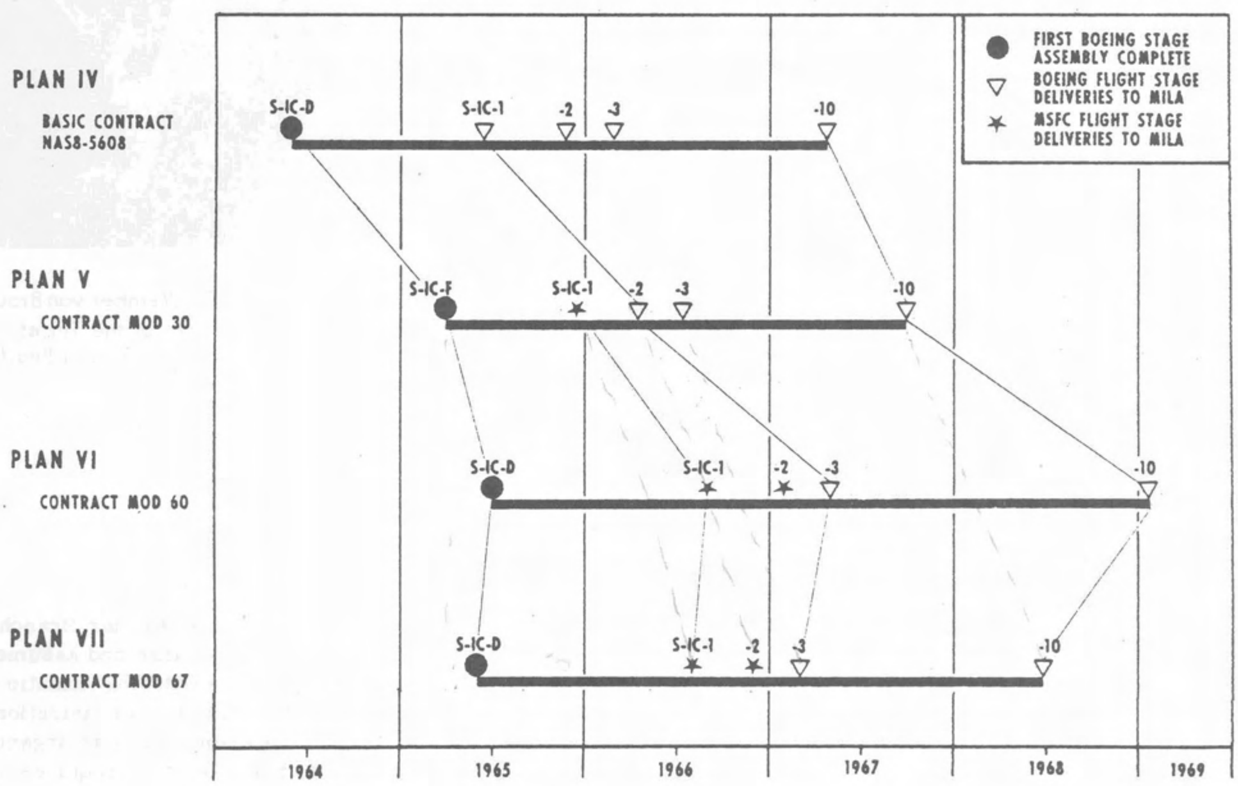


Figure X-1 Comparison of Schedule Plans IV, V, VI & VII for the S-IC Stage

deleted the Boeing responsibility for the assembly of the S-IC-2 stage, and added the S-IC-D stage assembly to Boeing. Modification No. 67 was also significant in that it deleted the manpower clause, Article XVII, which had been the basis of several manpower limitations by NASA. The Boeing proposal for the Modifications 60 and 67 redirections was submitted to NASA on May 25, 1964.

Program obligations of The Boeing Company were substantially increased by Contract Modifications 34, 35, 36, 44, 52, 62, 83, 89, 94, 102, 110 and 113.

Modifications 34, 35, and 36 authorized the design, fabrication, test and qualification of equipment to be used on the Saturn V Launcher Umbilical Tower, and the design, development and documentation of S-IC personnel work platforms for use at Merritt Island Launch Area.

Modification No. 44 shifted the responsibility for the government to provide gaseous nitrogen to Boeing and eliminated the missile-grade air facilities. Modifications 52 and 94 added a Mechanical Automation Breadboard in Building 4708, at MSFC.

Boeing effort to provide Saturn V engineering assistance to NASA/MSFC was extended through December 31, 1964 by Modification No. 62. Modifications 83, 89, 110, and 113 extended Boeing manufacturing and development support to MSFC by 1,950,000 hours for calendar year 1964.

The largest single addition was the S-IC/Mississippi Test Operation (MTO) Activation Task, added by Modification 102 at an increase in contract value of nearly $10 million. This modification added the requirement for activation of one position of an S-IC dual-position test stand at MTO encompassing a stage test and checkout station, stage-to-facility interconnecting equipment, a test control center, and an S-IC storage building. Some modification of design for flight stages S-IC-1 through S-IC-10 was also included.

CONTRACT NAS8-2577

Contract NAS8-2577 was extended to June 30, 1964, to cover existing construction and architectural engiеering subcontracts. The Boeing Company has instituted closure action on this contract and no further extensions are anticipated.

CONTRACT NAS8-5606(F)

During the reporting period, Contract NAS8-5606(F) was rewritten, and the concept of incremental funding eliminated. Funding is now based upon actual need established by extracts from the primary requirements document, D5-12374, submitted by The Boeing Company.

The work statement has gradually expanded due to increased facilities equipment requirements added by the modification of Contract NAS8-5608.

CONTRACT NAS8-13002

On January 23, 1964, in response to a request from the NASA/MSFC Contracting Officer, a proposal for a Saturn V/S-IC full-scale tail section mockup (Fig. X-2) for exhibit at the New York World's Fair was submitted. A fixed contract, NAS8-13002, was subsequently negotiated. During the reporting period, the mockup was fabricated and shipped to New York, arriving at the World's Fair Grounds on March 24, 1964. The contract was completed during the week of April 18, 1964, when NASA/MSFC officially accepted the mockup. Contract closure action was in process by The Boeing Company at the close of the fiscal year.

Figure X-2 - NASA/MSFC Director Dr. Wernher von Braun Accepts Title to the World's Fair Model of the Thrust Structure from R. C. Dunigan (right) and Gordon Beall.

ORGANIZATION

On February 21, 1964, the Saturn Booster Branch was renamed the Launch Systems Branch and assumed the responsibility to manage the new Boeing Atlantic Test Center at Cape Kennedy. This new organization provides increased technical capability and an organization that is responsive to S-IC Program requirements at the Kennedy Space Center.

PROGRAM SCHEDULES

January 27, 1964, marked the initial release of Boeing Document D5-11040-3, "Launch Systems Branch Plan VII Program Schedules." (This document was preceded by D5-11040, -1, and -2, which presented schedule plans IV and V, Va, and VI, respectively). Document D5-11040-3 established the Branch scheduling base for the S-IC Research and Development Program currently under contract. Included in this document are: (1) A Saturn V/S-IC Stage Summary schedule (Figure X-3) which displays the assembly, testing, contractual delivery and planned utilization of each S-IC stage under contract, and an F-1 engine demand schedule and other major Saturn V program milestones; and (2) A Saturn V/S-IC Test and Checkout Equipment summary schedule (Figure X-4) depicting MSFC, Michoud, and Mississippi Test Operations requirements.

Since the initial release, major revisions to Document D5-11040-3 have been made to reflect schedule changes: to add a Saturn V/S-IC Phasing Summary Schedule (Figure X-5); to depict a geographical representation of major activities to be performed in support of the program; and to reflect the activation and checkout of S-IC/MTO Position 1 as a Boeing contractual responsibility (Contract NAS8-5608, Modification 102).

S-IC PROGRAM REPORTING AND CONTROL MILESTONES

Document D5-12535, "Launch Systems Branch Reporting Milestones," was developed to identify and define program reporting and control milestones for the Saturn V/S-IC program described by the technical work statement in Contract NAS8-5608. The milestones included in this document provide time-oriented events against which program progress and performance will be measured. Certain of the milestones depicted are contractual and others are utilized for general Branch management of the program. The contractual reporting milestones have been established by coordination with NASA/MSFC.

SUMMARY PROGRAM PLAN

Contract NAS8-5608 stipulated that the "C-5/S-IC Development Program Plan," developed under Contract NAS8-2577, be revised to incorporate the provisions and requirements of Contract NAS8-5608. This was accomplished and released as Boeing Document D5-11960, "Saturn V/S-IC R&D Summary Program Plan," dated November 1, 1963.

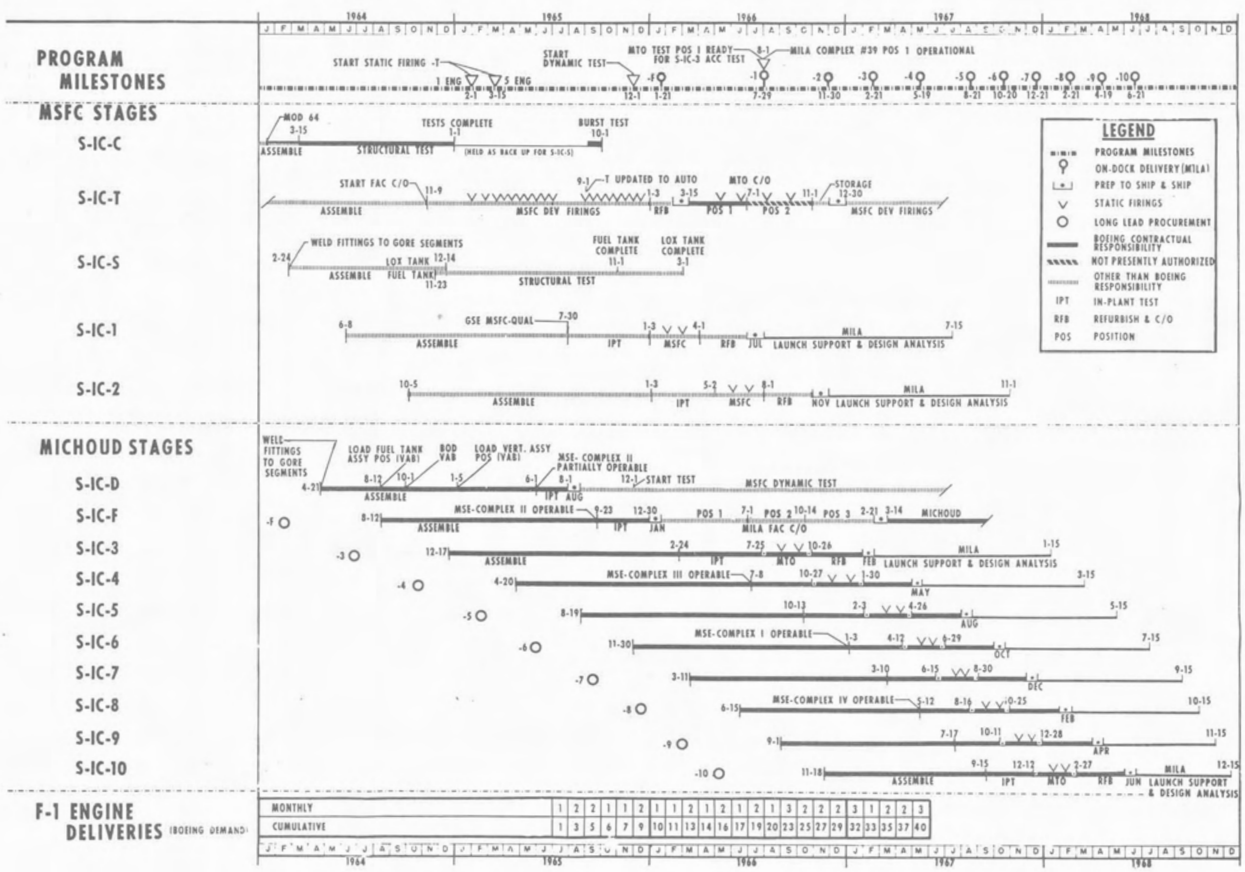


Figure X-3 - Saturn V/S-IC Stage Summary

This summary plan describes the total Boeing task and responsibilities, and provides a firm basis for Boeing Launch Systems Branch planning and management control. Because of the scope and complexity of the program, the Summary Program Plan was made concise and is supported by referenced, detailed plans and other documentation.

PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

During the past year, GSE/MSE networks for all contracted equipment were developed, and networks covering stage electrical and instrumentation systems were completed. This completed the basic PERT coverage of the Boeing S-IC program. During December 1963, NASA/MSFC concurred that the S-IC PERT System was fully implemented.

An improved PERT reporting format was implemented during March 1964. The report was expanded to encompass the Launch Systems Branch assessment of program status trends. During April 1964, Modification No. 100 to Contract NAS8-5608 was received in response to the need for an expanded PERT system. It enlarged the system to approximately 6000 real activities instead of the 1200 limitation specified in the basic contract. This modification was negotiated with NASA/MSFC during June 1964.

Technical Assistance Order (TAO) I-V-S-IC-13 was received in March 1964, authorizing Boeing to develop a PERT system which integrated the PERT reports of the major Saturn/Apollo contractors and government agencies into a single reporting system. The design of the system was completed by Boeing during June 1964.

PROGRAM INFORMATION CENTER (PIC)

The Launch Systems Branch's Program Information Center (PIC) at Michoud has been developed to provide Boeing and NASA management with the necessary program visibility. The PIC presents a display of program plans, schedules, resources, and highlights of significant program events and milestones.

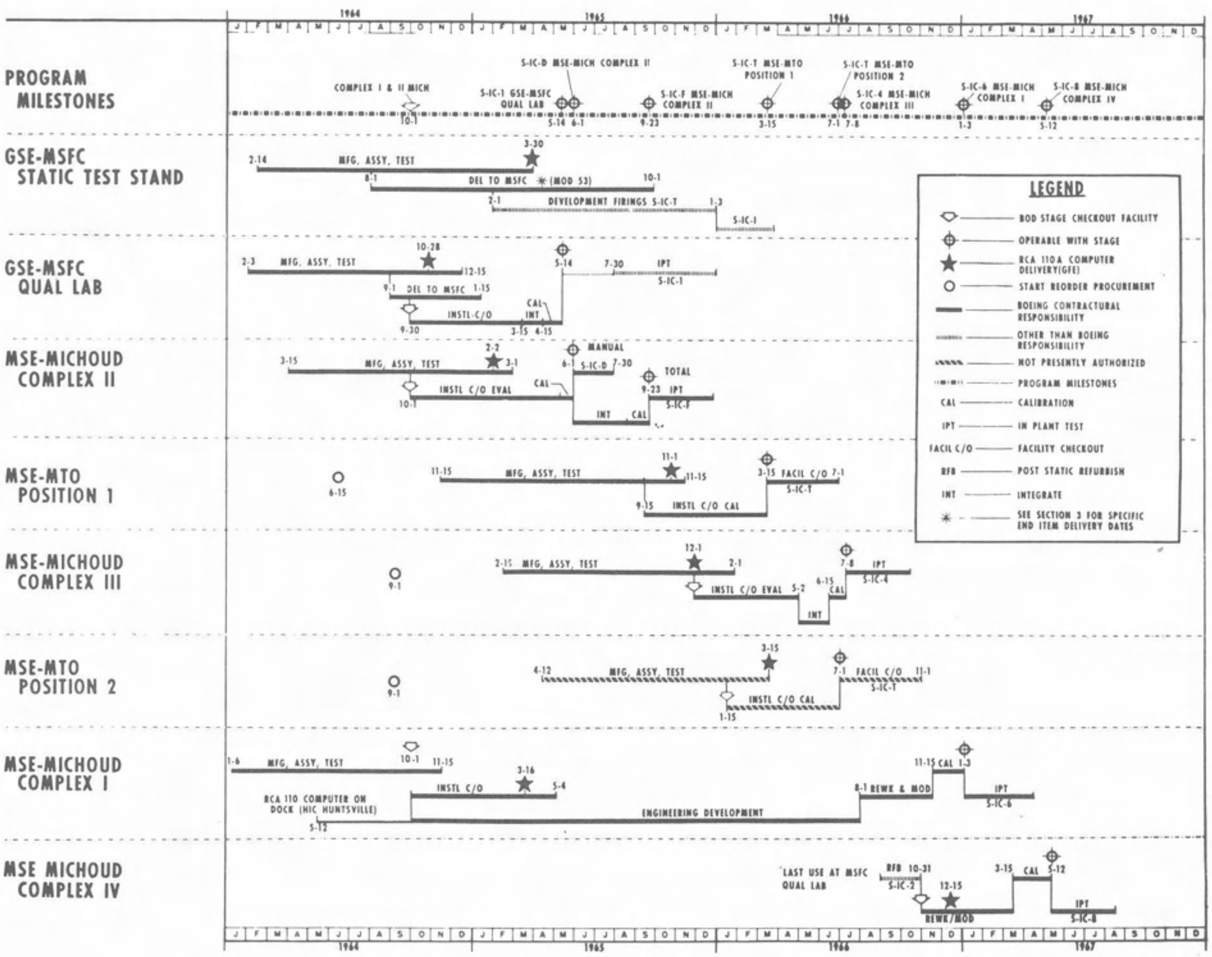


Figure X-4 - Saturn V/S-IC Test & Checkout Equipment Summary

March 1964, marked the go-ahead for the construction of the permanent Michoud PIC. A temporary PIC had been in service since April 1963. The formal opening will be concurrent with the seventh S-IC Quarterly Technical Progress and Program Review currently scheduled for late July 1964. (See Figure X-6.)

SATURN V/S-IC RESPONSIBILITY MATRICES

Saturn V/S-IC Responsibility Matrices were developed to reflect the current status of NASA/Boeing assigned responsibilities for those resolved functional and physical elements required to deliver the S-IC Stage on-dock at MILA. These items were identified to Level 5 in S-IC Program element detail with some facility items identified to Level 6.

SATURN S-IC MAKE-OR-BUY PLAN

A complete revision to Document D5-11413, "Saturn S-IC Make-or-Buy Plan," was approved by NASA/MSFC early in FY 64. Modifications to Contract NAS8-5608 since that time have necessitated numerous revisions to the plan.

Methods for reducing the make-or-buy approval processing time and associated costs have been jointly explored in a series of Boeing-NASA/MSFC meetings during the past year. Documentation of the mutual agreements resulting from these discussions have been transmitted to NASA/MSFC for review and approval.

DOCUMENT CONTROL PROGRAM

A Branch Document Control program was implemented during April 1964, to minimize cost of Branch document preparation and distribution; eliminate redundant documentation; ensure that required documents are prepared; provide management visibility of existing documentation; and ensure that documents are prepared in accord with approved format. This program provides control for that Boeing documentation prepared within

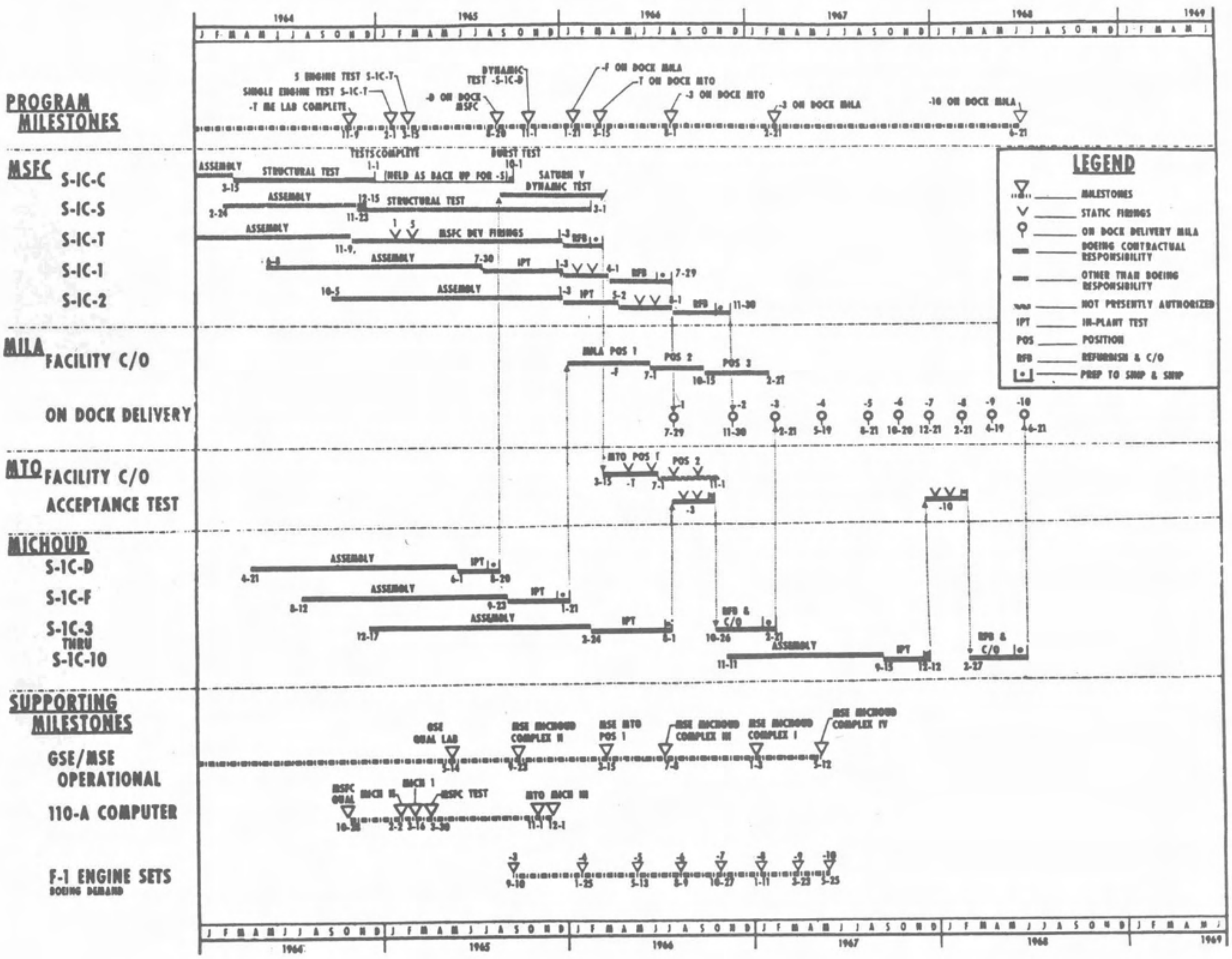


Figure X-5 - Saturn V/S-IC Phasing Summary

the Launch Systems Branch and identified with a "D5" or "T5" prefix to the identification numbers.

BACKUP PROGRAM STUDY

In March 1964, a comprehensive study was initiated to determine where Saturn V/S-IC backup programs were required. Results of this study were submitted to NASA/MSFC on April 1, 1964, by Document D5-11096, "Saturn V/S-IC Backup Program Requirements." This study also identified product improvement and growth items and provided NASA/MSFC the opportunity for review and selection of those items which appear to offer the greatest potential. It also served as a guide to NASA/MSFC for subsequent planning of back-up programs and product improvement funding requirements.

MANPOWER

There were 3782 permanent employees procured for the Launch Systems Branch for the period July 1, 1963, through July 2, 1964. The manpower on-board at all Branch locations on July 2, 1964, was 8684. Of this total, 4391 are transfers from within The Boeing Company, and 4293 are new hires.

TRAINING

Significant training accomplishments during the year by the Launch Systems Branch included the establishment of an employee certification program, activation of the Michoud Training Center, and approval and implementation of major training programs.

FACILITIES AND STAFF

The permanent Boeing Training Center, located in the main factory building at Michoud, was completed in December 1963 (See Figure X-7). Training classes are also held in the Michoud plant welding area (Figure X-8), in various conference rooms at the Michoud Plant, and downtown New Orleans at the 225 Baronne Building and Claiborne Towers. Two permanent classrooms have also been established at the Huntsville Industrial Center.

Thirty-three personnel are actively engaged in developing and presenting S-IC training programs. This staff includes approximately 22 Instructor-Supervisors.

TRAINING PROGRAMS

Training programs within the Branch include Em-

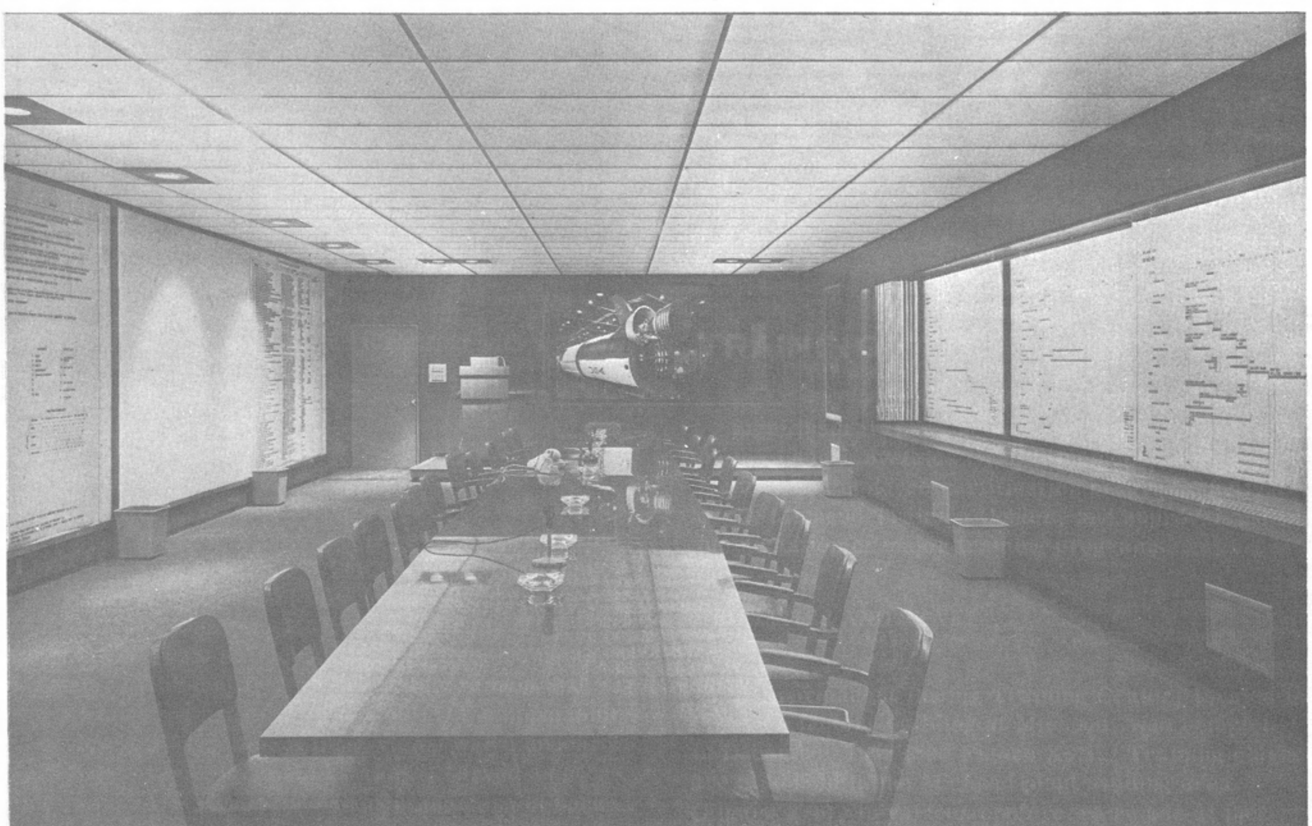


Figure X-6 - Program Information Center

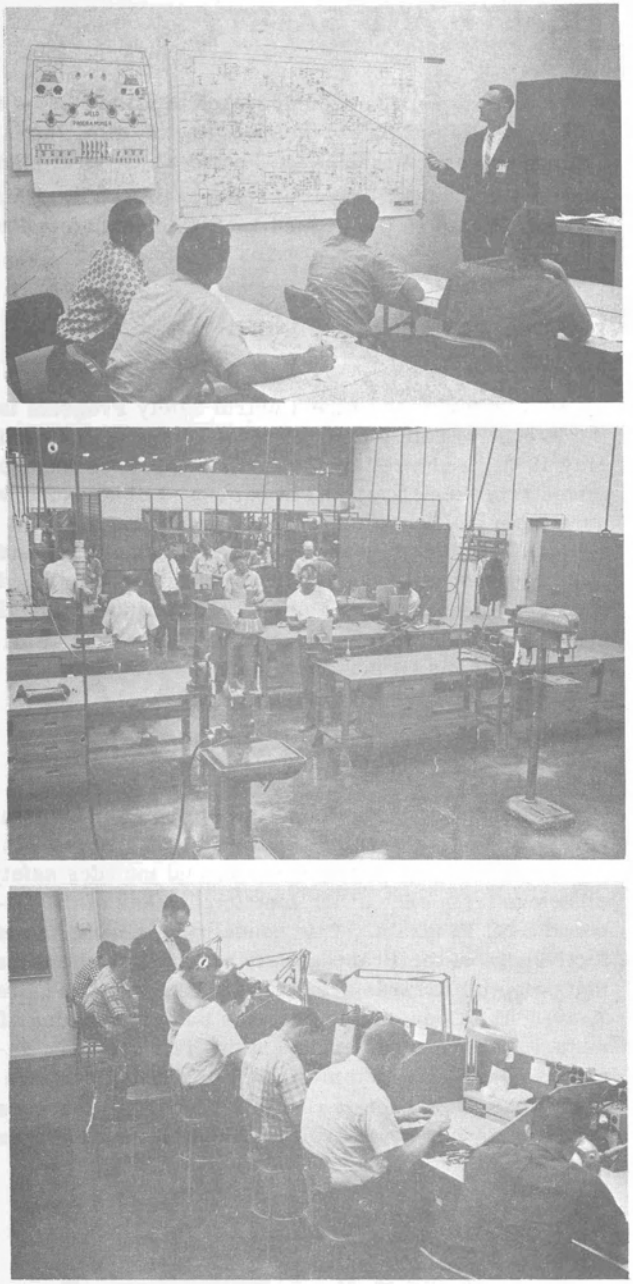


Figure X-7 - Training Classes in the Diverse Skills Needed to Build the S-IC are Being Taught in the Classrooms of the Boeing Training Unit

ployee Certification, Paid-Time Training, Off-Hours Training, and Continuing Education.

The Certification Program consists of training courses in specialized skill areas (e.g., penetrant inspection, soldering, welding, shot peening, contamination control, radiographic inspection, etc.) for employees who must attain a certain proficiency in their particular work to meet the standards of the S-IC program. During the fiscal year, 420 employees were certified in 12 types of certification courses ranging from 8 to 200 classroom hours each.

During the fiscal year, one hundred forty-two paid-time courses, oriented to improving the skills required in the employee's particular job were started, and 25 off-hours voluntary training courses were begun. In these off-hours courses, 461 employees completed training in subjects ranging from basic mathematics to computer programming.

A continuing-education program is also available for all Branch employees and management. In fiscal year 1964, this program included:

a) Technical Sessions, sponsored by colleges and universities throughout the country;
b) Seminars, Symposiums, and Conferences, sponsored by professional technical societies and organizations;
c) Graduate Study Program, Boeing-funded graduate work at nearby colleges and universities;
d) Cooperative Study Program, sponsored by Boeing, whereby college and university students work within the Branch; and
e) A Management Training Program offering advanced and fundamental management courses.

SCHOOL RELATIONS

Contacts were established with local technical, vocational, and secondary schools to compare their scholastic standards with job requirements.

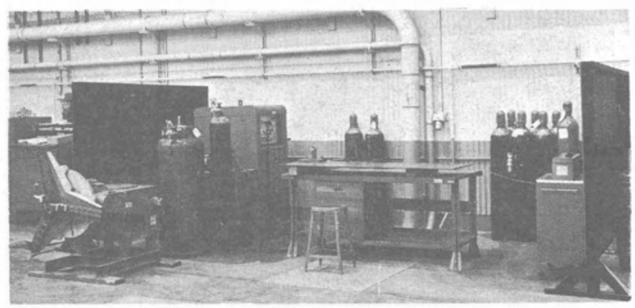


Figure X-8 - Welding Area in the Michoud Plant Where Training Classes are Held

SECURITY ACTIVITIES

Quarterly security inspections by representatives of the Air Force and NASA/MSFC were conducted at Branch facilities in New Orleans and Huntsville. The Boeing Launch Systems Branch Security Program was determined to be satisfactory.

During the past year, an extensive program was implemented to ensure that all classified files and secret control stations within the Launch Systems Branch contain only current and correctly classified documentation. Boeing was commended by NASA/MSFC for their effort and accomplishments on this program. Emphasis was also placed on a security indoctrination program.

FIRE PROTECTION AND EVACUATION CONTROL

Fire brigades have been established at Michoud and Huntsville Launch Systems Branch facilities. These brigades consist of volunteer Boeing employees who receive training in fire prevention and fire fighting (Figure X-9). Monthly fire brigade meetings are held.

The Fire and Evacuation Control Plan for the Branch leased facilities at 225 Baronne Street in New Orleans was put into operation during the year.

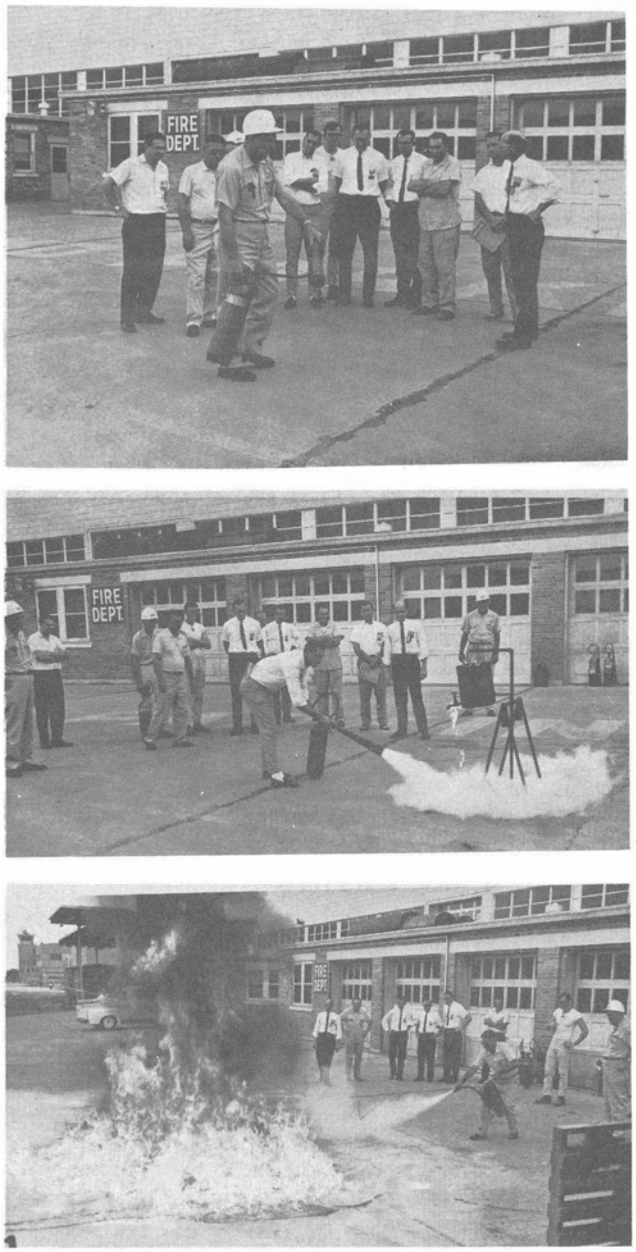


Figure X-9 - Company Personnel Receive Instruction in the Use of Fire Fighting Equipment Under Varying Conditions

HEALTH AND SAFETY

To ensure an organized approach to all problems involving health and safety on the S-IC program, the Launch Systems Branch Vice President-General Manager directed the establishment of a safety program. This was designated as the Branch Line-Control Safety Program.

EXECUTIVE SAFETY COUNCIL

Administering the Line-Control Safety Program is the Executive Safety Council. This Council, formed in May 1963, is chaired by the Assistant Branch Manager, or his representative, and is composed of key supervisors from the Boeing functional organizations.

During the fiscal year, the Council established authority, responsibility, and general policy for safety and accident prevention programs at Michoud and Huntsville, and directed that safety councils be established at all Launch Systems Branch locations.

MICHOUD SAFETY COUNCIL

The Michoud Safety Council was formed in September 1963. This Council is chaired by the Launch Systems Branch Operations Manager, and includes safety directors from each of the functional areas of the Michoud S-IC Program. This council implements the effectiveness of the Branch safety program, and ensures that potential hazards are properly controlled (Figure X-10). The Council also resolves safety problems of mutual concern to the organizations represented. Increased emphasis by this Council on safety practices of Boeing subcontractors resulted in a marked decrease in frequency and severity of accidents during the fiscal year.

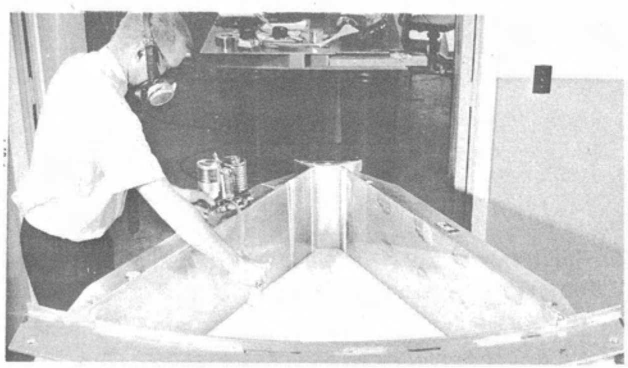


Figure X-10 - A Hygienist Takes a Sample of Toxic Polyurethane Resin Vapors to Determine Their Concentration

HUNTSVILLE SAFETY COUNCIL

The Huntsville Safety Council, chaired by the Boeing

Huntsville-Deputy Manager, was formed in January 1964, and operates on the same principal as the Michoud Safety Council. An MSFC/Boeing agreement has been reached on proper safety coordination where Boeing employees are working in NASA supervised shops.

VISITATIONS

On February 24, 1964, Dr. Wernher von Braun and members of his immediate staff toured the Boeing/Wichita facility (Figure X-11) where they were briefed on the scope of Wichita Saturn support effort, program status, and Boeing/Wichita resources.

Representative Olin Teague, Chairman of the House Subcommittee on Manned Space Flight, toured the Michoud Operations on January 24, 1964.

On March 27, 1964, Virgil I. "Gus" Grissom became the first United States Astronaut to visit the Michoud Operations. Major Grissom was briefed by the Saturn Manager of the Launch Systems Branch, and then toured the Boeing Michoud facilities (Figure X-12).

Figure X-12 - Astronaut V. I. "Gus" Grissom is Shown With NASA and Boeing Representatives at the Boeing Michoud Plant

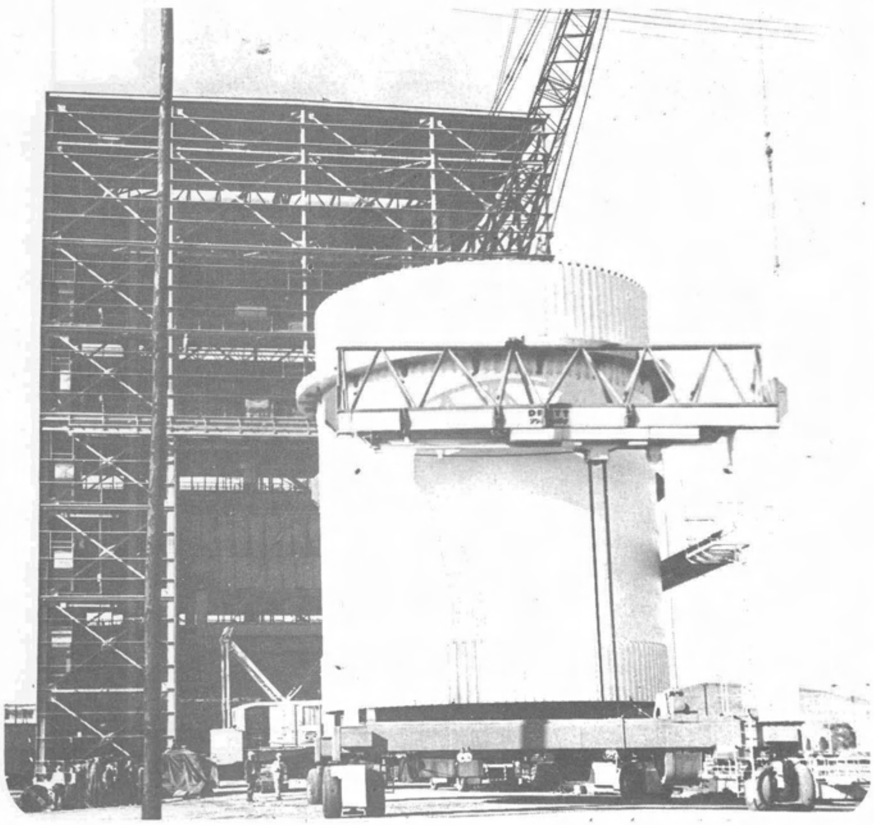
Figure X-11 - Dr. von Braun and Lt. Col. C. C. Bliss Talk With Boeing Airplane Division Vice-President/General Manager, J. O. Yeasting, During a Visit to the Wichita Facility

EQUAL EMPLOYMENT OPPORTUNITY

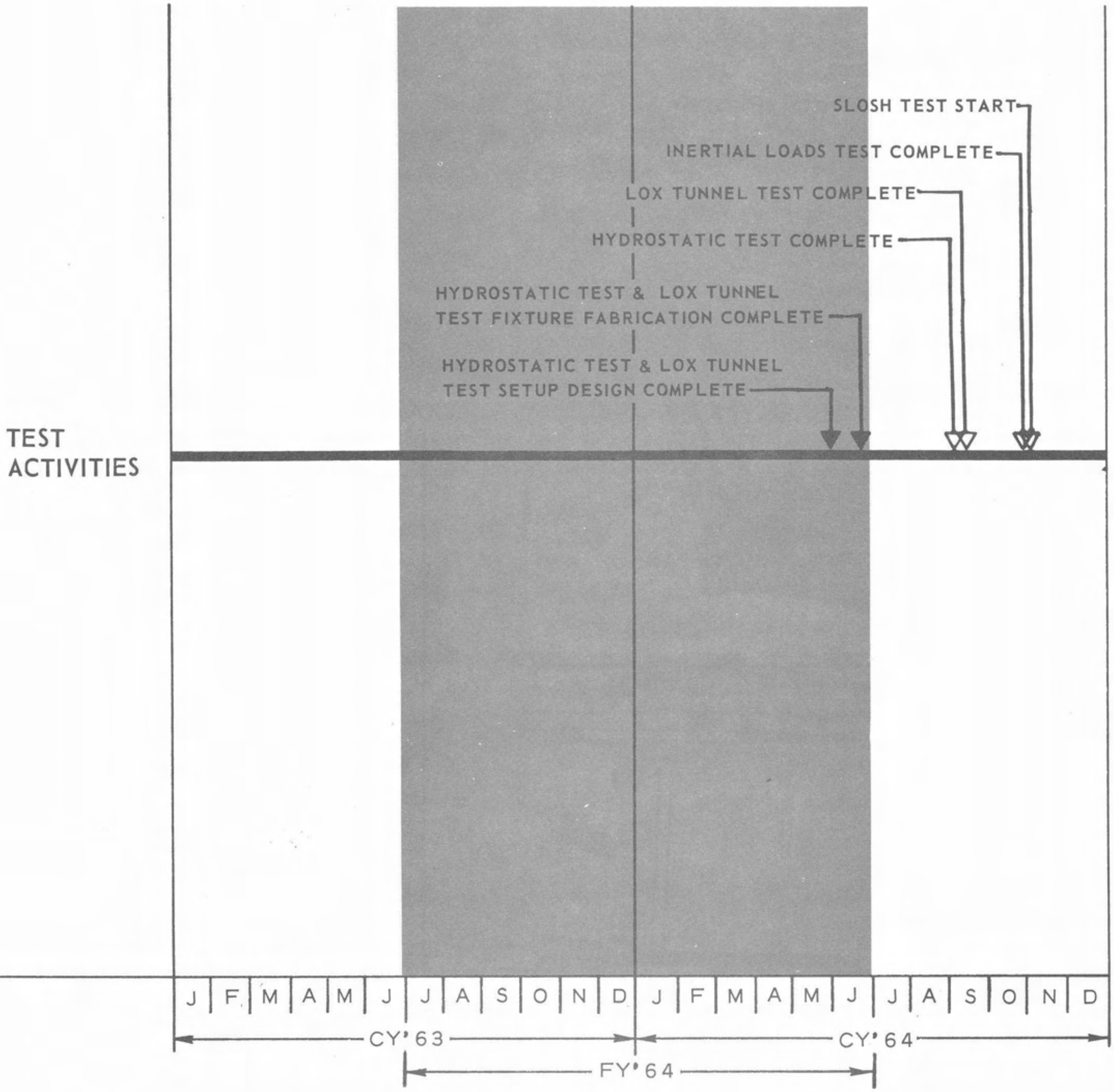
A Plan for Progress Committee, established in May 1963, held bi-monthly meetings to ensure implementation, within the Branch, of the Plan for Progress Agreement signed by Boeing with the President of the United States. A log of the significant activities was reviewed by a government compliance officer in March 1964. Typical activities include: contact with the Urban League on job requirements; presentations on job opportunities at city-wide workshops, senior highschools, and special meetings; review of job classifications to ensure proper placement; and publicizing minority achievement on television and national periodicals.

GOOD NEIGHBOR FUND

A Boeing Good Neighbor Association was established within the Branch. It has pledged funds to the United Givers of New Orleans and the Huntsville United Fund, and has made numerous contributions to charities that do not participate in the United Fund.



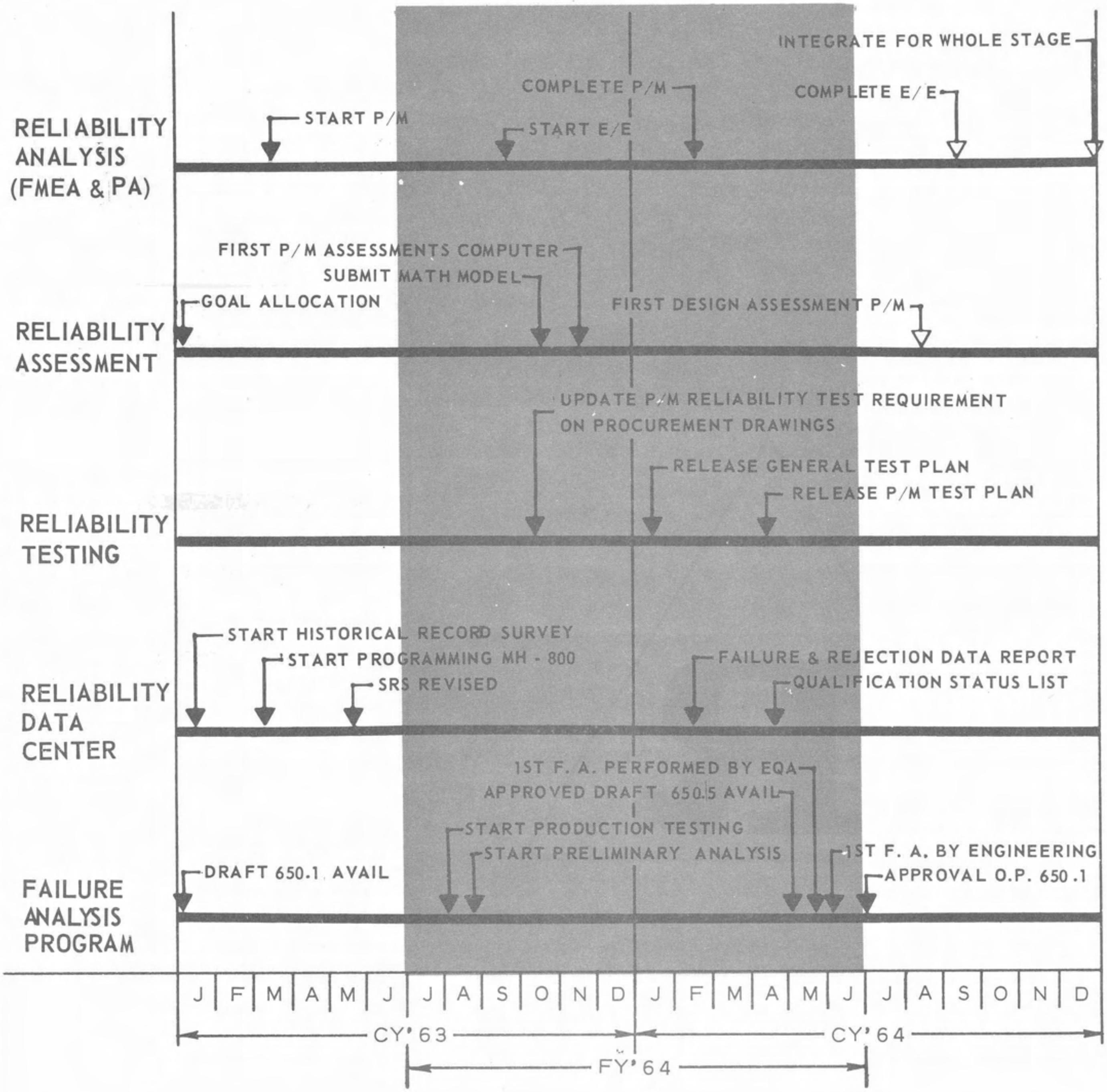
S-IC MISSION SYSTEMS SUPPORT


SLOSH TEST START
INERTIAL LOADS TEST COMPLETE
LOX TUNNEL TEST COMPLETE
HYDROSTATIC TEST COMPLETE
HYDROSTATIC TEST & LOX TUNNEL TEST FIXTURE FABRICATION COMPLETE
HYDROSTATIC TEST & LOX TUNNEL TEST SETUP DESIGN COMPLETE
TEST ACTIVITIES
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

MAJOR COMPONENT STRUCTURAL TEST PROGRAM

Contract Modification No. 64, received January 17, 1964, authorized Boeing to perform the testing of the S-IC-C test fuel tank at MSFC. The tank was fabricated by NASA/MSFC and installed on the test fixture early in March. Preparation for testing was begun. Minor delays, primarily due to delayed receipt of instrumentation towers and to strain-gage bonding problems caused by the severe environmental conditions on the outdoor stand, have been encountered. However, hydrostatic testing will start in July, and the series of structural tests (excluding the burst test) are expected to be completed as scheduled during February 1965. The tank is to be held as a backup for the S-IC-S; therefore, the burst test is not scheduled until September 1965.

RELIABILITY


RELIABILITY ANALYSIS (FMEA & PA)
START P/M
START E/E
COMPLETE P/M
COMPLETE E/E
INTEGRATE FOR WHOLE STAGE
RELIABILITY ASSESSMENT
GOAL ALLOCATION
FIRST P/M ASSESSMENTS COMPUTER
SUBMIT MATH MODEL
FIRST DESIGN ASSESSMENT P/M
RELIABILITY TESTING
UPDATE P/M RELIABILITY TEST REQUIREMENT ON PROCUREMENT DRAWINGS
RELEASE GENERAL TEST PLAN
RELEASE P/M TEST PLAN
RELIABILITY DATA CENTER
START HISTORICAL RECORD SURVEY
START PROGRAMMING MH - 800
SRS REVISED
FAILURE & REJECTION DATA REPORT
QUALIFICATION STATUS LIST
FAILURE ANALYSIS PROGRAM
DRAFT 650.1 AVAIL
START PRODUCTION TESTING
START PRELIMINARY ANALYSIS
1ST F. A. PERFORMED BY EQA
APPROVED DRAFT 650.5 AVAIL
1ST F. A. BY ENGINEERING
APPROVAL O.P. 650.1
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

INTRODUCTION

With the signing of Contract NAS8-5608, The Saturn S-IC Reliability Program was activated in January 1963. This program, based on Document D5-11013, "The Reliability Program Plan," has been revised twice consonant with program changes. Official comments on this plan were received from NASA/Michoud on July 2, 1964. A revised plan will be documented and issued in August 1964.

The stage design reliability analysis which includes failure mode and effect analysis (FMEA) and probability analysis (PA), was started in March of 1963 on the propulsion/mechanical system; this work was completed in February 1964. The electrical/electronic FMEAs and PAs were begun in September 1964, thereby affording the first integrated "single thread" analysis for the whole stage in December 1964.

The design review program, which started in February 1963, has progressed well during the year.

The reliability assessment of the S-IC stage began with goal allocation in early 1963. The math model was submitted for approval to NASA/Michoud and NASA/MSFC in October 1963. The model was programmed into the computer and successful computer runs were made in November 1963, on several propulsion/mechanical systems. Work is continuing on the math model as reliability analyses are completed, and the first complete design assessment for the stage is scheduled for July 1965.

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion Mechanical and Thrust Vector Control Systems," accepted by NASA/Michoud, was released in April 1964.

The Data Center initiated historical record surveys early in 1963 to provide reliability data to designers for part selection. To date, surveys have been made on over 500 components. In addition to inspection reports, unsatisfactory condition reports, and inter-service data exchange program reports, over 700 documents and reports are available concerning the performance of some of these components in past programs.

In March 1963, NASA/MSFC made the decision that their MH800 computer would be used for data recording and analysis rather than the IBM7090, and the Data Center proceeded with the necessary reprogramming. This programming is now about 70-percent complete and all basic programs are scheduled for completion in the first quarter of 1965. Difficulties have been encountered in acquiring computer time to check out and test required computer programs. If sufficient time is not provided, the Data Center programs may be delayed still further. Action has been taken to bring this problem to the attention of NASA/MSFC and Boeing management.

Production testing began during the third quarter of 1963. Reliability approval of all Unplanned Event Records (UER) is now required to ensure that complete and accurate reliability data is provided on discrepancies or failures.

The equipment quality analysis (EQA) laboratory which assesses the quality of purchased components was activated in the first quarter of 1964. The first three EQAs have been conducted and reports were issued.

Reliability auditing of all organizations for compliance with Document D5-11013, "The Reliability Program Plan," continued throughout the year on a quarterly basis.

Reliability oriented training courses were attended by 1077 personnel during the year.

ACTIVITIES

RELIABILITY PLANNING

Document D5-11013, "The Reliability Program Plan." was updated in October 1963 and February 1964, to keep it in line with overall S-IC program changes. Preliminary NASA/Michoud comments on the plan were discussed with NASA/MSFC Reliability personnel in May 1964, and formal NASA/MSFC comments were received by Boeing July 2, 1964. A revised plan will be issued in August 1964.

RELIABILITY ANALYSIS

Considerable progress was made with the S-IC reliability analysis in the following areas.

PROPULSION/MECHANICAL

First reliability analyses of the propulsion/mechanical systems were completed. The analyses were included in Document D5-12572-1, "Saturn S-IC Emergency Detection Parameter Selection Analysis," and submitted to NASA/MSFC in March 1964. Updating of the analyses to include design changes and NASA/Michoud refinements is in progress to meet the quarterly revision date of September 1964.

A preliminary propulsion/mechanical qualitative "single thread" analysis was completed and sent to NASA/Michoud for comment in June 1964. Based on this analsis, development of preliminary emergency detection and malfunction detection systems (EDS/MDS) parameter recommendations was started.

OPERATIONAL ELECTRICAL SYSTEM

Work on the reliability analysis of the operational electrical system was temporarily suspended during March and April 1964. This was to enable the design changes indicated as necessary by the partially completed FMEA to be incorporated in the drawings for the first flight stage. The FMEAs were completed in June 1964. The probability analyses are half completed.

INSTRUMENTATION/RF/TELEMETRY SYSTEM

An analysis was performed on the instrumentation/RF/telemetry system to assess the probability of successful data transmission from the S-IC stage. This was submitted to NASA/Michoud in June 1964, for decision on whether further reliability disciplines should be applied to this system.

RELIABILITY ASSESSMENT

The S-IC reliability assessment math model was programmed in the computer and proven by conducting the first design assessment runs against selected propulsion/mechanical systems. The planned assessment program was presented to NASA/MSFC in January 1964, and it is described in Document D5-11954, "Saturn S-IC Stage Reliability Assessment and Reliability Program," released in July 1964.

RELIABILITY DOCUMENTATION

Document D5-11910, "The Reliability Status Report," was issued in August 1963, and was revised June 1964. This document contains the planning detail for the performance of reliability disciplines at subsystem and component level. It provides for sign-off by Boeing Stage Design Engineering and for the check signatures of either Boeing Reliability Engineering or Booster Technology.

The time/cycle recording requirements of the S-IC stage have been documented in Document D5-12713, "Time/Cycle Recording Requirements."

Current reliability documents, operating procedures, and instructions in use by the Launch Systems Branch are shown in Figure R-1.

RELIABILITY EDUCATION

During the year, 1077 people, representing all levels of Boeing technical manpower, attended reliability courses and training programs.

These training programs encompass the whole spectrum of reliability activity as follows:

1) A 4-hour course on the basic tenets of reliability;
2) Courses, varying in length and intensity, on the Saturn Records System which contain basic reliability discussions and detailed instruction on the completion of SRS forms;
3) An 8-hour reliability analysis course in sufficient detail to enable design and staff engineers to perform FMEA and PA and based on the methods described in Document D5-11944, "Design Reliability Methods."
4) A course on contractual reliability requirements considering each paragraph of the contract reliability work statement (Exhibit A, Part I, H. of Contract NAS8-5608) and relating these paragraphs to the reliability tasks defined in Paragraph IV of Document D5-11013, "Reliability Program Plan."

Recommendations have been made to Boeing Management defining requirements for courses to be initiated this year.

SUPPLIER CONTROL

All procurement specifications of critical propulsion/mechanical components have been revised to include reliability requirements and have been signed-off by Boeing Reliability Engineering.

During the year, more than 200 management review board meetings were held to consider supplier proposals and to select suppliers. All of these were attended by reliability representatives of the Manufacturing organization.

Quality and Reliability Assurance personnel are presently performing source surveys and monitoring at 98 vendors' plants.

PART SELECTION

Proposals were made to NASA/MSFC and NASA/Michoud in February 1964, on a part selection and control program. The presentation was favorably received and Boeing is preparing Document D5-11372, "Saturn S-IC Parts Selection and Control Program" for submittal to NASA in July 1964.

DESIGN REVIEWS

During the year, 35 critical design reviews of crucial components were held either at supplier plants or at Boeing. Critical design reviews at subsystem level were rescheduled so that they would agree with Schedule Plan VII. So far, 13 of these reviews have been conducted and the critical design review program is presently on schedule. The Boeing Manufacturing Reliability organization supported the design review program by attending or coordinating a total of 137 design reviews within the Boeing Operations organization.

RELIABILITY DATA CENTER

The Data Center has analyzed all Unplanned Event Records generated to date to detect existing or potential reliability problem areas. Weekly UER analyses have been issued since November 1963. During late 1963, and early 1964, review of the UERs being received by the Data Center showed that the reliability data contained therein was incomplete. Investigation showed that this was attributable to certain incompatibilities

which existed among various standard operating instructions within Boeing. These differences have now been resolved and compatible instructions will be issued by July 1964. Document D5-11593, "The Saturn Records System," is being revised accordingly.

The Data Center has received only about 10 percent of the computer time required to check out its programs under Schedule Plan VII. All major programs were scheduled to be completed in July 1964, but it has been necessary to slide this to March 1965.

The following contractually required programs are among those which will be delayed; the qualification status list; time and cycle recording; revised UER program to enable NASA/MSFC to retrieve reliability data from the Boeing program; the configuration control program and the reliability mathematical model. This problem has been presented to Boeing and NASA/MSFC management for solution.

EQUIPMENT QUALITY ANALYSIS (EQA)

The first EQA was performed on April 14, 1964, and the first report was published on May 12, 1964. The Boeing EQA Procedure 680.2 has been published, and meetings of an EQA Committee have been held to approve the selection and scheduling of components for EQA during 1964.

TESTING

RELIABILITY TEST PROGRAM

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion/Mechanical and Thrust Vector Control Systems," was completed and released in April 1964. The released document incorporated changes recommended by the NASA/Michoud Reliability Office during a review in February 1964. The documentation was again reviewed with the NASA/Michoud Reliability Office in June. The proposed testing concept was acceptable to NASA/Michoud reliability personnel who are now reviewing test requirements contained in the document preparatory to approving the conduct of the testing.

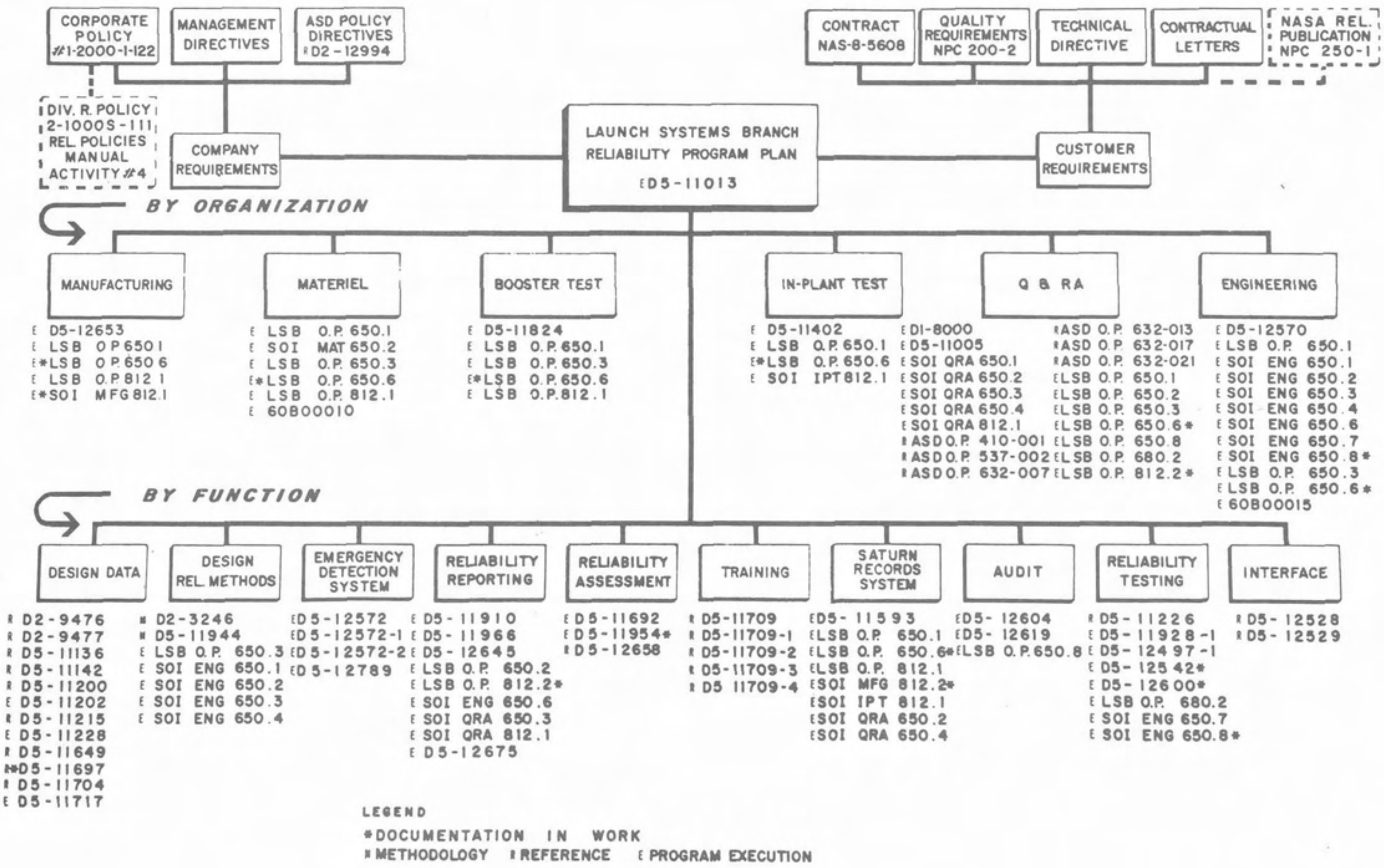


Figure R-1 Reliability Documentation and Procedures

SAFETY CRITICAL ITEMS

The hardware in the S-IC-T critical items list is under study by the Boeing Booster Test organization to determine test requirements and sequences, periodic inspections, and maintenance operations needed to assure safe operation of safety critical items.

MISSISSIPPI TEST OPERATIONS

Saturn Record System Procedures for Mississippi Test Operations have been written, and will be released by Mid-July 1964.

PRODUCTION

Production testing began during the third quarter of 1963. Reliability monitoring of the testing and the resultant handling of Saturn Record System paper work was begun accordingly. These efforts have now progressed to require reliability approval of all initiated UER paper work. This approval is designed to ensure that complete and accurate reliability data is provided on discrepancies or failures.

FAILURE ANALYSIS

The failure analysis program was implemented during the last quarter of the period. Analyses have been conducted both in the Boeing EQA and the Engineering laboratories. The Failure Analysis Operating Procedure, 650.1 was published June 24, 1964.

RELIABILITY AUDITING

The Reliability Audits Operating Procedure, 650.8 was published in June 1964. It establishes that direct audits shall be conducted on a quarterly basis. Since December 1962, audit presentations showing program progress and problems have been made to Boeing management and to NASA/Michoud and NASA/MSFC.

RELIABILITY CHART ROOM

The reliability chart room now has 28 program monitoring charts on display. The charts are frequently used during formal review meetings to show reliability program progress to Boeing and NASA management.

PREDICTION

During the first 6 months of FY 1965, the following significant reliability milestones will be complete:

1) The electrical/electronic reliability analysis will be completed in September 1964.
2) The first integrated "single thread" analysis for the whole stage will be completed in December 1964.
3) The first complete propulsion/mechanical systems design assessment using the computerized reliability mathematical model is scheduled for August 1964.
4) NASA/Michoud comments on Document D5-11013, "The Reliability Program Plan," will be included in the next revision to the plan scheduled for release in August 1964.
5) The Boeing Manufacturing Reliability organization will be fully manned by November 1964. This will enable them to undertake the certification of completed Saturn Record System forms for data validity.
6) The Data Center will complete the following programs: the UER program will be revised by October to enable preliminary UERs to be recorded; the time and cycle recording program will be completed in August 1964; the qualification status listing will be in the computer by September 1964.

GOVERNMENT FIELD PRINTING PLANT
(Under Contract NAS 8-5618)
NASA – MICHOUD OPERATIONS – 1964
NEW ORLEANS 26, LOUISIANA

M-95 R. K. SULLIVAN 5-1220

LG-66
12.4.10

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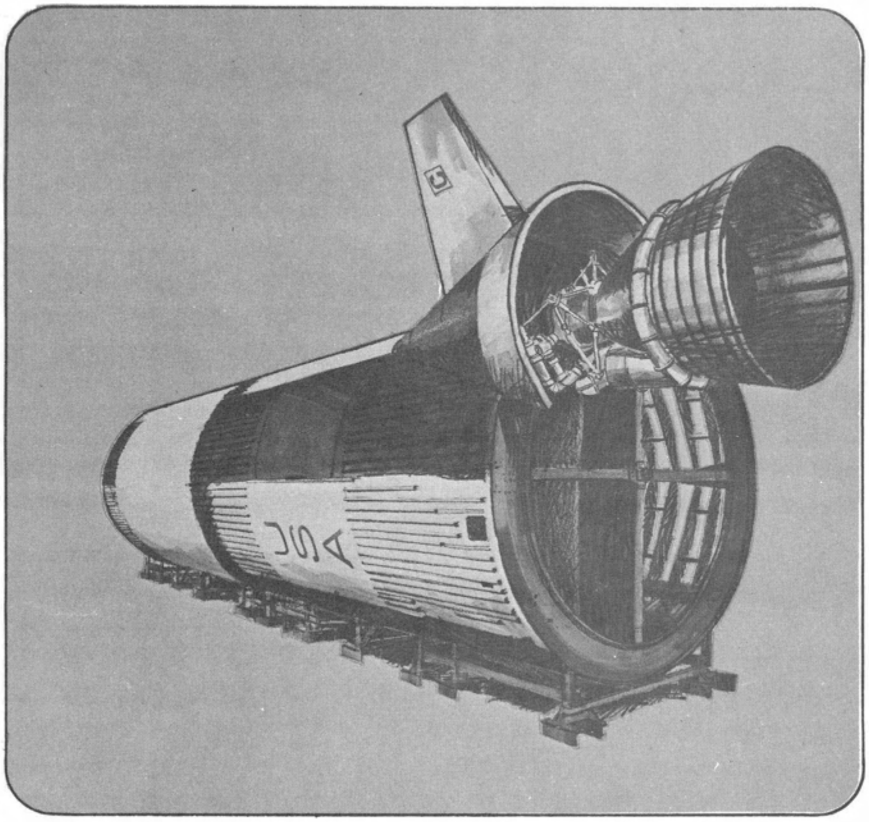


SATURN S-IC

FISCAL YEAR 1964 ANNUAL PROGRESS REPORT

Aug 14, 1964

D5-12601-1 [redacted]

LAUNCH SYSTEMS BRANCH
AERO - SPACE DIVISION
THE BOEING COMPANY

THE BOEING COMPANY
LAUNCH SYSTEMS BRANCH, AERO-SPACE DIVISION P. O. BOX 26088, NEW ORLEANS, LA. 70126

July 2, 1964

National Aeronautics and Space Administration
George C. Marshall Space Flight Center

IN REPLY REFER TO

Fiscal year 1964 progress of the Saturn V/S-IC Stage Program has reflected a significant transition from primarily a conceptual to an implementation phase of program activity.

The developmental nature of the S-IC Stage Program has resulted in changes to the program requirements. The most significant change was the change to program schedule Plan VII. Numerous contract modifications have been received which have significantly expanded the scope of the work assigned to The Boeing Company. At the close of FY '64, The Boeing Company capabilities are focused on implementing these new program requirements.

The release of S-IC and GSE/MSE basic design was behind schedule at the beginning of this fiscal year period. Combined action by NASA/MSFC and Boeing in such areas as approval of GSE design criteria and establishment of a streamlined approval release system has significantly improved our schedule position relative to release of design documentation.

Throughout the reporting period, the assembly and manufacturing effort was greatly affected by program changes. At the outset of the fiscal year, the assembly and manufacturing activity was primarily involved with structural component activity per Plan V requirements. Program changes such as the NASA/MSFC redirection from schedule Plan V to Plan VII, the impact of Boeing intertank redesign and the transfer of thrust structure tooling and assembly from NASA/MSFC to Boeing at Michoud has required changes in planning and program phasing. It was a period which saw many adjustments to tool loading schedules and procurement activities. As of the end of June 1964, the Launch Systems Branch had realigned its stage assembly effort in support of the new customer schedule requirements. Launch Systems Branch Michoud-assembled S-IC stages and GSE/MSE for all locations are currently predicted to be delivered per the NASA/MSFC Plan VII schedule requirements. At the same time, an all-out effort is in progress by NASA/MSFC and the Launch Systems Branch to ensure that critical problems affecting the completion of the S-IC-T stage were being properly dealt with.

Behind-schedule activation of various facilities in the Michoud complex created problems during the past year. The use of partial and interim facilities in addition to other work-around techniques has allowed Launch Systems Branch to minimize schedule impact. Permanent facility activations commenced during the fourth quarter of calendar year 1963 and continued through the end of June 1964. The remaining facilities are predicted to be completed during fiscal year 1965.

Many new and varied developmental problems will undoubtedly arise during the next fiscal year. I am confident that Boeing and NASA/MSFC management will overcome these challenges with the same team spirit demonstrated in the past.

THE BOEING COMPANY
Aero-Space Division

R. C. Dunigan

R. C. Dunigan
S-IC Program Executive
Launch Systems Branch

SATURN

S-IC

FISCAL YEAR 1964
ANNUAL PROGRESS REPORT

D5-12601-1 ■ AUGUST 14, '64

LAUNCH SYSTEMS BRANCH

AERO - SPACE DIVISION

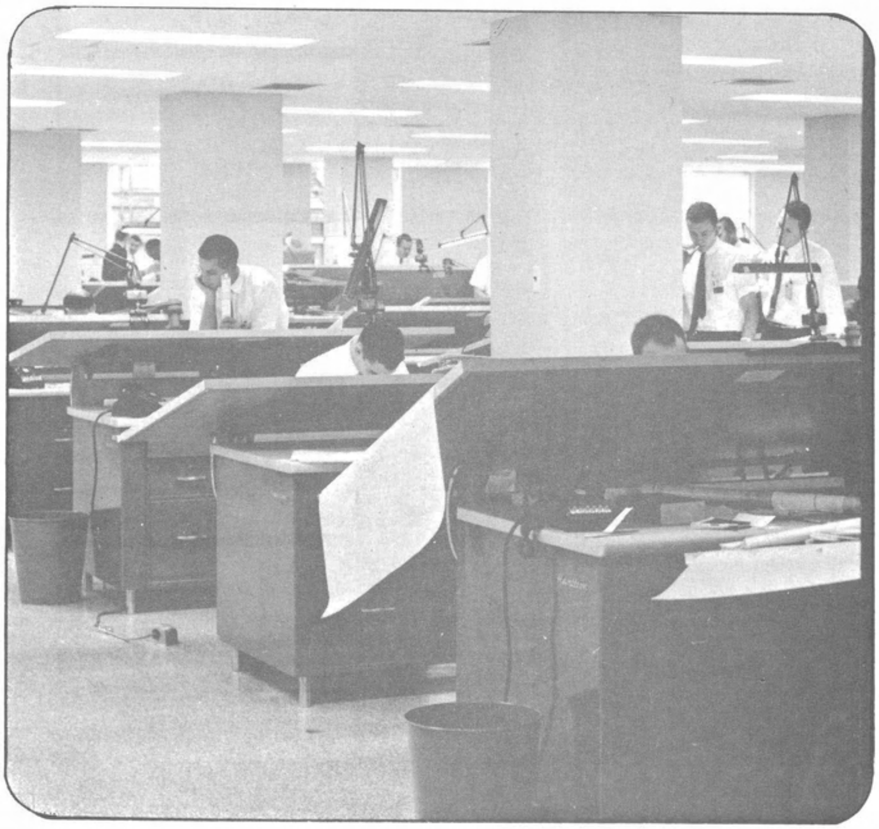
THE BOEING COMPANY

FOREWORD

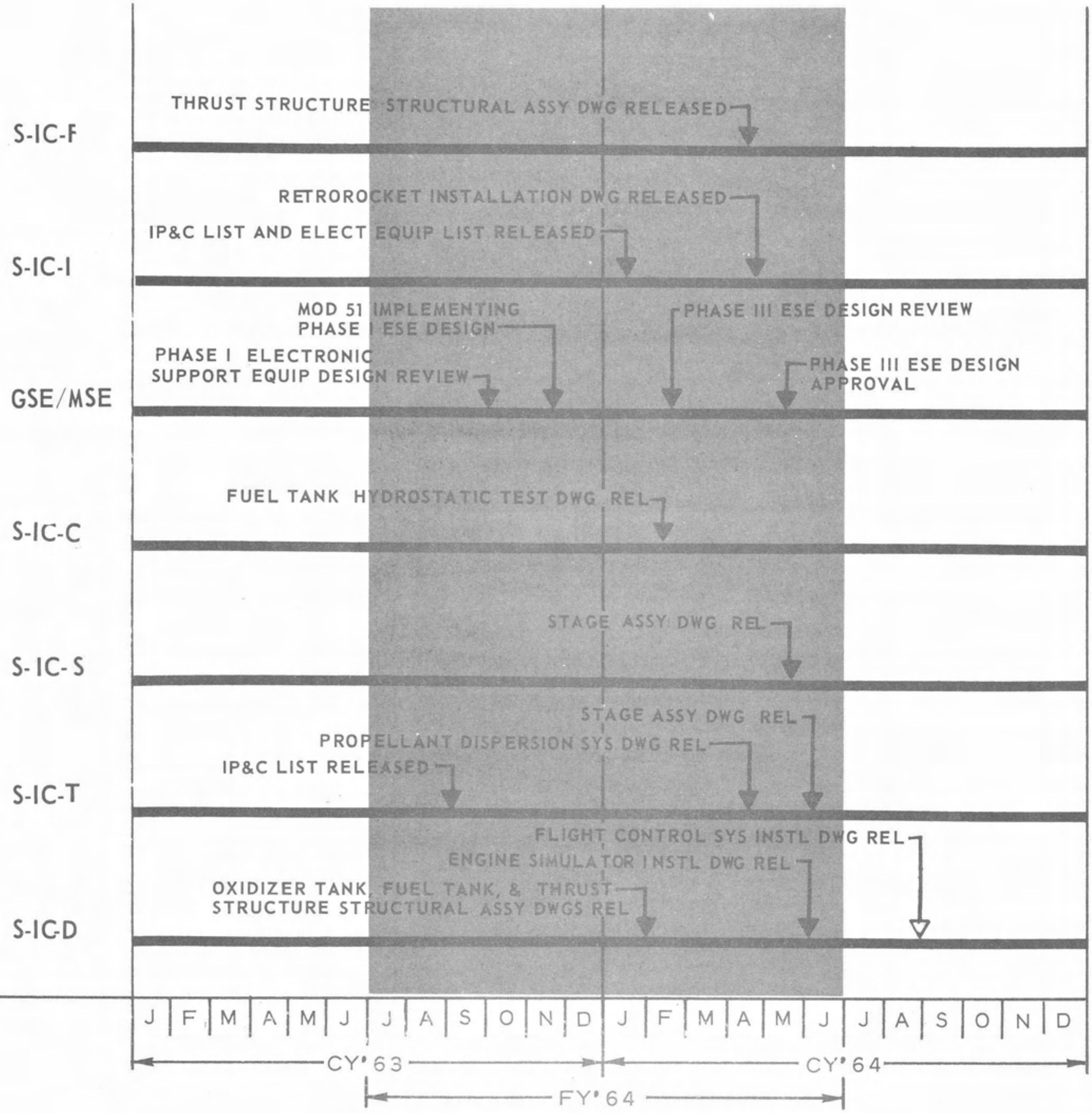
This Annual Progress Report has been prepared by The Boeing Company to fill the requirement under Article XXXI, Paragraph C, of Contract NAS8-5608 as modified by Modification 100. It encompasses the progress made by The Boeing Company on the Saturn S-IC Program for the fiscal year 1964 (from July 1, 1963 through July 2, 1964). The main objective of this report is to serve as an historical presentation stressing Boeing accomplishments and present capabilities under Contract NAS8-5608.

CONTENTS

ILLUSTRATIONS



DESIGN AND ENGINEERING



THRUST STRUCTURE STRUCTURAL ASSY DWG RELEASED
S-IC-F
RETROROCKET INSTALLATION DWG RELEASED
IP&C LIST AND ELECT EQUIP LIST RELEASED
S-IC-I
MOD 51 IMPLEMENTING
PHASE I ESE DESIGN
PHASE III ESE DESIGN REVIEW
PHASE I ELECTRONIC
SUPPORT EQUIP DESIGN REVIEW
PHASE III ESE DESIGN
APPROVAL
GSE/MSE
FUEL TANK HYDROSTATIC TEST DWG REL
S-IC-C
STAGE ASSY DWG REL
S-IC-S
STAGE ASSY DWG REL
PROPELLANT DISPERSION SYS DWG REL
IP&C LIST RELEASED
S-IC-T
FLIGHT CONTROL SYS INSTL DWG REL
ENGINE SIMULATOR INSTL DWG REL
OXIDIZER TANK, FUEL TANK, & THRUST
STRUCTURE STRUCTURAL ASSY DWGS REL
S-IC-D
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

During Fiscal Year (FY) 1964, two major program redirections (NASA/MSFC Plan V and VII) from NASA/MSFC resulted in S-IC stage program schedule changes. This rescheduling reflected changes in phasing as well as an interchange of certain task assignments. Little relief was afforded to the Engineering documentation release schedule, since the S-IC-T release requirements remained unchanged in order to provide early capability for test firings.

The S-IC stage basic design documentation, lagging at the beginning of FY '64, is currently on schedule. The recovery, which was accomplished during the last quarter of the fiscal year, is the result of concentrated effort on the factors that delayed design activity and the streamlining of the design approval process.

On June 4, 1964, the release of the S-IC-T stage assembly drawing completed the basic releases for that test stage. The basic design releases of all major structural elements for subsequent vehicles were also completed during the year.

Change action against released basic design became a substantial design effort during the year. During the last quarter of the reporting period, there was also increased emphasis in technical assistance rendered in solving fabrication problems encountered by NASA/MSFC, Boeing, and the various vendors.

Early in FY '64, release of GSE/MSE drawings was slow because of delays in design criteria approvals. These delays were offset in part by a more detailed design review during the Pre-Phase I and Phase I reviews, making it possible to proceed more accurately and quickly to Phase III or production design releases. This has enabled Boeing to maintain on-schedule status at FY'64 year end.

S-IC STAGE DESIGN

Several variations of the S-IC are being designed by Boeing under specifications and technical direction provided by NASA/MSFC. The configurations being designed and their primary purposes are listed below:

Model	Purpose
S-IC-T	Static test of F-1 engines and engine systems.
S-IC-C	Fuel Tank only—for structural testing.
S-IC-S	All major structural components—for use in structural testing of assembled stage.
S-IC-D	For use in dynamic testing of the assembled Saturn V vehicle. This configuration is further defined under Electrical and Instrumentation Section.
S-IC-F	Facilities checkout at MILA.
S-IC-1 through S-IC-10	Flight vehicles

The progress made on S-IC design and development throughout FY'64 is discussed in the following sections.

DOCUMENTATION

Release of basic design documentation, at the start of the fiscal year, was substantially behind the schedule required to meet hardware program schedules. This documentation was returned to schedule during the second half of the year (Figure I-1). Schedule position was regained by (1) recovery on the design schedule, and (2) reduction of release processing flow time. The design schedule was recovered by concentrated effort in areas where design criteria had caused delayed effort. Release processing time was shortened in March 1964, by reducing flow-time for the approval process, as authorized by Contract Modification 76. Although there were S-IC program schedule changes during the year, there was little effect on documentation release schedules as the S-IC-T schedule was not altered.

Change action against released basic design became a substantial design effort during the year. At the close of FY'64, change documentation release, with only minor exception, was being made in accordance with change commitments established by the joint NASA/MSFC-Boeing Change Board. Documentation has been completed for approximately 200 changes since inception of change action against the S-IC stages. Changes have resulted from design criteria revision, adverse structural test results (intertank), instrumentation requirement additions, and weight saving.

WEIGHT STATUS

There was increasing emphasis during the year on S-IC vehicle weight control and reduction. The first major weight reduction — approximately 4500 pounds — was accomplished during the first quarter through use of a computerized analytical model study of the S-IC thrust structure. The resulting design documentation was issued under Change Action Memo (CAM) 72. Deletion of the requirement for the in-flight LOX dome purge system (CAM 112) shortly thereafter, eliminated 1200 pounds of system weight.

A joint NASA/MSFC-Boeing weight reduction team was established in September 1963, to review and implement weight saving ideas. Under this weight reduction program, eight weight saving changes have been approved by NASA/MSFC to effect an additional total weight reduction of approximately 7000 pounds. The effects of these weight changes are detailed in Figure I-2. Program schedule impact has been minimized by committing the changes to later flight vehicles; however, all presently committed weight reduction changes will be incorporated on vehicles on which payload weight capability will become critical.

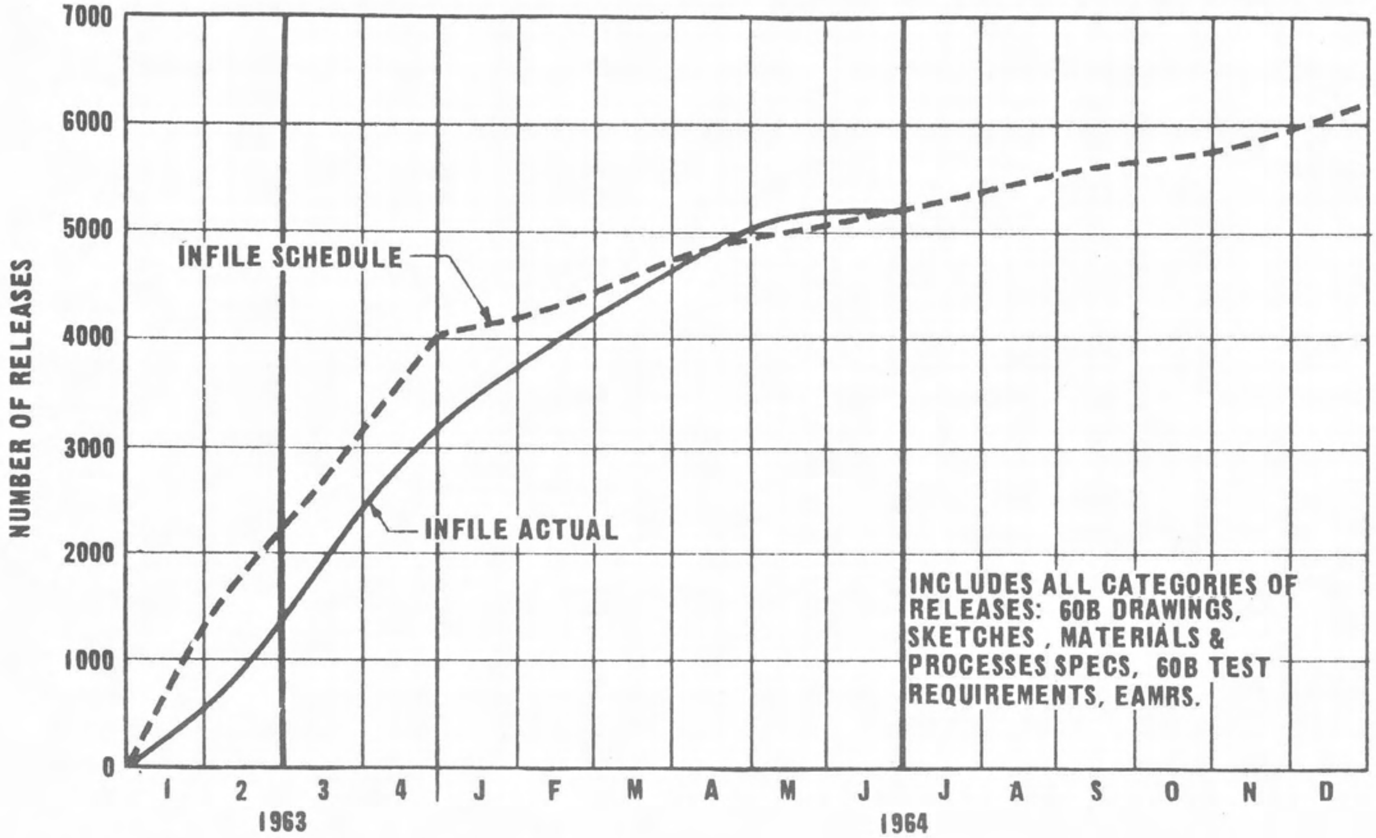
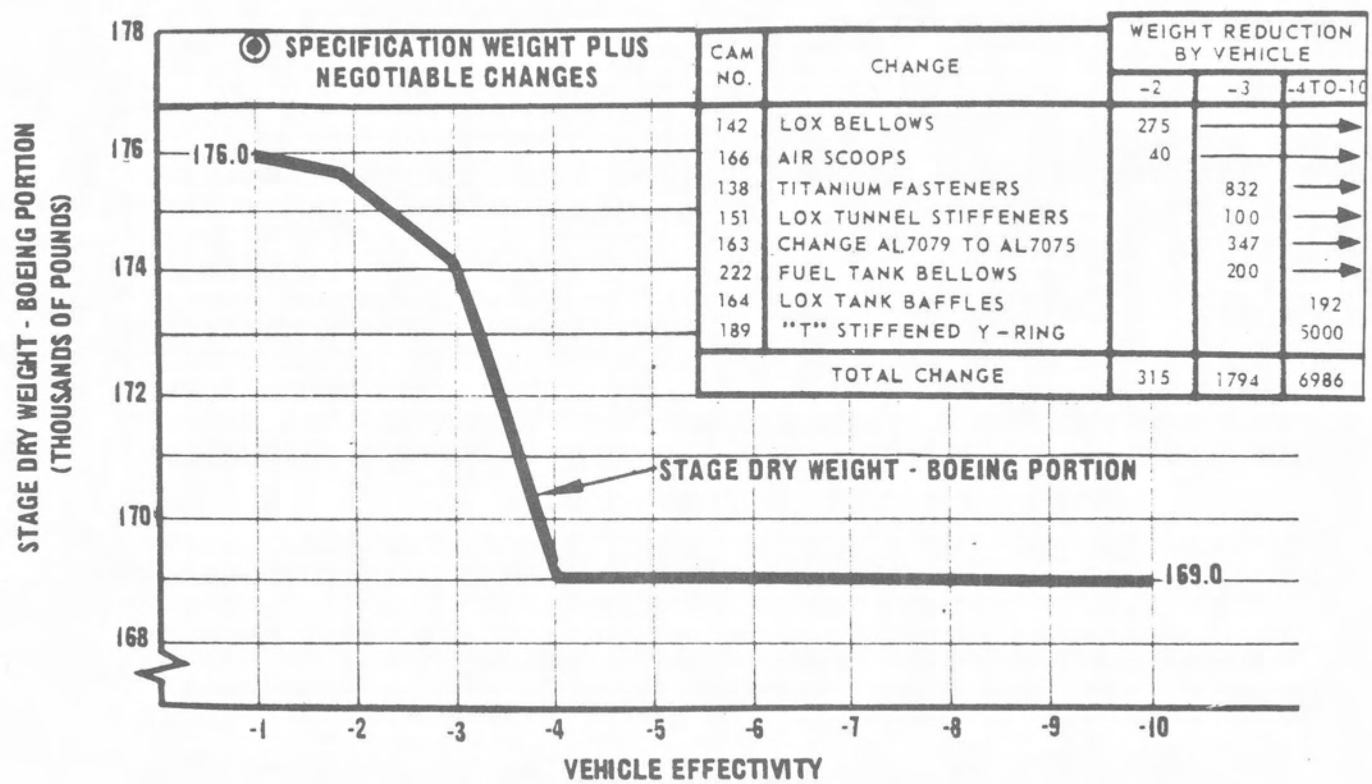


Figure 1-1 - S-IC Stage Basic Release Schedule -- Plan VII



CAM NO.	CHANGE	WEIGHT REDUCTION BY VEHICLE		
		-2	-3	-4 TO -10
142	LOX BELLOWS	275	→	→
166	AIR SCOOPS	40	→	→
138	TITANIUM FASTENERS		832	→
151	LOX TUNNEL STIFFENERS		100	→
163	CHANGE AL7079 TO AL7075		347	→
222	FUEL TANK BELLOWS		200	→
164	LOX TANK BAFFLES			192
189	"T" STIFFENED Y-RING			5000
	TOTAL CHANGE	315	1794	6986

Figure 1-2 - S-IC Weight Reduction Program

The only weight originally specified in Contract NAS8-5608 was the total stage dry weight of 287,000 pounds. To provide a direct basis for evaluation of Boeing weight control performance, a specification allowance for the Boeing-controlled portion of the S-IC was established as 174,282 pounds at a NASA/MSFC-Boeing meeting in March 1964. The specification allowance and the general definition of Boeing responsibility were formalized by Contract Modification 109. The calculated weight for the Boeing-controlled portion of the S-IC at the time of establishment of specification allowance was 172,285 pounds. The weight history of the S-IC-1 is shown in Figure I-3. The effect on weight of changes considered to be negotiable is carried in the specification allowance line subsequent to formal definition of Boeing responsibility.

STRUCTURAL DESIGN

Basic release of documentation for the S-IC-T was completed in early June with the release of the stage assembly drawing. Basic release of all major structural elements for subsequent vehicles was also completed during the last quarter of the fiscal year. The heat shield installations remain to be released, and the stage assembly drawings for S-IC-D and subsequent vehicles will be released following completion of electrical and instrumentation design early in CY'65.

With the completion of most of the basic design activity, emphasis has shifted to change design and technical support of manufacturing, vendors, and the various test activities affecting S-IC structure.

Significant structural design problems were encountered and resolved during the year. The most important of these were a dynamic loading problem and an intertank structural problem.

Early in the fiscal year, analytical studies of stage dynamic loads indicated a possibility that a direct dynamic coupling of transient engine thrust buildup and vehicle release loads would substantially exceed specified load factors for stage structural design. After further study, it was recommended that the stage holddown release mechanism be changed from an instantaneous release device to a system in which holddown restraint is released gradually to avoid sudden application of release loads. This solution was agreed to, and subsequent study, including revised estimates of engine thrust buildup rates, indicated that the holddown mechanism change would eliminate the problem.

A second major problem was encountered during development testing of 1/8-scale models of the intertank structure. The intertank structure consists of a longitudinally corrugated skin with circumferential stiffener rings. Design of the intertank was based on the very

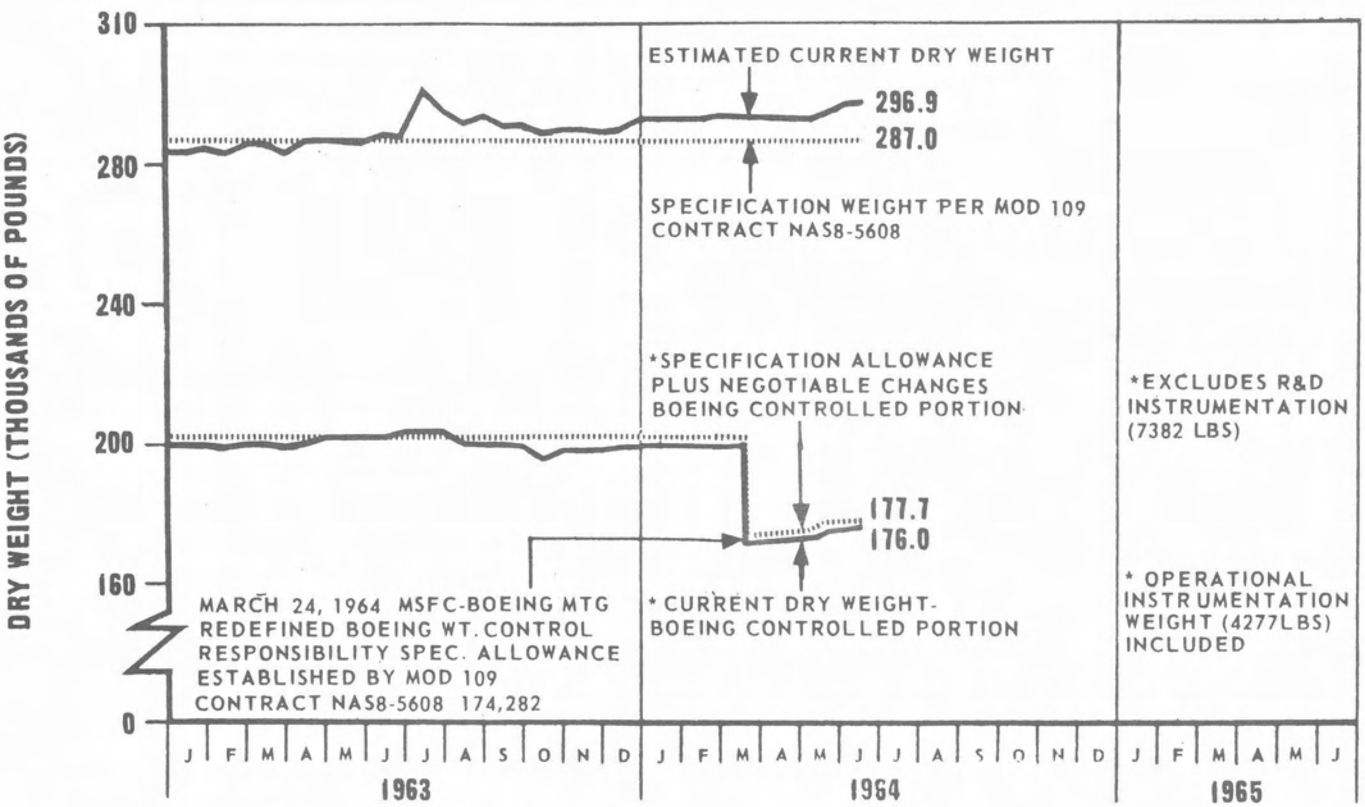


Figure I-3 - S-IC Dry Weight Status

limited experimental data available for this type of structure under compression loading; however, because of the limited data available and because of its questionable applicability to large structures, such as the S-IC intertank, scale-model development testing was essential.

Initial tests during the second quarter of the year resulted in failures at substantially less than the expected load (as applicable to the scale model). Subsequent testing confirmed the early test results.

A change (CAM 207) has been initiated to redesign the intertank in accordance with NASA/MSFC Technical Directives 180 and 211. The intertanks for the S-IC-T, -D, and -S will use the existing design, since these units will not be subjected to flight vehicle loads. The S-IC-1, -2, and -3 intertanks will be a heavier (approximately 2600 pounds) "minimum risk" unit with thicker skins and stronger ring frames. Such an approach is necessary to avoid program schedule delays, since substantial testing is required to establish a minimum weight design of adequate strength.

As presently planned, the S-IC-4 will incorporate a lighter weight design. One intertank of the present configuration and one intertank of the heavy S-IC-1 configuration will be loaded to destruction to provide data for correlation of full-scale and sub-scale tests, and additional sub-scale tests will be utilized to determine S-IC-4 design. An S-IC-4 configuration intertank will also be loaded to destruction to verify its design.

PROPULSION AND MECHANICAL EQUIPMENT DESIGN

Basic release of documentation for the S-IC-T was completed during the last quarter of the year, with the exception of the F-1 engine conversion drawings, which are scheduled for release early in calendar year 1965. Release of all basic drawings for the S-IC-D, -F, -S, and -1 has also been completed. All component, assembly, and subsystem qualification test requirements have also been released.

As with structural design, emphasis has shifted to change design and technical support of manufacturing, vendors, and the test activities affecting propulsion and mechanical equipment.

ELECTRICAL AND INSTRUMENTATION DESIGN

This S-IC-T basic design was completed during the last half of FY '64. Basic release of S-IC-D test instrumentation, cables, and equipment mass simulators was begun following definition of the S-IC-D configuration in February. Approximately 1100 electrical/instrumentation basic drawings remain to be released for the S-IC-D. The remaining release breakdown includes cable assemblies, equipment and cable installations, mass-simulated equipment, brackets, connectors, and other installation details. The general configuration definition to which S-IC-D basic release is being made is described below:

a) The electrical configuration will be the same as the S-IC-1, except that electrical/electronic equipment and transducers will be omitted. Dummy equipment simulating the mass of the actual equipment will be installed for all items weighing over 20 pounds, and for all shock-mounted equipment.

b) Installation provisions will be made for all instrumentation equipment.

c) All electrical cabling will be installed.

d) Except for the engine servo-actuators, propulsion components weighing over 20 pounds will be simulated by dummies. All flight hardware mounting provisions will be included.

During the latter half of the fiscal year the highest priority was assigned to release of documentation for CAM 177, which provides the Systems "A" Basic and the Research and Development Measurement systems for the S-IC-T vehicle. System "A" measurements are defined by NASA/MSFC Document SK10-1596 Revision A, "S-IC-T Static Firing Measurement Requirements." Measurement Systems "A" is a system of transducers which will be wired directly to recorders as the primary instrumentation for data gathering during ground test firings. Over 700 items of electrical and instrumentation documentation have been required by CAM 177. Design work was completed on all items by the first of June and all remaining documentation was completed and in release process at the end of the year.

Responsibility for releasing S-IC-1 through S-IC-10 measurement instrumentation program was transferred from NASA/MSFC to Boeing following NASA/MSFC approval of the S-IC-1 Instrumentation Program and Components (IP&C) list late in the second quarter of the fiscal year. Approval of the IP&C list permitted identification of the instrumentation and electrical configuration for the S-IC-1. Instrumentation program and electrical equipment lists will be released individually for S-IC-2 through S-IC-10, with the various releases scheduled through January 1966. Any change between the instrument list for S-IC-1 and subsequent lists will be implemented by change action to revise affected structures, propulsion, and electrical documentation.

Direction to proceed with design and development of a visual instrumentation installation was received late in the third quarter of the fiscal year by Modification 75 to the contract. The visual instrumentation consists of two television cameras viewing the engine turbo pumps and four ejectable and recoverable movie cameras, two to record liquid movement in the oxidizer tank and two to record stage separation (separation view cameras will be omitted from the S-IC-T). Development was well under way at the end of the fiscal year, with preliminary drafts of procurement drawings for the LOX tank optical system (fiber optics bundles, lenses, etc.) and the photo-optics timer specification distributed to potential suppliers. Preliminary drafts of procurement drawings for other components are nearing completion. The NASA/MSFC breadboard of the photo-optics strobe light has been received at Michoud and is under test.

Some difficulties and delays were encountered during the year in the development of the various propellant measuring systems for the S-IC. These systems consist of the fuel and LOX loading probes (for determination of loading completion), the LOX and fuel engine cutoff sensors, and the R&D instrumentation for liquid level and fuel slosh measurement. All of these systems are to be installed in the S-IC-T. Despite the delays encountered, all are expected to be delivered in time to be installed in the S-IC-T, and all parts are expected to be qualified before the S-IC-T is placed on the test stand.

GSE/MSE DESIGN

Simulated flight tests and static firing tests of the S-IC stage will be accomplished primarily through application of automatic digital programing and evaluation techniques. Ground support equipment (GSE) will evaluate the performance and integrity of a completely assembled stage at R-Qual and R-Test. Manufacturing support equipment (MSE) will accomplish the same goals at Michoud and the Mississippi Test Operations (MTO). Tests conducted on the S-IC stage will be fully automated except when automation is impractical for economic or technical reasons. Automated testing is the goal to which engineering design effort is being directed. Boeing design concepts developed early in the program were reviewed during the first half of the reporting period; subsequent redirection culminated in Modification 51 to Contract NAS8-5608 on November 21, 1963.

DOCUMENTATION RELEASE

Early in FY '64, release of drawings was slowed as a result of delay in the approval of the design criteria. These delays were offset, in part, by a more detailed design review. By achieving greater definition of detail during the Prephase I and Phase I (System Design Concept) reviews, it was possible to proceed more accurately and quickly to Phase III (Production Design) releases and maintain schedule (Figure I-4). Contract Modification 51 directed incorporation of the Phase I design changes. This was followed by the Phase III design submittal on February 25, 1964. NASA/MSFC gave approval on May 15, 1964 based on incorporation of comments resulting from the design review. The majority of comments fell within the contract scope and did not significantly affect overall design. Action has been initiated to incorporate all items which were within the scope of the contract. Change Action Memos have been initiated for nine recommended design improvement items which are beyond the scope of the contract.

On June 2, 1964, Boeing was given limited direction to resume work on the MTO design, temporarily suspended in December 1963. Interim funding was provided until Modification 102 officially became part of the

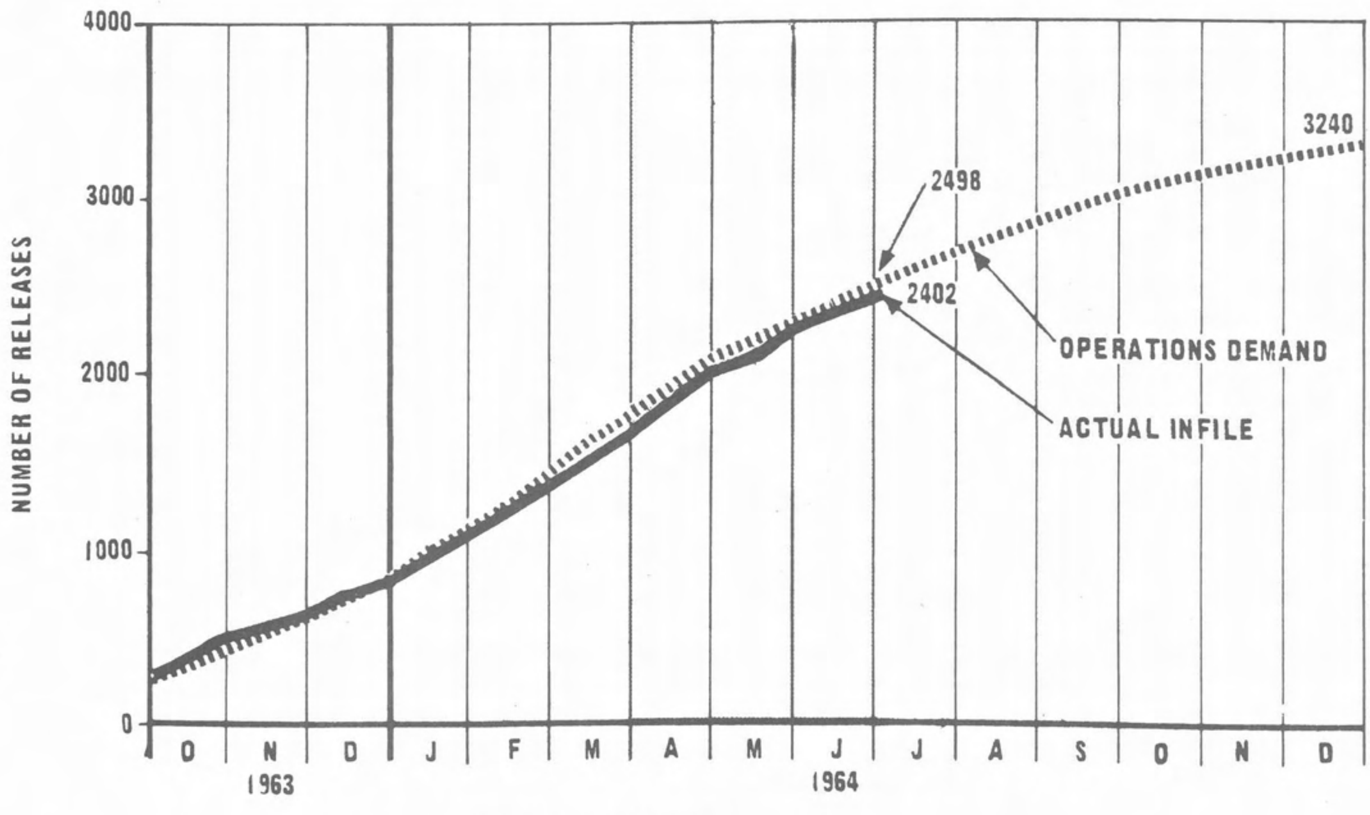


Figure I-4 - Engineering Basic Release Schedule-- GSE/MSE

contract. Work is now in progress detailing the design requirements for the MTO test and checkout complexes.

TEST AND CHECKOUT EQUIPMENT DESIGN

Substantial changes have been made to the original concept of the test and checkout complexes during the year. These changes resulted from the Prephase I and Phase I design reviews and had a major impact on the degree of automation and capability of the test and checkout complexes. Some of these changes are described briefly below.

The original test and checkout equipment concept called for centralized control of testing. This has been modified to add provision for switching test control to test operators at the individual test stations within the test and checkout complex.

Another expansion of capability has been incorporated in the area of data recording. Originally, records were to be stored within the computer for printout later. The new design retains computer storage and adds the ability to store data in direct writing recorders.

Capability of the mechanical test control equipment has also been increased. In the original concept, testing could be conducted on a limited one-at-a-time basis. The expansion of equipment adds flexibility and permits simultaneous testing of components.

Equipment sharing has been eliminated. At the Michoud complex, instead of using one computer plus a switching distributor to control testing on two vehicles, inidividual computers will be used in the testing of each vehicle. These are representative of the Prephase I and Phase I design changes. In general, test and checkout capabilities have increased with a necessary accompanying increase in equipment design effort.

The test and checkout complexes (Figure I-5) are composed of a control and monitor station, a computer station, a mechanical test station, a data systems test station, the related interconnection equipment, checkout calibration, and maintenance equipment. Test personnel direct and control the execution of tests performed by the digital computer. Computer codes allow full automatic and semi-automatic operations as well as local control from the test stations. Each test station contains the stimuli generators and control circuitry necessary to test the stage system with the computer. Error detection and fault isolation techniques are employed to make more effective usage of the test equipment and to reduce operating time on stage systems.

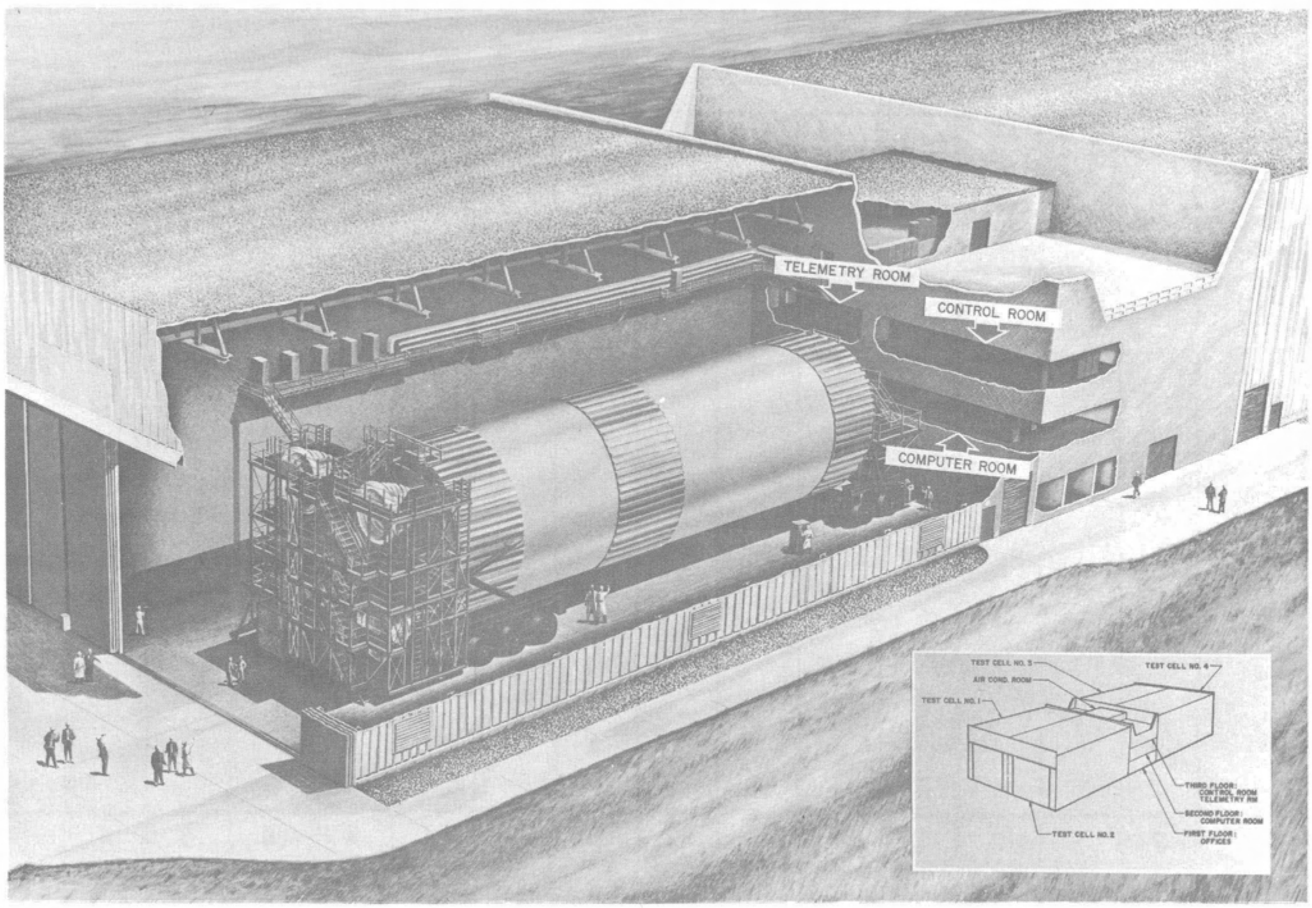


Figure I-5 - Test and Checkout Complex

Control and Monitor Station

The Control and Monitor Station (Figure I-6) includes the control and monitor console, the audio communication equipment, the closed-circuit TV equipment, and the cathode ray tube (CRT) interface and control logic equipment. The console provides control of the computer-directed test system and furnishes stage and test system status information. Design of all portions of the console has been completed, with assembly drawings and wiring schematics released for procurement of equipment.

The CRT display incorporated in the console, provides display capability for subsystem testing, troubleshooting, maintenance, and for presentation of supplementary information during normal testing (Figure I-7). Preliminary design of the CRT was completed during the first quarter of this reporting period along with construction of a feasibility model. Since then, checkout of the model has been completed and demonstrations of its capabilities have been made to NASA/MSFC personnel on several occasions. Late in April, authorization to proceed with the Boeing-Raytheon CRT display system was received for the NASA/MSFC Quality Division and Michoud Test and Checkout Complexes, and a contract was let to Raytheon on June 3, 1964, to proceed with production of five units.

The audio communications systems consist of the general area paging system, local area paging system, and the intercommunications system. Design of each of these systems has been completed, specification drawings have been released, and equipment is now beginning to arrive at Michoud from suppliers.

A closed-circuit TV system is provided for each test cell to enable the test engineers to monitor activity on and around the stage. Design in this area is 95 percent complete, with some equipment already received, functionally tested, and prepared for storage until ready for assembly into the system.

Computer Station

The Computer Station (Figure I-8) utilizes the RCA-110A digital computer. Under control of its internal program and guided by the test conductor, the computer generates digital words, analogs, and discretes as required to program the individual test stations and stage under test.

Design of the Computer Station, including the equip-

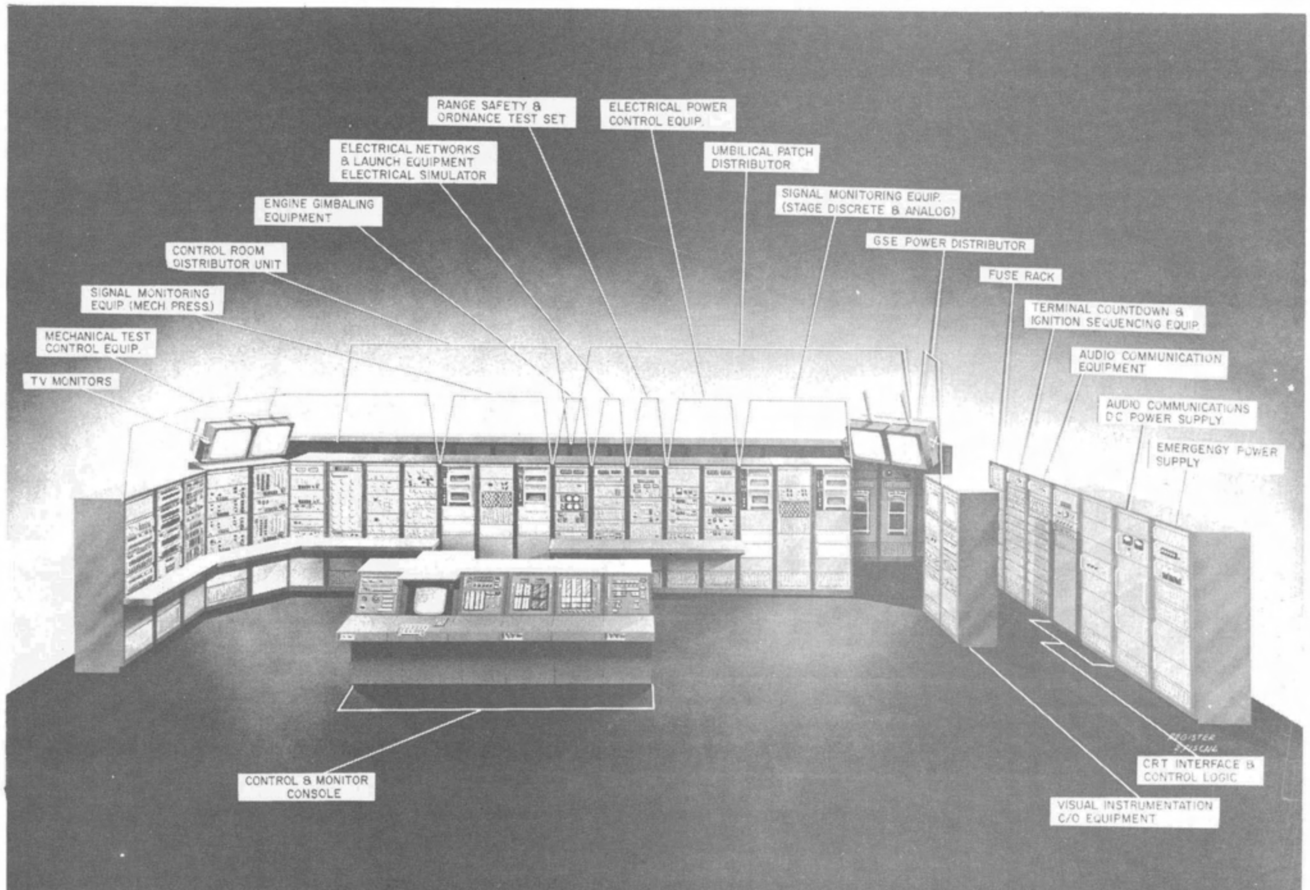


Figure I-6 - Control and Monitor Station

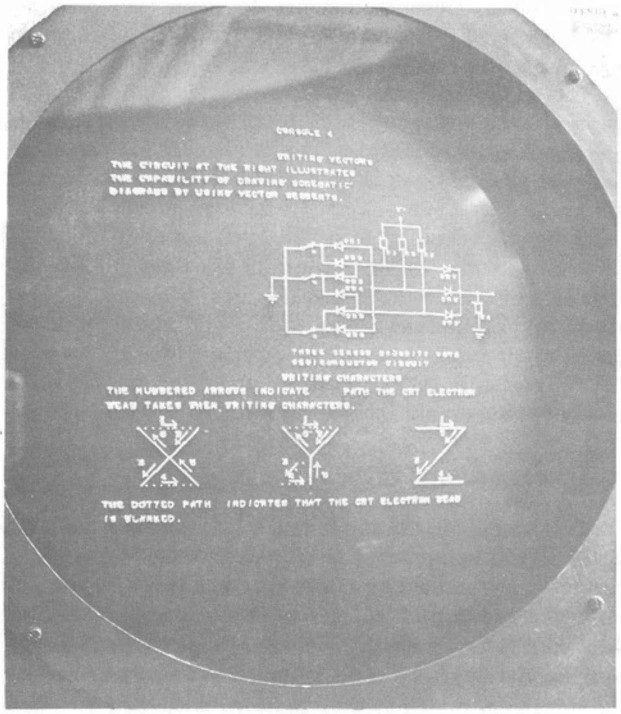


Figure I-7 - Typical CRT Presentation

ment necessary to generate special inputs required by the ground computer system and that equipment necessary to ensure computer interface compatibility with other test and checkout equipment, has been completed. Information recently received from RCA reveals significant differences in the 110A computer interface. Modifications are necessary to include additional interface circuits. Redesign will be initiated as soon as firm data is obtained from RCA. Specification and assembly drawings have been released for some of the associated equipment, and procurement is under way.

The Boeing Company has been using NASA/MSFC computer facilities a few hours each week for program development, training, and coding of automatic test procedures and processors including the MSFC specified Acceptance Test or Launch Language (ATOLL) translator . Use of the NASA/MSFC facilities has been an interim measure necessitated by the lack of an RCA 110A computer. NASA/MSFC has since supplied an RCA 110 computer which was installed at the Boeing Engineering Evaluation Laboratory in Huntsville. Installation took place in late May and checkout continued through early June. On June 11, the computer became operational. Shortly after that, the CRT display feasibility model was interfaced with the computer for continued developmental research.

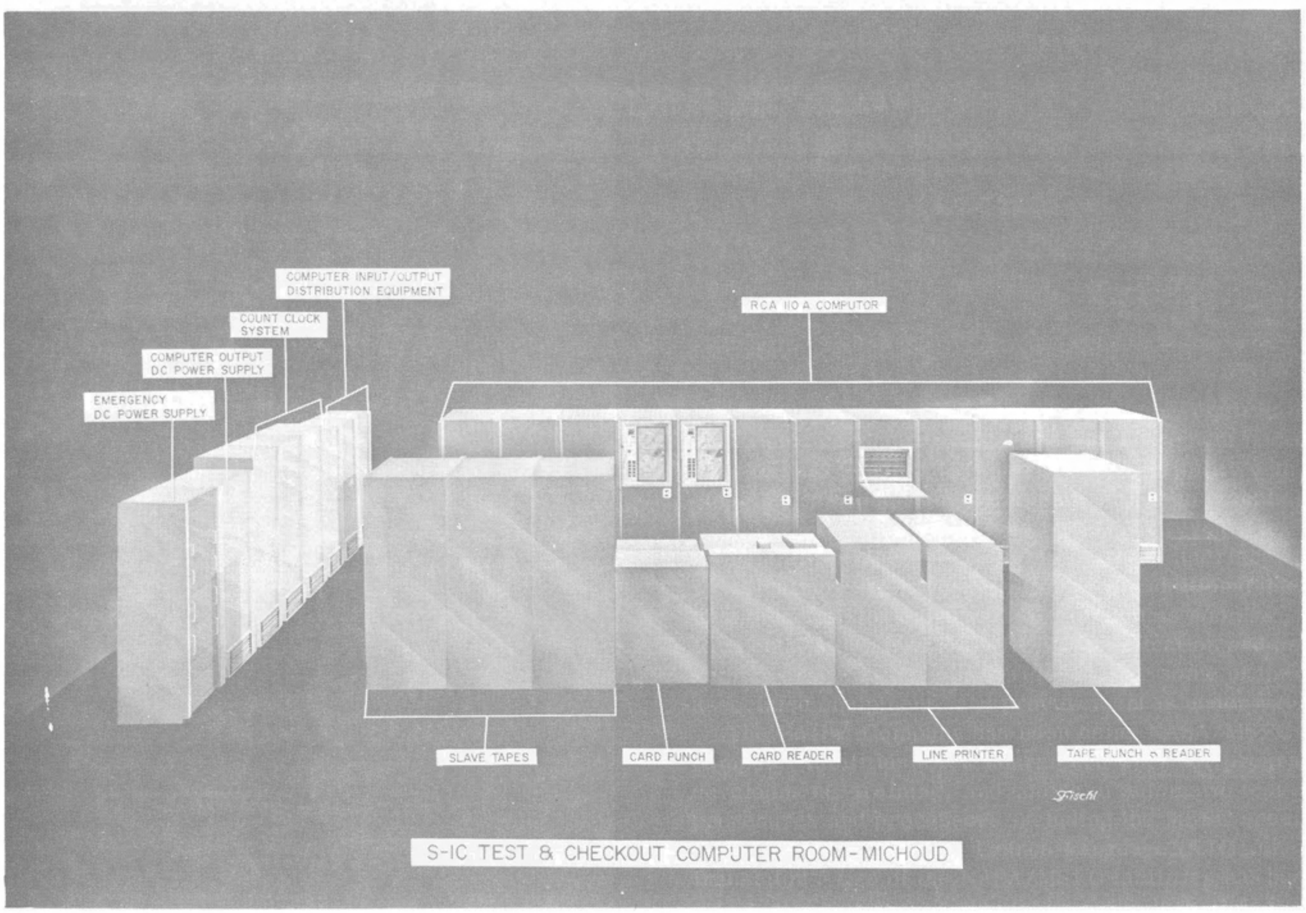


Figure I-8 - Computer Station

In December 1963, Modification 59 was incorporated, adding timing equipment for the Michoud computer stations. The NASA/MSFC design has been completed and the Boeing revised drawings are in process of being released.

Electrical Power Station

The Electrical Power Station consists of the 60-cycle AC ground power supply, the stage DC ground power supplies, the overall test battery supply, emergency DC power supplies, the GSE DC power supply, the computer output DC power supply, and the audio communication equipment power supply. The overall test battery supply provides ground power to the stage battery bus in lieu of vehicle battery power during test and checkout. In the event that power from a DC ground supply is lost, an emergency DC power supply will provide power to the stage and to essential test and checkout control equipment necessary to place the stage in a safe condition and proceed with an orderly shutdown. The GSE DC power supply provides the 28-volt DC power required by the test and checkout equipment for switching, indication, display, and control functions necessary to program the electrical and the mechanical test stations, either in the manual or automatic mode. The computer output DC power supply provides the minus 28-volt DC power required to operate relays in the computer discrete output distribution rack. Power required by the audio communication equipment for the entire test complex is provided by the audio communication equipment power supply.

Design for the Electrical Power Station has been completed. Specification drawings have been released and contracts have been let for all power supplies. Acceptance test procedures are being prepared, with the first of the tests beginning at the end of June 1964. Design of the 400-cycle AC ground power supply was cancelled with the decision to substitute an ignition system, operating from a 750-volt AC system, for the S-IC-F, -D, and flight stages. The S-IC-T will use a 28-volt DC pyrotechnic ignitor.

Electrical Test Station

The Electrical Test Station consists of the range safety and ordnance test rack, the range safety transmitting antenna equipment, the exploding bridge wire (EBW) pulse sensor equipment, the electrical networks test sets, the electrical power control equipment, the signal monitoring equipment, and the terminal countdown and ignition sequencing equipment.

The stage range safety and ordnance systems are tested after they are installed in the fully assembled S-IC stage. The EBW pulse sensor equipment analyzes the voltage output of the EBW firing units, and determines if the firing unit is acceptable. The electrical networks test rack consists of the local control panel, the upper stage electrical networks substitute, the switch selector control equipment, the launch equipment electrical simulator, the emergency detection system checkout equipment, the engine gimballing equipment, and the portable engine gimballing equipment. The upper stage electrical networks substitute provides all the necessary terminations and control signals normally provided to the S-IC stage by the upper stages. Switch selector control equipment provides signals to program the stage switch selector. Simulation of various launch functions which are not available as part of the factory and pre-static firing checkout procedure is provided by the launch equipment electrical simulator. The emergency detection system checkout equipment checks out the emergency detection system of the S-IC stage. The engine gimballing equipment, both rack mounted and portable, provides signals for testing the engine servo-actuators on the S-IC stage, the stage hydraulic system, and the associated stage electrical wiring. Central control for all major GSE power and GSE stage power is provided by the electrical power control equipment. Signal monitoring equipment is provided to record selected stage pressures and analog signals. The terminal countdown sequencer provides signals, in the proper sequence and time relationships to control the launch functions required during countdown and static firing. The ignition sequencer provides signals in the proper sequence and time relationships to control the ignition and shutdown of the five engines of the S-IC stage.

Design for all portions of the Electrical Test Station has been completed. The major portion of specification and assembly drawings have been released, and procurement of equipment has begun.

Mechanical Test Station

The Mechanical Test Station consists of test and test-related equipment and its control equipment, to provide control and monitor functions for propulsion testing. The station is controlled by the computer to perform mechanical tests which normally consist of the following:

1) Application of turbo-pump heater power, allowing the thermostat to cycle, and evaluation of the results;
2) Performance of all valve operation, timing, and sequencing;
3) Activation of pressure switches, and evaluation of results;
4) Application of pneumatic and hydraulic pressures to the stage, in the sequence necessary to perform overall performance tests, such as simulated launch, cutoff, and abort.

The mechanical test control equipment consists of control and display equipment (switches, indicator lights, sequential displays, and communications equipment) to control the Mechanical Test Station.

The test display and control panel indicates the system under test, test status, malfunction indication,

and control mode. Certain major test parameters are also displayed, such as hydraulic pressure and flow rates, pneumatic supply pressure, and station power supply voltage. Controls include those required for manual control tests and certain emergency or panic stop controls.

The pneumatic supply unit, pneumatic pressure test racks, and flowmeters, provide and control high-pressure helium, nitrogen, or dry air to pressurize and test the fuel and LOX feed systems, the fuel and LOX tanks, and the ullage systems. Design has been completed for the pneumatic equipment, and drawings have been released for procurement and assembly.

The hydraulic power supply units provide hydraulic fluid to the S-IC to provide flow to both the engine start valves and the engine gimballing system. Design for all the hydraulic equipment has been completed, critical design reviews have been held, and the majority of drawings have been released. Design has also been completed on the hydraulic control interconnection equipment.

Data System Test Station

The Data System Test Station (Figure I-9) consists of the digital data acquisition system (DDAS), integrated telemetry ground equipment, RF terminal equipment, remote automatic calibration unit, DDAS tape recorder, instrumentation calibration equipment, telemetry digitizing equipment, and the visual instrumentation checkout equipment. A relatively new technique is being employed in the test and checkout of the Saturn V stages. This is the use of the airborne telemetry system as a ground test tool. The DDAS, a development of NASA/MSFC, makes use of airborne pulse-code-modulation telemetry system components for sampling and encoding data which is then transmitted over a coaxial link via a carrier frequency. This data is used for prelaunch checkout and sent by the DDAS ground equipment to the computer and to various test stations for evaluation. The integrated telemetry ground equipment receives, demultiplexes, and decodes telemetry signals from the stage during factory checkout. The RF terminal equipment serves as a distribution center for all telemetry RF and video signals arriving from the test cells. The stage and its associated ground support equipment incorporates a remote automatic calibration of instrumentation transducers. This system provides a capability to test the measuring transducers required for monitoring functional readiness of the vehicle from a remote position. The instrumentation calibration equipment provides and controls power and calibration signals to the telemetry equipment on the stage. The telemetry digitizing equipment receives the analog out-

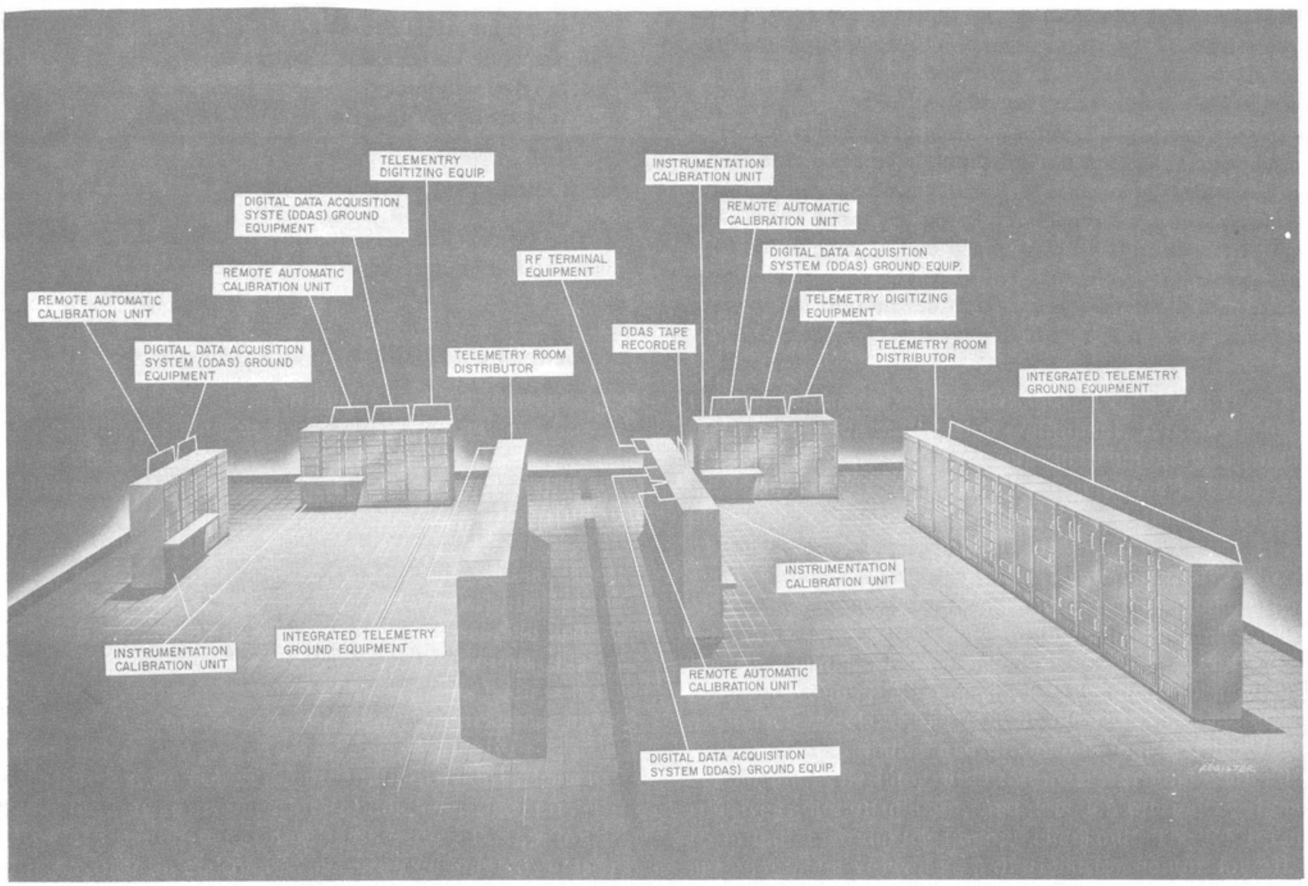


Figure I-9 - Data System Test Station

puts of the telemetry discriminators for digitizing and programing into the stage DDAS format. This permits computer analysis of identical data transmitted via the DDAS and the telemetry measurement links. The TV instrumentation and film camera checkout equipment controls and monitors the application of power and control signals, and evaluates TV picture quality.

Design for the Data System Test Station has been completed. Specification and assembly drawings have been released and vendors have been selected for all items. Fabrication is already in progress at the vendor locations and at Michoud for the Boeing-made items.

Interconnection Equipment

Equipment to interconnect the test and checkout equipment to itself and to the stage provides the capability of transferring electrical power, test instrumentation data, hydraulic power, and pneumatics to and from the S-IC stage during test and checkout. Design of this equipment has been completed and specification and fabrication drawings have been released to initiate procurement and manufacture of parts.

Checkout Auxiliary Equipment

The checkout auxiliary equipment is that equipment which is not a part of the automated test complex, but which is also required to checkout a completely assembled stage. This includes the pneumatic leak detection set to detect pneumatic leaks in the stage propulsion system, an antenna checkout set, stage weighing equipment, area contamination detection equipment to detect RP-1, RJ-1, and trichloroethylene vapors and monitor the content of oxygen in specific locations, internal access equipment, and other assorted equipment for sensing and measuring. Boeing design in this area is in progress and is expected to be complete in the near future. In addition, Modification 36 directed Boeing to design and fabricate two sets of work platforms and bulkhead protection equipment for use at MILA. Design of this equipment is currently in progress.

HANDLING AND TRANSPORTATION EQUIPMENT

Equipment required to move and position the stage and its components during assembly and test consists of the forward handling ring, the stage attach fittings, the fin and fairing cradles, retrorocket handling equipment, and component handling equipment. The forward handling ring (Figure I-10) provides a method for raising or lowering the S-IC stage to the vertical or horizontal position, and enables the assembled stage to be towed on the stage transporter. Final assembly of the initial forward handling ring was begun during the first quarter, with completion and testing occurring during the second quarter. Testing revealed inadequacies in the towing beam, necessitating redesign of that portion. The modified version of the handling ring, incorporating the redesigned towing beam, completed all testing

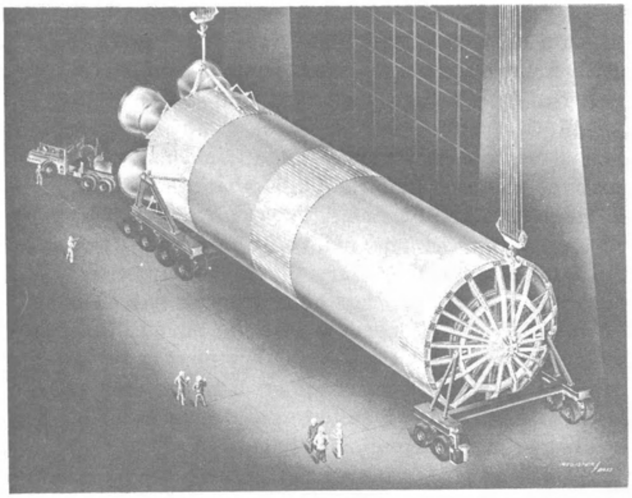


Figure I-10 - Forward Handling Ring With Stage

satisfactorily, and was shipped to NASA/MSFC in the early part of February 1964. A second handling ring has since been completed and shipped to NASA/MSFC for use with the weight simulator (Figure I-11) and handling of the S-IC stages to be assembled and tested there. Design for the stage attach fittings and the fin and fairing cradles has been completed, with design of the retrorocket handling equipment and component handling equipment to be completed in the near future. Design is also in progress for the stage pressure control and monitor system that will maintain positive pressure in the fuel and LOX tanks during transportation of the stage.

A listing of the major handling and transportation equipment of Boeing design is shown in Part VIII of this report.

OPERATING AND SERVICE EQUIPMENT

Basic release on all umbilical assemblies including umbilical plates, ground carriers, simulators, and substitutes was completed in April 1964. Shortly after,

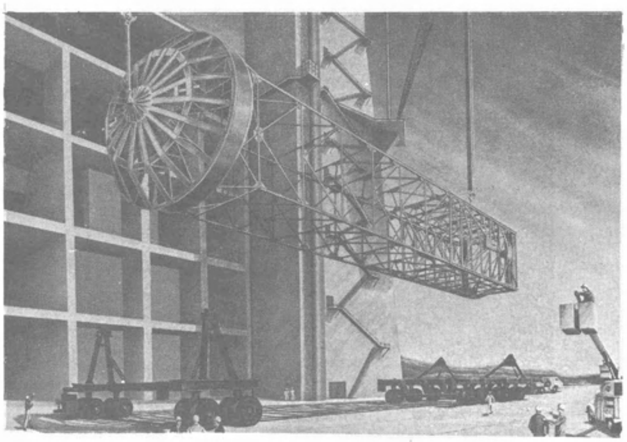


Figure I-11 - Forward Handling Ring With Weight Simulator

on May 26, 1964, the unqualified first article aft No. 1 ground carrier assembly, the aft vehicle skin panel assembly, and the aft flight assembly were delivered to NASA/MSFC.

During the reporting period, Modifications 34 and 35 were received for umbilical equipment to be used at the Merritt Island Launch Area. Modification 34 called for Boeing to design and build four sets of pneumatic equipment for the Saturn V launcher umbilical tower. Phase I approval has been granted by NASA/MSFC, and work is proceeding with the Phase III portion. Modification 35 required the design of umbilical carriers, plates, and associated equipment. Design in this area has been completed, and drawings have been released for fabrication of parts.

MECHANICAL AUTOMATION BREADBOARD (MAB)

During the second quarter of this reporting period, Boeing received Modification 52, calling for design of the MAB (Figure I-12). Modification 94 directed Boeing to manufacture the MAB. The MAB is intended to prove out the automated mechanical checkout concept, and to provide a checkout of the stage peculiar mechanical GSE for the S-IC stages. By utilizing flight equipment, including one F-1 engine, a complete fuel and LOX delivery system, a control pressure system, and limited purge system components, stage systems are duplicated for checkout of the associated GSE. The F-1 engine and four electrically simulated engines will be gimballed and subjected to simulated flight loads. The engine will also be capable of accepting all automated prestart and testing operations. Fuel and LOX tank ullage space will be simulated, and pressurization will be effected as necessary during fuel and LOX loading checkout and launch. Fill and drain functions will be simulated by timing devices in conjunction with operational hardware.

Design of the fuel, LOX, and control pressure/purge subsystem were released to NASA/MSFC for review and approval. Also released were preliminary data on the F-1 engine, hydraulic subsystem, and interconnection equipment Design comments have been received from NASA/MSFC and are being incorporated into the hardware design.

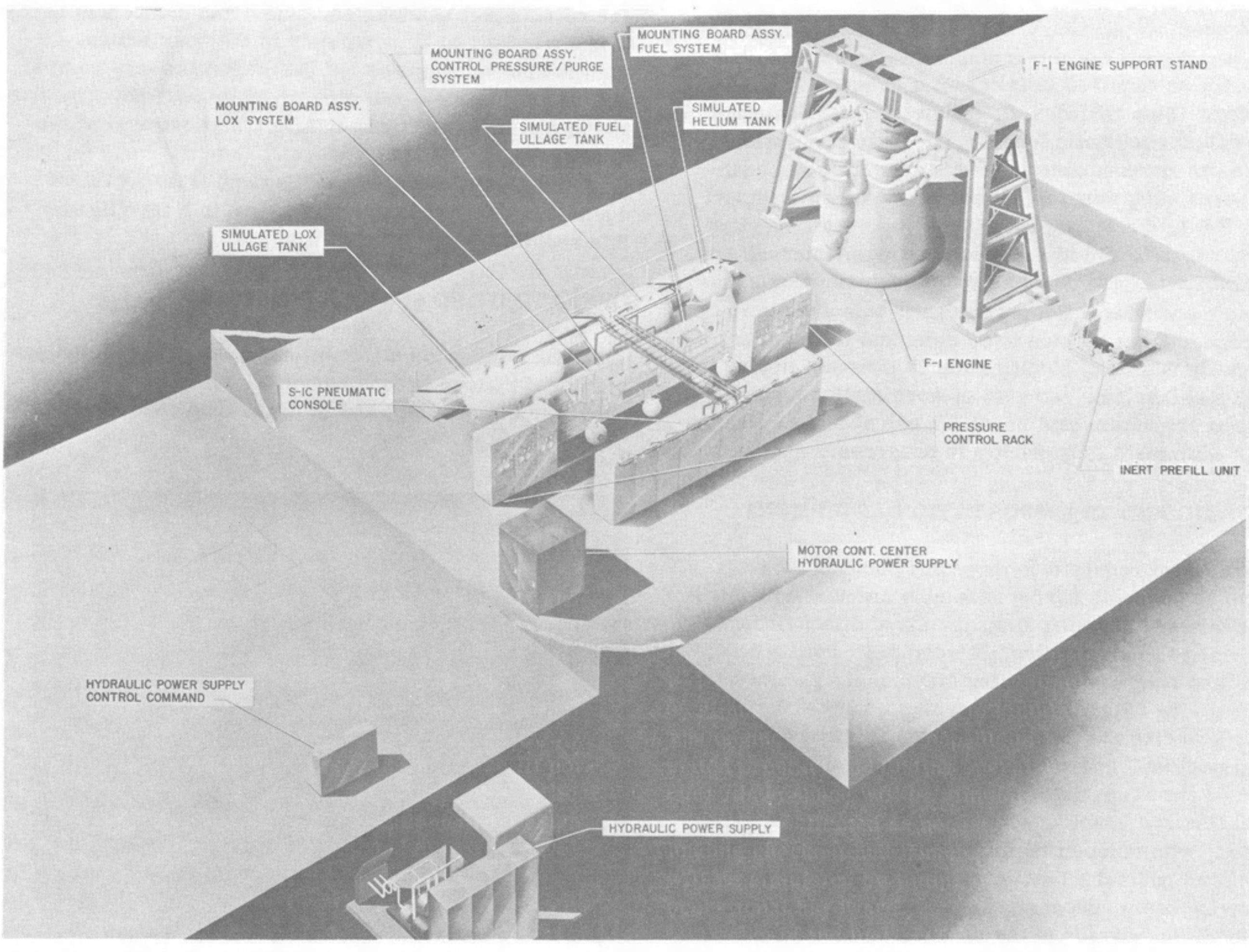
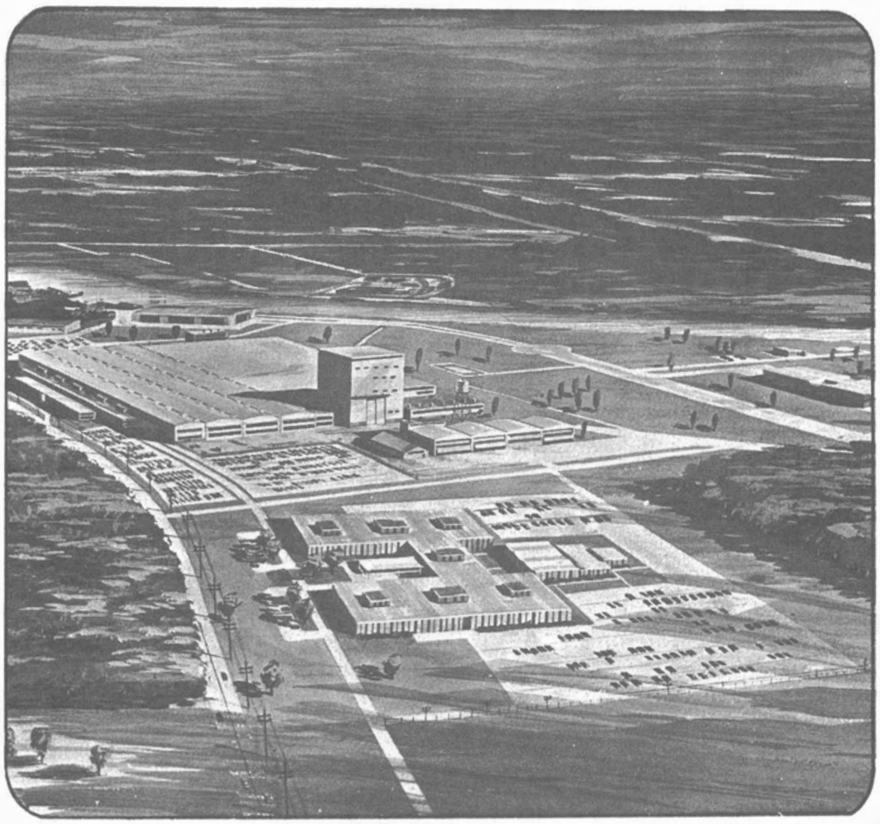
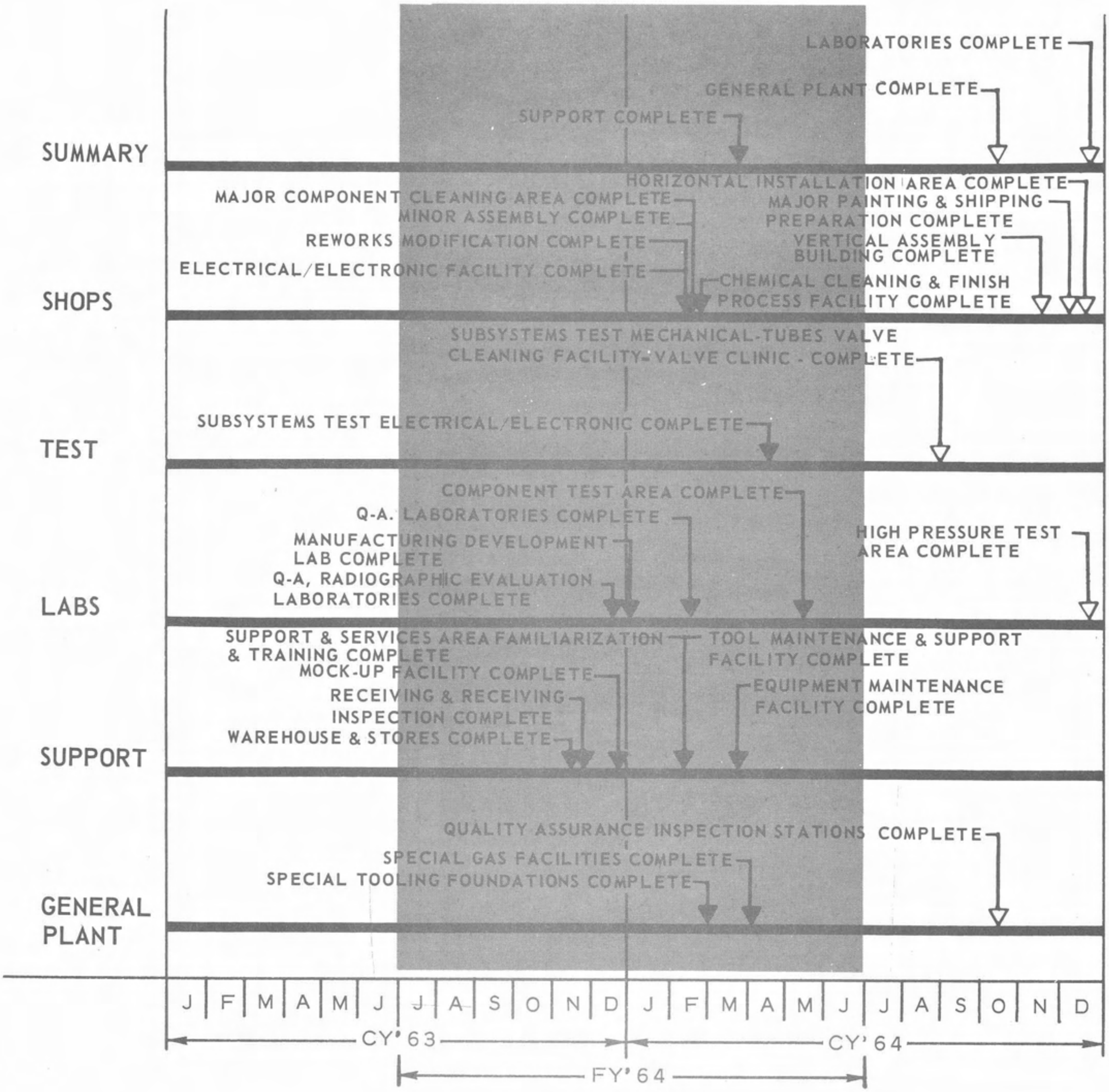


Figure I-12 - Mechanical Automation Breadboard Mockup

II



FACILITIES PLANNING AND ACTIVATION


SUMMARY
LABORATORIES COMPLETE
GENERAL PLANT COMPLETE
SUPPORT COMPLETE
SHOPS
HORIZONTAL INSTALLATION AREA COMPLETE
MAJOR COMPONENT CLEANING AREA COMPLETE
MINOR ASSEMBLY COMPLETE
MAJOR PAINTING & SHIPPING PREPARATION COMPLETE
REWORKS MODIFICATION COMPLETE
VERTICAL ASSEMBLY BUILDING COMPLETE
ELECTRICAL/ELECTRONIC FACILITY COMPLETE
CHEMICAL CLEANING & FINISH PROCESS FACILITY COMPLETE
TEST
SUBSYSTEMS TEST MECHANICAL-TUBES VALVE CLEANING FACILITY-VALVE CLINIC - COMPLETE
SUBSYSTEMS TEST ELECTRICAL/ELECTRONIC COMPLETE
LABS
COMPONENT TEST AREA COMPLETE
Q-A. LABORATORIES COMPLETE
MANUFACTURING DEVELOPMENT LAB COMPLETE
HIGH PRESSURE TEST AREA COMPLETE
Q-A, RADIOGRAPHIC EVALUATION LABORATORIES COMPLETE
SUPPORT
SUPPORT & SERVICES AREA FAMILIARIZATION & TRAINING COMPLETE
TOOL MAINTENANCE & SUPPORT FACILITY COMPLETE
MOCK-UP FACILITY COMPLETE
EQUIPMENT MAINTENANCE FACILITY COMPLETE
RECEIVING & RECEIVING INSPECTION COMPLETE
WAREHOUSE & STORES COMPLETE
GENERAL PLANT
QUALITY ASSURANCE INSPECTION STATIONS COMPLETE
SPECIAL GAS FACILITIES COMPLETE
SPECIAL TOOLING FOUNDATIONS COMPLETE
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

Significant progress toward total activation of the facilities complex at Michoud was made during fiscal year 1964, in preparation for full-scale assembly of both ground test and flight stages.

NASA/MSFC and Boeing personnel held discussions during the initial portion of the reporting period to establish mutual agreement on the use of interim and partial facilities in addition to other workaround techniques required to support Plan Va schedule.

Boeing subcontractors experienced an electricians strike during the third quarter of CY '63. This hampered facilities activation efforts but the use of partial and interim facilities lessened program impact and allowed Boeing to continue its support of NASA/MSFC ground test requirements in an orderly manner. The completion of Phase V of special tooling foundations was accomplished during this quarter.

During this fourth quarter of CY '63, six facilities were activated. They included: the Receiving and Receiving Inspection, Quality Assurance Radiographic Evaluation Laboratories, mockup facility, tank farm, warehouses and stores, and special tooling foundations—Phase VI. The activation of such facilities reduced the need for interim and partial facilities.

The change in program schedules from NASA/MSFC Schedule Plan V to Plan VII highlighted the commencement of the first quarter (CY '64). The change from Plan V to Plan VII as related to facilities activation impact consisted of changes in demand dates and resulted in subsequent schedule revisions for some facilities.

The user demand dates of five facilities were changed as a result of the transition from Plan V to Plan VII. This resulted in revisions to facilities activation schedule requirements.

Facility	Demand Dates Plan V	Demand Dates Plan VII
Major Component Cleaning Facility	10-15-63	2-17-64
Engine Buildup	8-3-64	11-1-64
Horizontal Installation	11-16-64	1-14-65
Major Painting & Shipping Preparation	7-1-64	9-15-64
Stage Test Positions 1, 2, 3, and 4	8-1-64	10-1-64

Significant progress was realized during the first quarter of CY '64, with the continuing activation of complete facilities and the corresponding reduction in partial and interim facilities. Through the combined efforts and discussions between NASA/MSFC and Boeing, funding problems were overcome on the stage test facility and Phase II construction activities for this facility were initiated. The Tool Maintenance and Support facility, Familiarization and Training area, Support and Services areas, and the Equipment Maintenance Facility were completed during this period, thereby completing the support areas activation for the Michoud Complex. In addition, five facilities in the Shop category were completed. They include Chemical Cleaning and Finish Process Facility, Major Component Cleaning Area, Electrical/Electronic Facility, Rework and Modification Facility, and Minor Assembly. The following facilities within the Lab category were also completed: Manufacturing Development Lab, the remaining Quality Assurance Labs, and the Component Test Materials and Process Lab. During this same period, Phases VII and VIII of Special Tooling Foundation were also completed.

Late in the first quarter of CY '64, NASA/MSFC and Boeing concentrated on eliminating potential stage delivery impact items which were resulting from funding problems on the completion of construction of the Vertical Assembly Building, and problems of definition of criteria for the Major Painting and Shipping Preparation facility.

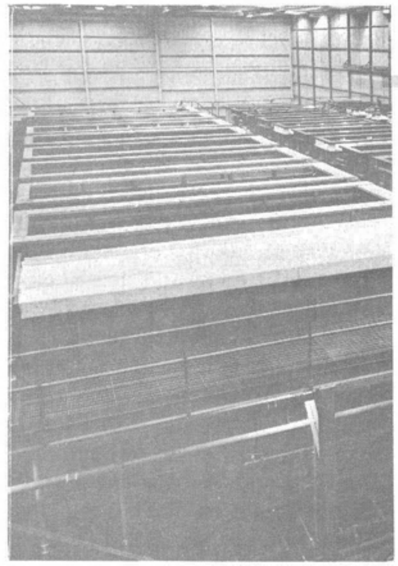
During the second quarter of CY '64, the funding problem for the completion of the Vertical Assembly Building was resolved and construction work was started on May 5, 1964, with a scheduled completion of November 18, 1964. A firm definition of criteria was established for the Major Painting and Shipping Preparation Facility and the design is scheduled to be complete on August 7, 1964 with the total facility completion scheduled for December 11, 1964.

Nine construction contracts were completed during the second quarter of CY '64, with eight contracts continuing in work and four contracts pending NASA/MSFC approval as of July 2, 1964.

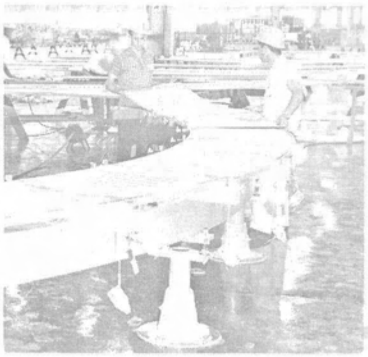
Facilities activated during the same quarter include Subsystems Test Electrical/Elctronic Facility, and Phase I of the Stage Test Facility under the Test category. Component Test Propulsion and Mechanical Lab and Structural Test were completed in the Laboratories category. In the General Plant Area, Special Gas Facilities was also completed. These achievements have reduced the use of interim and partial facilities and accomplished another milestone toward total completion of the Michoud Complex

It has been established that the impact to stage deliveries has been minimized by the use of interim and partial facilities in operation or work-around methods. The cumulative effect of utliizing interim and partial facilities, and a large number of work-around methods, could delay scheduled deliveries of S-IC stages.

During fiscal year 1965 it is predicted that the remaining facilities will be completed: Horizontal Installation Facility, Engine Buildup Facility, and the Major Painting and Shipping Preparation Facility and the Vertical Assembly Building in the Shops category. Also the High-Pressure Test Facility and Quality Assurance Inspection Stations in the Laboratories area will be completed. Subsystems Test Mechanical, and Stage Test Facility Phase II are the remaining facilities to be completed in the Test category.

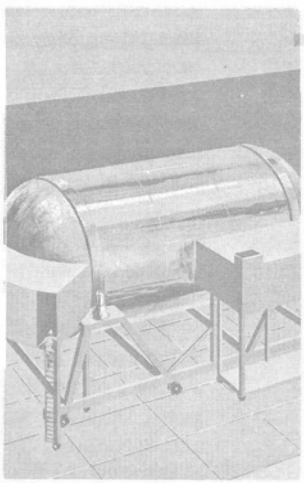


Chemical Cleaning and Finish Process Facility

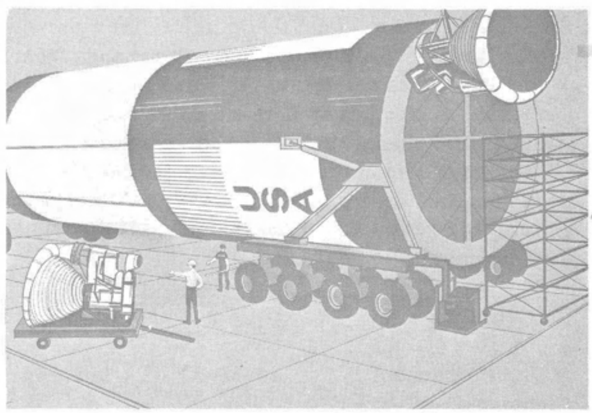


Minor Assembly

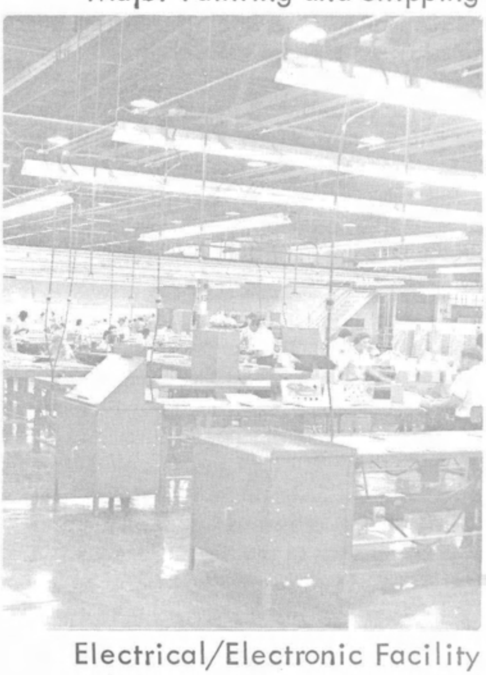
FACILITIES/SHOPS



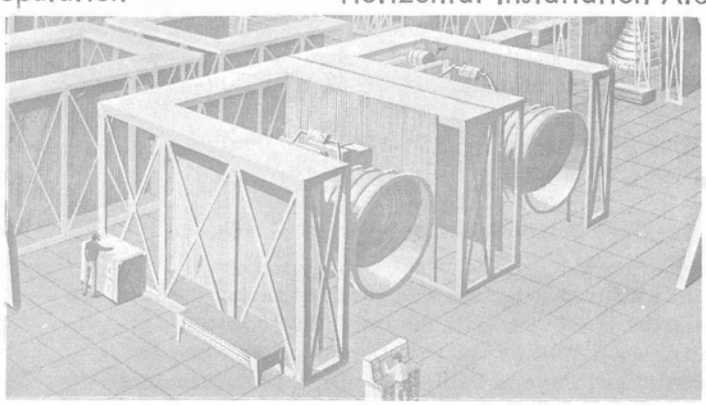
Major Painting and Shipping Preparation



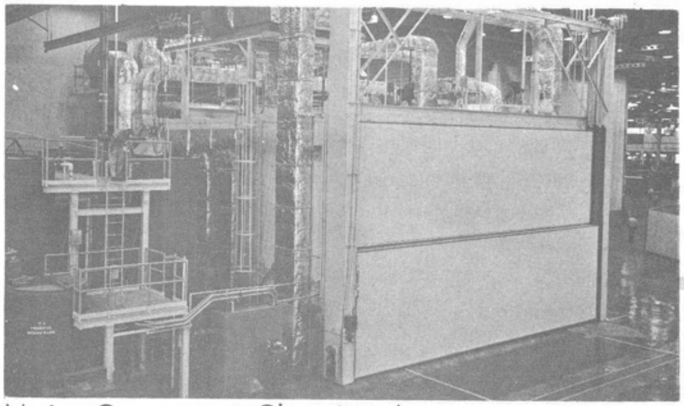
Horizontal Installation Area



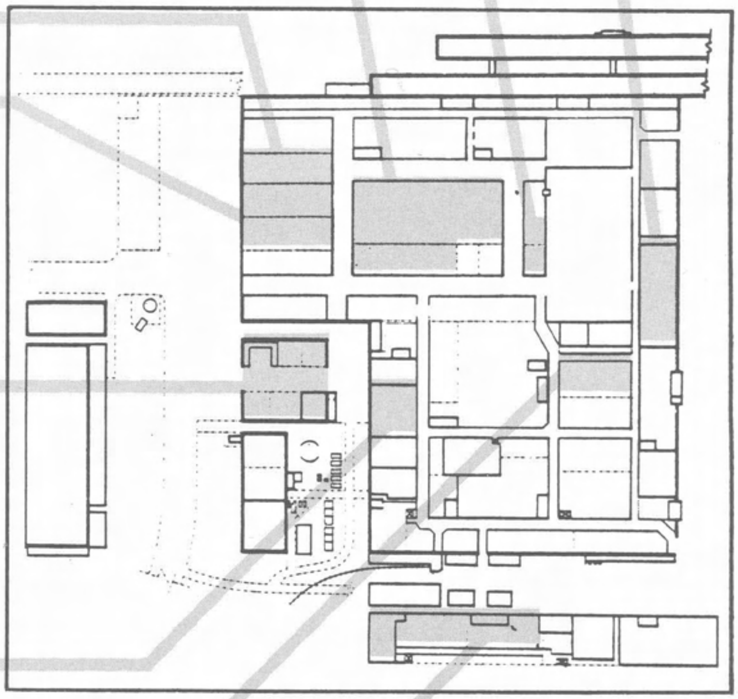
Electrical/Electronic Facility

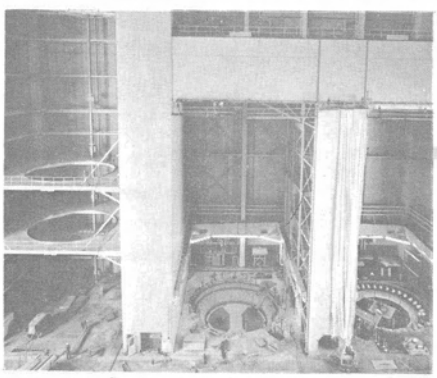


Engine Build-up Facility



Major Component Cleaning Area





Vertical Assembly Building

Rework and Modification

ELECTRICAL/ELECTRONIC FACILITY

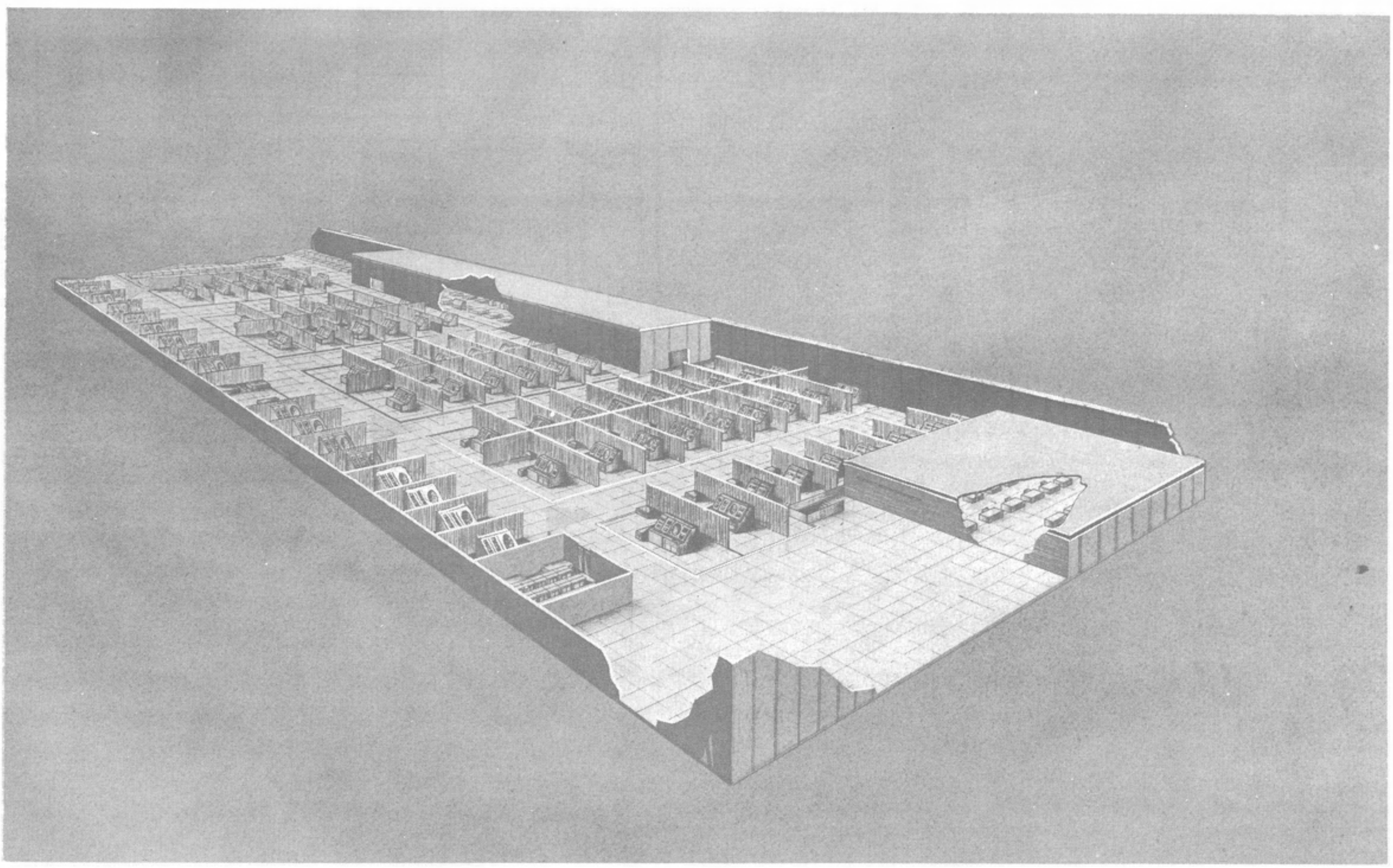
Function - The Electrical/Electronic facility is used to fabricate, assemble and rework electrical and electronic components and assemblies for the S-IC stage and GSE. The facility consists of the following areas: 1) Electrical Fabrication; 2) Electronic Fabrication; 3) GSE Console Assembly.

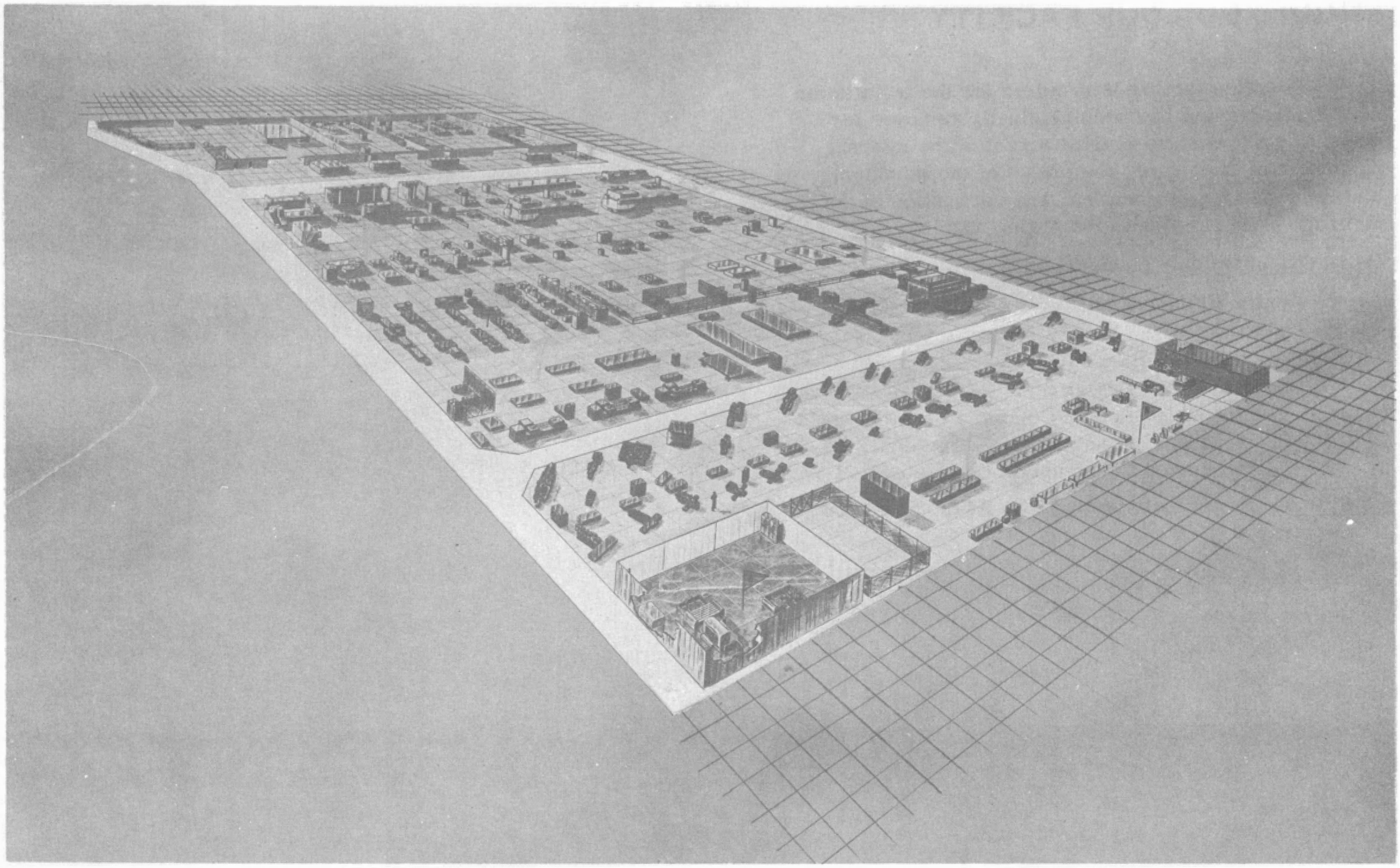
Using Organization - Manufacturing

Area - Electrical/Electronics facility - 51,000 sq. ft.

Milestones - Design Complete ------- 6-21-63
Construction Started ---- 7-18-63
Construction Complete -- 1-3-64

Contracts - 63-24 -- A&E
63-47 -- Construction





REWORK & MODIFICATION – TOOL MAINTENANCE

Function -- This area consists of a "blue streak" type shop which is capable of producing small parts as required for program changes, late or misplaced items, and emergency repairs as required to support both the S-IC booster production and tool maintenance programs This area consists of the following:

1. Rework and Modification facility consisting of the following areas: a) Tube Bending; b) Sheet Metal; c) Machining; d) Fixture Bore; e) Heat-Treat and Non-Metals; f) Woodwork and Plaster; and g) GSE/MSE Assembly and Maintenance.
2. Tool Maintenance and Support Facility composed of the following areas: a) Welding; b) Bench Assembly; and c) Fixture Maintenance.

Using Organization - Manufacturing

Area - Rework and Modification -- 75,844 sq. ft.
Tool Maintenance -------- 21,672 sq. ft.
TOTAL ----------------- 97,516 sq. ft.

Milestones - Design Complete ------------7-12-63
Truss Modification ----------7-8-63
Construction Started ---------7-22-63
Truss Modification Complete--9-20-63
Construction Complete -------2-14-64

Contracts - 62-4 --- A&E
62-9 --- Construction
63-6 --- Construction
63-40 -- Construction
63-48 -- Construction
63-59 -- Construction
63-62 -- Construction

ENGINE BUILDUP FACILITY

Function - This facility is required for the installation of components that had been originally removed for shipping purposes, re-establishment of the internal alignment of the engine, the preset of the actuator, and the assembly, inspection, and verfication of the fit of the skirt relative to the engine nozzle.

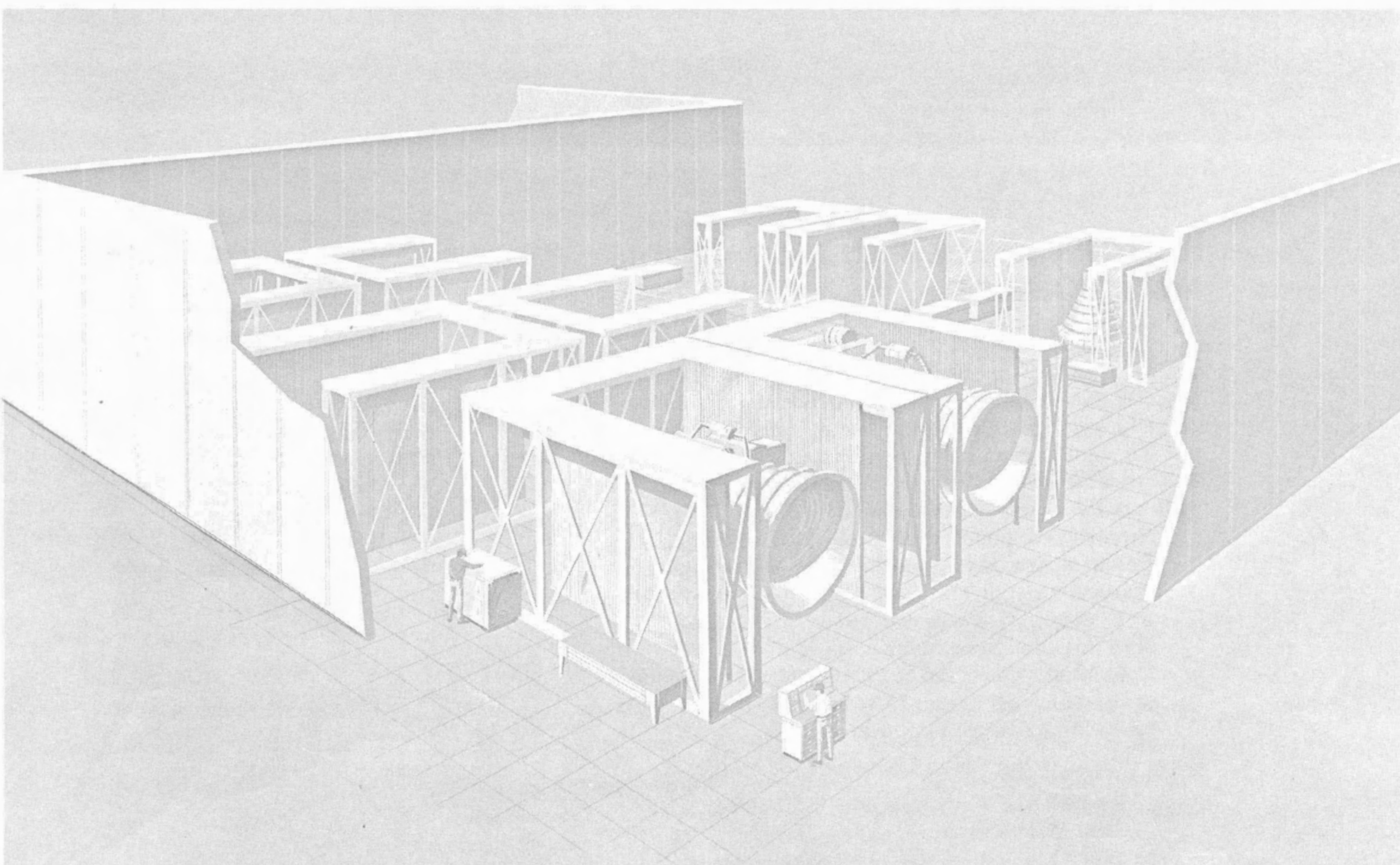
Using Organization - Manufacturing

Area - Engine Buildup Facility -- Approximately 12,960 square feet

Milestones - (Boeing effort only)

Scheduled Design Start --------- 8-21-64
Scheduled Design Complete ----- 11-9-64
Scheduled Construction Start ---- 12-22-64
Scheduled Construction Complete-3-23-65

Contracts - No numbers assigned to A&E or Construction Contracts



VERTICAL ASSEMBLY AREA

Function - This facility is required to assemble the complete S-IC stage in a vertical position. In addition, the area will be used to assemble tanks, install baffles, assemble tank connection sections, perform hydrostatic testing, clean flight vehicle LOX piping and RP-1 fuel tanks.

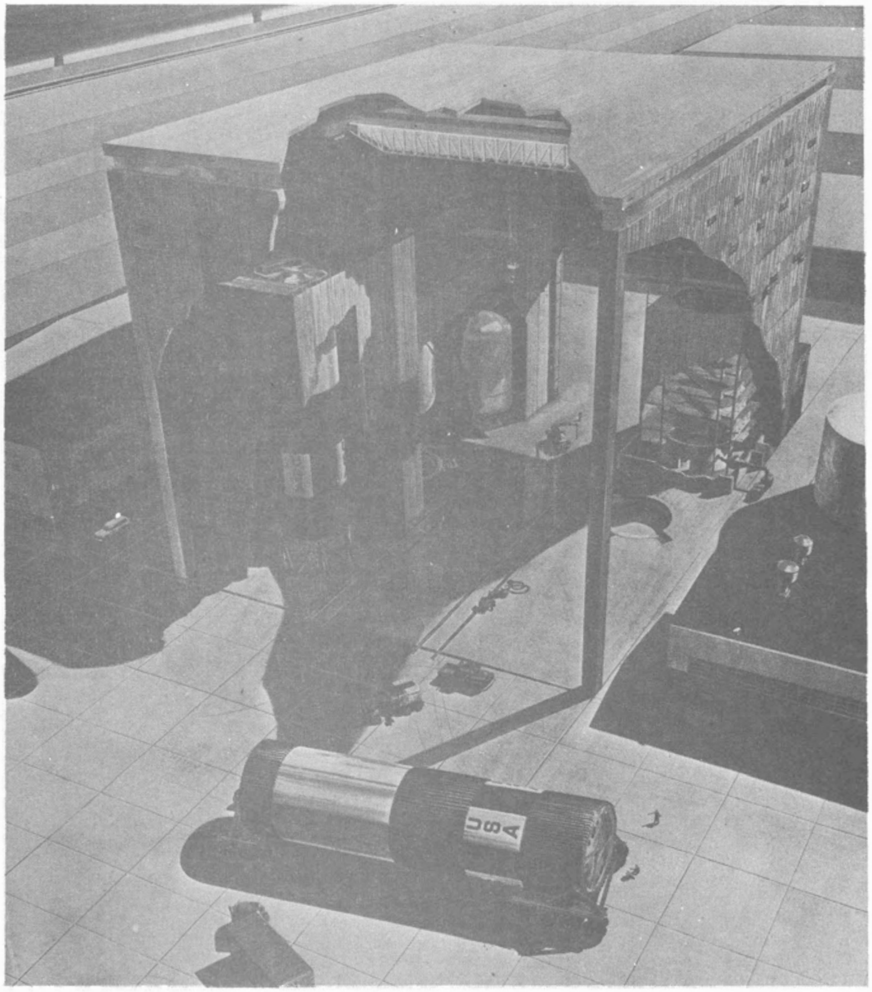
Using Organization - Manufacturing and In-Plant Test

Area - 44,414 square feet

Milestones

63-4 Tank Farm --	Design Started ------ 9-15-62 Design Complete ---- 3-1-63 Construction Started--4-27-63
63-64 Phase I ---- (Tank Assembly Position 1 & 2 including structural 90 ft. & 155 ft. towers)	Design Started ------ 8-9-63 Design Complete ---- 10-28-63 Construction Started--12-10-63 Construction completion scheduled for 6-8-64, but due to schedule slide anticipated completion early in the third quarter, CY '64
64-8 Phase II ----- (Tank Farm Distribution, Complete 155 ft. Tower, Hydrostatic Test Tower, Hydrostatic Test Position)	Design Started -------- 6-3-63 Design Complete ------ 2-6-64 Construction Started ---5-4-64 Construction Complete--10-19-64

Contracts -
63-64 -- A&E
62-12 -- Hydrostatic Test Position and Final Assembly Construction
64-8 --- Tank Positions 1 & 2 Construction
63-4 --- Tank Farm Construction



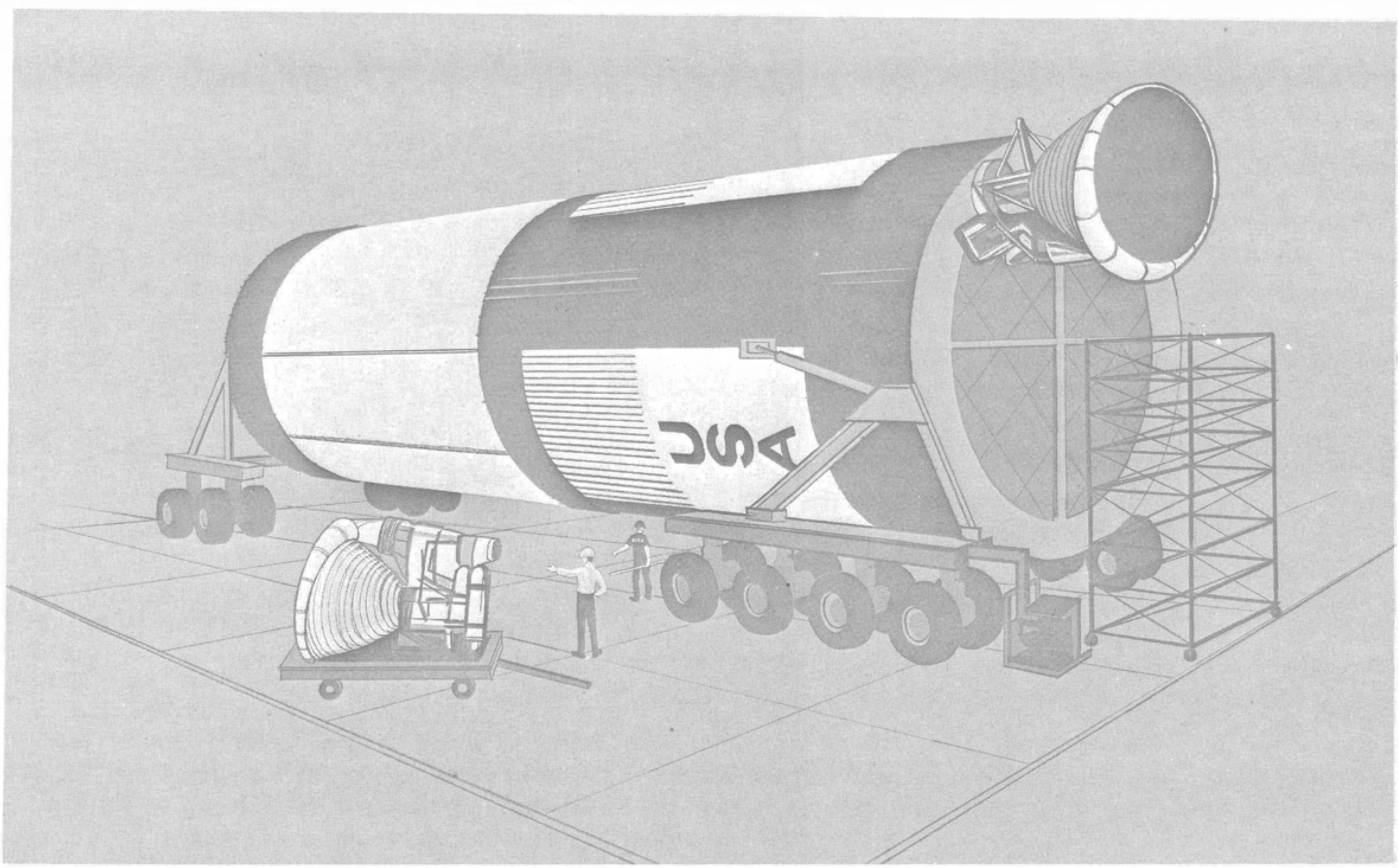
HORIZONTAL INSTALLATION AREA

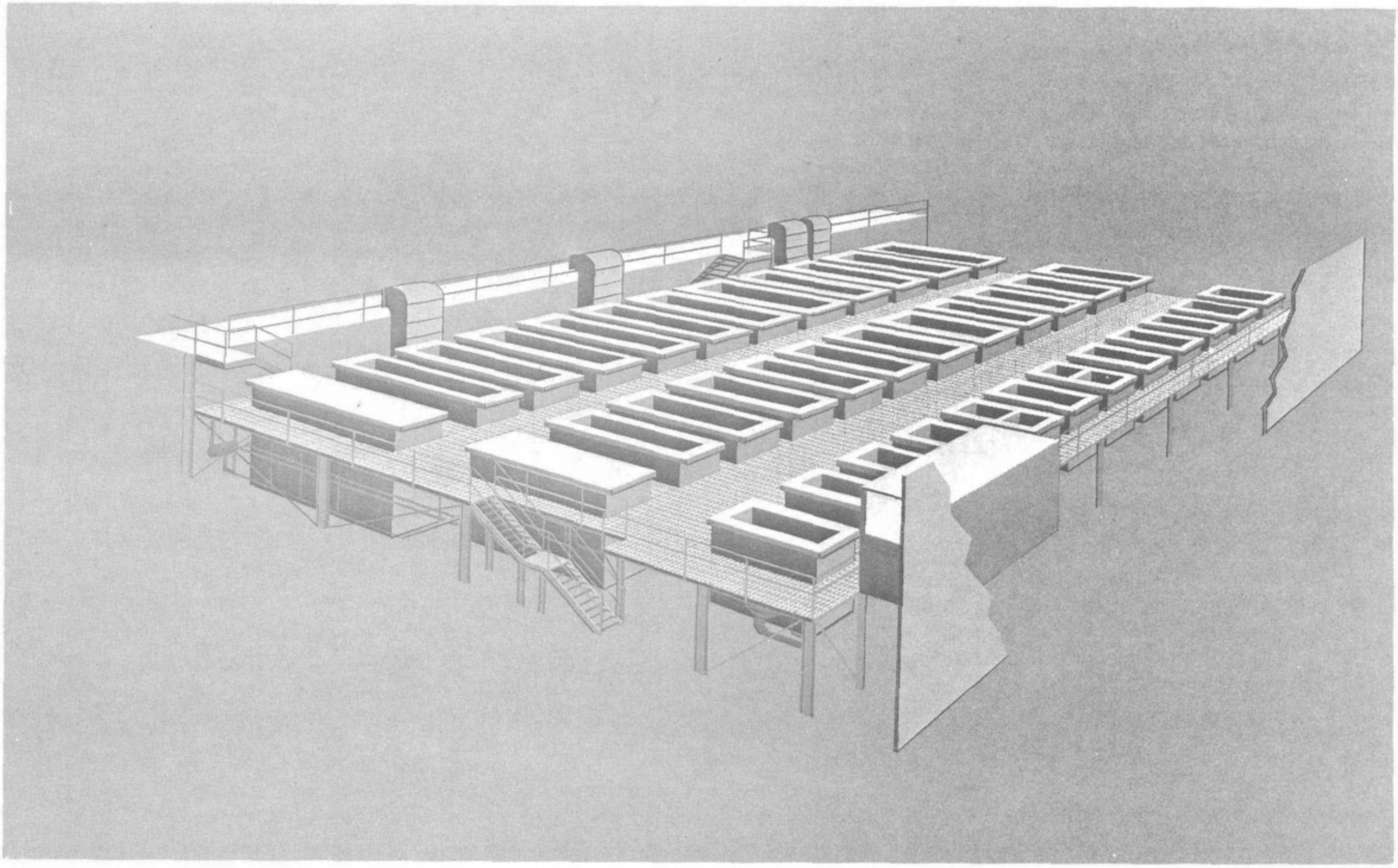
Function - This facility will be used to install the F-1 engines and associated hardware on the S-IC stage in the horizontal position and to refurbish the engines after static testing.

Area - 51,976 square feet

Milestones - Scheduled Design Start -------- 6-22-64
Scheduled Design Complete ---- 8-14-64
Scheduled Construction Start --- 9-16-64
Scheduled Construction Complete - 12-21-64

Contracts - 64-18 -- A&E





CHEMICAL CLEANING AND FINISH PROCESS FACILITY

Function - This facility provides the capability for chemical cleaning of aluminum and steel segments in unfinished and semi-finished form. In general, this applies to all stage and ground support equipment components not considered contamination sensitive.

This area is a manual, semiautomatic facility consisting of an aluminum cleaning line of 10 tanks and a steel cleaning line of 11 tanks.

Using Organization - Manufacturing

Area - Chemical Cleaning and Finish Process facility -- 25,100 square feet

Milestones - Tank Design Started -------------3-19-63
Aluminum Line Design Complete --7-8-63
Steel Line Design Complete -------8-1-63
Aluminum Line Construction Complete ------------------------2-26-64
Steel Line Construction Complete--2-26-64

Contracts - 63-31 -- A&E
63-15 -- Tank Fabrication
63-46 -- Tank Fabrication
63-44 -- Construction Aluminum Clean Line
63-54 -- Construction Steel and Plating Line
63-11 -- Crane Fabrication and Erection

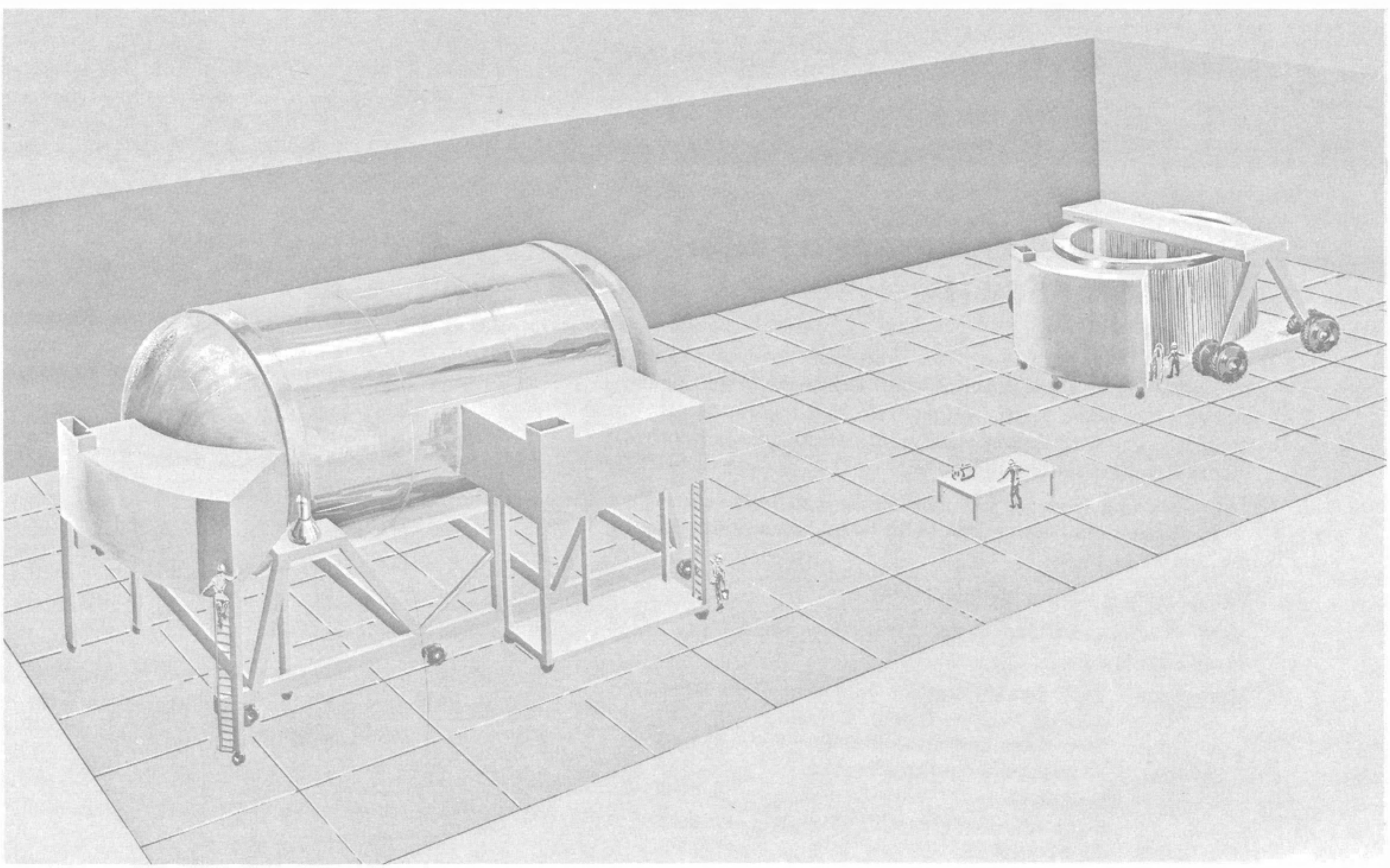
MAJOR PAINTING AND SHIPPING PREPARATION

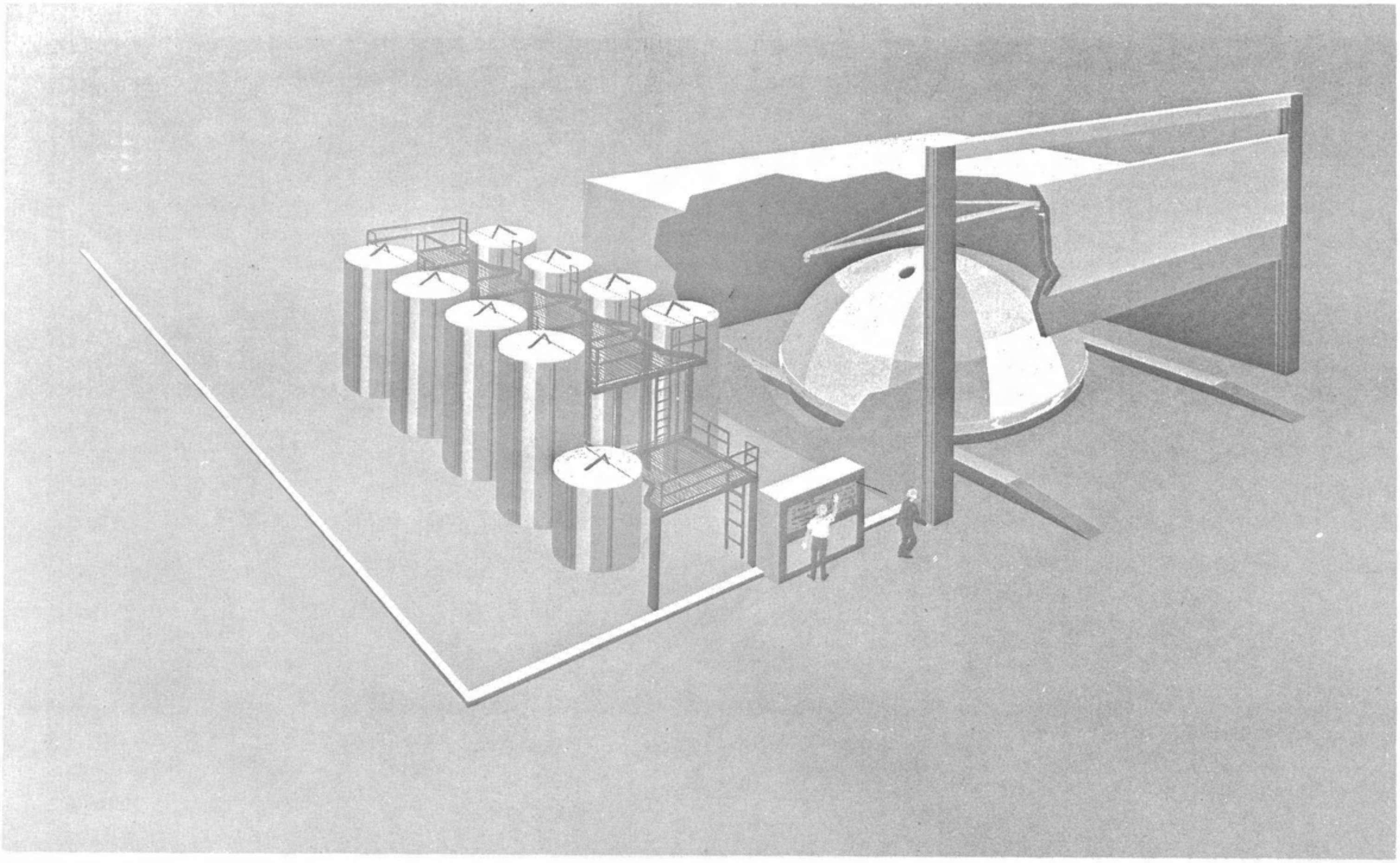
Function - This facility is required for final preparation of the booster for shipment. This preparation includes painting, decal application, protective coating, dust sealing and systems draining.

Area - 16,800 square feet

Milestones - Design Started ---------------- 6-10-64
Scheduled Design Complete ----- 8-7-64
Scheduled Construction Started - 9-8-64
Scheduled Construction Complete -12-11-64

Contracts - 64-19 -- Design





MAJOR COMPONENT CLEANING AREA

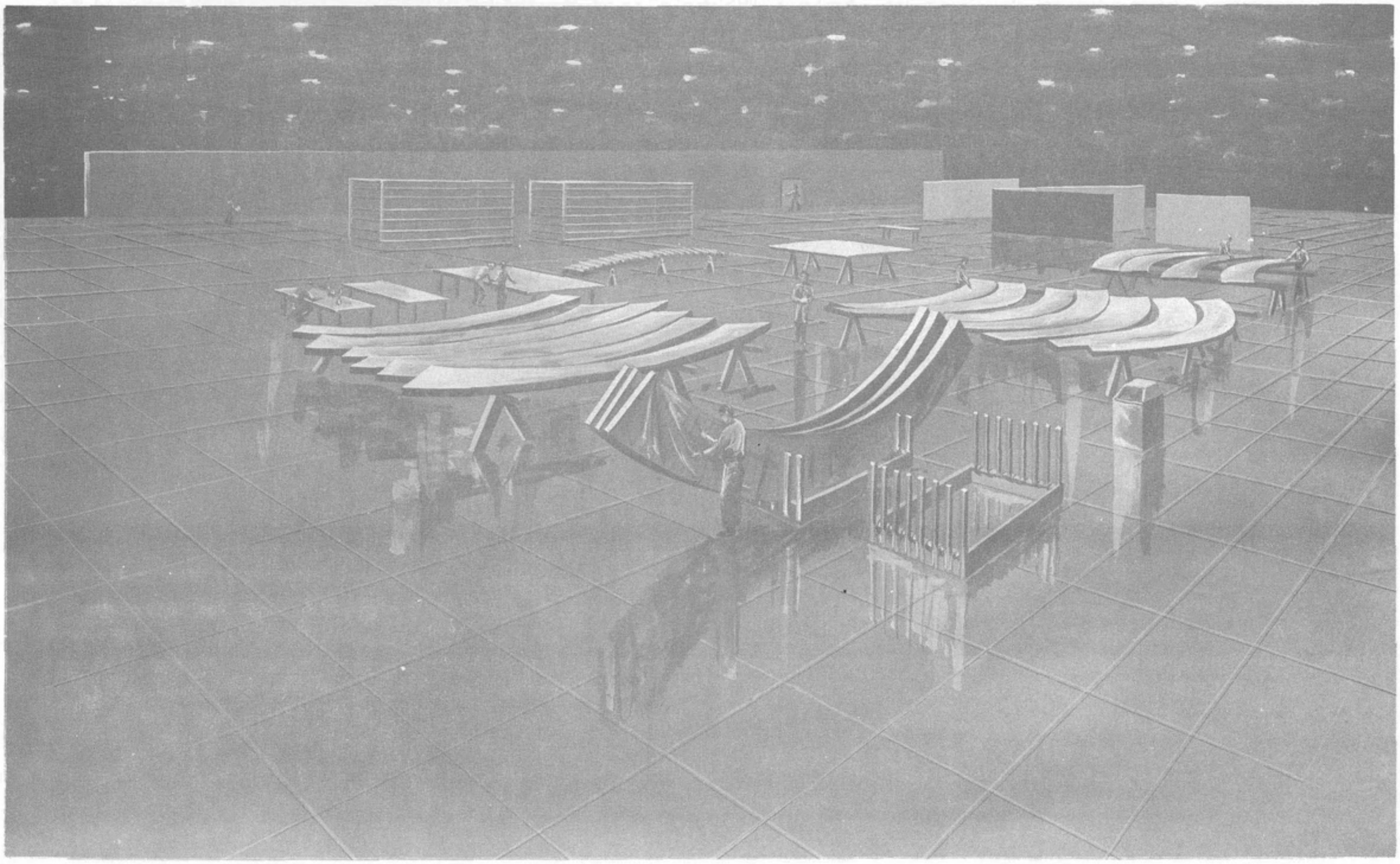
Function - This area is used for the cleaning and conversion coating of bulkheads, baffles, and other tank components too large for the immersion cleaning line. Skin sections and Y-rings are also cleaned in this area. Systems required to perform the cleaning and coating operations include: trichloroethylene, alkaline cleaning solution, deodorizer, iridite, and demineralized water distribution.

Using Organization - Manufacturing

Area - Major Component Cleaning facility -- 4,560 sq. ft.

Milestones - Design Started ------------- 4-15-63
Design Complete ----------- 8-7-63
Construction Started -------- 10-10-63
Tank Fabrication Complete -- 1-21-64
Construction Complete ------ 2-19-64

Contracts - Design -- In-house
63-41 --- Pile Driving
63-46 --- Tank Fabrication
63-57 --- Construction



MINOR ASSEMBLY AREA

Function - The Minor Assembly Area provides facilities to assemble vehicle components prior to major assembly. This includes provisions for welding, machining and mechanical fabrication.

Using Organization - Manufacturing

Area - 238,516 square feet

Milestones

63-40 Truss Mod ----- Started ---- 1962
Complete -- 10-31-63

63-11 Cranes -------- Started ---- 4-9-63
Fabrication & Installation Complete -- 2-21-64

63-62 Crane Access -- Started ---- 10-25-63
Platforms Complete -- 11-20-63

Special Tooling Foundations Phases 5, 6, 7 & 8

63-35 -- Started ---- 1963
Complete -- 9-27-63

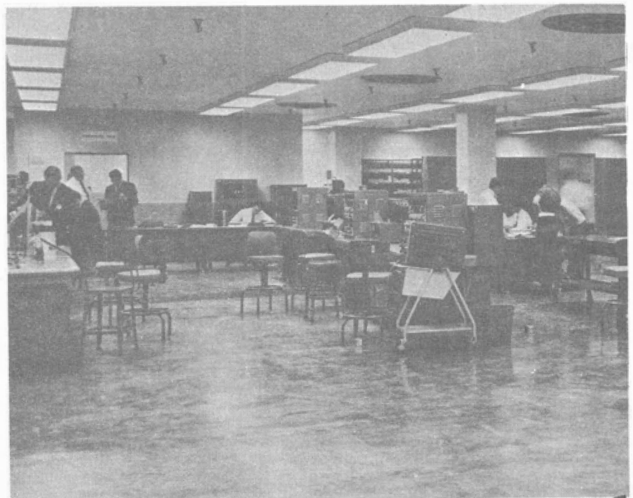
63-55 -- Started ---- 1963
Complete -- 10-31-63

63-61 -- Started ---- 1963
Complete -- 2-29-64

63-67 -- Started ---- 1963
Complete -- 3-1-64

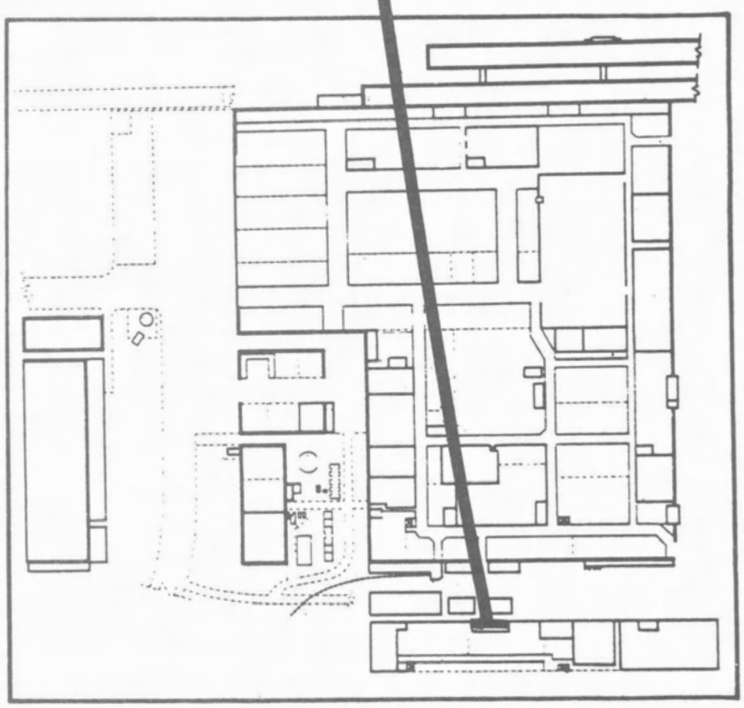
Contracts - 62-4 --- A&E Gray Box
63-40 -- Truss Mod
63-11 -- Cranes Fabrication & Installation
63-33 -- Y-ring Weld Area
63-62 -- Crane Access Platforms
63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8

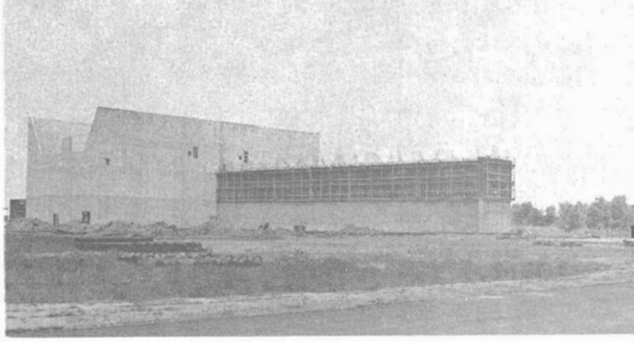
(The illustration shows a typical area)



Subsystems Test Electrical/Electronic

FACILITIES/TEST





Stage Test Position and Support

SYSTEMS TEST

ELECTRICAL/ELECTRONIC

Function - All electrical and electronic components, and subsystems of Ground Support Equipment and Saturn S-IC flight electrical and electronic systems are tested in this area. The subsystems Test electrical/electronic area is comprised of the: 1) Instrument Test Area; 2) Bench Test Area; 3) Telemetry Ground Station; 4) RF and TV Test Area; 5) Development and Special Test Area. These areas provide the capability for performing the following: testing of sensing devices, printed circuit cards, electronic chassis, various electrical and electronic components, subsystems, telemetry systems and electromagnetic radiating devices.

In addition, the facilities will provide the capability for: 1) developing special test equipment; 2) performing component and subsystems test; 3) compatibility testing between GSE and flight instrumentation and the resolution of any discrepancies disclosed in such testing.

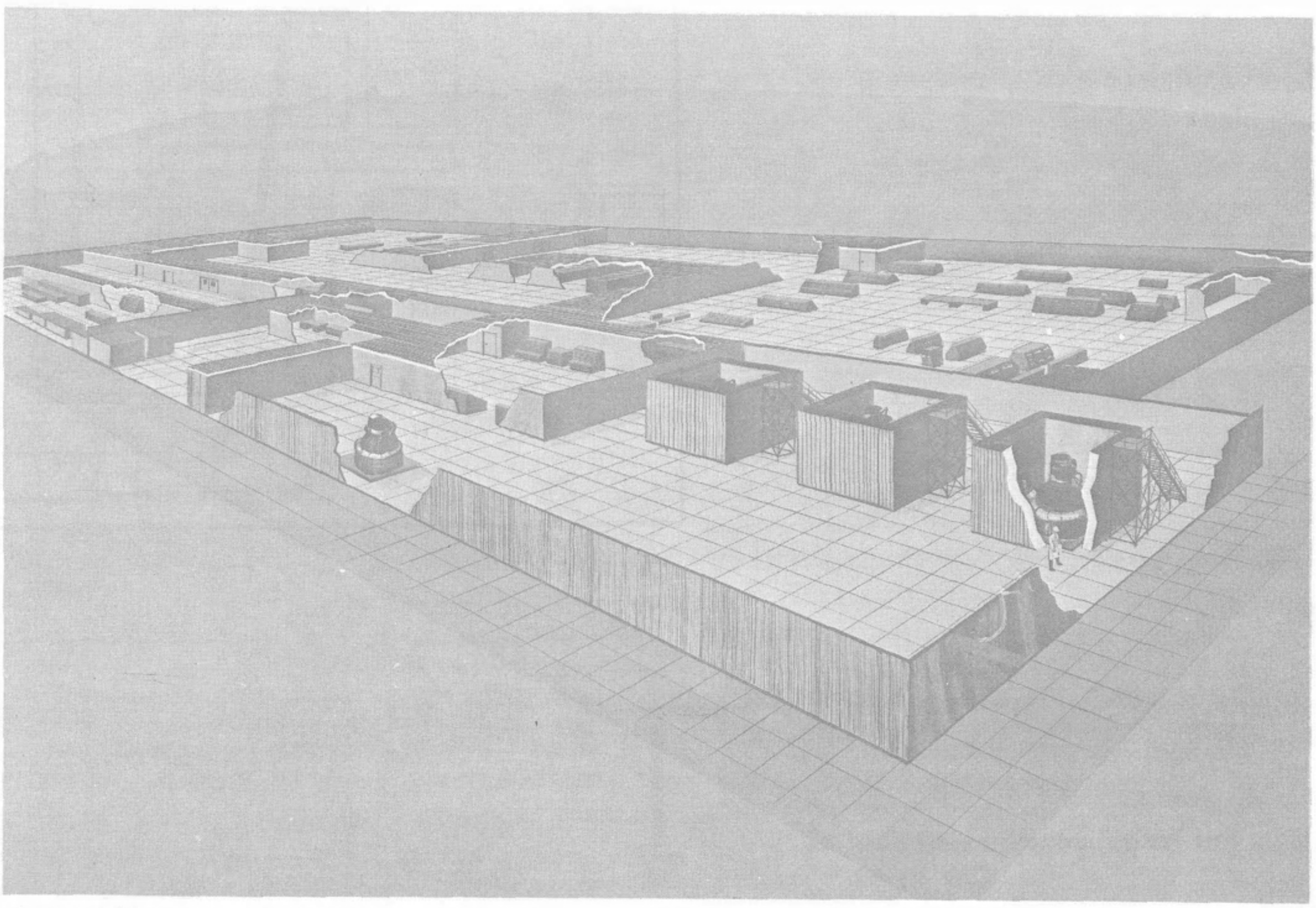
Using Organization - In-Plant Test

Area - Subsystems Test Electrical/Electronic - 14,252 square feet.

Milestones - Design Start ----------- 9-18-63
Design Complete ------- 10-23-63
Construction Start ------ 12-6-63
Construction Complete -- 4-17-6'

Contracts - In-House -- Design
63-69 ----- Construction

(The artist concept depicts the electrical/electronic area of subsystems test.)



Electrical/Electronic Area of Subsystems Test

SUBSYSTEMS TEST

MECHANICAL

Function - The Mechanical Subsystems Test area shall provide the capability of testing S-IC vehicle mechanical subsystems and components, vendor furnished items, and subsystems which have failed in static-firing or upper-level checkout. This shall include testing and measuring instruments, testing components and subassemblies that must operate at extremely low temperatures, test and proof of pressure pneumatic system components, check valve cracking pressures, and testing the LOX and fuel systems flight hydraulic components and subassemblies of the F-1 engine. Shops included in this area are: 1) Engine Test Cell; 2) Hydraulic Test Area; 3) Cryogenic Test Area; 4) Pneumatic Test Area; 5) Tool Crib; 6) Testing Staging Area, and 7) Hydrostatic Test Area.

Using Organization - In-Plant Test

Area - 27,192 square feet

Milestones - Design Start ------- 6-10-63
Design Complete --- 12-27-63
Construction Start -- 6-17-64

Anticipated completion early in the third quarter CY '64.

Contracts - 62-13 -- A&E
64-1 --- Construction

VALVE CLINIC

Function - The Valve Clinic is used for dismantling and reassembling valves. All inoperable valves, orifices, regulators, etc., are to be dismantled as required and inspected to determine the cause and extent of damage or malfunction.

Using Organization - Manufacturing

Milestones — Design Started------------6-10-63
Design Complete----------12-27-63
Construction Started ------2-11-64

Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design

TUBE AND VALVE CLEANING FACILITY

Function - The Tube and Valve Cleaning facility is required for the cleaning of fuel, LOX, and pneumatic components to the cleanliness levels required for the system. Tubing will be flushed with the proper cleaning agents, dryed, and packaged at this location. Valves and components are to be cleaned and rinsed in ultrasonically energized fluids, placed in vacuum ovens for drying, and flushed to certify the cleanliness levels.

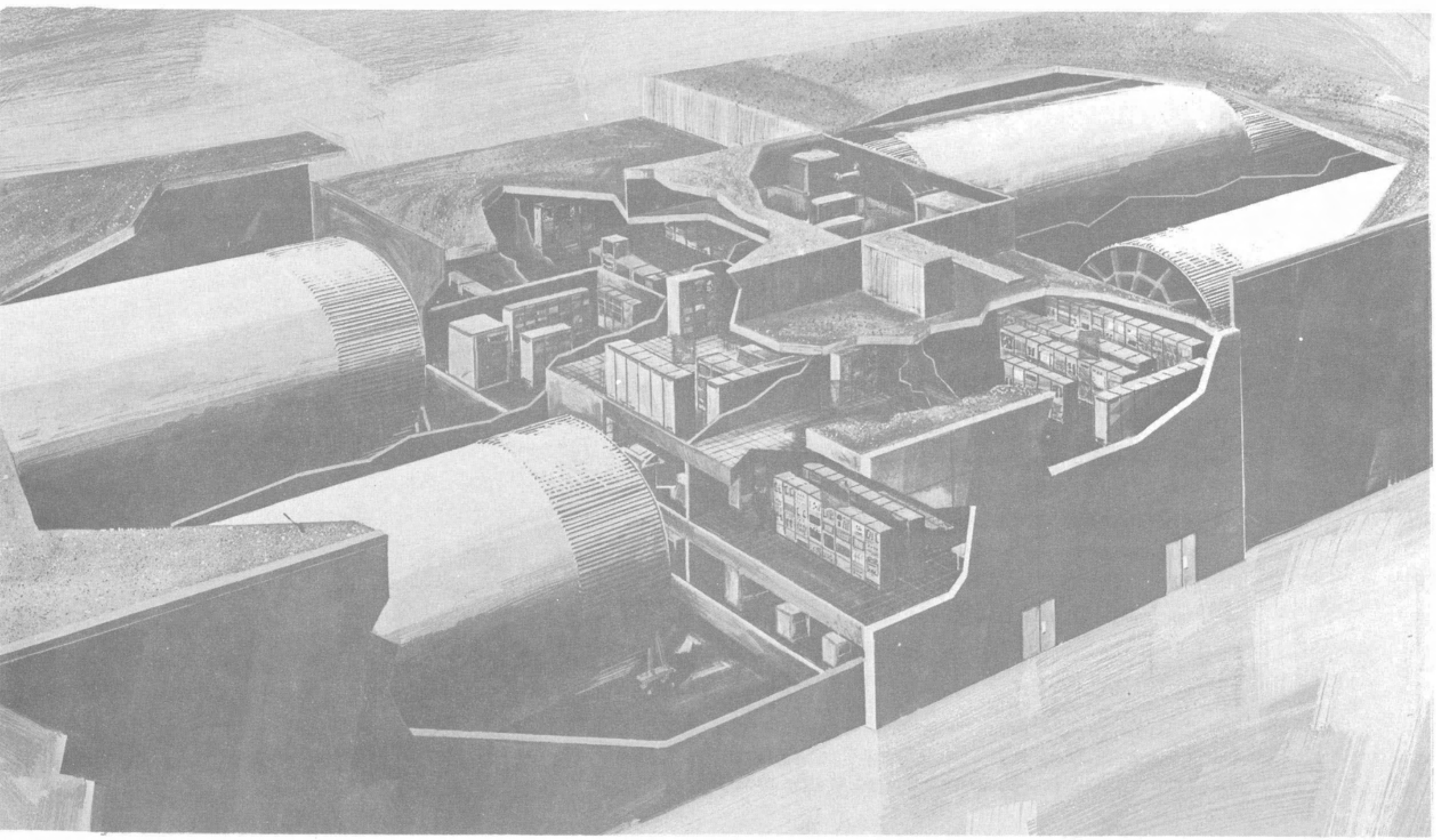
Using Organization - Manufacturing

Area - 6,670 square feet

Milestones - Design Started ---------- 6-10-63
Design Complete -------- 12-27-63
Construction Start -------2-7-64

Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design



STAGE TEST POSITION AND SUPPORT

Function - The Stage Test Position is necessary to fulfill requirements of the final stage checkout program of the S-IC stage. This will be accomplished in four stage test positions for performing various tests on the pneumatic, hydraulic, mechanical, telemetry and electrical systems of the S-IC stage to ensure system integrity.

Using Organization - In-Plant Test

Area - 114,432 square feet (66,120 Test Cells; 48,312 support facility).

Milestones - Contract 63-71 Phase I

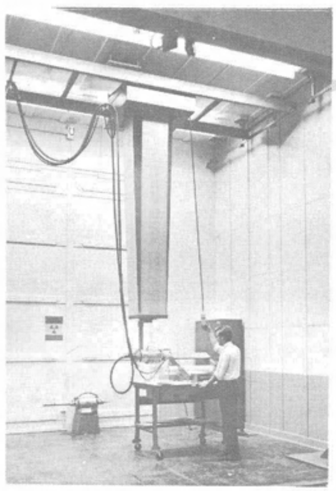
Design Started ----------5-24-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Construction Complete ---Is basically completed except for seeding and secondary road work which cannot be accomplished until November 1, 1964.

Contracts — 63-71 -- Phase I Construction
64-9 --- Phase II Construction
63-29 -- A&E

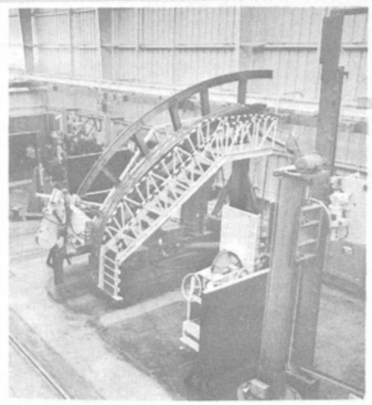
Contract 64-9 Phase II

Design Started ----------10-2-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Scheduled Construction Completion -------------1-4-65

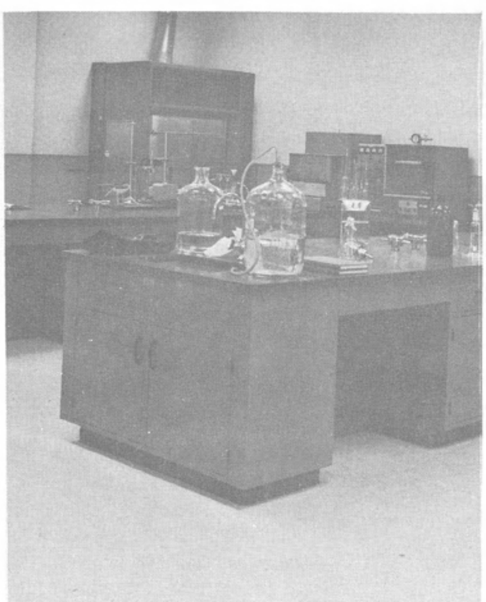
FACILITIES/LABORATORIES



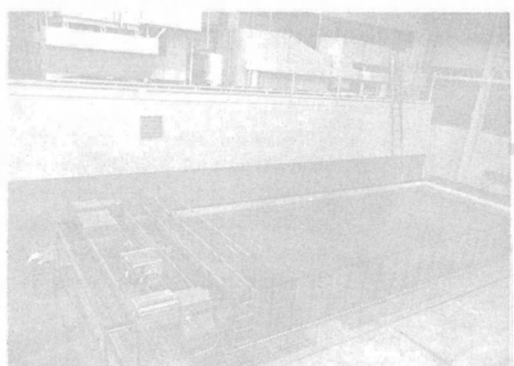
Quality Assurance
Radiographic Evaluation Laboratories



Manufacturing Development Laboratory

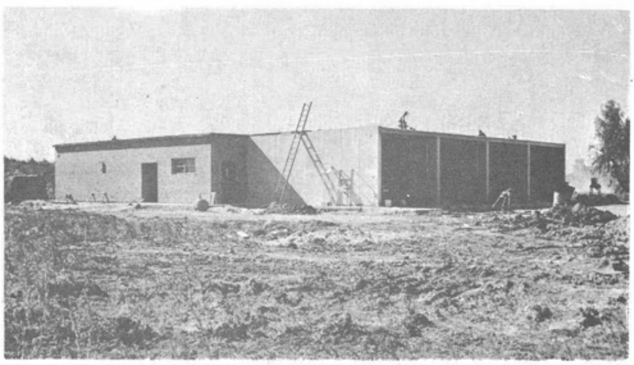


Measurement Control Laboratories

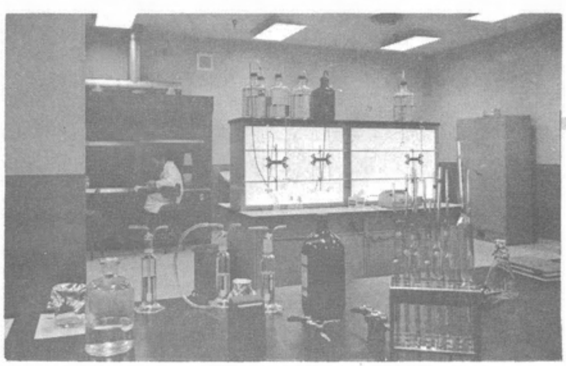


Non-Destructive Test Laboratory

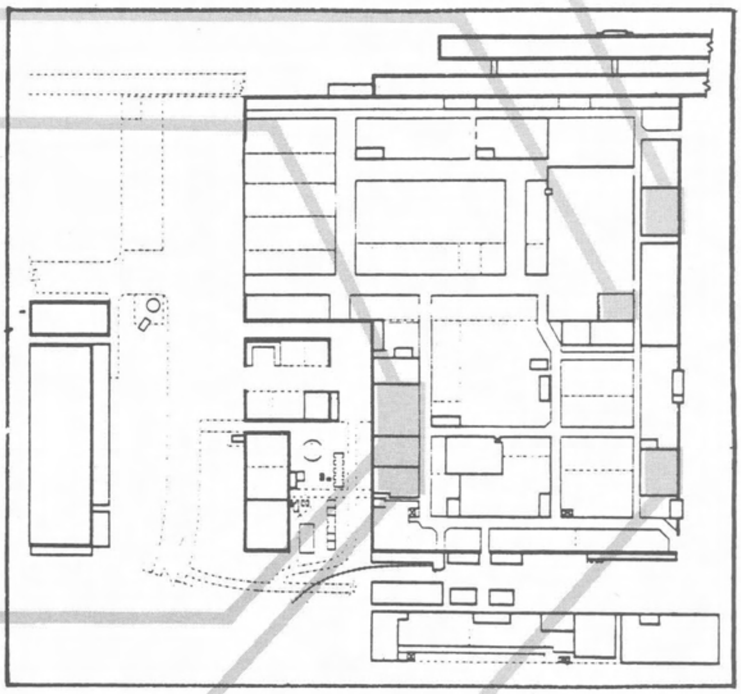
Component Test Area
(Material and Processes Laboratory)



High Pressure Test Area (Remote from Plant)



Quality Evaluation Laboratories



MANUFACTURING DEVELOPMENT LABORATORY

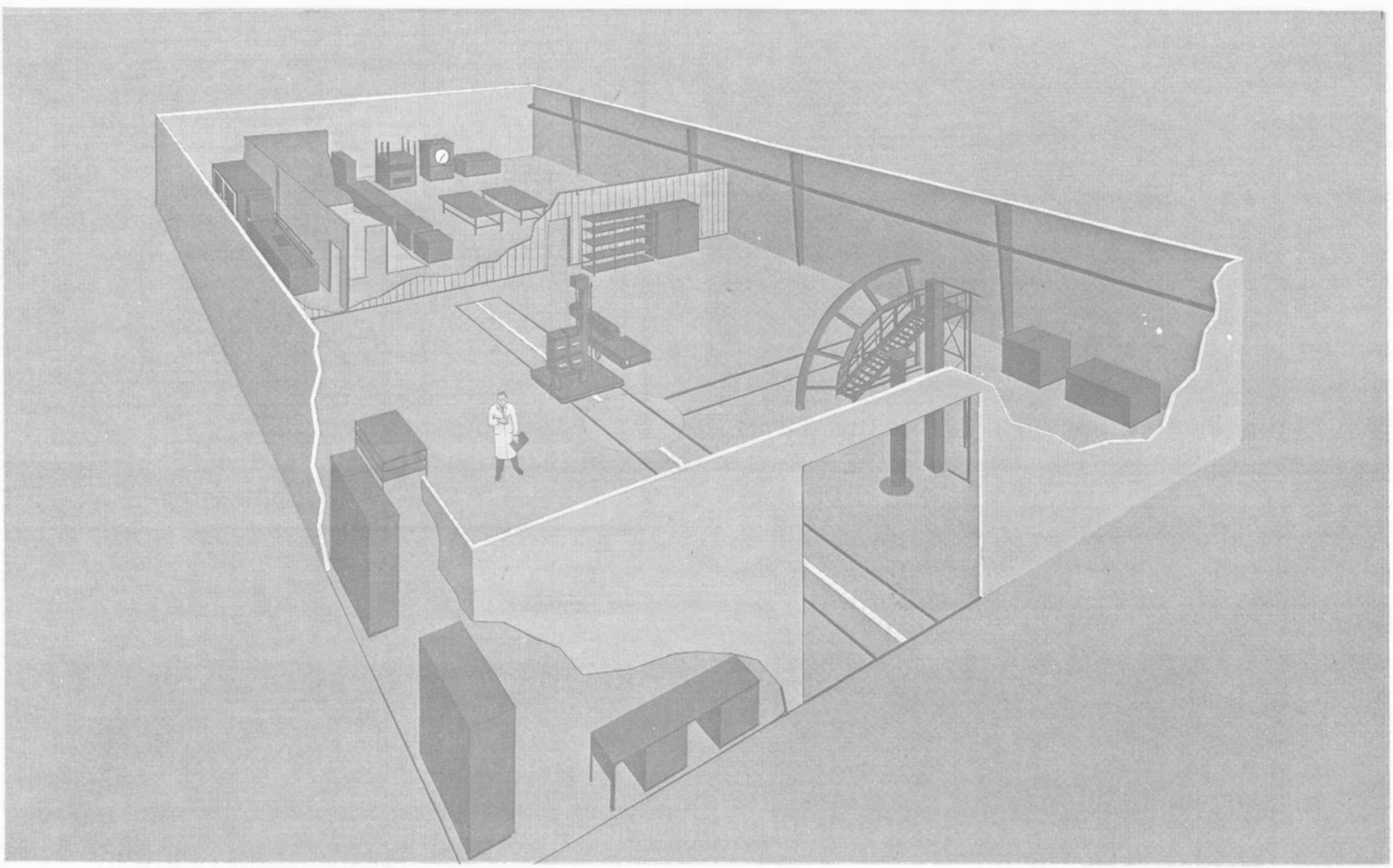
Function - This area is used for the development of new production processes, refining of existing techniques and to eliminate production problems. It also serves to train personnel in new welding methods. This laboratory is subdivided into five totally enclosed sections: 1) Welding Area, 2) Radiation Area, 3) Specimen Preparation Shop, 4) Wire and Instrument Control, and 5) NASA Office.

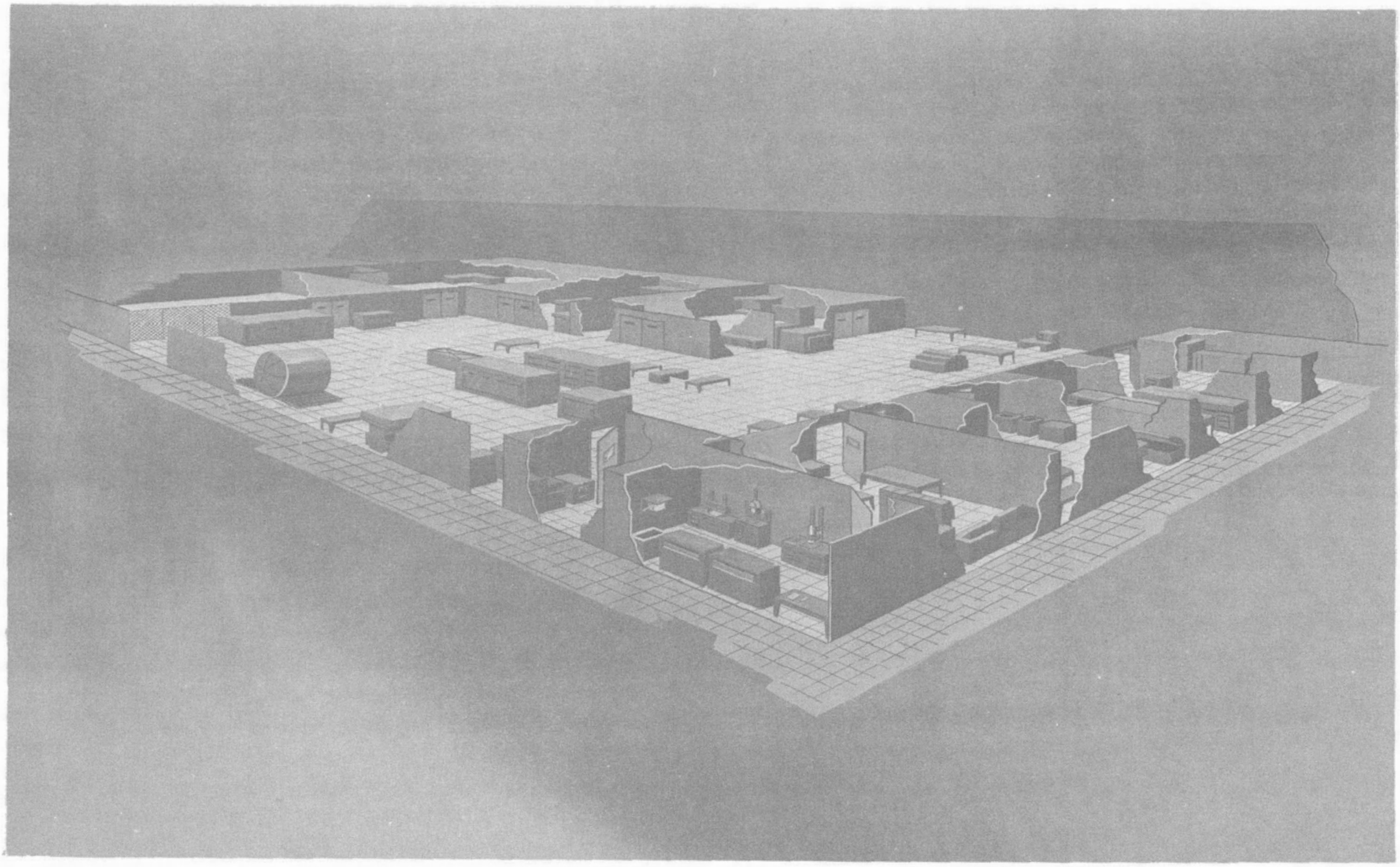
Using Organization - Manufacturing

Area - Manufacturing Development Laboratory -- 6,600 square feet.

Milestones - Design Complete ------- 6-13-63
Construction Start ------ 6-25-63
Construction Complete -- 1-3-64

Contracts - 62-15 -- A&E
63-20 -- Interim Construction
63-25 -- A&E
63-41 -- Construction
63-56 -- Construction





The above illustration shows the Material and Processes Laboratory-Component Test Area

COMPONENT TEST AREA

Function - This area is used to test various mechanical, electrical, and hydraulic components of the S-IC booster to establish and substantiate the design concepts and manufacturing techniques employed. This component testing also provides reliability assurance. Test equipment here is capable of producing, sensing, and recording simulated flight and ground handling conditions (e.g., acceleration, force, vibration, pressure, and temperature environments) to establish the high degree of reliability necessary for the first firing.

Using Organization - Engineering

Area - Component Test Areas -- 73,504 square feet

Milestones - Design Start ----------- 5-15-63
Design Complete ------- 9-26-63
Construction Start ------ 8-12-63
Construction Complete -- 6-15-64

Contracts - 63-32 -- A&E
63-55 -- Construction (Pilings)
63-58 -- Construction
63-66 -- Construction
63-68 -- Construction

HIGH PRESSURE TEST

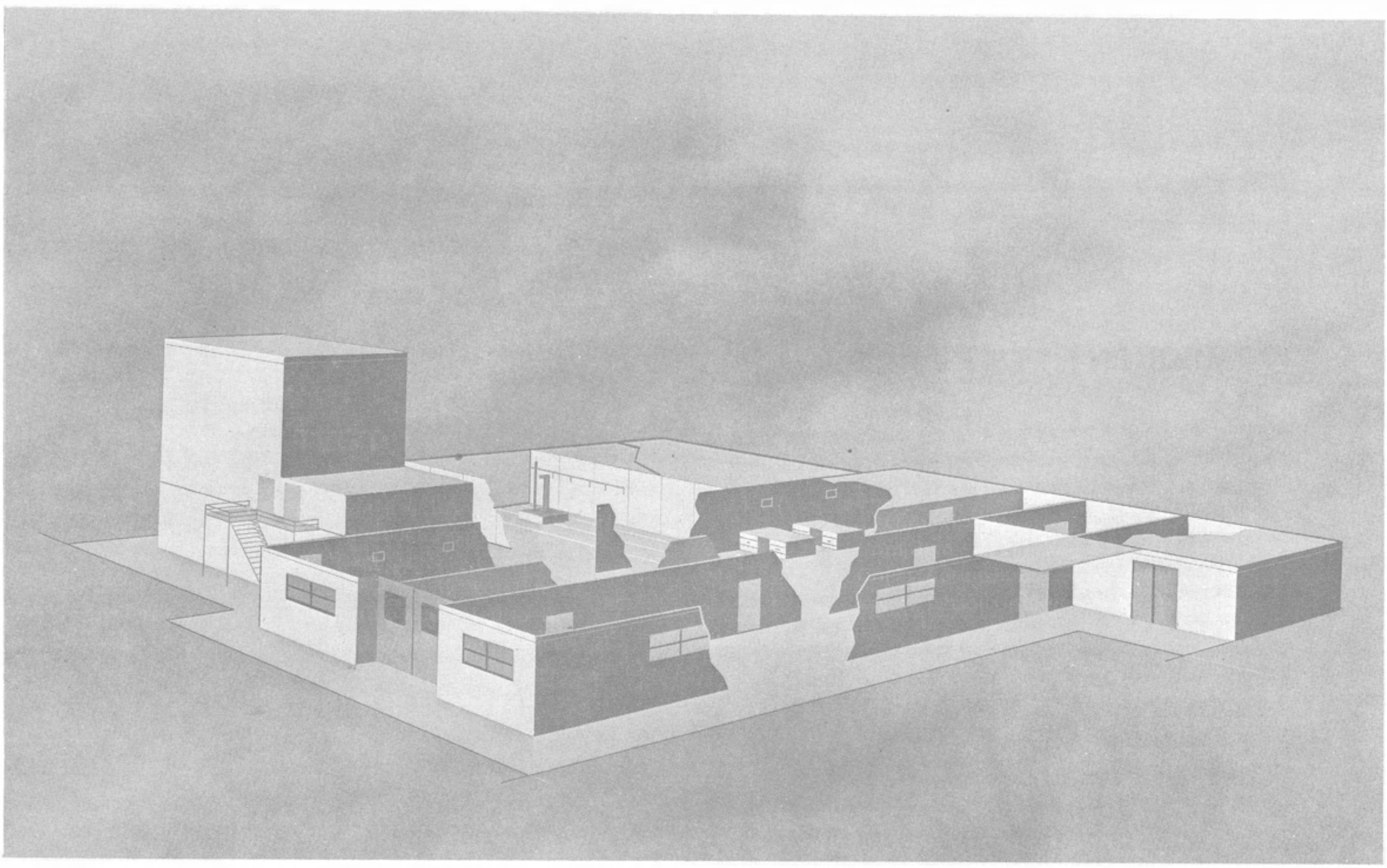
Function - The High-Pressure Test facility will be used to conduct all testing of a hazardous nature for both booster and ground support equipment. Components, subassemblies, subscale test hardware, tanks, and ground support equipment will be subjected to various pressure flow and burst tests to ensure compliance with design requirements under normal and emergency environment and operating conditions.

Using Organization - Engineering

Area - 5,020 square feet

Milestone--

High-Pressure Test:	Design Start ----------	6-12-64
	Design Complete ------	8-3-64
	Construction Start -----	9-8-64
	Construction Complete -	12-22-64
Liquid-Level Test:	Design Start ----------	2-6-64
	Design Complete ------	6-10-64
	Construction Start -----	6-29-64
	Construction Complete -	8-13-64
Helium & Nitrogen Modification:	Technical Support Start -----------------	1963
	Technical Support Complete -------------	4-21-64
	Construction Start -----	5-8-64
	Construction Complete -	10-1-64



QUALITY ASSURANCE LABORATORIES

Function--Quality Evaluation Laboratory - These laboratories are used by the Quality and Reliability Assurance organization to ensure the quality levels of all products and assemblies. Laboratories included in the Quality Evaluation Laboratories are are: 1) Chemical; 2) Metallurgical; 3) Spectro-Analysis; 4) Physical Test; 5) Equipment Quality Analysis; 6) Contamination Control.

Nondestructive Test Laboratory - Nondestructive testing equipment and techniques are maintained and used for such areas as fabrication control and special investigations, in addition to the primary receiving-inspection demands. The equipment and instrumentation of this laboratory is used by technical personnel to perform services such as examination of surface defects, internal defects, discontinuity and porosity in metal parts and welds; and also the detection of cracks and defects in both ferrous and nonferrous materials.

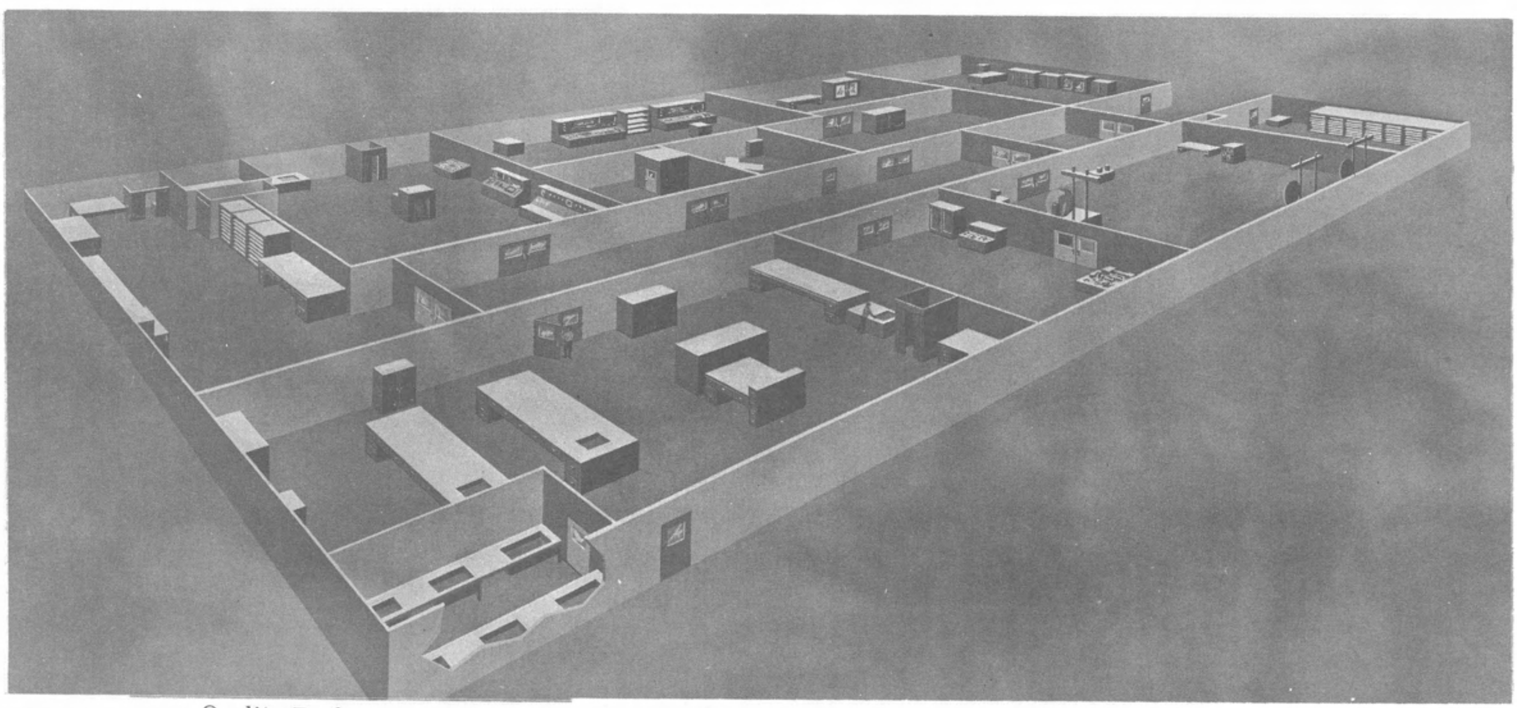
Measurement Control Laboratory - The Measurement Control Laboratory provides the capability to perform initial and periodic calibration and accuracy certification of all measuring and testing equipment used in the Boeing-Saturn Operations at Michoud. In addition, calibration-certification services for transfer standards are performed in this area in accordance with the present agreements between Boeing, Chrysler, and NASA. Laboratories included in the Measurement Control Laboratory area are: 1) Measurement Receiving Area; 2) Micorwave-Electronic Electrical Laboratory; 3) Precision Measurement Laboratory; 4) Pyrometry-Pressure Flow Laboratory; 5) Measurement Office Area.

Using Organization - Quality Assurance

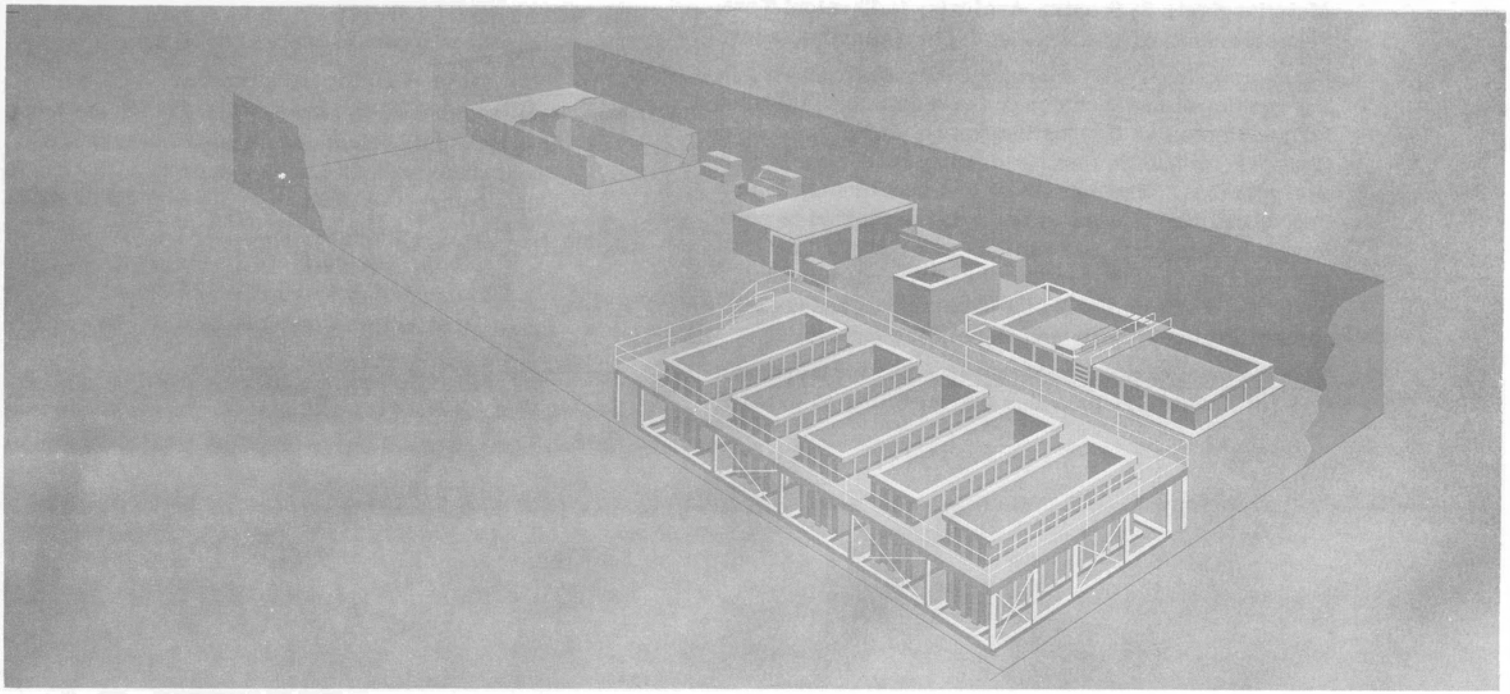
Area - Quality Assurance Labs---- 28,714 square feet
Qualification Evaluation Lab-approx. 8,970 sq. ft.
Nondestructive Test Lab---- approx. 8,000 sq. ft.
Measurement Control Lab---approx. 9,660 sq. ft.

Milestones - Design Started --------- 1-1-63
Design Complete ------- 6-5-63
Construction Started ---- 7-30-63
Construction Complete -- 5-15-64

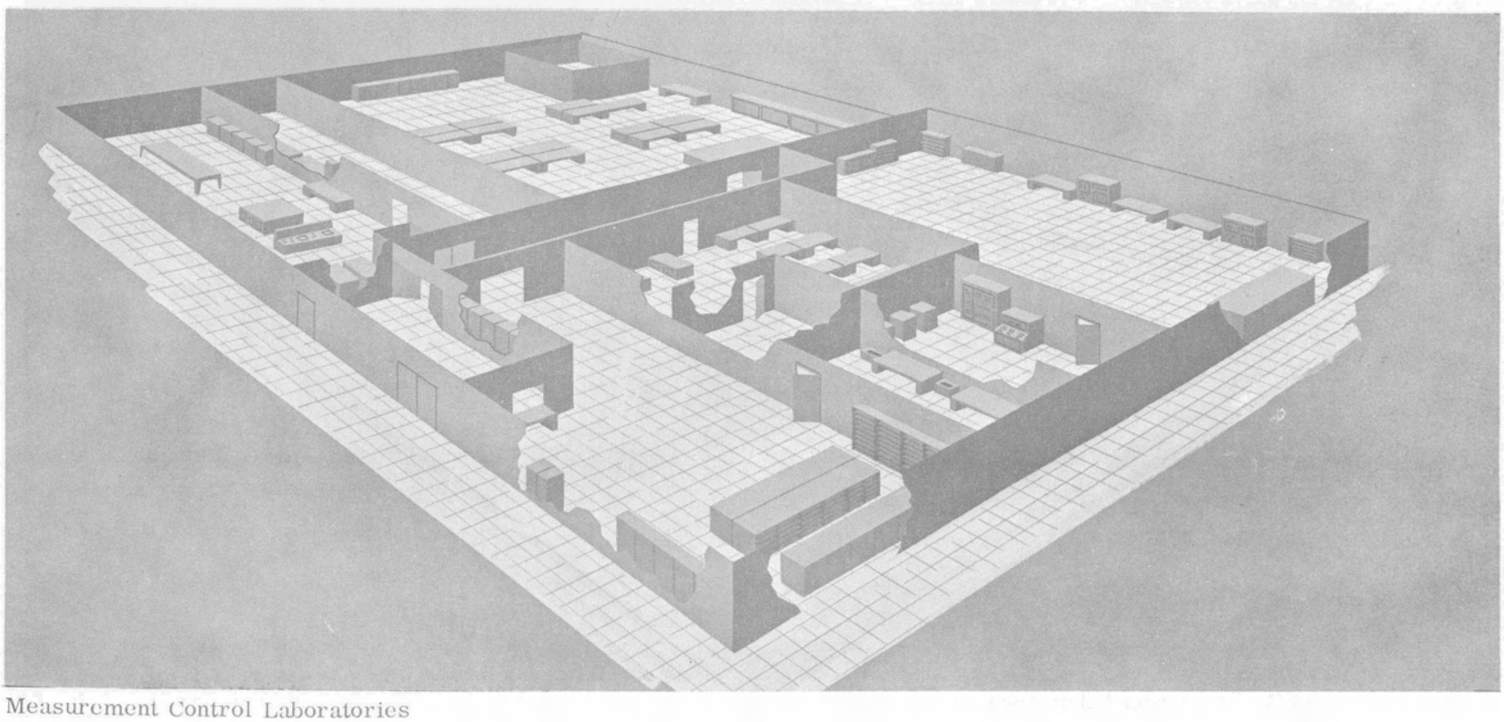
Contracts - 62-11 -- A&E
63-3 --- Construction



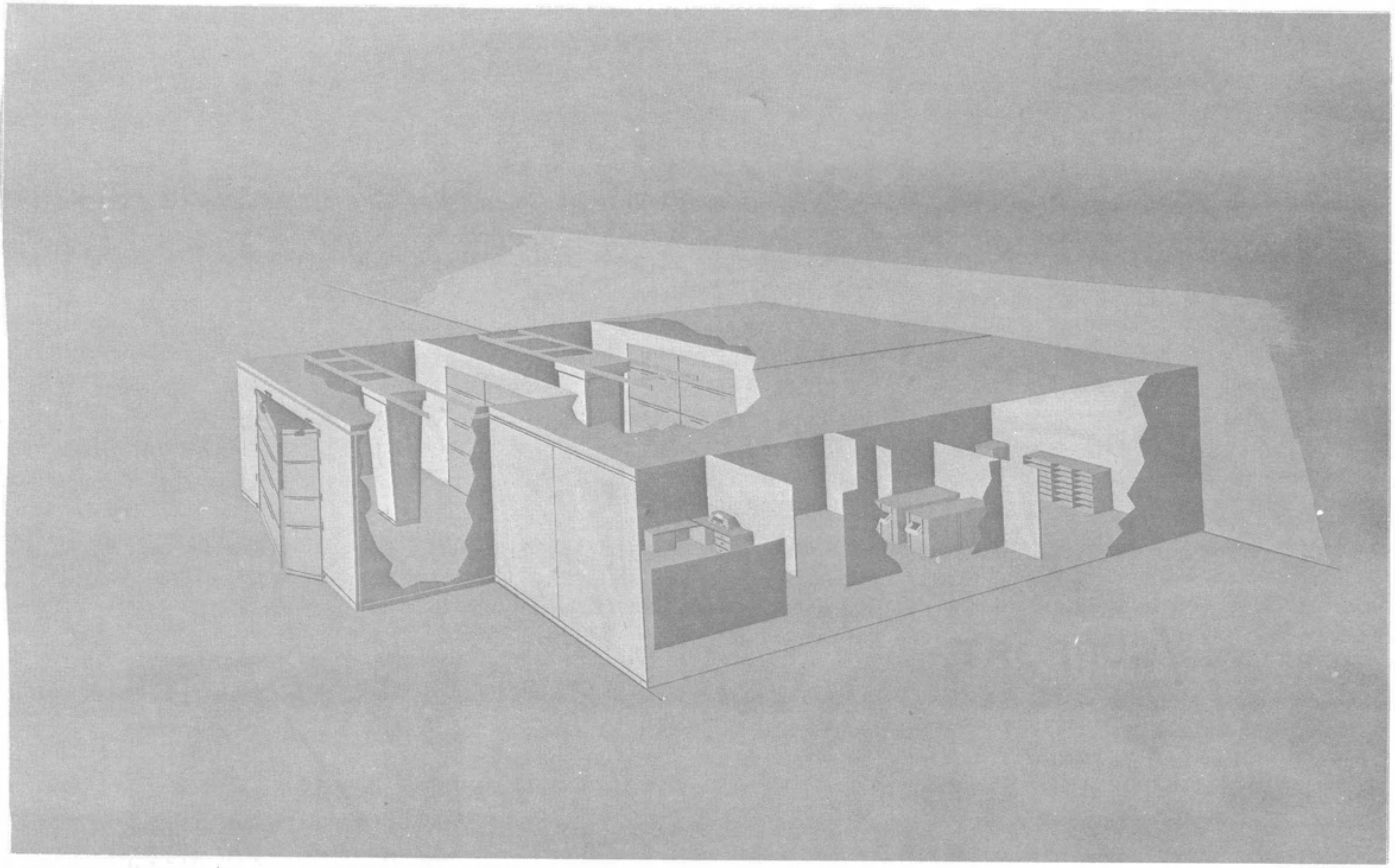
Quality Evaluation Laboratory



Non-Destructive Test Laboratory



Measurement Control Laboratories



QUALITY ASSURANCE RADIOGRAPHIC EVALUATION LABORATORIES

Function - The Centralized Radiographic Evaluation Laboratory provides both X-ray and radio-chemical evaluation support for weld development, weldor certification, and weld and raw material inspection. This laboratory is equipped to detect, evaluate, and record surface and subsurface discontinuities in welds and materials. It also provides for the developing and storage of the permanent X-ray film records for the total S-IC fabrication program.

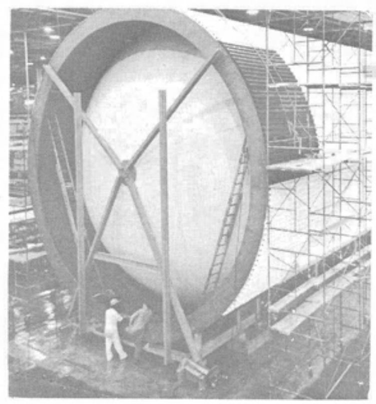
Using Organization - Quality Assurance

Area - Quality Assurance Radiographic Laboratory -- 3,443 square feet.

Milestones - Start Redesign ----------- 2-27-63
Partial No. 34 Complete -- 4-10-63
Design Complete --------- 5-29-63
Construction Started ------ 6-19-63
Construction Complete ----12-6-63

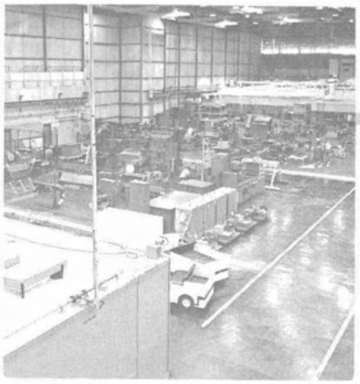
Contracts - 62-7 --- A&E and In-house Design
63-45 -- Construction

FACILITIES/SUPPORT

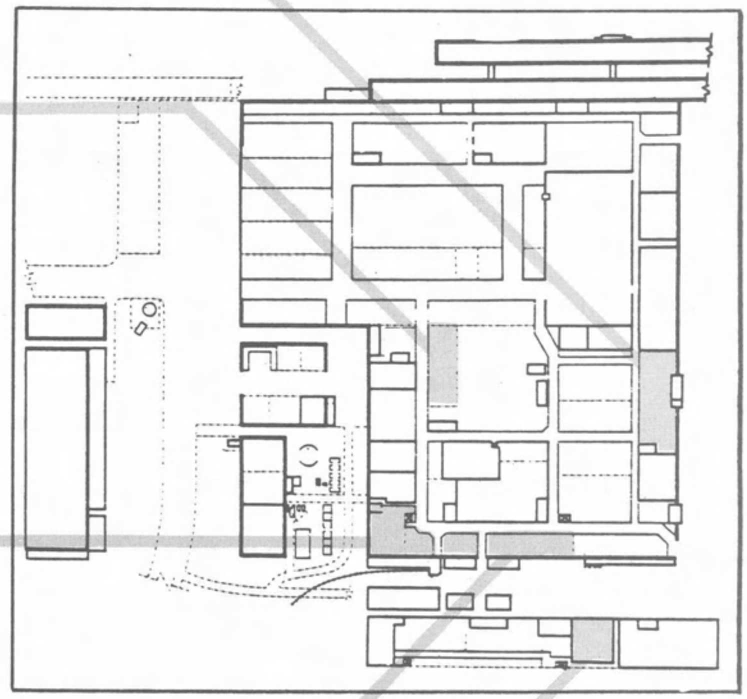


Mockup Facility

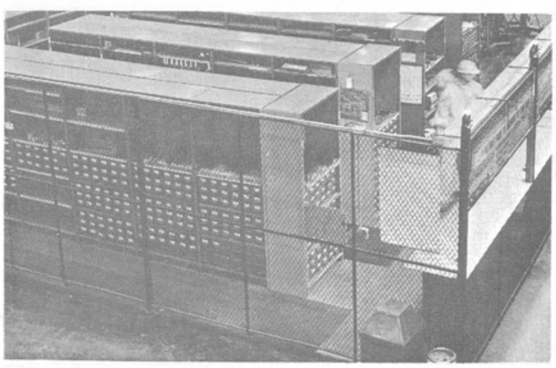
Support and Services Area – Familiarization and Training



Equipment Maintenance Facility



Receiving and Receiving Inspection Facility



Warehouse and Stores

RECEIVING AND RECEIVING INSPECTION FACILITY

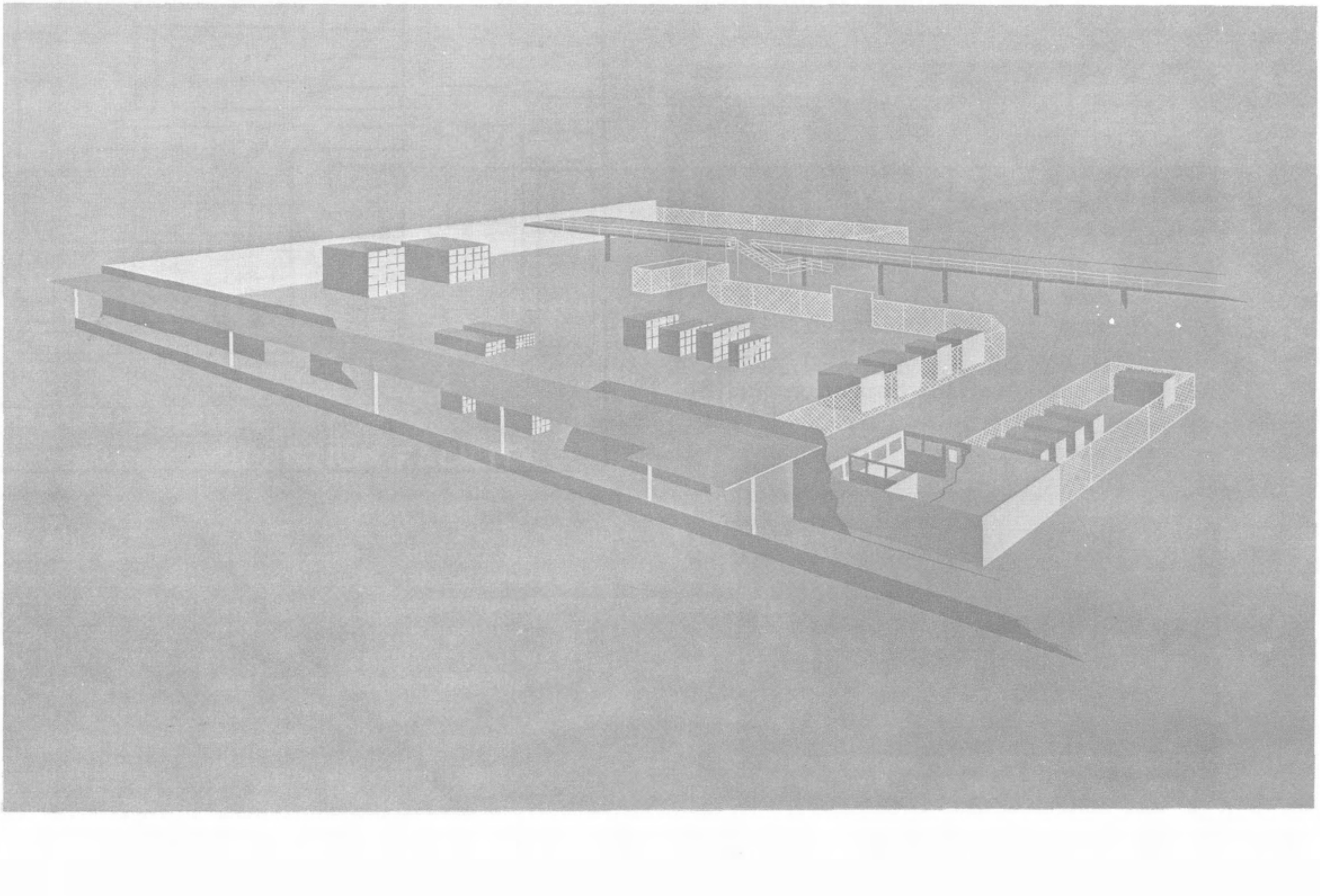
Function - The Receiving-Inspection area receives those components supplied by vendors, subassemblies, raw materials, and test equipment from the general receiving area. These items receive a planned inspection to verify compliance with specifications and general acceptance requirements. Visual and dimensional inspections are performed here with support from the Quality Evaluation Laboratories.

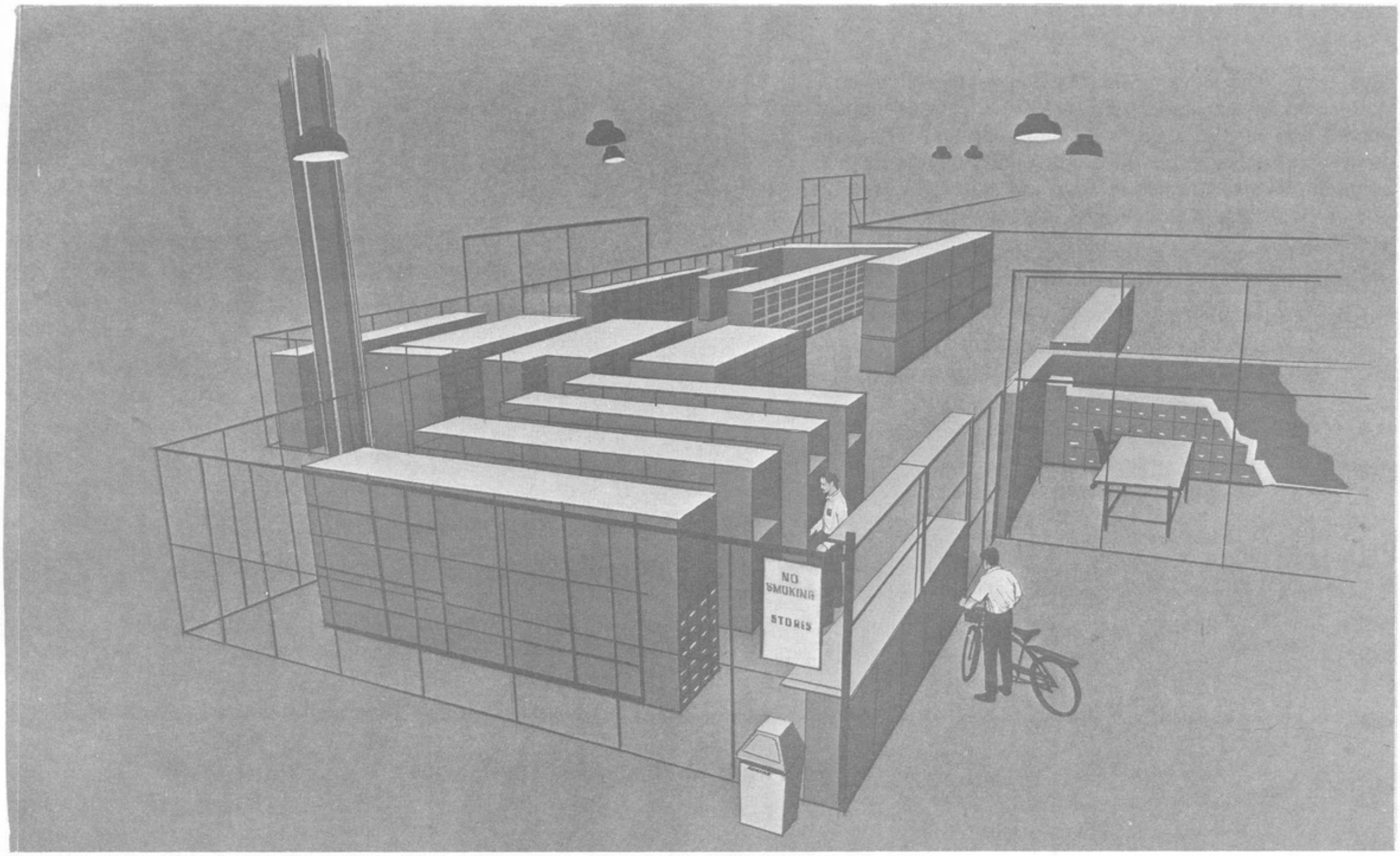
Using Organization - Finance and Quality Assurance

Area - Receiving and Receiving-Inspection Facility -- 24,506 square feet.

Milestones - Design ---------------- 6-20-63
Design Complete --------8-1-63
Construction Start ------ 9-10-63
Construction Complete -- 11-26-63

Contracts - 62-4 -- A&E
63-56 - Construction





WAREHOUSE AND STORES

Function - Foundations must be provided for special tool- the capability to store raw materials and subcontractor supplied items as required to support the manufacture of the S-IC booster.

Using Organization - Materiel

Area - 122,779 square feet

Milestones - Equipment Installation Started - 8-20-63
Equipment Installation Complete - 11-14-63

Contracts - 62-4 -- A&E

MOCKUP FACILITY

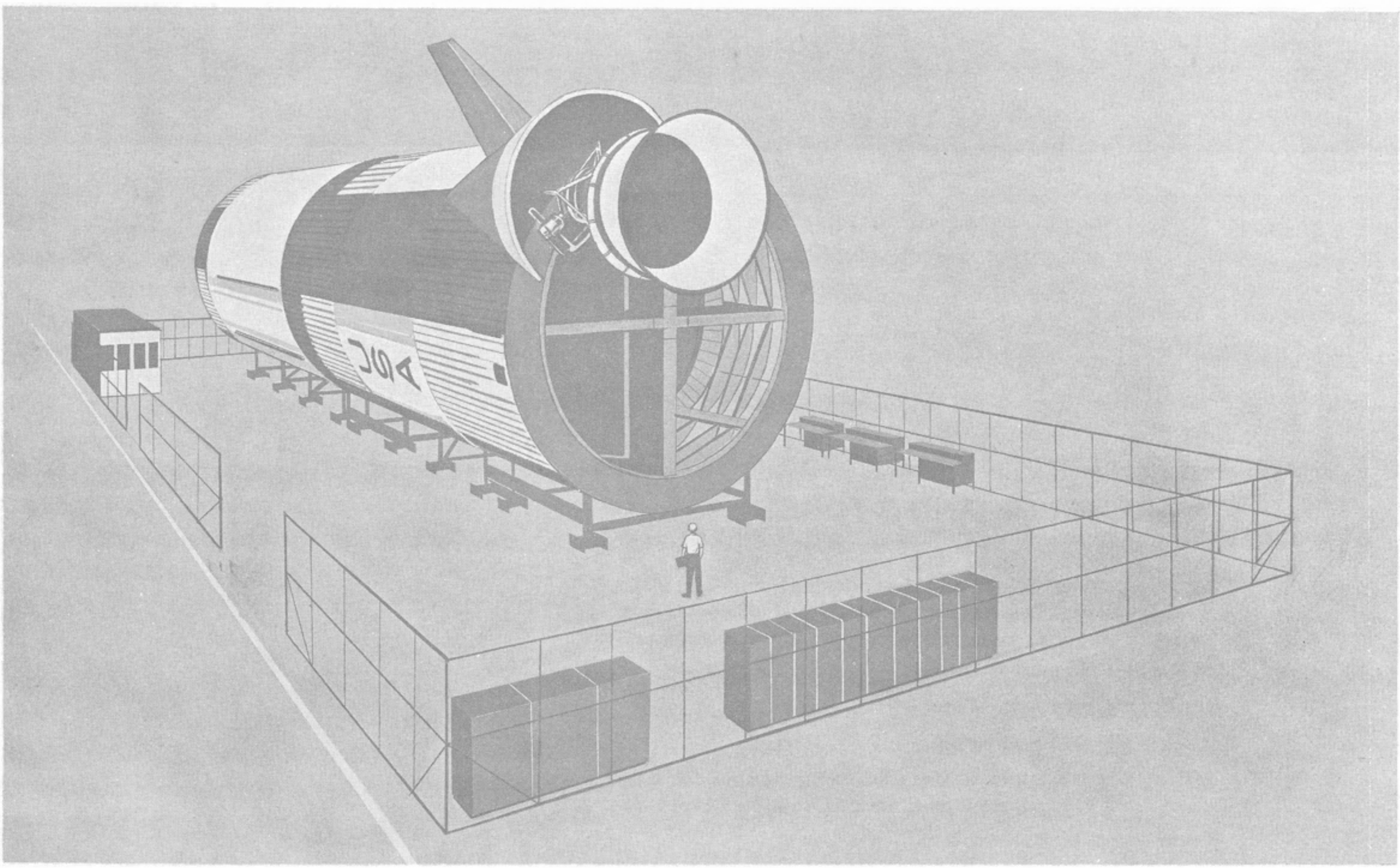
Function - The Mockup Facility houses the Michoud full-scale S-IC manufacturing model. This horizontal model was built to a Class III configuration. It serves as a forming board for developing and fabricating propulsion, electrical, astrionics, and hydraulic systems; for critical tank contours; and for component assembly locations.

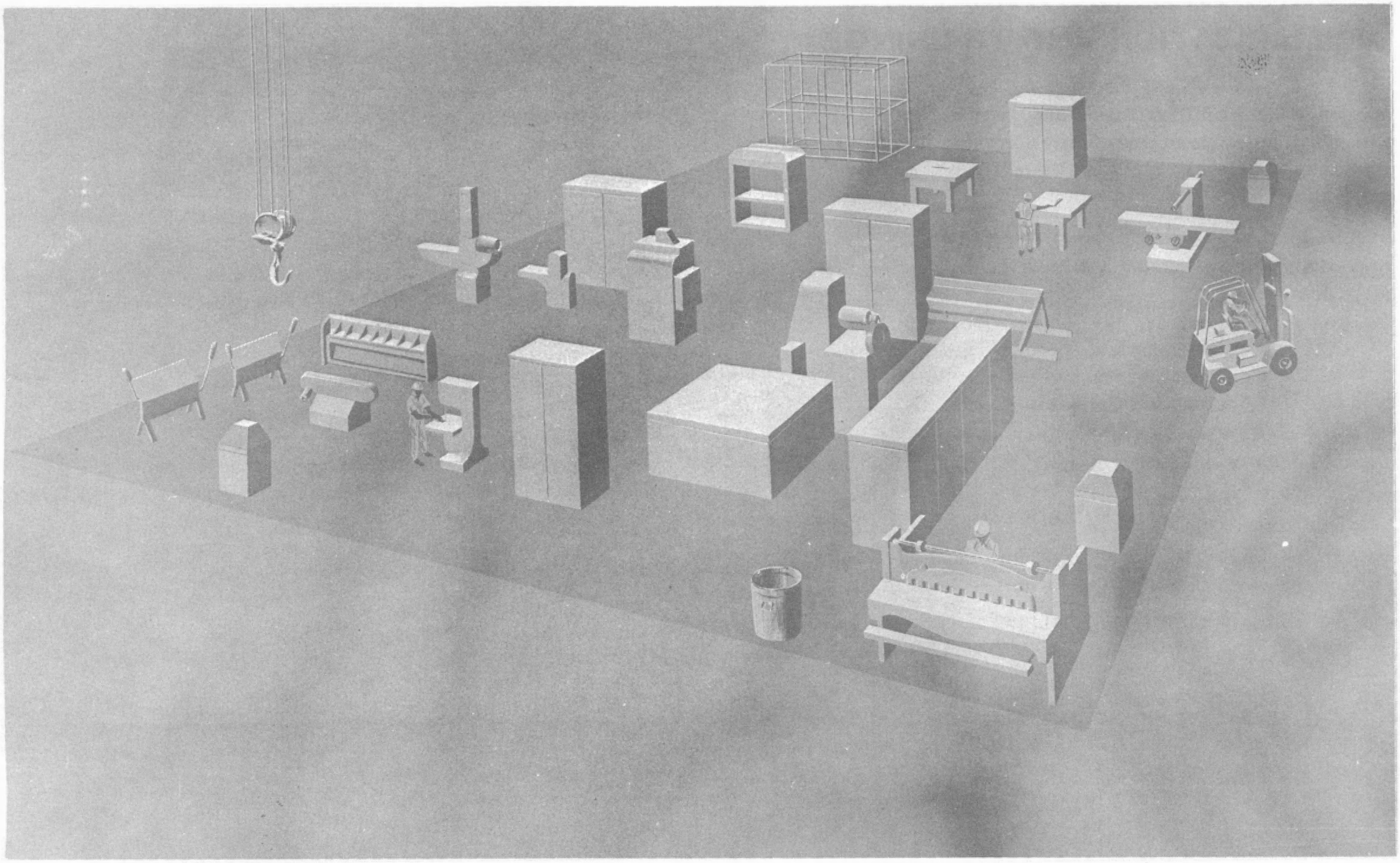
Using Organization - Manufacturing

Area - Full-Scale Model Facility -- 14,400 square feet

Milestones - Design Start ----------- 5-1-63
Design Complete ------- 10-8-63
Construction Start ------ 10-25-63
Construction Complete -- 12-27-63

Contracts - Design -- In-house
63-63 --- Construction





EQUIPMENT MAINTENANCE FACILITY

Function - The Equipment Maintenance facility is required to provide maintenance for general factory and office equipment. It affords the capability of fabricating items that, because of economy or scheduling, are not purchased from vendors; and provides for maintenance of production machine tools, fixtures and other accessory equipment, air-conditioning equipment and systems, metal office equipment, production welders, and general plant items. The facility is capable of housing and providing for maintenance of mobile equipment and consists of the following:

1) Machine Shop
2) Sheet-Metal
3) Woodwork Shop
4) Electrical Shop
5) Paint Shop
6) Transportation
7) Facilities Checkout Equipment
8) Filter Cleaning Facility

Using Organization - Facilities

Area - Equipment Maintenance facility — 23,678 square feet.

Milestones - Design Start ----------- 6-26-63
Design Complete ------- 9-30-63
Construction Start ------ 10-25-63
Construction Complete -- 3-26-64

Contracts - Design -- In-house
63-61 --- Construction

SUPPORT AND SERVICES AREAS
FAMILIARIZATION AND TRAINING

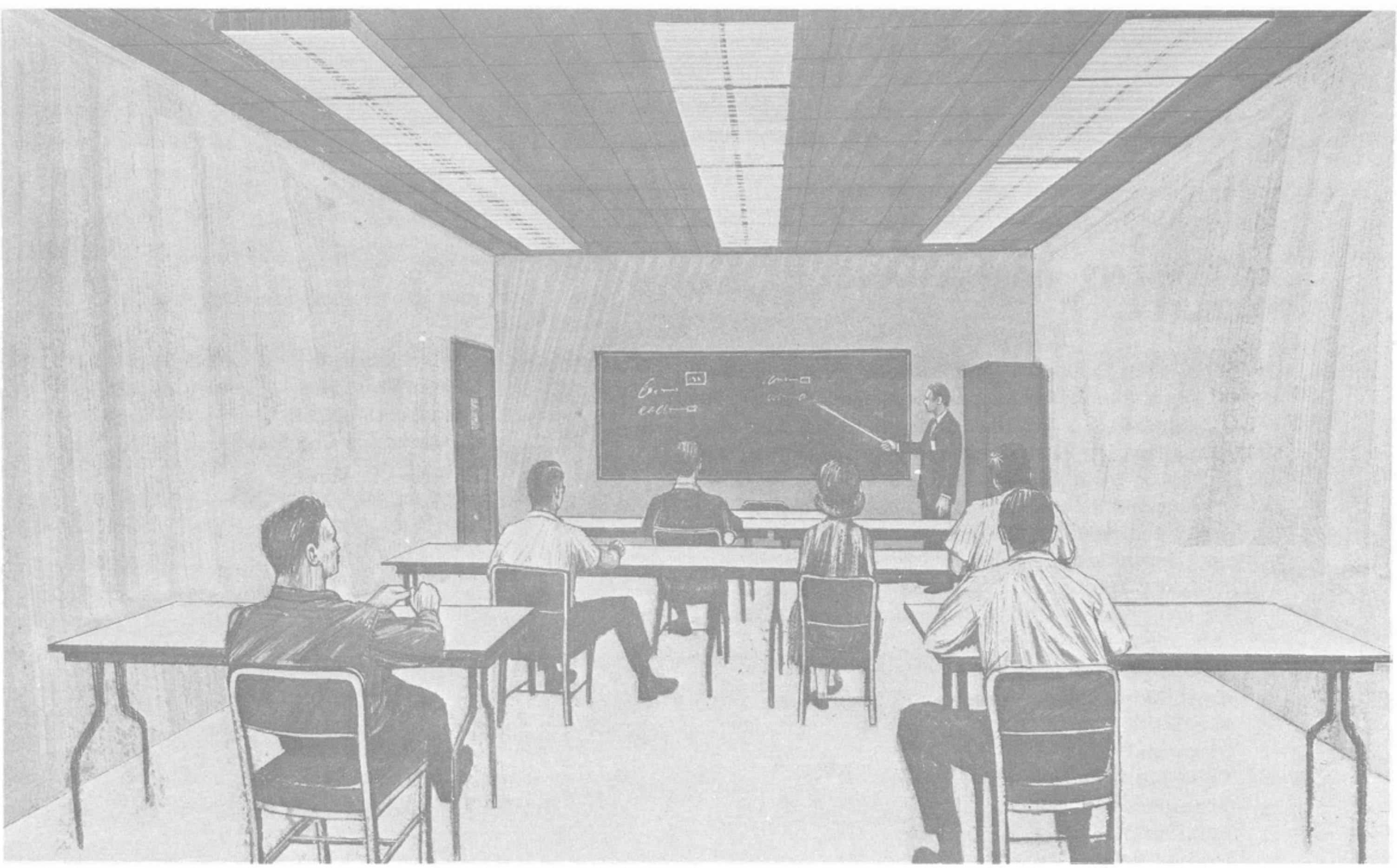
Function - The Familiarization and Training area will be used to train, orient, and certify personnel in sheet-metal assembly work, electrical fabrication, and optical tooling.

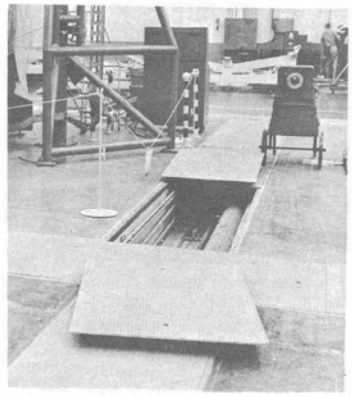
Using Organization - Industrial Relations Organization

Area - Familiarization and Training Facility -- 11,660 square feet.

Milestones - Design Start ----------- 9-15-63
Design Complete ------- 10-28-63
Construction Start ------ 10-28-63
Construction Complete -- 2-14-64

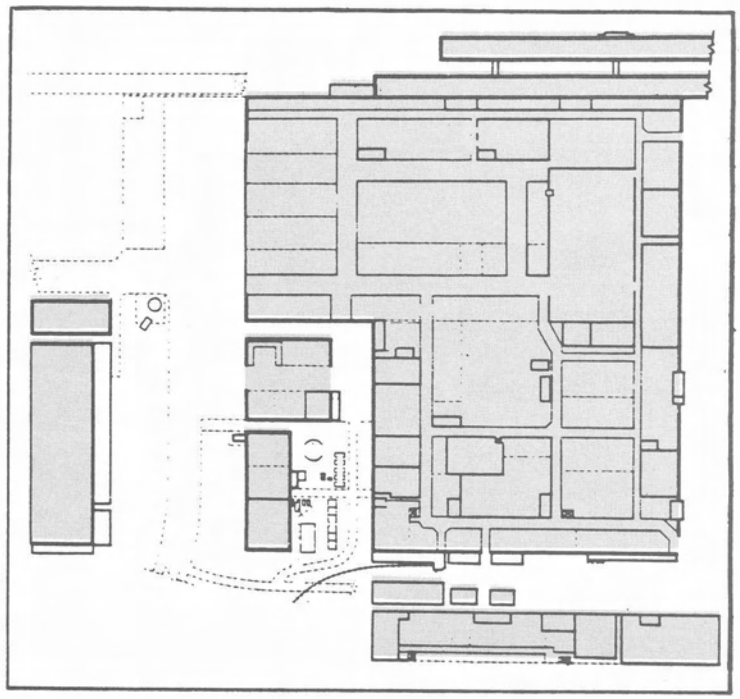
Contracts - 63-27 -- A&E
63-47 -- Construction

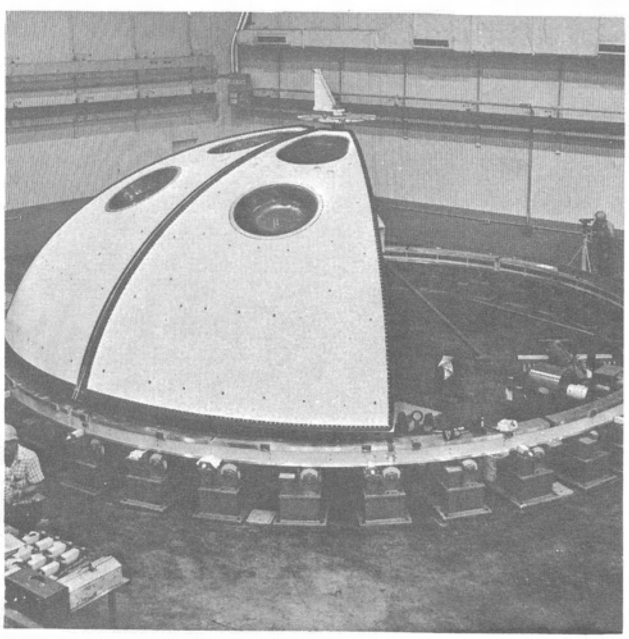




Special Gas Facilities

FACILITIES/GENERAL PLANT





Special Tooling Foundations

SPECIAL GAS FACILITIES

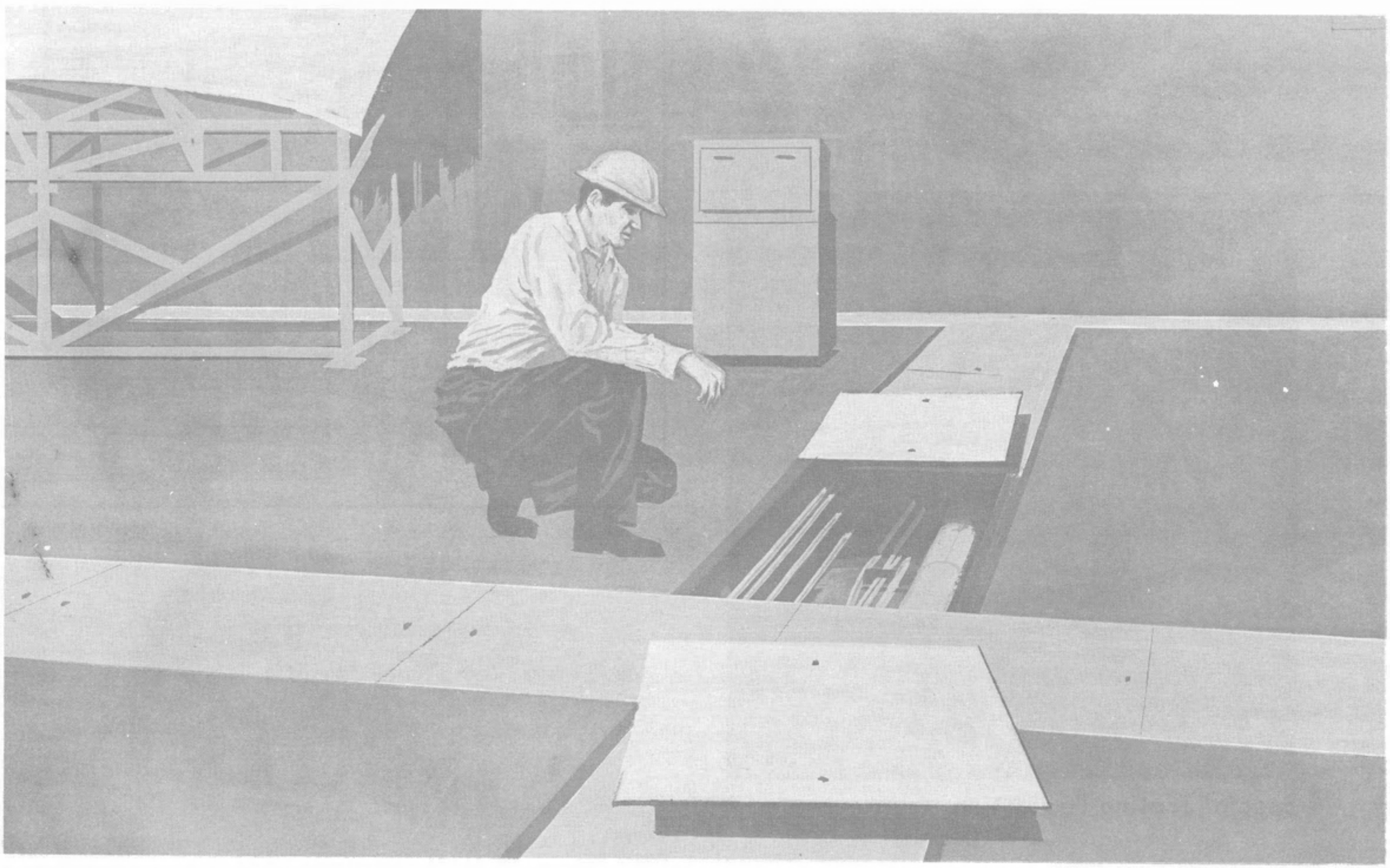
Function - The Special Gas facility will handle piped gaseous nitrogen (GN_2), helium, and argon; and liquid nitrogen (LN_2) stored in pressure vessels. Nitrogen will be used for testing, drying, packaging and purging. Helium will be used for pressurization and to create an inert atmosphere for certain welding processes. The principal use of argon is to be for weld shieldings. Small amounts of bottled CO_2 and CCl_2F_2 (Refrigerant 12) will also be used, primarily for instrumentation testing and other laboratory functions.

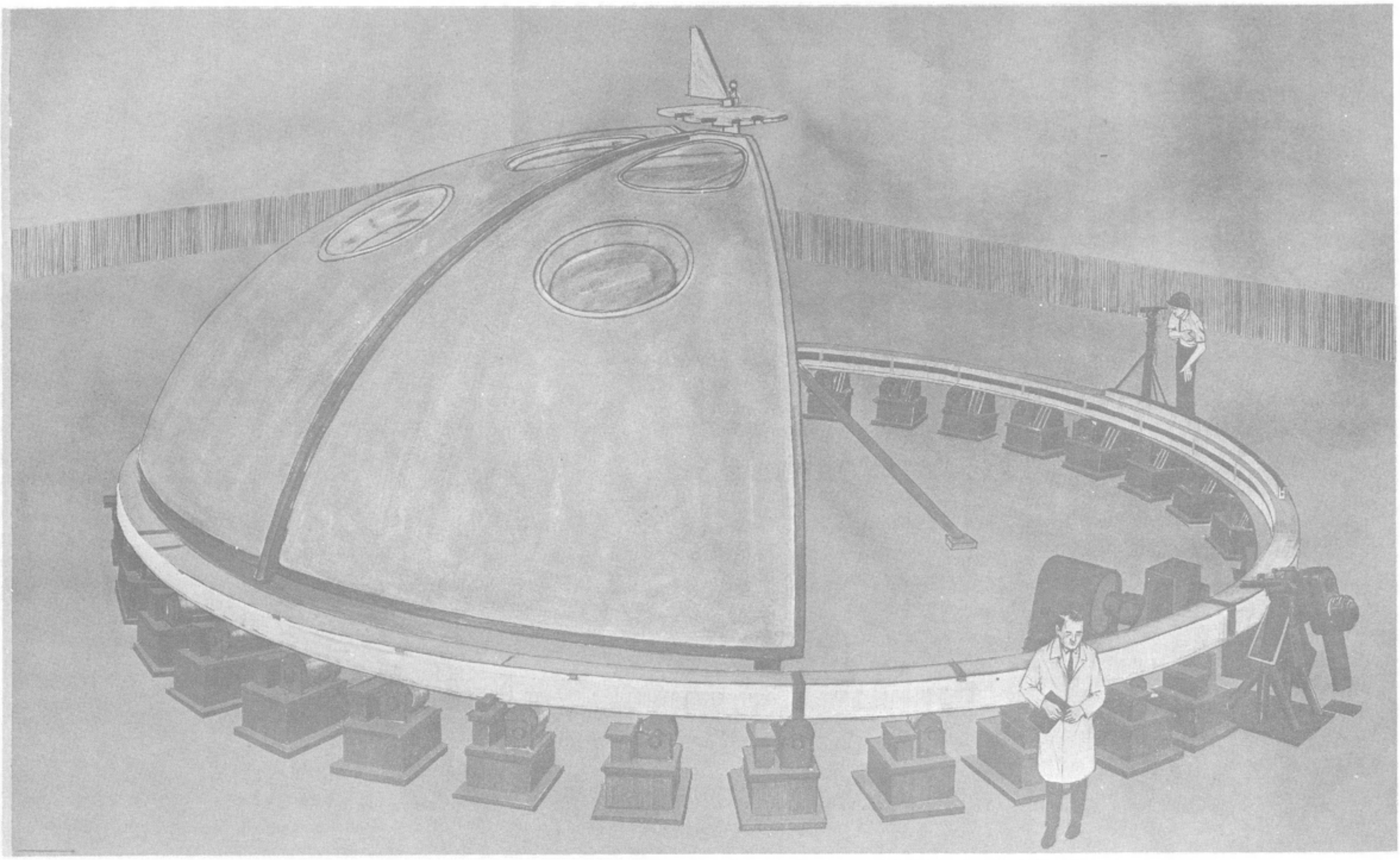
Using Organization - Manufacturing

Area - Not applicable

Milestones - Design Started --------- 1-1-63
Design Complete ------- 8-13-63
Construction Started ---- 12-21-63
Construction Complete -- 4-3-64

Contracts - In-house -- Design
63-53 -----Construction





SPECIAL TOOLING FOUNDATIONS

Function - Foundations must be provided for special tooling required in the assembly and manufacture of the S-IC booster and GSE/MSE.

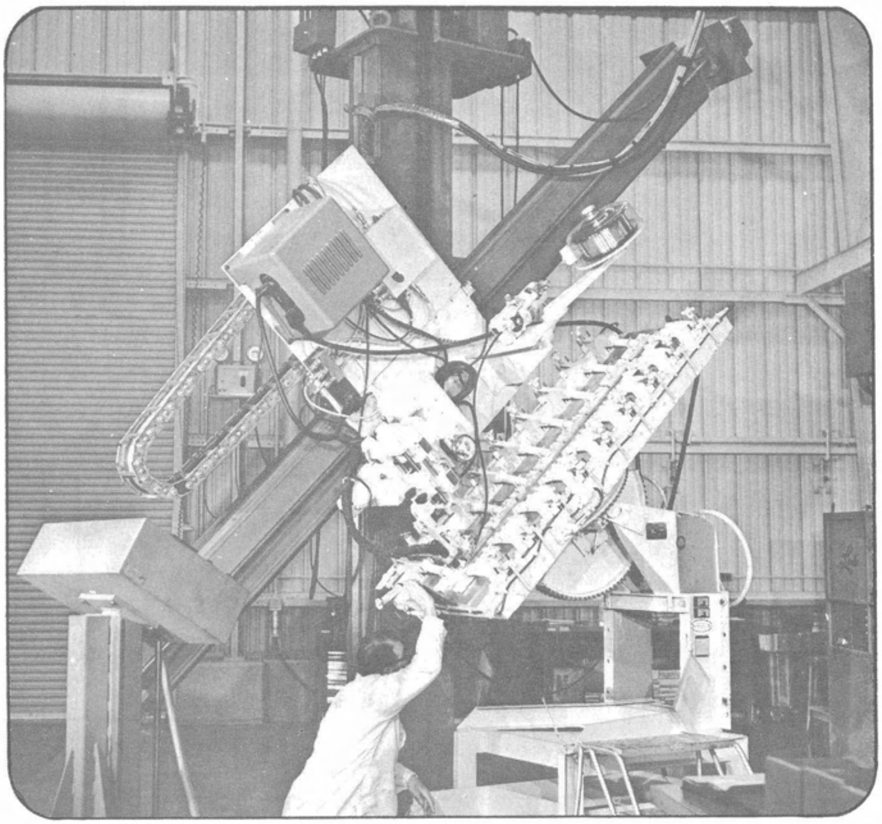
Using Organization - Manufacturing

Area - Not applicable

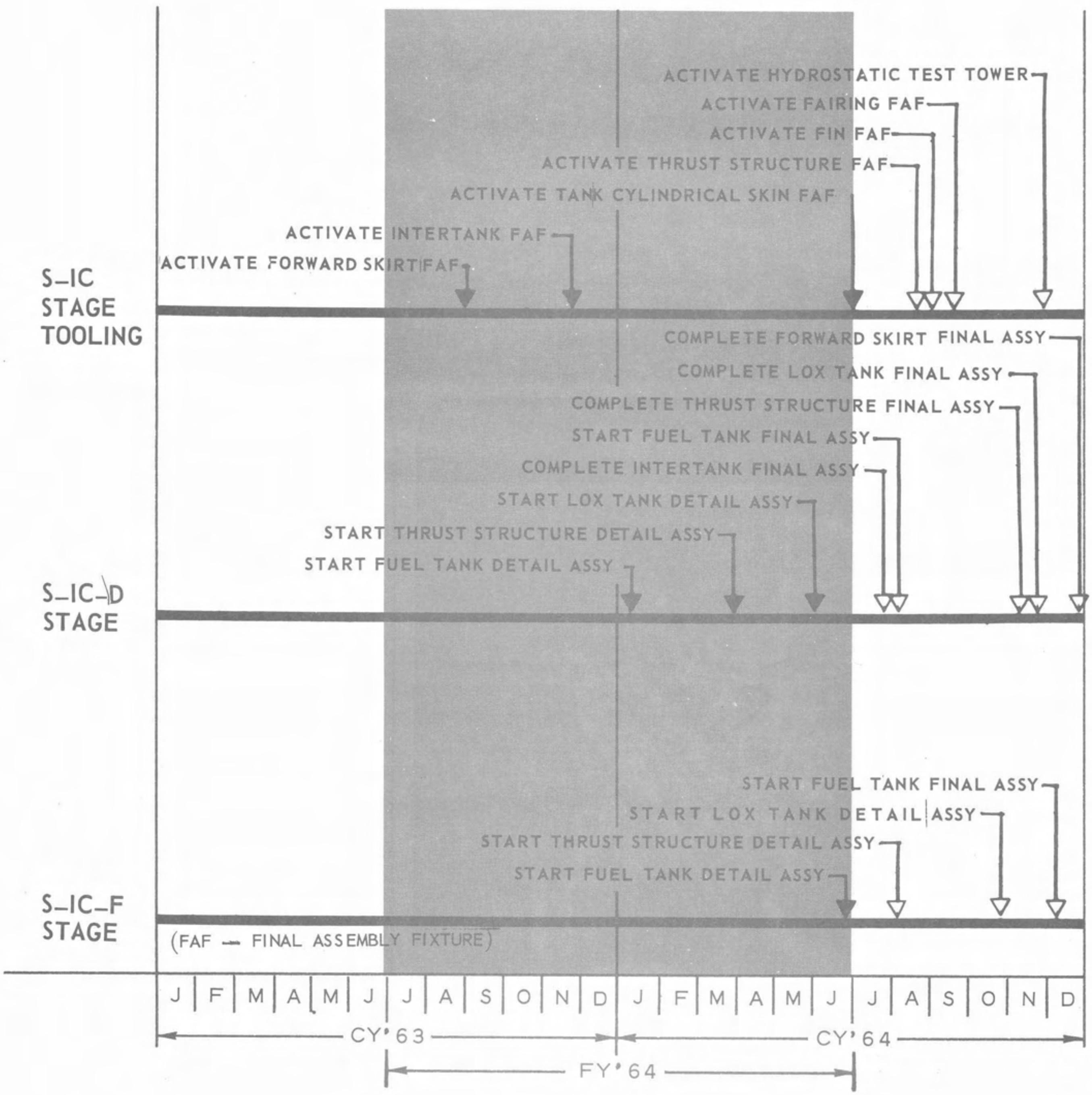
Milestones - Special Tooling Foundations Phases 5, 6, 7, and 8.

Phase 5 Started ---- 1963
Phase 5 Complete -- 9-27-63
Phase 6 Started ---- 1963
Phase 6 Complete -- 10-31-63
Phase 7 Started ---- 1963
Phase 7 Complete -- 2-29-64
Phase 8 Started ---- 1963
Phase 8 Complete -- 3-1-64

Contracts - 63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8



ASSEMBLY AND MANUFACTURING



ACTIVATE HYDROSTATIC TEST TOWER
ACTIVATE FAIRING FAF
ACTIVATE FIN FAF
ACTIVATE THRUST STRUCTURE FAF
ACTIVATE TANK CYLINDRICAL SKIN FAF
ACTIVATE INTERTANK FAF
ACTIVATE FORWARD SKIRT FAF
S-IC STAGE TOOLING
COMPLETE FORWARD SKIRT FINAL ASSY
COMPLETE LOX TANK FINAL ASSY
COMPLETE THRUST STRUCTURE FINAL ASSY
START FUEL TANK FINAL ASSY
COMPLETE INTERTANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-D STAGE
START FUEL TANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-F STAGE
(FAF — FINAL ASSEMBLY FIXTURE)
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

SUMMARY

S-IC stage assembly and manufacturing activity at the beginning of this reporting period was primarily oriented to structure component manufacture in support of the NASA/MSFC ground test program, and the fabrication and erection of stage tooling at Michoud. During the last three months of 1963, the scope of work was expanded to include increased procurement of stage systems specialty hardware, and components for test and checkout equipment. Ground support equipment (GSE) requirements for the NASA/MSFC ground test program were also defined during the same period, permitting Boeing to assess their capability to deliver equipment for R-Test and R-Qual laboratories at MSFC. By the end of June 1964, firm delivery dates were established for R-Test GSE, and the requirements were formally established for one set of test and checkout equipment to be installed at Mississippi Test Operations.

On January 22, 1964, the program schedule changed from NASA/MSFC Plan V to NASA/MSFC Plan VII. (See Part X of this report for a discussion of this change.) This changed The Boeing Company's responsibilities from providing the S-IC-F stage, and the S-IC-2 through S-IC-10 stages to providing the S-IC-D, the S-IC-F and the S-IC-3 through S-IC-10 stages. In conjunction with these program revisions, assembly and manufacturing activities were rephased to the new Plan VII schedule requirements. By the end of the first quarter of CY'64, Boeing had incorporated Plan VII schedules into its stage production schedules, established a GSE/MSE manufacturing program that supported the defined requirements of both MSFC and Michoud operations, and had made substantial progress in manufacturing development.

At the end of the first quarter of CY'64, delay of construction on the hydrostatic test facility for the Michoud vertical assembly building suggested a slippage in completion of the S-IC-D stage. However, by the end of the reporting period, the condition had been lessened and was no longer considered a problem affecting delivery of the S-IC-D. Other major problems during March 1964, were: indications of major rework to intertank tooling resulting from potential structural changes to intertank hardware; and incompatabilities between Boeing production requirements and delivery schedules proposed by NASA/MSFC for government-furnished F-1 engines, beginning with the S-IC-3 stage. The requirement for redesigned intertank hardware became firm in the second quarter of CY'64 and Boeing assembly and manufacturing schedules were adjusted to absorb two additional intertank assemblies, plus the necessary rework of the assembly tooling. Resolution of the NASA/MSFC-Boeing F-1 engine schedules was still being studied at the close of the reporting period.

At the end of June 1964, The Boeing Company's Contract NAS8-5608 assembly and manufacture activity included assembly operations on S-IC-D hardware and GSE/MSE for all locations. Minor behind-schedule conditions existed in several areas; however, recovery is predicted and all GSE/MSE and S-IC stages are forecast to be delivered per the NASA/MSFC Plan VII schedule requirements.

S-IC-D STAGE

The Boeing Company activity for the S-IC-D stage, Plan V requirements, was directed toward assisting NASA/MSFC in a role similar to that of the S-IC-T stage; namely, that of supplying NASA/MSFC specific assemblies, major components, and hardware items as required. NASA/MSFC Plan VII effected the realignment of The Boeing Company responsibilities to include assembly of the S-IC-D stage at the Michoud facility.

Under Plan VII, the S-IC-D stage is to be delivered to MSFC on August 20, 1965. Assembly and manufacturing activities were rephased to the new Plan VII requirements, and by the end of March 1964, Boeing had completed the incorporation of Plan VII into its production schedules.

Actual production of the S-IC-D stage was initiated during the third quarter of CY'63 with the fabrication of fuel-tank skin ring segments (Figure III-1). In November 1963, procurement activity started with the placing of purchase orders for long lead items. The first quarter of CY'64 was highlighted by an increase in component fabrication for the S-IC-D stage. By the end of the second quarter of 1964, components were available at Michoud for tank assembly. Fittings were being welded in bulkhead gore segments, and weld operations on the S-IC-D fuel tank skin rings were performed. Parts were available for the thrust structure and center-engine support structure (Figures III-2 and III-3), and were scheduled for assembly in the early part of July 1964.

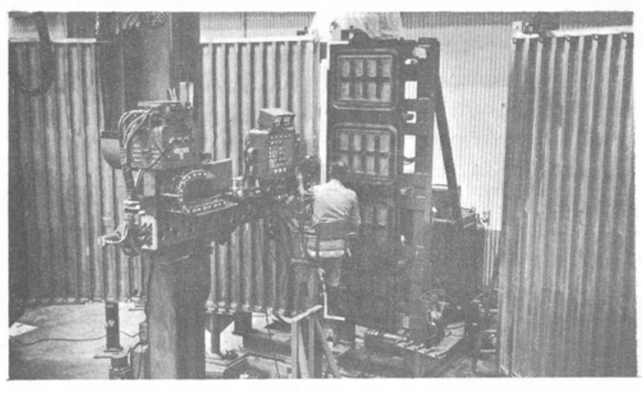


Figure III-1 - Boeing Technician Routing an S-IC-D Tank Skin Ring Segment Prior to Welding in the Environmentally Controlled Minor Assembly Area at Michoud

At the close of the first quarter of CY'64, construction of the hydrostatic test facility in the Michoud Vertical Assembly Building was being delayed. This con-

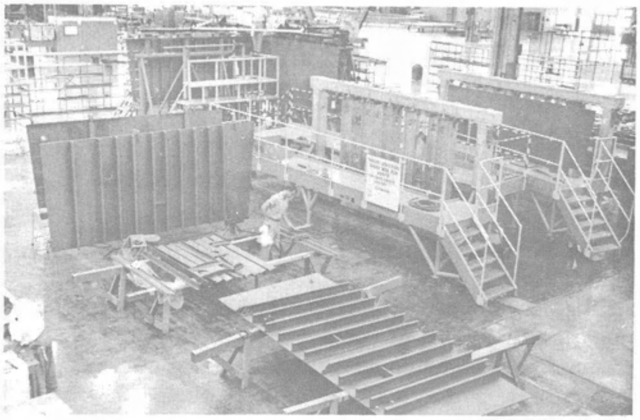


Figure III-2 - Shear Web Panels for the Center Engine Support Assembly (Background) are Being Completed at Michoud

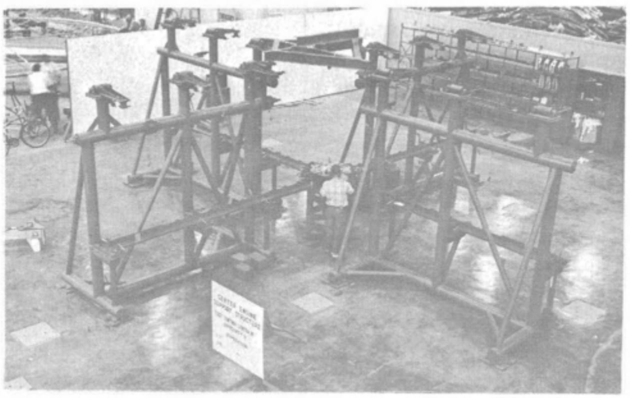


Figure III-3 - Assembly Fixture Used For the Center-Engine Support Nears Completion.

dition threatened completion schedules for the S-IC-D fuel and LOX tanks and resulted in a predicted late delivery of the S-IC-D stage. Close cooperation between NASA/MSFC and Boeing in resolving funding problems allowed Phase II vertical assembly building construction to proceed in April 1964. Although a 17-day behind schedule condition still exists on this construction, the use of work around methods has alleviated this condition and hydrostatic testing is no longer considered a major problem area. Construction progress at this time is shown in Figures III-4 and -5.

As a result of findings derived from tests conducted on a scale model intertank during the early months of 1964, a second problem was discovered. Failure of the scale-model intertank under some loading conditions suggested certain modifications to the intertank structural hardware, which in turn required modification of the intertank assembly tooling. At first, this indicated that the S-IC-D intertank assembly schedule would be adversely affected. Subsequent studies on intertank assembly fixture loadings indicated that both the hardware and tooling could be modified without impairing S-IC-D intertank completion schedules.

At the close of the reporting period Boeing activity in support of the S-IC-D stage was generally supporting NASA/MSFC Plan VII schedules. Delivery of the S-IC-D stage to MSFC on August 20, 1965, is currently expected to occur on schedule.

S-IC-F STAGE

At the outset of the reporting period, Boeing emphasis on the S-IC-F stage was centered on stage tooling design and fabrication requirements. Boeing had completed approximately 60 percent of the tool design and 35 percent of the tool fabrication for the total S-IC-F stage requirements by the end of September 1963.

Working to Plan V schedules, Boeing began fabricating S-IC-F detail parts at Boeing/Wichita, during the fourth quarter of CY'63. Assembly operations were then due to start at Michoud during the first quarter of CY'64. However, when NASA/MSFC Plan VII schedules became effective in January 1964, a revision of S-IC-F stage production schedules was necessary to meet a new NASA/MSFC on-dock delivery date, January 21, 1966, to the Merritt Island Launch Area. Under the new schedule requirements, major assembly activities are to start at Michoud in August 1964. Component fabrication is on schedule in support of this assembly requirement, and the S-IC-F stage is forecast to be completed on schedule.

S-IC-3

Michoud assembly activities in support of the S-IC-3 stage are scheduled to start late in the fourth quarter of CY'64. Plan VII requires delivery of this stage to Mississippi Test Operations on August 1, 1966, for static

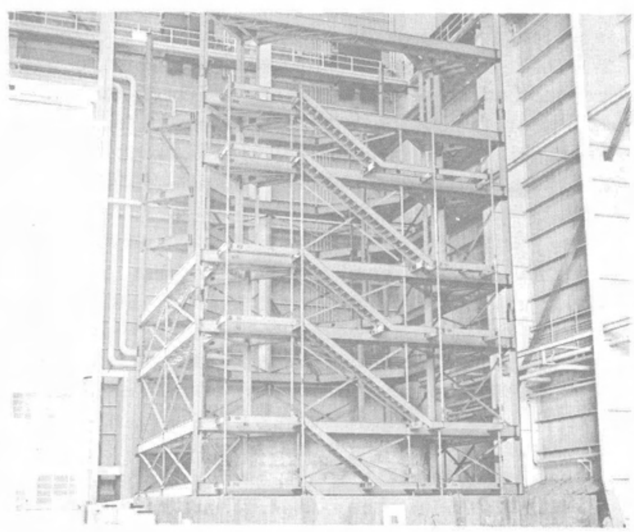


Figure III-4 - Construction Progress on the Hydrostatic Test Tower in the Vertical Assembly Building at Michoud

testing. Following this, the stage is to be returned to Michoud for refurbishment, checkout, and eventual delivery to MILA on February 21, 1967.

Hardware orders for the S-IC-3 were released during the fourth quarter of CY'63, and by the end of the first quarter of CY'64 the fabrication of detail components was underway. By the close of the reporting period, approximately 90 percent of the known structural hardware components had been placed on order.

The only item of concern relative to the S-IC-3 stage is the availability of F-1 engines from Rocketdyne. During the first quarter of CY'64, it became apparent that the NASA/MSFC proposed availability dates of these government furnished engines were not compatible with Boeing engine buildup schedules in support of the S-IC-3 stage assembly. This is currently under study by both NASA/MSFC and Boeing. Although progress is being made, the problem has not been completely resolved. It is anticipated that a satisfactory solution will be effected by either acceleration of engine deliveries to Michoud or the authorization of workaround techniques, so that the Plan VII schedules for delivery of the S-IC-3 stage will be met.

S-IC STAGE TOOLING

Fabrication and erection of tooling for Michoud started during the early months of 1963 and continued through the reporting period. Significant tooling activated during the fiscal year were the intertank, forward skirt, and thrust structure final assembly positions (Figures III-6, III-7, and III-8) along with the necessary supporting subassembly and minor assembly tooling. The LOX and fuel-tank minor assembly tooling, used to assemble bulkheads and cylindrical tank skins (Figure III-9), was certified for the assembly of production hardware. By the end of the reporting period, tank tooling was being installed in the tank final assembly area in the Michoud Vertical Assembly Building.

The change from NASA/MSFC Plan V to Plan VII in January caused considerable adjustments to Boeing tool loading schedules. These adjustments were incorporated into the Boeing schedules by the end of March 1964. During the second quarter of CY'64, it was necessary to further realign tool loading for both the intertank and thrust-structure assemblies.

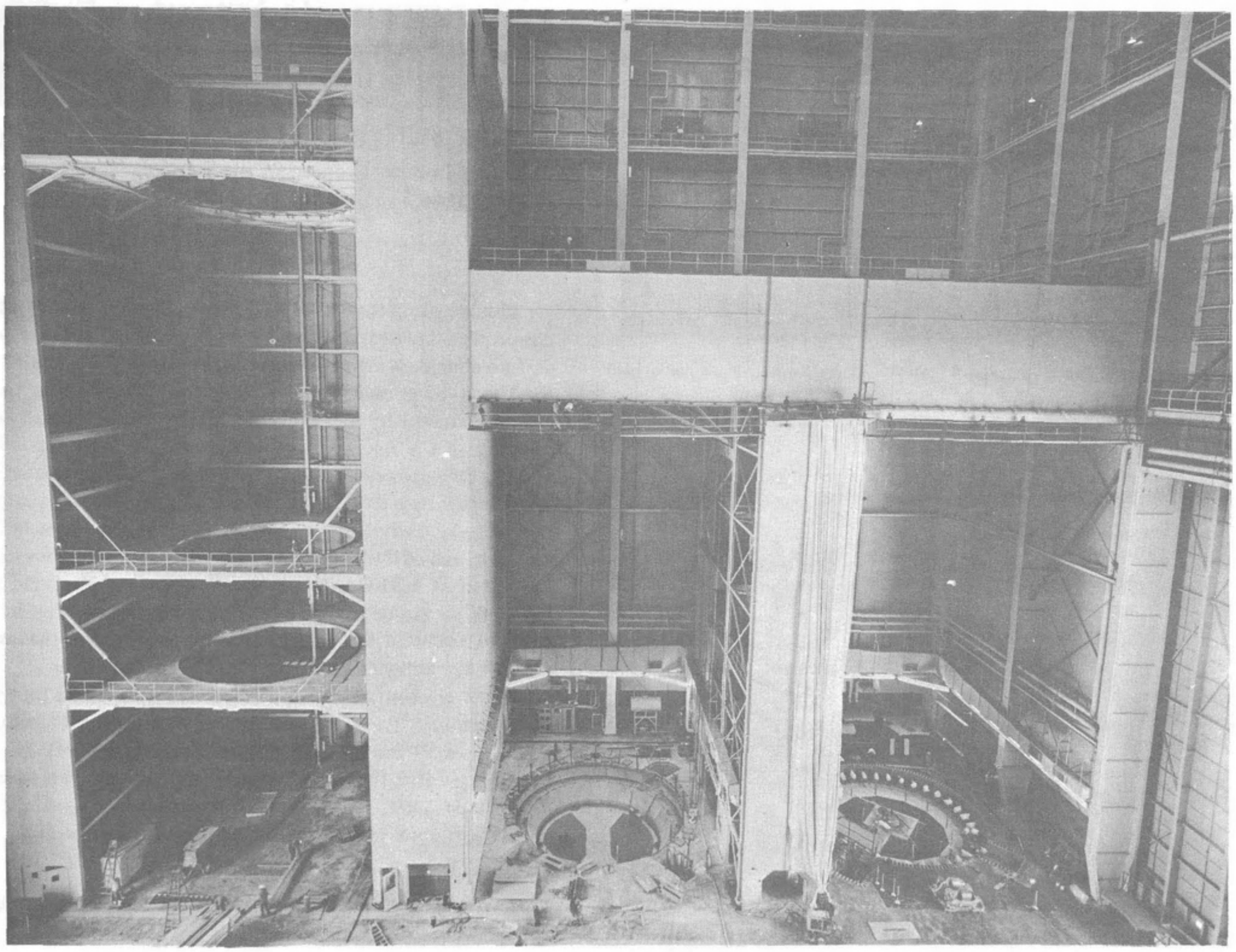


Figure III-5 - Construction Progress on the Vertical Assembly Installations in the Vertical Assembly Building at Michoud.

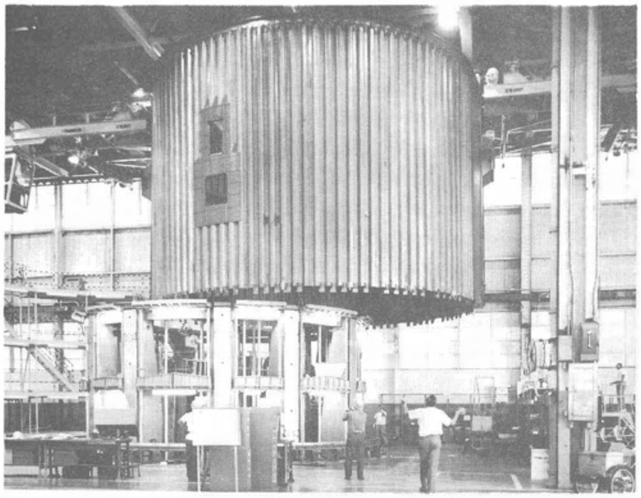


Figure III-6 - Two Overhead Cranes Swing Away the Completed S-IC-S (1) Intertank Assembly at Michoud. The Upper Structure of the Fixture was Removed to Facilitate the Removal.

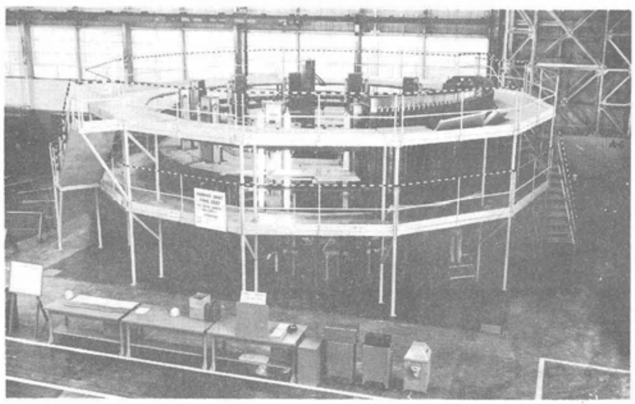


Figure III-7 - Forward Skirt Final Assembly Fixture with S-IC-S Skin Panels

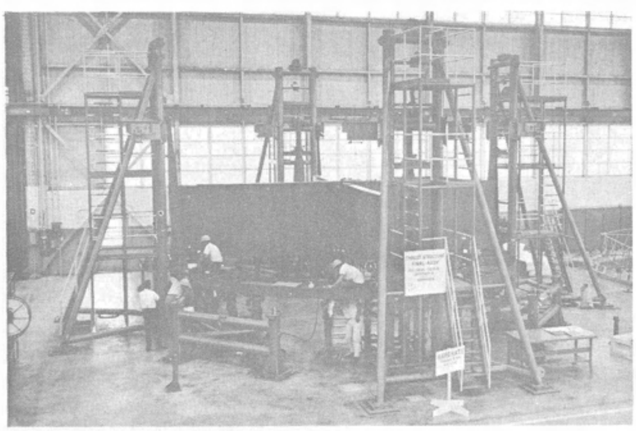


Figure III-8 - First Loading Operation of the No. 1 Thrust-Structure Final Assembly Fixture at Michoud. Lower Thrust Ring, Hold-Down Posts, and Center Engine Support Assemblies are seen Positioned in Fixture

The rearrangement of loading for the intertank resulted from the requirement for two additional intertanks for the S-IC-S stage. These additional intertanks were introduced as a result of engineering recommendations following tests conducted on a scale model intertank. The schedule has been adjusted to allow assembly of the additional intertanks and modification to the intertank tooling. Modification will occur during the third quarter of CY'64, and will not impair Boeing's ability to meet delivery commitments supporting the Plan VII schedule.

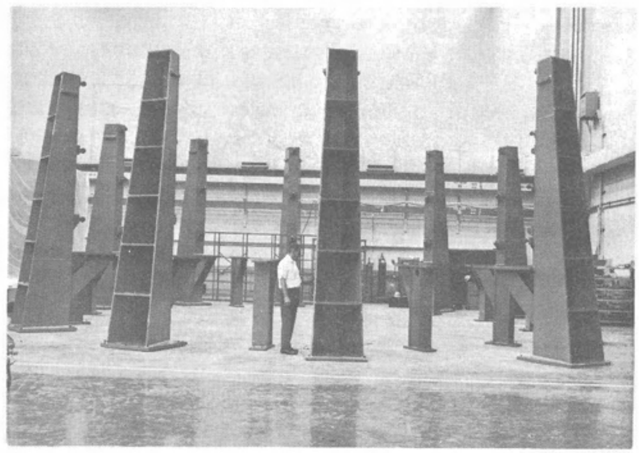


Figure III-9 - Tool Erection of a Tank Cylindrical Skin Assembly Fixture Located in the Environmentally-Controlled Bulkhead Subassembly Area at Michoud

Thrust structure tool erection (Figure III-10) at Michoud was accelerated and tool loading schedules amended so that S-IC thrust structures could be assembled for the S-IC-S and follow-on stages. This was a major change caused by a NASA/MSFC decision, in the second quarter of CY'64, to stop assembling thrust structures at MSFC/Huntsville and transfer both the responsibility and the tooling to Boeing/Michoud for assembly of the S-IC-S, -1, and -2 stage thrust structures from MSFC. At the close of the reporting period, the tooling previously installed at MSFC was being relocated at Michoud while the S-IC-S stage thrust-structure hardware was being used to activate the initial assembly position that was a part of the original tooling plan.

Work is continuing on the tooling still remaining to be activated. Tank assembly will be started in August 1964, as will the fin and fairing (Figure III-11) tooling.

Hydrostatic test will be activated late in the fourth quarter of 1964, and assembly of the S-IC-D stage will activate the vertical assembly position in January 1965.

MANUFACTURING DEVELOPMENT

Manufacturing development effort was moved from

the interim location to the permanent Manufacturing Development Laboratory facility in December 1963. The manufacturing development effort is oriented along: (1) weld development, weld equipment checkout and certification; and (2) process and production technique development and certification. Particular emphasis has been placed in the development of chemical milling production techniques.

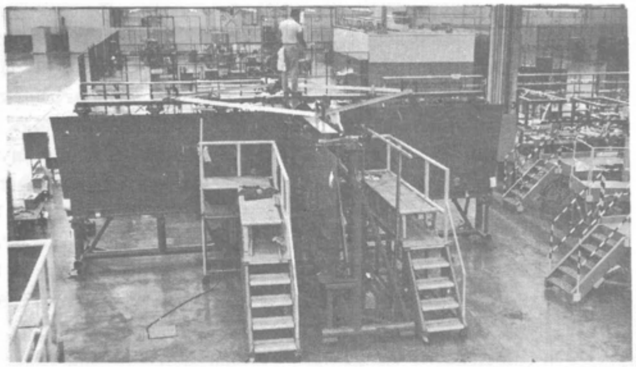


Figure III-10 - Center Engine Support Assembly Fixture at Michoud Showing Shear Web Subassemblies Loaded in the Fixture

Figure III-11 - Engine Fairing Tooling at Michoud

The completion of weld certification activity on bulkhead fitting welds, apex-to-base welds, and actuator supports are typical of weld certification efforts during the period.

Weld development activity (Figures III-12 through III-17) has continued at a high rate in areas such as inert-gas-shielded tungsten-arc (TIG) spot welding, oscillated inert-gas-shielded metal (MIG) arc welding, weld planishing and gore-to-gore welding.

Completing the chemical cleaning and finish process facility in the first quarter of CY'64 allowed process certification to be completed in all operations of the aluminum cleaning and conversion coating line except conversion coating, during March 1964. Certification of conversion coating application was completed in April.

Process and production technique development acti-

Figure III-12 - Shrink Fitting--Temperature Inspection During Freezing of Bulkhead Fitting Prior to Welding Operation

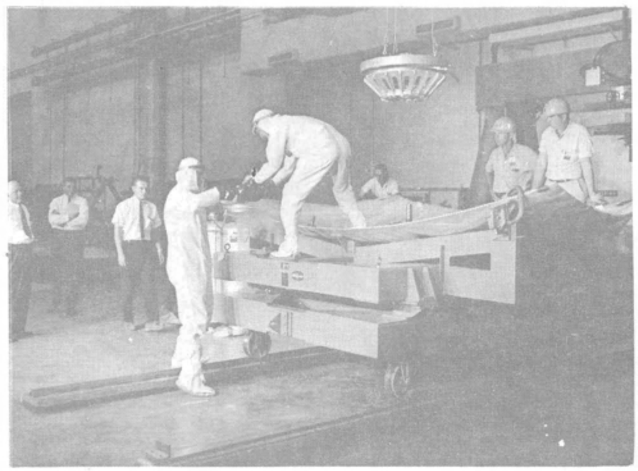


Figure III-13 - Shrink Fitting--Frozen Bulkhead Fitting Being Positioned for Welding to Gore Base

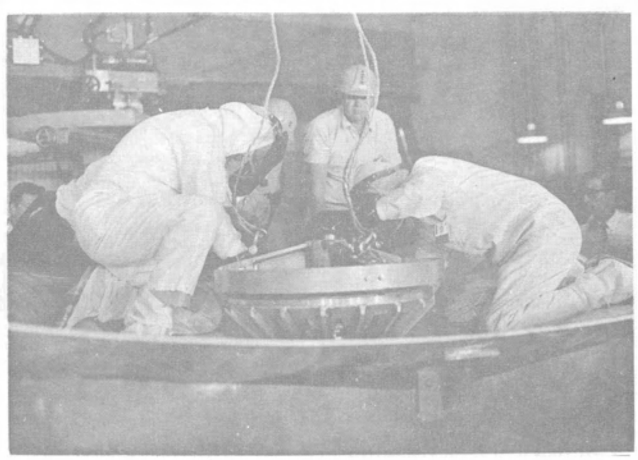


Figure III-14 - Shrink Fitting--Technicians Clamping Frozen Fitting into Place for Welding to Gore Base

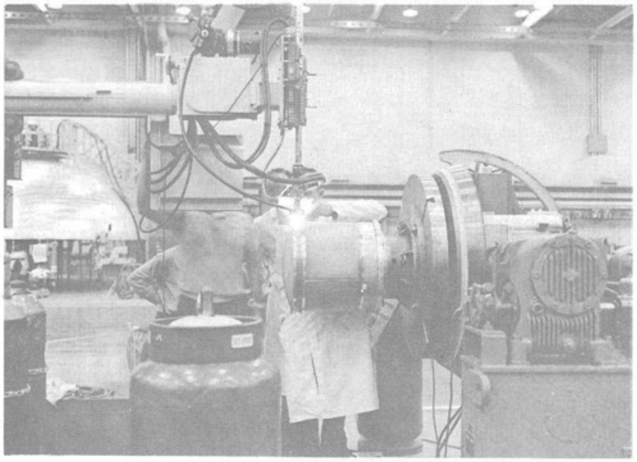


Figure III-15 - Technicians Perform a Weld Operation on a Helium Distributor, in the Bulkhead Minor Assembly Area at Michoud

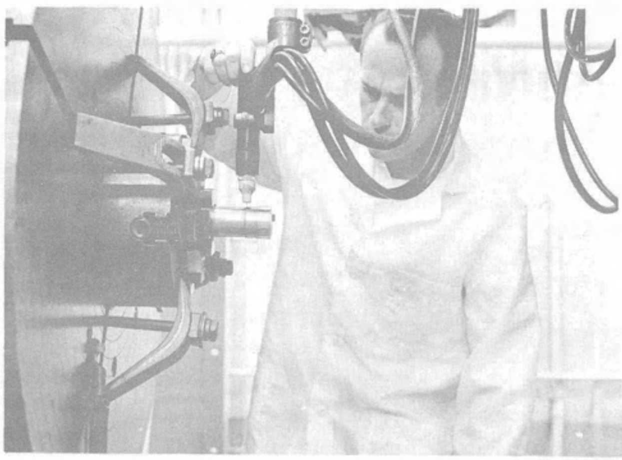


Figure III-16 - A Test Weld Set-Up on Weld Lathe in the Manufacturing Developmental Laboratory at Michoud

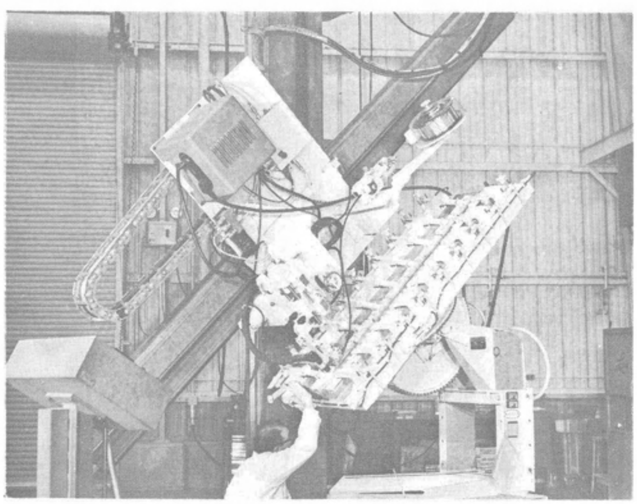


Figure III-17 - Technician Runs Weld Tests Using Inert Gas Process in the Manufacturing Development Laboratories at Michoud

vity was in evidence in such areas as mold dies, thermocouple welding, and stage wiring identification.

The establishment of sufficient chemical milling capability to support program schedules and reliability requirements has accounted for a considerable degree of activity in combined efforts between NASA/MSFC and Boeing. Chemical milling problems have been attributed basically to non-uniform chemical milling etch rates peculiar to 2219-T37 aluminum.

Chemical milling conferences have been held throughout the reporting period with NASA/MSFC, Boeing, prime aluminum fabricators, and nearly all present and potential chemical milling suppliers being represented. Techniques and courses of action to resolve this problem are being discussed and decided upon at these meetings. To date the non-uniform etch-rate problem is being investigated along two lines: (1) improvement of metallurgical homogeneity; and (2) development of a chemical milling etch not sensitive to metallurgical inconsistencies.

Additional developmental effort was expended in the investigation of ram flaring techniques, bonding adhesive, and machining and fastener applications.

In the area of weight reduction, a manufacturing process for pocket milling T-sections in machined Y-rings was under development as part of a 5000-pound-per-vehicle weight reduction proposal.

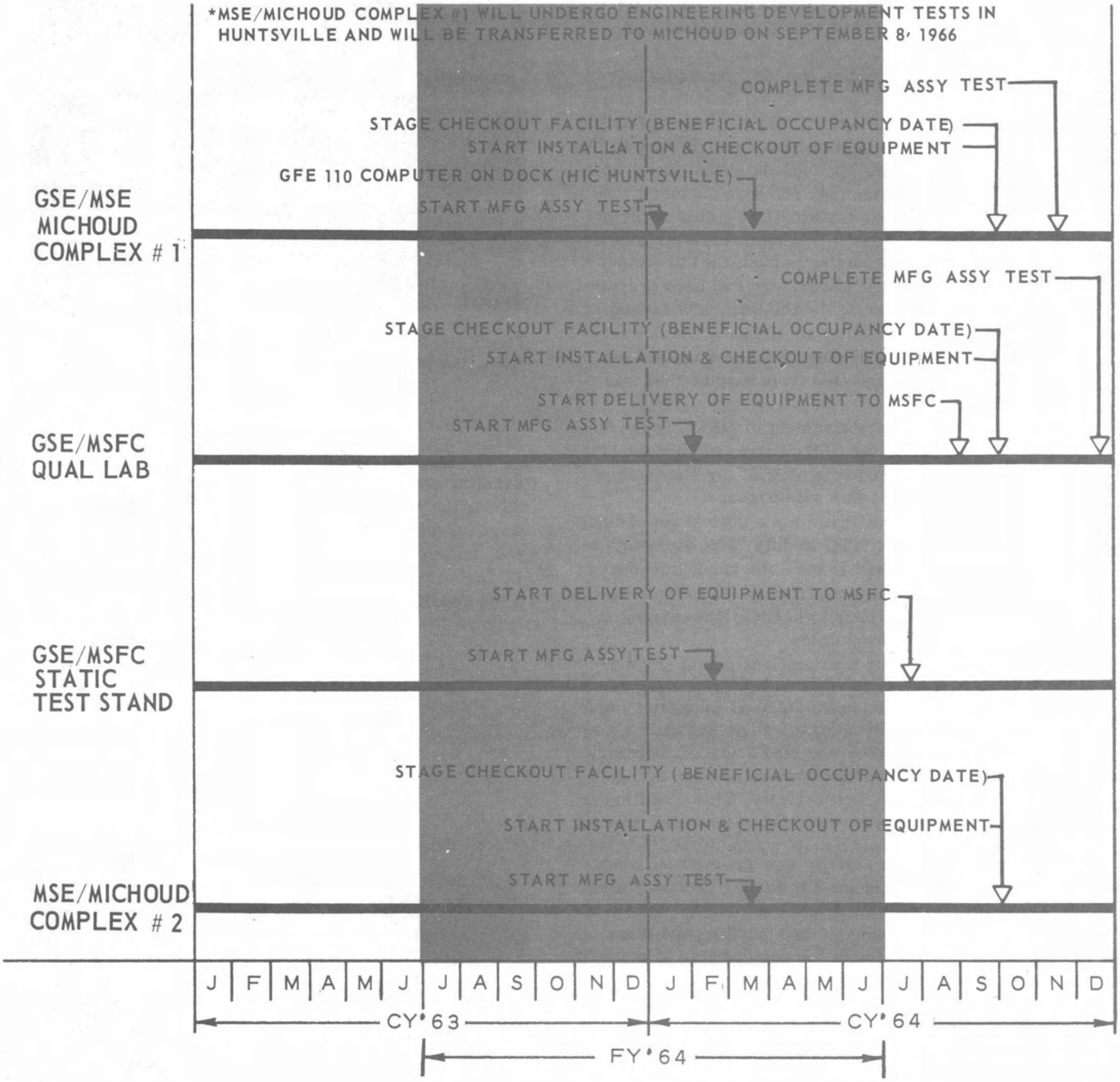
Extensive coordination between The Boeing Company and the Parsons Corporation of Traverse City, Michigan, was conducted to eliminate problems encountered in manufacturing the one-piece LOX tunnel assemblies.

Two major process modifications in the second quarter of 1964 resulted in manhour savings and increased reliability:

1) Conversion Coating Plan for Bulkhead Assemblies--the conversion coating of detail parts was changed to conversion coating of the entire bulkhead by use of the major component cleaning facility. This procedure eliminated the manhours previously required for stripping conversion coating prior to each welding operation;
2) Electrical Conductive Coatings--the process call-out on ground support equipment drawings was changed from abrasive cleaning prior to conversion coating to less costly chemical cleaning, resulting in increased reliability.

GSE/MSE

Fabrication of GSE items was hampered during the third quarter of CY'63, pending the result of deliberations between NASA/MSFC and Boeing on GSE Pre-Phase I submittals. Subsequent to these discussions in the following quarter, NASA/MSFC issued authorization to proceed. The agreement on the definition of the functional and physical characteristics of the equipment involved, allowed Boeing to establish delivery capability through an assessment of the required manpower and workloads. As a result of this assessment, Boeing was predicting ability of meeting delivery requirements on


*MSE/MICHOUD COMPLEX #1 WILL UNDERGO ENGINEERING DEVELOPMENT TESTS IN HUNTSVILLE AND WILL BE TRANSFERRED TO MICHOUD ON SEPTEMBER 8, 1966
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
GFE 110 COMPUTER ON DOCK (HIC HUNTSVILLE)
START MFG ASSY TEST
GSE/MSE MICHOUD COMPLEX # 1
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
GSE/MSFC QUAL LAB
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
GSE/MSFC STATIC TEST STAND
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START MFG ASSY TEST
MSE/MICHOUD COMPLEX # 2
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

the R-Qual Laboratory set by the end of the fourth quarter of CY'63; however, delivery of several items of the Test Division GSE were predicted to be later than required. During the fourth quarter of CY'63, fabrication of subassembly and parts test equipment was initiated. Modification No. 67 to Contract NAS8-5608, which effected NASA/MSFC Plan VII Schedule, called for the simultaneous installation of test and checkout equipment at both the MSFC Quality Laboratory and at Michoud. Since Modification No. 53, providing test and checkout equipment to the MSFC Test Laboratory, was being negotiated in April 1964, it was not possible to determine the full effect on manufacturing capability or schedule adherence. The outlook at that time, however, indicated that assembly and manufacturing activity in support of both modifications would occur at the same time.

By the end of the reporting period, the list of equipment for the MSFC Test Laboratory had been prepared, on-dock date requirements established, and Boeing Company delivery capability confirmed. The delivery of this equipment, finally negotiated as Modification No. 106, will span the period from August 1964 into October 1965.

In addition to the establishment of MSFC Test Laboratory requirements for GSE, a firm requirement for the first of two proposed sets of MSE for Mississippi Test Operations (MTO) was authorized.

An anticipated requirement for a second set of equipment to be available at MTO in July 1966, along with an additional set at Michoud at the same time, introduces the necessity of obtaining contract go-ahead from NASA/MSFC early in the third quarter of 1964 if the equipment is to be available on those dates.

Four sets of test and checkout equipment (Figure III-18) were in work at the close of the reporting period. The equipment for the MSFC Test Laboratory and for the Michoud MSE Complex 2 was on schedule. Assembly and manufacture of the MSFC Qual Laboratory and Michoud MSE Complex 1 equipment were 3 and 6 weeks behind schedule, respectively. This condition is expected to be alleviated by the end of the third quarter of 1964.

Concurrent with the activity in support of the stage test and checkout equipment The Boeing Company also was assembling subsystems test equipment, subassembly and parts test equipment, and handling and transportation equipment. Due to the requirement to perform testing on specialty hardware items for the S-IC-T, it was necessary to activate interim test facilities. At the close of the reporting period the construction of the permanent test facility was not complete; however, the continued use of the interim facility provided the testing required to support S-IC-T schedules.

Twenty-one stations, composed of subassembly and parts test equipment, were scheduled for activation by the end of the reporting period. Only three permanent stations and four of an interim nature were activated at that time, but testing schedules were supported with approved workaround equipment and procedures which will accommodate test activities until the qualified test stations become available.

Figure III-18 - GSE/MSE Drawer and Rack Assemblies Shown Nearing Completion and also Ready for Shipment

The forward handling ring was the major item of handling and transportation equipment to be in work during the reporting period. The first unit of the forward handling ring completed assembly and test, and was delivered to MSFC during the first quarter of 1964. By the end of the second quarter of 1964 a second forward handling ring had been delivered and a third unit (Figure III-19) was being assembled.

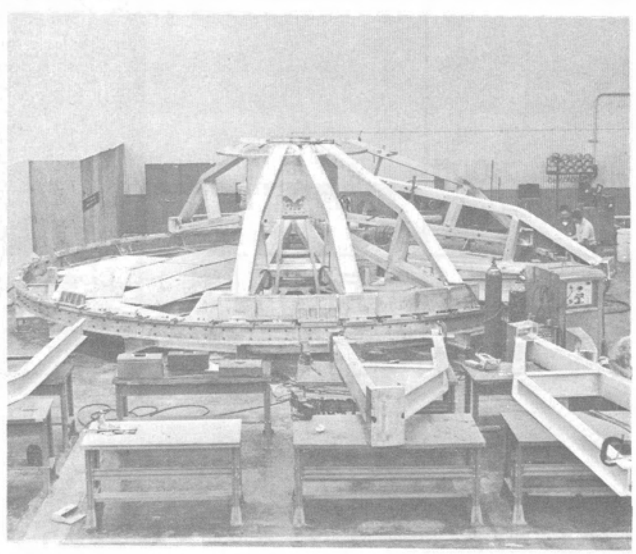
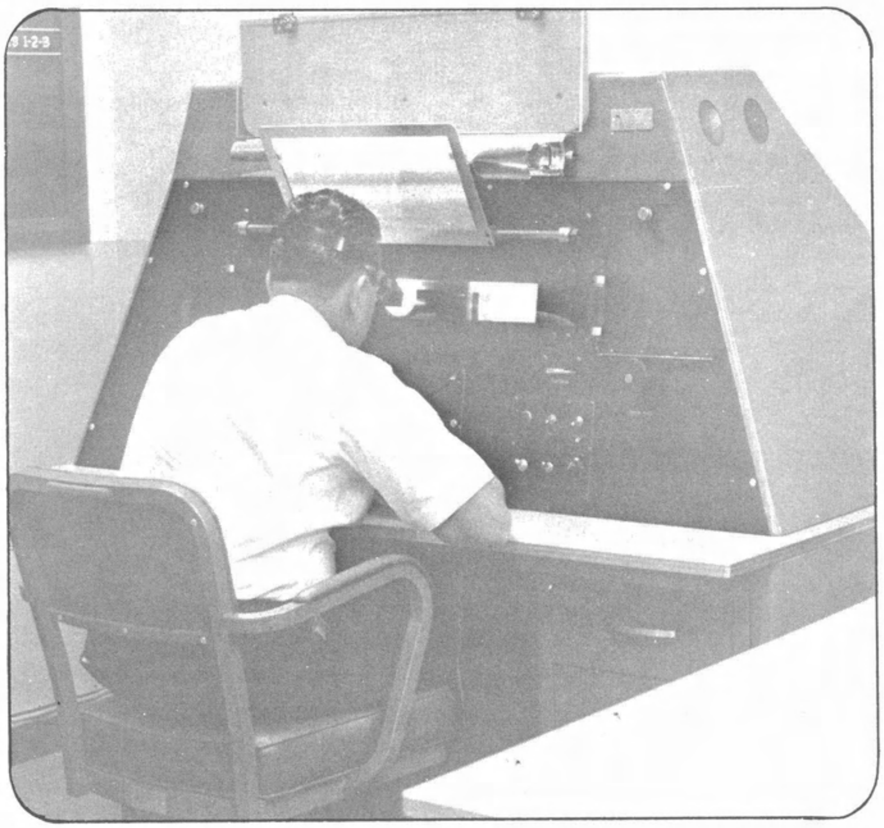


Figure III-19 - Tooling Mechanics Installing Radial Trusses on Third Forward Handling Ring Assembled at Michoud



QUALITY ASSURANCE

Fiscal year 1964 was characterized by significant progress in all basic functions of quality and reliability assurance. In July 1963, interim facilities were in use and numerous workaround measures were used to perform required tasks. Systems, procedures, and techniques were basically conceptual at the beginning of FY 64. By the year's end, they had become operational. Permanent facilities had been activated and refinements had been made in systems, procedures, and techniques as initial deliveries were accomplished on the S-IC-T vehicle components..

QUALITY ASSURANCE CAPABILITY

Significant progress was made during FY 64 in expanding inspection and test capabilities consistent with accelerating hardware schedules. During the early part of FY 64, interim facilities such as those shown in Figures IV-1 and IV-2 were still in use. In January 1964, final activation of the permanent Quality Evaluation Laboratories was initiated. Figure IV-3 shows the early construction of the laboratory and Figures IV-4 through IV-7 show the laboratory at the end of CY '63. Figure IV-8 shows the electrical and electronics area of the permanent Measurement Control Laboratory during initial activation in December 1963. At the close of CY 63, approximately 80 percent of all equipment required had been received. A view of the present laboratory is shown in Figure IV-9. Interim facilities

Figure IV-1 - Interim Quality Assurance Development Laboratory in Use at Michoud in Early FY 64

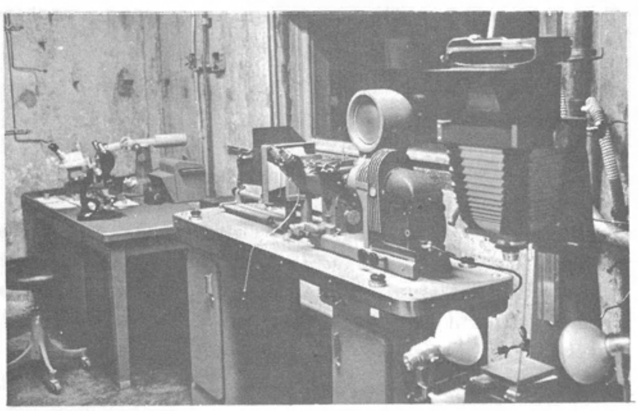


Figure IV-2 - Interior View of Interim Quality Assurance Development Laboratory Facility

Figure IV-3 - Construction Progress of Permanent Quality Evaluation Laboratories at Michoud

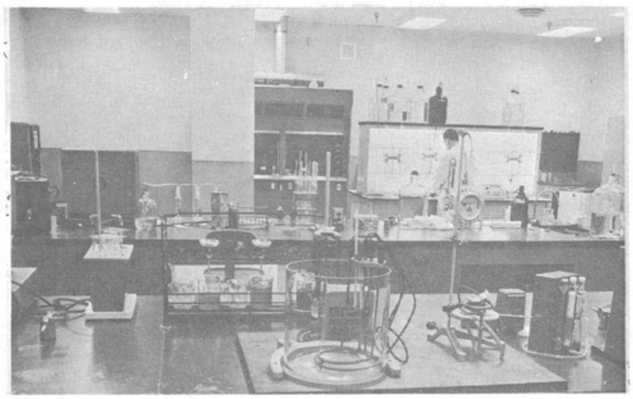


Figure IV-4 - Interior of the Permanent Quality Evaluation Laboratories at Michoud

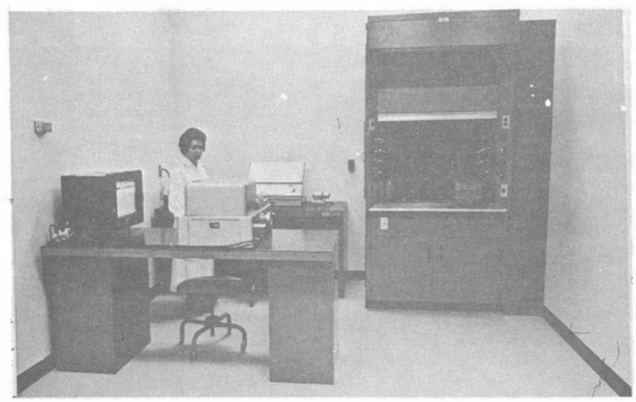


Figure IV-5 - Densitometer Used in Conjunction With Emission Spectrometer in Obtaining Qualitative and Quantitative Analyses of Inorganic Material

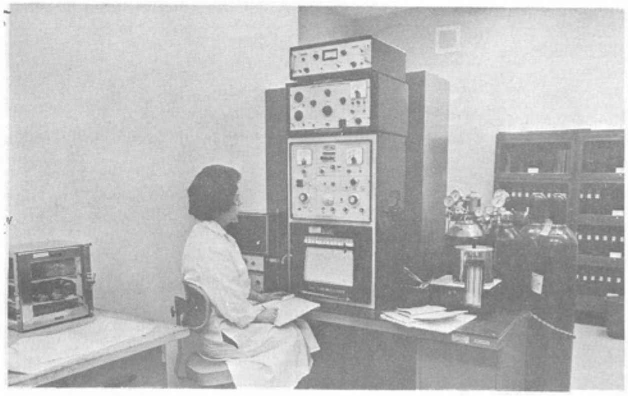


Figure IV-6 - Gas Chromatograph Used in Obtaining Quantitative Analysis of Organic Material

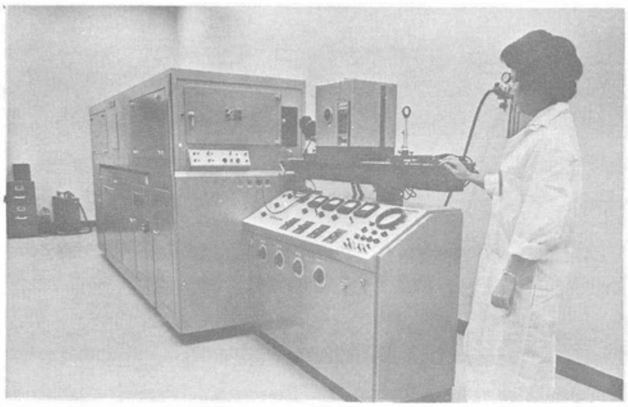


Figure IV-7 - Three-Meter Grating Spectrograph in Quality Evaluation Laboratory

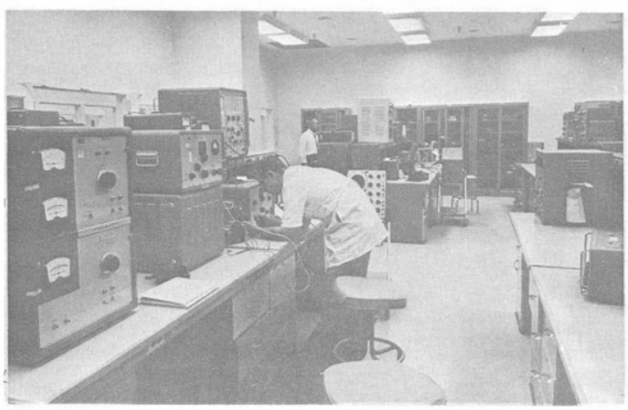


Figure IV-8 - Electrical/Electronics Area of Measurement Control Laboratories at Michoud

such as portable vans (Figure IV-10) that had represented primary capability had been replaced by permanent facilities at the close of CY 63. It is important to note, however, that many interim facilities will continue to be used on a secondary basis to supplement and enhance primary capability in permanent facilities. Following is a brief summary of notable progress:

Figure IV-9 - Pressure, Vacuum Flow, and Mass Area of Measurement Control Laboratories

CENTRAL RADIOGRAPHIC EVALUATION LAB

This laboratory was completed during the early part of FY'64 and its associated mechanized X-ray tooling was activated. In conjunction with mechanized X-ray tooling, this laboratory provides extensive inspection coverage of all stage weldments. It has automatic film processing and mechanized viewing capabilities, three detail inspection vaults, and ancillary processing equipment. At the end of the reporting period, the workload approximated 5,000 X-ray exposures per month. An increase to a peak load in excess of 10,000 feet of film per month is anticipated.

Items of inspection tooling and equipment were developed and activated during the fiscal year that substantially increased radiographic capabilities. Most noteworthy are the gore apex to gore base, bulkhead to Y-ring, polar cap, Y-ring dollies, LOX tunnel and skin ring tools, film paper stripper unit, film viewing console and status board, X-ray suspension system, 300 KV suspension system, 300 KV suspension X-ray machine, and 150 KV suspension X-ray anode machine.

QUALITY EVALUATION AND MEASUREMENT CONTROL LABORATORIES

Brick-and-mortar construction for permanent laboratory facilities was completed in December 1963, and initial activation followed. This acquisition allowed an orderly transition to the operational stage and paved the way for elimination of some workaround measures and retirement of interim facilities to a secondary status.

During the first half of FY '64, flow time for incoming material analysis was excessive because preparation equipment was not available. The transition to permanent facilities, accompanied by acquisition of equipment, enabled a reduction in flow time, and, in many instances, decreased manhour requirements. An example is the lathe (Figure IV-12) necessary for test specimen preparation. Prior to acquisition of this equipment, the Boeing Manufacturing organization assisted in the preparation of test specimens.

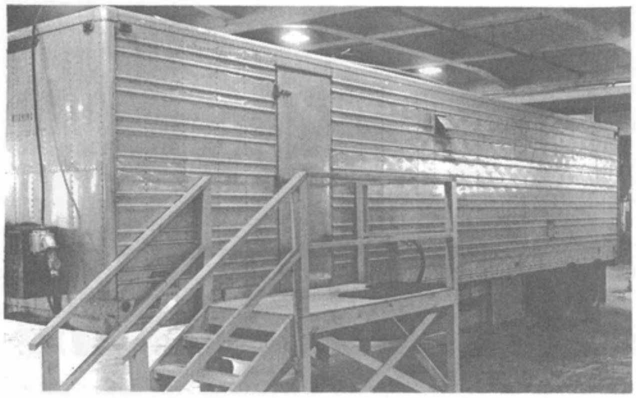


Figure IV-10 - Typical Interim Facility--Pyrometric Van

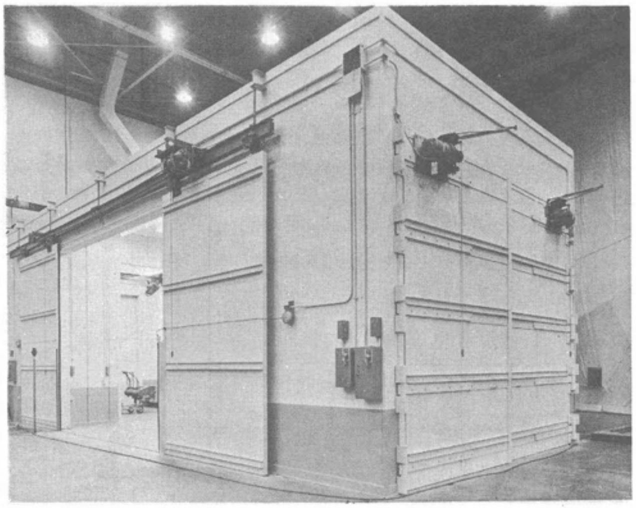


Figure IV-11 - Central Radiographic Evaluation Laboratory Activated in Early FY'64

In January 1964, workaround methods were required to support penetrant inspection of gore segments because the permanent Non-Destructive Test Laboratory was not completed. Portable spray equipment has been used. It is anticipated that automatic spray equipment will be installed early in FY '65.

A LOX impact test facility is being installed to enable appropriate test of components and is expected to be fully integrated during the first half of FY '65.

Capabilities in the Measurement Control Laboratory increased consistent with program demands. New equipment was added each month, and at the close of FY '64, was approximately 80 percent complete. Figure IV-13 shows the Optical Rotary Surface Plate and associated equipment, and the Optical Comparator.

The volume of activity in the Quality Evaluation and Measurement Control Laboratories experienced a significant increase. Orders increased from 1100 to 2900 per month during FY'64. Total orders for the year were about 25,600.

DIMENSIONAL INSPECTION

Dimensional inspection requirements for bulkheads, thrust structures, and intertank assemblies dictated the need for a 34-foot rotary turntable. During FY '64, an area was allocated and the foundation and plans for its installation were completed. At the close of FY '64 Boeing personnel were completing final checkout of the equipment at the vendor's plant.

The rotary turntable will be located in the factory area as shown in Figure IV-14. This turntable, the first

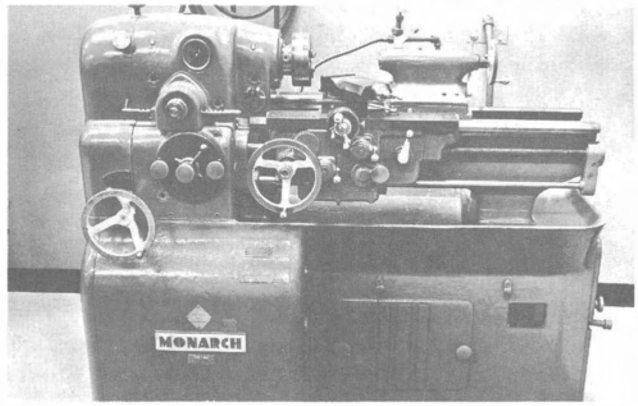


Figure IV-12 - Specimen Preparation Equipment--Monarch Lathe

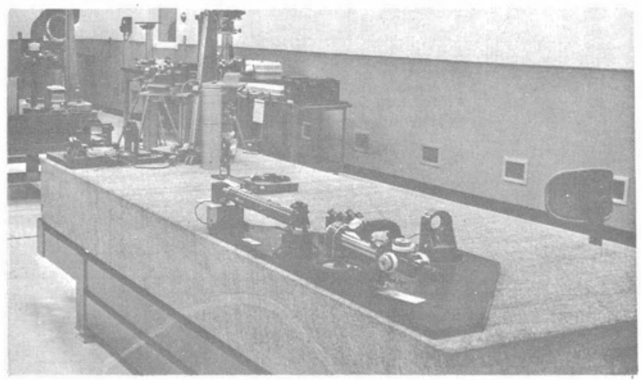


Figure IV-13 - Optical Rotary Table in Measurement Control Laboratories

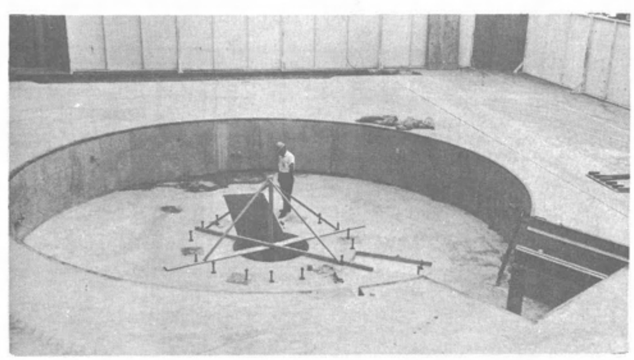


Figure IV-14 - Construction Work Area for 34-Foot Rotary Turntable

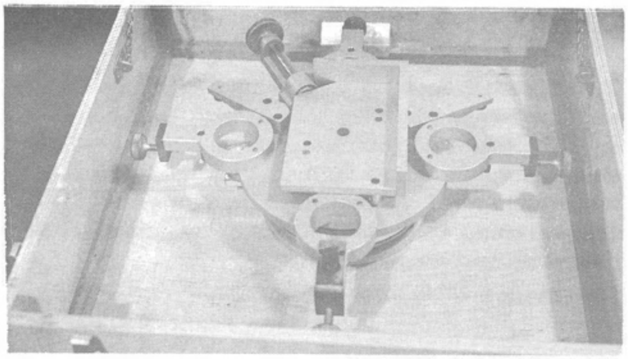


Figure IV-15 - Fitting Optical Target Used for Inspection of Fuel Suction Fittings

Figure IV-16 - Tooling Bars and Associated Optical Tooling Equipment in Use in Michoud Plant

unit of this size with design features necessary to perform precise optical dimensional measurements, will become an integral part of the in-process inspection plan.

Inspection capability for determining critical dimensions increased significantly during the fiscal year. The fitting optical target shown in Figure IV-15 was developed and placed in use. This equipment will be used in inspection of fuel suction fittings.

Tooling bars and associated optical tooling equipment (Figure IV-16) were placed in use during the reporting period.

Unavailability of sufficient tooling equipment during the early part of the FY required some workaround measures. However, at the close of FY'64, the required equipment had been obtained and in-process inspection was being accomplished as planned.

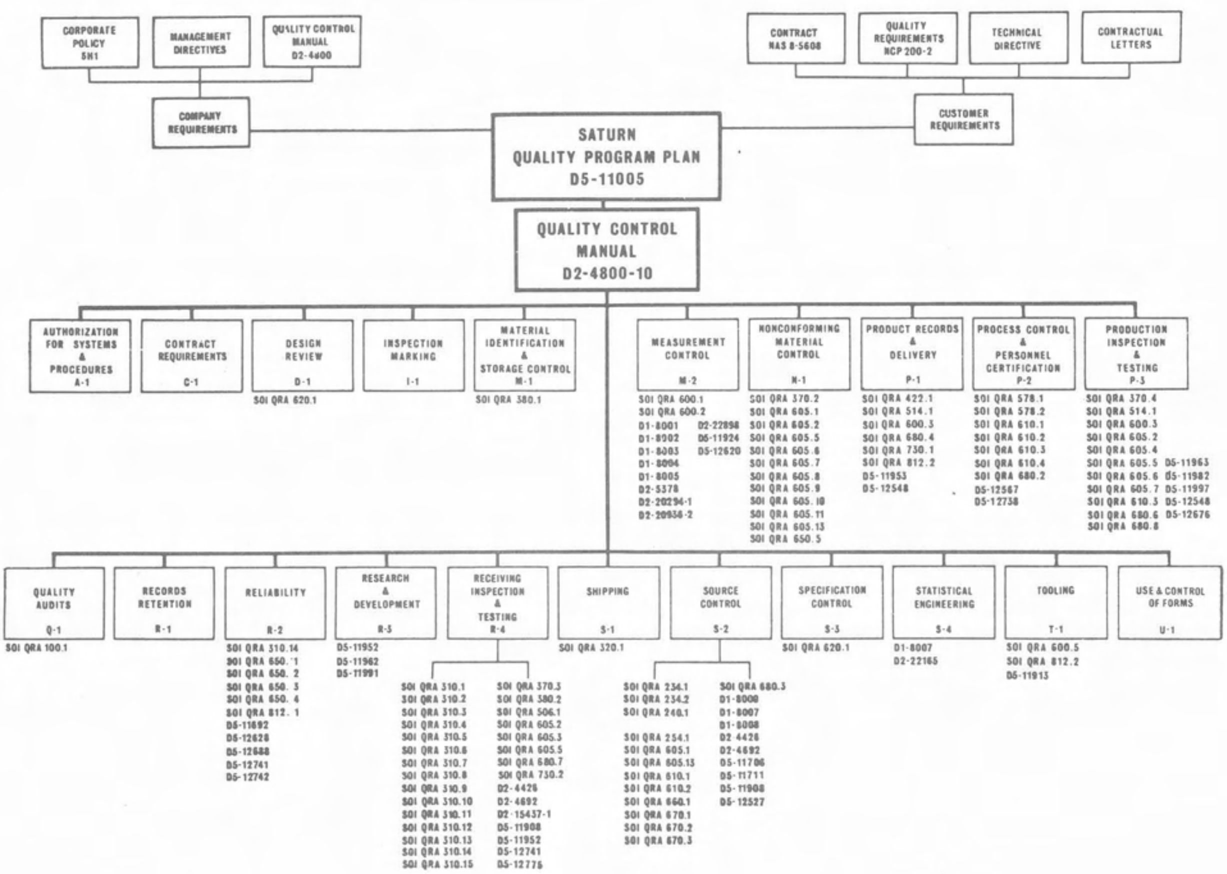


Figure IV-17 - Quality Assurance Program Documentation

QUALITY ASSURANCE SYSTEMS

Fiscal year 1964 saw the evolution of basic systems from a conceptual to an operational stage. Systems involving Quality Engineering, subcontractor control, in-process inspection, and audit reviews were analyzed and refined consistent with product integrity and program schedules.

QUALITY ENGINEERING

The volume of engineering releases increased significantly during FY 64. During the last quarter 4600 releases were reviewed to ensure compliance with NPC 200-2. Coordination with the Engineering organization improved communication of requirements, and, at the end of FY 64, more than 80 percent of the requests submitted had been accepted for incorporation.

Emphasis was placed on quality performance reporting during the year. A system for bi-weekly analysis of stage nonconformances was initiated. A report tabulating nonconformance in Receiving Inspection and major assembly areas is issued to appropriate management.

SUBCONTRACTOR CONTROL

In early July 1963, an interdivisional source control meeting was held to refine the corporate system and ensure full use of resources. As a result of this meeting, the Launch Systems Branch was assigned the responsibility for the survey and surveillance of processing facilities in the states of Alabama, Florida, Kentucky, Louisiana, Mississippi, South Carolina, Tennessee, and Texas.

Numerous surveys of supplier performance were conducted during the FY to ensure compliance with the requirements of NPC 200-3. A notable example was the visit of a combined NASA/MSFC and Boeing team to Los Angeles area suppliers during the latter part of FY 64. Major problems requiring immediate action were multiple inspection by government source inspectors, and misinterpretation of the cleaning requirements of NASA/MSFC Specification 164. Action items were assigned to both MSFC and Boeing personnel to resolve these problems.

The vendor rating system was refined during the FY. All experience is now integrated in the Boeing Aero-Space Division system, ensuring a more complete and

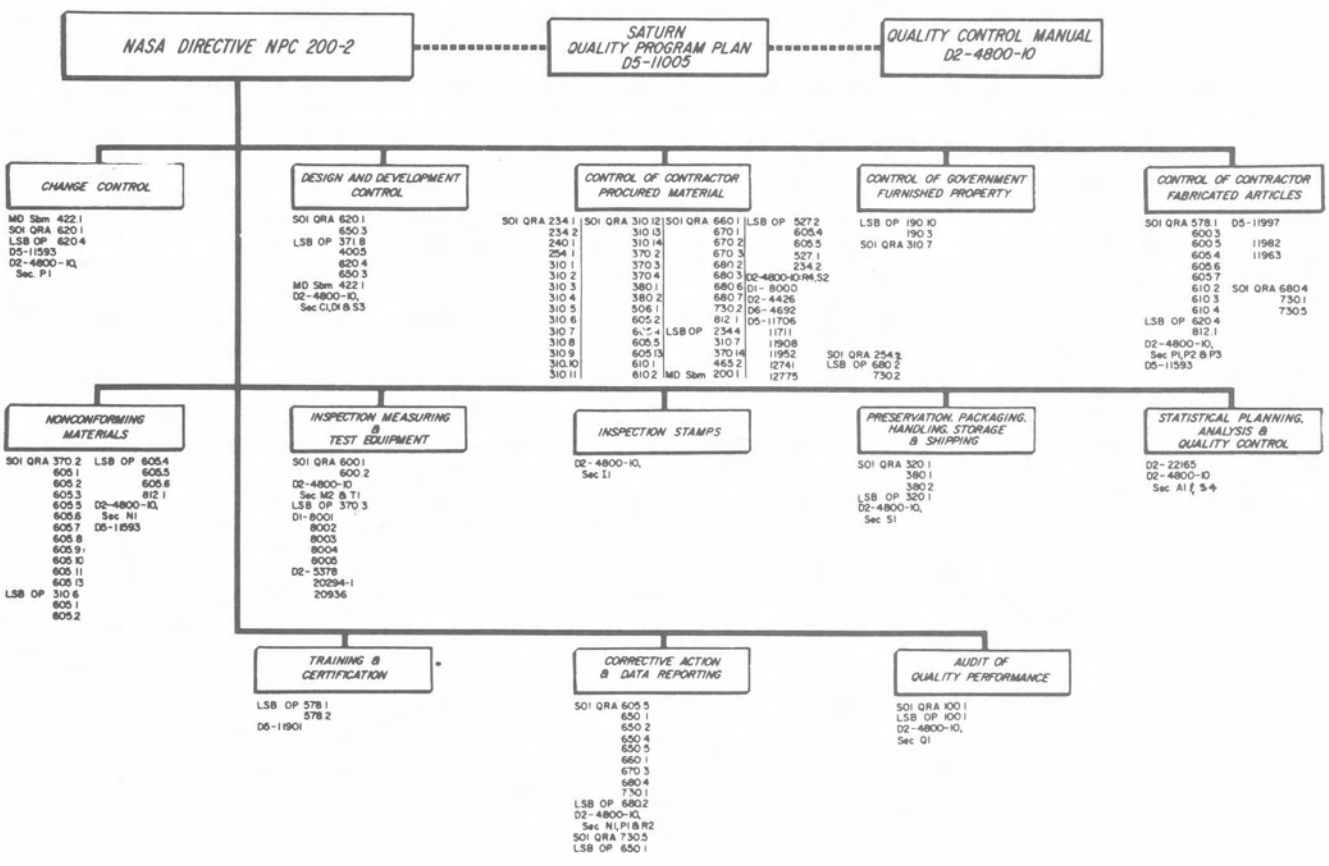


Figure IV-18 - Quality Program Documentation--NPC 200-2

accurate evaluation of all vendor performance data. This, in turn, assures validity of the acceptance sampling system.

During FY '64, 409 proposals involving 102 procurements were evaluated.

A vendor performance reporting system was initiated at Boeing/Huntsville and is being maintained on a current basis. The system is used for items delivered to MSFC and denotes any outstanding problem areas related to tooling items.

IN-PROCESS INSPECTION, TEST, AND DELIVERY

Emphasis of development and refinement of the In-Process inspection system, paced by initial deliveries of S-IC-T stage hardware, was increased during the FY'64. Special inspection processes involving fabrication and assembly operations were reviewed throughout the year.

Interim clean rooms for test inspection of small hydraulic pneumatic and electrical components were activated during the early part of the FY. The first electrical/electronic test inspections were also initiated.

Initial deliveries of hardware allowed refinement of the basic delivery system. Early in the reporting period, coordination with NASA/MSFC Technical Liaison and Contract Administration resulted in the reduction of delivery forms required to accompany stage hardware and tooling items shipped from Boeing/Wichita and Boeing/Seattle. A system to control nonconformance items shipped from outplant areas was also initiated.

QUALITY ASSURANCE TECHNIQUES

Consistent with the transition from a concept to an operational stage, notable progress was made in the development and application of inspection techniques during the year. Following is a brief summary of this progress:

PENETRANT INSPECTION

Considerable progress was made in developing and refining penetrant inspection techniques. A notable example is the extended use of portable spray equipment originally developed for penetrant inspection of Y-rings. This equipment is now being used to inspect gore segments, cylindrical skins, polar caps, and other miscellaneous parts.

OPTICAL TOOLING

The equipment acquisition phase of the Optical Tooling Program neared completion during the FY. Surface tables, tooling bars, alignment scopes and clinometers were obtained and placed in operation. This equipment and techniques were combined to establish an optical tooling program capable of meeting inspection requirements on assemblies completed to date.

RADIOGRAPHIC DEFECT LOCATION AND DEFINITION

Adaptations to mechanized X-ray equipment were accomplished to permit the same accurate three-dimensional location of weld defects as was obtained in manual X-ray systems. The capability was developed to apply this technique to such welds as apex to base, gore to gore and bulkhead to Y-ring.

DIMENSIONAL VERIFICATION

Inspection of large assemblies for dimensional verification was accomplished during the year on such items as a complete intertank, thrust structure components and head assembly components. Experience gained in these areas will be applied to alignment inspection of larger assemblies such as fuel and LOX tanks and a complete stage.

QUALITY ASSURANCE PROCEDURES

Considerable effort was devoted to the development and refinement of operation procedures. Following are specific examples:

SPECIAL INSPECTION PROCEDURES (D5-11982)

This document was completely revised during the year to broaden its scope. D5-11982 will eventually become a multi-volume document encompassing all the unique inspection techniques utilized on the Saturn Program. At the end of FY '63, ten categories of hardware oriented procedures had been written and incorporated into D5-11982.

NON-DESTRUCTIVE TEST APPLICATION TECHNIQUE DEVELOPMENT PLAN (D5-11962)

The Non-Destructive Test Application Technique Development Plan was developed during the year and was being reviewed as the year ended. This document describes the development of application techniques for various non-destructive tests.

DOCUMENTATION

Implementing documentation developed during the year included Standard Operating Instructions, Operating Procedures, and Technical Documents. The need was recognized for a visibility media to portray the documentation released to incorporate the provisions of the Quality Program Plan. Three documents trees were subsequently developed to provide this visibility. These were: 1) Q&RA Program Documentation (Figure IV-17), 2) Reliability Program Documentation, and 3) NPC 200-2 Documentation (Figure IV-18).

QUALITY ASSURANCE AUDITS

Periodic quality assurance audits of all Quality and Reliability Assurance functions and the Launch Systems Branch Training Program were initiated during FY'64. Several special audits were also conducted during the year and included audits of the factory drawing service, inspection stamp control, Saturn records system, and Wichita and Seattle quality functions. Results of audits were documented in the Launch Systems Branch Quarterly Audit Reports and forwarded to the contracting officer in accordance with NASA publication NPC 200-2.

SPECIAL INSPECTION TECHNIQUE DEVELOPMENT

The need was recognized for several specialized inspection tools during 1964 and significant progress was made in developing and acquiring this equipment. Following are notable examples of this specialized equipment.

SUPPLEMENTARY INSPECTION

A supplementary inspection technique was needed to determine actual fusion diameter of spot welds. To do this, an ultrasonic recording scanner was designed. This equipment was initially used to support hardware inspection of bulkhead assemblies.

A proposed new ultrasonic hand scanner was subsequently developed and submitted to NASA for procurement during the latter part of the year. In addition, an improved scanning system for both the hand scanner and the ultrasonic recording scanner was tested and approved for use in both systems. This improved system uses the pulse echo single transducer instead of the double transducer required for the "Pitch and Catch" method.

CONTOUR EVALUATOR PACKAGE

The bulkhead contour evaluator was received from the vendor in June 1964. This equipment will be used with a contour template for final inspection of bulkhead assemblies.

OPTICAL TARGET PACKAGE

This package was completed by the vendor and received June 26, 1964. This equipment will be used for dimensional inspection of fittings and also in conjunction with the 34-foot rotary table during final dimensional inspection of the bulkhead assemblies.

MICROWAVE THICKNESS MEASURING EQUIPMENT

Developmental work was completed during the year on equipment to measure the thickness of gore segments during chemical milling and subsequent operations. The equipment has been ordered and the vendor will deliver it during the first quarter of FY '65.

PREDICTIONS

Quality and Reliability Assurance anticipates continued acceleration of activity consistent with the program demands of FY '65. Fabrication, assembly, and test developmental activity will be particularly significant. Activation of remote sites will also receive considerable attention.

Quality Assurance capability is expected to increase. Specifically the following will be accomplished:

1) The 34-foot rotary table will be installed, checked out, and placed in use to perform critical optical dimensional inspection of bulkheads, thrust structures, and intertank assemblies;
2) The Technical Development Laboratory is expected to be completed and activated. The purpose of the laboratory is to develop non-destructive test techniques, design inspection equipment and perform technical liaison with Manufacturing Development and MSFC;
3) Permanent penetrant inspection facilities, using automatic spray equipment, will be activated and integrated in the inspection plan.

V

SYSTEM AND SUBSYSTEMS TEST

DEVELOPMENT, QUALIFICATION, AND RELIABILITY TESTING

"S-IC Contractor Test Program Summary," Document D5-11928-1, listing development qualification, and reliability testing considered to be Boeing responsibility, was prepared and submitted to NASA/MSFC for comment during the second quarter of the fiscal year (FY). The document was subsequently revised in accordance with NASA/MSFC comments, resubmitted early in February, and made a contractual document by Contract Modification 92, received April 15, 1964.

Development testing, which began during FY'63, continued throughout FY'64, most of the work being accomplished at the Boeing-Seattle and Wichita facilities because of the lack of test facilities and equipment at Michoud. While development testing was substantially behind schedule at the end of the fiscal year, no serious program schedule impact is foreseen, since those tests crucial to design development have been scheduled to provide required information at the time needed.

The qualification and reliability test programs have recently been rescheduled to coincide with late availability of laboratories and test equipment at Michoud. The new schedules are to be provided in the next issue of Document D5-11928-1, and at present still allow for meeting the Plan VII schedule end dates for qualification and reliability testing.

TEST PARTICIPATION-MSFC

Boeing personnel at MSFC have participated in F-1 engine static firings, LOX and fuel systems loading and unloading, and F-1 engine setup and dismantling. Other participation effort during the year, has included the preparation of documents, plans and procedures, and data acquisition planning support; the preparation of installation drawings, wiring diagrams, and operation and maintenance procedures; and design reviews and construction surveillance.

The purpose of this effort is to prepare Boeing personnel to assume full responsibility for the S-IC static firing program at MTO.

MTO ACTIVATION

A June 2, 1964 letter from the NASA/MICHOUD Contracting Office to the Boeing Launch Systems Branch Contract Administration Office gave Boeing limited authorization to proceed with the activation of MTO in an amount not to exceed $570,000 pending receipt of formal NASA Headquarters approved supplemental agreement, "MTO Activation Authorization," Modification No. 102 to Contract NAS8-5608.

Major activities during the reporting period were con-

EVENT	ACTION	DATE
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Submitted to NASA	February 19, 1964
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Modification 92 Received	April 10, 1964
PARTICIPATE IN CHECKOUT OF MSFC TEST STAND	Participation by Boeing	November 9, 1964
MTO ACTIVATION	Go-Ahead	June 2, 1964
MTO ACTIVATION	MTO Activation Plan Complete (D5-11071-3)	August 1, 1964
GOVERNMENT FURNISHED FACILITIES, EQUIPMENT AND SERVICE REQUIREMENTS FOR MTO	Document D5-11061 Complete	July 1, 1964
GENERAL TEST PLAN	Submitted to NASA	November 1, 1964
TEST DATA ANALYSIS	Flight Test Evaluation and Reports Plan Complete (D5-11056)	January 2, 1965

Figure V-1 - Documentation Status

centrated on planning and documentation. Document D5-11071-3, "Plan for Activation and Operation of S-IC Complex at MTO," is in process and scheduled for completion August 1, 1964. The status of significant documentation necessary for the activation program is shown in Figure V-1. At the close of the period, efforts were continuing in design and specification reviews on the S-IC complex and technical systems, and GSE design and installation liaison. Interface common to MSFC and MTO in the brick-and-mortar and equipment areas were also in process.

TEST PLANNING

Major emphasis was placed on the General Test Plan document during this reporting period. The General Test Plan document defines development, qualification, reliability, production, acceptance, prelaunch, flight and special tests for the S-IC stage and GSE from development of components through operational flights. It provides objectives, test descriptions, test progression, concepts, policies and responsibilities. The original effort was started early in the reporting period and resulted in a preliminary draft which was distributed late in December 1963.

Subsequent to joint NASA/MSFC-Boeing reviews the first coordination copy was released on March 26, 1964. The NASA/MSFC comments were reviewed June 4 and 5, 1964, at a joint meeting. The comments are being incorporated into a second coordination copy which is scheduled for release on July 24, 1964.

FLIGHT EVALUATION

TEST ANALYSIS & EVALUATION

A Boeing S-IC Flight Test Evaluation Committee, made up of members from all technical organizations, has been instrumental in defining Boeing analysis requirements for external data submitted for inclusion in the "Engineering Instrumentation Requirements" document.

The committee is presently developing detailed techniques for providing calibration data required by Technical Directive 170, and specifications of calibration data to be used for the linearization of flight test data at Slidell.

CENTRALIZED DATA REDUCTION

On October 4, 1963, formal announcement was made by NASA/MSFC of the establishment of a "Joint Usage Laboratory" at Slidell and Michoud for Boeing and Chrysler test data reduction. Boeing was asked to participate in the establishment of equipment specifications. As a result, the Boeing Data Reduction Steering Committee was established, with the Saturn Booster Test organization manager as the Boeing senior member.

Subsequent to the request from NASA/MSFC for Boeing participation in the establishment of equipment specifications for the Centralized Data Reduction Facility, the Data Reduction Steering Committee established a joint system description and specification which was completed and submitted to NASA/MSFC on January 1, 1964.

By November 26, 1963, the scope of the Centralized Data Reduction activities was defined. The recommendation submitted to NASA/MSFC called for third-party operations at Slidell and Michoud with data user (Boeing or Chrysler) surveillance.

Test Data Reduction facilities will be provided at the Computer Operations Office, Slidell, Louisiana, and the Michoud Engineering Building, New Orleans, Louisiana. The Slidell facility will reduce the various raw telemetry data records, as received from Merritt Island Launch Area (MILA), to a common digital tape format for IBM7094 computer entry. The data records to be reduced will be direct analog wideband FM PAM/FM/FM telemetry tapes, PCM/FM telemetry tapes and predetection recorded magnetic tapes.

The Michoud Data Reduction facility will receive data in recorded form from the various data acquisition sites and from the Slidell facility and will process the data to satisfy the requirements of quick-look preliminary analysis, detailed test analysis, data evaluation and analysis, and test reporting. This facility will also be used quite extensively for vibrational and acoustical analysis.

The vibration and acoustical analysis system will give support in the areas of component test, static test, and flight test data reduction. This system is capable of reducing direct analog magnetic tapes, wide-band FM magnetic tapes, and SS/FM telemetry tapes.

S-V SYSTEMS SUPPORT

SYSTEMS STUDIES

Engineering support under technical assistance orders has steadily increased in scope during the past year. Saturn V studies in aerodynamics, systems design, flight control and test data analysis, mission abort analysis structural design, and wind tunnel testing were conducted. Support to Astrionics and P&VE Laboratories has continued and a number of new tasks has been added. System studies conducted and pertinent results are discussed in the following paragraphs.

SATURN V FLIGHT CONTROL SYSTEM ANALYSIS

Document D5-11240-1, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis," released April 6, 1964, contains an evaluation and comparison of slosh stability, structural coupling, dynamic loads, and vehicle transient responses for various control laws and feedback parameters considered for application to the Saturn V. Control system analysis and specifications for the 4106 configuration of the Saturn vehicle are contained in Document D5-11290-2, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis--Vehicle 4106."

FLIGHT TEST DATA ANALYSIS SYSTEM

Development work was completed on the flight test data analysis system. Significant developmental and supporting documents released were:

a) D5-11247-1, "Saturn Flight Test Data Analysis System Definition";
b) D5-11247-2, "Data Source Comparison Computer Program";
c) D5-11249, "Saturn Flight Test Report Vehicle (I, II, III, and IV) Data Source Comparison," Vol. 1-4;
d) D5-13029, "The Mathematical Development for the AMR Range Data Reduction Computer Program";
e) D5-13025, "Coordinate System Definition in Saturn Flight Test Data Analysis System."

D5-11247-1 defines basic system concepts for the Saturn flight test data analysis system, and D5-11247-2 contains the mathematical and statistical techniques for post-flight data comparison. Four volumes of D5-11249 give tracking data comparisons for flight data obtained from SA-1, SA-2, SA-3, and SA-4 and demonstrate system development. D5-13029 and D5-13025 present the mathematical formulations for conversion of AMR tracking information from tracking station format to vehicle position with respect to station, launch, and inertial coordinates. Portions of this development work were used in Boeing presentations at the NASA/MSFC Flight Evaluation Working Group Meeting and to the Saturn data reduction sub-group panel.

SATURN V FLIGHT PERFORMANCE

Studies and presentations of mission abort were conducted for the powered and unpowered modes. The ability of the vehicle to complete developmental missions after an engine had been shut down was also determined. Significant analyses, with recommendations for mission and abort criteria, are contained in Document D5-11392, "Saturn V Vehicle Abort Analysis and Criteria." Presentations were given to the Aero-Astrodynamics Laboratory and to the MSC/MSFC crew safety panel. Results of a study to define Saturn V flight performance reserve for the LOR mission were presented at the second guidance and performance sub-panel meeting at MSC April 28, 1964.

LAUNCH ESCAPE SYSTEM

A study was conducted to evaluate the capability of the Launch Escape System (LES) to provide protection from booster explosions. It was determined that the Apollo capsule would be subjected to damaging overpressure if the LES is initiated simultaneously with the explosion of the booster. Prior warning time of approximately two seconds is required for the astronaut to escape. Results of this study were presented to the MSC/MSFC crew safety panel.

ASSISTANCE TO LAUNCH SUPPORT EQUIPMENT OFFICE

Technical assistance to the Launch Support Equipment Office, Huntsville, Alabama, and to KSC, includes engineering studies, analysis, and report writing as applicable to: Coordination for Saturn V launch support equipment; Engineering for design, budgeting, and scheduling in the launch equipment area, the propellant area, and the launch system and umbilical equipment reliability area.

MTO ACTIVATION

During this reporting period, on-dock dates for all contractor furnished test and checkout equipment were determined.

Support was provided to NASA/MSFC for the S-IC Complex (MTO) design review. A major revision to Document D5-11061, "Government Furnished Facilities, Equipment and Services for Mississippi Test Operations," was completed. Document D5-11071-2, "Plan for Activation and Operation of the S-IC Complex at MTO," was prepared and released as the work statement to support a request for estimate (RFE) which was issued to cover the MTO Activation Plan. The RFE meeting was held in New Orleans, November 6, 1963, and a presentation to NASA/MSFC was made on December 9, 1963.

Documentation was developed for the Saturn records system procedure, manpower plan, test evaluation and reports plan, activation static firing and special test data plan, and the safety plan.

This resulted in a significant contribution to the Saturn program in that the initial overall requirements for Mississippi Test Operations were defined through this work effort.

EQUIPMENT MANAGEMENT SYSTEM

The establishment and documentation of an equipment management system to cover all ground support equipment (GSE) for the Saturn V program, the development and documentation of an initial Saturn V program elements list, and the development of a preliminary Saturn V GSE list was completed in December 1963.

An S-IC equipment data support group, consisting of full-time representatives from the Launch Systems Branch was organized on September 16, 1963, in Huntsville. This group was assigned the task of reviewing and updating the equipment listed in the data bank established as a result of the task force effort. The first updated S-IC equipment list was completed on October 11, 1963, and a computed version of the S-IC equipment list was completed on November 8, 1963. An outline of the proposed Saturn V equipment management system was documented and was submitted to the Saturn V Project Office for comment on September 24, 1963.

This effort represented an important contribution to the program since it provided program visibility of known equipment requirements and responsibilities, assistance in identifying duplicated or omitted equipment, a basis for equipment accountability, data to identify contract deficiencies, a basis for equipment status reporting, and data for development of installation and checkout packages.

TAO 6 was released December 31, 1963 to ensure continuity of the Saturn V Equipment Management support effort following the expiration of TAO 30.

TAO 6 provides for 20 Boeing technical personnel to support the Saturn V Project Office at NASA/MSFC, for implementation, maintenance and future development of the equipment management system. Specifically, this support consists of follow-on studies for further application of the management system and assistance in the maintenance and further development of:

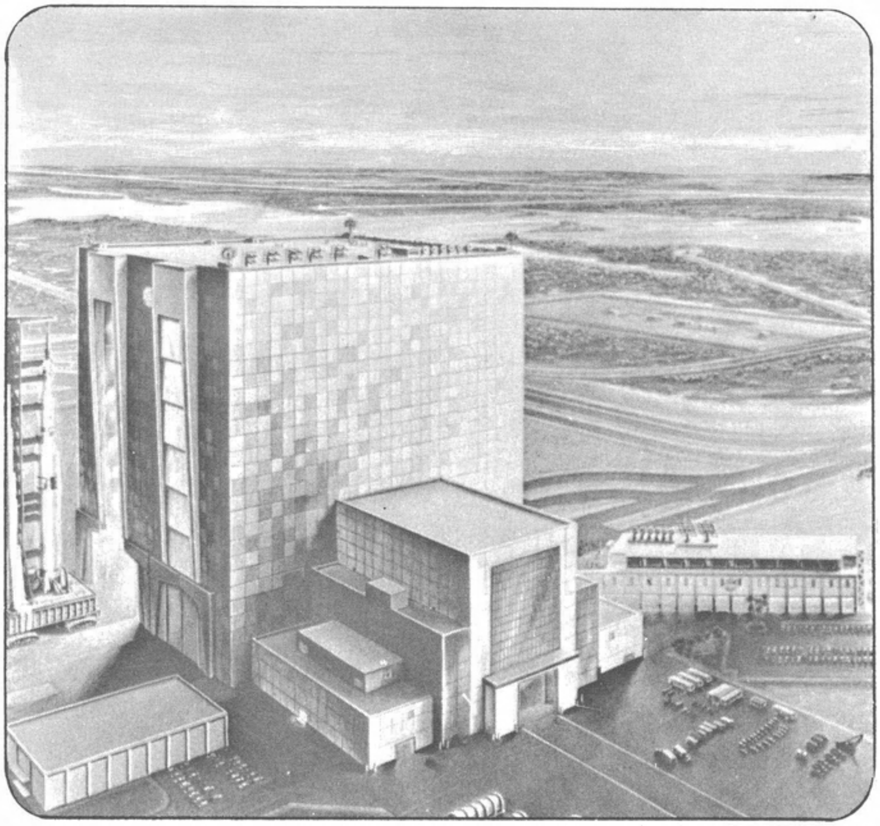
1) Saturn V Program Elements List;
2) Saturn V Master Equipment List;
3) Equipment Allocation Techniques;
4) Problem Resolution Schedules.

The Saturn V/S-IC master equipment list has been placed into computer format and is now stored in the Michoud Computer Office. Updating of this data bank occurs on a monthly basis.

Development of report requirements and planning of computer programming is now in progress.

Responsibility for work covered by TAO 6 was transferred from Boeing Booster Test to Boeing Engineering in March 1963; however, Booster Test is providing support.

VII



LAUNCH OPERATIONS SUPPORT

MERRITT ISLAND LAUNCH AREA LIAISON

The Boeing activities in the Cape Kennedy area were consolidated into one organization during February. Mr. A.M. Johnston was appointed Manager of the Boeing Atlantic Test Center (BATC) reporting directly to Mr. G.H. Stoner, Vice President and General Manager, Launch Systems Branch of the Aero-Space Division, The Boeing Company. Mr. H.W. Montgomery was appointed Manager of Saturn S-IC activities at BATC.

Document D5-11058, "MILA S-IC/Saturn V Checkout and Test Plan," was revised to reflect the Kennedy Space Center (KSC) planning for a fifty eight day cycle of Launch operations. Document D5-11059, "S-IC MILA Equipment List," was released and served as the first guide for MILA use requirements.

Liaison activities included the preparation of document D5-11830, "MILA S-IC Launch Operations Record Systems." The system provides a method of fulfilling the Saturn V vehicle record requirements while maintaining a high degree of compatibility with Boeing records at other locations.

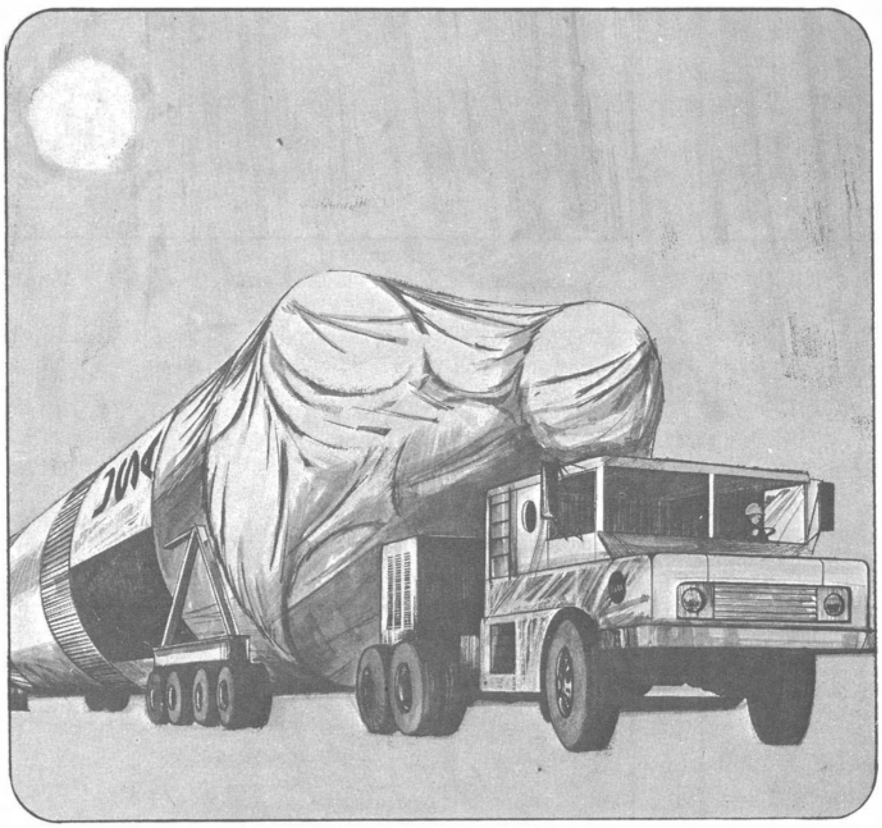
Document D5-11816, "Launch Operations Support Plan S-IC/Saturn V, " was prepared during this report period. The plan presented the BATC concept of the Boeing effort to be performed under Part VII of Contract NAS8-5608. The document became the basis for negotiation of task orders to authorize Boeing support effort for KSC for FY '65. The approved task orders will allow for a growth of 100 persons for a total of 123 under this part of the contract.

The "BATC Training Plan" is in process with initial release scheduled for October 1, 1964. This plan will serve as the basis for negotiations regarding off-site personnel training and will ultimately support the KSC training plan.

A compilation of all tests to be performed on the S-IC-F stage at MILA is also in process. The initial release, scheduled for August 15, 1964 will be in document form—"S-IC-F Catalog of Tests - MILA."

LAUNCH OPERATIONS PARTICIPATION

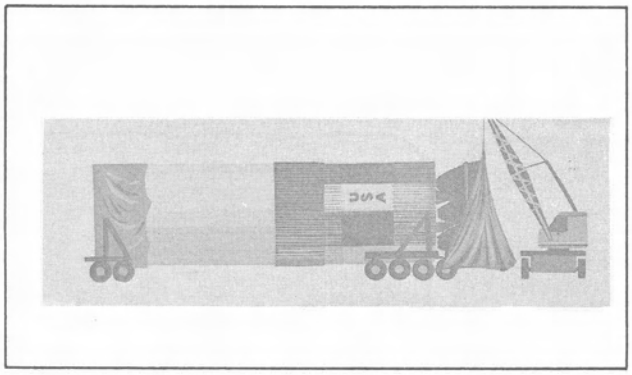
Twenty-three BATC personnel are currently assigned to support NASA/KSC Launch Vehicle Operations Activities. Assignments vary with the individual organization supported but cover S-V/S-IC MILA program planning, and participation in Saturn I test activities for familiarization and training purposes. Numerous working-group meetings and design reviews were attended by support personnel during the reporting period. These included meetings of the Instrumentation Working Group reviews covering S-IC transporter and pneumatic systems, Saturn V propellant loading system, propellant dispersion system, RCA 110 computer networks, and thrust-vector control system.



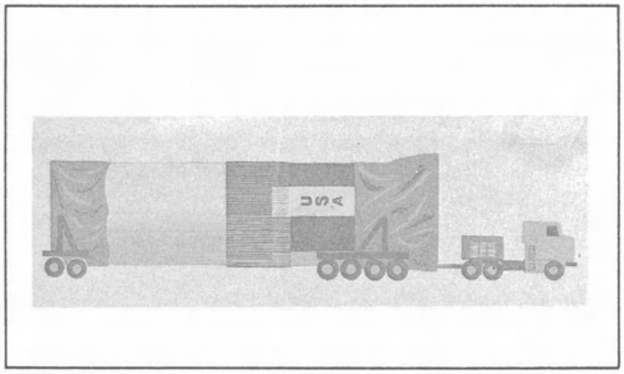
STAGE TRANSPORTATION

STAGE PREPARATION
EQUIPMENT:

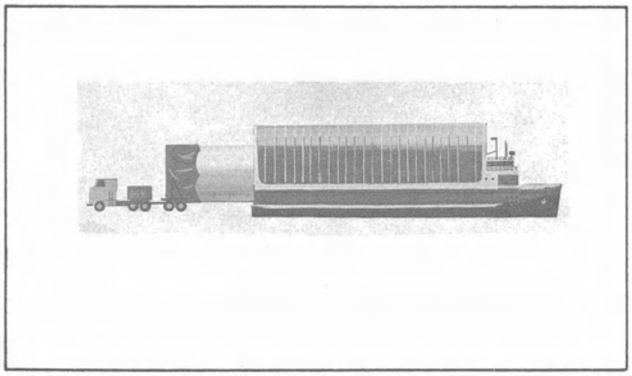
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings



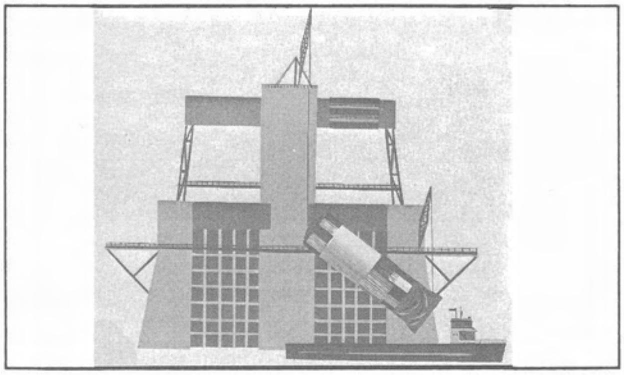
HANDLING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



LAND TRANSPORTATION
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

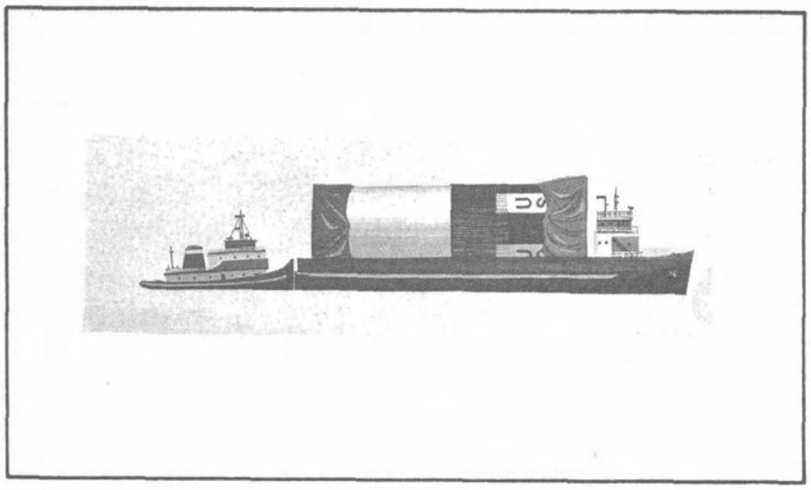


LOADING-UNLOADING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

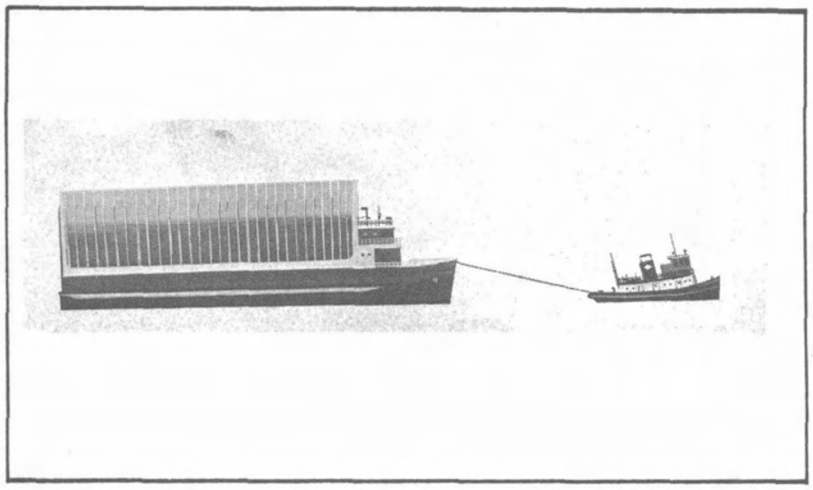


* THE PROTECTIVE COVERS AND PLUGS ARE JOINT BOEING-NASA DESIGNED ITEMS.

WATER TRANSPORTATION — OPEN
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Transportation Accessory Kit
Forward Handling Ring
Stage Attach Fittings



WATER TRANSPORTATION — CLOSED
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



STAGE TRANSPORTATION SEQUENCE

A complete revision to Document D5-11053, "Saturn V S-IC Stage Transportation Plan," has been the prime order of business during this reporting period. This revision encompasses all phases of transportation, identifies the Boeing organizations responsible for each of the transportation functions, and contains the latest schedules and equipment requirements. This document is scheduled for release in September 1964.

Document D5-11763, "Saturn V S-IC Stage Transportation Requirements," is also in process and is a compilation of the detailed requirements for transporting the S-IC Stage in accordance with the above Transportation Plan. This document is scheduled for release in January 1965.

The first barge movement (S-IC-D to MSFC transport sequence shown) is scheduled for August 1, 1965, with no problems anticipated at this time.

IX

MANUFACTURING SUPPORT TO MSFC

S-IC-C TEST FUEL TANK

Boeing support of the ground test program for the S-IC-C test fuel tank involved the fabrication and delivery of stage hardware details and assemblies and fabrication and erection of the tank support structure.

Fabrication and delivery of minor stage hardware, such as tank ring baffles continued during the third quarter of CY'63. During August 1963, the assembly of the one-half intertank was completed in support of the NASA/MSFC test fuel tank requirements. The one-half intertank was delivered to MSFC by barge (Figures IX-1 and -2) on November 16, 1963. Stage hardware deliveres were completed during the last quarter of CY'63.

Effort during the first quarter of CY'64 was directed toward completion of the tank support structure. This activity culminated March 11, 1964 with the installation of the test fuel tank on the support structure.

Figure IX-1 - The Michoud Plant and the Partially Completed Vertical Assembly Building are a Backdrop for the One-Half Intertank Being Towed to the Slip for Shipment to MSFC

S-IC-T STAGE

The Boeing effort on the S-IC-T static test stage encompasses the fabrication of structural hardware details and assemblies (thrust structure, intertank, and tank components), and the procurement and delivery of specialty hardware in support of NASA/MSFC.

Figure IX-2 - The Half Intertank is Carefully Loaded on the Barge at the Dock and Secured by Boeing Mechanics

STRUCTURAL HARDWARE

S-IC-T structural hardware deliveries to MSFC began during the second quarter of CY'63 with the delivery of the fuel tank lower-head apex gores. Deliveries of this hardware (Figures IX-3 and -4) continued through the second quarter of CY'64 with the final major structural hardware deliveries having been completed in May.

The last of the basic structural subassemblies delivered during the reporting period included the GOX and helium distributors, and the LOX tank ring baffles and cruciforms (Figure IX-5). At the close of FY 64, there were 656 items remaining to be delivered to MSFC by Boeing in support of the S-IC-T stage. Delivery of these items, such categories as minor tooling, specialty hardware, and minor structure components (Figure IX-6), will continue through January 15, 1965.

SPECIALTY HARDWARE

Specialty hardware deliveries began in November 1963, and were continuing at the close of FY64. These deliveries consist of both items to be shipped directly from suppliers to MSFC, and items routed through

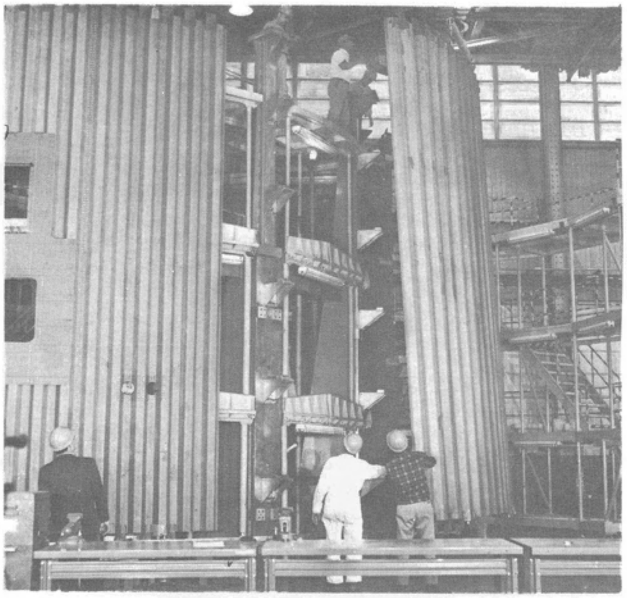


Figure IX-3 - An S-IC-T Intertank Panel is Removed from the Intertank Assembly Fixture

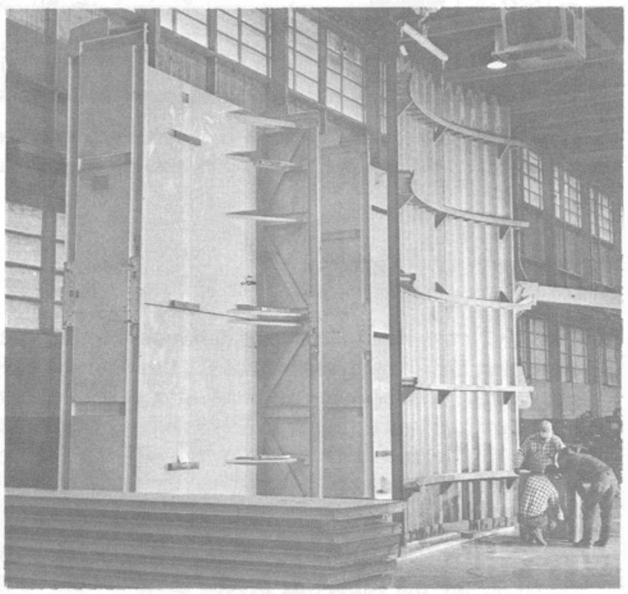


Figure IX-4 - The -T Intertank Panels are Placed in the Shipping Case Vertically

Boeing/Michoud for test and calibration. A need for increased delivery rates during the latter part of FY 64 resulted in concerted efforts by Boeing Management to attain better adherence to delivery schedules by suppliers for critical items. Key members of both NASA/MSFC and Boeing Management were maintaining close liaison through such media as the monthly MSFC/Boeing S-IC-T stage meetings. These meetings were held to ensure that critical areas affecting completion of the S-IC-T stage would receive the proper attention.

Typical of the conditions affecting hardware deliv-

Figure IX-5 - A Cruciform Baffle Segment is in its Assembly Fixture at the Left. Another Baffle Segment is on a Stand.

Figure IX-6 - Segments of Anti-Slosh Cantilever Circumferentials Await Shipment in the Michoud Tank Ring Baffle Pick-up Area for the S-IC-S and -T

eries were changes in design criteria; revised vibration/shock testing requirements; supplier design deficiencies; and over-optimistic delivery capability quotations. Corrective actions initiated by Boeing included overtime authorization; negotiation of unqualified hardware deliveries and direct shipment authorization; establishing resident personnel at supplier locations to expedite design decisions; assistance in resolving production and quality problems; and periodic Boeing Management visits to ensure continuing management awareness of problems and follow-up of remedial action.

S-IC-S STAGE

Boeing support to NASA/MSFC major structural component hardware (S-IC-S) requirements were initially oriented to fabrication, assembly, and delivery of stage hardware details and assemblies to support the assembly of an equivalent structural stage at MSFC. Hardware deliveries from Boeing were to be provided so that the stage could be assembled in two major sections. The first section (upper structural

stage) would include a LOX tank, an intertank, and a forward skirt. The second section (lower structural stage) would include an intertank, fuel tank, thrust structure, fin and fairing assemblies, engine actuator supports, and propellant line supports. Boeing effort is directed toward final delivery of components to MSFC for the lower structural stage by November 31, 1964, and for the upper structural stage by December 14, 1964.

STRUCTURAL HARDWARE

Thrust Structure

Structural components were being fabricated for the thrust structure (Figure IX-7) of the S-IC-S stage during the fourth quarter of CY 63. By the end of the first quarter of CY 64, the fabrication of structural components for the entire S-IC-S stage was about 87 percent complete. They were scheduled to be 92 percent complete but were slightly behind schedule because the fabrication of the S-IC-T stage had priority.

During the first quarter of CY 64, deliveries were made to MSFC for the S-IC-S thrust structure, with the majority of items being scheduled for delivery during the quarter ending July 2, 1964.

Shortly after the beginning of the second quarter of CY 64, Boeing was requested to assume responsibility for complete assembly of the S-IC-S, S-IC-1, and S-IC-2 thrust structures. These structures will be assembled at Michoud, necessitating transfer of previously delivered thrust structure subassemblies and assembly fixtures from MSFC to Michoud. At the close of the reporting period, the S-IC-S stage thrust structure was in the final assembly operation at Michoud. Minor assembly activities are in phase with final assembly requirements. Present status indicates the completed S-IC-S thrust structure willbe delivered to MSFC by September 30, 1964, as scheduled.

Intertank

Intertank assembly activities during the fiscal year included two units of the original configuration for the S-IC-S. The first -S intertank assembly was completed, removed from the final assembly fixture, and shipped to MSFC on June 18, 1964. Delivery of this intertank differed from the S-IC-T in that the structure was removed from the assembly fixture in one piece, and shipped as a single unit rather than in sections as occurred on the -T. The second intertank for S-IC-S was then loaded onto the final assembly fixture and is expected to be completed and removed by July 14, 1964. No major problems have been encountered in the assembly of these two units. Current planning calls for two additional intertanks of a revised configuration for S-IC-S to be assembled in the fourth quarter of 1964.

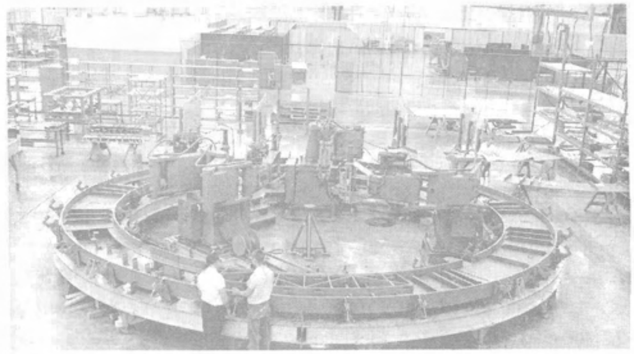


Figure IX-7 - S-IC-S Thrust Ring being Loaded into the Lower Thrust Ring Subassembly Fixture

Forward Skirt

Final assembly of the S-IC-S forward skirt (Figure IX-8) was started in the last week of the reporting period. Assembly activity is progressing on schedule and is to be completed by September 8, 1964.

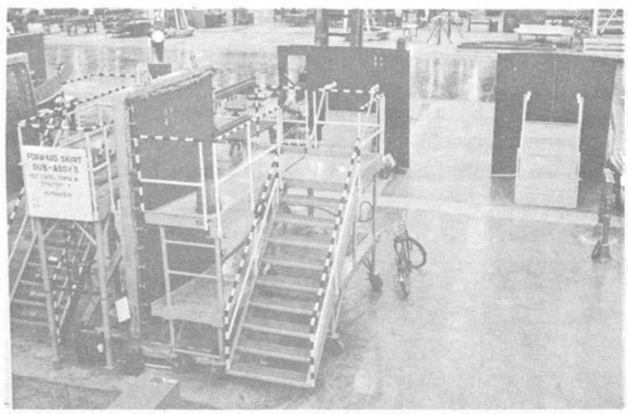


Figure IX-8 - Skin Panels for the S-IC-S are Assembled in the Fixture at the Left and Held for Shipment as shown

LOX and Fuel Tank

Boeing support of the S-IC-S LOX and fuel tank assemblies consisted of assembly of the forward bulkhead (Figure IX-9) for the LOX tank at Michoud and the delivery of detail tank components to MSFC for subsequent assembly by NASA/MSFC at Huntsville. By the end of the second quarter CY 64, over 500 tank components for the S-IC-S had been delivered to MSFC. At the end of the first quarter of CY 64, the forecast for completion of S-IC-S tank component deliveries was the end of June. Subsequent redirection by NASA/MSFC, altering both quantities and delivery demand dates, has necessitated a re-evaluation of delivery capability. LOX tank component deliveries that were outstanding on July 2, 1964, included 16 ring-baffle segment assemblies, four panel assemblies, four cruciform baffle assemblies, three covers, and one GOX distributor. Fuel tank components still to be delivered included 40 ring-baffle bearings, two cover assembl-

ies, a helium distributor assembly, and a helium cover assembly. Delivery dates through August 17, 1964, have been cited.

The assembly of the forward LOX tank bulkhead at Michoud was to be delivered to MSFC on June 22, 1964, but is behind schedule and is presently forecast for delivery on August 11, 1964. This schedule position is caused by an accumulation of technical problems encountered during the assembly process. Fitting-to-gore welds developed excessive warpage and shrinkage. The gore segments had to be returned to Wichita for rework. Difficulties were then encountered during the gore-to-gore weld operation, and following this the polar cap was determined to be overformed, and a new polar cap had to be fabricated. While this was being produced, the bulkhead was successfully welded to the Y-ring and brackets were welded onto the assembly out-of-sequence in an effort to reduce down time. Assembly completion is predicted for July 25, after which the bulkhead must be prepared for shipment. The bulkhead will then be loaded on a barge and routed to MSFC.

Fin and Fairing

Fin and fairing assembly operations for the S-IC-S are presently scheduled to begin in July 1964. Delivery of the completed assemblies is forecast for the fourth quarter of CY 64.

SPECIALTY HARDWARE

Specialty hardware required of The Boeing Company for the S-IC-S stage is included under four part numbers, which represent a total of twenty parts. The last part is forecast to be on-dock at MSFC by July 28, 1964, which supports MSFC delivery requirements.

S-IC-1 AND S-IC-2 STAGES

Structural component fabrication dominated Boeing efforts in support of the S-IC-1 and the S-IC-2 stages. However, by the end of the reporting period, bulkhead gores were being assembled at Michoud for the S-IC-1 and the assembly for the S-IC-1 base heat shield was about to start. Further assembly activities at Michoud on the S-IC-1 will be paced by the availability of tooling, which is currently loaded with S-IC-S and S-IC-D hardware. Hardware deliveries to MSFC for S-IC-1 and S-IC-2 stages were limited to components for LOX and fuel tanks. Michoud assembly activities and deliveries to MSFC will continue to accelerate as program emphasis swings to the first flight stages, and on-schedule performance is predicted.

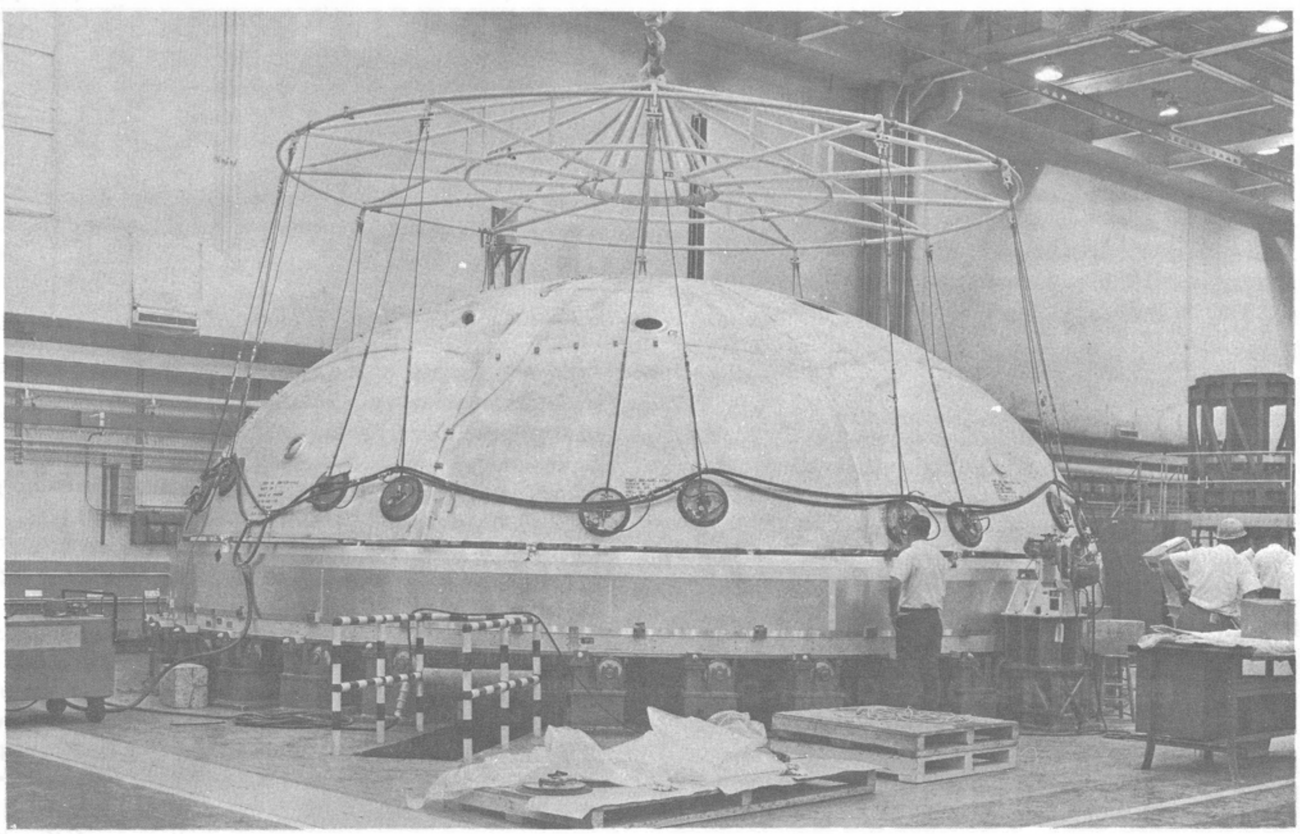
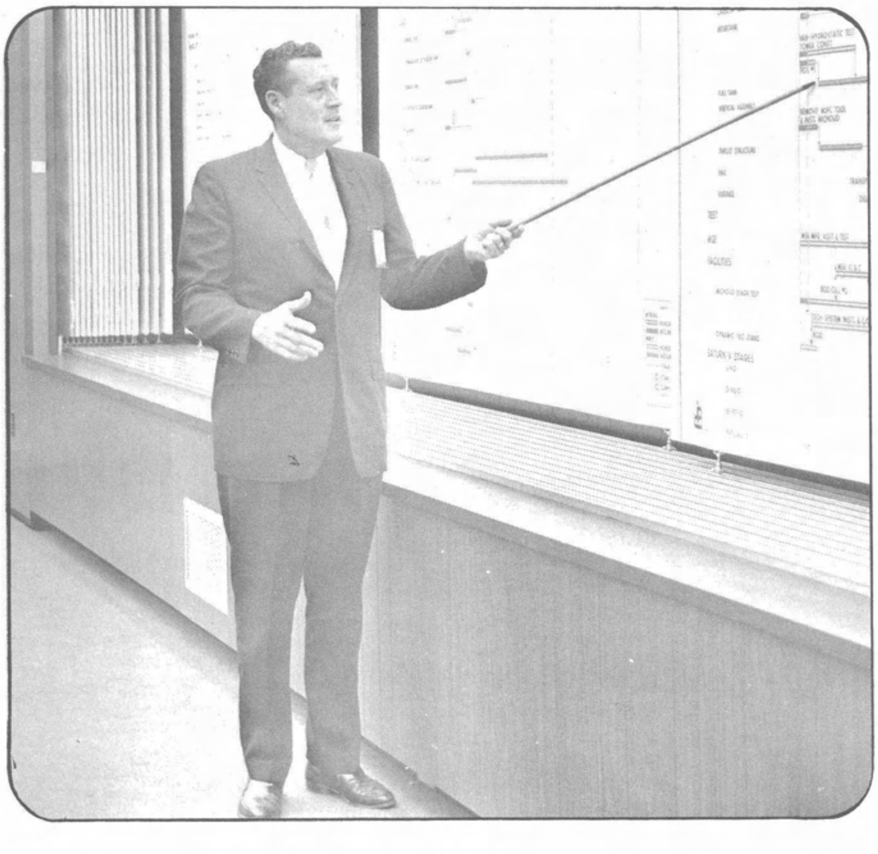


Figure IX-9 - S-IC-S Forward LOX Bulkhead was moved from the Polar Cap Weld Fixture to this Bulkhead-to-Y-ring Weld Turntable by means ot the Vacuum Handling Tool shown still Attached

X



PROGRAM MANAGEMENT

CONTRACTING ACTIVITIES

GENERAL

During FY 64, The Boeing Company was actively engaged in the following Saturn V/S-IC stage program contracts with NASA/MSFC:

Contract NAS8-5608--"Long Range Saturn S-IC Stage Program."

Contract NAS8-2577--"Preparatory Effort Leading to a Project for Engineering, Fabrication, Assembly, Checkout, Static Testing, Transportation, and Launch of the Saturn S-IC Stages"

Contract NAS8-5606(F)--"Facilities Required for Saturn S-IC Stage Program."

Contract NAS8-13002--"Saturn V/S-IC Full-Scale Tail-Section Mockup."

The prime contract, Contract NAS8-5608, effective January 1, 1963, was based on Schedule Plan IV. Through negotiations in late 1962 and in early 1963, Boeing's work base was expanded significantly and because of this, official Schedule Plan V was established in May 1963. In late June 1963, in anticipation of FY 64 funding limitations, NASA/MSFC directed Boeing not to add additional personnel to the S-IC program. This restriction was later removed and a manpower schedule recommended by Boeing was substituted.

In December 1963, Schedule Plan VI, consistent with FY 64 funding, was established. A major program redirection in January 1964, necessitated a change from Schedule Plan VI to Schedule Plan VII. Plan VI was never completely negotiated or implemented because of its short duration, (December 20, 1963 through January 22, 1964). Schedule Plan V and the subsequent modifications to it, served as a baseline for the negotiated transition to Plan VII.

Schedule Plan VII was compared to Schedule Plan V (Figure X-1), to reflect program slides in stage deliveries and in completion of Ground Support Equipment and Manufacturing Support Equipment (GSE/MSE). The responsibility for assembly of the S-IC-D dynamic test stage was transferred from MSFC to Boeing/Michoud, and the assembly of the S-IC-2 flight stage was transferred from Boeing to MSFC.

As of January 1, 1964, sufficient Construction of Facilities funds had been obligated to Contract NAS8-5608 to satisfy all construction requirements through FY 64 with the exception of the stage test facility, the high-pressure test facility, and the Vertical Assembly Building. Funding for these facilities was provided by subsequent modifications received prior to FY end.

CONTRACT NAS8-5608

Modification No. 30, effective August 2, 1963, completed negotiation of Schedule Plan V program redirection and substantially increased the contract value. Modification No. 60, dated December 20, 1963, directed a change to the Plan VI delivery schedule. Modification No. 67, dated January 22, 1964, redirected the program to Plan VII, which revised the delivery dates for stages S-IC-D, S-IC-F, S-IC-3 through S-IC-10,

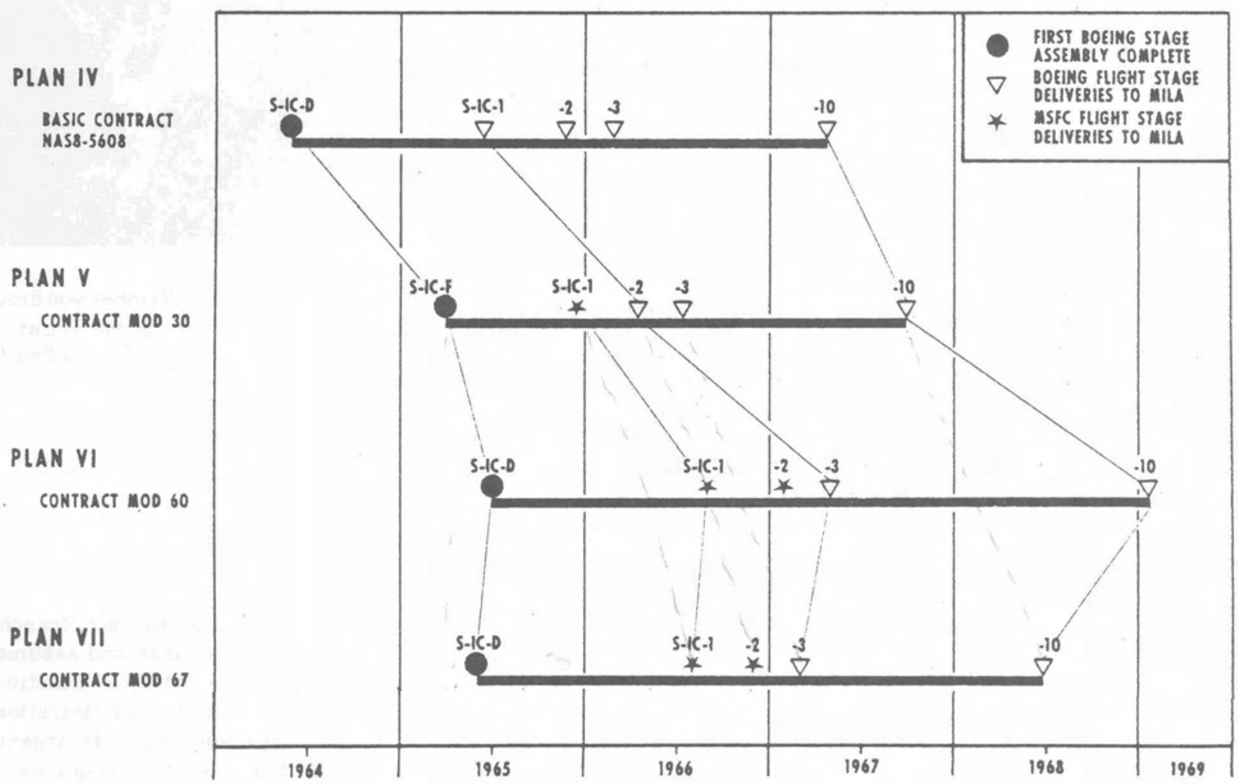


Figure X-1 Comparison of Schedule Plans IV, V, VI & VII for the S-IC Stage

deleted the Boeing responsibility for the assembly of the S-IC-2 stage, and added the S-IC-D stage assembly to Boeing. Modification No. 67 was also significant in that it deleted the manpower clause, Article XVII, which had been the basis of several manpower limitations by NASA. The Boeing proposal for the Modifications 60 and 67 redirections was submitted to NASA on May 25, 1964.

Program obligations of The Boeing Company were substantially increased by Contract Modifications 34, 35, 36, 44, 52, 62, 83, 89, 94, 102, 110 and 113.

Modifications 34, 35, and 36 authorized the design, fabrication, test and qualification of equipment to be used on the Saturn V Launcher Umbilical Tower, and the design, development and documentation of S-IC personnel work platforms for use at Merritt Island Launch Area.

Modification No. 44 shifted the responsibility for the government to provide gaseous nitrogen to Boeing and eliminated the missile-grade air facilities. Modifications 52 and 94 added a Mechanical Automation Breadboard in Building 4708, at MSFC.

Boeing effort to provide Saturn V engineering assistance to NASA/MSFC was extended through December 31, 1964 by Modification No. 62. Modifications 83, 89, 110, and 113 extended Boeing manufacturing and development support to MSFC by 1,950,000 hours for calendar year 1964.

The largest single addition was the S-IC/Mississippi Test Operation (MTO) Activation Task, added by Modification 102 at an increase in contract value of nearly $10 million. This modification added the requirement for activation of one position of an S-IC dual-position test stand at MTO encompassing a stage test and checkout station, stage-to-facility interconnecting equipment, a test control center, and an S-IC storage building. Some modification of design for flight stages S-IC-1 through S-IC-10 was also included.

CONTRACT NAS8-2577

Contract NAS8-2577 was extended to June 30, 1964, to cover existing construction and architectural engiéering subcontracts. The Boeing Company has instituted closure action on this contract and no further extensions are anticipated.

CONTRACT NAS8-5606(F)

During the reporting period, Contract NAS8-5606(F) was rewritten, and the concept of incremental funding eliminated. Funding is now based upon actual need established by extracts from the primary requirements document, D5-12374, submitted by The Boeing Company.

The work statement has gradually expanded due to increased facilities equipment requirements added by the modification of Contract NAS8-5608.

CONTRACT NAS8-13002

On January 23, 1964, in response to a request from the NASA/MSFC Contracting Officer, a proposal for a Saturn V/S-IC full-scale tail section mockup (Fig. X-2) for exhibit at the New York World's Fair was submitted. A fixed contract, NAS8-13002, was subsequently negotiated. During the reporting period, the mockup was fabricated and shipped to New York, arriving at the World's Fair Grounds on March 24, 1964. The contract was completed during the week of April 18, 1964, when NASA/MSFC officially accepted the mockup. Contract closure action was in process by The Boeing Company at the close of the fiscal year.

Figure X-2 - NASA/MSFC Director Dr. Wernher von Braun Accepts Title to the World's Fair Model of the Thrust Structure from R. C. Dunigan (right) and Gordon Beall.

ORGANIZATION

On February 21, 1964, the Saturn Booster Branch was renamed the Launch Systems Branch and assumed the responsibility to manage the new Boeing Atlantic Test Center at Cape Kennedy. This new organization provides increased technical capability and an organization that is responsive to S-IC Program requirements at the Kennedy Space Center.

PROGRAM SCHEDULES

January 27, 1964, marked the initial release of Boeing Document D5-11040-3, "Launch Systems Branch Plan VII Program Schedules." (This document was preceded by D5-11040, -1, and -2, which presented schedule plans IV and V, Va, and VI, respectively). Document D5-11040-3 established the Branch scheduling base for the S-IC Research and Development Program currently under contract. Included in this document are: (1) A Saturn V/S-IC Stage Summary schedule (Figure X-3) which displays the assembly, testing, contractual delivery and planned utilization of each S-IC stage under contract, and an F-1 engine demand schedule and other major Saturn V program milestones; and (2) A Saturn V/S-IC Test and Checkout Equipment summary schedule (Figure X-4) depicting MSFC, Michoud, and Mississippi Test Operations requirements.

Since the initial release, major revisions to Document D5-11040-3 have been made to reflect schedule changes: to add a Saturn V/S-IC Phasing Summary Schedule (Figure X-5); to depict a geographical representation of major activities to be performed in support of the program; and to reflect the activation and checkout of S-IC/MTO Position 1 as a Boeing contractual responsibility (Contract NAS8-5608, Modification 102).

S-IC PROGRAM REPORTING AND CONTROL MILESTONES

Document D5-12535, "Launch Systems Branch Reporting Milestones," was developed to identify and define program reporting and control milestones for the Saturn V/S-IC program described by the technical work statement in Contract NAS8-5608. The milestones included in this document provide time-oriented events against which program progress and performance will be measured. Certain of the milestones depicted are contractual and others are utilized for general Branch management of the program. The contractual reporting milestones have been established by coordination with NASA/MSFC.

SUMMARY PROGRAM PLAN

Contract NAS8-5608 stipulated that the "C-5/S-IC Development Program Plan," developed under Contract NAS8-2577, be revised to incorporate the provisions and requirements of Contract NAS8-5608. This was accomplished and released as Boeing Document D5-11960, "Saturn V/S-IC R&D Summary Program Plan," dated November 1, 1963.

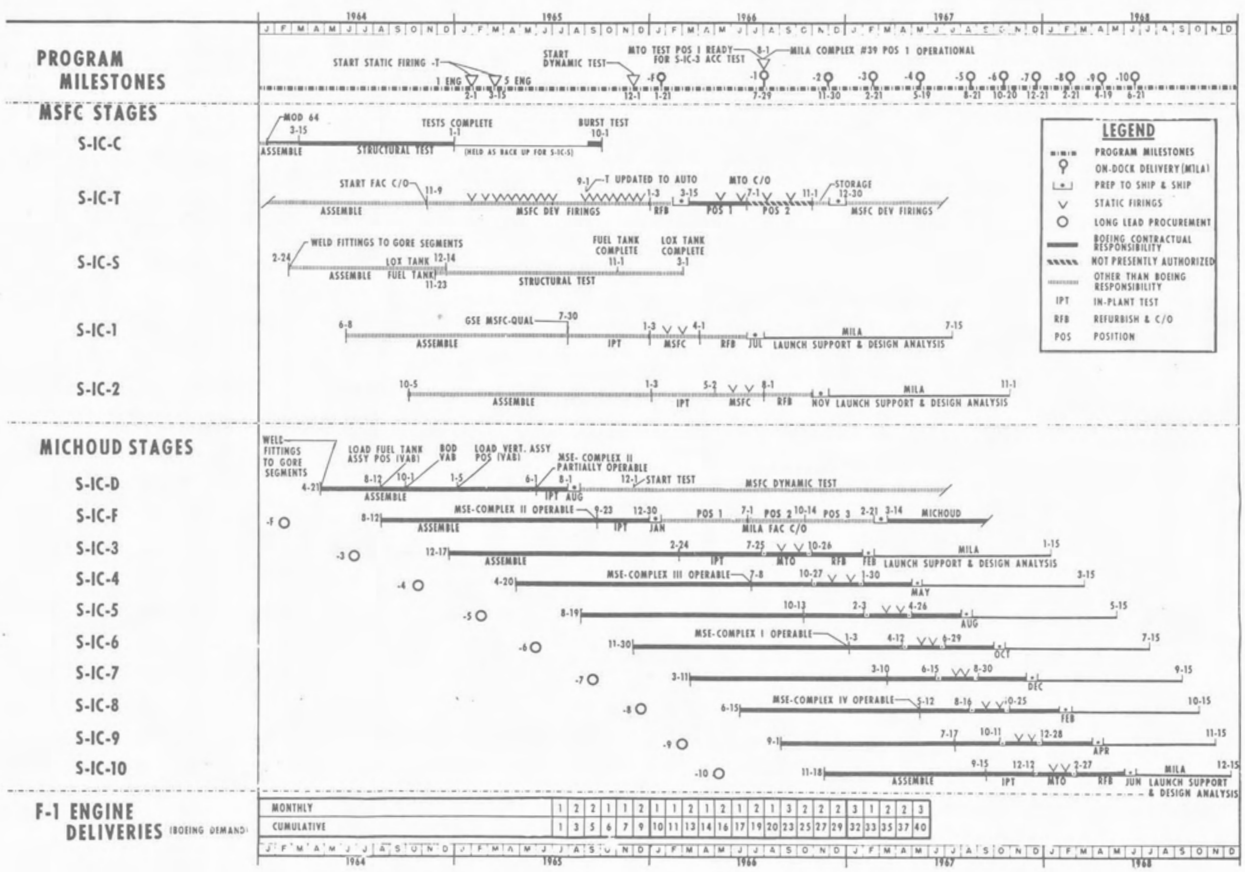


Figure X-3 - Saturn V/S-IC Stage Summary

This summary plan describes the total Boeing task and responsibilities, and provides a firm basis for Boeing Launch Systems Branch planning and management control. Because of the scope and complexity of the program, the Summary Program Plan was made concise and is supported by referenced, detailed plans and other documentation.

PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

During the past year, GSE/MSE networks for all contracted equipment were developed, and networks covering stage electrical and instrumentation systems were completed. This completed the basic PERT coverage of the Boeing S-IC program. During December 1963, NASA/MSFC concurred that the S-IC PERT System was fully implemented.

An improved PERT reporting format was implemented during March 1964. The report was expanded to encompass the Launch Systems Branch assessment of program status trends. During April 1964, Modification No. 100 to Contract NAS8-5608 was received in response to the need for an expanded PERT system. It enlarged the system to approximately 6000 real activities instead of the 1200 limitation specified in the basic contract. This modification was negotiated with NASA/MSFC during June 1964.

Technical Assistance Order (TAO) I-V-S-IC-13 was received in March 1964, authorizing Boeing to develop a PERT system which integrated the PERT reports of the major Saturn/Apollo contractors and government agencies into a single reporting system. The design of the system was completed by Boeing during June 1964.

PROGRAM INFORMATION CENTER (PIC)

The Launch Systems Branch's Program Information Center (PIC) at Michoud has been developed to provide Boeing and NASA management with the necessary program visibility. The PIC presents a display of program plans, schedules, resources, and highlights of significant program events and milestones.

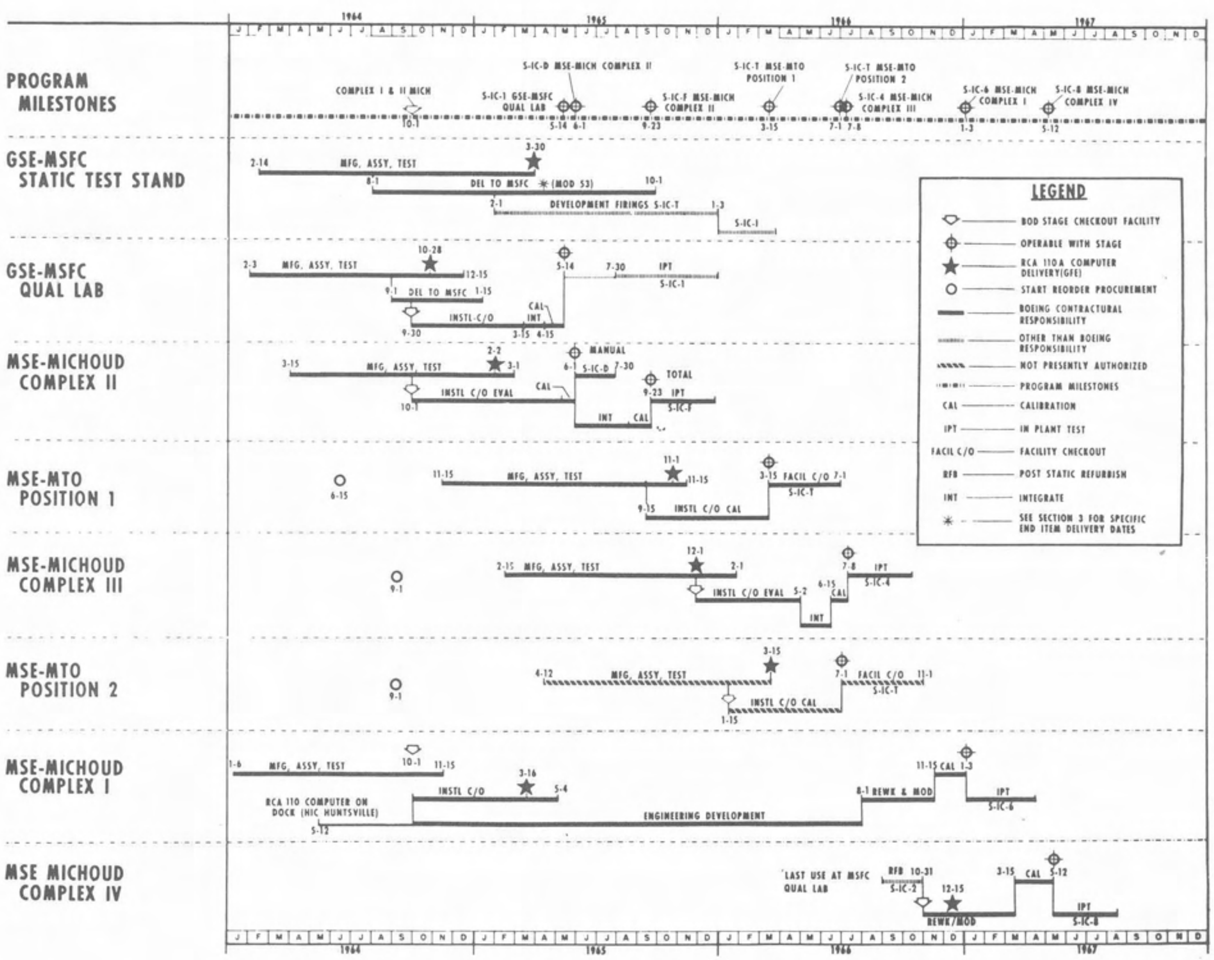


Figure X-4 - Saturn V/S-IC Test & Checkout Equipment Summary

March 1964, marked the go-ahead for the construction of the permanent Michoud PIC. A temporary PIC had been in service since April 1963. The formal opening will be concurrent with the seventh S-IC Quarterly Technical Progress and Program Review currently scheduled for late July 1964. (See Figure X-6.)

SATURN V/S-IC RESPONSIBILITY MATRICES

Saturn V/S-IC Responsibility Matrices were developed to reflect the current status of NASA/Boeing assigned responsibilities for those resolved functional and physical elements required to deliver the S-IC Stage on-dock at MILA. These items were identified to Level 5 in S-IC Program element detail with some facility items identified to Level 6.

SATURN S-IC MAKE-OR-BUY PLAN

A complete revision to Document D5-11413, "Saturn S-IC Make-or-Buy Plan," was approved by NASA/MSFC early in FY 64. Modifications to Contract NAS8-5608 since that time have necessitated numerous revisions to the plan.

Methods for reducing the make-or-buy approval processing time and associated costs have been jointly explored in a series of Boeing-NASA/MSFC meetings during the past year. Documentation of the mutual agreements resulting from these discussions have been transmitted to NASA/MSFC for review and approval.

DOCUMENT CONTROL PROGRAM

A Branch Document Control program was implemented during April 1964, to minimize cost of Branch document preparation and distribution; eliminate redundant documentation; ensure that required documents are prepared; provide management visibility of existing documentation; and ensure that documents are prepared in accord with approved format. This program provides control for that Boeing documentation prepared within

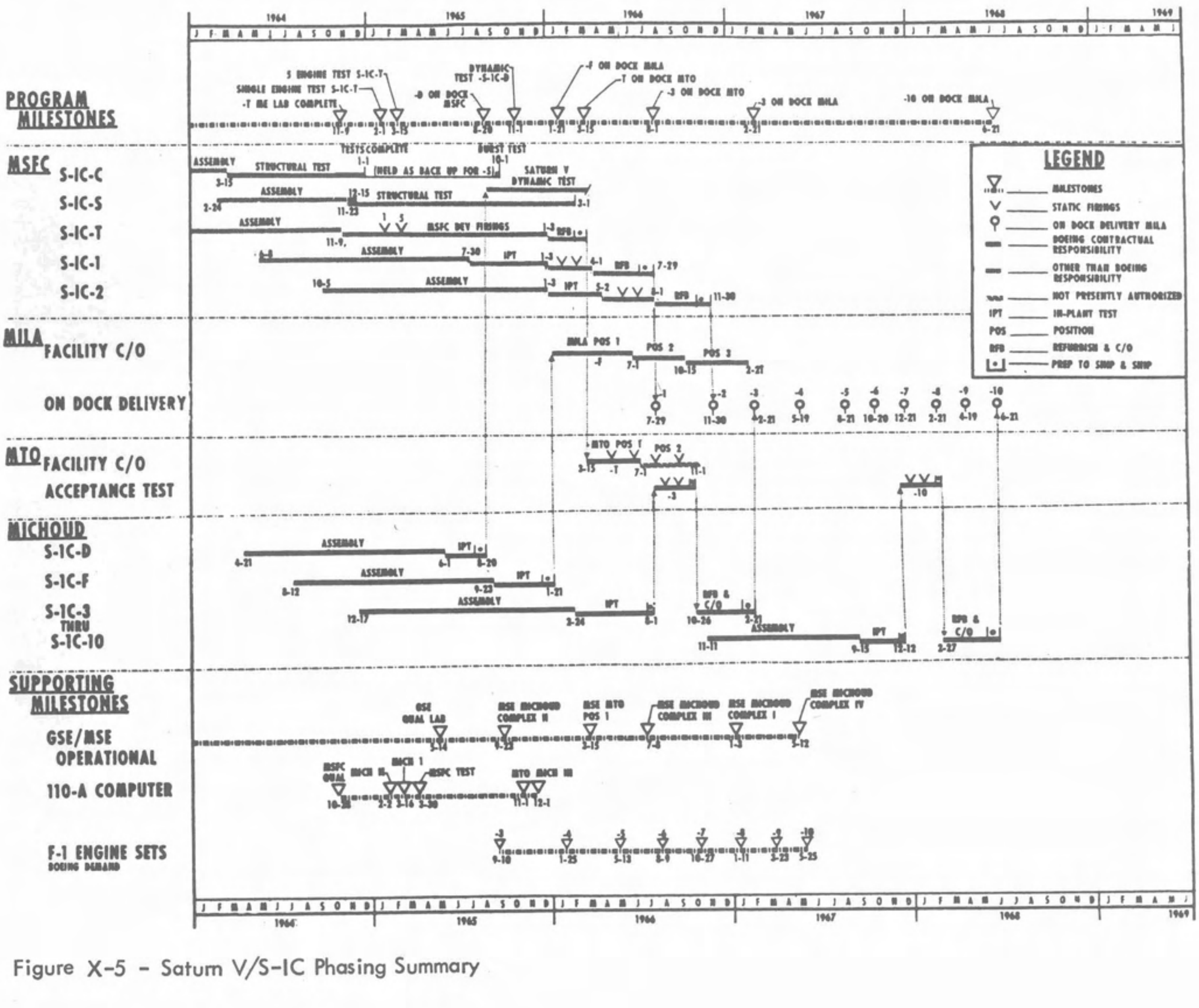


Figure X-5 - Saturn V/S-IC Phasing Summary

the Launch Systems Branch and identified with a "D5" or "T5" prefix to the identification numbers.

BACKUP PROGRAM STUDY

In March 1964, a comprehensive study was initiated to determine where Saturn V/S-IC backup programs were required. Results of this study were submitted to NASA/MSFC on April 1, 1964, by Document D5-11096, "Saturn V/S-IC Backup Program Requirements." This study also identified product improvement and growth items and provided NASA/MSFC the opportunity for review and selection of those items which appear to offer the greatest potential. It also served as a guide to NASA/MSFC for subsequent planning of back-up programs and product improvement funding require-ments.

MANPOWER

There were 3782 permanent employees procured for the Launch Systems Branch for the period July 1, 1963, through July 2, 1964. The manpower on-board at all Branch locations on July 2, 1964, was 8684. Of this total, 4391 are transfers from within The Boeing Company, and 4293 are new hires.

TRAINING

Significant training accomplishments during the year by the Launch Systems Branch included the establish-ment of an employee certification program, activation of the Michoud Training Center, and approval and im-plementation of major training programs.

FACILITIES AND STAFF

The permanent Boeing Training Center, located in the main factory building at Michoud, was completed in December 1963 (See Figure X-7). Training classes are also held in the Michoud plant welding area (Figure X-8), in various conference rooms at the Michoud Plant, and downtown New Orleans at the 225 Baronne Building and Claiborne Towers. Two permanent classrooms have also been established at the Huntsville Industrial Center.

Thirty-three personnel are actively engaged in developing and presenting S-IC training programs. This staff includes approximately 22 Instructor-Supervisors.

TRAINING PROGRAMS

Training programs within the Branch include Em-

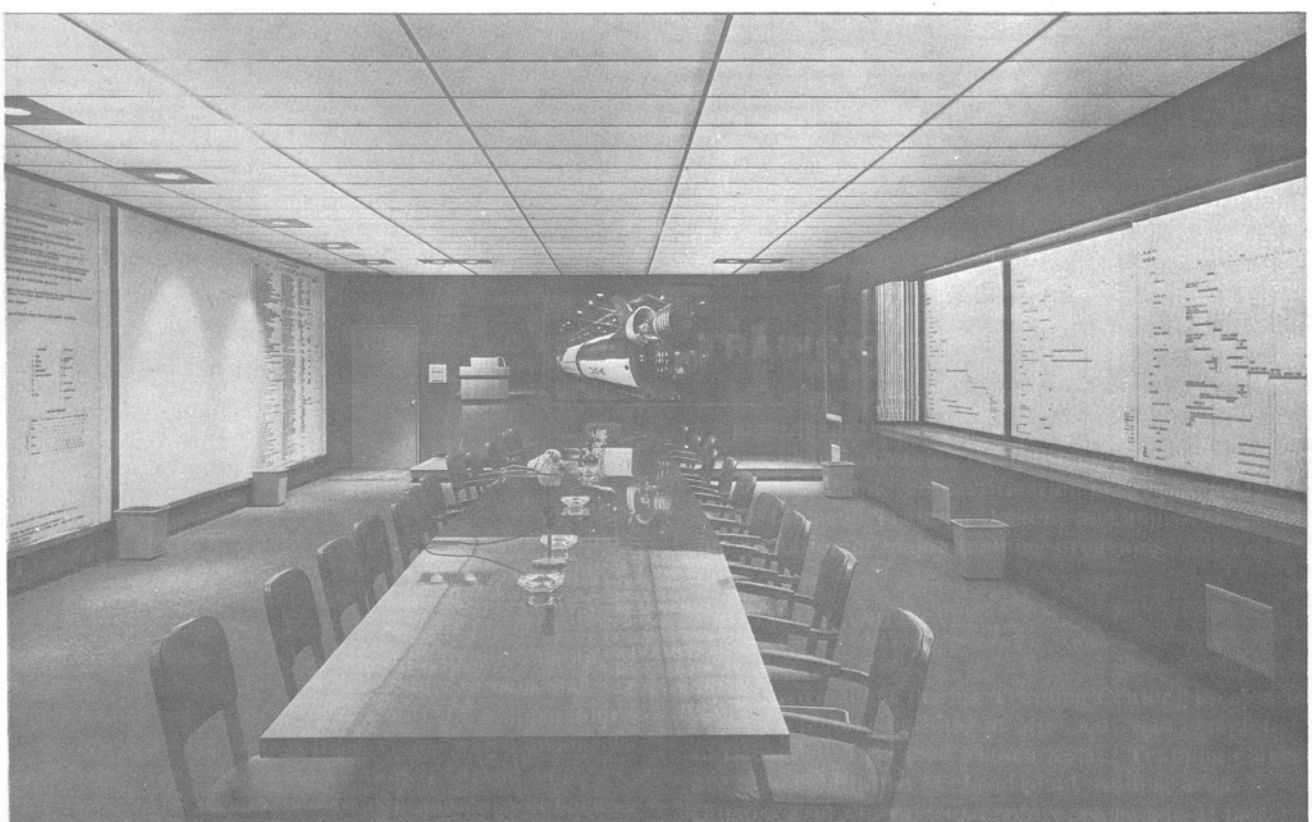


Figure X-6 - Program Information Center

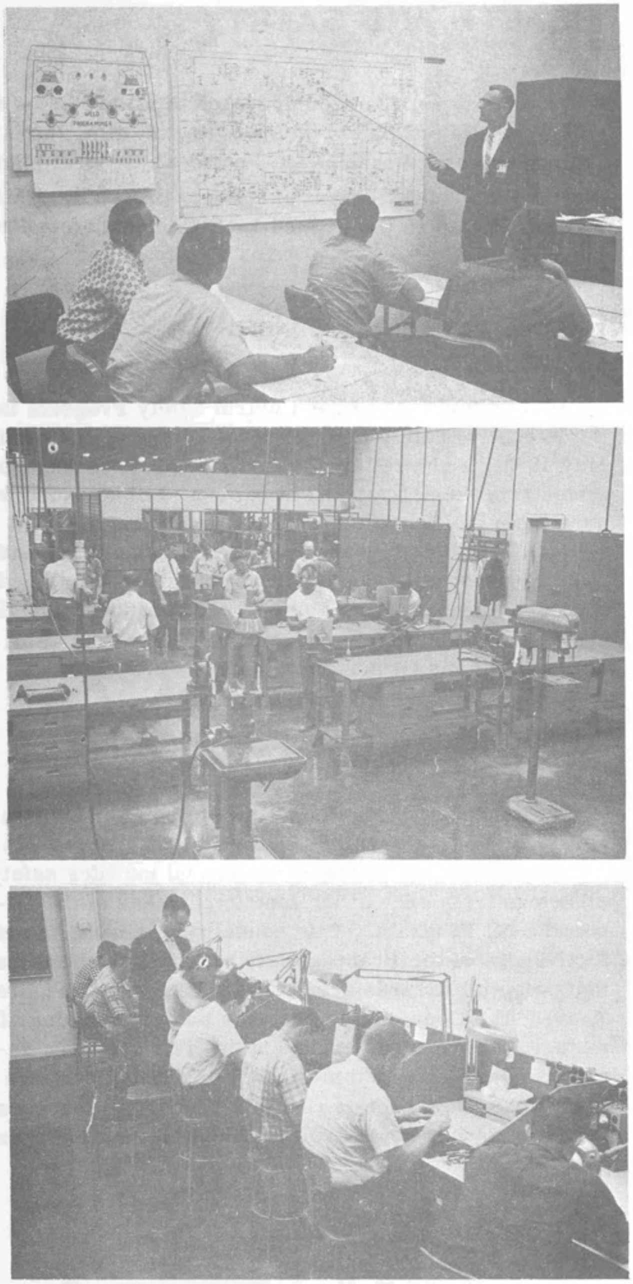


Figure X-7 - Training Classes in the Diverse Skills Needed to Build the S-IC are Being Taught in the Classrooms of the Boeing Training Unit

ployee Certification, Paid-Time Training, Off-Hours Training, and Continuing Education.

The Certification Program consists of training courses in specialized skill areas (e.g., penetrant inspection, soldering, welding, shot peening, contamination control, radiographic inspection, etc.) for employees who must attain a certain proficiency in their particular work to meet the standards of the S-IC program. During the fiscal year, 420 employees were certified in 12 types of certification courses ranging from 8 to 200 classroom hours each.

During the fiscal year, one hundred forty-two paid-time courses, oriented to improving the skills required in the employee's particular job were started, and 25 off-hours voluntary training courses were begun. In these off-hours courses, 461 employees completed training in subjects ranging from basic mathematics to computer programming.

A continuing-education program is also available for all Branch employees and management. In fiscal year 1964, this program included:

a) Technical Sessions, sponsored by colleges and universities throughout the country;
b) Seminars, Symposiums, and Conferences, sponsored by professional technical societies and organizations;
c) Graduate Study Program, Boeing-funded graduate work at nearby colleges and universities;
d) Cooperative Study Program, sponsored by Boeing, whereby college and university students work within the Branch; and
e) A Management Training Program offering advanced and fundamental management courses.

SCHOOL RELATIONS

Contacts were established with local technical, vocational, and secondary schools to compare their scholastic standards with job requirements.

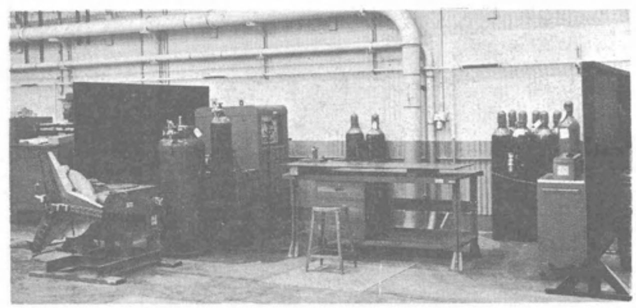


Figure X-8 - Welding Area in the Michoud Plant Where Training Classes are Held

SECURITY ACTIVITIES

Quarterly security inspections by representatives of the Air Force and NASA/MSFC were conducted at Branch facilities in New Orleans and Huntsville. The Boeing Launch Systems Branch Security Program was determined to be satisfactory.

During the past year, an extensive program was implemented to ensure that all classified files and secret control stations within the Launch Systems Branch contain only current and correctly classified documentation. Boeing was commended by NASA/MSFC for their effort and accomplishments on this program. Emphasis was also placed on a security indoctrination program.

FIRE PROTECTION AND EVACUATION CONTROL

Fire brigades have been established at Michoud and Huntsville Launch Systems Branch facilities. These brigades consist of volunteer Boeing employees who receive training in fire prevention and fire fighting (Figure X-9). Monthly fire brigade meetings are held.

The Fire and Evacuation Control Plan for the Branch leased facilities at 225 Baronne Street in New Orleans was put into operation during the year.

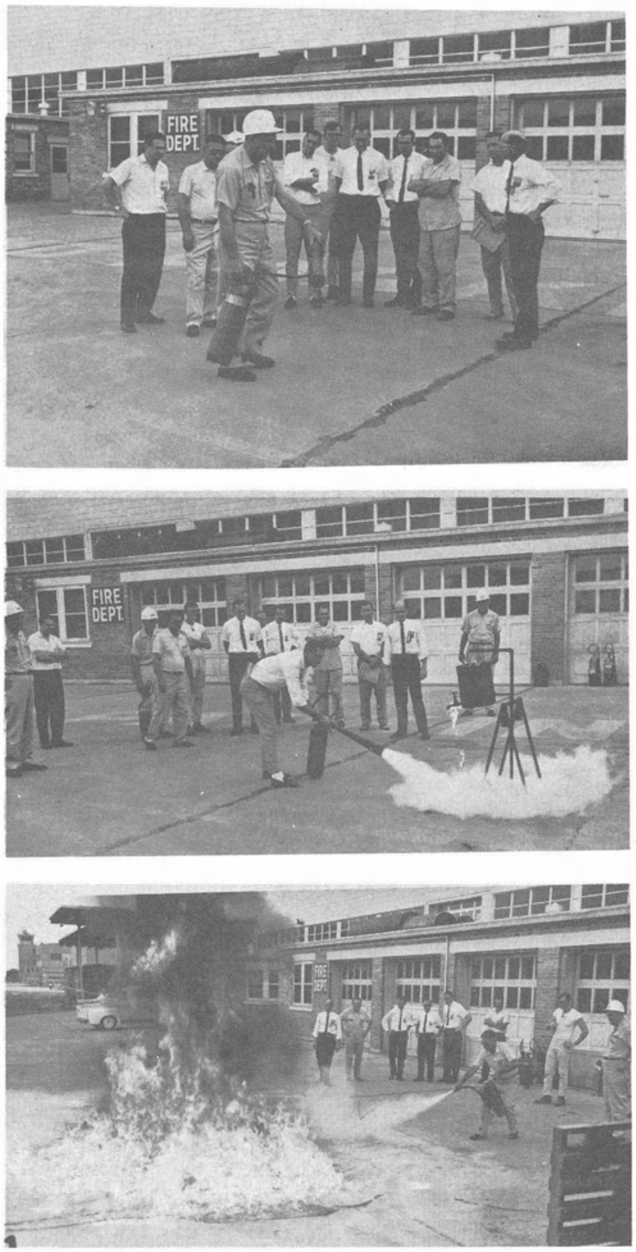


Figure X-9 - Company Personnel Receive Instruction in the Use of Fire Fighting Equipment Under Varying Conditions

HEALTH AND SAFETY

To ensure an organized approach to all problems involving health and safety on the S-IC program, the Launch Systems Branch Vice President-General Manager directed the establishment of a safety program. This was designated as the Branch Line-Control Safety Program.

EXECUTIVE SAFETY COUNCIL

Administering the Line-Control Safety Program is the Executive Safety Council. This Council, formed in May 1963, is chaired by the Assistant Branch Manager, or his representative, and is composed of key supervisors from the Boeing functional organizations.

During the fiscal year, the Council established authority, responsibility, and general policy for safety and accident prevention programs at Michoud and Huntsville, and directed that safety councils be established at all Launch Systems Branch locations.

MICHOUD SAFETY COUNCIL

The Michoud Safety Council was formed in September 1963. This Council is chaired by the Launch Systems Branch Operations Manager, and includes safety directors from each of the functional areas of the Michoud S-IC Program. This council implements the effectiveness of the Branch safety program, and ensures that potential hazards are properly controlled (Figure X-10). The Council also resolves safety problems of mutual concern to the organizations represented. Increased emphasis by this Council on safety practices of Boeing subcontractors resulted in a marked decrease in frequency and severity of accidents during the fiscal year.

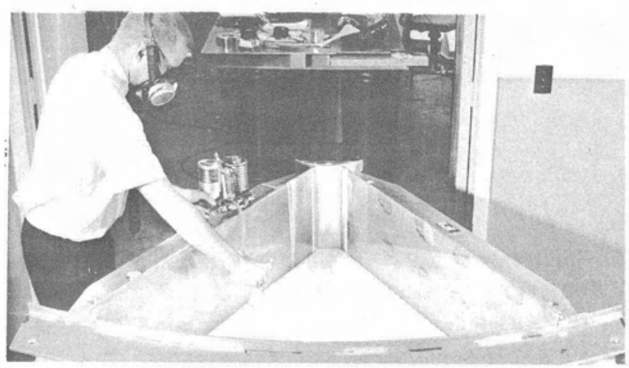


Figure X-10 - A Hygienist Takes a Sample of Toxic Polyurethane Resin Vapors to Determine Their Concentration

HUNTSVILLE SAFETY COUNCIL

The Huntsville Safety Council, chaired by the Boeing

Huntsville-Deputy Manager, was formed in January 1964, and operates on the same principal as the Michoud Safety Council. An MSFC/Boeing agreement has been reached on proper safety coordination where Boeing employees are working in NASA supervised shops.

VISITATIONS

On February 24, 1964, Dr. Wernher von Braun and members of his immediate staff toured the Boeing/Wichita facility (Figure X-11) where they were briefed on the scope of Wichita Saturn support effort, program status, and Boeing/Wichita resources.

Representative Olin Teague, Chairman of the House Subcommittee on Manned Space Flight, toured the Michoud Operations on January 24, 1964.

On March 27, 1964, Virgil I. "Gus" Grissom became the first United States Astronaut to visit the Michoud Operations. Major Grissom was briefed by the Saturn Manager of the Launch Systems Branch, and then toured the Boeing Michoud facilities (Figure X-12).

Figure X-11 - Dr. von Braun and Lt. Col. C. C. Bliss Talk With Boeing Airplane Division Vice-President/ General Manager, J. O. Yeasting, During a Visit to the Wichita Facility

EQUAL EMPLOYMENT OPPORTUNITY

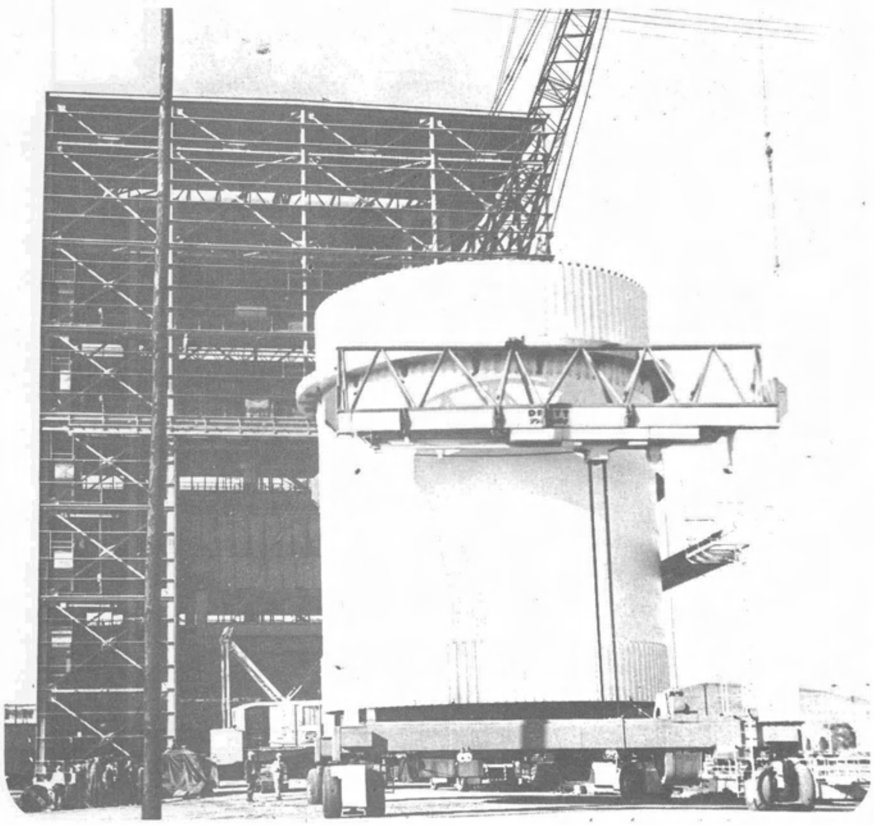
A Plan for Progress Committee, established in May 1963, held bi-monthly meetings to ensure implementation, within the Branch, of the Plan for Progress Agreement signed by Boeing with the President of the United States. A log of the significant activities was reviewed by a government compliance officer in March 1964. Typical activities include: contact with the Urban League on job requirements; presentations on job opportunities at city-wide workshops, senior highschools, and special meetings; review of job classifications to ensure

Figure X-12 - Astronaut V. I. "Gus" Grissom is Shown With NASA and Boeing Representatives at the Boeing Michoud Plant

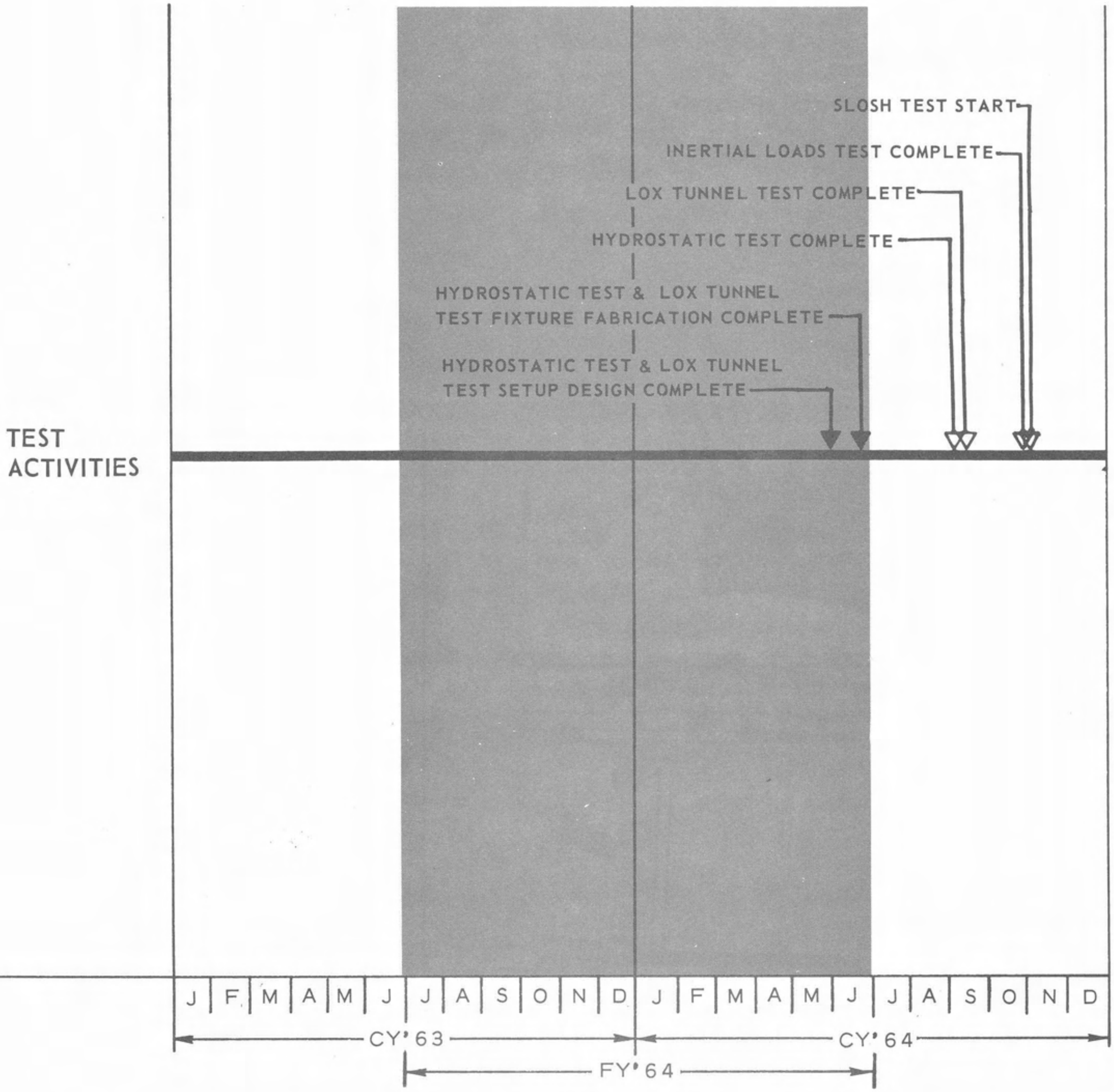
proper placement; and publicizing minority achievement on television and national periodicals.

GOOD NEIGHBOR FUND

A Boeing Good Neighbor Association was established within the Branch. It has pledged funds to the United Givers of New Orleans and the Huntsville United Fund, and has made numerous contributions to charities that do not participate in the United Fund.



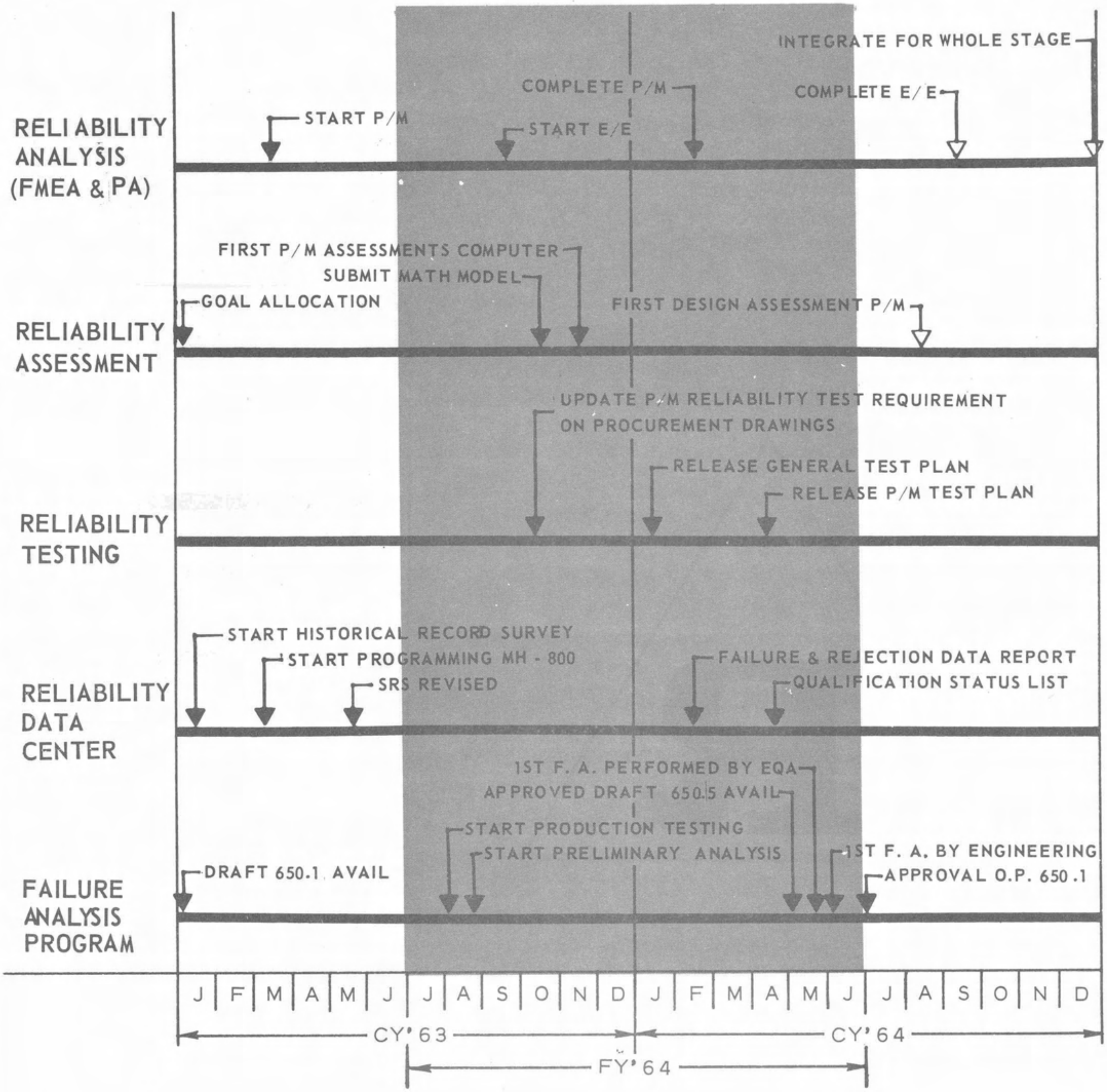
S-IC MISSION SYSTEMS SUPPORT


SLOSH TEST START
INERTIAL LOADS TEST COMPLETE
LOX TUNNEL TEST COMPLETE
HYDROSTATIC TEST COMPLETE
HYDROSTATIC TEST & LOX TUNNEL
TEST FIXTURE FABRICATION COMPLETE
HYDROSTATIC TEST & LOX TUNNEL
TEST SETUP DESIGN COMPLETE
TEST
ACTIVITIES
J F M A M J J A S O N D J F M A M J J A S O N D
CY' 63
CY' 64
FY' 64

MAJOR COMPONENT STRUCTURAL TEST PROGRAM

Contract Modification No. 64, received January 17, 1964, authorized Boeing to perform the testing of the S-IC-C test fuel tank at MSFC. The tank was fabricated by NASA/MSFC and installed on the test fixture early in March. Preparation for testing was begun. Minor delays, primarily due to delayed receipt of instrumentation towers and to strain-gage bonding problems caused by the severe environmental conditions on the outdoor stand, have been encountered. However, hydrostatic testing will start in July, and the series of structural tests (excluding the burst test) are expected to be completed as scheduled during February 1965. The tank is to be held as a backup for the S-IC-S; therefore, the burst test is not scheduled until September 1965.

RELIABILITY


RELIABILITY ANALYSIS (FMEA & PA)
START P/M
START E/E
COMPLETE P/M
COMPLETE E/E
INTEGRATE FOR WHOLE STAGE
RELIABILITY ASSESSMENT
GOAL ALLOCATION
FIRST P/M ASSESSMENTS COMPUTER
SUBMIT MATH MODEL
FIRST DESIGN ASSESSMENT P/M
RELIABILITY TESTING
UPDATE P/M RELIABILITY TEST REQUIREMENT ON PROCUREMENT DRAWINGS
RELEASE GENERAL TEST PLAN
RELEASE P/M TEST PLAN
RELIABILITY DATA CENTER
START HISTORICAL RECORD SURVEY
START PROGRAMMING MH - 800
SRS REVISED
FAILURE & REJECTION DATA REPORT
QUALIFICATION STATUS LIST
FAILURE ANALYSIS PROGRAM
DRAFT 650.1 AVAIL
START PRODUCTION TESTING
START PRELIMINARY ANALYSIS
1ST F. A. PERFORMED BY EQA
APPROVED DRAFT 650.5 AVAIL
1ST F. A. BY ENGINEERING
APPROVAL O.P. 650.1
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

INTRODUCTION

With the signing of Contract NAS8-5608, The Saturn S-IC Reliability Program was activated in January 1963. This program, based on Document D5-11013, "The Reliability Program Plan," has been revised twice consonant with program changes. Official comments on this plan were received from NASA/Michoud on July 2, 1964. A revised plan will be documented and issued in August 1964.

The stage design reliability analysis which includes failure mode and effect analysis (FMEA) and probability analysis (PA), was started in March of 1963 on the propulsion/mechanical system; this work was completed in February 1964. The electrical/electronic FMEAs and PAs were begun in September 1964, thereby affording the first integrated "single thread" analysis for the whole stage in December 1964.

The design review program, which started in February 1963, has progressed well during the year.

The reliability assessment of the S-IC stage began with goal allocation in early 1963. The math model was submitted for approval to NASA/Michoud and NASA/MSFC in October 1963. The model was programmed into the computer and successful computer runs were made in November 1963, on several propulsion/mechanical systems. Work is continuing on the math model as reliability analyses are completed, and the first complete design assessment for the stage is scheduled for July 1965.

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion Mechanical and Thrust Vector Control Systems," accepted by NASA/Michoud, was released in April 1964.

The Data Center initiated historical record surveys early in 1963 to provide reliability data to designers for part selection. To date, surveys have been made on over 500 components. In addition to inspection reports, unsatisfactory condition reports, and inter-service data exchange program reports, over 700 documents and reports are available concerning the performance of some of these components in past programs.

In March 1963, NASA/MSFC made the decision that their MH800 computer would be used for data recording and analysis rather than the IBM7090, and the Data Center proceeded with the necessary reprogramming. This programming is now about 70-percent complete and all basic programs are scheduled for completion in the first quarter of 1965. Difficulties have been encountered in acquiring computer time to check out and test required computer programs. If sufficient time is not provided, the Data Center programs may be delayed still further. Action has been taken to bring this problem to the attention of NASA/MSFC and Boeing management.

Production testing began during the third quarter of 1963. Reliability approval of all Unplanned Event Records (UER) is now required to ensure that complete and accurate reliability data is provided on discrepancies or failures.

The equipment quality analysis (EQA) laboratory which assesses the quality of purchased components was activated in the first quarter of 1964. The first three EQAs have been conducted and reports were issued.

Reliability auditing of all organizations for compliance with Document D5-11013, "The Reliability Program Plan," continued throughout the year on a quarterly basis.

Reliability oriented training courses were attended by 1077 personnel during the year.

ACTIVITIES

RELIABILITY PLANNING

Document D5-11013, "The Reliability Program Plan." was updated in October 1963 and February 1964, to keep it in line with overall S-IC program changes. Preliminary NASA/Michoud comments on the plan were discussed with NASA/MSFC Reliability personnel in May 1964, and formal NASA/MSFC comments were received by Boeing July 2, 1964. A revised plan will be issued in August 1964.

RELIABILITY ANALYSIS

Considerable progress was made with the S-IC reliability analysis in the following areas.

PROPULSION/MECHANICAL

First reliability analyses of the propulsion/mechanical systems were completed. The analyses were included in Document D5-12572-1, "Saturn S-IC Emergency Detection Parameter Selection Analysis," and submitted to NASA/MSFC in March 1964. Updating of the analyses to include design changes and NASA/Michoud refinements is in progress to meet the quarterly revision date of September 1964.

A preliminary propulsion/mechanical qualitative "single thread" analysis was completed and sent to NASA/Michoud for comment in June 1964. Based on this analsis, development of preliminary emergency detection and malfunction detection systems (EDS/MDS) parameter recommendations was started.

OPERATIONAL ELECTRICAL SYSTEM

Work on the reliability analysis of the operational electrical system was temporarily suspended during March and April 1964. This was to enable the design changes indicated as necessary by the partially completed FMEA to be incorporated in the drawings for the first flight stage. The FMEAs were completed in June 1964. The probability analyses are half completed.

INSTRUMENTATION/RF/TELEMETRY SYSTEM

An analysis was performed on the instrumentation/RF/telemetry system to assess the probability of successful data transmission from the S-IC stage. This was submitted to NASA/Michoud in June 1964, for decision on whether further reliability disciplines should be applied to this system.

RELIABILITY ASSESSMENT

The S-IC reliability assessment math model was programmed in the computer and proven by conducting the first design assessment runs against selected propulsion/mechanical systems. The planned assessment program was presented to NASA/MSFC in January 1964, and it is described in Document D5-11954, "Saturn S-IC Stage Reliability Assessment and Reliability Program," released in July 1964.

RELIABILITY DOCUMENTATION

Document D5-11910, "The Reliability Status Report," was issued in August 1963, and was revised June 1964. This document contains the planning detail for the performance of reliability disciplines at subsystem and component level. It provides for sign-off by Boeing Stage Design Engineering and for the check signatures of either Boeing Reliability Engineering or Booster Technology.

The time/cycle recording requirements of the S-IC stage have been documented in Document D5-12713, "Time/Cycle Recording Requirements."

Current reliability documents, operating procedures, and instructions in use by the Launch Systems Branch are shown in Figure R-1.

RELIABILITY EDUCATION

During the year, 1077 people, representing all levels of Boeing technical manpower, attended reliability courses and training programs.

These training programs encompass the whole spectrum of reliability activity as follows:

1) A 4-hour course on the basic tenets of reliability;
2) Courses, varying in length and intensity, on the Saturn Records System which contain basic reliability discussions and detailed instruction on the completion of SRS forms;
3) An 8-hour reliability analysis course in sufficient detail to enable design and staff engineers to perform FMEA and PA and based on the methods described in Document D5-11944, "Design Reliability Methods."
4) A course on contractual reliability requirements considering each paragraph of the contract reliability work statement (Exhibit A, Part I, H. of Contract NAS8-5608) and relating these paragraphs to the reliability tasks defined in Paragraph IV of Document D5-11013, "Reliability Program Plan."

Recommendations have been made to Boeing Management defining requirements for courses to be initiated this year.

SUPPLIER CONTROL

All procurement specifications of critical propulsion/mechanical components have been revised to include reliability requirements and have been signed-off by Boeing Reliability Engineering.

During the year, more than 200 management review board meetings were held to consider supplier proposals and to select suppliers. All of these were attended by reliability representatives of the Manufacturing organization.

Quality and Reliability Assurance personnel are presently performing source surveys and monitoring at 98 vendors' plants.

PART SELECTION

Proposals were made to NASA/MSFC and NASA/Michoud in February 1964, on a part selection and control program. The presentation was favorably received and Boeing is preparing Document D5-11372, "Saturn S-IC Parts Selection and Control Program" for submittal to NASA in July 1964.

DESIGN REVIEWS

During the year, 35 critical design reviews of crucial components were held either at supplier plants or at Boeing. Critical design reviews at subsystem level were rescheduled so that they would agree with Schedule Plan VII. So far, 13 of these reviews have been conducted and the critical design review program is presently on schedule. The Boeing Manufacturing Reliability organization supported the design review program by attending or coordinating a total of 137 design reviews within the Boeing Operations organization.

RELIABILITY DATA CENTER

The Data Center has analyzed all Unplanned Event Records generated to date to detect existing or potential reliability problem areas. Weekly UER analyses have been issued since November 1963. During late 1963, and early 1964, review of the UERs being received by the Data Center showed that the reliability data contained therein was incomplete. Investigation showed that this was attributable to certain incompatibilities

which existed among various standard operating instructions within Boeing. These differences have now been resolved and compatible instructions will be issued by July 1964. Document D5-11593, "The Saturn Records System," is being revised accordingly.

The Data Center has received only about 10 percent of the computer time required to check out its programs under Schedule Plan VII. All major programs were scheduled to be completed in July 1964, but it has been necessary to slide this to March 1965.

The following contractually required programs are among those which will be delayed; the qualification status list; time and cycle recording; revised UER program to enable NASA/MSFC to retrieve reliability data from the Boeing program; the configuration control program and the reliability mathematical model. This problem has been presented to Boeing and NASA/MSFC management for solution.

EQUIPMENT QUALITY ANALYSIS (EQA)

The first EQA was performed on April 14, 1964, and the first report was published on May 12, 1964. The Boeing EQA Procedure 680.2 has been published, and meetings of an EQA Committee have been held to approve the selection and scheduling of components for EQA during 1964.

TESTING

RELIABILITY TEST PROGRAM

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion/Mechanical and Thrust Vector Control Systems," was completed and released in April 1964. The released document incorporated changes recommended by the NASA/Michoud Reliability Office during a review in February 1964. The documentation was again reviewed with the NASA/Michoud Reliability Office in June. The proposed testing concept was acceptable to NASA/Michoud reliability personnel who are now reviewing test requirements contained in the document preparatory to approving the conduct of the testing.

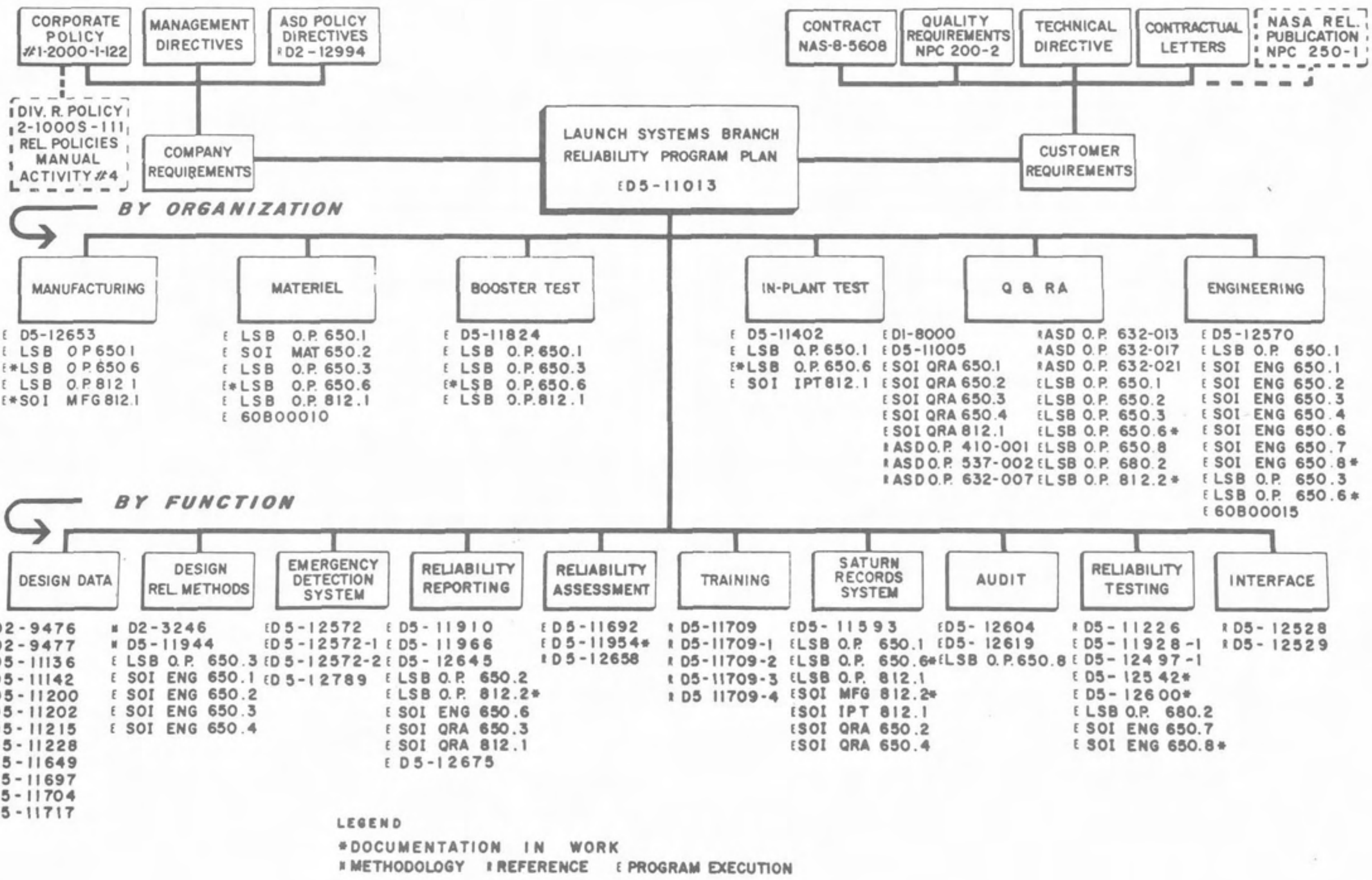


Figure R-1 Reliability Documentation and Procedures

SAFETY CRITICAL ITEMS

The hardware in the S-IC-T critical items list is under study by the Boeing Booster Test organization to determine test requirements and sequences, periodic inspections, and maintenance operations needed to assure safe operation of safety critical items.

MISSISSIPPI TEST OPERATIONS

Saturn Record System Procedures for Mississippi Test Operations have been written, and will be released by Mid-July 1964.

PRODUCTION

Production testing began during the third quarter of 1963. Reliability monitoring of the testing and the resultant handling of Saturn Record System paper work was begun accordingly. These efforts have now progressed to require reliability approval of all initiated UER paper work. This approval is designed to ensure that complete and accurate reliability data is provided on discrepancies or failures.

FAILURE ANALYSIS

The failure analysis program was implemented during the last quarter of the period. Analyses have been conducted both in the Boeing EQA and the Engineering laboratories. The Failure Analysis Operating Procedure, 650.1 was published June 24, 1964.

RELIABILITY AUDITING

The Reliability Audits Operating Procedure, 650.8 was published in June 1964. It establishes that direct audits shall be conducted on a quarterly basis. Since December 1962, audit presentations showing program progress and problems have been made to Boeing management and to NASA/Michoud and NASA/MSFC.

RELIABILITY CHART ROOM

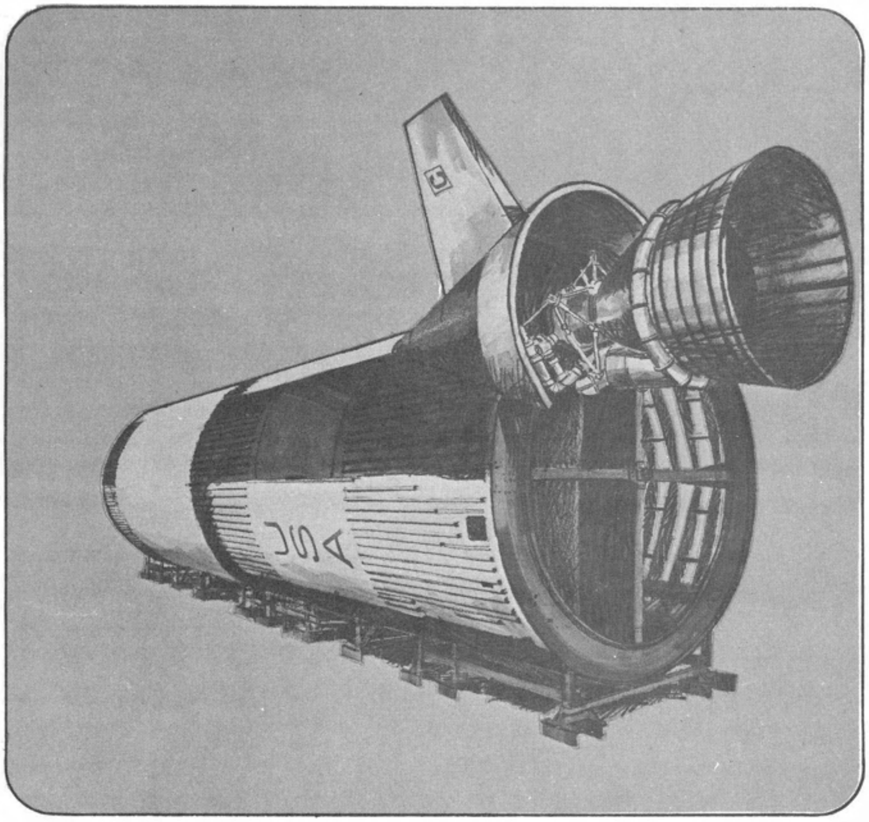
The reliability chart room now has 28 program monitoring charts on display. The charts are frequently used during formal review meetings to show reliability program progress to Boeing and NASA management.

PREDICTION

During the first 6 months of FY 1965, the following significant reliability milestones will be complete:

1) The electrical/electronic reliability analysis will be completed in September 1964.
2) The first integrated "single thread" analysis for the whole stage will be completed in December 1964.
3) The first complete propulsion/mechanical systems design assessment using the computerized reliability mathematical model is scheduled for August 1964.
4) NASA/Michoud comments on Document D5-11013, "The Reliability Program Plan," will be included in the next revision to the plan scheduled for release in August 1964.
5) The Boeing Manufacturing Reliability organization will be fully manned by November 1964. This will enable them to undertake the certification of completed Saturn Record System forms for data validity.
6) The Data Center will complete the following programs: the UER program will be revised by October to enable preliminary UERs to be recorded; the time and cycle recording program will be completed in August 1964; the qualification status listing will be in the computer by September 1964.

GOVERNMENT FIELD PRINTING PLANT
(Under Contract NAS 8-5618)
NASA – MICHOUD OPERATIONS – 1964
NEW ORLEANS 26, LOUISIANA



SATURN S-IC

FISCAL YEAR 1964 ANNUAL PROGRESS REPORT

Aug 14, 1964

D5-12601-1 [redacted]

LAUNCH SYSTEMS BRANCH
AERO - SPACE DIVISION
THE BOEING COMPANY

THE BOEING COMPANY
LAUNCH SYSTEMS BRANCH, AERO-SPACE DIVISION P. O. BOX 26088, NEW ORLEANS, LA. 70126

July 2, 1964

National Aeronautics and Space Administration
George C. Marshall Space Flight Center

IN REPLY REFER TO

Fiscal year 1964 progress of the Saturn V/S-IC Stage Program has reflected a significant transition from primarily a conceptual to an implementation phase of program activity.

The developmental nature of the S-IC Stage Program has resulted in changes to the program requirements. The most significant change was the change to program schedule Plan VII. Numerous contract modifications have been received which have significantly expanded the scope of the work assigned to The Boeing Company. At the close of FY '64, The Boeing Company capabilities are focused on implementing these new program requirements.

The release of S-IC and GSE/MSE basic design was behind schedule at the beginning of this fiscal year period. Combined action by NASA/MSFC and Boeing in such areas as approval of GSE design criteria and establishment of a streamlined approval release system has significantly improved our schedule position relative to release of design documentation.

Throughout the reporting period, the assembly and manufacturing effort was greatly affected by program changes. At the outset of the fiscal year, the assembly and manufacturing activity was primarily involved with structural component activity per Plan V requirements. Program changes such as the NASA/MSFC redirection from schedule Plan V to Plan VII, the impact of Boeing intertank redesign and the transfer of thrust structure tooling and assembly from NASA/MSFC to Boeing at Michoud has required changes in planning and program phasing. It was a period which saw many adjustments to tool loading schedules and procurement activities. As of the end of June 1964, the Launch Systems Branch had realigned its stage assembly effort in support of the new customer schedule requirements. Launch Systems Branch Michoud-assembled S-IC stages and GSE/MSE for all locations are currently predicted to be delivered per the NASA/MSFC Plan VII schedule requirements. At the same time, an all-out effort is in progress by NASA/MSFC and the Launch Systems Branch to ensure that critical problems affecting the completion of the S-IC-T stage were being properly dealt with.

Behind-schedule activation of various facilities in the Michoud complex created problems during the past year. The use of partial and interim facilities in addition to other work-around techniques has allowed Launch Systems Branch to minimize schedule impact. Permanent facility activations commenced during the fourth quarter of calendar year 1963 and continued through the end of June 1964. The remaining facilities are predicted to be completed during fiscal year 1965.

Many new and varied developmental problems will undoubtedly arise during the next fiscal year. I am confident that Boeing and NASA/MSFC management will overcome these challenges with the same team spirit demonstrated in the past.

THE BOEING COMPANY
Aero-Space Division

R. C. Dunigan

R. C. Dunigan
S-IC Program Executive
Launch Systems Branch

SATURN

S-IC

FISCAL YEAR 1964
ANNUAL PROGRESS REPORT

D5-12601-1 ■ AUGUST 14, '64

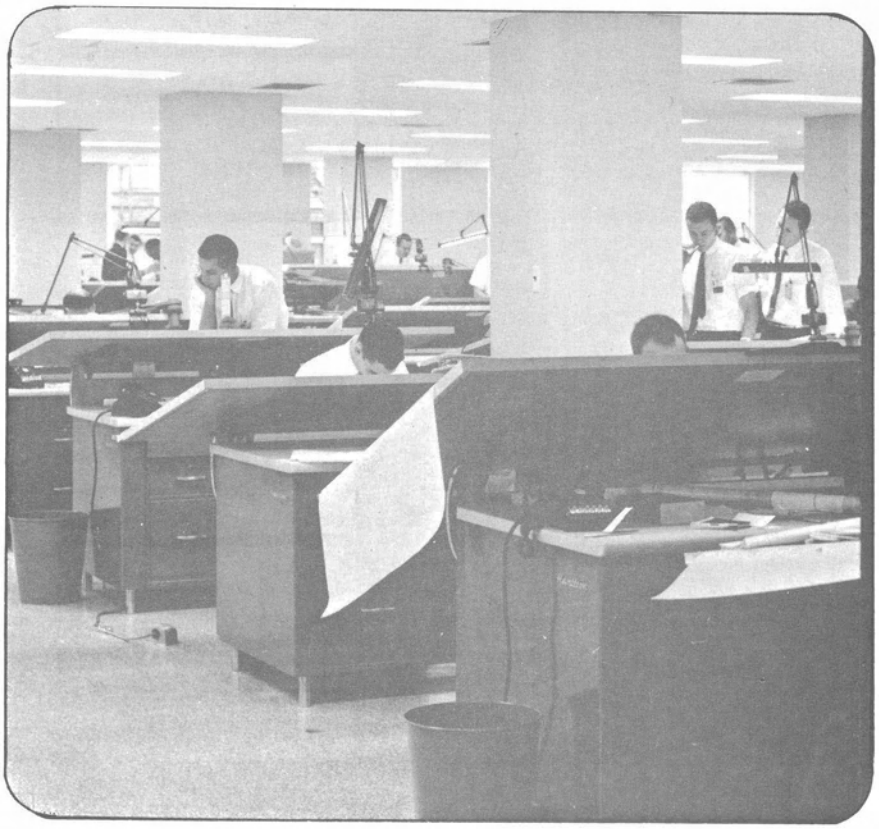
LAUNCH SYSTEMS BRANCH
AERO - SPACE DIVISION
THE BOEING COMPANY

FOREWORD

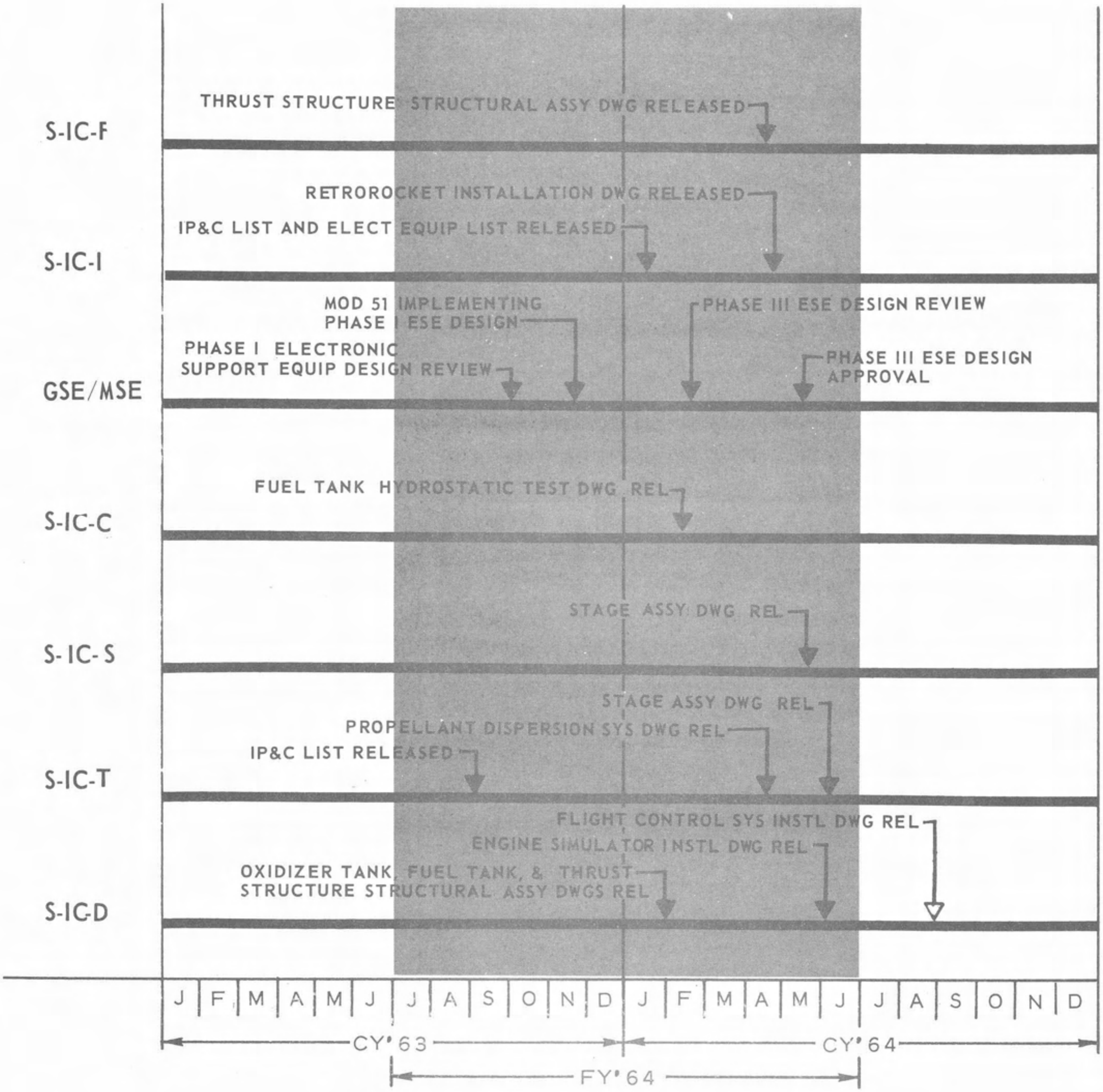
This Annual Progress Report has been prepared by The Boeing Company to fill the requirement under Article XXXI, Paragraph C, of Contract NAS8-5608 as modified by Modification 100. It encompasses the progress made by The Boeing Company on the Saturn S-IC Program for the fiscal year 1964 (from July 1, 1963 through July 2, 1964). The main objective of this report is to serve as an historical presentation stressing Boeing accomplishments and present capabilities under Contract NAS8-5608.

CONTENTS

ILLUSTRATIONS



DESIGN AND ENGINEERING


THRUST STRUCTURE STRUCTURAL ASSY DWG RELEASED
S-IC-F
RETROROCKET INSTALLATION DWG RELEASED
IP&C LIST AND ELECT EQUIP LIST RELEASED
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MOD 51 IMPLEMENTING PHASE I ESE DESIGN
PHASE III ESE DESIGN REVIEW
PHASE I ELECTRONIC SUPPORT EQUIP DESIGN REVIEW
PHASE III ESE DESIGN APPROVAL
GSE/MSE
FUEL TANK HYDROSTATIC TEST DWG REL
S-IC-C
STAGE ASSY DWG REL
S-IC-S
STAGE ASSY DWG REL
PROPELLANT DISPERSION SYS DWG REL
IP&C LIST RELEASED
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ENGINE SIMULATOR INSTL DWG REL
OXIDIZER TANK, FUEL TANK, & THRUST STRUCTURE STRUCTURAL ASSY DWGS REL
S-IC-D
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

During Fiscal Year (FY) 1964, two major program redirections (NASA/MSFC Plan V and VII) from NASA/MSFC resulted in S-IC stage program schedule changes. This rescheduling reflected changes in phasing as well as an interchange of certain task assignments. Little relief was afforded to the Engineering documentation release schedule, since the S-IC-T release requirements remained unchanged in order to provide early capability for test firings.

The S-IC stage basic design documentation, lagging at the beginning of FY '64, is currently on schedule. The recovery, which was accomplished during the last quarter of the fiscal year, is the result of concentrated effort on the factors that delayed design activity and the streamlining of the design approval process.

On June 4, 1964, the release of the S-IC-T stage assembly drawing completed the basic releases for that test stage. The basic design releases of all major structural elements for subsequent vehicles were also completed during the year.

Change action against released basic design became a substantial design effort during the year. During the last quarter of the reporting period, there was also increased emphasis in technical assistance rendered in solving fabrication problems encountered by NASA/MSFC, Boeing, and the various vendors.

Early in FY '64, release of GSE/MSE drawings was slow because of delays in design criteria approvals. These delays were offset in part by a more detailed design review during the Pre-Phase I and Phase I reviews, making it possible to proceed more accurately and quickly to Phase III or production design releases. This has enabled Boeing to maintain on-schedule status at FY '64 year end.

S-IC STAGE DESIGN

Several variations of the S-IC are being designed by Boeing under specifications and technical direction provided by NASA/MSFC. The configurations being designed and their primary purposes are listed below:

Model	Purpose
S-IC-T	Static test of F-1 engines and engine systems.
S-IC-C	Fuel Tank only—for structural testing.
S-IC-S	All major structural components—for use in structural testing of assembled stage.
S-IC-D	For use in dynamic testing of the assembled Saturn V vehicle. This configuration is further defined under Electrical and Instrumentation Section.
S-IC-F	Facilities checkout at MILA.
S-IC-1 through S-IC-10	Flight vehicles

The progress made on S-IC design and development throughout FY '64 is discussed in the following sections.

DOCUMENTATION

Release of basic design documentation, at the start of the fiscal year, was substantially behind the schedule required to meet hardware program schedules. This documentation was returned to schedule during the second half of the year (Figure I-1). Schedule position was regained by (1) recovery on the design schedule, and (2) reduction of release processing flow time. The design schedule was recovered by concentrated effort in areas where design criteria had caused delayed effort. Release processing time was shortened in March 1964, by reducing flow-time for the approval process, as authorized by Contract Modification 76. Although there were S-IC program schedule changes during the year, there was little effect on documentation release schedules as the S-IC-T schedule was not altered.

Change action against released basic design became a substantial design effort during the year. At the close of FY '64, change documentation release, with only minor exception, was being made in accordance with change commitments established by the joint NASA/MSFC-Boeing Change Board. Documentation has been completed for approximately 200 changes since inception of change action against the S-IC stages. Changes have resulted from design criteria revision, adverse structural test results (intertank), instrumentation requirement additions, and weight saving.

WEIGHT STATUS

There was increasing emphasis during the year on S-IC vehicle weight control and reduction. The first major weight reduction — approximately 4500 pounds — was accomplished during the first quarter through use of a computerized analytical model study of the S-IC thrust structure. The resulting design documentation was issued under Change Action Memo (CAM) 72. Deletion of the requirement for the in-flight LOX dome purge system (CAM 112) shortly thereafter, eliminated 1200 pounds of system weight.

A joint NASA/MSFC-Boeing weight reduction team was established in September 1963, to review and implement weight saving ideas. Under this weight reduction program, eight weight saving changes have been approved by NASA/MSFC to effect an additional total weight reduction of approximately 7000 pounds. The effects of these weight changes are detailed in Figure I-2. Program schedule impact has been minimized by committing the changes to later flight vehicles; however, all presently committed weight reduction changes will be incorporated on vehicles on which payload weight capability will become critical.

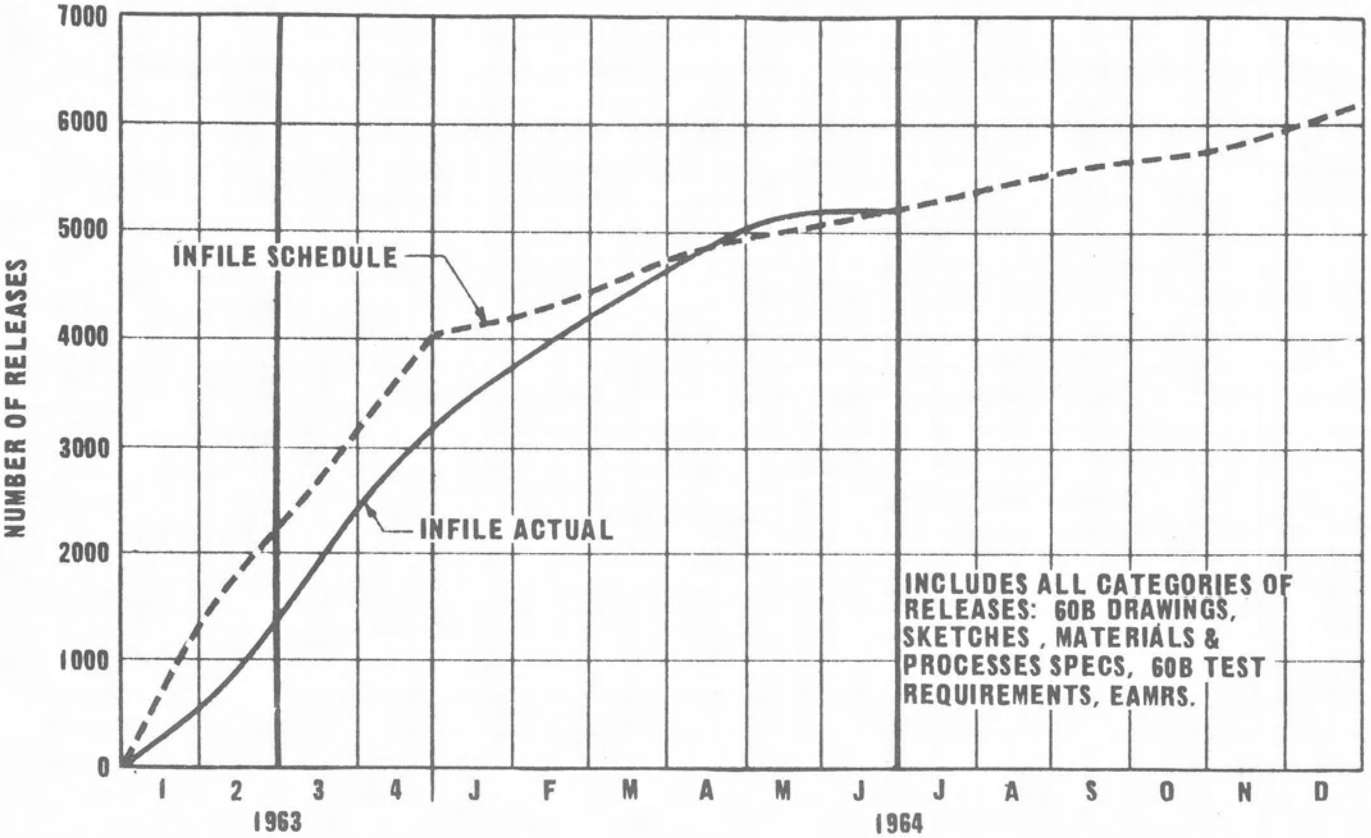
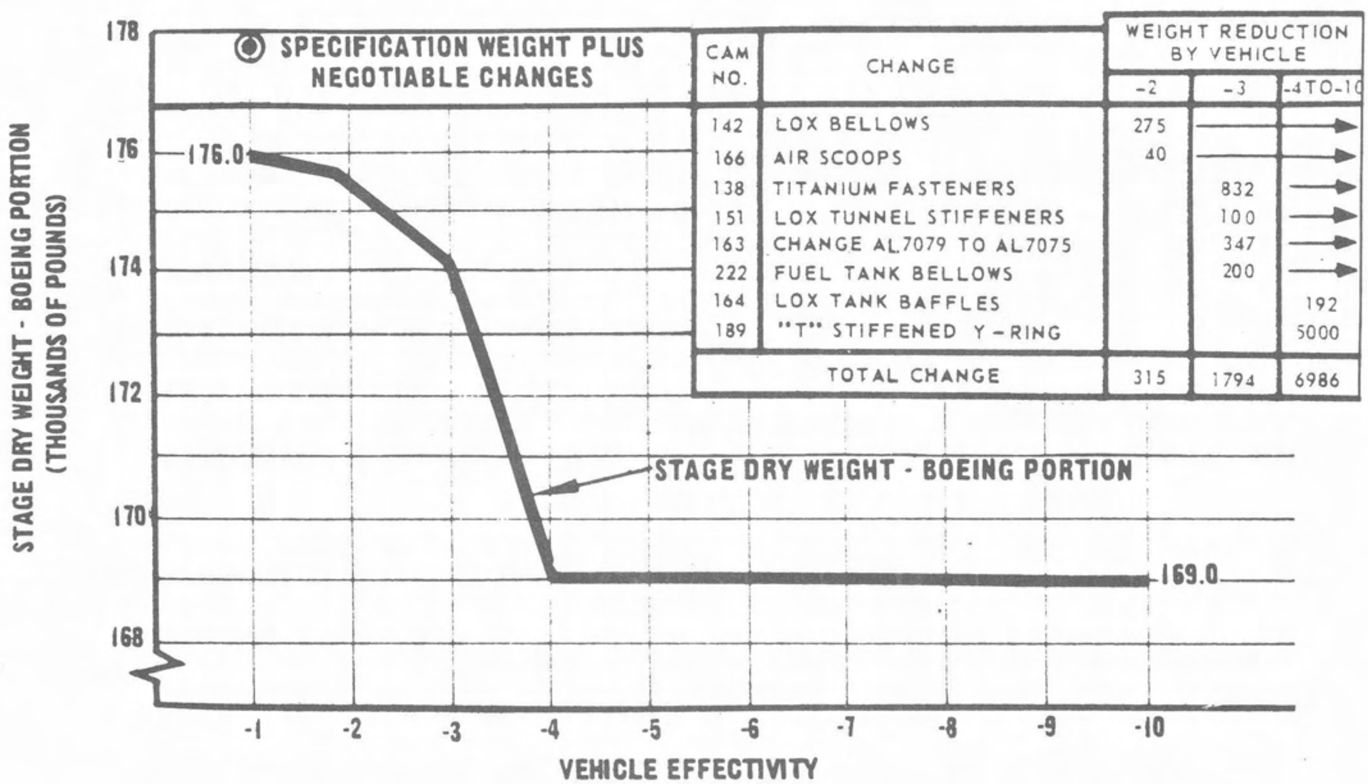


Figure I-1 - S-IC Stage Basic Release Schedule -- Plan VII



CAM NO.	CHANGE	WEIGHT REDUCTION BY VEHICLE -2	-3	-4 TO -10
142	LOX BELLOWS	275	→	→
166	AIR SCOOPS	40	→	→
138	TITANIUM FASTENERS		832	→
151	LOX TUNNEL STIFFENERS		100	→
163	CHANGE AL7079 TO AL7075		347	→
222	FUEL TANK BELLOWS		200	→
164	LOX TANK BAFFLES			192
189	"T" STIFFENED Y-RING			5000
	TOTAL CHANGE	315	1794	6986

Figure I-2 - S-IC Weight Reduction Program

The only weight originally specified in Contract NAS8-5608 was the total stage dry weight of 287,000 pounds. To provide a direct basis for evaluation of Boeing weight control performance, a specification allowance for the Boeing-controlled portion of the S-IC was established as 174,282 pounds at a NASA/MSFC-Boeing meeting in March 1964. The specification allowance and the general definition of Boeing responsibility were formalized by Contract Modification 109. The calculated weight for the Boeing-controlled portion of the S-IC at the time of establishment of specification allowance was 172,285 pounds. The weight history of the S-IC-1 is shown in Figure I-3. The effect on weight of changes considered to be negotiable is carried in the specification allowance line subsequent to formal definition of Boeing responsibility.

STRUCTURAL DESIGN

Basic release of documentation for the S-IC-T was completed in early June with the release of the stage assembly drawing. Basic release of all major structural elements for subsequent vehicles was also completed during the last quarter of the fiscal year. The heat shield installations remain to be released, and the stage assembly drawings for S-IC-D and subsequent vehicles will be released following completion of electrical and instrumentation design early in CY'65.

With the completion of most of the basic design activity, emphasis has shifted to change design and technical support of manufacturing, vendors, and the various test activities affecting S-IC structure.

Significant structural design problems were encountered and resolved during the year. The most important of these were a dynamic loading problem and an intertank structural problem.

Early in the fiscal year, analytical studies of stage dynamic loads indicated a possibility that a direct dynamic coupling of transient engine thrust buildup and vehicle release loads would substantially exceed specified load factors for stage structural design. After further study, it was recommended that the stage holddown release mechanism be changed from an instantaneous release device to a system in which holddown restraint is released gradually to avoid sudden application of release loads. This solution was agreed to, and subsequent study, including revised estimates of engine thrust buildup rates, indicated that the holddown mechanism change would eliminate the problem.

A second major problem was encountered during development testing of 1/8-scale models of the intertank structure. The intertank structure consists of a longitudinally corrugated skin with circumferential stiffener rings. Design of the intertank was based on the very

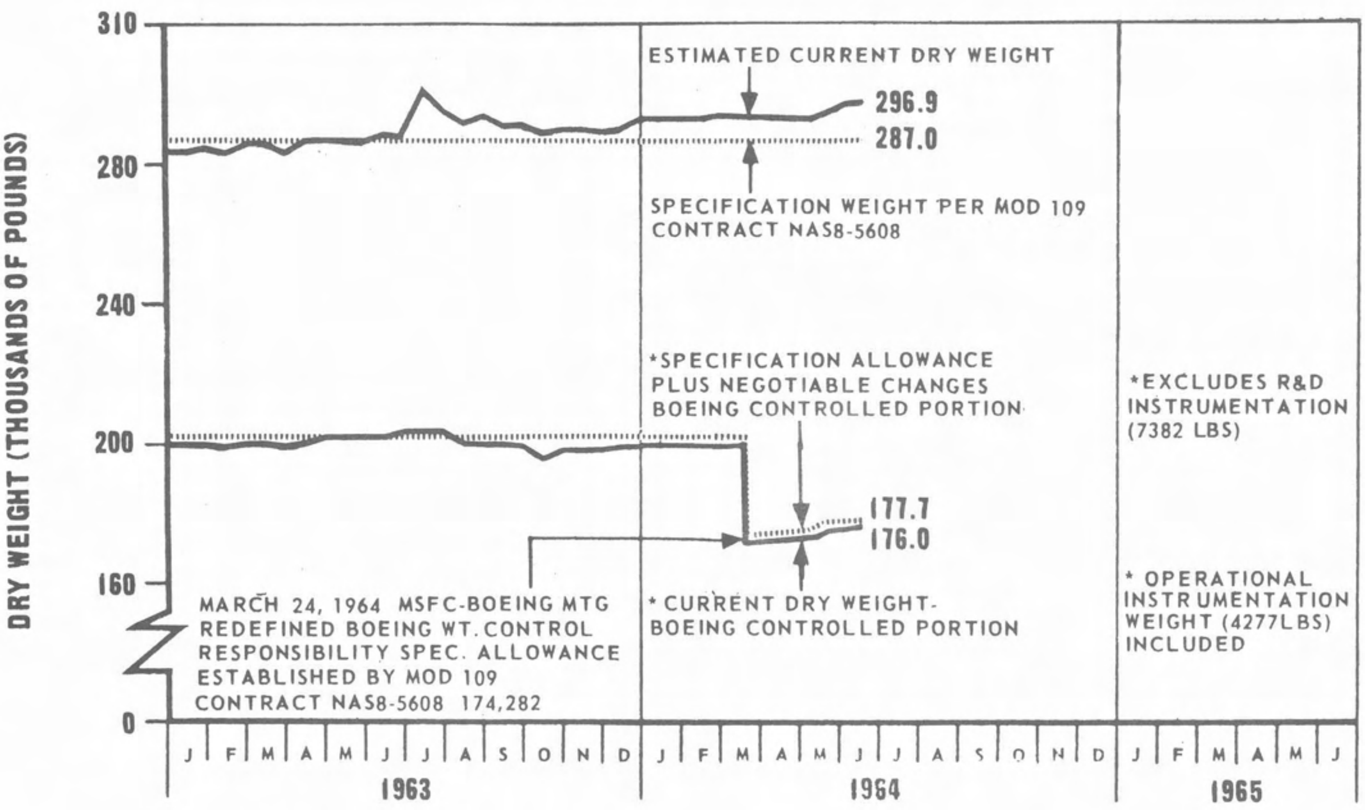


Figure I-3 - S-IC Dry Weight Status

limited experimental data available for this type of structure under compression loading; however, because of the limited data available and because of its questionable applicability to large structures, such as the S-IC intertank, scale-model development testing was essential.

Initial tests during the second quarter of the year resulted in failures at substantially less than the expected load (as applicable to the scale model). Subsequent testing confirmed the early test results.

A change (CAM 207) has been initiated to redesign the intertank in accordance with NASA/MSFC Technical Directives 180 and 211. The intertanks for the S-IC-T, -D, and -S will use the existing design, since these units will not be subjected to flight vehicle loads. The S-IC-1, -2, and -3 intertanks will be a heavier (approximately 2600 pounds) "minimum risk" unit with thicker skins and stronger ring frames. Such an approach is necessary to avoid program schedule delays, since substantial testing is required to establish a minimum weight design of adequate strength.

As presently planned, the S-IC-4 will incorporate a lighter weight design. One intertank of the present configuration and one intertank of the heavy S-IC-1 configuration will be loaded to destruction to provide data for correlation of full-scale and sub-scale tests, and additional sub-scale tests will be utilized to determine S-IC-4 design. An S-IC-4 configuration intertank will also be loaded to destruction to verify its design.

PROPULSION AND MECHANICAL EQUIPMENT DESIGN

Basic release of documentation for the S-IC-T was completed during the last quarter of the year, with the exception of the F-1 engine conversion drawings, which are scheduled for release early in calendar year 1965. Release of all basic drawings for the S-IC-D, -F, -S, and -1 has also been completed. All component, assembly, and subsystem qualification test requirements have also been released.

As with structural design, emphasis has shifted to change design and technical support of manufacturing, vendors, and the test activities affecting propulsion and mechanical equipment.

ELECTRICAL AND INSTRUMENTATION DESIGN

This S-IC-T basic design was completed during the last half of FY '64. Basic release of S-IC-D test instrumentation, cables, and equipment mass simulators was begun following definition of the S-IC-D configuration in February. Approximately 1100 electrical/instrumentation basic drawings remain to be released for the S-IC-D. The remaining release breakdown includes cable assemblies, equipment and cable installations, mass-simulated equipment, brackets, connectors, and other installation details. The general configuration definition to which S-IC-D basic release is being made is described below:

a) The electrical configuration will be the same as the S-IC-1, except that electrical/electronic equipment and transducers will be omitted. Dummy equipment simulating the mass of the actual equipment will be installed for all items weighing over 20 pounds, and for all shock-mounted equipment.

b) Installation provisions will be made for all instrumentation equipment.

c) All electrical cabling will be installed.

d) Except for the engine servo-actuators, propulsion components weighing over 20 pounds will be simulated by dummies. All flight hardware mounting provisions will be included.

During the latter half of the fiscal year the highest priority was assigned to release of documentation for CAM 177, which provides the Systems "A" Basic and the Research and Development Measurement systems for the S-IC-T vehicle. System "A" measurements are defined by NASA/MSFC Document SK10-1596 Revision A, "S-IC-T Static Firing Measurement Requirements." Measurement Systems "A" is a system of transducers which will be wired directly to recorders as the primary instrumentation for data gathering during ground test firings. Over 700 items of electrical and instrumentation documentation have been required by CAM 177. Design work was completed on all items by the first of June and all remaining documentation was completed and in release process at the end of the year.

Responsibility for releasing S-IC-1 through S-IC-10 measurement instrumentation program was transferred from NASA/MSFC to Boeing following NASA/MSFC approval of the S-IC-1 Instrumentation Program and Components (IP&C) list late in the second quarter of the fiscal year. Approval of the IP&C list permitted identification of the instrumentation and electrical configuration for the S-IC-1. Instrumentation program and electrical equipment lists will be released individually for S-IC-2 through S-IC-10, with the various releases scheduled through January 1966. Any change between the instrument list for S-IC-1 and subsequent lists will be implemented by change action to revise affected structures, propulsion, and electrical documentation.

Direction to proceed with design and development of a visual instrumentation installation was received late in the third quarter of the fiscal year by Modification 75 to the contract. The visual instrumentation consists of two television cameras viewing the engine turbo pumps and four ejectable and recoverable movie cameras, two to record liquid movement in the oxidizer tank and two to record stage separation (separation view cameras will be omitted from the S-IC-T). Development was well under way at the end of the fiscal year, with preliminary drafts of procurement drawings for the LOX tank optical system (fiber optics bundles, lenses, etc.) and the photo-optics timer specification distributed to potential suppliers. Preliminary drafts of procurement drawings for other components are nearing completion. The NASA/MSFC breadboard of the photo-optics strobe light has been received at Michoud and is under test.

Some difficulties and delays were encountered during the year in the development of the various propellant measuring systems for the S-IC. These systems consist of the fuel and LOX loading probes (for determination of loading completion), the LOX and fuel engine cutoff sensors, and the R&D instrumentation for liquid level and fuel slosh measurement. All of these systems are to be installed in the S-IC-T. Despite the delays encountered, all are expected to be delivered in time to be installed in the S-IC-T, and all parts are expected to be qualified before the S-IC-T is placed on the test stand.

GSE/MSE DESIGN

Simulated flight tests and static firing tests of the S-IC stage will be accomplished primarily through application of automatic digital programing and evaluation techniques. Ground support equipment (GSE) will evaluate the performance and integrity of a completely assembled stage at R-Qual and R-Test. Manufacturing support equipment (MSE) will accomplish the same goals at Michoud and the Mississippi Test Operations (MTO). Tests conducted on the S-IC stage will be fully automated except when automation is impractical for economic or technical reasons. Automated testing is the goal to which engineering design effort is being directed. Boeing design concepts developed early in the program were reviewed during the first half of the reporting period; subsequent redirection culminated in Modification 51 to Contract NAS8-5608 on November 21, 1963.

DOCUMENTATION RELEASE

Early in FY '64, release of drawings was slowed as a result of delay in the approval of the design criteria. These delays were offset, in part, by a more detailed design review. By achieving greater definition of detail during the Prephase I and Phase I (System Design Concept) reviews, it was possible to proceed more accurately and quickly to Phase III (Production Design) releases and maintain schedule (Figure I-4). Contract Modification 51 directed incorporation of the Phase I design changes. This was followed by the Phase III design submittal on February 25, 1964. NASA/MSFC gave approval on May 15, 1964 based on incorporation of comments resulting from the design review. The majority of comments fell within the contract scope and did not significantly affect overall design. Action has been initiated to incorporate all items which were within the scope of the contract. Change Action Memos have been initiated for nine recommended design improvement items which are beyond the scope of the contract.

On June 2, 1964, Boeing was given limited direction to resume work on the MTO design, temporarily suspended in December 1963. Interim funding was provided until Modification 102 officially became part of the

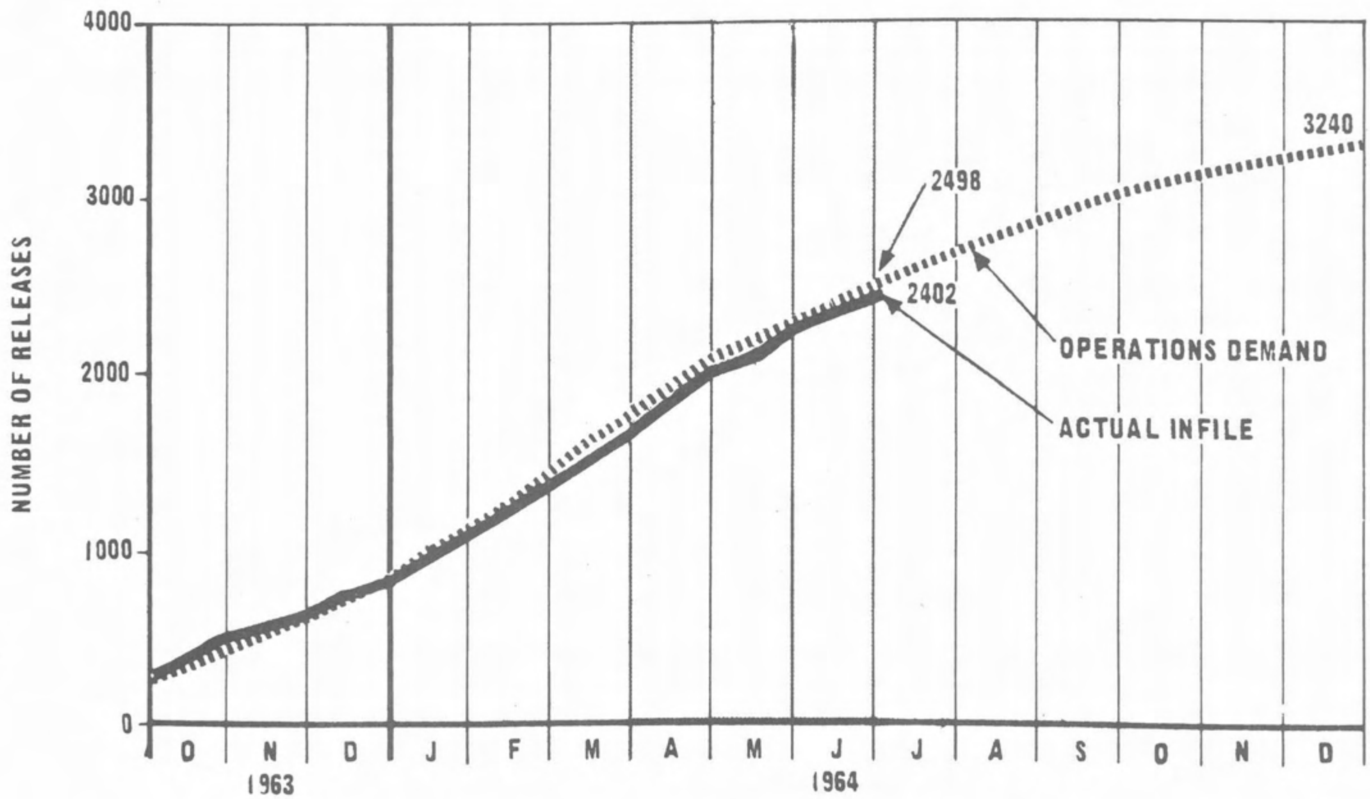


Figure I-4 - Engineering Basic Release Schedule-- GSE/MSE

contract. Work is now in progress detailing the design requirements for the MTO test and checkout complexes.

TEST AND CHECKOUT EQUIPMENT DESIGN

Substantial changes have been made to the original concept of the test and checkout complexes during the year. These changes resulted from the Prephase I and Phase I design reviews and had a major impact on the degree of automation and capability of the test and checkout complexes. Some of these changes are described briefly below.

The original test and checkout equipment concept called for centralized control of testing. This has been modified to add provision for switching test control to test operators at the individual test stations within the test and checkout complex.

Another expansion of capability has been incorporated in the area of data recording. Originally, records were to be stored within the computer for printout later. The new design retains computer storage and adds the ability to store data in direct writing recorders.

Capability of the mechanical test control equipment has also been increased. In the original concept, testing could be conducted on a limited one-at-a-time basis. The expansion of equipment adds flexibility and permits simultaneous testing of components.

Equipment sharing has been eliminated. At the Michoud complex, instead of using one computer plus a switching distributor to control testing on two vehicles, inidividual computers will be used in the testing of each vehicle. These are representative of the Prephase I and Phase I design changes. In general, test and checkout capabilities have increased with a necessary accompanying increase in equipment design effort.

The test and checkout complexes (Figure I-5) are composed of a control and monitor station, a computer station, a mechanical test station, a data systems test station, the related interconnection equipment, checkout calibration, and maintenance equipment. Test personnel direct and control the execution of tests performed by the digital computer. Computer codes allow full automatic and semi-automatic operations as well as local control from the test stations. Each test station contains the stimuli generators and control circuitry necessary to test the stage system with the computer. Error detection and fault isolation techniques are employed to make more effective usage of the test equipment and to reduce operating time on stage systems.

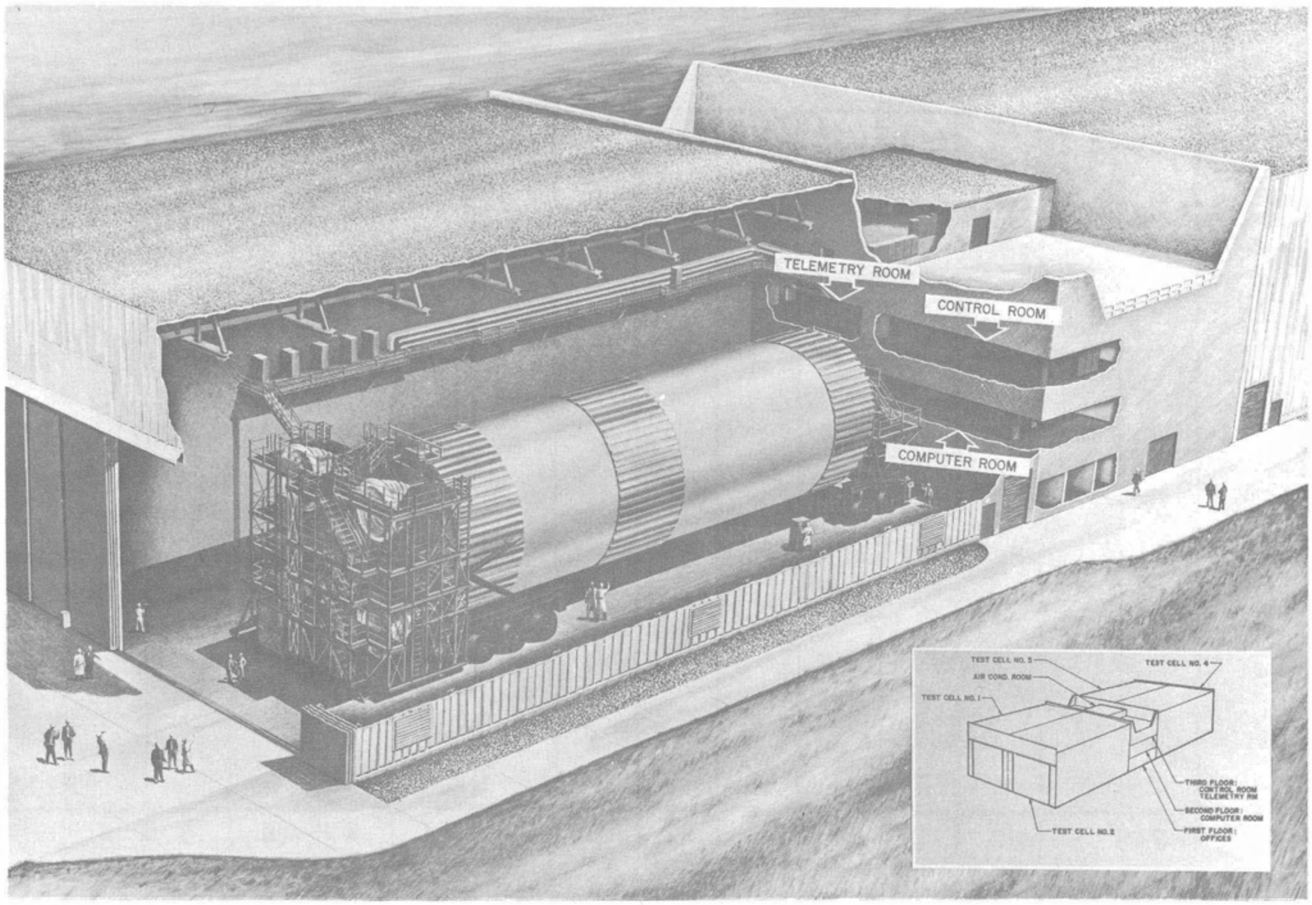


Figure I-5 - Test and Checkout Complex

Control and Monitor Station

The Control and Monitor Station (Figure I-6) includes the control and monitor console, the audio communication equipment, the closed-circuit TV equipment, and the cathode ray tube (CRT) interface and control logic equipment. The console provides control of the computer-directed test system and furnishes stage and test system status information. Design of all portions of the console has been completed, with assembly drawings and wiring schematics released for procurement of equipment.

The CRT display incorporated in the console, provides display capability for subsystem testing, troubleshooting, maintenance, and for presentation of supplementary information during normal testing (Figure I-7). Preliminary design of the CRT was completed during the first quarter of this reporting period along with construction of a feasibility model. Since then, checkout of the model has been completed and demonstrations of its capabilities have been made to NASA/MSFC personnel on several occasions. Late in April, authorization to proceed with the Boeing-Raytheon CRT display system was received for the NASA/MSFC Quality Division and Michoud Test and Checkout Complexes, and a contract was let to Raytheon on June 3, 1964, to proceed with production of five units.

The audio communications systems consist of the general area paging system, local area paging system, and the intercommunications system. Design of each of these systems has been completed, specification drawings have been released, and equipment is now beginning to arrive at Michoud from suppliers.

A closed-circuit TV system is provided for each test cell to enable the test engineers to monitor activity on and around the stage. Design in this area is 95 percent complete, with some equipment already receiveed, functionally tested, and prepared for storage until ready for assembly into the system.

Computer Station

The Computer Station (Figure I-8) utilizes the RCA-110A digital computer. Under control of its internal program and guided by the test conductor, the computer generates digital words, analogs, and discretes as required to program the individual test stations and stage under test.

Design of the Computer Station, including the equip-

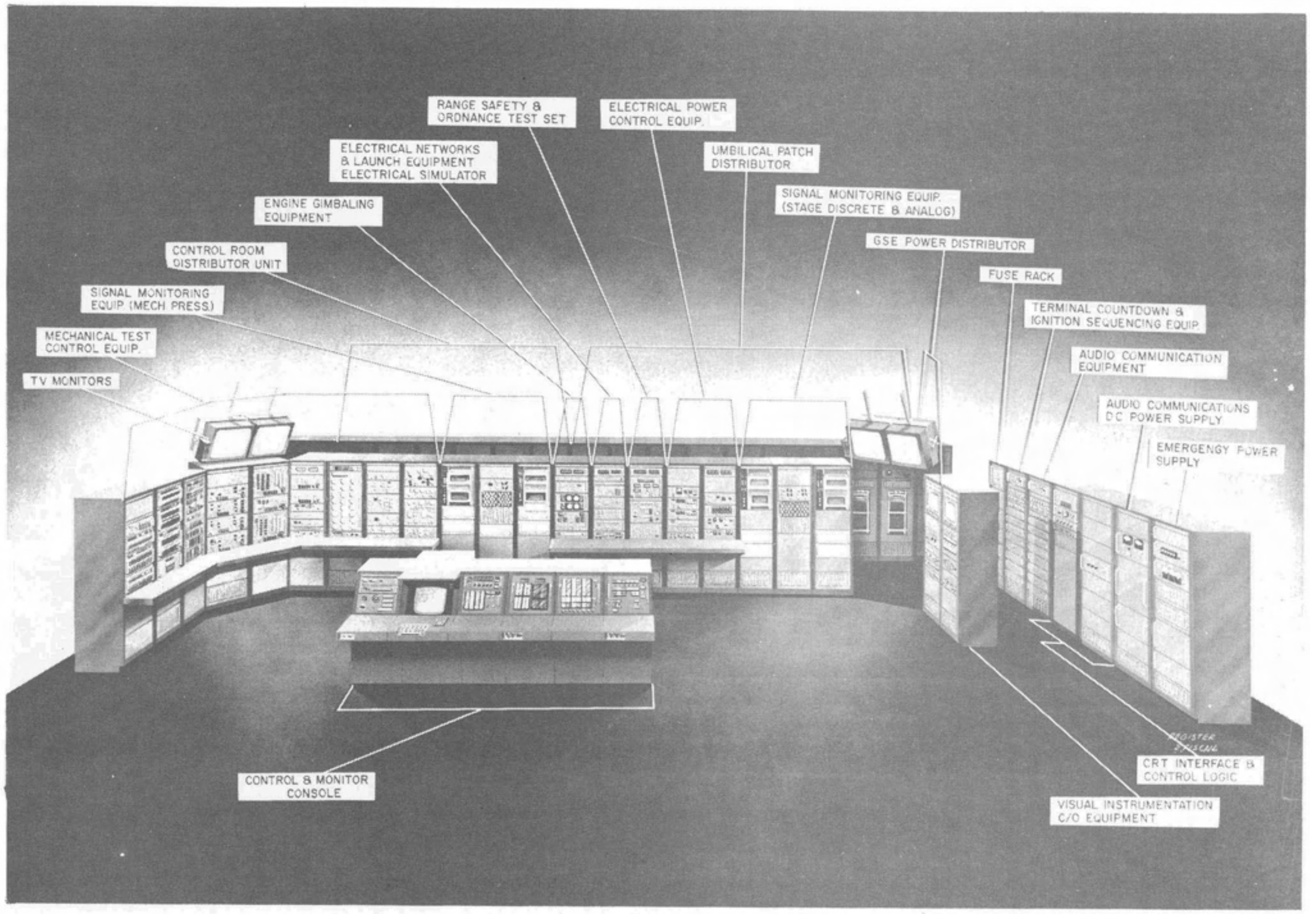


Figure I-6 - Control and Monitor Station

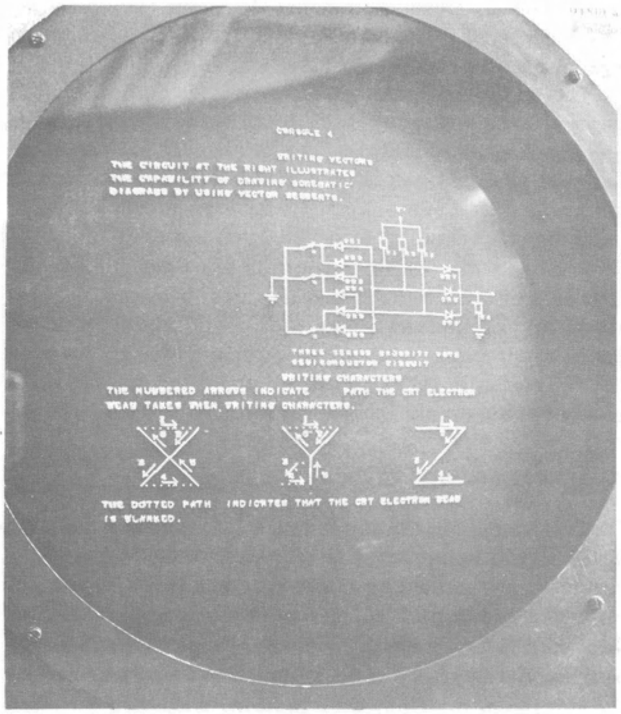


Figure I-7 - Typical CRT Presentation

ment necessary to generate special inputs required by the ground computer system and that equipment necessary to ensure computer interface compatibility with other test and checkout equipment, has been completed. Information recently received from RCA reveals significant differences in the 110A computer interface. Modifications are necessary to include additional interface circuits. Redesign will be initiated as soon as firm data is obtained from RCA. Specification and assembly drawings have been released for some of the associated equipment, and procurement is under way.

The Boeing Company has been using NASA/MSFC computer facilities a few hours each week for program development, training, and coding of automatic test procedures and processors including the MSFC specified Acceptance Test or Launch Language (ATOLL) translator . Use of the NASA/MSFC facilities has been an interim measure necessitated by the lack of an RCA 110A computer. NASA/MSFC has since supplied an RCA 110 computer which was installed at the Boeing Engineering Evaluation Laboratory in Huntsville. Installation took place in late May and checkout continued through early June. On June 11, the computer became operational. Shortly after that, the CRT display feasibility model was interfaced with the computer for continued developmental research.

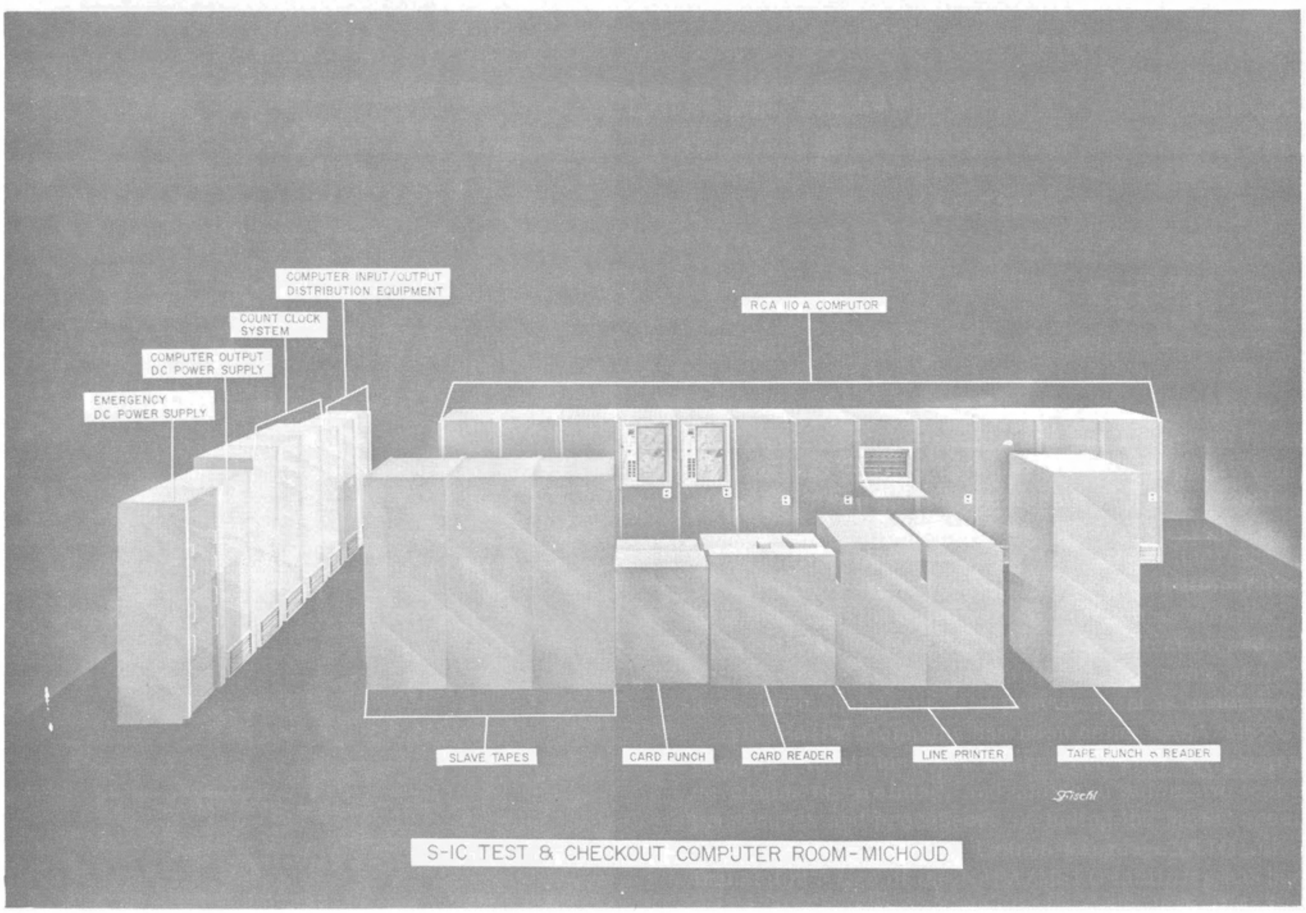


Figure I-8 - Computer Station

In December 1963, Modification 59 was incorporated, adding timing equipment for the Michoud computer stations. The NASA/MSFC design has been completed and the Boeing revised drawings are in process of being released.

Electrical Power Station

The Electrical Power Station consists of the 60-cycle AC ground power supply, the stage DC ground power supplies, the overall test battery supply, emergency DC power supplies, the GSE DC power supply, the computer output DC power supply, and the audio communication equipment power supply. The overall test battery supply provides ground power to the stage battery bus in lieu of vehicle battery power during test and checkout. In the event that power from a DC ground supply is lost, an emergency DC power supply will provide power to the stage and to essential test and checkout control equipment necessary to place the stage in a safe condition and proceed with an orderly shutdown. The GSE DC power supply provides the 28-volt DC power required by the test and checkout equipment for switching, indication, display, and control functions necessary to program the electrical and the mechanical test stations, either in the manual or automatic mode. The computer output DC power supply provides the minus 28-volt DC power required to operate relays in the computer discrete output distribution rack. Power required by the audio communication equipment for the entire test complex is provided by the audio communication equipment power supply.

Design for the Electrical Power Station has been completed. Specification drawings have been released and contracts have been let for all power supplies. Acceptance test procedures are being prepared, with the first of the tests beginning at the end of June 1964. Design of the 400-cycle AC ground power supply was cancelled with the decision to substitute an ignition system, operating from a 750-volt AC system, for the S-IC-F, -D, and flight stages. The S-IC-T will use a 28-volt DC pyrotechnic ignitor.

Electrical Test Station

The Electrical Test Station consists of the range safety and ordnance test rack, the range safety transmitting antenna equipment, the exploding bridge wire (EBW) pulse sensor equipment, the electrical networks test sets, the electrical power control equipment, the signal monitoring equipment, and the terminal countdown and ignition sequencing equipment.

The stage range safety and ordnance systems are tested after they are installed in the fully assembled S-IC stage. The EBW pulse sensor equipment analyzes the voltage output of the EBW firing units, and determines if the firing unit is acceptable. The electrical networks test rack consists of the local control panel, the upper stage electrical networks substitute, the switch selector control equipment, the launch equipment electrical simulator, the emergency detection system checkout equipment, the engine gimballing equipment, and the portable engine gimballing equipment. The upper stage electrical networks substitute provides all the necessary terminations and control signals normally provided to the S-IC stage by the upper stages. Switch selector control equipment provides signals to program the stage switch selector. Simulation of various launch functions which are not available as part of the factory and pre-static firing checkout procedure is provided by the launch equipment electrical simulator. The emergency detection system checkout equipment checks out the emergency detection system of the S-IC stage. The engine gimballing equipment, both rack mounted and portable, provides signals for testing the engine servo-actuators on the S-IC stage, the stage hydraulic system, and the associated stage electrical wiring. Central control for all major GSE power and GSE stage power is provided by the electrical power control equipment. Signal monitoring equipment is provided to record selected stage pressures and analog signals. The terminal countdown sequencer provides signals, in the proper sequence and time relationships to control the launch functions required during countdown and static firing. The ignition sequencer provides signals in the proper sequence and time relationships to control the ignition and shutdown of the five engines of the S-IC stage.

Design for all portions of the Electrical Test Station has been completed. The major portion of specification and assembly drawings have been released, and procurement of equipment has begun.

Mechanical Test Station

The Mechanical Test Station consists of test and test-related equipment and its control equipment, to provide control and monitor functions for propulsion testing. The station is controlled by the computer to perform mechanical tests which normally consist of the following:

1) Application of turbo-pump heater power, allowing the thermostat to cycle, and evaluation of the results;
2) Performance of all valve operation, timing, and sequencing;
3) Activation of pressure switches, and evaluation of results;
4) Application of pneumatic and hydraulic pressures to the stage, in the sequence necessary to perform overall performance tests, such as simulated launch, cutoff, and abort.

The mechanical test control equipment consists of control and display equipment (switches, indicator lights, sequential displays, and communications equipment) to control the Mechanical Test Station.

The test display and control panel indicates the system under test, test status, malfunction indication,

and control mode. Certain major test parameters are also displayed, such as hydraulic pressure and flow rates, pneumatic supply pressure, and station power supply voltage. Controls include those required for manual control tests and certain emergency or panic stop controls.

The pneumatic supply unit, pneumatic pressure test racks, and flowmeters, provide and control high-pressure helium, nitrogen, or dry air to pressurize and test the fuel and LOX feed systems, the fuel and LOX tanks, and the ullage systems. Design has been completed for the pneumatic equipment, and drawings have been released for procurement and assembly.

The hydraulic power supply units provide hydraulic fluid to the S-IC to provide flow to both the engine start valves and the engine gimballing system. Design for all the hydraulic equipment has been completed, critical design reviews have been held, and the majority of drawings have been released. Design has also been completed on the hydraulic control interconnection equipment.

Data System Test Station

The Data System Test Station (Figure I-9) consists of the digital data acquisition system (DDAS), integrated telemetry ground equipment, RF terminal equipment, remote automatic calibration unit, DDAS tape recorder, instrumentation calibration equipment, telemetry digitizing equipment, and the visual instrumentation checkout equipment. A relatively new technique is being employed in the test and checkout of the Saturn V stages. This is the use of the airborne telemetry system as a ground test tool. The DDAS, a development of NASA/MSFC, makes use of airborne pulse-code-modulation telemetry system components for sampling and encoding data which is then transmitted over a coaxial link via a carrier frequency. This data is used for prelaunch checkout and sent by the DDAS ground equipment to the computer and to various test stations for evaluation. The integrated telemetry ground equipment receives, demultiplexes, and decodes telemetry signals from the stage during factory checkout. The RF terminal equipment serves as a distribution center for all telemetry RF and video signals arriving from the test cells. The stage and its associated ground support equipment incorporates a remote automatic calibration of instrumentation transducers. This system provides a capability to test the measuring transducers required for monitoring functional readiness of the vehicle from a remote position. The instrumentation calibration equipment provides and controls power and calibration signals to the telemetry equipment on the stage. The telemetry digitizing equipment receives the analog out-

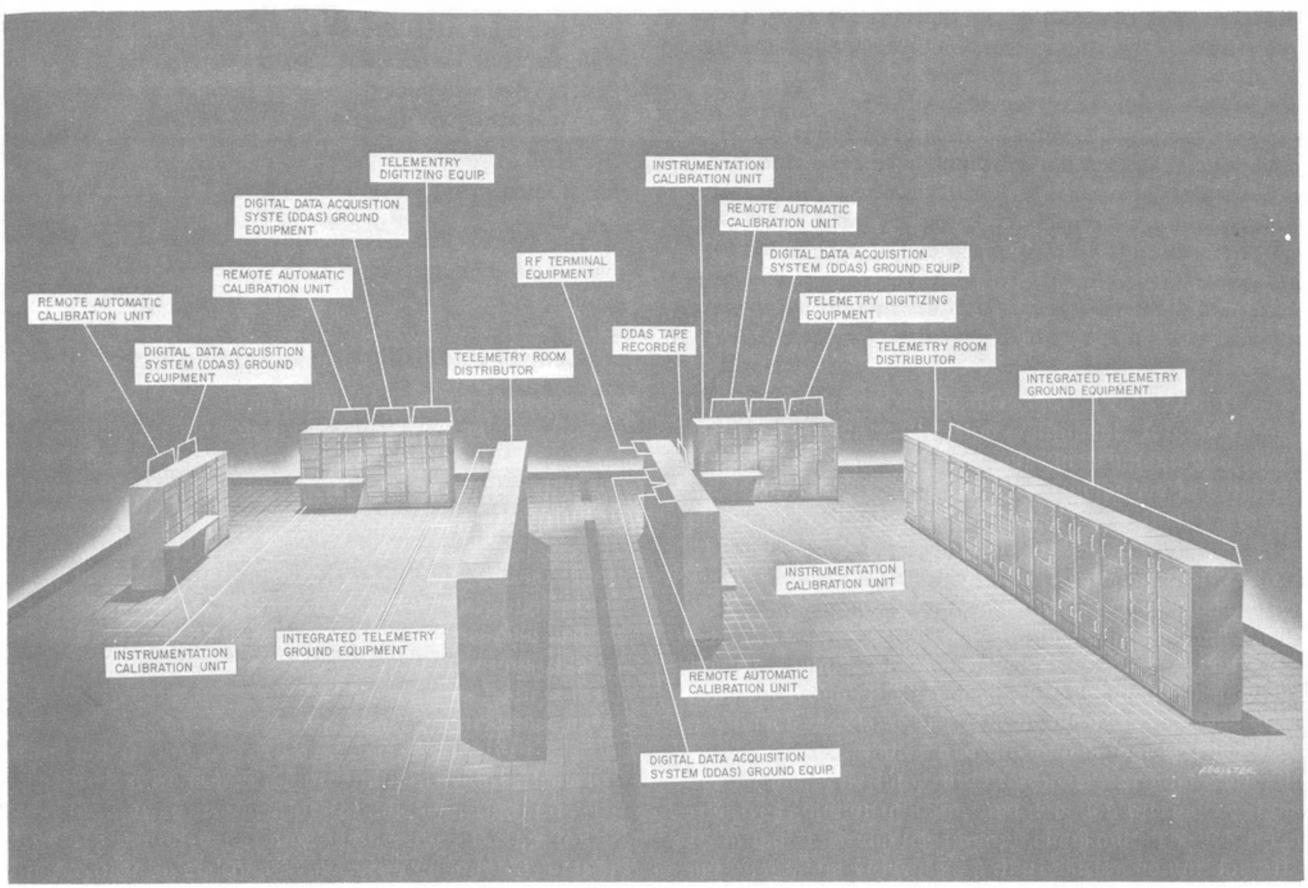


Figure I-9 - Data System Test Station

puts of the telemetry discriminators for digitizing and programing into the stage DDAS format. This permits computer analysis of identical data transmitted via the DDAS and the telemetry measurement links. The TV instrumentation and film camera checkout equipment controls and monitors the application of power and control signals, and evaluates TV picture quality.

Design for the Data System Test Station has been completed. Specification and assembly drawings have been released and vendors have been selected for all items. Fabrication is already in progress at the vendor locations and at Michoud for the Boeing-made items.

Interconnection Equipment

Equipment to interconnect the test and checkout equipment to itself and to the stage provides the capability of transferring electrical power, test instrumentation data, hydraulic power, and pneumatics to and from the S-IC stage during test and checkout. Design of this equipment has been completed and specification and fabrication drawings have been released to initiate procurement and manufacture of parts.

Checkout Auxiliary Equipment

The checkout auxiliary equipment is that equipment which is not a part of the automated test complex, but which is also required to checkout a completely assembled stage. This includes the pneumatic leak detection set to detect pneumatic leaks in the stage propulsion system, an antenna checkout set, stage weighing equipment, area contamination detection equipment to detect RP-1, RJ-1, and trichloroethylene vapors and monitor the content of oxygen in specific locations, internal access equipment, and other assorted equipment for sensing and measuring. Boeing design in this area is in progress and is expected to be complete in the near future. In addition, Modification 36 directed Boeing to design and fabricate two sets of work platforms and bulkhead protection equipment for use at MILA. Design of this equipment is currently in progress.

HANDLING AND TRANSPORTATION EQUIPMENT

Equipment required to move and position the stage and its components during assembly and test consists of the forward handling ring, the stage attach fittings, the fin and fairing cradles, retrorocket handling equipment, and component handling equipment. The forward handling ring (Figure I-10) provides a method for raising or lowering the S-IC stage to the vertical or horizontal position, and enables the assembled stage to be towed on the stage transporter. Final assembly of the initial forward handling ring was begun during the first quarter, with completion and testing occurring during the second quarter. Testing revealed inadequacies in the towing beam, necessitating redesign of that portion. The modified version of the handling ring, incorporating the redesigned towing beam, completed all testing

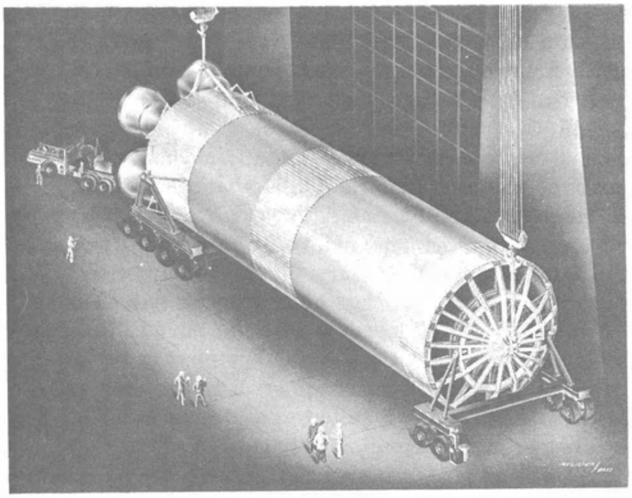


Figure I-10 - Forward Handling Ring With Stage

satisfactorily, and was shipped to NASA/MSFC in the early part of February 1964. A second handling ring has since been completed and shipped to NASA/MSFC for use with the weight simulator (Figure I-11) and handling of the S-IC stages to be assembled and tested there. Design for the stage attach fittings and the fin and fairing cradles has been completed, with design of the retrorocket handling equipment and component handling equipment to be completed in the near future. Design is also in progress for the stage pressure control and monitor system that will maintain positive pressure in the fuel and LOX tanks during transportation of the stage.

A listing of the major handling and transportation equipment of Boeing design is shown in Part VIII of this report.

OPERATING AND SERVICE EQUIPMENT

Basic release on all umbilical assemblies including umbilical plates, ground carriers, simulators, and substitutes was completed in April 1964. Shortly after,

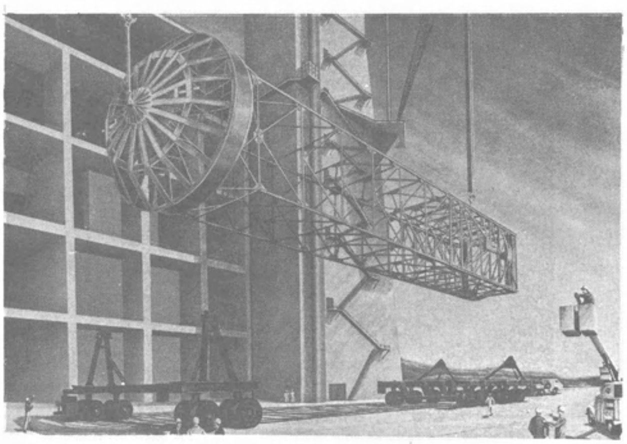


Figure I-11 - Forward Handling Ring With Weight Simulator

on May 26, 1964, the unqualified first article aft No. 1 ground carrier assembly, the aft vehicle skin panel assembly, and the aft flight assembly were delivered to NASA/MSFC.

During the reporting period, Modifications 34 and 35 were received for umbilical equipment to be used at the Merritt Island Launch Area. Modification 34 called for Boeing to design and build four sets of pneumatic equipment for the Saturn V launcher umbilical tower. Phase I approval has been granted by NASA/MSFC, and work is proceeding with the Phase III portion. Modification 35 required the design of umbilical carriers, plates, and associated equipment. Design in this area has been completed, and drawings have been released for fabrication of parts.

MECHANICAL AUTOMATION BREADBOARD (MAB)

During the second quarter of this reporting period, Boeing received Modification 52, calling for design of the MAB (Figure I-12). Modification 94 directed Boeing to manufacture the MAB. The MAB is intended to prove out the automated mechanical checkout concept, and to provide a checkout of the stage peculiar mechanical GSE for the S-IC stages. By utilizing flight equipment, including one F-1 engine, a complete fuel and LOX delivery system, a control pressure system, and limited purge system components, stage systems are duplicated for checkout of the associated GSE. The F-1 engine and four electrically simulated engines will be gimballed and subjected to simulated flight loads. The engine will also be capable of accepting all automated prestart and testing operations. Fuel and LOX tank ullage space will be simulated, and pressurization will be effected as necessary during fuel and LOX loading checkout and launch. Fill and drain functions will be simulated by timing devices in conjunction with operational hardware.

Design of the fuel, LOX, and control pressure/purge subsystem were released to NASA/MSFC for review and approval. Also released were preliminary data on the F-1 engine, hydraulic subsystem, and interconnection equipment Design comments have been received from NASA/MSFC and are being incorporated into the hardware design.

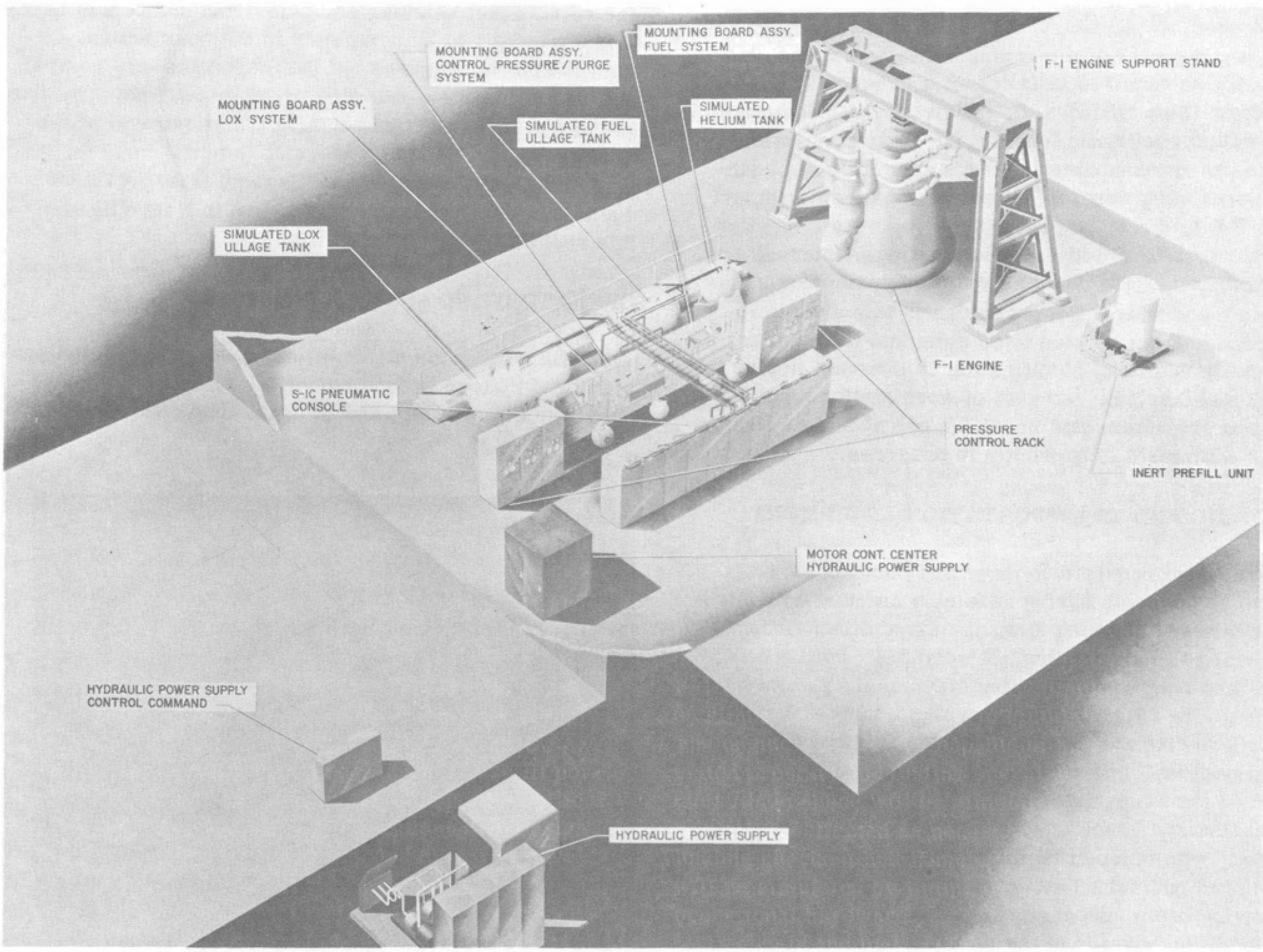
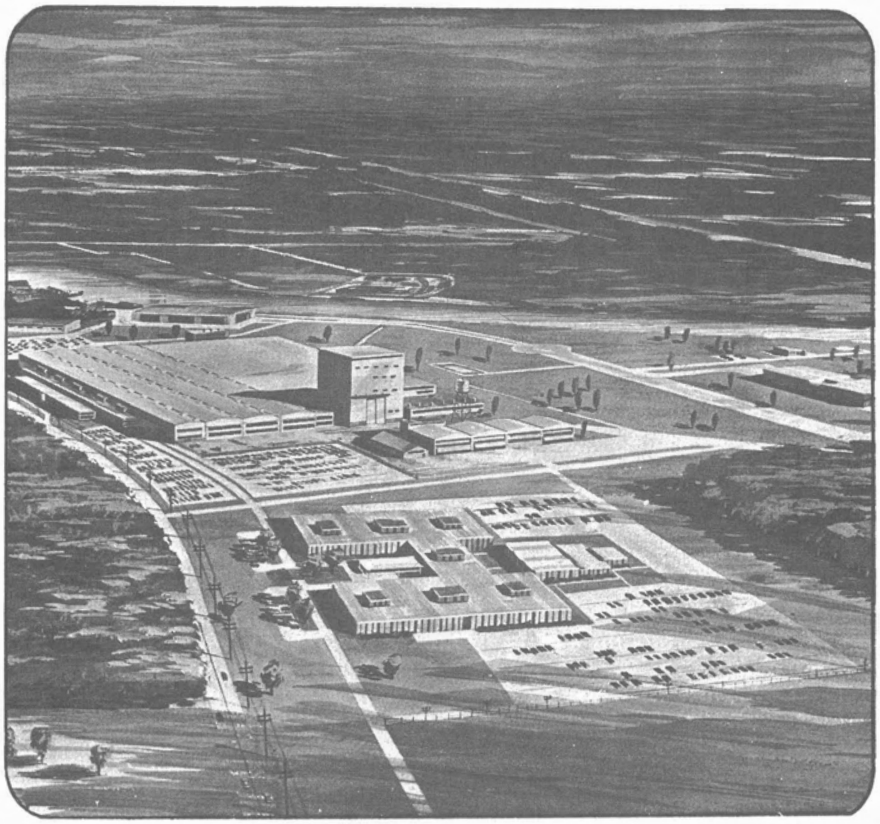
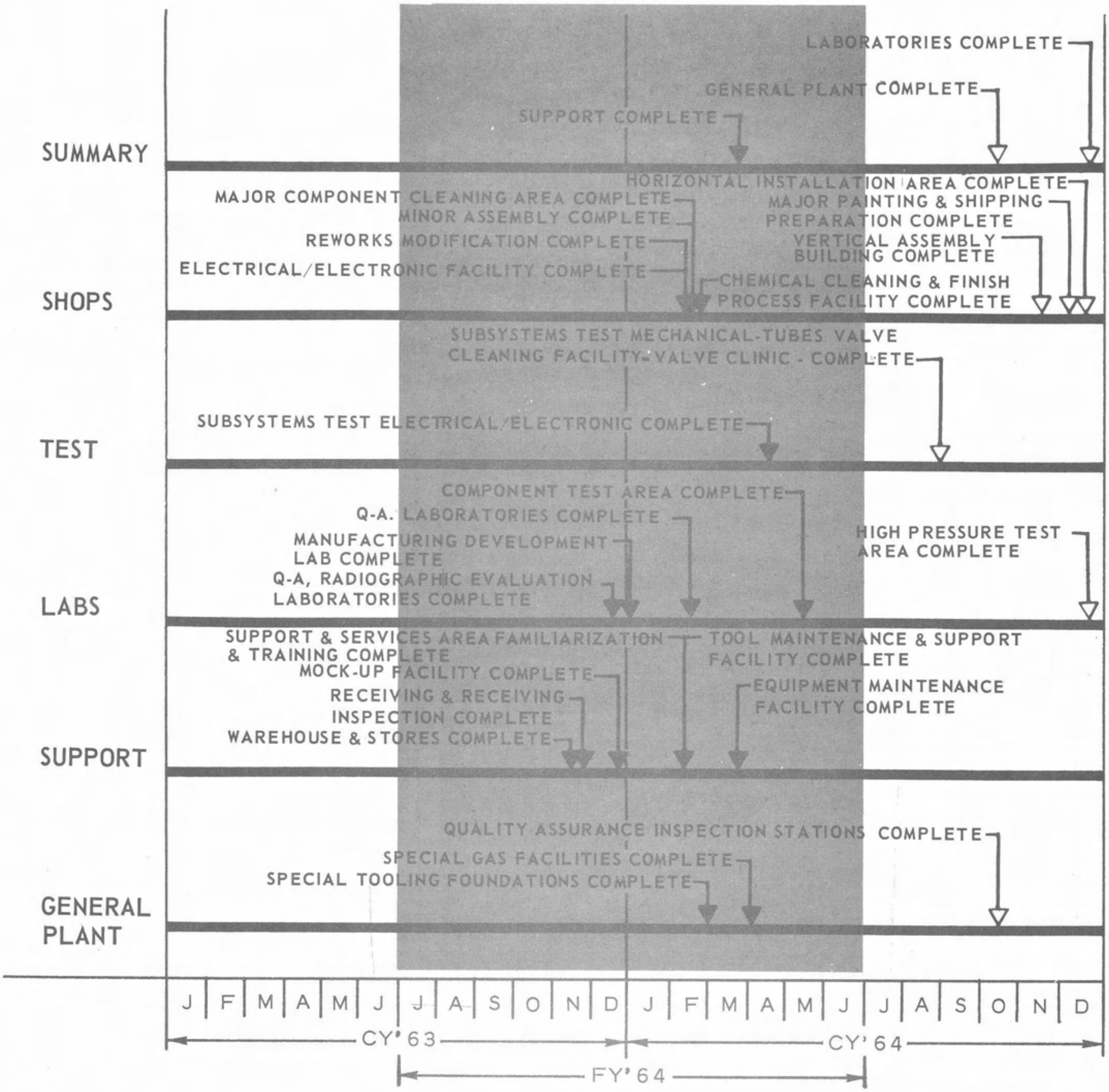


Figure I-12 - Mechanical Automation Breadboard Mockup



FACILITIES PLANNING AND ACTIVATION


LABORATORIES COMPLETE
GENERAL PLANT COMPLETE
SUPPORT COMPLETE
SUMMARY
HORIZONTAL INSTALLATION AREA COMPLETE
MAJOR COMPONENT CLEANING AREA COMPLETE
MINOR ASSEMBLY COMPLETE
MAJOR PAINTING & SHIPPING PREPARATION COMPLETE
REWORKS MODIFICATION COMPLETE
VERTICAL ASSEMBLY BUILDING COMPLETE
ELECTRICAL/ELECTRONIC FACILITY COMPLETE
CHEMICAL CLEANING & FINISH PROCESS FACILITY COMPLETE
SHOPS
SUBSYSTEMS TEST MECHANICAL-TUBES VALVE CLEANING FACILITY-VALVE CLINIC - COMPLETE
SUBSYSTEMS TEST ELECTRICAL/ELECTRONIC COMPLETE
TEST
COMPONENT TEST AREA COMPLETE
Q-A. LABORATORIES COMPLETE
MANUFACTURING DEVELOPMENT LAB COMPLETE
HIGH PRESSURE TEST AREA COMPLETE
Q-A, RADIOGRAPHIC EVALUATION LABORATORIES COMPLETE
LABS
SUPPORT & SERVICES AREA FAMILIARIZATION & TRAINING COMPLETE
TOOL MAINTENANCE & SUPPORT FACILITY COMPLETE
MOCK-UP FACILITY COMPLETE
EQUIPMENT MAINTENANCE FACILITY COMPLETE
RECEIVING & RECEIVING INSPECTION COMPLETE
WAREHOUSE & STORES COMPLETE
SUPPORT
QUALITY ASSURANCE INSPECTION STATIONS COMPLETE
SPECIAL GAS FACILITIES COMPLETE
SPECIAL TOOLING FOUNDATIONS COMPLETE
GENERAL PLANT
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

Significant progress toward total activation of the facilities complex at Michoud was made during fiscal year 1964, in preparation for full-scale assembly of both ground test and flight stages.

NASA/MSFC and Boeing personnel held discussions during the initial portion of the reporting period to establish mutual agreement on the use of interim and partial facilities in addition to other workaround techniques required to support Plan Va schedule.

Boeing subcontractors experienced an electricians strike during the third quarter of CY '63. This hampered facilities activation efforts but the use of partial and interim facilities lessened program impact and allowed Boeing to continue its support of NASA/MSFC ground test requirements in an orderly manner. The completion of Phase V of special tooling foundations was accomplished during this quarter.

During this fourth quarter of CY '63, six facilities were activated. They included: the Receiving and Receiving Inspection, Quality Assurance Radiographic Evaluation Laboratories, mockup facility, tank farm, warehouses and stores, and special tooling foundations—Phase VI. The activation of such facilities reduced the need for interim and partial facilities.

The change in program schedules from NASA/MSFC Schedule Plan V to Plan VII highlighted the commencement of the first quarter (CY '64). The change from Plan V to Plan VII as related to facilities activation impact consisted of changes in demand dates and resulted in subsequent schedule revisions for some facilities.

The user demand dates of five facilities were changed as a result of the transition from Plan V to Plan VII. This resulted in revisions to facilities activation schedule requirements.

Facility	Demand Dates	
	Plan V	Plan VII
Major Component Cleaning Facility	10-15-63	2-17-64
Engine Buildup	8-3-64	11-1-64
Horizontal Installation	11-16-64	1-14-65
Major Painting & Shipping Preparation	7-1-64	9-15-64
Stage Test Positions 1, 2, 3, and 4	8-1-64	10-1-64

Significant progress was realized during the first quarter of CY '64, with the continuing activation of complete facilities and the corresponding reduction in partial and interim facilities. Through the combined efforts and discussions between NASA/MSFC and Boeing, funding problems were overcome on the stage test facility and Phase II construction activities for this facility were initiated. The Tool Maintenance and Support facility, Familiarization and Training area, Support and Services areas, and the Equipment Maintenance Facility were completed during this period, thereby completing the support areas activation for the Michoud Complex. In addition, five facilities in the Shop category were completed. They include Chemical Cleaning and Finish Process Facility, Major Component Cleaning Area, Electrical/Electronic Facility, Rework and Modification Facility, and Minor Assembly. The following facilities within the Lab category were also completed: Manufacturing Development Lab, the remaining Quality Assurance Labs, and the Component Test Materials and Process Lab. During this same period, Phases VII and VIII of Special Tooling Foundation were also completed.

Late in the first quarter of CY '64, NASA/MSFC and Boeing concentrated on eliminating potential stage delivery impact items which were resulting from funding problems on the completion of construction of the Vertical Assembly Building, and problems of definition of criteria for the Major Painting and Shipping Preparation facility.

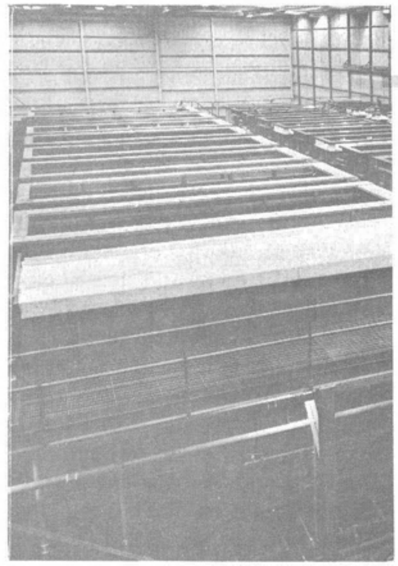
During the second quarter of CY '64, the funding problem for the completion of the Vertical Assembly Building was resolved and construction work was started on May 5, 1964, with a scheduled completion of November 18, 1964. A firm definition of criteria was established for the Major Painting and Shipping Preparation Facility and the design is scheduled to be complete on August 7, 1964 with the total facility completion scheduled for December 11, 1964.

Nine construction contracts were completed during the second quarter of CY '64, with eight contracts continuing in work and four contracts pending NASA/MSFC approval as of July 2, 1964.

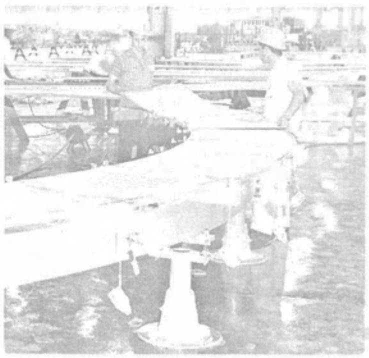
Facilities activated during the same quarter include Subsystems Test Electrical/Elctronic Facility, and Phase I of the Stage Test Facility under the Test category. Component Test Propulsion and Mechanical Lab and Structural Test were completed in the Laboratories category. In the General Plant Area, Special Gas Facilities was also completed. These achievements have reduced the use of interim and partial facilities and accomplished another milestone toward total completion of the Michoud Complex

It has been established that the impact to stage deliveries has been minimized by the use of interim and partial facilities in operation or work-around methods. The cumulative effect of utliizing interim and partial facilities, and a large number of work-around methods, could delay scheduled deliveries of S-IC stages.

During fiscal year 1965 it is predicted that the remaining facilities will be completed: Horizontal Installation Facility, Engine Buildup Facility, and the Major Painting and Shipping Preparation Facility and the Vertical Assembly Building in the Shops category. Also the High-Pressure Test Facility and Quality Assurance Inspection Stations in the Laboratories area will be completed. Subsystems Test Mechanical, and Stage Test Facility Phase II are the remaining facilities to be completed in the Test category.

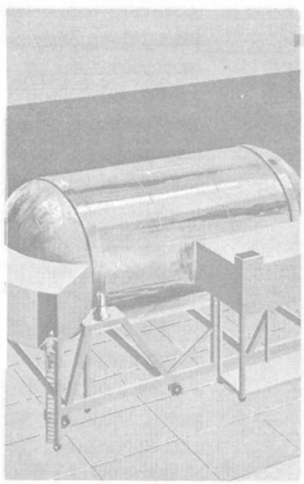


Chemical Cleaning and Finish Process Facility

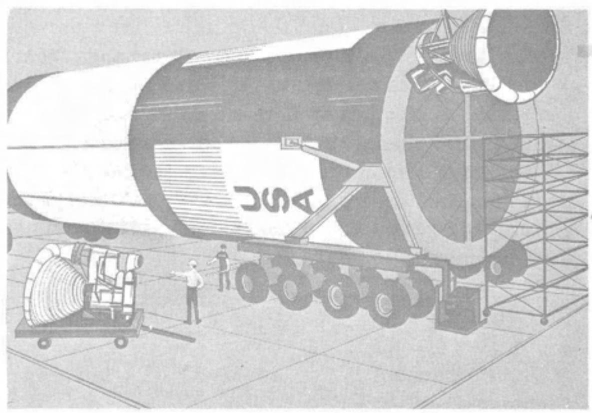


Minor Assembly

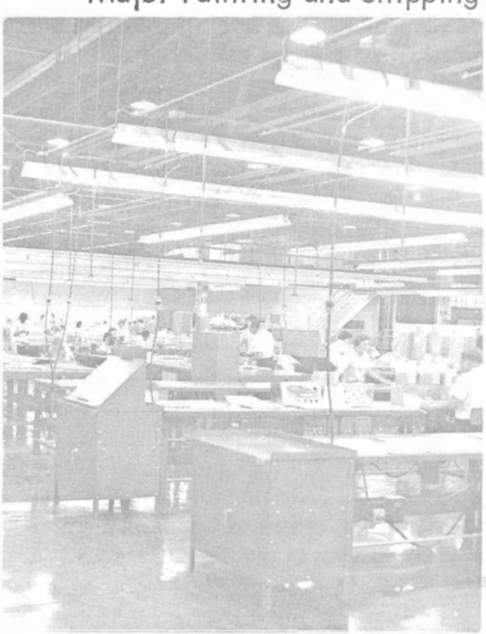
FACILITIES/SHOPS



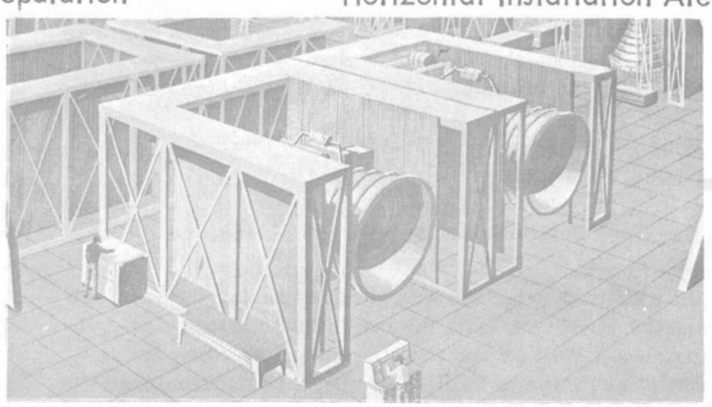
Major Painting and Shipping Preparation



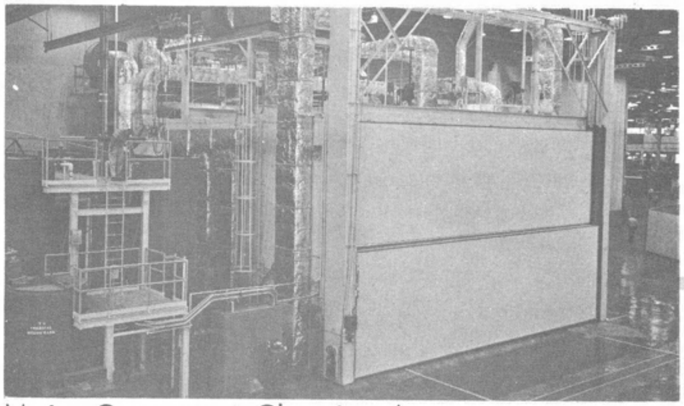
Horizontal Installation Area



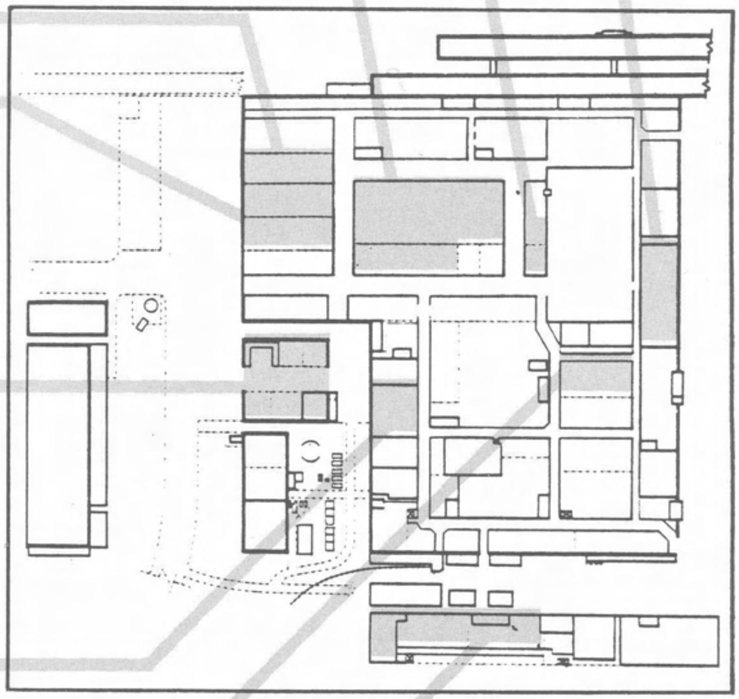
Electrical/Electronic Facility

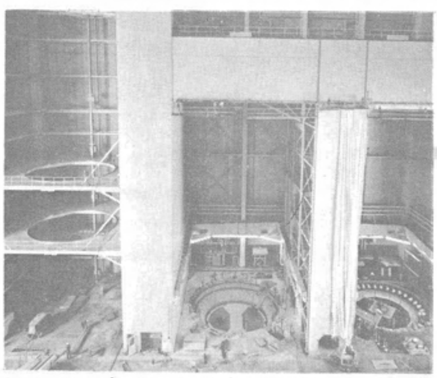


Engine Build-up Facility



Major Component Cleaning Area





Vertical Assembly Building

Rework and Modification

ELECTRICAL/ELECTRONIC FACILITY

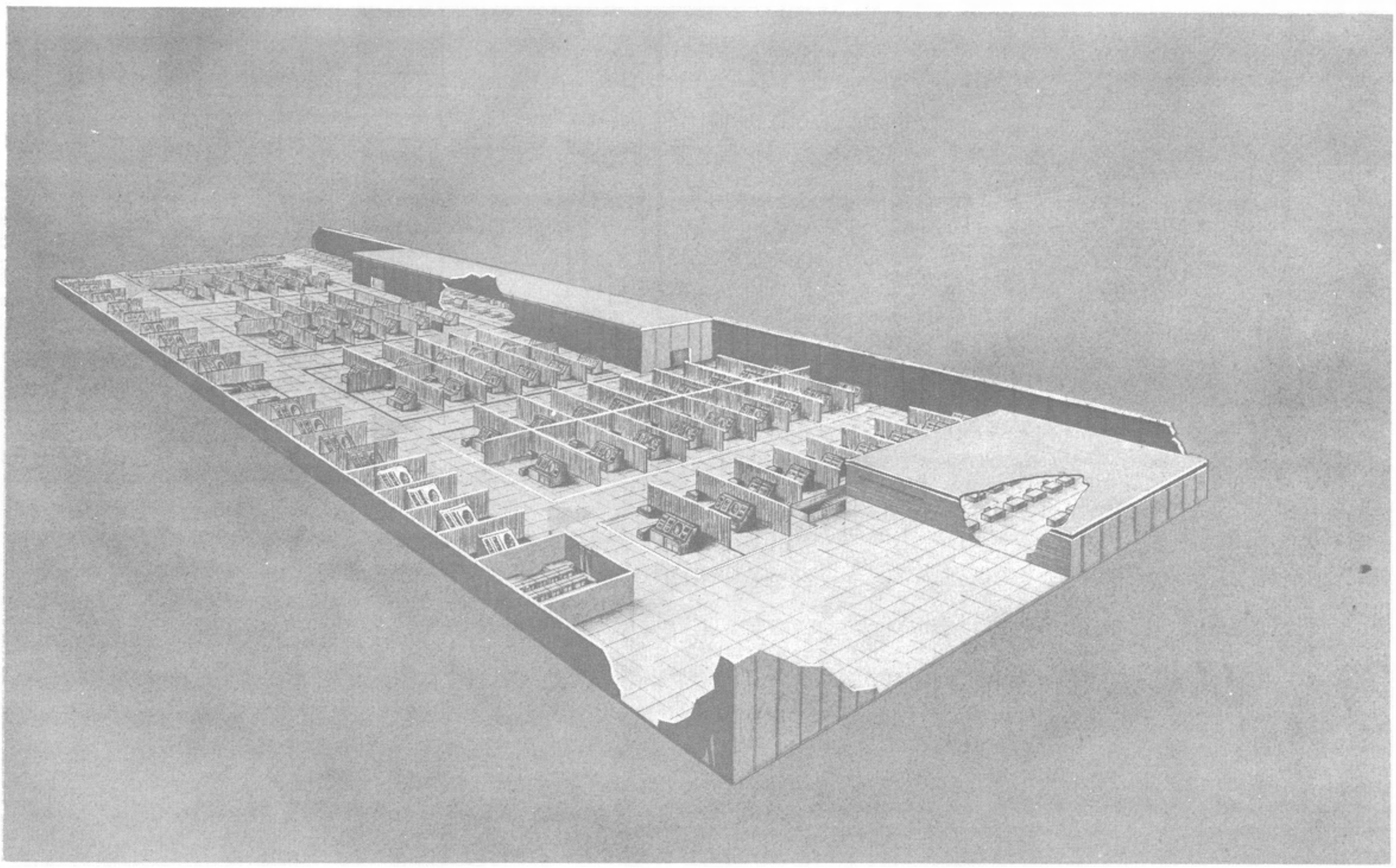
Function - The Electrical/Electronic facility is used to fabricate, assemble and rework electrical and electronic components and assemblies for the S-IC stage and GSE. The facility consists of the following areas: 1) Electrical Fabrication; 2) Electronic Fabrication; 3) GSE Console Assembly.

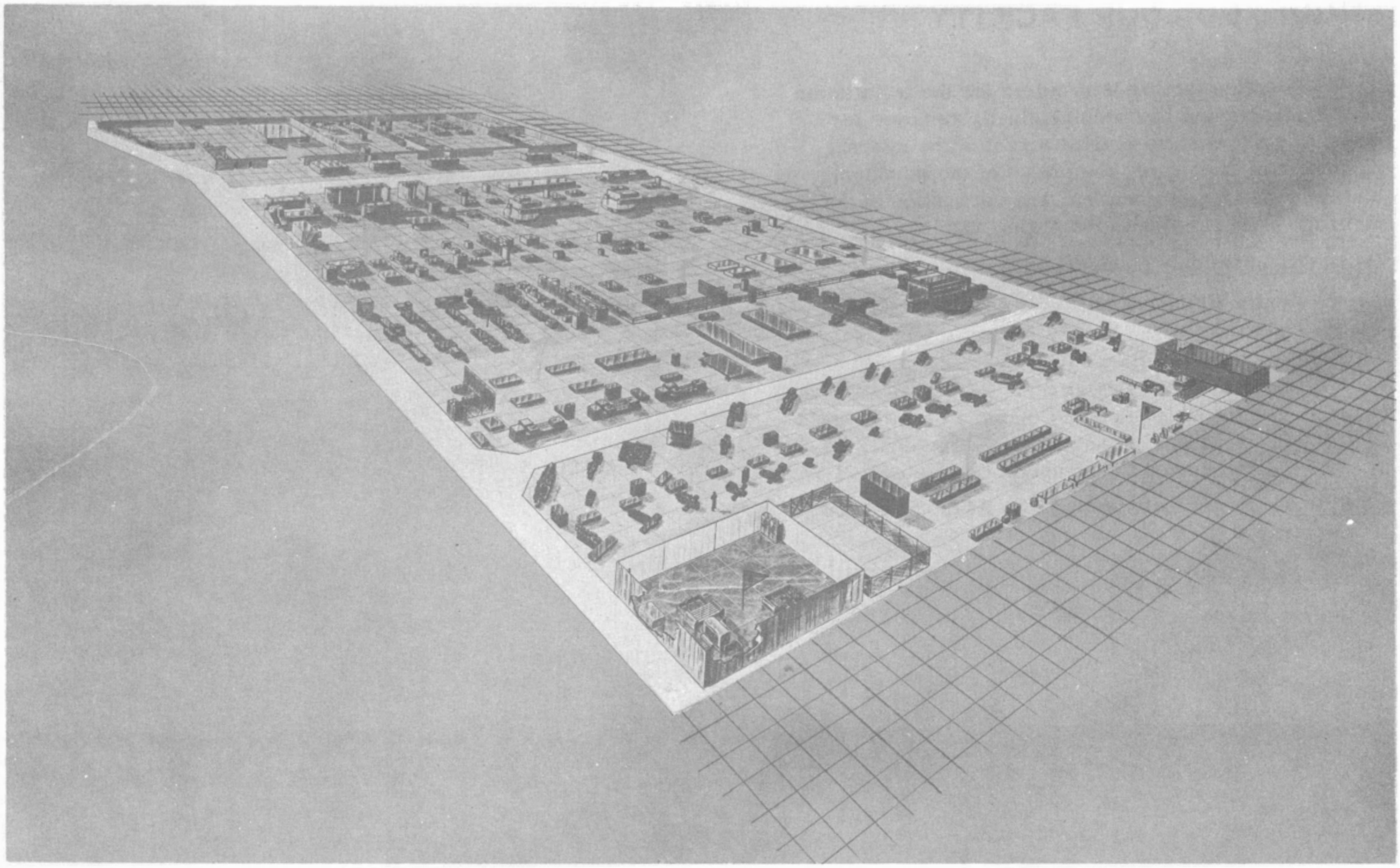
Using Organization - Manufacturing

Area - Electrical/Electronics facility - 51,000 sq. ft.

Milestones - Design Complete ------- 6-21-63
Construction Started ---- 7-18-63
Construction Complete -- 1-3-64

Contracts - 63-24 -- A&E
63-47 -- Construction





REWORK & MODIFICATION – TOOL MAINTENANCE

Function -- This area consists of a "blue streak" type shop which is capable of producing small parts as required for program changes, late or misplaced items, and emergency repairs as required to support both the S-IC booster production and tool maintenance programs This area consists of the following:

1. Rework and Modification facility consisting of the following areas: a) Tube Bending; b) Sheet Metal; c) Machining; d) Fixture Bore; e) Heat-Treat and Non-Metals; f) Woodwork and Plaster; and g) GSE/ MSE Assembly and Maintenance.
2. Tool Maintenance and Support Facility composed of the following areas: a) Welding; b) Bench Assembly; and c) Fixture Maintenance.

Using Organization - Manufacturing

Area - Rework and Modification -- 75,844 sq. ft.
Tool Maintenance -------- 21,672 sq. ft.
TOTAL ----------------- 97,516 sq. ft.

Milestones - Design Complete ------------7-12-63
Truss Modification ----------7-8-63
Construction Started ---------7-22-63
Truss Modification Complete--9-20-63
Construction Complete -------2-14-64

Contracts - 62-4 --- A&E
62-9 --- Construction
63-6 --- Construction
63-40 -- Construction
63-48 -- Construction
63-59 -- Construction
63-62 -- Construction

ENGINE BUILDUP FACILITY

Function - This facility is required for the installation of components that had been originally removed for shipping purposes, re-establishment of the internal alignment of the engine, the preset of the actuator, and the assembly, inspection, and verfication of the fit of the skirt relative to the engine nozzle.

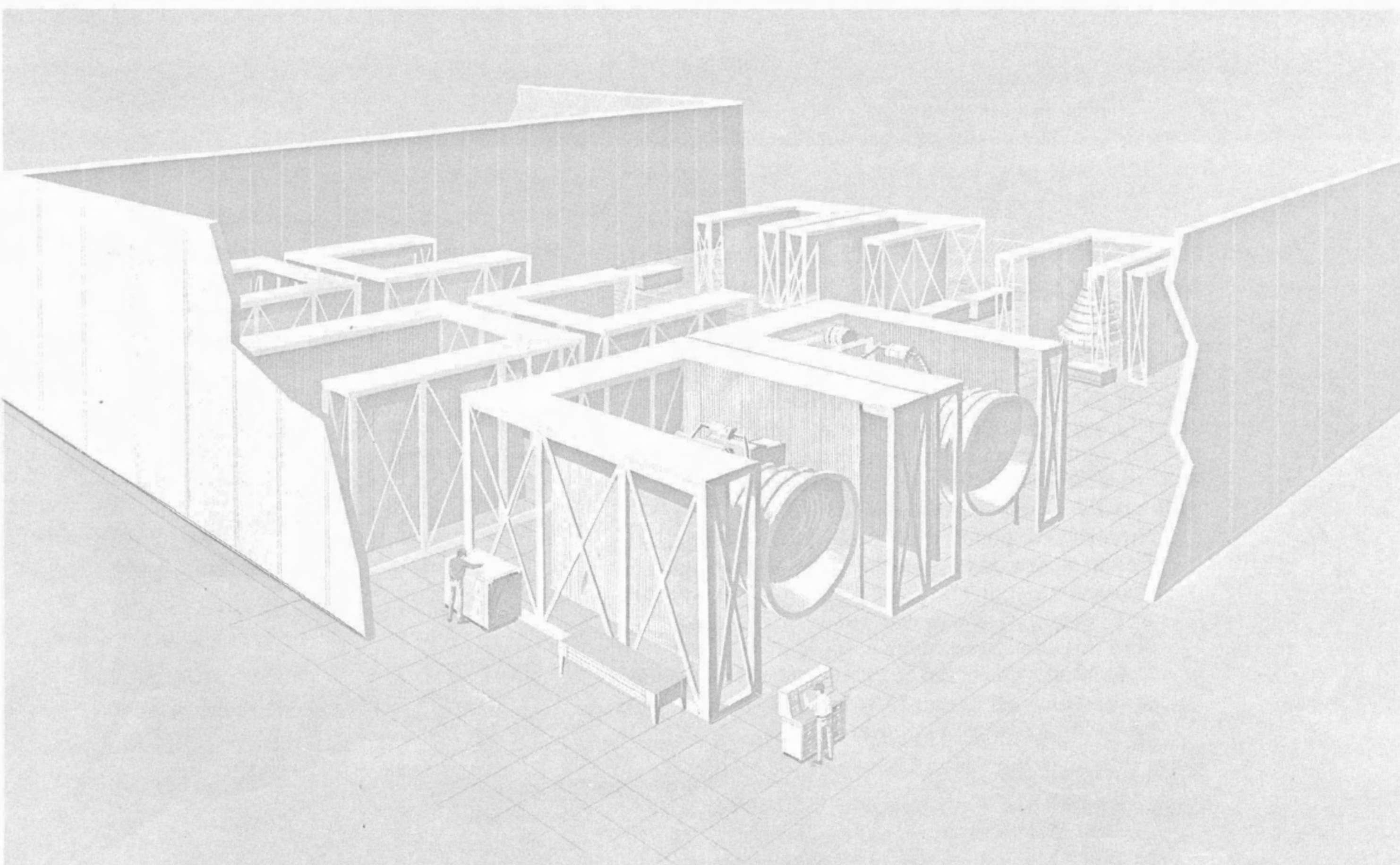
Using Organization - Manufacturing

Area - Engine Buildup Facility -- Approximately 12,960 square feet

Milestones - (Boeing effort only)

Scheduled Design Start --------- 8-21-64
Scheduled Design Complete ----- 11-9-64
Scheduled Construction Start ---- 12-22-64
Scheduled Construction Complete -3-23-65

Contracts - No numbers assigned to A&E or Construction Contracts



VERTICAL ASSEMBLY AREA

Function - This facility is required to assemble the complete S-IC stage in a vertical position. In addition, the area will be used to assemble tanks, install baffles, assemble tank connection sections, perform hydrostatic testing, clean flight vehicle LOX piping and RP-1 fuel tanks.

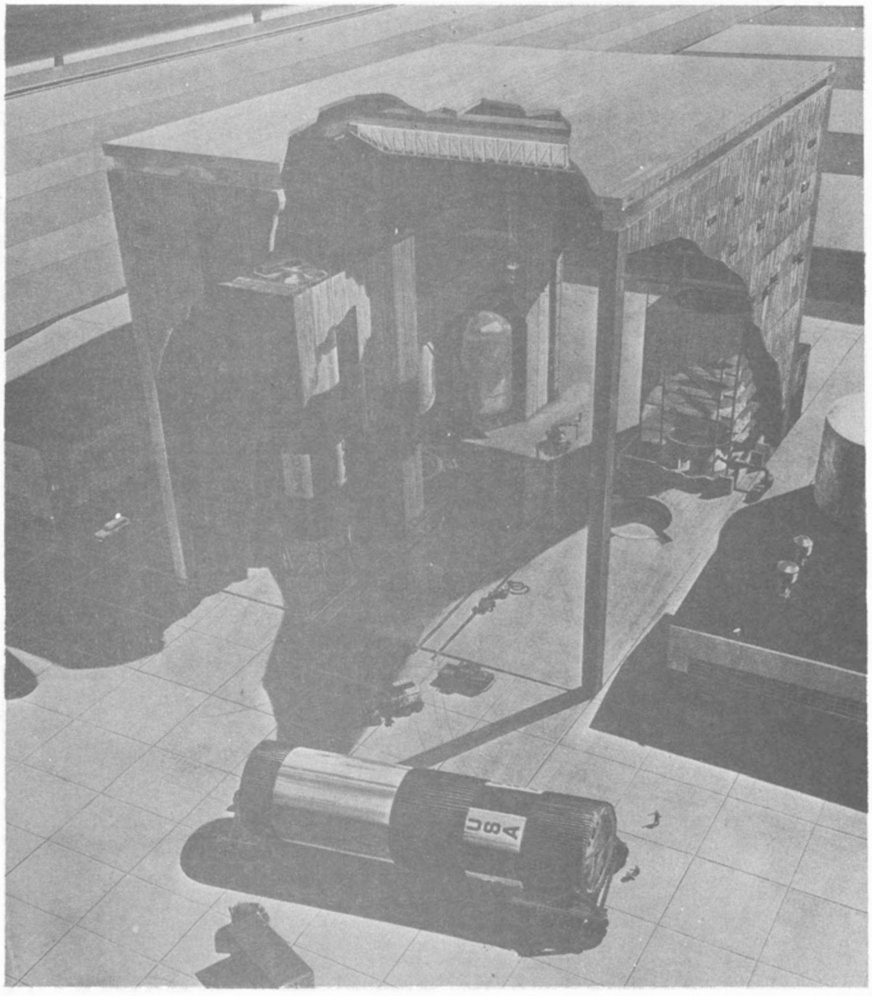
Using Organization - Manufacturing and In-Plant Test

Area - 44,414 square feet

Milestones

63-4 Tank Farm --	Design Started ------ 9-15-62 Design Complete ---- 3-1-63 Construction Started--4-27-63
63-64 Phase I ---- (Tank Assembly Position 1 & 2 including structural 90 ft. & 155 ft. towers)	Design Started ------ 8-9-63 Design Complete ---- 10-28-63 Construction Started--12-10-63 Construction completion scheduled for 6-8-64, but due to schedule slide anticipated completion early in the third quarter, CY '64
64-8 Phase II ----- (Tank Farm Distribution, Complete 155 ft. Tower, Hydrostatic Test Tower, Hydrostatic Test Position)	Design Started -------- 6-3-63 Design Complete ------ 2-6-64 Construction Started ---5-4-64 Construction Complete--10-19-64

Contracts - 63-64 -- A&E
62-12 -- Hydrostatic Test Position and Final Assembly Construction
64-8 --- Tank Positions 1 & 2 Construction
63-4 --- Tank Farm Construction



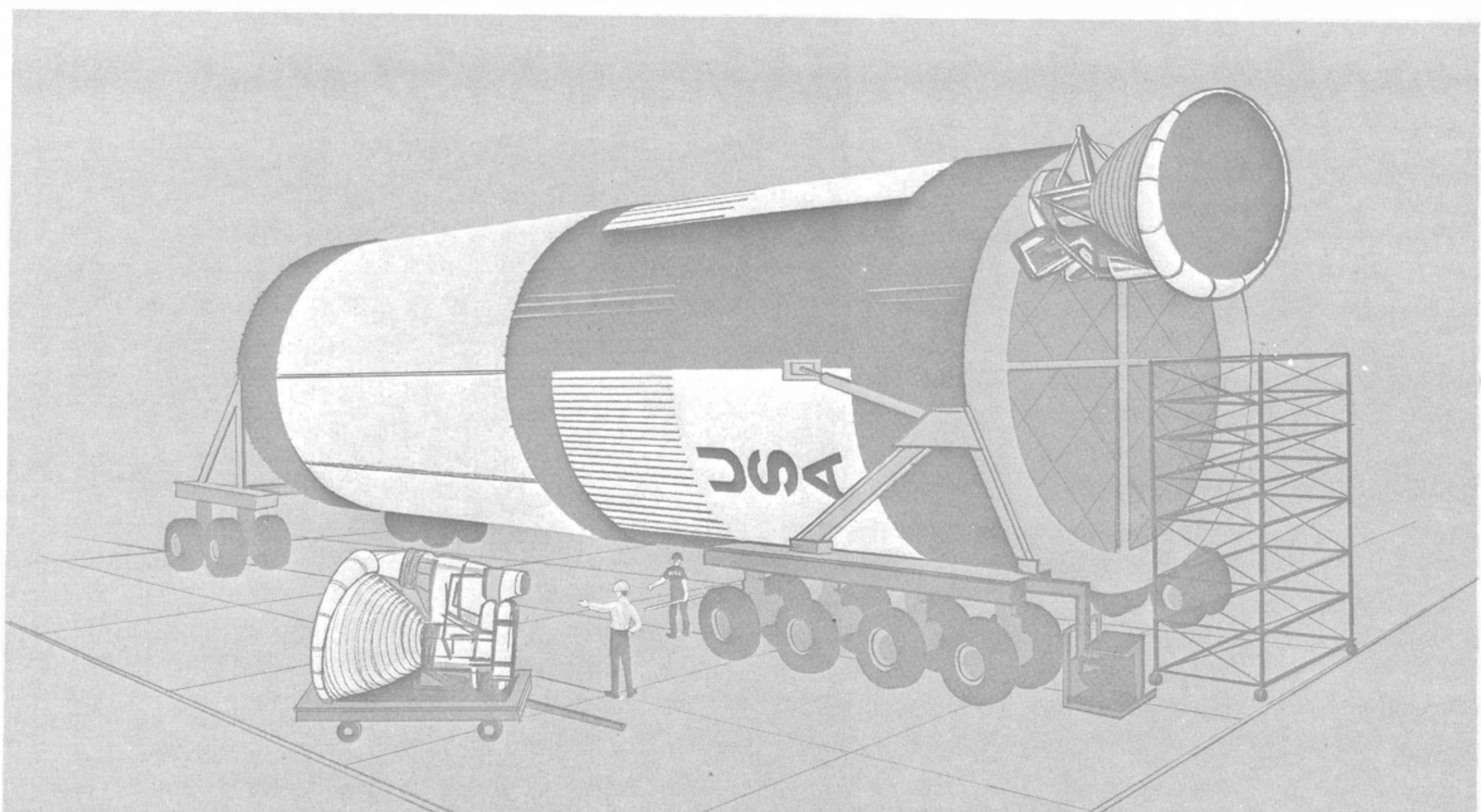
HORIZONTAL INSTALLATION AREA

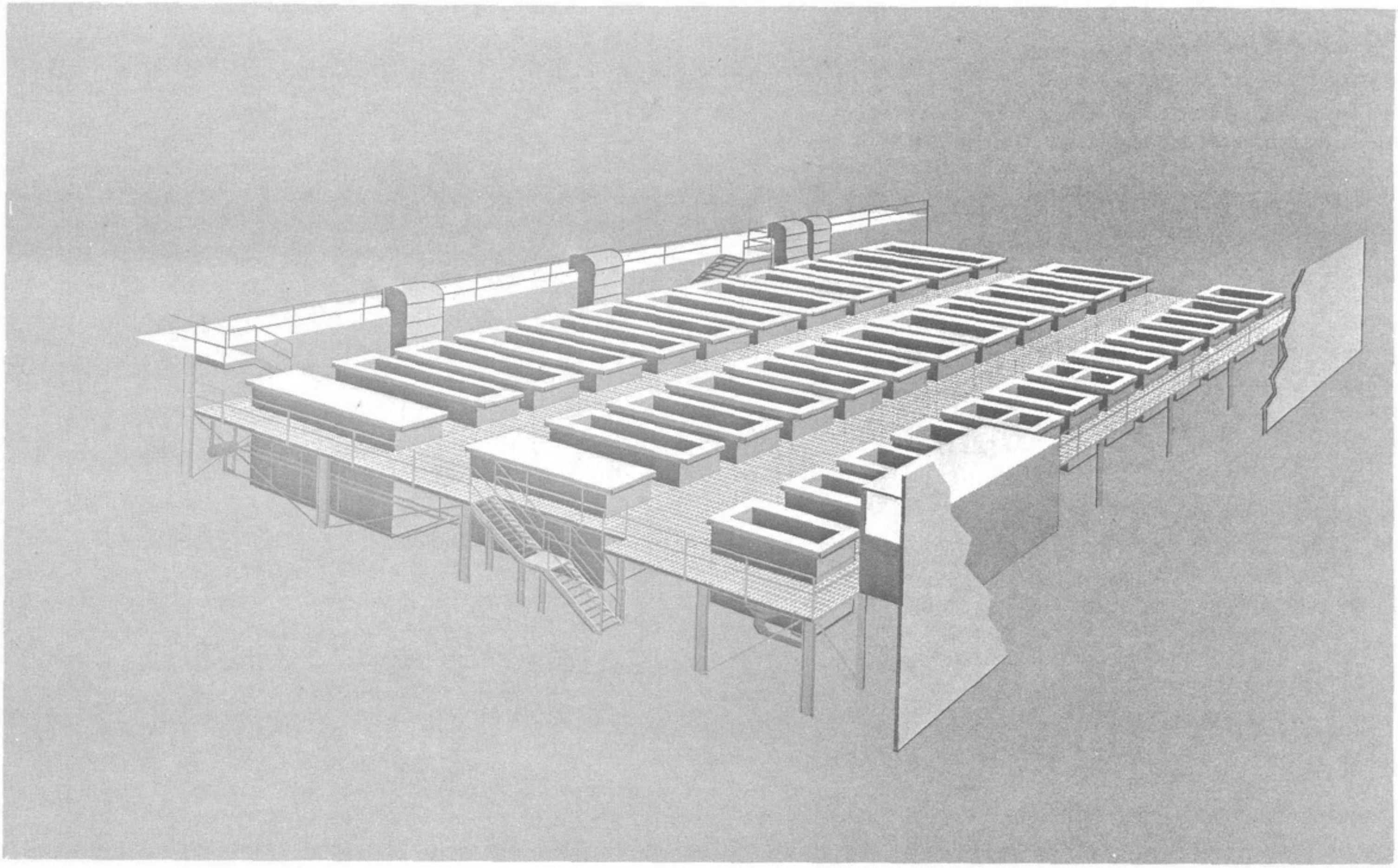
Function - This facility will be used to install the F-1 engines and associated hardware on the S-IC stage in the horizontal position and to refurbish the engines after static testing.

Area - 51,976 square feet

Milestones - Scheduled Design Start -------- 6-22-64
Scheduled Design Complete ---- 8-14-64
Scheduled Construction Start --- 9-16-64
Scheduled Construction Complete - 12-21-64

Contracts - 64-18 -- A&E





CHEMICAL CLEANING AND FINISH PROCESS FACILITY

Function - This facility provides the capability for chemical cleaning of aluminum and steel segments in unfinished and semi-finished form. In general, this applies to all stage and ground support equipment components not considered contamination sensitive.

This area is a manual, semiautomatic facility consisting of an aluminum cleaning line of 10 tanks and a steel cleaning line of 11 tanks.

Using Organization - Manufacturing

Area - Chemical Cleaning and Finish Process facility -- 25,100 square feet

Milestones - Tank Design Started -------------3-19-63
Aluminum Line Design Complete --7-8-63
Steel Line Design Complete -------8-1-63
Aluminum Line Construction Complete -----------------------2-26-64
Steel Line Construction Complete--2-26-64

Contracts - 63-31 -- A&E
63-15 -- Tank Fabrication
63-46 -- Tank Fabrication
63-44 -- Construction Aluminum Clean Line
63-54 -- Construction Steel and Plating Line
63-11 -- Crane Fabrication and Erection

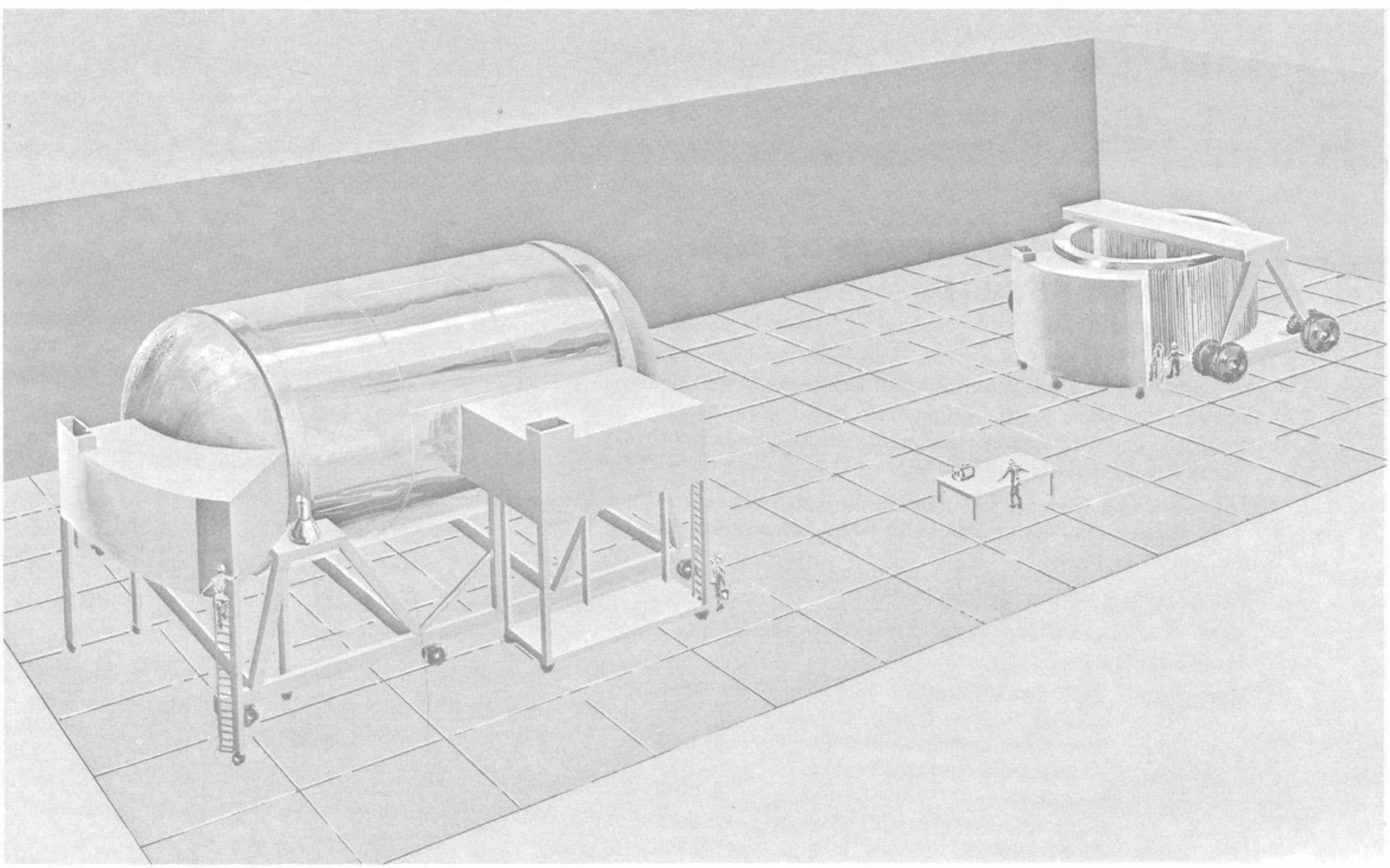
MAJOR PAINTING AND SHIPPING PREPARATION

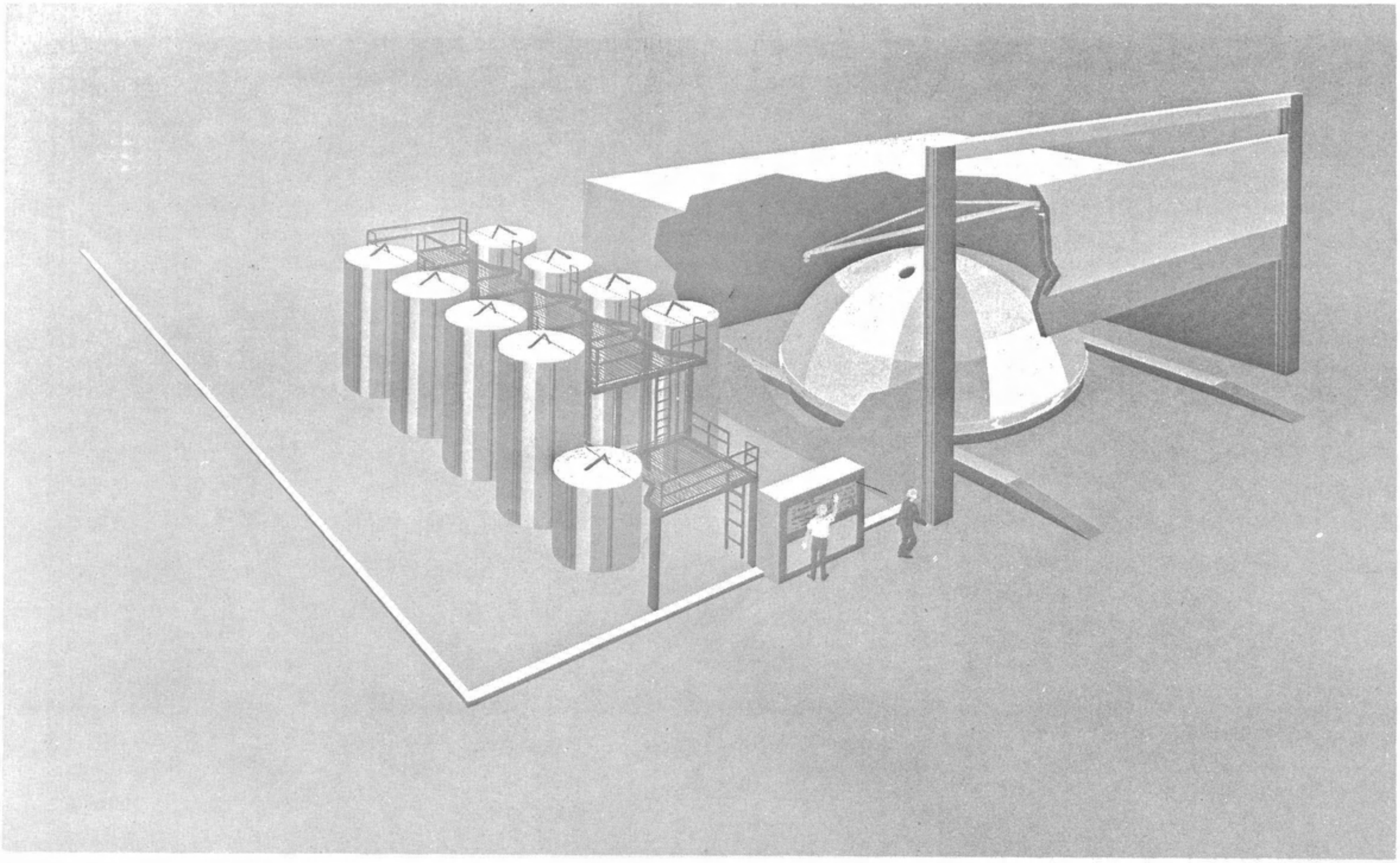
Function - This facility is required for final preparation of the booster for shipment. This preparation includes painting, decal application, protective coating, dust sealing and systems draining.

Area - 16,800 square feet

Milestones - Design Started ---------------- 6-10-64
Scheduled Design Complete ----- 8-7-64
Scheduled Construction Started - 9-8-64
Scheduled Construction Complete-12-11-64

Contracts - 64-19 -- Design





MAJOR COMPONENT CLEANING AREA

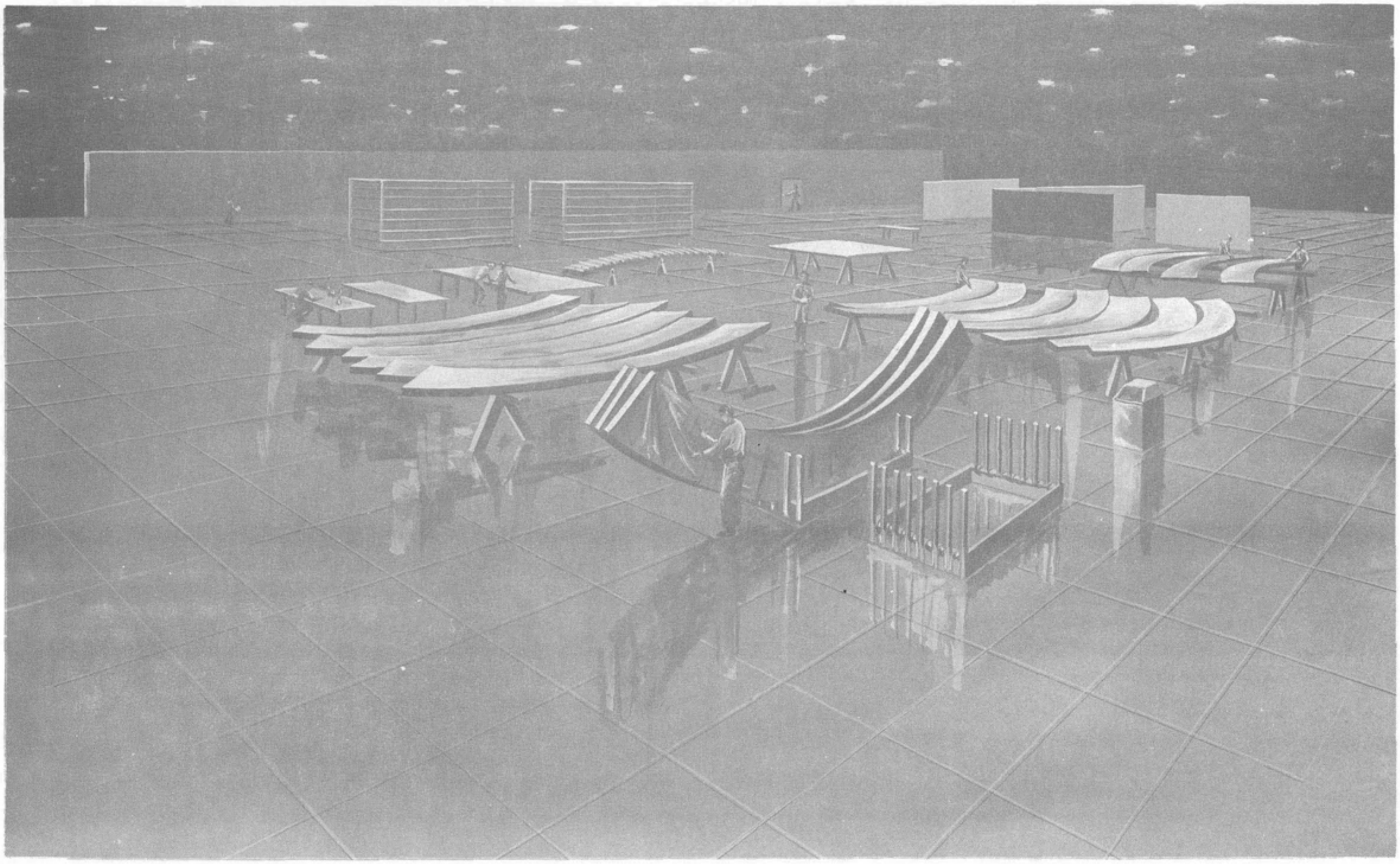
Function - This area is used for the cleaning and conversion coating of bulkheads, baffles, and other tank components too large for the immersion cleaning line. Skin sections and Y-rings are also cleaned in this area. Systems required to perform the cleaning and coating operations include: trichloroethylene, alkaline cleaning solution, deodorizer, iridite, and demineralized water distribution.

Using Organization - Manufacturing

Area - Major Component Cleaning facility -- 4,560 sq. ft.

Milestones - Design Started ------------- 4-15-63
Design Complete ----------- 8-7-63
Construction Started -------- 10-10-63
Tank Fabrication Complete -- 1-21-64
Construction Complete ------ 2-19-64

Contracts - Design -- In-house
63-41 --- Pile Driving
63-46 --- Tank Fabrication
63-57 --- Construction



MINOR ASSEMBLY AREA

Function - The Minor Assembly Area provides facilities to assemble vehicle components prior to major assembly. This includes provisions for welding, machining and mechanical fabrication.

Using Organization - Manufacturing

Area - 238,516 square feet

Milestones

63-40 Truss Mod ----- Started ---- 1962
Complete -- 10-31-63

63-11 Cranes -------- Started ---- 4-9-63
Fabrication & Installation Complete -- 2-21-64

63-62 Crane Access -- Started ---- 10-25-63
Platforms Complete -- 11-20-63

Special Tooling Foundations Phases 5, 6, 7 & 8

63-35 -- Started ---- 1963
Complete -- 9-27-63

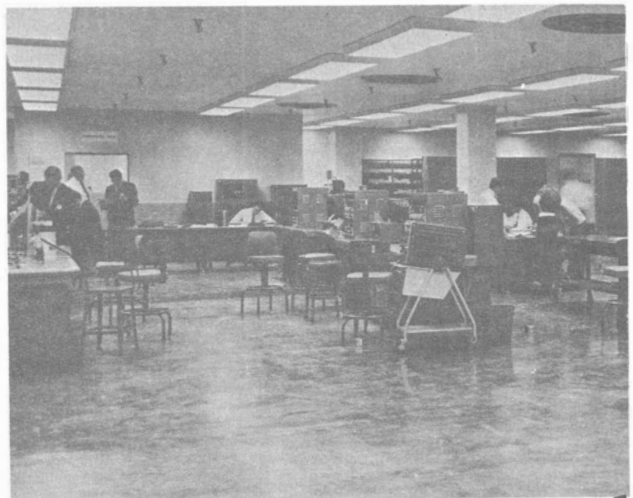
63-55 -- Started ---- 1963
Complete -- 10-31-63

63-61 -- Started ---- 1963
Complete -- 2-29-64

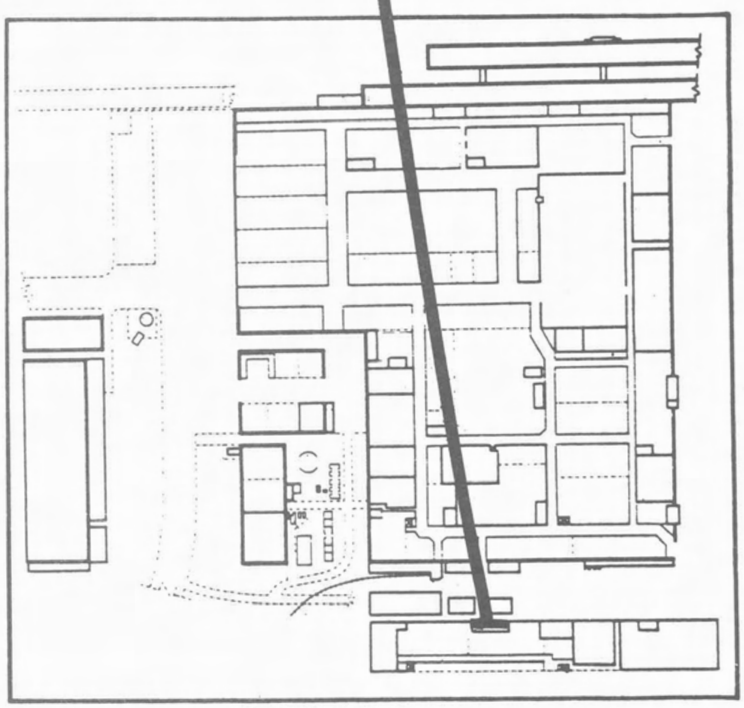
63-67 -- Started ---- 1963
Complete -- 3-1-64

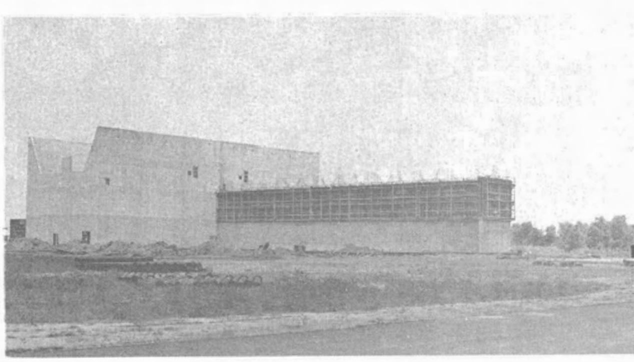
Contracts - 62-4 --- A&E Gray Box
63-40 -- Truss Mod
63-11 -- Cranes Fabrication & Installation
63-33 -- Y-ring Weld Area
63-62 -- Crane Access Platforms
63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8

(The illustration shows a typical area)


Subsystems Test Electrical/Electronic

FACILITIES/**TEST**




Stage Test Position and Support

SYSTEMS TEST

ELECTRICAL/ELECTRONIC

Function - All electrical and electronic components, and subsystems of Ground Support Equipment and Saturn S-IC flight electrical and electronic systems are tested in this area. The subsystems Test electrical/electronic area is comprised of the: 1) Instrument Test Area; 2) Bench Test Area; 3) Telemetry Ground Station; 4) RF and TV Test Area; 5) Development and Special Test Area. These areas provide the capability for performing the following: testing of sensing devices, printed circuit cards, electronic chassis, various electrical and electronic components, subsystems, telemetry systems and electromagnetic radiating devices.

In addition, the facilities will provide the capability for: 1) developing special test equipment; 2) performing component and subsystems test; 3) compatibility testing between GSE and flight instrumentation and the resolution of any discrepancies disclosed in such testing.

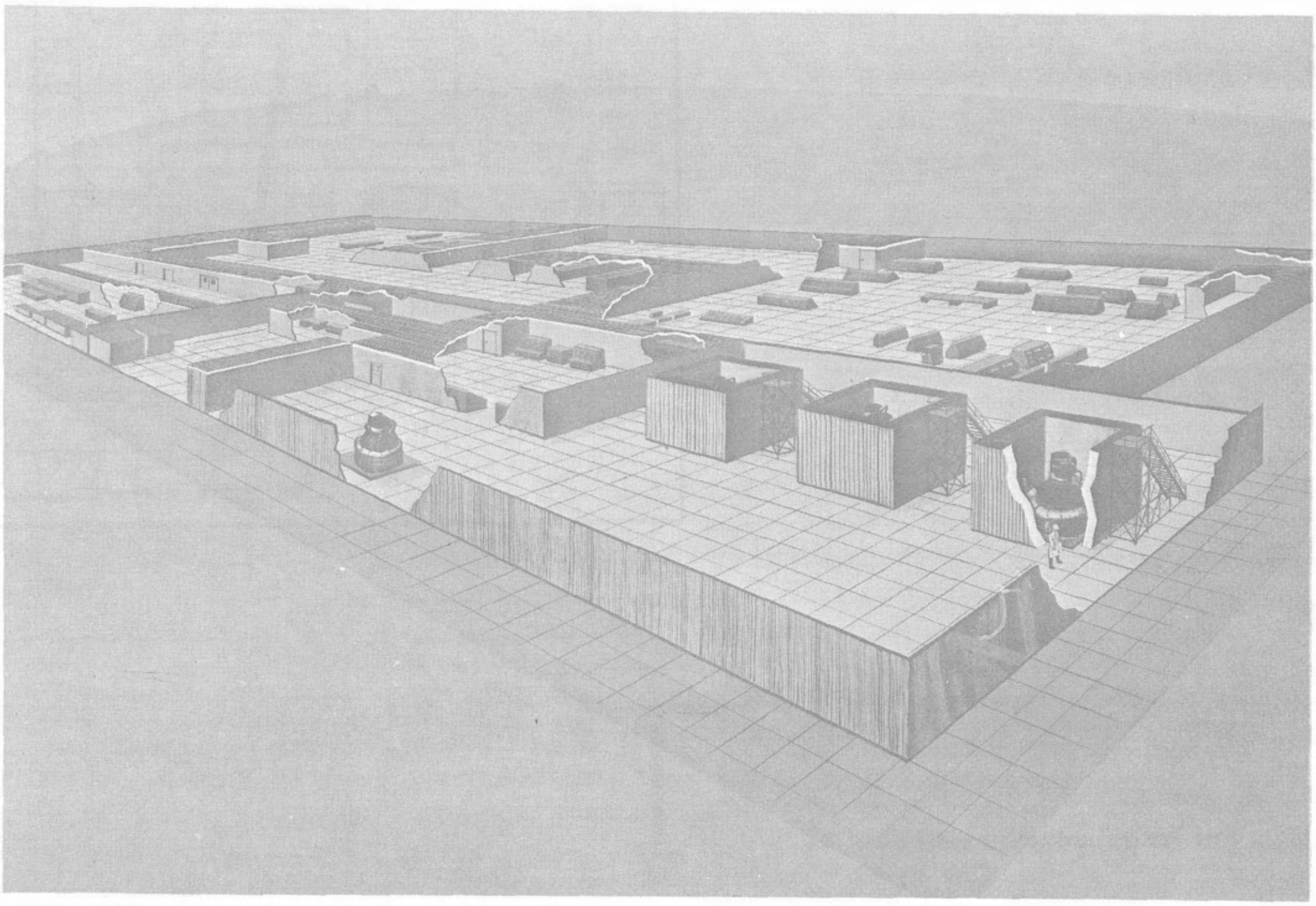
Using Organization - In-Plant Test

Area - Subsystems Test Electrical/Electronic - 14,252 square feet.

Milestones - Design Start ----------- 9-18-63
Design Complete ------- 10-23-63
Construction Start ------ 12-6-63
Construction Complete -- 4-17-6'

Contracts - In-House -- Design
63-69 ----- Construction

(The artist concept depicts the electrical/electronic area of subsystems test.)



Electrical/Electronic Area of Subsystems Test

SUBSYSTEMS TEST

MECHANICAL

Function - The Mechanical Subsystems Test area shall provide the capability of testing S-IC vehicle mechanical subsystems and components, vendor furnished items, and subsystems which have failed in static-firing or upper-level checkout. This shall include testing and measuring instruments, testing components and subassemblies that must operate at extremely low temperatures, test and proof of pressure pneumatic system components, check valve cracking pressures, and testing the LOX and fuel systems flight hydraulic components and subassemblies of the F-1 engine. Shops included in this area are: 1) Engine Test Cell; 2) Hydraulic Test Area; 3) Cryogenic Test Area; 4) Pneumatic Test Area; 5) Tool Crib; 6) Testing Staging Area, and 7) Hydrostatic Test Area.

Using Organization - In-Plant Test

Area - 27,192 square feet

Milestones - Design Start ------- 6-10-63
Design Complete --- 12-27-63
Construction Start -- 6-17-64

Anticipated completion early in the third quarter CY '64.

Contracts - 62-13 -- A&E
64-1 --- Construction

VALVE CLINIC

Function - The Valve Clinic is used for dismantling and reassembling valves. All inoperable valves, orifices, regulators, etc., are to be dismantled as required and inspected to determine the cause and extent of damage or malfunction.

Using Organization - Manufacturing

Milestones — Design Started------------6-10-63
Design Complete----------12-27-63
Construction Started ------2-11-64

Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design

TUBE AND VALVE CLEANING FACILITY

Function - The Tube and Valve Cleaning facility is required for the cleaning of fuel, LOX, and pneumatic components to the cleanliness levels required for the system. Tubing will be flushed with the proper cleaning agents, dryed, and packaged at this location. Valves and components are to be cleaned and rinsed in ultrasonically energized fluids, placed in vacuum ovens for drying, and flushed to certify the cleanliness levels.

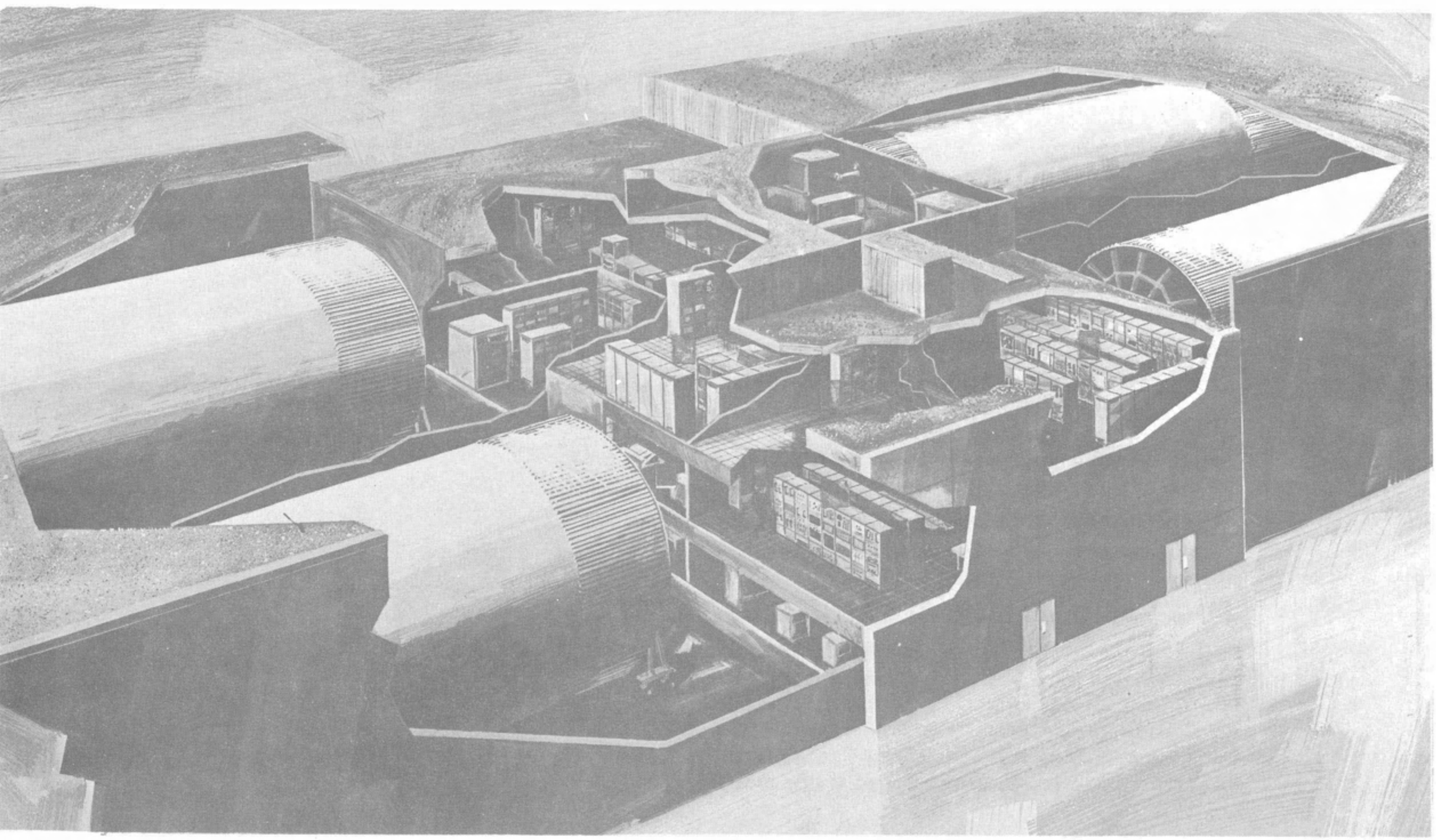
Using Organization - Manufacturing

Area - 6,670 square feet

Milestones - Design Started ----------6-10-63
Design Complete --------12-27-63
Construction Start -------2-7-64

Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design



STAGE TEST POSITION AND SUPPORT

Function - The Stage Test Position is necessary to fulfill requirements of the final stage checkout program of the S-IC stage. This will be accomplished in four stage test positions for performing various tests on the pneumatic, hydraulic, mechanical, telemetry and electrical systems of the S-IC stage to ensure system integrity.

Using Organization - In-Plant Test

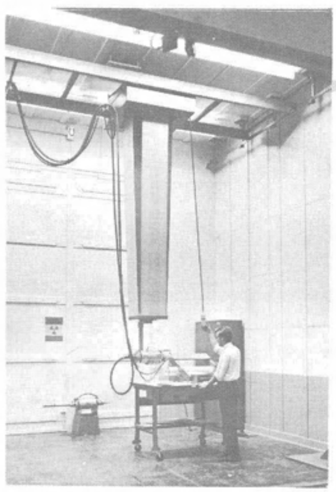
Area - 114,432 square feet (66,120 Test Cells; 48,312 support facility).

Milestones - Contract 63-71 Phase I
Design Started ----------5-24-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Construction Complete ---Is basically completed except for seeding and secondary road work which cannot be accomplished until November 1, 1964.

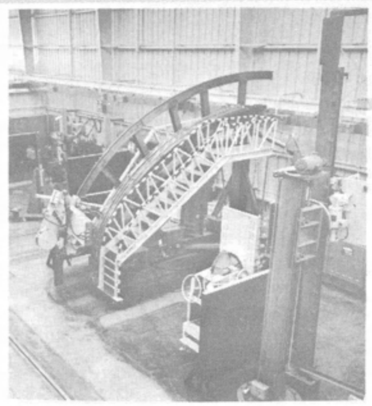
Contracts — 63-71 -- Phase I Construction
64-9 --- Phase II Construction
63-29 -- A&E

Contract 64-9 Phase II
Design Started ----------10-2-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Scheduled Construction Completion -------------1-4-65

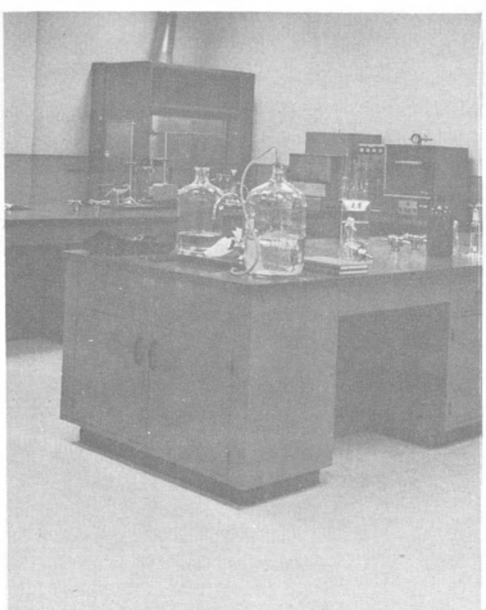
FACILITIES/LABORATORIES



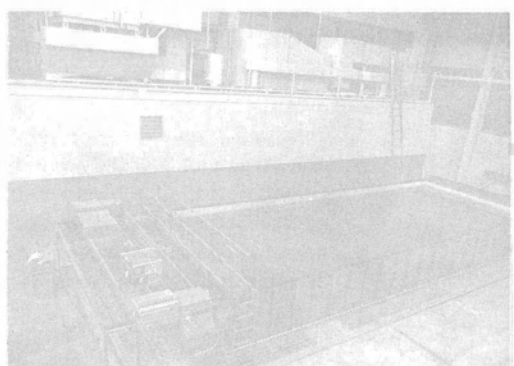
Quality Assurance
Radiographic Evaluation Laboratories



Manufacturing Development Laboratory

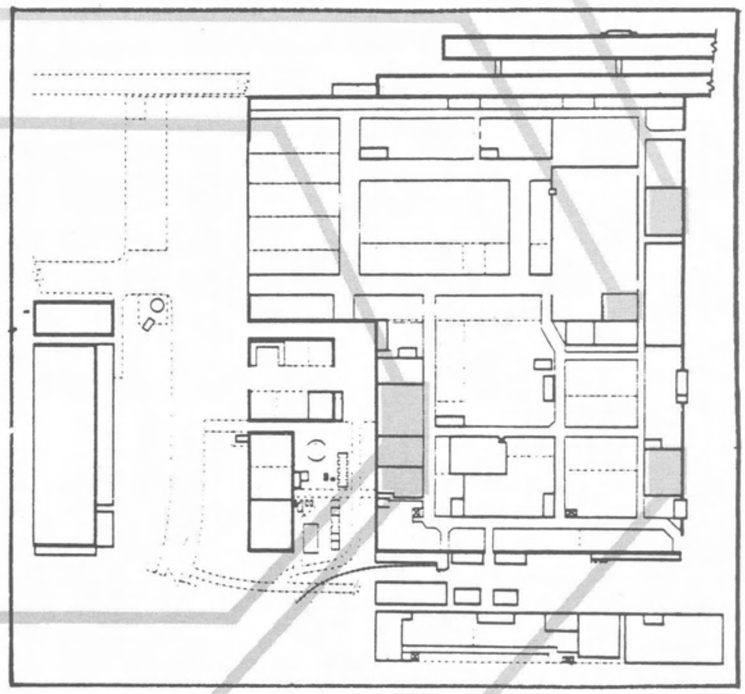


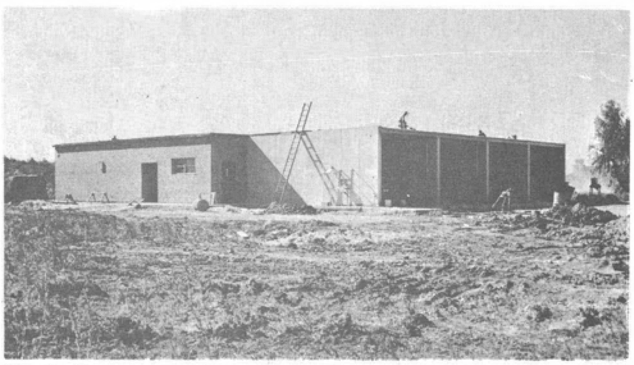
Measurement Control Laboratories



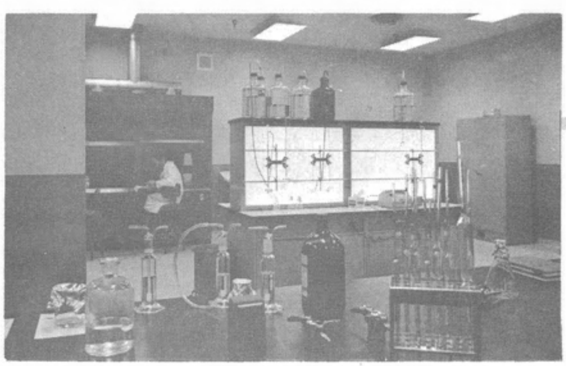
Non-Destructive Test Laboratory

Component Test Area
(Material and Processes Laboratory)





High Pressure Test Area (Remote from Plant)



Quality Evaluation Laboratories

MANUFACTURING DEVELOPMENT LABORATORY

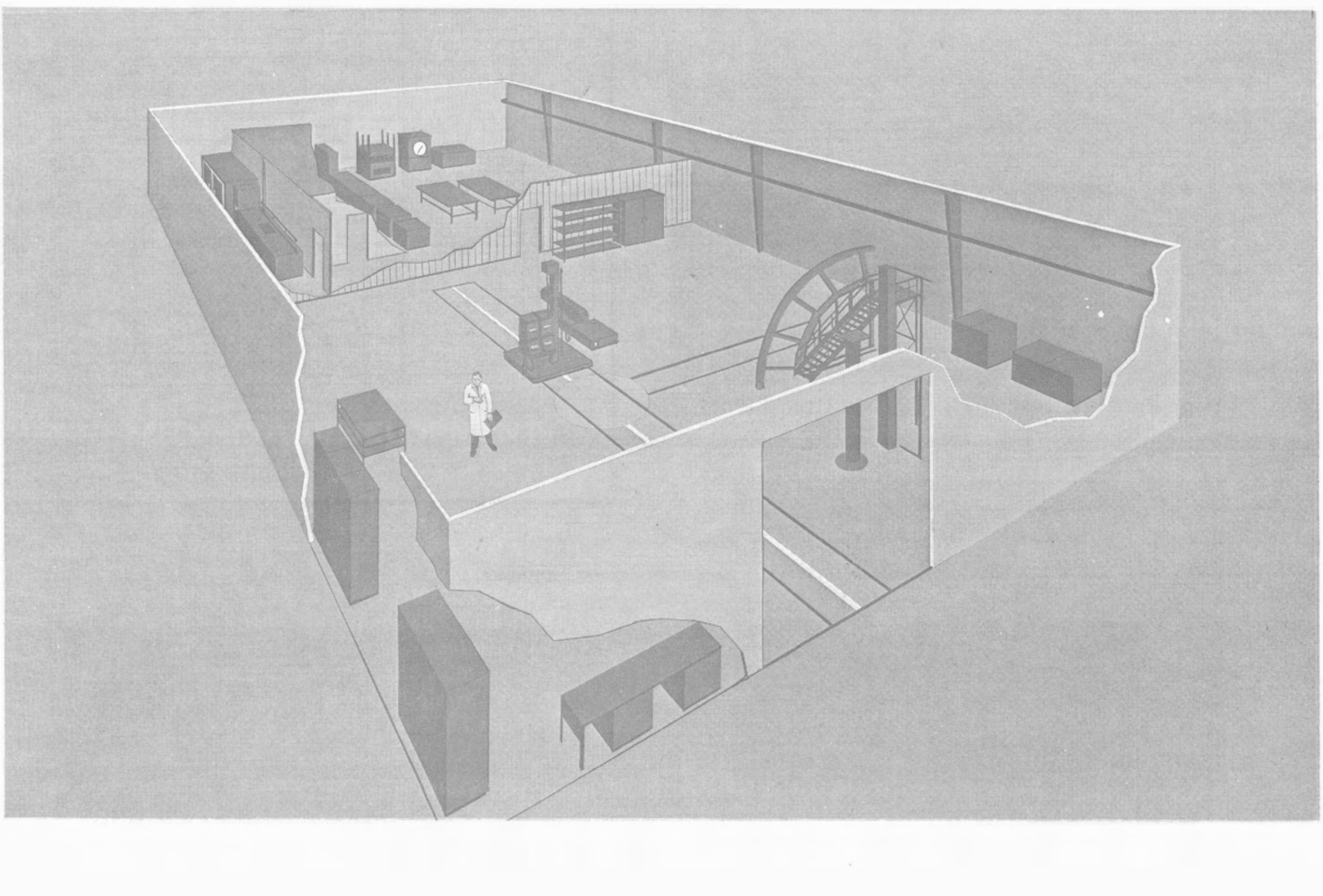
Function - This area is used for the development of new production processes, refining of existing techniques and to eliminate production problems. It also serves to train personnel in new welding methods. This laboratory is subdivided into five totally enclosed sections: 1) Welding Area, 2) Radiation Area, 3) Specimen Preparation Shop, 4) Wire and Instrument Control, and 5) NASA Office.

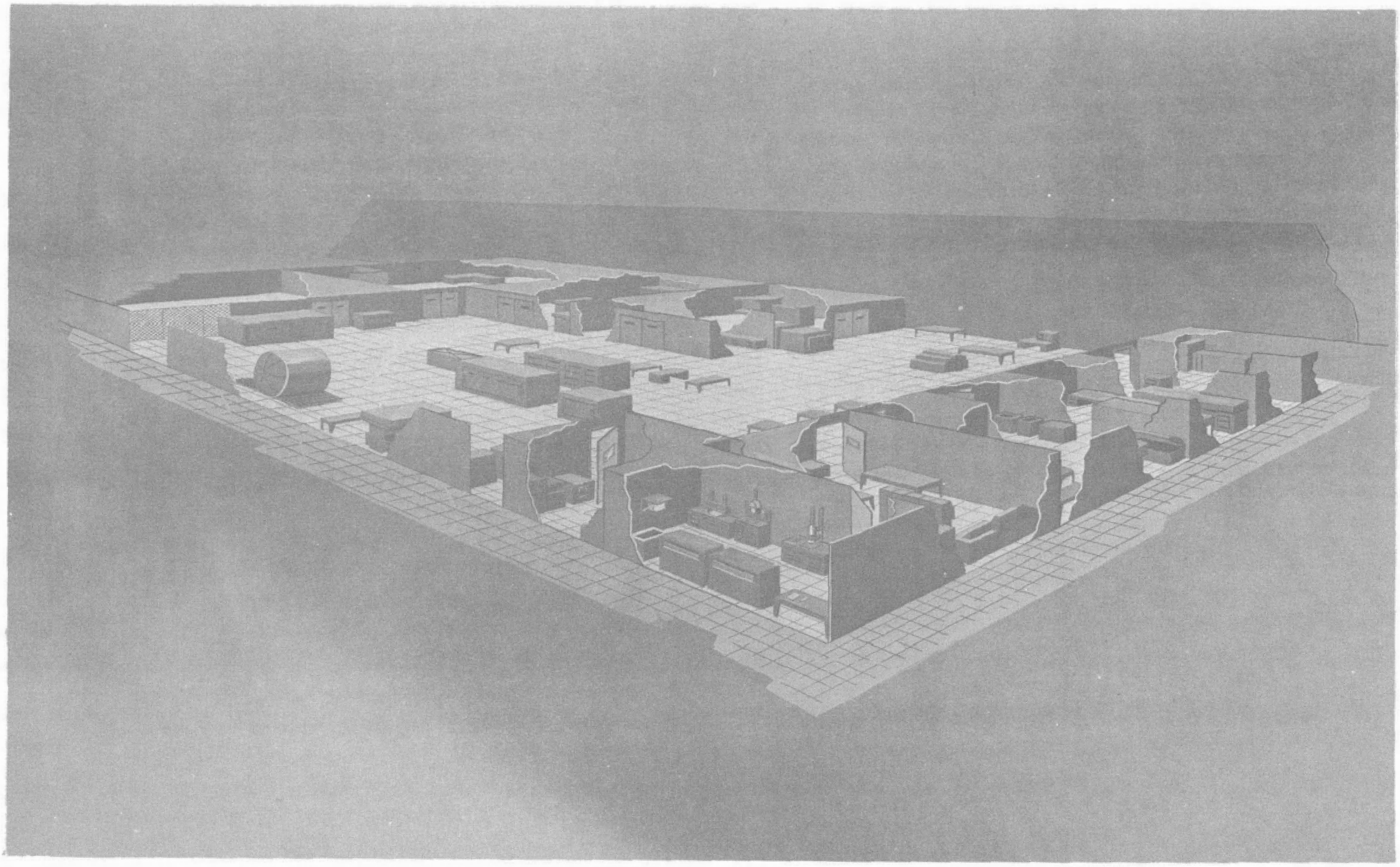
Using Organization - Manufacturing

Area - Manufacturing Development Laboratory -- 6,600 square feet.

Milestones - Design Complete ------- 6-13-63
Construction Start ------ 6-25-63
Construction Complete -- 1-3-64

Contracts - 62-15 -- A&E
63-20 -- Interim Construction
63-25 -- A&E
63-41 -- Construction
63-56 -- Construction





The above illustration shows the Material and Processes Laboratory-Component Test Area

COMPONENT TEST AREA

Function - This area is used to test various mechanical, electrical, and hydraulic components of the S-IC booster to establish and substantiate the design concepts and manufacturing techniques employed. This component testing also provides reliability assurance. Test equipment here is capable of producing, sensing, and recording simulated flight and ground handling conditions (e.g., acceleration, force, vibration, pressure, and temperature environments) to establish the high degree of reliability necessary for the first firing.

Using Organization - Engineering

Area - Component Test Areas -- 73,504 square feet

Milestones - Design Start ----------- 5-15-63
Design Complete ------- 9-26-63
Construction Start ------ 8-12-63
Construction Complete -- 6-15-64

Contracts - 63-32 -- A&E
63-55 -- Construction (Pilings)
63-58 -- Construction
63-66 -- Construction
63-68 -- Construction

HIGH PRESSURE TEST

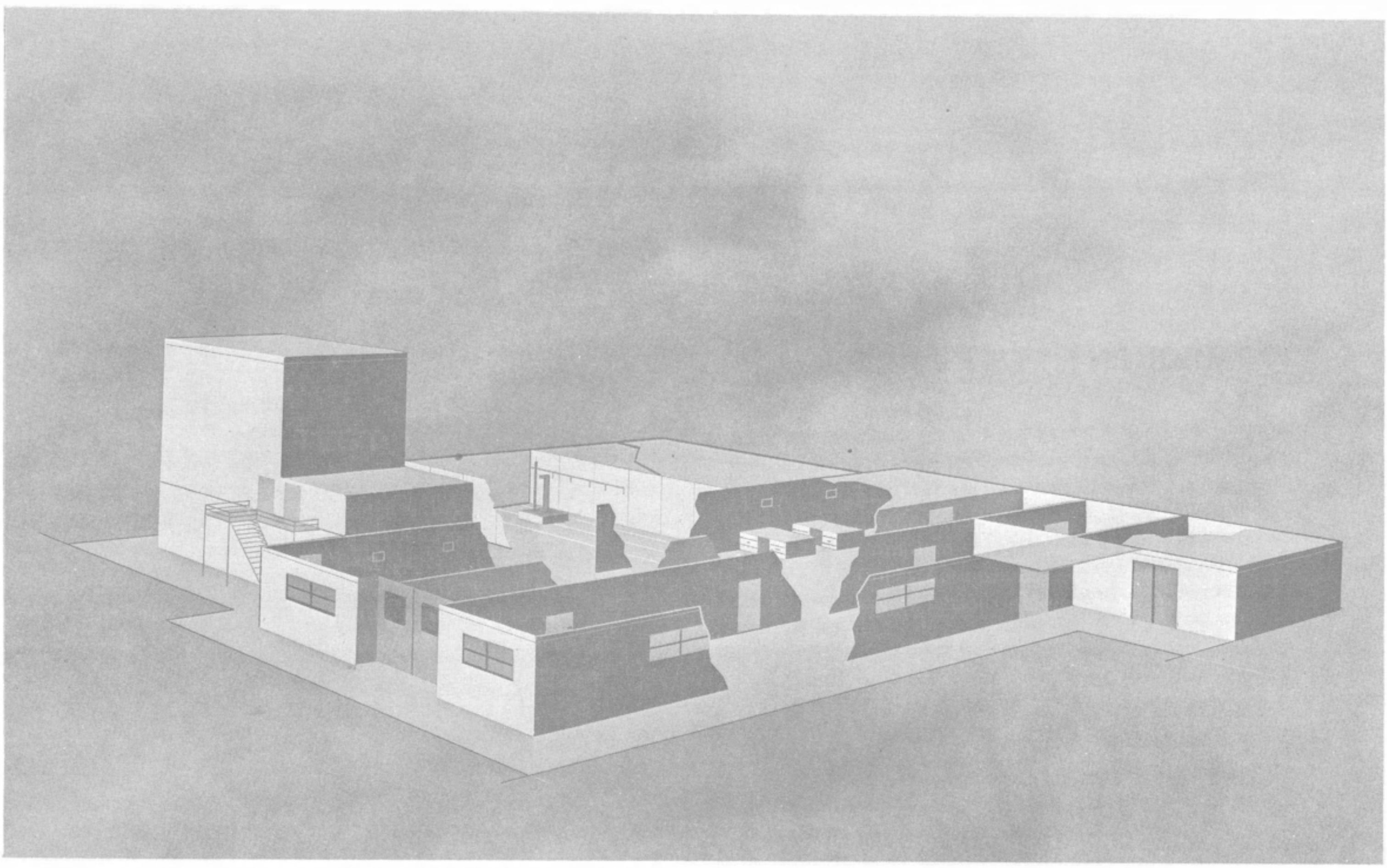
Function - The High-Pressure Test facility will be used to conduct all testing of a hazardous nature for both booster and ground support equipment. Components, subassemblies, subscale test hardware, tanks, and ground support equipment will be subjected to various pressure flow and burst tests to ensure compliance with design requirements under normal and emergency environment and operating conditions.

Using Organization - Engineering

Area - 5,020 square feet

Milestone--

High-Pressure Test:	Design Start ----------	6-12-64
	Design Complete ------	8-3-64
	Construction Start -----	9-8-64
	Construction Complete -	12-22-64
Liquid-Level Test:	Design Start ----------	2-6-64
	Design Complete ------	6-10-64
	Construction Start -----	6-29-64
	Construction Complete -	8-13-64
Helium & Nitrogen Modification:	Technical Support Start -----------------	1963
	Technical Support Complete -------------	4-21-64
	Construction Start -----	5-8-64
	Construction Complete -	10-1-64



QUALITY ASSURANCE LABORATORIES

Function--Quality Evaluation Laboratory - These laboratories are used by the Quality and Reliability Assurance organization to ensure the quality levels of all products and assemblies. Laboratories included in the Quality Evaluation Laboratories are are: 1) Chemical; 2) Metallurgical; 3) Spectro-Analysis; 4) Physical Test; 5) Equipment Quality Analysis; 6) Contamination Control.

Nondestructive Test Laboratory - Nondestructive testing equipment and techniques are maintained and used for such areas as fabrication control and special investigations, in addition to the primary receiving-inspection demands. The equipment and instrumentation of this laboratory is used by technical personnel to perform services such as examination of surface defects, internal defects, discontinuity and porosity in metal parts and welds; and also the detection of cracks and defects in both ferrous and nonferrous materials.

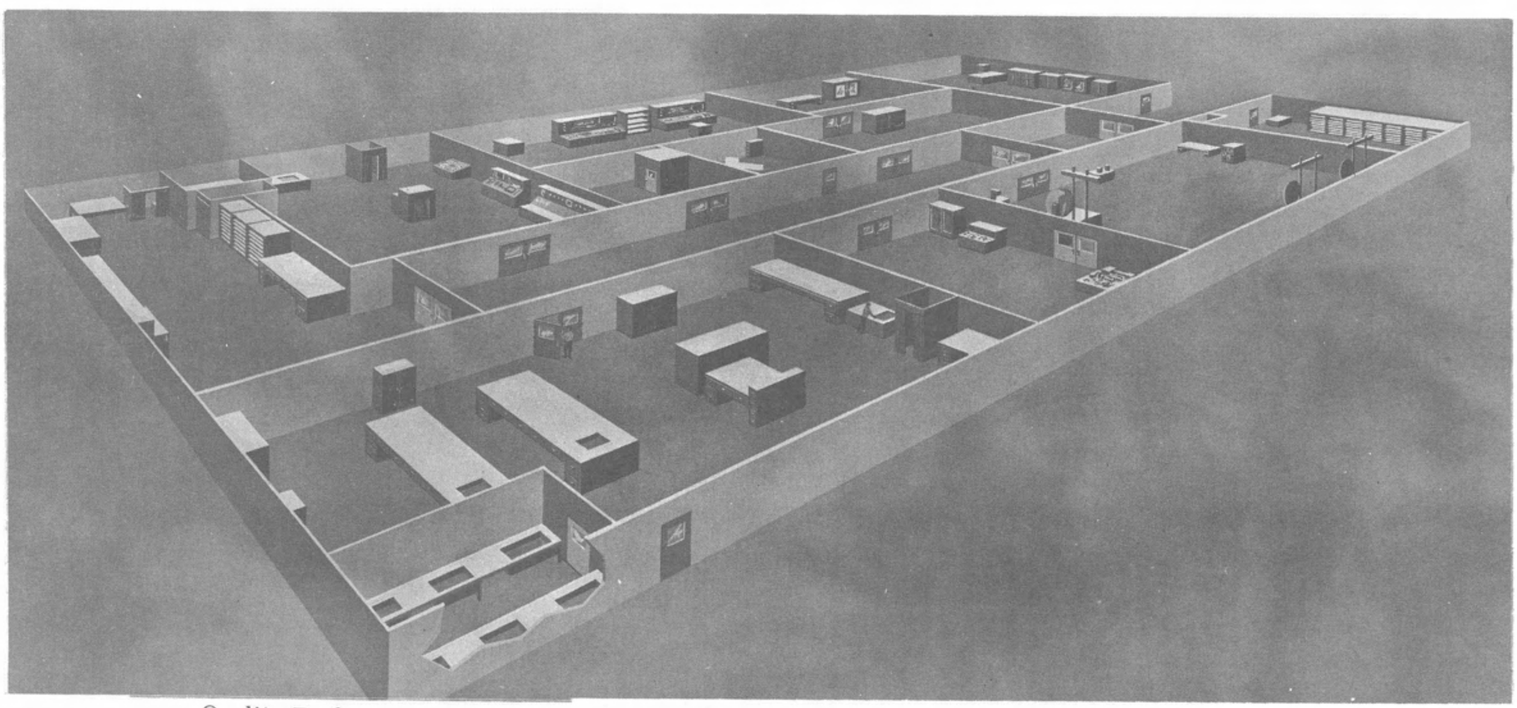
Measurement Control Laboratory - The Measurement Control Laboratory provides the capability to perform initial and periodic calibration and accuracy certification of all measuring and testing equipment used in the Boeing-Saturn Operations at Michoud. In addition, calibration-certification services for transfer standards are performed in this area in accordance with the present agreements between Boeing, Chrysler, and NASA. Laboratories included in the Measurement Control Laboratory area are: 1) Measurement Receiving Area; 2) Micorwave-Electronic Electrical Laboratory; 3) Precision Measurement Laboratory; 4) Pyrometry-Pressure Flow Laboratory; 5) Measurement Office Area.

Using Organization - Quality Assurance

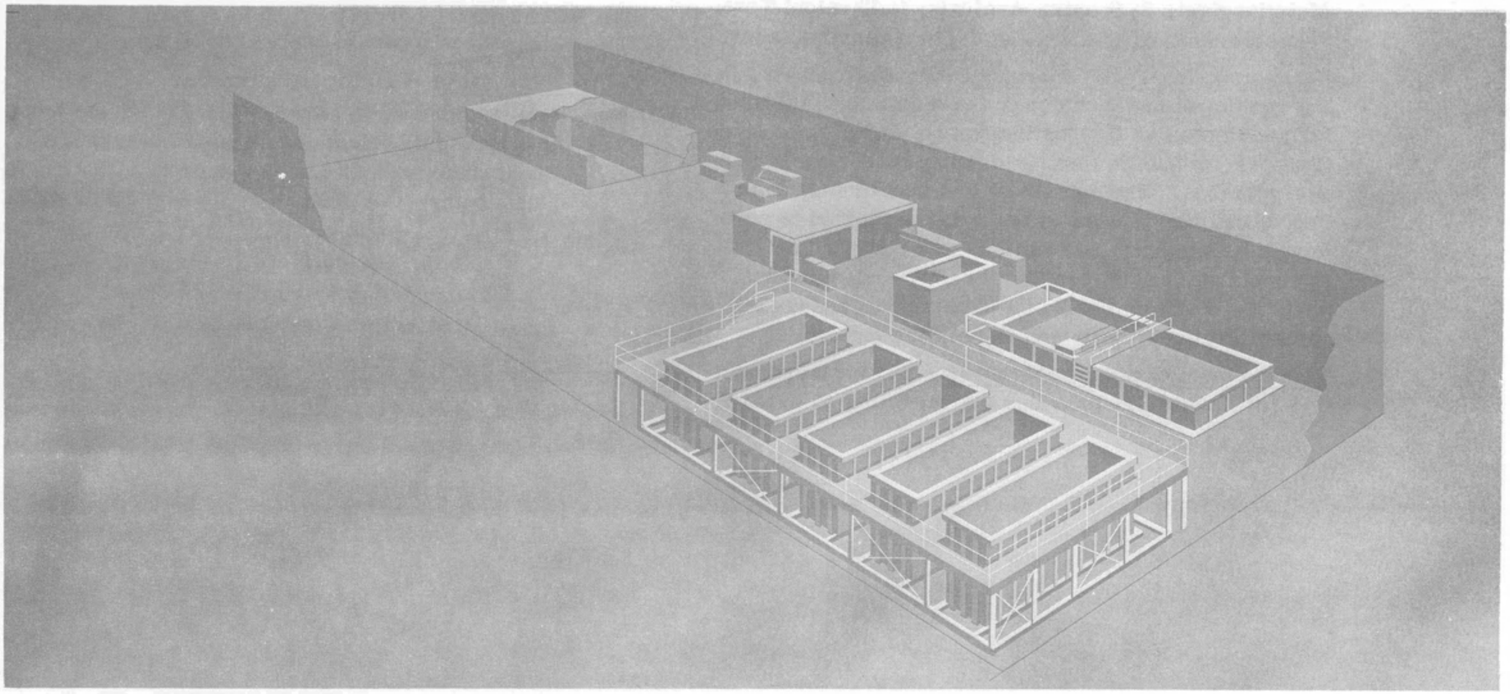
Area - Quality Assurance Labs---- 28,714 square feet
Qualification Evaluation Lab-approx. 8,970 sq. ft.
Nondestructive Test Lab---- approx. 8,000 sq. ft.
Measurement Control Lab---approx. 9,660 sq. ft.

Milestones - Design Started --------- 1-1-63
Design Complete ------- 6-5-63
Construction Started ---- 7-30-63
Construction Complete -- 5-15-64

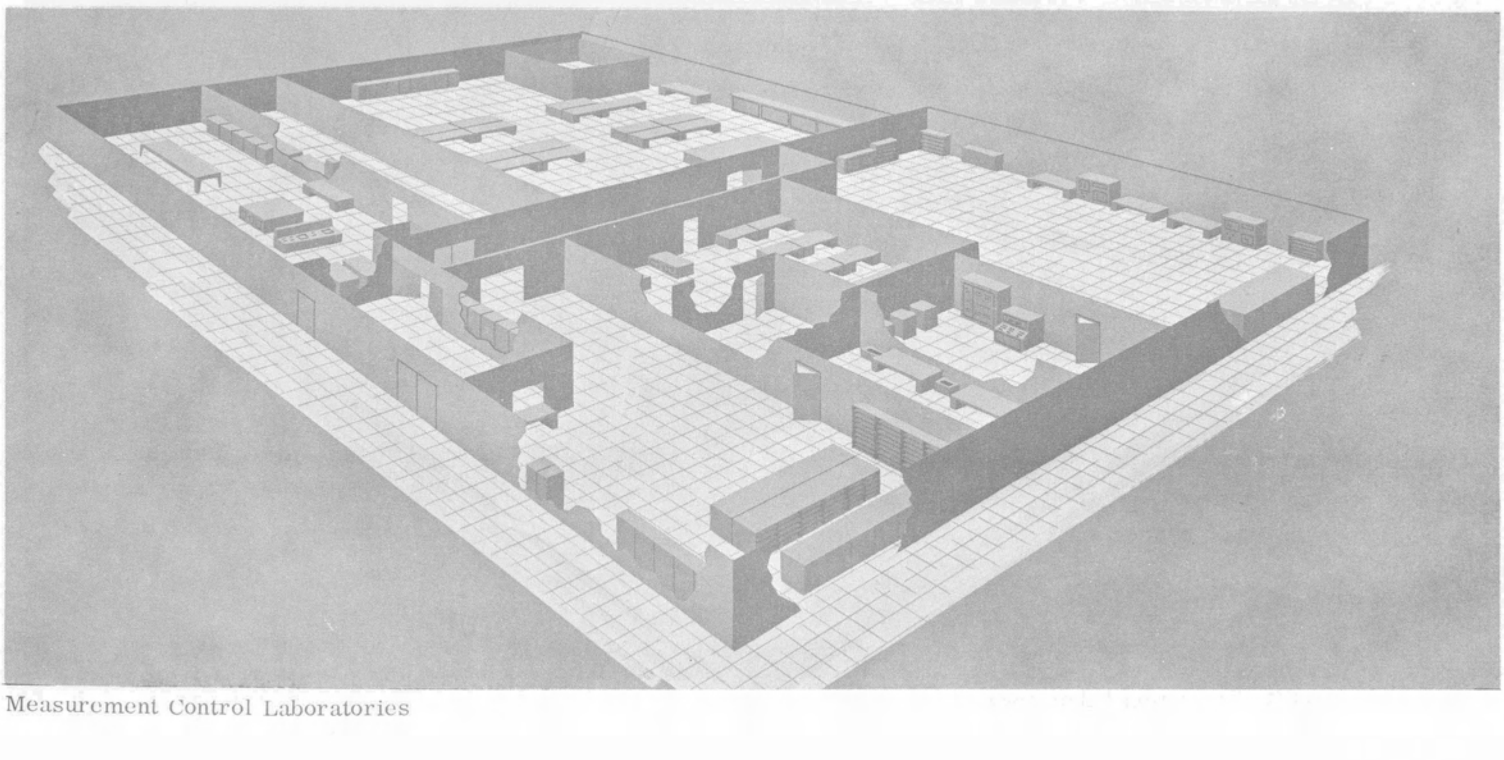
Contracts - 62-11 -- A&E
63-3 --- Construction



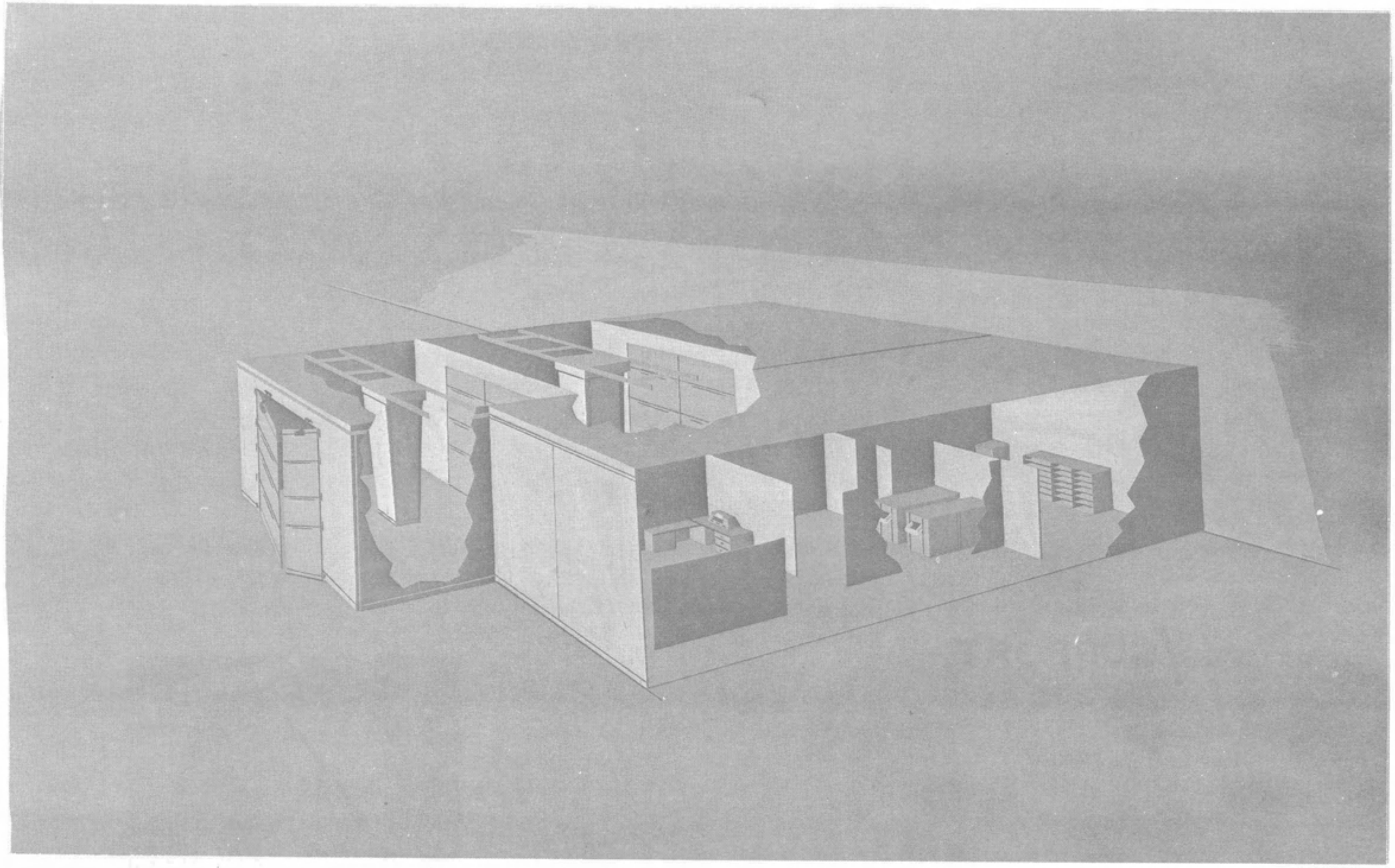
Quality Evaluation Laboratory



Non-Destructive Test Laboratory



Measurement Control Laboratories



QUALITY ASSURANCE RADIOGRAPHIC EVALUATION LABORATORIES

Function - The Centralized Radiographic Evaluation Laboratory provides both X-ray and radio-chemical evaluation support for weld development, weldor certification, and weld and raw material inspection. This laboratory is equipped to detect, evaluate, and record surface and subsurface discontinuities in welds and materials. It also provides for the developing and storage of the permanent X-ray film records for the total S-IC fabrication program.

Using Organization - Quality Assurance

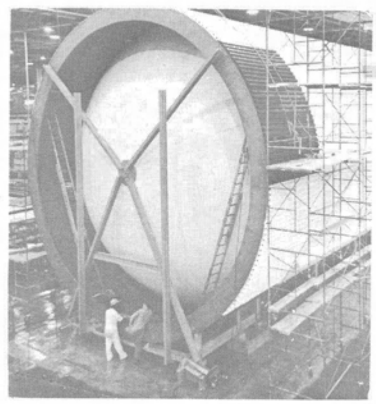
Area - Quality Assurance Radiographic Laboratory -- 3,443 square feet.

Milestones - Start Redesign ----------- 2-27-63
Partial No. 34 Complete -- 4-10-63
Design Complete --------- 5-29-63
Construction Started ------ 6-19-63
Construction Complete ----12-6-63

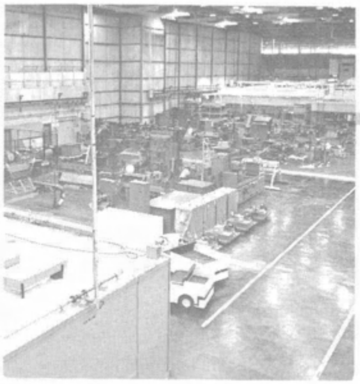
Contracts - 62-7 --- A&E and In-house Design
63-45 -- Construction

FACILITIES/**SUPPORT**

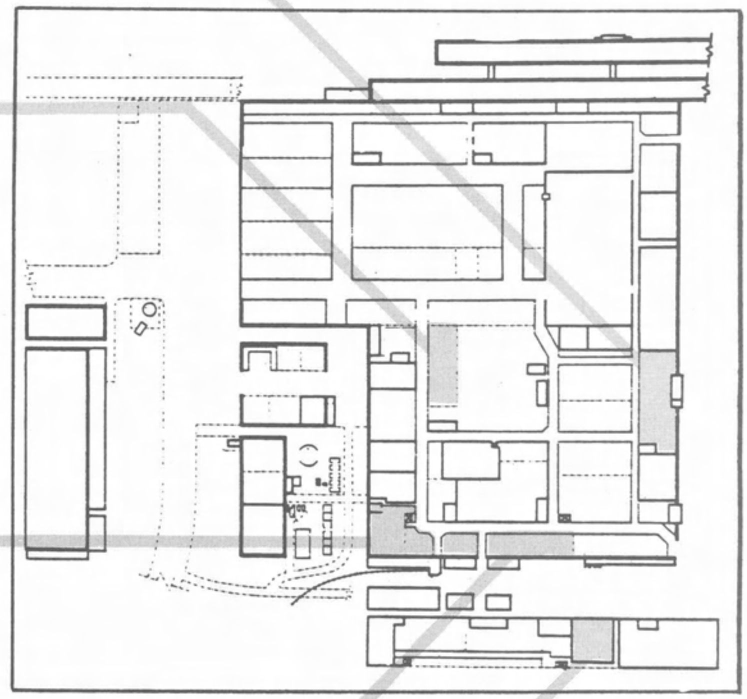
Mockup Facility



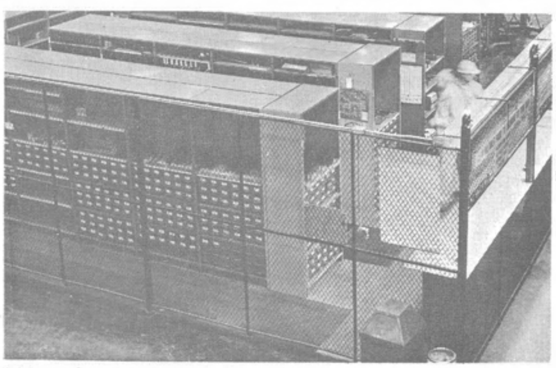
Support and Services Area –
Familiarization and Training



Equipment Maintenance Facility



Receiving and Receiving Inspection Facility



Warehouse and Stores

RECEIVING AND RECEIVING INSPECTION FACILITY

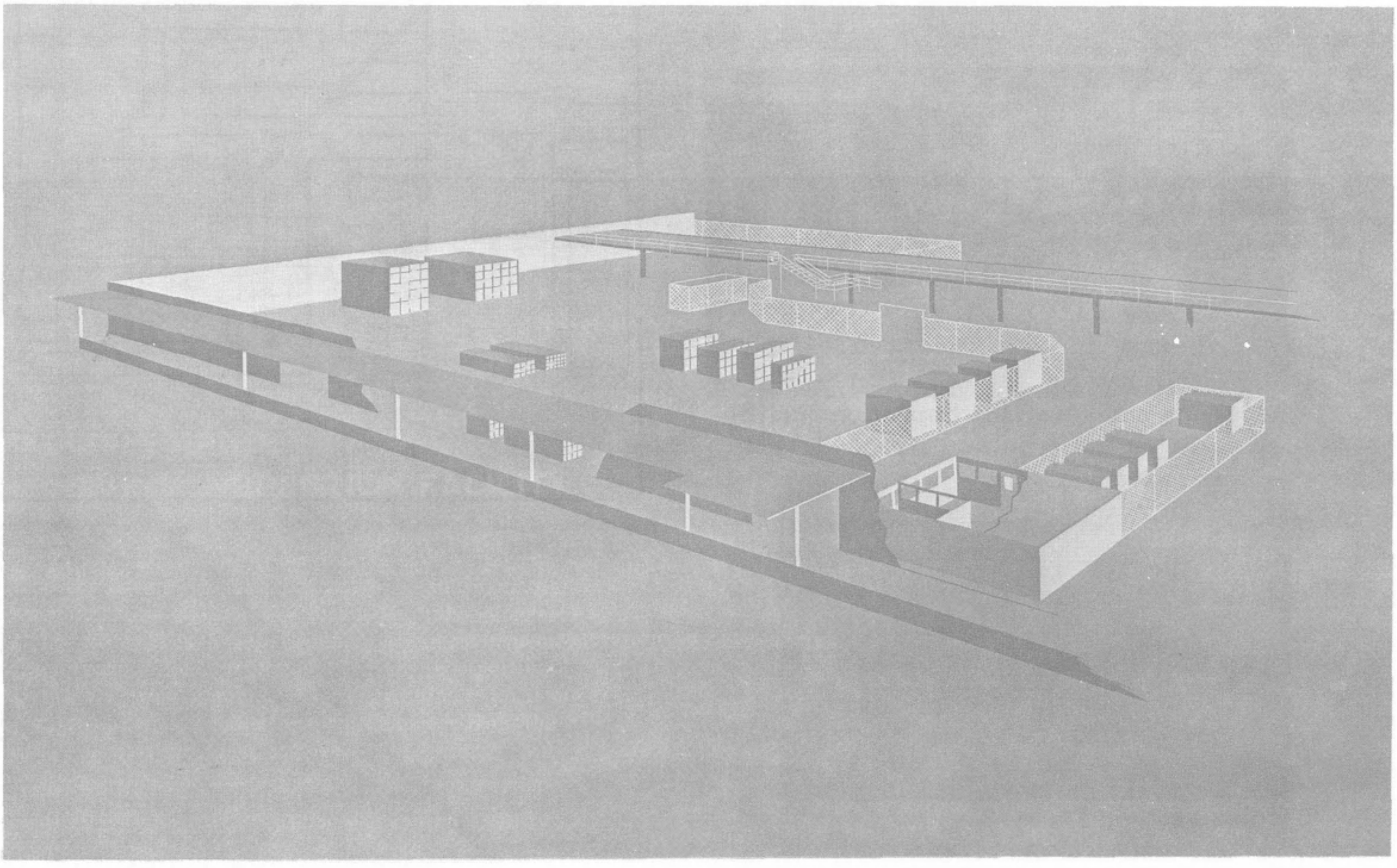
Function - The Receiving-Inspection area receives those components supplied by vendors, subassemblies, raw materials, and test equipment from the general receiving area. These items receive a planned inspection to verify compliance with specifications and general acceptance requirements. Visual and dimensional inspections are performed here with support from the Quality Evaluation Laboratories.

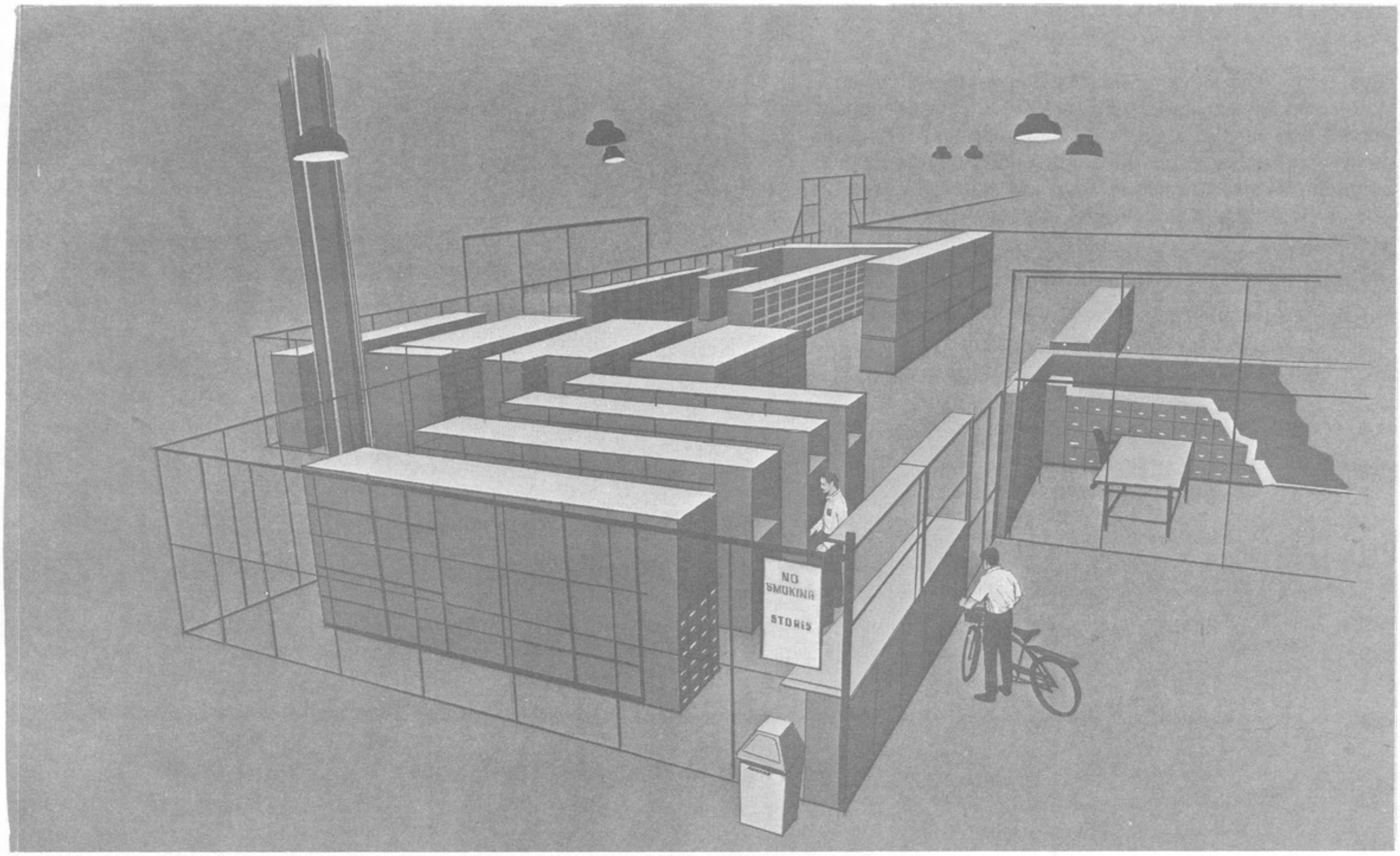
Using Organization - Finance and Quality Assurance

Area - Receiving and Receiving-Inspection Facility -- 24,506 square feet.

Milestones - Design ---------------- 6-20-63
Design Complete --------8-1-63
Construction Start ------ 9-10-63
Construction Complete -- 11-26-63

Contracts - 62-4 -- A&E
63-56 - Construction





WAREHOUSE AND STORES

Function - Foundations must be provided for special tool-the capability to store raw materials and subcontractor supplied items as required to support the manufacture of the S-IC booster.

Using Organization - Materiel

Area - 122,779 square feet

Milestones - Equipment Installation Started - 8-20-63
Equipment Installation Complete - 11-14-63

Contracts - 62-4 -- A&E

MOCKUP FACILITY

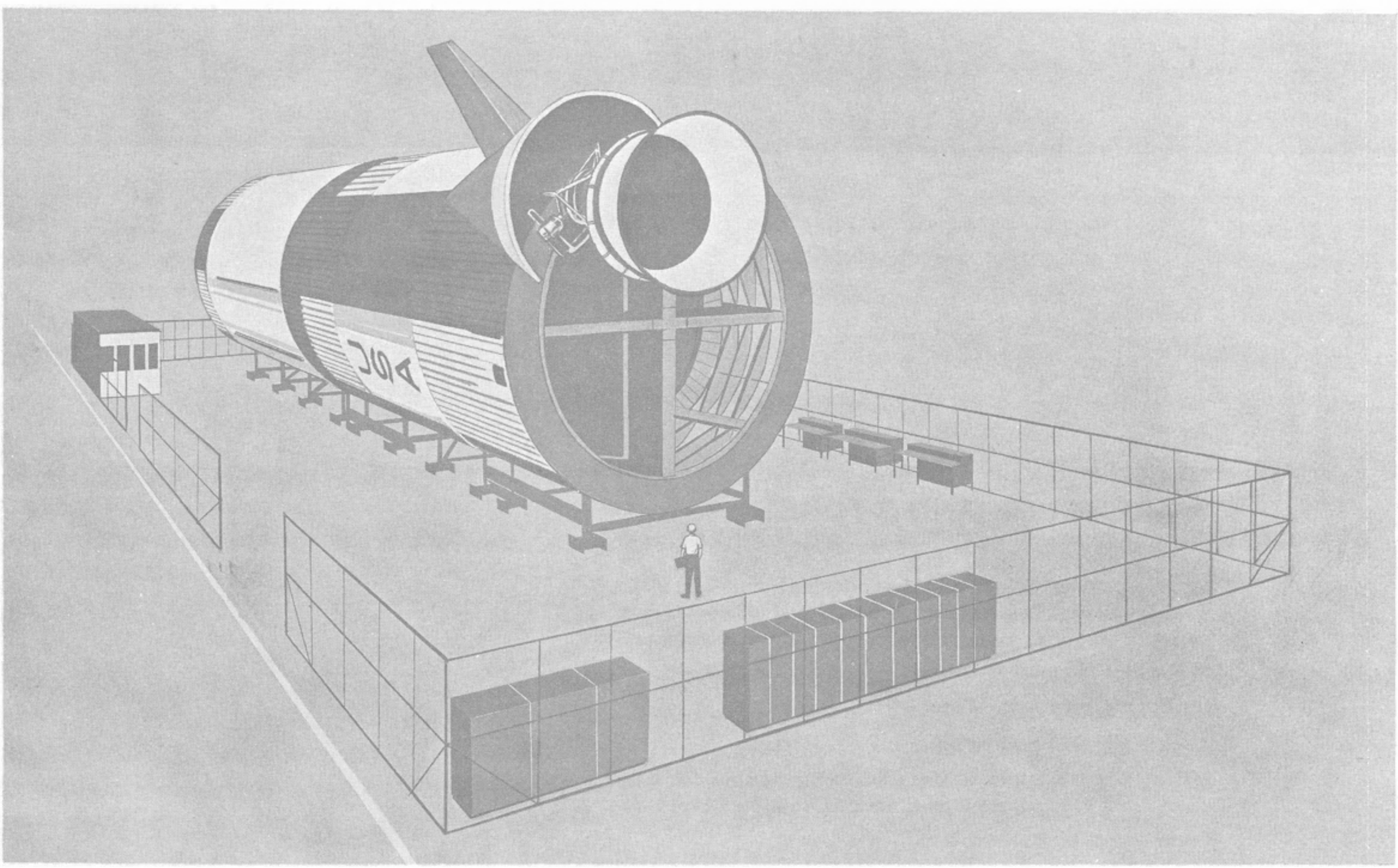
Function - The Mockup Facility houses the Michoud full-scale S-IC manufacturing model. This horizontal model was built to a Class III configuration. It serves as a forming board for developing and fabricating propulsion, electrical, astrionics, and hydraulic systems; for critical tank contours; and for component assembly locations.

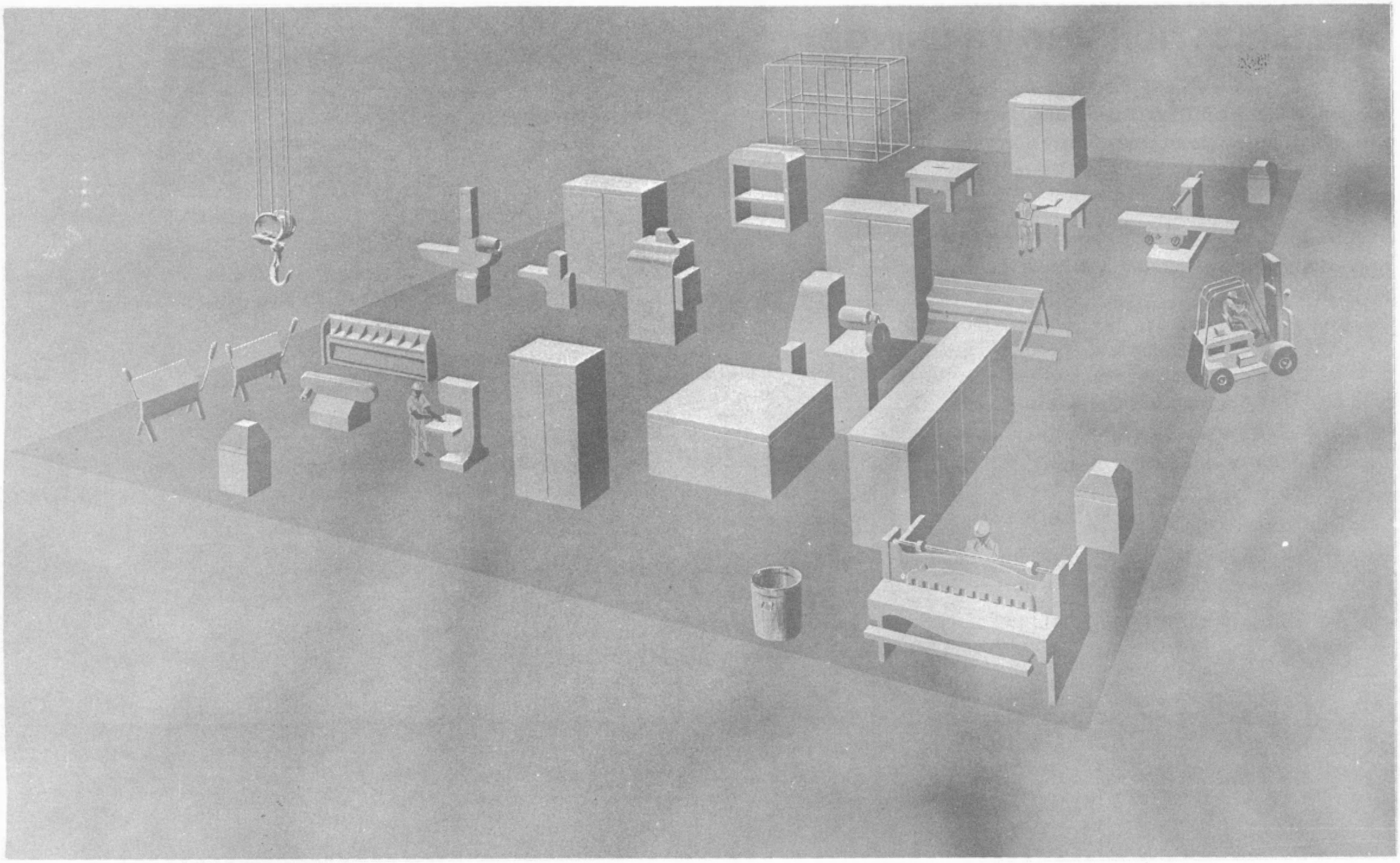
Using Organization - Manufacturing

Area - Full-Scale Model Facility -- 14,400 square feet

Milestones - Design Start ----------- 5-1-63
Design Complete ------- 10-8-63
Construction Start ------ 10-25-63
Construction Complete -- 12-27-63

Contracts - Design -- In-house
63-63 --- Construction





EQUIPMENT MAINTENANCE FACILITY

Function - The Equipment Maintenance facility is required to provide maintenance for general factory and office equipment. It affords the capability of fabricating items that, because of economy or scheduling, are not purchased from vendors; and provides for maintenance of production machine tools, fixtures and other accessory equipment, air-conditioning equipment and systems, metal office equipment, production welders, and general plant items. The facility is capable of housing and providing for maintenance of mobile equipment and consists of the following:

1) Machine Shop
2) Sheet-Metal
3) Woodwork Shop
4) Electrical Shop
5) Paint Shop
6) Transportation
7) Facilities Checkout Equipment
8) Filter Cleaning Facility

Using Organization - Facilities

Area - Equipment Maintenance facility — 23,678 square feet.

Milestones - Design Start ----------- 6-26-63
Design Complete ------- 9-30-63
Construction Start ------ 10-25-63
Construction Complete -- 3-26-64

Contracts - Design -- In-house
63-61 --- Construction

SUPPORT AND SERVICES AREAS
FAMILIARIZATION AND TRAINING

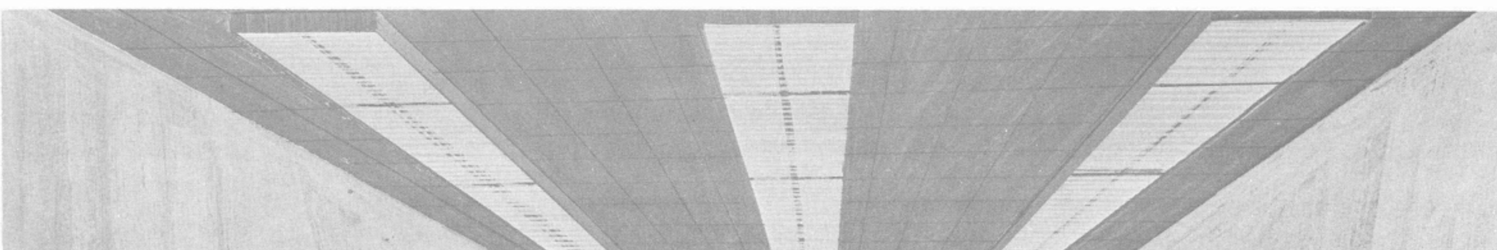
Function - The Familiarization and Training area will be used to train, orient, and certify personnel in sheet-metal assembly work, electrical fabrication, and optical tooling.

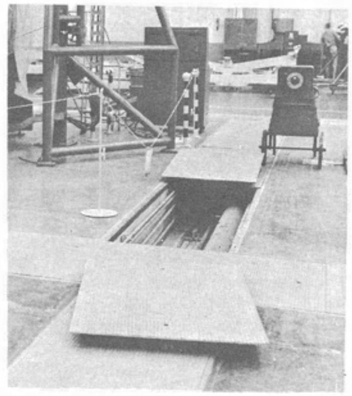
Using Organization - Industrial Relations Organization

Area - Familiarization and Training Facility -- 11,660 square feet.

Milestones - Design Start ----------- 9-15-63
Design Complete ------- 10-28-63
Construction Start ------ 10-28-63
Construction Complete -- 2-14-64

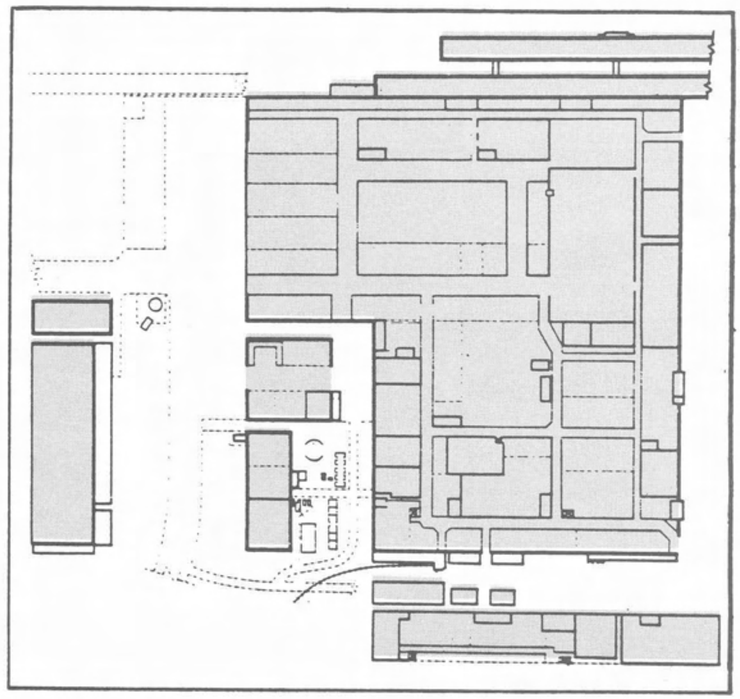
Contracts - 63-27 -- A&E
63-47 -- Construction

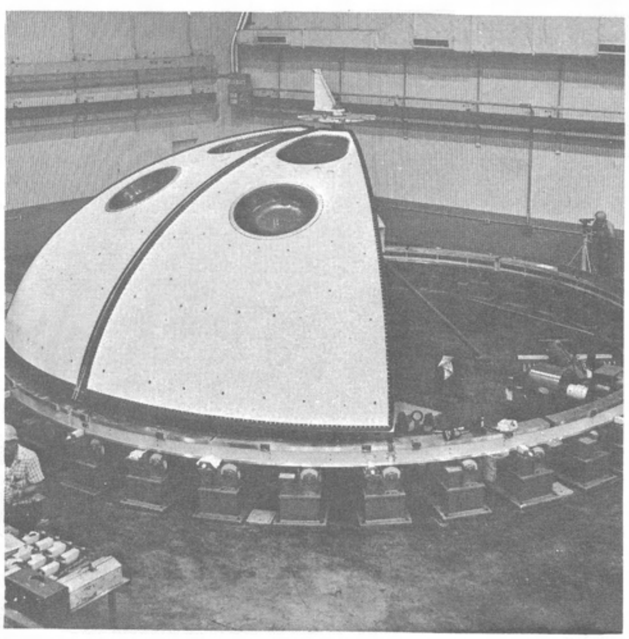




Special Gas Facilities

FACILITIES/GENERAL PLANT





Special Tooling Foundations

SPECIAL GAS FACILITIES

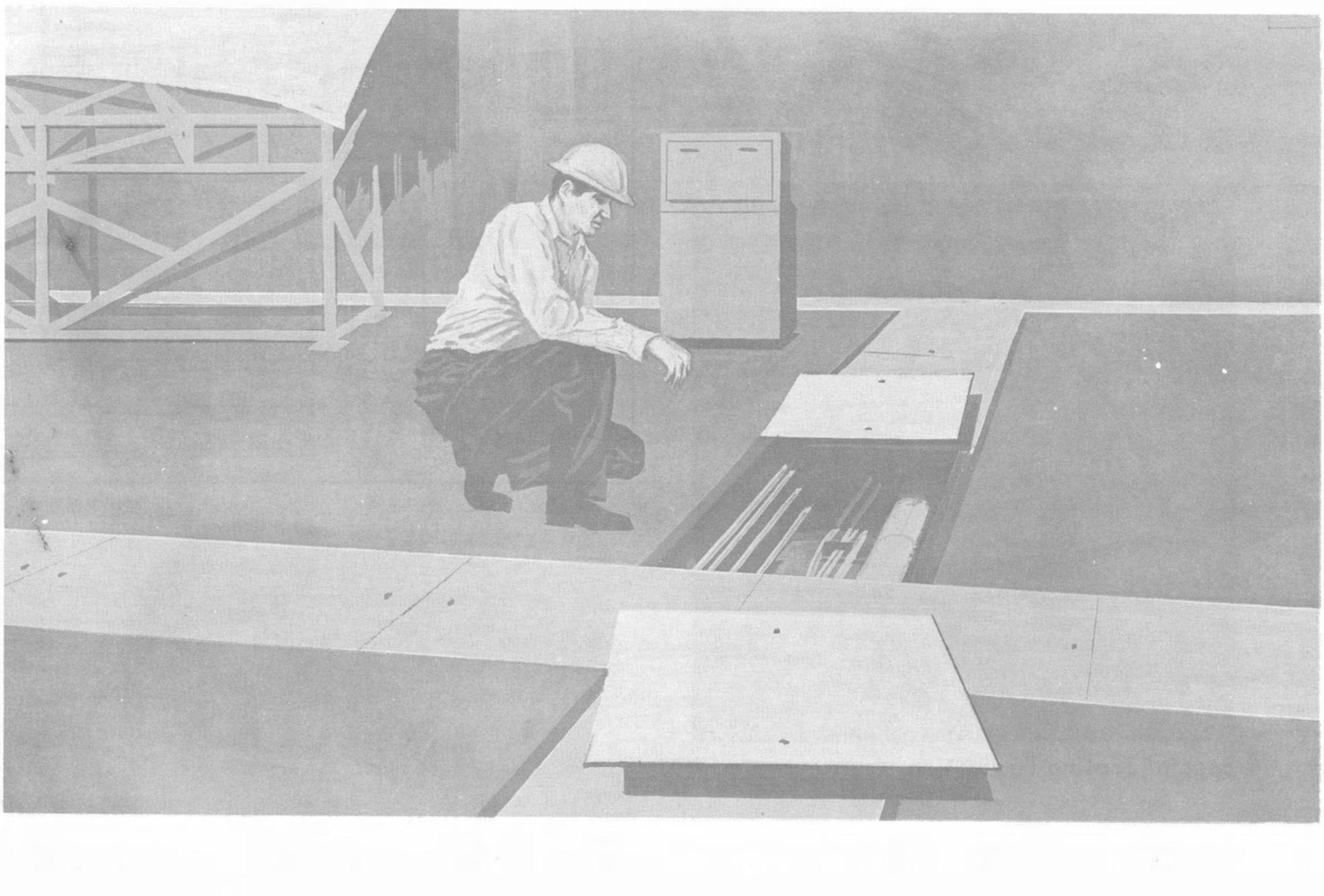
Function - The Special Gas facility will handle piped gaseous nitrogen (GN_2), helium, and argon; and liquid nitrogen (LN_2) stored in pressure vessels. Nitrogen will be used for testing, drying, packaging and purging. Helium will be used for pressurization and to create an inert atmosphere for certain welding processes. The principal use of argon is to be for weld shieldings. Small amounts of bottled CO_2 and CCl_2F_2 (Refrigerant 12) will also be used, primarily for instrumentation testing and other laboratory functions.

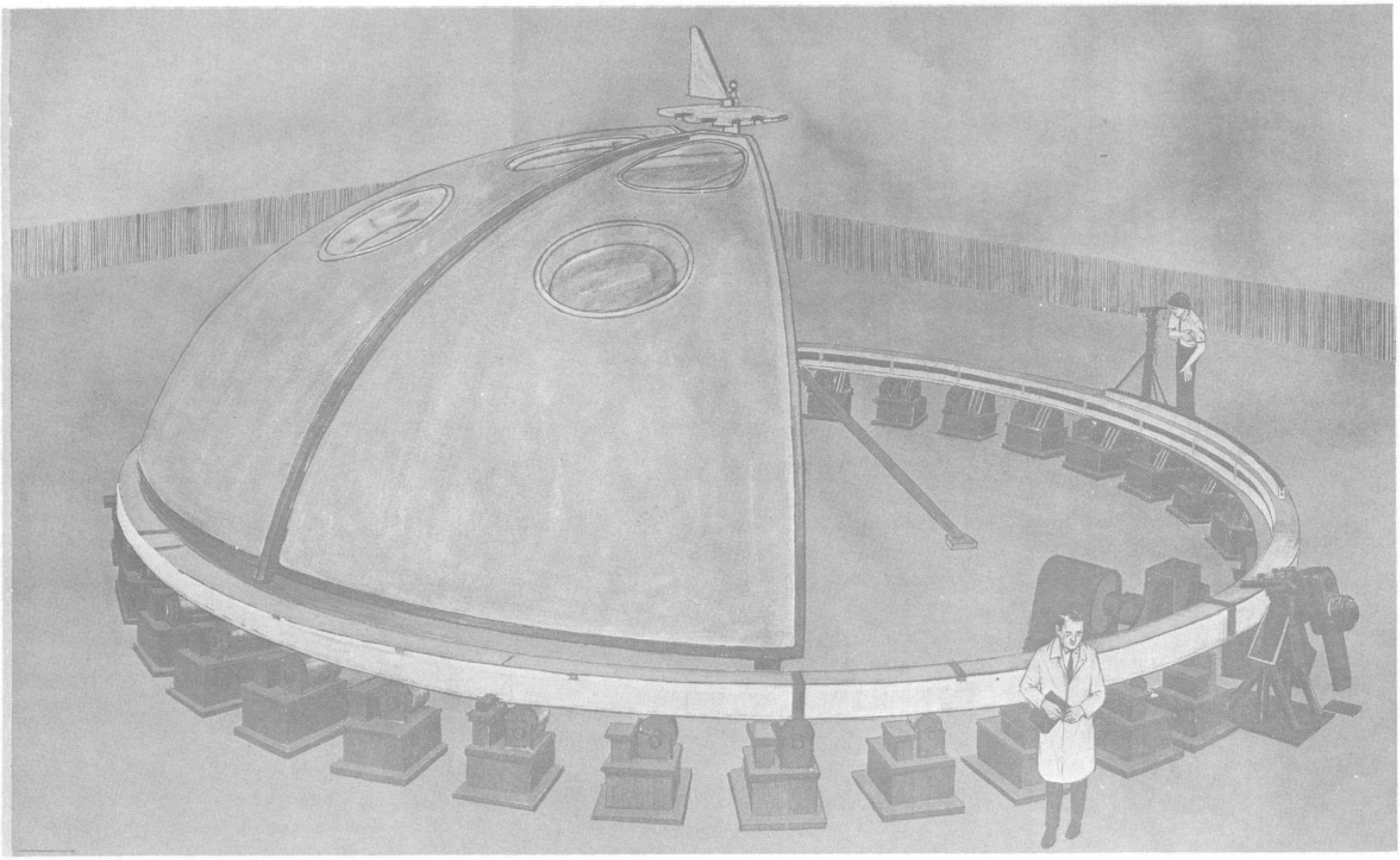
Using Organization - Manufacturing

Area - Not applicable

Milestones - Design Started --------- 1-1-63
Design Complete ------- 8-13-63
Construction Started ---- 12-21-63
Construction Complete -- 4-3-64

Contracts - In-house -- Design
63-53 ----- Construction





SPECIAL TOOLING FOUNDATIONS

Function - Foundations must be provided for special tooling required in the assembly and manufacture of the S-IC booster and GSE/MSE.

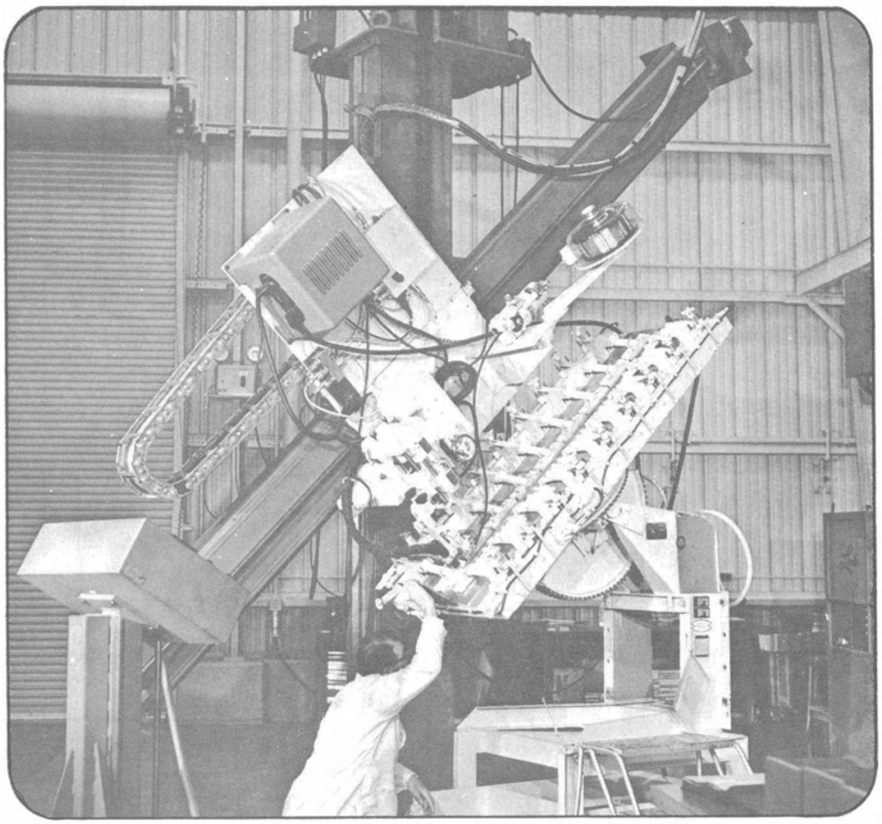
Using Organization - Manufacturing

Area - Not applicable

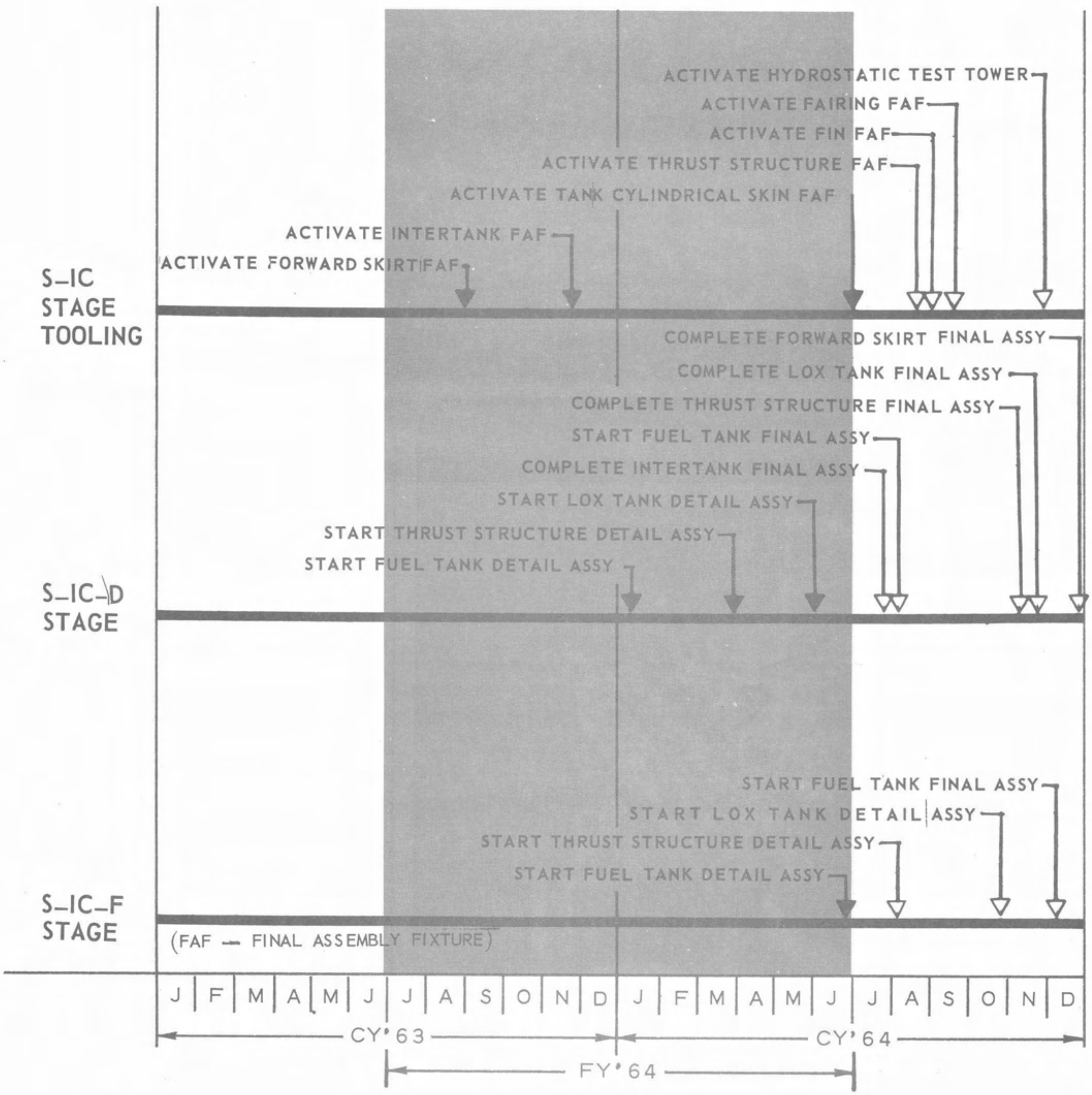
Milestones - Special Tooling Foundations Phases 5, 6, 7, and 8.

Phase 5 Started ---- 1963
Phase 5 Complete -- 9-27-63
Phase 6 Started ---- 1963
Phase 6 Complete -- 10-31-63
Phase 7 Started ---- 1963
Phase 7 Complete -- 2-29-64
Phase 8 Started ---- 1963
Phase 8 Complete -- 3-1-64

Contracts - 63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8



ASSEMBLY AND MANUFACTURING


ACTIVATE HYDROSTATIC TEST TOWER
ACTIVATE FAIRING FAF
ACTIVATE FIN FAF
ACTIVATE THRUST STRUCTURE FAF
ACTIVATE TANK CYLINDRICAL SKIN FAF
ACTIVATE INTERTANK FAF
ACTIVATE FORWARD SKIRT FAF
S-IC STAGE TOOLING
COMPLETE FORWARD SKIRT FINAL ASSY
COMPLETE LOX TANK FINAL ASSY
COMPLETE THRUST STRUCTURE FINAL ASSY
START FUEL TANK FINAL ASSY
COMPLETE INTERTANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-D STAGE
START FUEL TANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-F STAGE
(FAF — FINAL ASSEMBLY FIXTURE)
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

SUMMARY

S-IC stage assembly and manufacturing activity at the beginning of this reporting period was primarily oriented to structure component manufacture in support of the NASA/MSFC ground test program, and the fabrication and erection of stage tooling at Michoud. During the last three months of 1963, the scope of work was expanded to include increased procurement of stage systems specialty hardware, and components for test and checkout equipment. Ground support equipment (GSE) requirements for the NASA/MSFC ground test program were also defined during the same period, permitting Boeing to assess their capability to deliver equipment for R-Test and R-Qual laboratories at MSFC. By the end of June 1964, firm delivery dates were established for R-Test GSE, and the requirements were formally established for one set of test and checkout equipment to be installed at Mississippi Test Operations.

On January 22, 1964, the program schedule changed from NASA/MSFC Plan V to NASA/MSFC Plan VII. (See Part X of this report for a discussion of this change.) This changed The Boeing Company's responsibilities from providing the S-IC-F stage, and the S-IC-2 through S-IC-10 stages to providing the S-IC-D, the S-IC-F and the S-IC-3 through S-IC-10 stages. In conjunction with these program revisions, assembly and manufacturing activities were rephased to the new Plan VII schedule requirements. By the end of the first quarter of CY'64, Boeing had incorporated Plan VII schedules into its stage production schedules, established a GSE/MSE manufacturing program that supported the defined requirements of both MSFC and Michoud operations, and had made substantial progress in manufacturing development.

At the end of the first quarter of CY'64, delay of construction on the hydrostatic test facility for the Michoud vertical assembly building suggested a slippage in completion of the S-IC-D stage. However, by the end of the reporting period, the condition had been lessened and was no longer considered a problem affecting delivery of the S-IC-D. Other major problems during March 1964, were: indications of major rework to intertank tooling resulting from potential structural changes to intertank hardware; and incompatabilities between Boeing production requirements and delivery schedules proposed by NASA/MSFC for government-furnished F-1 engines, beginning with the S-IC-3 stage. The requirement for redesigned intertank hardware became firm in the second quarter of CY'64 and Boeing assembly and manufacturing schedules were adjusted to absorb two additional intertank assemblies, plus the necessary rework of the assembly tooling. Resolution of the NASA/MSFC-Boeing F-1 engine schedules was still being studied at the close of the reporting period.

At the end of June 1964, The Boeing Company's Contract NAS8-5608 assembly and manufacture activity included assembly operations on S-IC-D hardware and GSE/MSE for all locations. Minor behind-schedule conditions existed in several areas; however, recovery is predicted and all GSE/MSE and S-IC stages are forecast to be delivered per the NASA/MSFC Plan VII schedule requirements.

S-IC-D STAGE

The Boeing Company activity for the S-IC-D stage, Plan V requirements, was directed toward assisting NASA/MSFC in a role similar to that of the S-IC-T stage; namely, that of supplying NASA/MSFC specific assemblies, major components, and hardware items as required. NASA/MSFC Plan VII effected the realignment of The Boeing Company responsibilities to include assembly of the S-IC-D stage at the Michoud facility.

Under Plan VII, the S-IC-D stage is to be delivered to MSFC on August 20, 1965. Assembly and manufacturing activities were rephased to the new Plan VII requirements, and by the end of March 1964, Boeing had completed the incorporation of Plan VII into its production schedules.

Actual production of the S-IC-D stage was initiated during the third quarter of CY'63 with the fabrication of fuel-tank skin ring segments (Figure III-1). In November 1963, procurement activity started with the placing of purchase orders for long lead items. The first quarter of CY'64 was highlighted by an increase in component fabrication for the S-IC-D stage. By the end of the second quarter of 1964, components were available at Michoud for tank assembly. Fittings were being welded in bulkhead gore segments, and weld operations on the S-IC-D fuel tank skin rings were performed. Parts were available for the thrust structure and center-engine support structure (Figures III-2 and III-3), and were scheduled for assembly in the early part of July 1964.

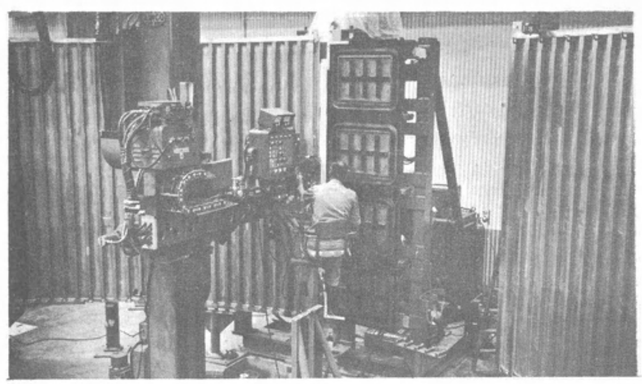


Figure III-1 - Boeing Technician Routing an S-IC-D Tank Skin Ring Segment Prior to Welding in the Environmentally Controlled Minor Assembly Area at Michoud

At the close of the first quarter of CY'64, construction of the hydrostatic test facility in the Michoud Vertical Assembly Building was being delayed. This con-

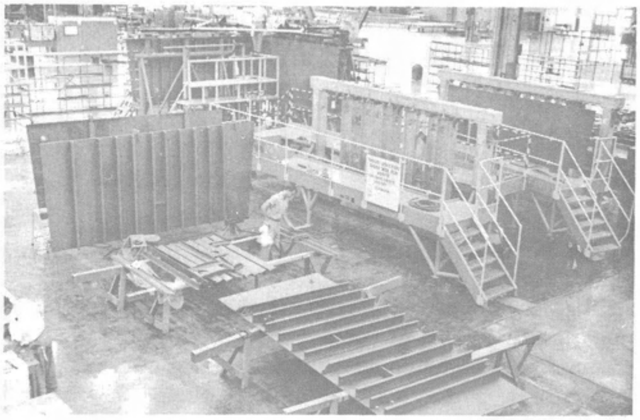


Figure III-2 - Shear Web Panels for the Center Engine Support Assembly (Background) are Being Completed at Michoud

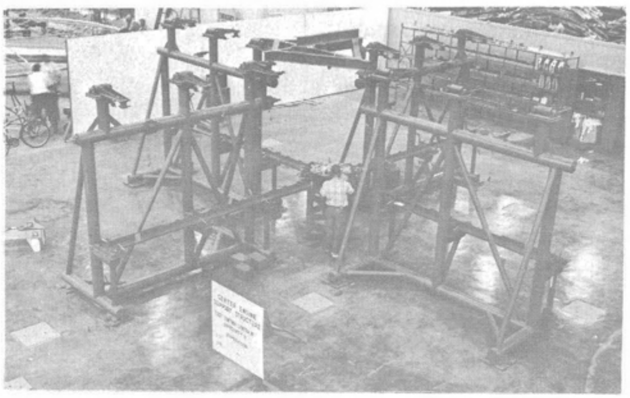


Figure III-3 - Assembly Fixture Used For the Center-Engine Support Nears Completion.

dition threatened completion schedules for the S-IC-D fuel and LOX tanks and resulted in a predicted late delivery of the S-IC-D stage. Close cooperation between NASA/MSFC and Boeing in resolving funding problems allowed Phase II vertical assembly building construction to proceed in April 1964. Although a 17-day behind schedule condition still exists on this construction, the use of work around methods has alleviated this condition and hydrostatic testing is no longer considered a major problem area. Construction progress at this time is shown in Figures III-4 and -5.

As a result of findings derived from tests conducted on a scale model intertank during the early months of 1964, a second problem was discovered. Failure of the scale-model intertank under some loading conditions suggested certain modifications to the intertank structural hardware, which in turn required modification of the intertank assembly tooling. At first, this indicated that the S-IC-D intertank assembly schedule would be adversely affected. Subsequent studies on intertank assembly fixture loadings indicated that both the hardware and tooling could be modified without impairing S-IC-D intertank completion schedules.

At the close of the reporting period Boeing activity in support of the S-IC-D stage was generally supporting NASA/MSFC Plan VII schedules. Delivery of the S-IC-D stage to MSFC on August 20, 1965, is currently expected to occur on schedule.

S-IC-F STAGE

At the outset of the reporting period, Boeing emphasis on the S-IC-F stage was centered on stage tooling design and fabrication requirements. Boeing had completed approximately 60 percent of the tool design and 35 percent of the tool fabrication for the total S-IC-F stage requirements by the end of September 1963.

Working to Plan V schedules, Boeing began fabricating S-IC-F detail parts at Boeing/Wichita, during the fourth quarter of CY'63. Assembly operations were then due to start at Michoud during the first quarter of CY'64. However, when NASA/MSFC Plan VII schedules became effective in January 1964, a revision of S-IC-F stage production schedules was necessary to meet a new NASA/MSFC on-dock delivery date, January 21, 1966, to the Merritt Island Launch Area. Under the new schedule requirements, major assembly activities are to start at Michoud in August 1964. Component fabrication is on schedule in support of this assembly requirement, and the S-IC-F stage is forecast to be completed on schedule.

S-IC-3

Michoud assembly activities in support of the S-IC-3 stage are scheduled to start late in the fourth quarter of CY'64. Plan VII requires delivery of this stage to Mississippi Test Operations on August 1, 1966, for static

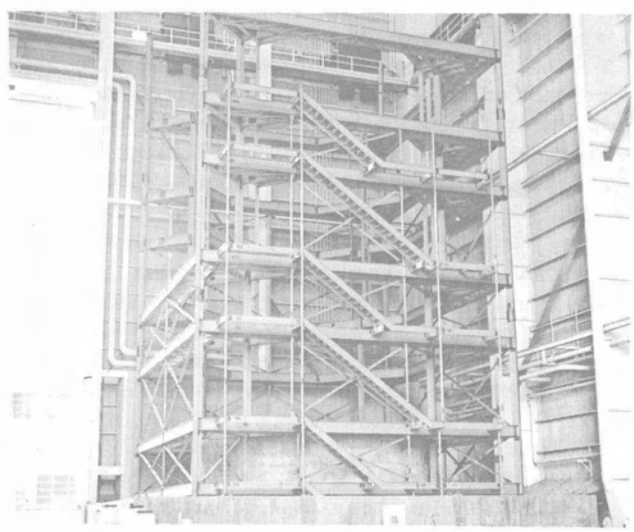


Figure III-4 - Construction Progress on the Hydrostatic Test Tower in the Vertical Assembly Building at Michoud

testing. Following this, the stage is to be returned to Michoud for refurbishment, checkout, and eventual delivery to MILA on February 21, 1967.

Hardware orders for the S-IC-3 were released during the fourth quarter of CY'63, and by the end of the first quarter of CY'64 the fabrication of detail components was underway. By the close of the reporting period, approximately 90 percent of the known structural hardware components had been placed on order.

The only item of concern relative to the S-IC-3 stage is the availability of F-1 engines from Rocketdyne. During the first quarter of CY'64, it became apparent that the NASA/MSFC proposed availability dates of these government furnished engines were not compatible with Boeing engine buildup schedules in support of the S-IC-3 stage assembly. This is currently under study by both NASA/MSFC and Boeing. Although progress is being made, the problem has not been completely resolved. It is anticipated that a satisfactory solution will be effected by either acceleration of engine deliveries to Michoud or the authorization of workaround techniques, so that the Plan VII schedules for delivery of the S-IC-3 stage will be met.

S-IC STAGE TOOLING

Fabrication and erection of tooling for Michoud started during the early months of 1963 and continued through the reporting period. Significant tooling activated during the fiscal year were the intertank, forward skirt, and thrust structure final assembly positions (Figures III-6, III-7, and III-8) along with the necessary supporting subassembly and minor assembly tooling. The LOX and fuel-tank minor assembly tooling, used to assemble bulkheads and cylindrical tank skins (Figure III-9), was certified for the assembly of production hardware. By the end of the reporting period, tank tooling was being installed in the tank final assembly area in the Michoud Vertical Assembly Building.

The change from NASA/MSFC Plan V to Plan VII in January caused considerable adjustments to Boeing tool loading schedules. These adjustments were incorporated into the Boeing schedules by the end of March 1964. During the second quarter of CY'64, it was necessary to further realign tool loading for both the intertank and thrust-structure assemblies.

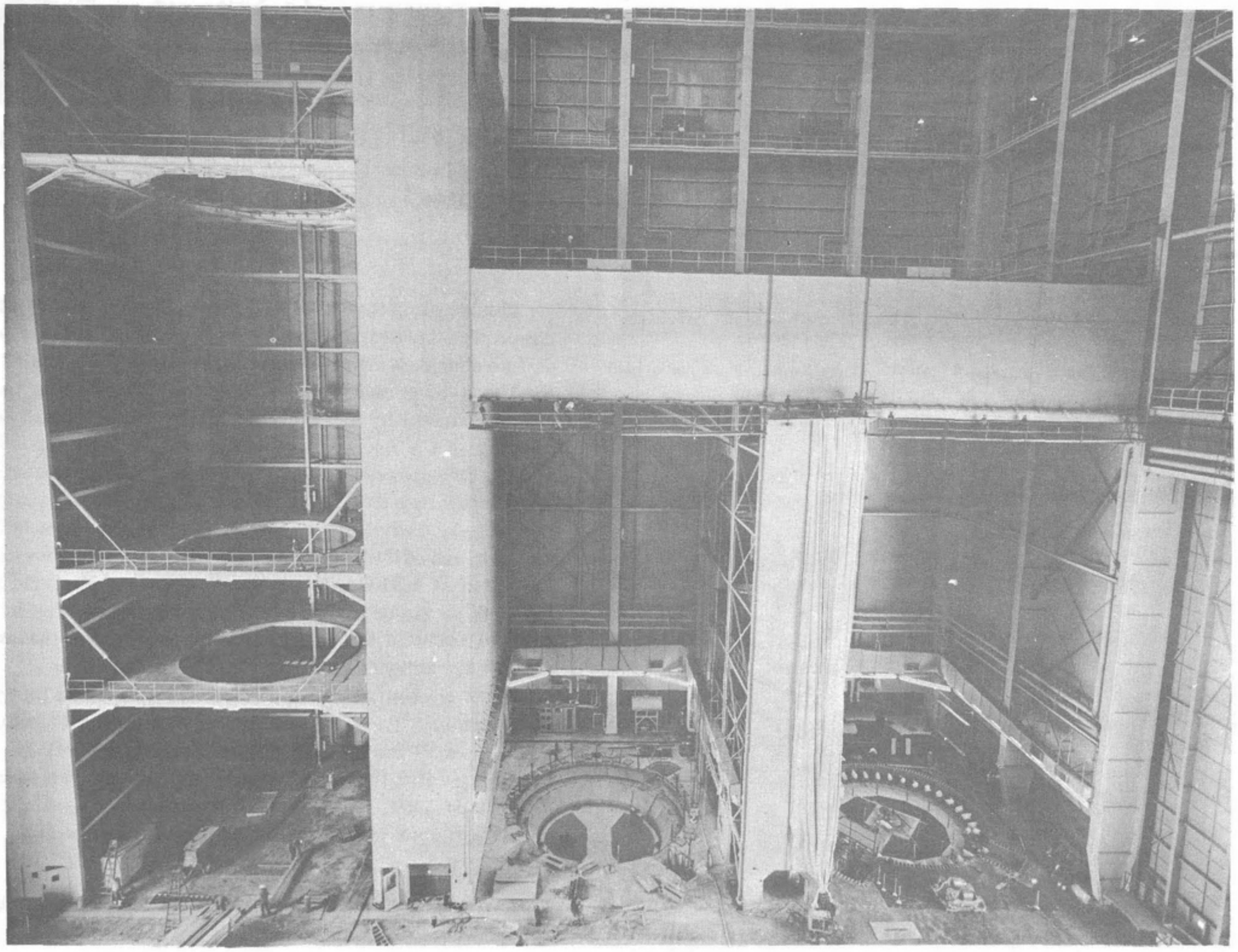


Figure III-5 - Construction Progress on the Vertical Assembly Installations in the Vertical Assembly Building at Michoud.

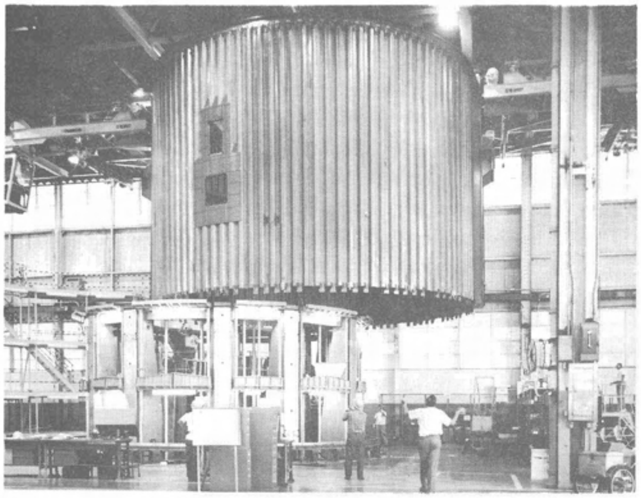


Figure III-6 - Two Overhead Cranes Swing Away the Completed S-IC-S (1) Intertank Assembly at Michoud. The Upper Structure of the Fixture was Removed to Facilitate the Removal.

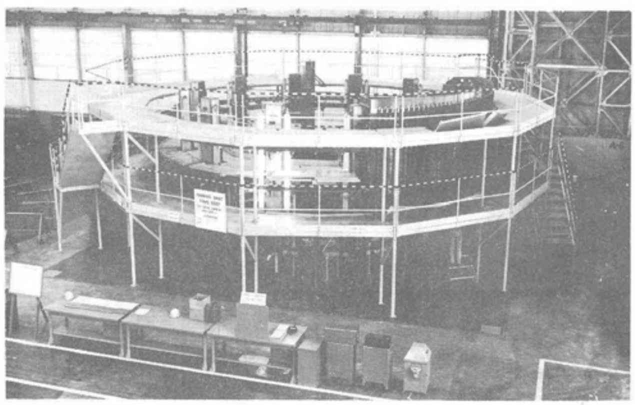


Figure III-7 - Forward Skirt Final Assembly Fixture with S-IC-S Skin Panels

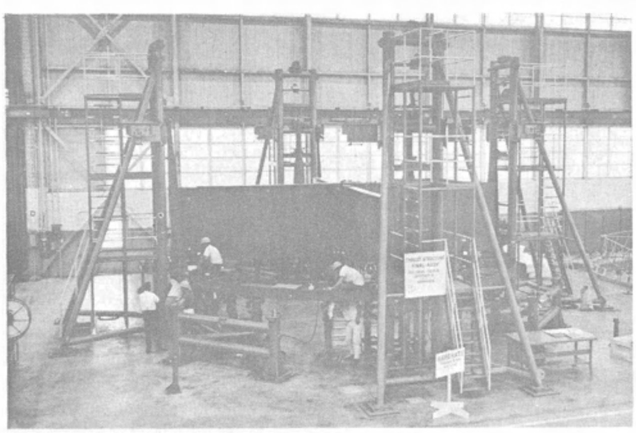


Figure III-8 - First Loading Operation of the No. 1 Thrust-Structure Final Assembly Fixture at Michoud. Lower Thrust Ring, Hold-Down Posts, and Center Engine Support Assemblies are seen Positioned in Fixture

The rearrangement of loading for the intertank resulted from the requirement for two additional intertanks for the S-IC-S stage. These additional intertanks were introduced as a result of engineering recommendations following tests conducted on a scale model intertank. The schedule has been adjusted to allow assembly of the additional intertanks and modification to the intertank tooling. Modification will occur during the third quarter of CY'64, and will not impair Boeing's ability to meet delivery commitments supporting the Plan VII schedule.

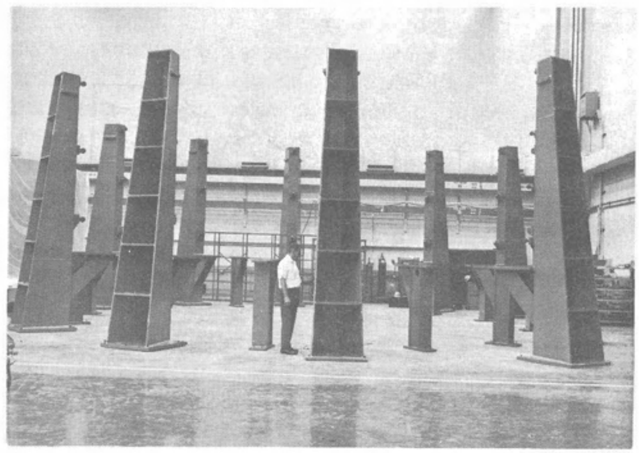


Figure III-9 - Tool Erection of a Tank Cylindrical Skin Assembly Fixture Located in the Environmentally-Controlled Bulkhead Subassembly Area at Michoud

Thrust structure tool erection (Figure III-10) at Michoud was accelerated and tool loading schedules amended so that S-IC thrust structures could be assembled for the S-IC-S and follow-on stages. This was a major change caused by a NASA/MSFC decision, in the second quarter of CY'64, to stop assembling thrust structures at MSFC/Huntsville and transfer both the responsibility and the tooling to Boeing/Michoud for assembly of the S-IC-S, -1, and -2 stage thrust structures from MSFC. At the close of the reporting period, the tooling previously installed at MSFC was being relocated at Michoud while the S-IC-S stage thrust-structure hardware was being used to activate the initial assembly position that was a part of the original tooling plan.

Work is continuing on the tooling still remaining to be activated. Tank assembly will be started in August 1964, as will the fin and fairing (Figure III-11) tooling.

Hydrostatic test will be activated late in the fourth quarter of 1964, and assembly of the S-IC-D stage will activate the vertical assembly position in January 1965.

MANUFACTURING DEVELOPMENT

Manufacturing development effort was moved from

the interim location to the permanent Manufacturing Development Laboratory facility in December 1963. The manufacturing development effort is oriented along: (1) weld development, weld equipment checkout and certification; and (2) process and production technique development and certification. Particular emphasis has been placed in the development of chemical milling production techniques.

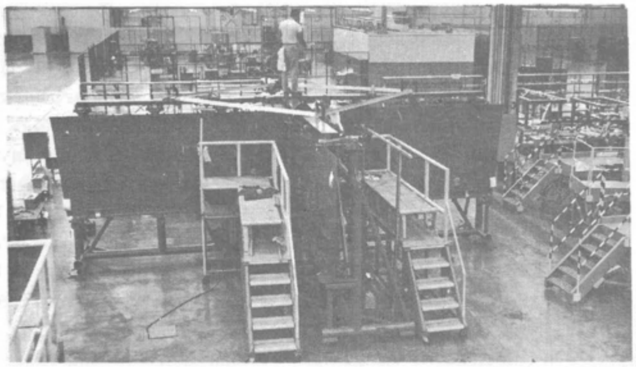


Figure III-10 - Center Engine Support Assembly Fixture at Michoud Showing Shear Web Subassemblies Loaded in the Fixture

Figure III-11 - Engine Fairing Tooling at Michoud

The completion of weld certification activity on bulkhead fitting welds, apex-to-base welds, and actuator supports are typical of weld certification efforts during the period.

Weld development activity (Figures III-12 through III-17) has continued at a high rate in areas such as inert-gas-shielded tungsten-arc (TIG) spot welding, oscillated inert-gas-shielded metal (MIG) arc welding, weld planishing and gore-to-gore welding.

Completing the chemical cleaning and finish process facility in the first quarter of CY'64 allowed process certification to be completed in all operations of the aluminum cleaning and conversion coating line except conversion coating, during March 1964. Certification of conversion coating application was completed in April.

Process and production technique development acti-

Figure III-12 - Shrink Fitting--Temperature Inspection During Freezing of Bulkhead Fitting Prior to Welding Operation

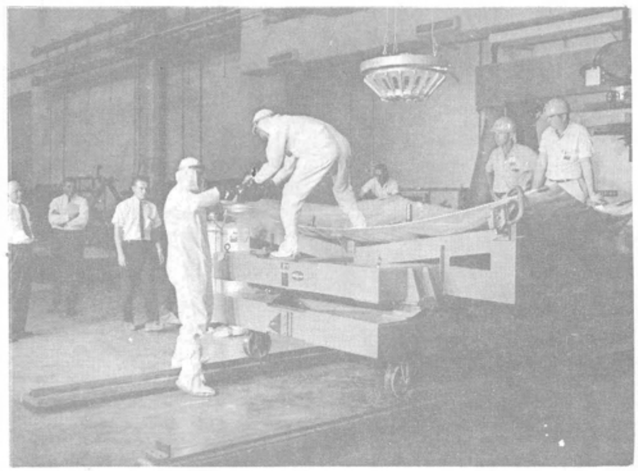


Figure III-13 - Shrink Fitting--Frozen Bulkhead Fitting Being Positioned for Welding to Gore Base

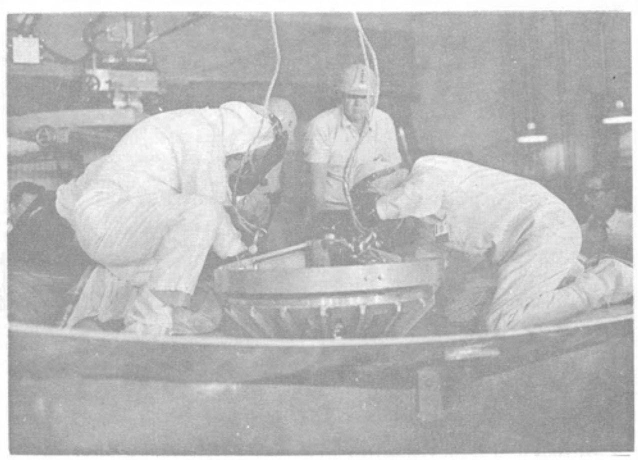


Figure III-14 - Shrink Fitting--Technicians Clamping Frozen Fitting into Place for Welding to Gore Base

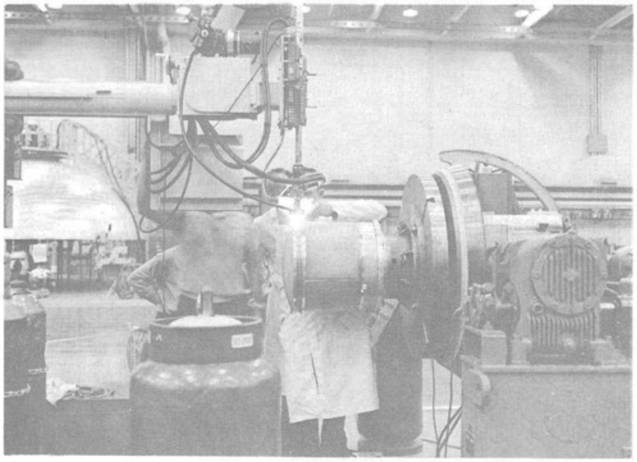


Figure III-15 - Technicians Perform a Weld Operation on a Helium Distributor, in the Bulkhead Minor Assembly Area at Michoud

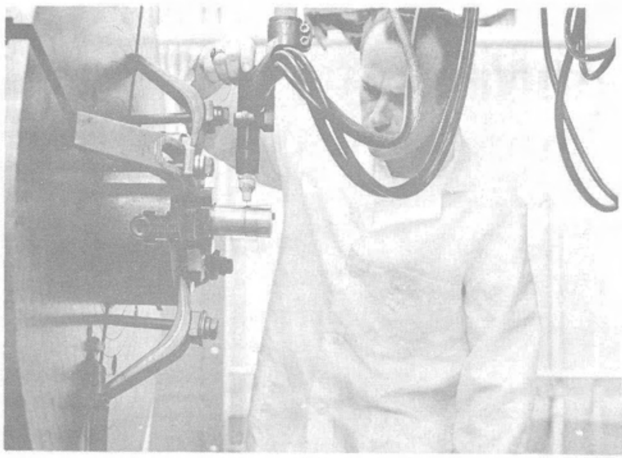


Figure III-16 - A Test Weld Set-Up on Weld Lathe in the Manufacturing Developmental Laboratory at Michoud

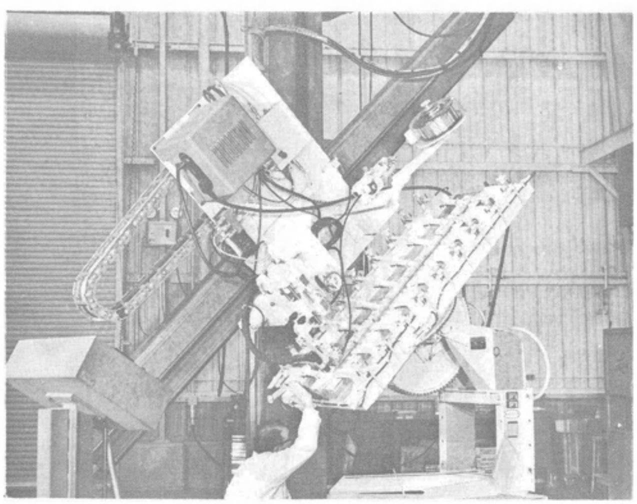


Figure III-17 - Technician Runs Weld Tests Using Inert Gas Process in the Manufacturing Development Laboratories at Michoud

vity was in evidence in such areas as mold dies, thermocouple welding, and stage wiring identification.

The establishment of sufficient chemical milling capability to support program schedules and reliability requirements has accounted for a considerable degree of activity in combined efforts between NASA/MSFC and Boeing. Chemical milling problems have been attributed basically to non-uniform chemical milling etch rates peculiar to 2219-T37 aluminum.

Chemical milling conferences have been held throughout the reporting period with NASA/MSFC, Boeing, prime aluminum fabricators, and nearly all present and potential chemical milling suppliers being represented. Techniques and courses of action to resolve this problem are being discussed and decided upon at these meetings. To date the non-uniform etch-rate problem is being investigated along two lines: (1) improvement of metallurgical homogeneity; and (2) development of a chemical milling etch not sensitive to metallurgical inconsistencies.

Additional developmental effort was expended in the investigation of ram flaring techniques, bonding adhesive, and machining and fastener applications.

In the area of weight reduction, a manufacturing process for pocket milling T-sections in machined Y-rings was under development as part of a 5000-pound-per-vehicle weight reduction proposal.

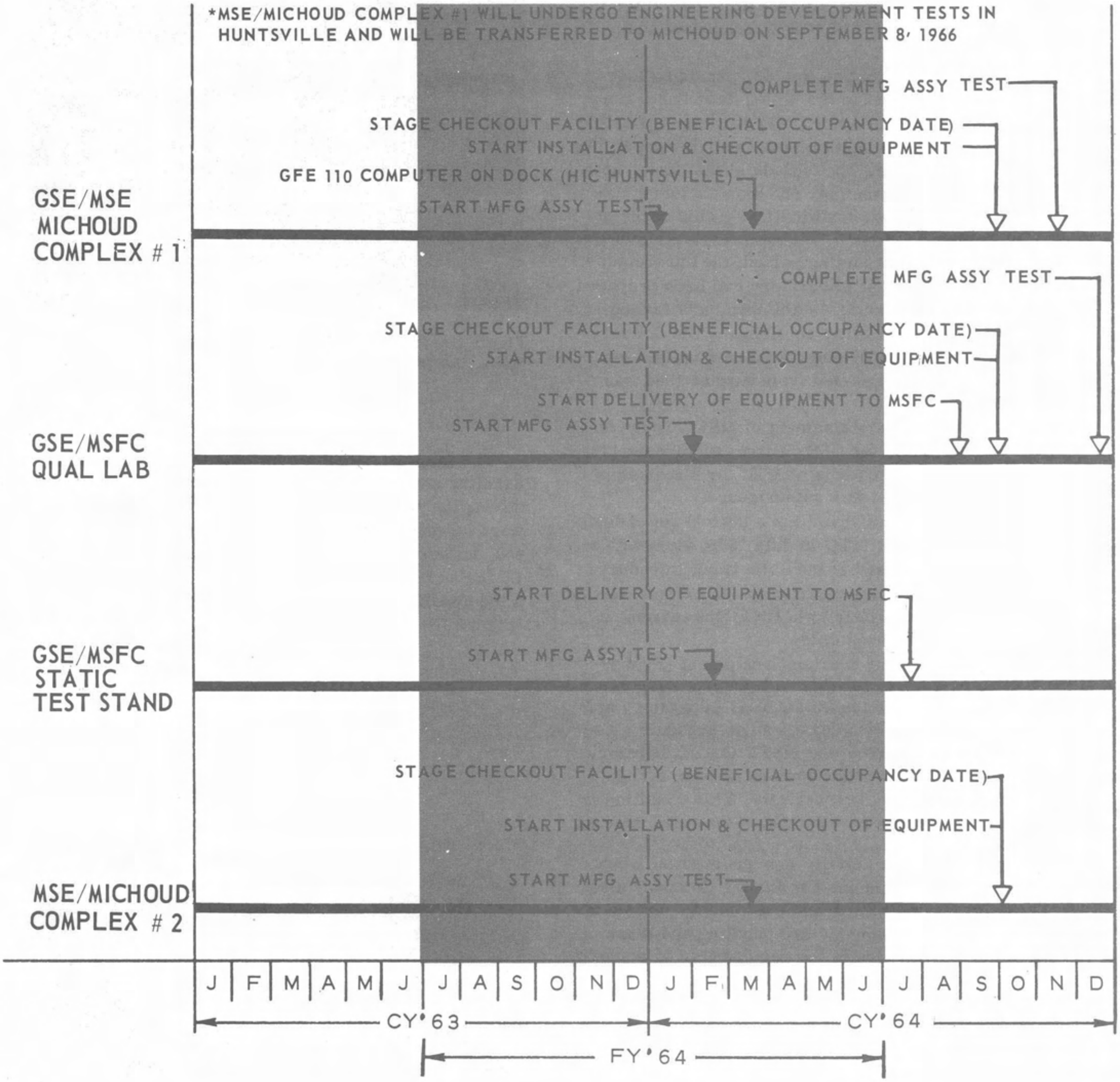
Extensive coordination between The Boeing Company and the Parsons Corporation of Traverse City, Michigan, was conducted to eliminate problems encountered in manufacturing the one-piece LOX tunnel assemblies.

Two major process modifications in the second quarter of 1964 resulted in manhour savings and increased reliability:

1) Conversion Coating Plan for Bulkhead Assemblies--the conversion coating of detail parts was changed to conversion coating of the entire bulkhead by use of the major component cleaning facility. This procedure eliminated the manhours previously required for stripping conversion coating prior to each welding operation;
2) Electrical Conductive Coatings--the process callout on ground support equipment drawings was changed from abrasive cleaning prior to conversion coating to less costly chemical cleaning, resulting in increased reliability.

GSE/MSE

Fabrication of GSE items was hampered during the third quarter of CY'63, pending the result of deliberations between NASA/MSFC and Boeing on GSE Pre-Phase I submittals. Subsequent to these discussions in the following quarter, NASA/MSFC issued authorization to proceed. The agreement on the definition of the functional and physical characteristics of the equipment involved, allowed Boeing to establish delivery capability through an assessment of the required manpower and workloads. As a result of this assessment, Boeing was predicting ability of meeting delivery requirements on


*MSE/MICHOUD COMPLEX #1 WILL UNDERGO ENGINEERING DEVELOPMENT TESTS IN HUNTSVILLE AND WILL BE TRANSFERRED TO MICHOUD ON SEPTEMBER 8, 1966
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
GFE 110 COMPUTER ON DOCK (HIC HUNTSVILLE)
START MFG ASSY TEST
GSE/MSE MICHOUD COMPLEX # 1*
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
GSE/MSFC QUAL LAB
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
GSE/MSFC STATIC TEST STAND
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START MFG ASSY TEST
MSE/MICHOUD COMPLEX # 2
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

the R-Qual Laboratory set by the end of the fourth quarter of CY'63; however, delivery of several items of the Test Division GSE were predicted to be later than required. During the fourth quarter of CY'63, fabrication of subassembly and parts test equipment was initiated. Modification No. 67 to Contract NAS8-5608, which effected NASA/MSFC Plan VII Schedule, called for the simultaneous installation of test and checkout equipment at both the MSFC Quality Laboratory and at Michoud. Since Modification No. 53, providing test and checkout equipment to the MSFC Test Laboratory, was being negotiated in April 1964, it was not possible to determine the full effect on manufacturing capability or schedule adherence. The outlook at that time, however, indicated that assembly and manufacturing activity in support of both modifications would occur at the same time.

By the end of the reporting period, the list of equipment for the MSFC Test Laboratory had been prepared, on-dock date requirements established, and Boeing Company delivery capability confirmed. The delivery of this equipment, finally negotiated as Modification No. 106, will span the period from August 1964 into October 1965.

In addition to the establishment of MSFC Test Laboratory requirements for GSE, a firm requirement for the first of two proposed sets of MSE for Mississippi Test Operations (MTO) was authorized.

An anticipated requirement for a second set of equipment to be available at MTO in July 1966, along with an additional set at Michoud at the same time, introduces the necessity of obtaining contract go-ahead from NASA/MSFC early in the third quarter of 1964 if the equipment is to be available on those dates.

Four sets of test and checkout equipment (Figure III-18) were in work at the close of the reporting period. The equipment for the MSFC Test Laboratory and for the Michoud MSE Complex 2 was on schedule. Assembly and manufacture of the MSFC Qual Laboratory and Michoud MSE Complex 1 equipment were 3 and 6 weeks behind schedule, respectively. This condition is expected to be alleviated by the end of the third quarter of 1964.

Concurrent with the activity in support of the stage test and checkout equipment The Boeing Company also was assembling subsystems test equipment, subassembly and parts test equipment, and handling and transportation equipment. Due to the requirement to perform testing on specialty hardware items for the S-IC-T, it was necessary to activate interim test facilities. At the close of the reporting period the construction of the permanent test facility was not complete; however, the continued use of the interim facility provided the testing required to support S-IC-T schedules.

Twenty-one stations, composed of subassembly and parts test equipment, were scheduled for activation by the end of the reporting period. Only three permanent stations and four of an interim nature were activated at that time, but testing schedules were supported with approved workaround equipment and procedures which will accommodate test activities until the qualified test stations become available.

Figure III-18 - GSE/MSE Drawer and Rack Assemblies Shown Nearing Completion and also Ready for Shipment

The forward handling ring was the major item of handling and transportation equipment to be in work during the reporting period. The first unit of the forward handling ring completed assembly and test, and was delivered to MSFC during the first quarter of 1964. By the end of the second quarter of 1964 a second forward handling ring had been delivered and a third unit (Figure III-19) was being assembled.

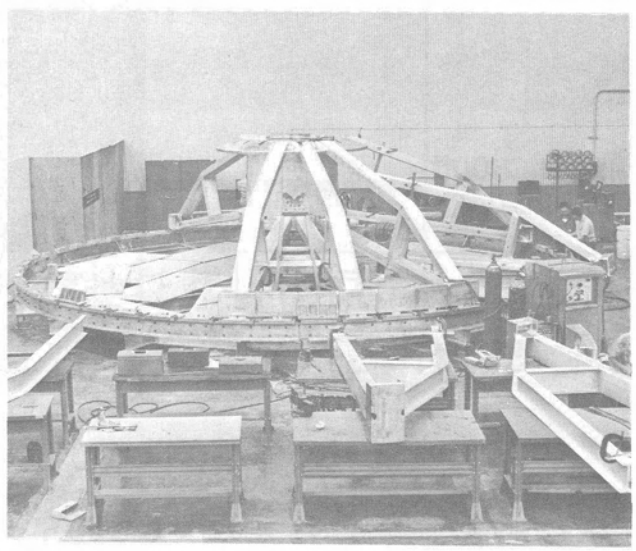
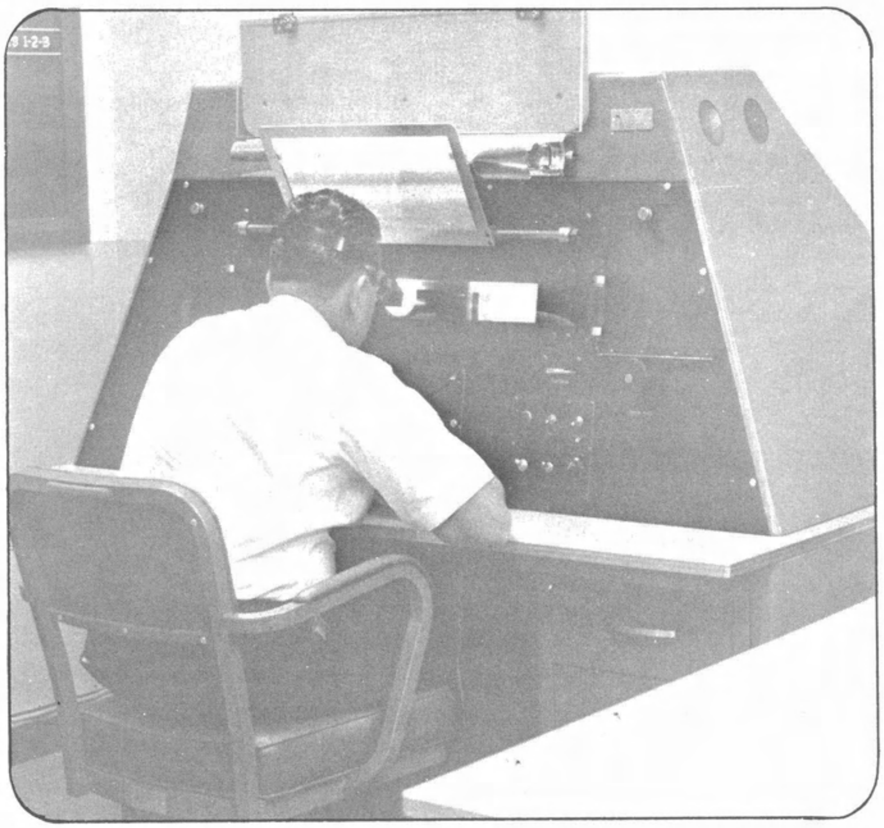


Figure III-19 - Tooling Mechanics Installing Radial Trusses on Third Forward Handling Ring Assembled at Michoud



QUALITY ASSURANCE

Fiscal year 1964 was characterized by significant progress in all basic functions of quality and reliability assurance. In July 1963, interim facilities were in use and numerous workaround measures were used to perform required tasks. Systems, procedures, and techniques were basically conceptual at the beginning of FY 64. By the year's end, they had become operational. Permanent facilities had been activated and refinements had been made in systems, procedures, and techniques as initial deliveries were accomplished on the S-IC-T vehicle components..

QUALITY ASSURANCE CAPABILITY

Significant progress was made during FY 64 in expanding inspection and test capabilities consistent with accelerating hardware schedules. During the early part of FY 64, interim facilities such as those shown in Figures IV-1 and IV-2 were still in use. In January

Figure IV-1 - Interim Quality Assurance Development Laboratory in Use at Michoud in Early FY 64

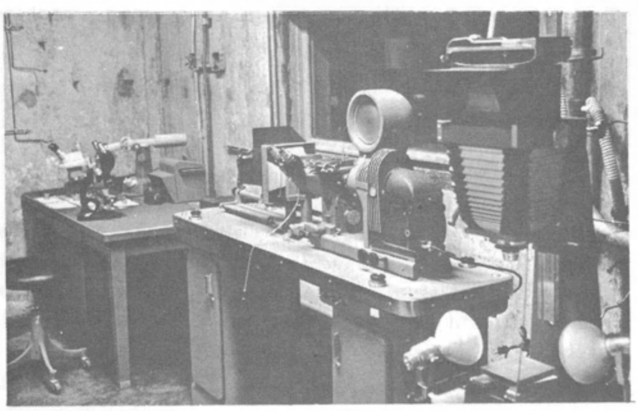


Figure IV-2 - Interior View of Interim Quality Assurance Development Laboratory Facility

1964, final activation of the permanent Quality Evaluation Laboratories was initiated. Figure IV-3 shows the early construction of the laboratory and Figures IV-4

Figure IV-3 - Construction Progress of Permanent Quality Evaluation Laboratories at Michoud

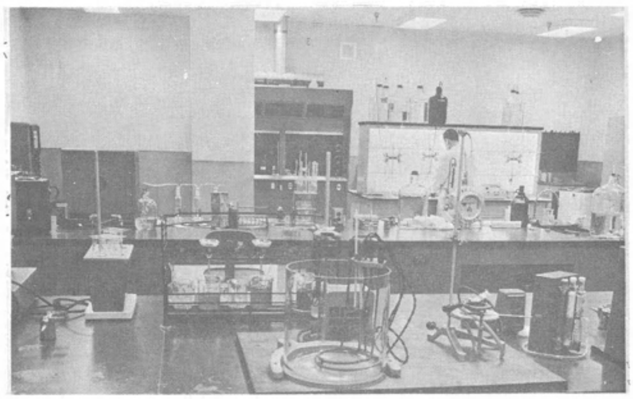


Figure IV-4 - Interior of the Permanent Quality Evaluation Laboratories at Michoud

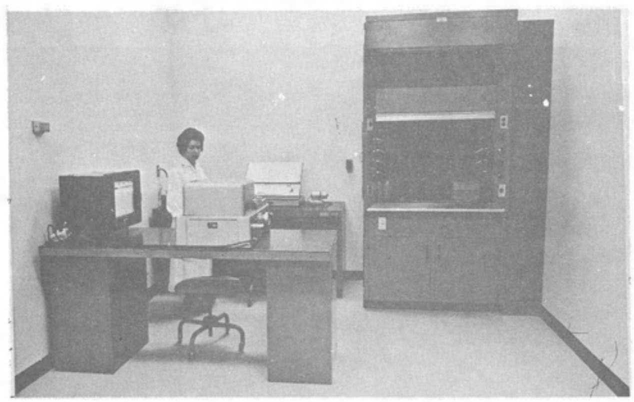


Figure IV-5 - Densitometer Used in Conjunction With Emission Spectrometer in Obtaining Qualitative and Quantitative Analyses of Inorganic Material

through IV-7 show the laboratory at the end of CY '63. Figure IV-8 shows the electrical and electronics area of the permanent Measurement Control Laboratory during initial activation in December 1963. At the close of CY 63, approximately 80 percent of all equipment required had been received. A view of the present laboratory is shown in Figure IV-9. Interim facilities

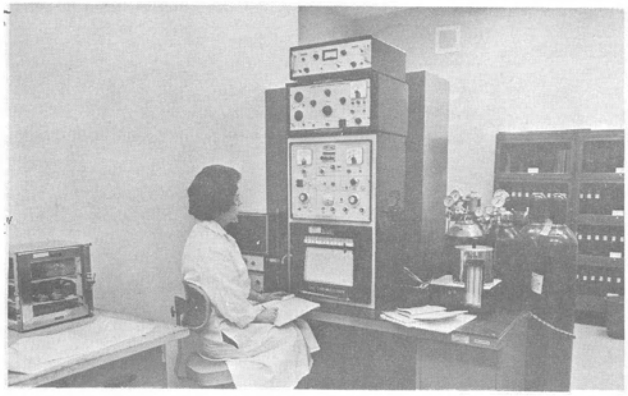


Figure IV-6 - Gas Chromatograph Used in Obtaining Quantitative Analysis of Organic Material

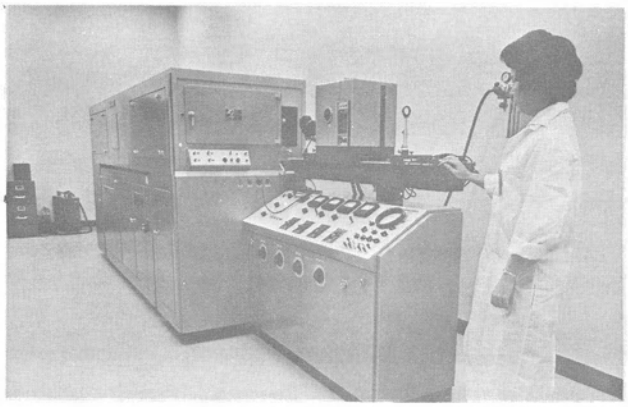


Figure IV-7 - Three-Meter Grating Spectrograph in Quality Evaluation Laboratory

Figure IV-8 - Electrical/Electronics Area of Measurement Control Laboratories at Michoud

such as portable vans (Figure IV-10) that had represented primary capability had been replaced by permanent facilities at the close of CY 63. It is important to note, however, that many interim facilities will continue to be used on a secondary basis to supplement and enhance primary capability in permanent facilities. Following is a brief summary of notable progress:

Figure IV-9 - Pressure, Vacuum Flow, and Mass Area of Measurement Control Laboratories

CENTRAL RADIOGRAPHIC EVALUATION LAB

This laboratory was completed during the early part of FY'64 and its associated mechanized X-ray tooling was activated. In conjunction with mechanized X-ray tooling, this laboratory provides extensive inspection coverage of all stage weldments. It has automatic film processing and mechanized viewing capabilities, three detail inspection vaults, and ancillary processing equipment. At the end of the reporting period, the workload approximated 5,000 X-ray exposures per month. An increase to a peak load in excess of 10,000 feet of film per month is anticipated.

Items of inspection tooling and equipment were developed and activated during the fiscal year that substantially increased radiographic capabilities. Most noteworthy are the gore apex to gore base, bulkhead to Y-ring, polar cap, Y-ring dollies, LOX tunnel and skin ring tools, film paper stripper unit, film viewing console and status board, X-ray suspension system, 300 KV suspension system, 300 KV suspension X-ray machine, and 150 KV suspension X-ray anode machine.

QUALITY EVALUATION AND MEASUREMENT CONTROL LABORATORIES

Brick-and-mortar construction for permanent laboratory facilities was completed in December 1963, and initial activation followed. This acquisition allowed an orderly transition to the operational stage and paved the way for elimination of some workaround measures and retirement of interim facilities to a secondary status.

During the first half of FY '64, flow time for incoming material analysis was excessive because preparation equipment was not available. The transition to permanent facilities, accompanied by acquisition of equipment, enabled a reduction in flow time, and, in many instances, decreased manhour requirements. An example is the lathe (Figure IV-12) necessary for test specimen preparation. Prior to acquisition of this equipment, the Boeing Manufacturing organization assisted in the preparation of test specimens.

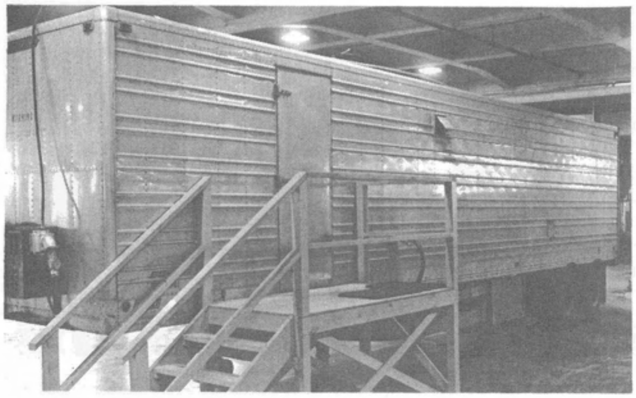


Figure IV-10 - Typical Interim Facility--Pyrometric Van

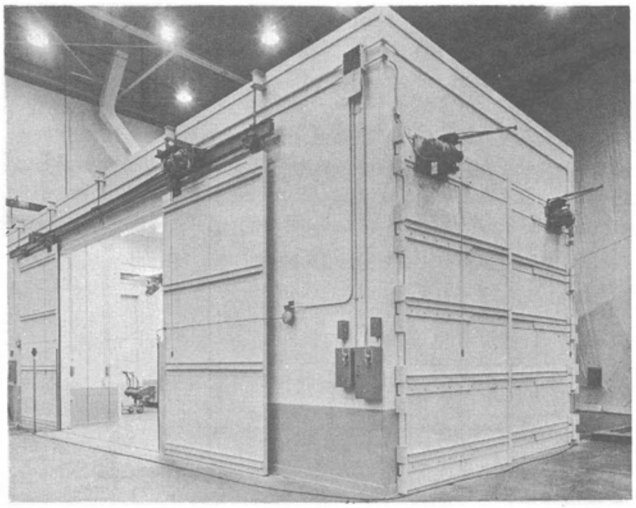


Figure IV-11 - Central Radiographic Evaluation Laboratory Activated in Early FY'64

In January 1964, workaround methods were required to support penetrant inspection of gore segments because the permanent Non-Destructive Test Laboratory was not completed. Portable spray equipment has been used. It is anticipated that automatic spray equipment will be installed early in FY '65.

A LOX impact test facility is being installed to enable appropriate test of components and is expected to be fully integrated during the first half of FY '65.

Capabilities in the Measurement Control Laboratory increased consistent with program demands. New equipment was added each month, and at the close of FY '64, was approximately 80 percent complete. Figure IV-13 shows the Optical Rotary Surface Plate and associated equipment, and the Optical Comparator.

The volume of activity in the Quality Evaluation and Measurement Control Laboratories experienced a significant increase. Orders increased from 1100 to 2900 per month during FY'64. Total orders for the year were about 25,600.

DIMENSIONAL INSPECTION

Dimensional inspection requirements for bulkheads, thrust structures, and intertank assemblies dictated the need for a 34-foot rotary turntable. During FY '64, an area was allocated and the foundation and plans for its installation were completed. At the close of FY '64 Boeing personnel were completing final checkout of the equipment at the vendor's plant.

The rotary turntable will be located in the factory area as shown in Figure IV-14. This turntable, the first

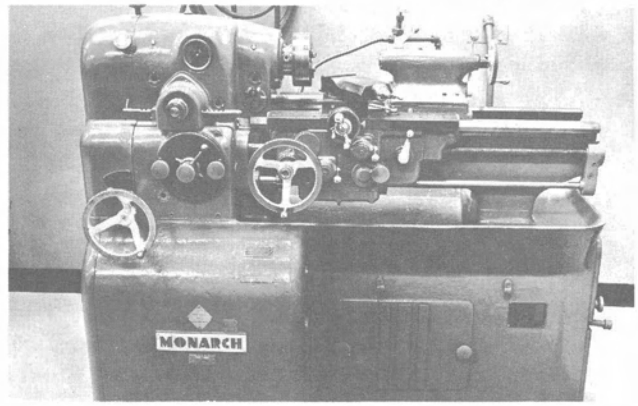


Figure IV-12 - Specimen Preparation Equipment--Monarch Lathe

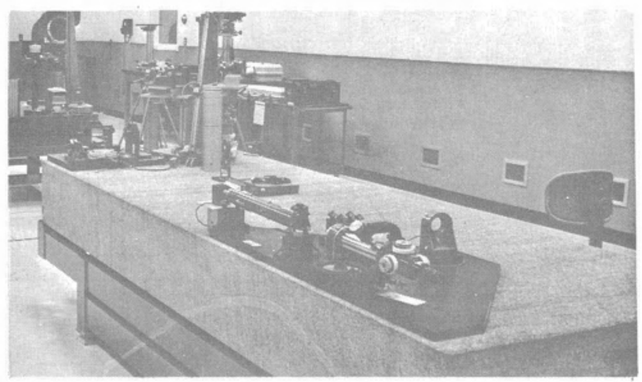


Figure IV-13 - Optical Rotary Table in Measurement Control Laboratories

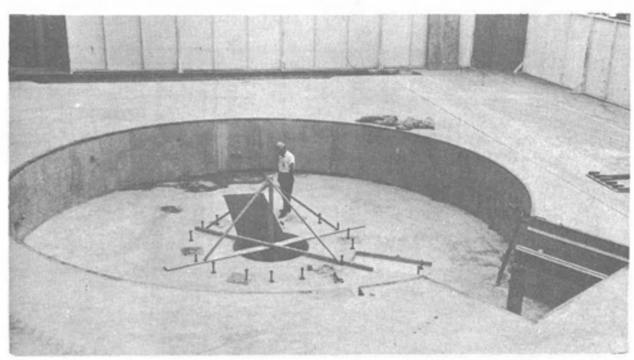


Figure IV-14 - Construction Work Area for 34-Foot Rotary Turntable

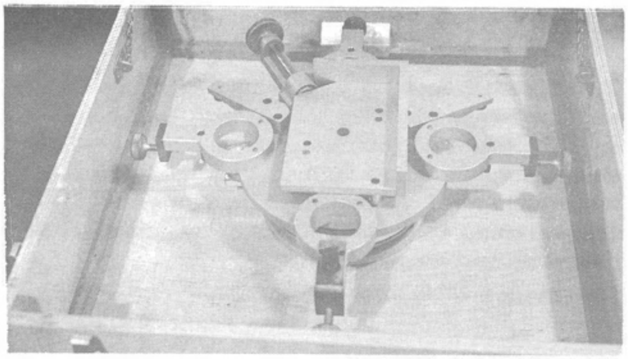


Figure IV-15 - Fitting Optical Target Used for Inspection of Fuel Suction Fittings

Figure IV-16 - Tooling Bars and Associated Optical Tooling Equipment in Use in Michoud Plant

unit of this size with design features necessary to perform precise optical dimensional measurements, will become an integral part of the in-process inspection plan.

Inspection capability for determining critical dimensions increased significantly during the fiscal year. The fitting optical target shown in Figure IV-15 was developed and placed in use. This equipment will be used in inspection of fuel suction fittings.

Tooling bars and associated optical tooling equipment (Figure IV-16) were placed in use during the reporting period.

Unavailability of sufficient tooling equipment during the early part of the FY required some workaround measures. However, at the close of FY'64, the required equipment had been obtained and in-process inspection was being accomplished as planned.

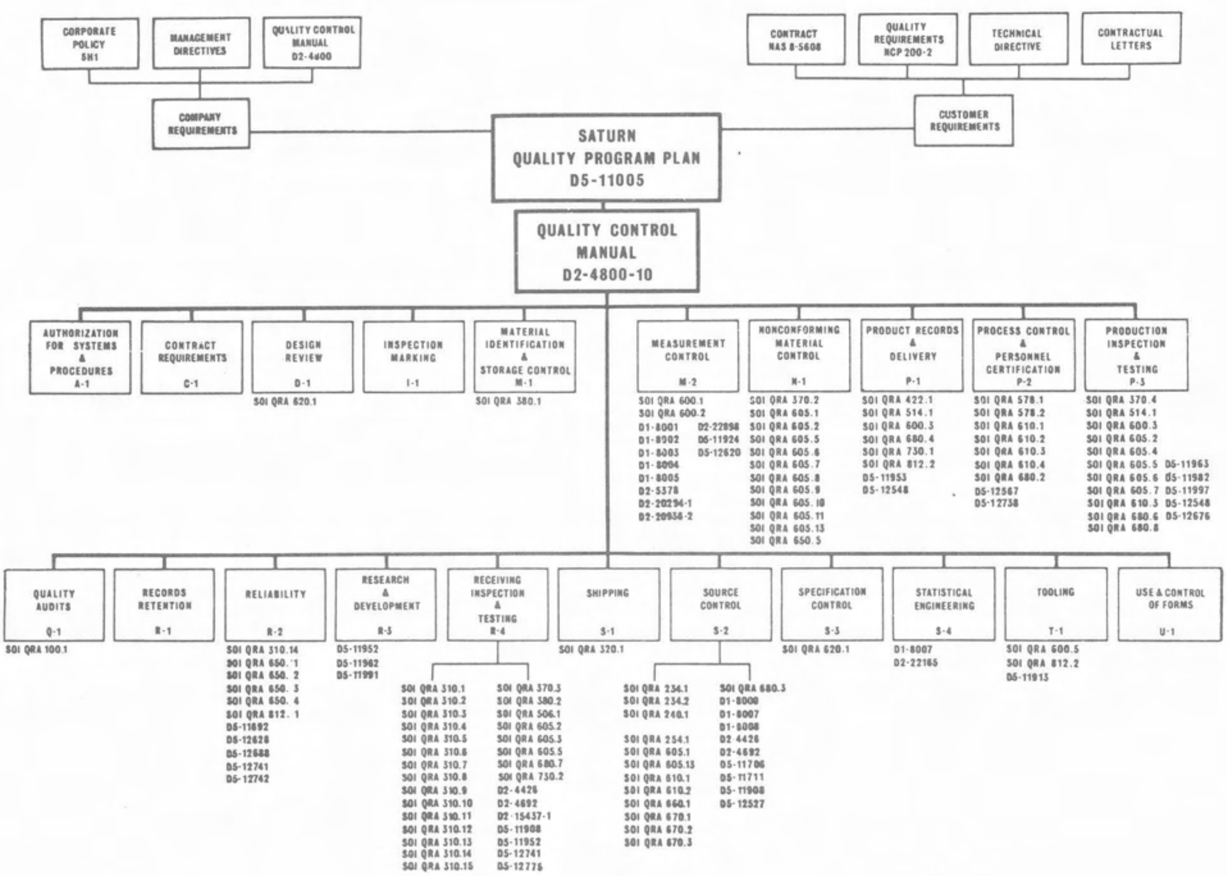


Figure IV-17 - Quality Assurance Program Documentation

QUALITY ASSURANCE SYSTEMS

Fiscal year 1964 saw the evolution of basic systems from a conceptual to an operational stage. Systems involving Quality Engineering, subcontractor control, in-process inspection, and audit reviews were analyzed and refined consistent with product integrity and program schedules.

QUALITY ENGINEERING

The volume of engineering releases increased significantly during FY 64. During the last quarter 4600 releases were reviewed to ensure compliance with NPC 200-2. Coordination with the Engineering organization improved communication of requirements, and, at the end of FY 64, more than 80 percent of the requests submitted had been accepted for incorporation.

Emphasis was placed on quality performance reporting during the year. A system for bi-weekly analysis of stage nonconformances was initiated. A report tabulating nonconformance in Receiving Inspection and major assembly areas is issued to appropriate management.

SUBCONTRACTOR CONTROL

In early July 1963, an interdivisional source control meeting was held to refine the corporate system and ensure full use of resources. As a result of this meeting, the Launch Systems Branch was assigned the responsibility for the survey and surveillance of processing facilities in the states of Alabama, Florida, Kentucky, Louisiana, Mississippi, South Carolina, Tennessee, and Texas.

Numerous surveys of supplier performance were conducted during the FY to ensure compliance with the requirements of NPC 200-3. A notable example was the visit of a combined NASA/MSFC and Boeing team to Los Angeles area suppliers during the latter part of FY 64. Major problems requiring immediate action were multiple inspection by government source inspectors, and misinterpretation of the cleaning requirements of NASA/MSFC Specification 164. Action items were assigned to both MSFC and Boeing personnel to resolve these problems.

The vendor rating system was refined during the FY. All experience is now integrated in the Boeing Aero-Space Division system, ensuring a more complete and

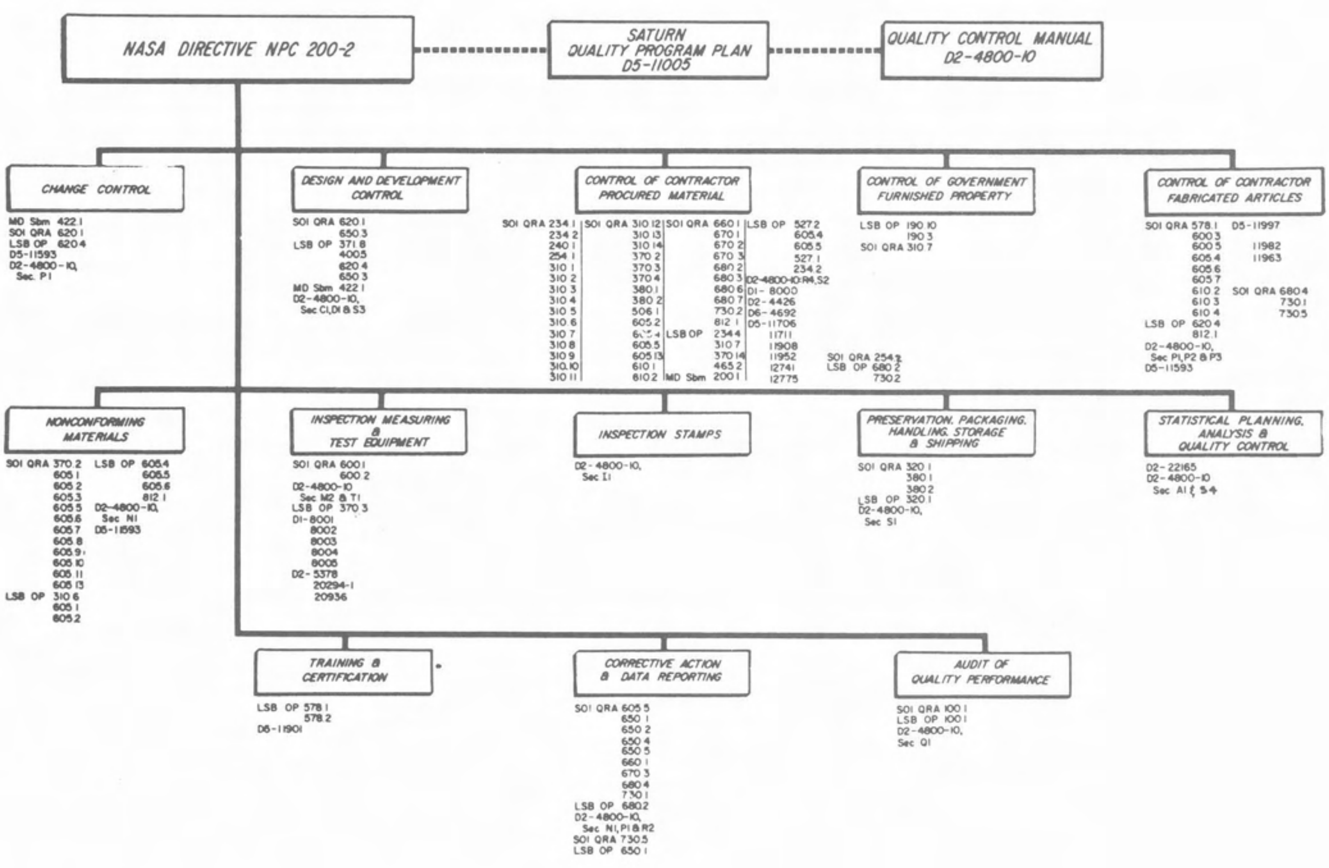


Figure IV-18 - Quality Program Documentation--NPC 200-2

accurate evaluation of all vendor performance data. This, in turn, assures validity of the acceptance sampling system.

During FY '64, 409 proposals involving 102 procurements were evaluated.

A vendor performance reporting system was initiated at Boeing/Huntsville and is being maintained on a current basis. The system is used for items delivered to MSFC and denotes any outstanding problem areas related to tooling items.

IN-PROCESS INSPECTION, TEST, AND DELIVERY

Emphasis of development and refinement of the In-Process inspection system, paced by initial deliveries of S-IC-T stage hardware, was increased during the FY'64. Special inspection processes involving fabrication and assembly operations were reviewed throughout the year.

Interim clean rooms for test inspection of small hydraulic pneumatic and electrical components were activated during the early part of the FY. The first electrical/electronic test inspections were also initiated.

Initial deliveries of hardware allowed refinement of the basic delivery system. Early in the reporting period, coordination with NASA/MSFC Technical Liaison and Contract Administration resulted in the reduction of delivery forms required to accompany stage hardware and tooling items shipped from Boeing/Wichita and Boeing/Seattle. A system to control nonconformance items shipped from outplant areas was also initiated.

QUALITY ASSURANCE TECHNIQUES

Consistent with the transition from a concept to an operational stage, notable progress was made in the development and application of inspection techniques during the year. Following is a brief summary of this progress:

PENETRANT INSPECTION

Considerable progress was made in developing and refining penetrant inspection techniques. A notable example is the extended use of portable spray equipment originally developed for penetrant inspection of Y-rings. This equipment is now being used to inspect gore segments, cylindrical skins, polar caps, and other miscellaneous parts.

OPTICAL TOOLING

The equipment acquisition phase of the Optical Tooling Program neared completion during the FY. Surface tables, tooling bars, alignment scopes and clinometers were obtained and placed in operation. This equipment and techniques were combined to establish an optical tooling program capable of meeting inspection requirements on assemblies completed to date.

RADIOGRAPHIC DEFECT LOCATION AND DEFINITION

Adaptations to mechanized X-ray equipment were accomplished to permit the same accurate three-dimensional location of weld defects as was obtained in manual X-ray systems. The capability was developed to apply this technique to such welds as apex to base, gore to gore and bulkhead to Y-ring.

DIMENSIONAL VERIFICATION

Inspection of large assemblies for dimensional verification was accomplished during the year on such items as a complete intertank, thrust structure components and head assembly components. Experience gained in these areas will be applied to alignment inspection of larger assemblies such as fuel and LOX tanks and a complete stage.

QUALITY ASSURANCE PROCEDURES

Considerable effort was devoted to the development and refinement of operation procedures. Following are specific examples:

SPECIAL INSPECTION PROCEDURES (D5-11982)

This document was completely revised during the year to broaden its scope. D5-11982 will eventually become a multi-volume document encompassing all the unique inspection techniques utilized on the Saturn Program. At the end of FY '63, ten categories of hardware oriented procedures had been written and incorporated into D5-11982.

NON-DESTRUCTIVE TEST APPLICATION TECHNIQUE DEVELOPMENT PLAN (D5-11962)

The Non-Destructive Test Application Technique Development Plan was developed during the year and was being reviewed as the year ended. This document describes the development of application techniques for various non-destructive tests.

DOCUMENTATION

Implementing documentation developed during the year included Standard Operating Instructions, Operating Procedures, and Technical Documents. The need was recognized for a visibility media to portray the documentation released to incorporate the provisions of the Quality Program Plan. Three documents trees were subsequently developed to provide this visibility. These were: 1) Q&RA Program Documentation (Figure IV-17), 2) Reliability Program Documentation, and 3) NPC 200-2 Documentation (Figure IV-18).

QUALITY ASSURANCE AUDITS

Periodic quality assurance audits of all Quality and Reliability Assurance functions and the Launch Systems Branch Training Program were initiated during FY'64. Several special audits were also conducted during the year and included audits of the factory drawing service, inspection stamp control, Saturn records system, and Wichita and Seattle quality functions. Results of audits were documented in the Launch Systems Branch Quarterly Audit Reports and forwarded to the contracting officer in accordance with NASA publication NPC 200-2.

SPECIAL INSPECTION TECHNIQUE DEVELOPMENT

The need was recognized for several specialized inspection tools during 1964 and significant progress was made in developing and acquiring this equipment. Following are notable examples of this specialized equipment.

SUPPLEMENTARY INSPECTION

A supplementary inspection technique was needed to determine actual fusion diameter of spot welds. To do this, an ultrasonic recording scanner was designed. This equipment was initially used to support hardware inspection of bulkhead assemblies.

A proposed new ultrasonic hand scanner was subsequently developed and submitted to NASA for procurement during the latter part of the year. In addition, an improved scanning system for both the hand scanner and the ultrasonic recording scanner was tested and approved for use in both systems. This improved system uses the pulse echo single transducer instead of the double transducer required for the "Pitch and Catch" method.

CONTOUR EVALUATOR PACKAGE

The bulkhead contour evaluator was received from the vendor in June 1964. This equipment will be used with a contour template for final inspection of bulkhead assemblies.

OPTICAL TARGET PACKAGE

This package was completed by the vendor and received June 26, 1964. This equipment will be used for dimensional inspection of fittings and also in conjunction with the 34-foot rotary table during final dimensional inspection of the bulkhead assemblies.

MICROWAVE THICKNESS MEASURING EQUIPMENT

Developmental work was completed during the year on equipment to measure the thickness of gore segments during chemical milling and subsequent operations. The equipment has been ordered and the vendor will deliver it during the first quarter of FY '65.

PREDICTIONS

Quality and Reliability Assurance anticipates continued acceleration of activity consistent with the program demands of FY '65. Fabrication, assembly, and test developmental activity will be particularly significant. Activation of remote sites will also receive considerable attention.

Quality Assurance capability is expected to increase. Specifically the following will be accomplished:

1) The 34-foot rotary table will be installed, checked out, and placed in use to perform critical optical dimensional inspection of bulkheads, thrust structures, and intertank assemblies;
2) The Technical Development Laboratory is expected to be completed and activated. The purpose of the laboratory is to develop non-destructive test techniques, design inspection equipment and perform technical liaison with Manufacturing Development and MSFC;
3) Permanent penetrant inspection facilities, using automatic spray equipment, will be activated and integrated in the inspection plan.

V

SYSTEM AND SUBSYSTEMS TEST

DEVELOPMENT, QUALIFICATION, AND RELIABILITY TESTING

"S-IC Contractor Test Program Summary," Document D5-11928-1, listing development qualification, and reliability testing considered to be Boeing responsibility, was prepared and submitted to NASA/MSFC for comment during the second quarter of the fiscal year (FY). The document was subsequently revised in accordance with NASA/MSFC comments, resubmitted early in February, and made a contractual document by Contract Modification 92, received April 15, 1964.

Development testing, which began during FY'63, continued throughout FY'64, most of the work being accomplished at the Boeing-Seattle and Wichita facilities because of the lack of test facilities and equipment at Michoud. While development testing was substantially behind schedule at the end of the fiscal year, no serious program schedule impact is foreseen, since those tests crucial to design development have been scheduled to provide required information at the time needed.

The qualification and reliability test programs have recently been rescheduled to coincide with late availability of laboratories and test equipment at Michoud. The new schedules are to be provided in the next issue of Document D5-11928-1, and at present still allow for meeting the Plan VII schedule end dates for qualification and reliability testing.

TEST PARTICIPATION-MSFC

Boeing personnel at MSFC have participated in F-1 engine static firings, LOX and fuel systems loading and unloading, and F-1 engine setup and dismantling. Other participation effort during the year, has included the preparation of documents, plans and procedures, and data acquisition planning support; the preparation of installation drawings, wiring diagrams, and operation and maintenance procedures; and design reviews and construction surveillance.

The purpose of this effort is to prepare Boeing personnel to assume full responsibility for the S-IC static firing program at MTO.

MTO ACTIVATION

A June 2, 1964 letter from the NASA/MICHOUD Contracting Office to the Boeing Launch Systems Branch Contract Administration Office gave Boeing limited authorization to proceed with the activation of MTO in an amount not to exceed $570,000 pending receipt of formal NASA Headquarters approved supplemental agreement, "MTO Activation Authorization," Modification No. 102 to Contract NAS8-5608.

Major activities during the reporting period were con-

EVENT	ACTION	DATE
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Submitted to NASA	February 19, 1964
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Modification 92 Received	April 10, 1964
PARTICIPATE IN CHECKOUT OF MSFC TEST STAND	Participation by Boeing	November 9, 1964
MTO ACTIVATION	Go-Ahead	June 2, 1964
MTO ACTIVATION	MTO Activation Plan Complete (D5-11071-3)	August 1, 1964
GOVERNMENT FURNISHED FACILITIES, EQUIPMENT AND SERVICE REQUIREMENTS FOR MTO	Document D5-11061 Complete	July 1, 1964
GENERAL TEST PLAN	Submitted to NASA	November 1, 1964
TEST DATA ANALYSIS	Flight Test Evaluation and Reports Plan Complete (D5-11056)	January 2, 1965

Figure V-1 - Documentation Status

centrated on planning and documentation. Document D5-11071-3, "Plan for Activation and Operation of S-IC Complex at MTO," is in process and scheduled for completion August 1, 1964. The status of significant documentation necessary for the activation program is shown in Figure V-1. At the close of the period, efforts were continuing in design and specification reviews on the S-IC complex and technical systems, and GSE design and installation liaison. Interface common to MSFC and MTO in the brick-and-mortar and equipment areas were also in process.

TEST PLANNING

Major emphasis was placed on the General Test Plan document during this reporting period. The General Test Plan document defines development, qualification, reliability, production, acceptance, prelaunch, flight and special tests for the S-IC stage and GSE from development of components through operational flights. It provides objectives, test descriptions, test progression, concepts, policies and responsibilities. The original effort was started early in the reporting period and resulted in a preliminary draft which was distributed late in December 1963.

Subsequent to joint NASA/MSFC-Boeing reviews the first coordination copy was released on March 26, 1964. The NASA/MSFC comments were reviewed June 4 and 5, 1964, at a joint meeting. The comments are being incorporated into a second coordination copy which is scheduled for release on July 24, 1964.

FLIGHT EVALUATION

TEST ANALYSIS & EVALUATION

A Boeing S-IC Flight Test Evaluation Committee, made up of members from all technical organizations, has been instrumental in defining Boeing analysis requirements for external data submitted for inclusion in the "Engineering Instrumentation Requirements" document.

The committee is presently developing detailed techniques for providing calibration data required by Technical Directive 170, and specifications of calibration data to be used for the linearization of flight test data at Slidell.

CENTRALIZED DATA REDUCTION

On October 4, 1963, formal announcement was made by NASA/MSFC of the establishment of a "Joint Usage Laboratory" at Slidell and Michoud for Boeing and Chrysler test data reduction. Boeing was asked to participate in the establishment of equipment specifications. As a result, the Boeing Data Reduction Steering Committee was established, with the Saturn Booster Test organization manager as the Boeing senior member.

Subsequent to the request from NASA/MSFC for Boeing participation in the establishment of equipment specifications for the Centralized Data Reduction Facility, the Data Reduction Steering Committee established a joint system description and specification which was completed and submitted to NASA/MSFC on January 1, 1964.

By November 26, 1963, the scope of the Centralized Data Reduction activities was defined. The recommendation submitted to NASA/MSFC called for third-party operations at Slidell and Michoud with data user (Boeing or Chrysler) surveillance.

Test Data Reduction facilities will be provided at the Computer Operations Office, Slidell, Louisiana, and the Michoud Engineering Building, New Orleans, Louisiana. The Slidell facility will reduce the various raw telemetry data records, as received from Merritt Island Launch Area (MILA), to a common digital tape format for IBM7094 computer entry. The data records to be reduced will be direct analog wideband FM PAM/FM/FM telemetry tapes, PCM/FM telemetry tapes and predetection recorded magnetic tapes.

The Michoud Data Reduction facility will receive data in recorded form from the various data acquisition sites and from the Slidell facility and will process the data to satisfy the requirements of quick-look preliminary analysis, detailed test analysis, data evaluation and analysis, and test reporting. This facility will also be used quite extensively for vibrational and acoustical analysis.

The vibration and acoustical analysis system will give support in the areas of component test, static test, and flight test data reduction. This system is capable of reducing direct analog magnetic tapes, wide-band FM magnetic tapes, and SS/FM telemetry tapes.

S-V SYSTEMS SUPPORT

SYSTEMS STUDIES

Engineering support under technical assistance orders has steadily increased in scope during the past year. Saturn V studies in aerodynamics, systems design, flight control and test data analysis, mission abort analysis structural design, and wind tunnel testing were conducted. Support to Astrionics and P&VE Laboratories has continued and a number of new tasks has been added. System studies conducted and pertinent results are discussed in the following paragraphs.

SATURN V FLIGHT CONTROL SYSTEM ANALYSIS

Document D5-11240-1, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis," released April 6, 1964, contains an evaluation and comparison of slosh stability, structural coupling, dynamic loads, and vehicle transient responses for various control laws and feedback parameters considered for application to the Saturn V. Control system analysis and specifications for the 4106 configuration of the Saturn vehicle are contained in Document D5-11290-2, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis--Vehicle 4106."

FLIGHT TEST DATA ANALYSIS SYSTEM

Development work was completed on the flight test data analysis system. Significant developmental and supporting documents released were:

a) D5-11247-1, "Saturn Flight Test Data Analysis System Definition";
b) D5-11247-2, "Data Source Comparison Computer Program";
c) D5-11249, "Saturn Flight Test Report Vehicle (I, II, III, and IV) Data Source Comparison," Vol. 1-4;
d) D5-13029, "The Mathematical Development for the AMR Range Data Reduction Computer Program";
e) D5-13025, "Coordinate System Definition in Saturn Flight Test Data Analysis System."

D5-11247-1 defines basic system concepts for the Saturn flight test data analysis system, and D5-11247-2 contains the mathematical and statistical techniques for post-flight data comparison. Four volumes of D5-11249 give tracking data comparisons for flight data obtained from SA-1, SA-2, SA-3, and SA-4 and demonstrate system development. D5-13029 and D5-13025 present the mathematical formulations for conversion of AMR tracking information from tracking station format to vehicle position with respect to station, launch, and inertial coordinates. Portions of this development work were used in Boeing presentations at the NASA/MSFC Flight Evaluation Working Group Meeting and to the Saturn data reduction sub-group panel.

SATURN V FLIGHT PERFORMANCE

Studies and presentations of mission abort were conducted for the powered and unpowered modes. The ability of the vehicle to complete developmental missions after an engine had been shut down was also determined. Significant analyses, with recommendations for mission and abort criteria, are contained in Document D5-11392, "Saturn V Vehicle Abort Analysis and Criteria." Presentations were given to the Aero-Astrodynamics Laboratory and to the MSC/MSFC crew safety panel. Results of a study to define Saturn V flight performance reserve for the LOR mission were presented at the second guidance and performance sub-panel meeting at MSC April 28, 1964.

LAUNCH ESCAPE SYSTEM

A study was conducted to evaluate the capability of the Launch Escape System (LES) to provide protection from booster explosions. It was determined that the Apollo capsule would be subjected to damaging overpressure if the LES is initiated simultaneously with the explosion of the booster. Prior warning time of approximately two seconds is required for the astronaut to escape. Results of this study were presented to the MSC/MSFC crew safety panel.

ASSISTANCE TO LAUNCH SUPPORT EQUIPMENT OFFICE

Technical assistance to the Launch Support Equipment Office, Huntsville, Alabama, and to KSC, includes engineering studies, analysis, and report writing as applicable to: Coordination for Saturn V launch support equipment; Engineering for design, budgeting, and scheduling in the launch equipment area, the propellant area, and the launch system and umbilical equipment reliability area.

MTO ACTIVATION

During this reporting period, on-dock dates for all contractor furnished test and checkout equipment were determined.

Support was provided to NASA/MSFC for the S-IC Complex (MTO) design review. A major revision to Document D5-11061, "Government Furnished Facilities, Equipment and Services for Mississippi Test Operations," was completed. Document D5-11071-2, "Plan for Activation and Operation of the S-IC Complex at MTO," was prepared and released as the work statement to support a request for estimate (RFE) which was issued to cover the MTO Activation Plan. The RFE meeting was held in New Orleans, November 6, 1963, and a presentation to NASA/MSFC was made on December 9, 1963.

Documentation was developed for the Saturn records system procedure, manpower plan, test evaluation and reports plan, activation static firing and special test data plan, and the safety plan.

This resulted in a significant contribution to the Saturn program in that the initial overall requirements for Mississippi Test Operations were defined through this work effort.

EQUIPMENT MANAGEMENT SYSTEM

The establishment and documentation of an equipment management system to cover all ground support equipment (GSE) for the Saturn V program, the development and documentation of an initial Saturn V program elements list, and the development of a preliminary Saturn V GSE list was completed in December 1963.

An S-IC equipment data support group, consisting of full-time representatives from the Launch Systems Branch was organized on September 16, 1963, in Huntsville. This group was assigned the task of reviewing and updating the equipment listed in the data bank established as a result of the task force effort. The first updated S-IC equipment list was completed on October 11, 1963, and a computed version of the S-IC equipment list was completed on November 8, 1963. An outline of the proposed Saturn V equipment management system was documented and was submitted to the Saturn V Project Office for comment on September 24, 1963.

This effort represented an important contribution to the program since it provided program visibility of known equipment requirements and responsibilities, assistance in identifying duplicated or omitted equipment, a basis for equipment accountability, data to identify contract deficiencies, a basis for equipment status reporting, and data for development of installation and checkout packages.

TAO 6 was released December 31, 1963 to ensure continuity of the Saturn V Equipment Management support effort following the expiration of TAO 30.

TAO 6 provides for 20 Boeing technical personnel to support the Saturn V Project Office at NASA/MSFC, for implementation, maintenance and future development of the equipment management system. Specifically, this support consists of follow-on studies for further application of the management system and assistance in the maintenance and further development of:

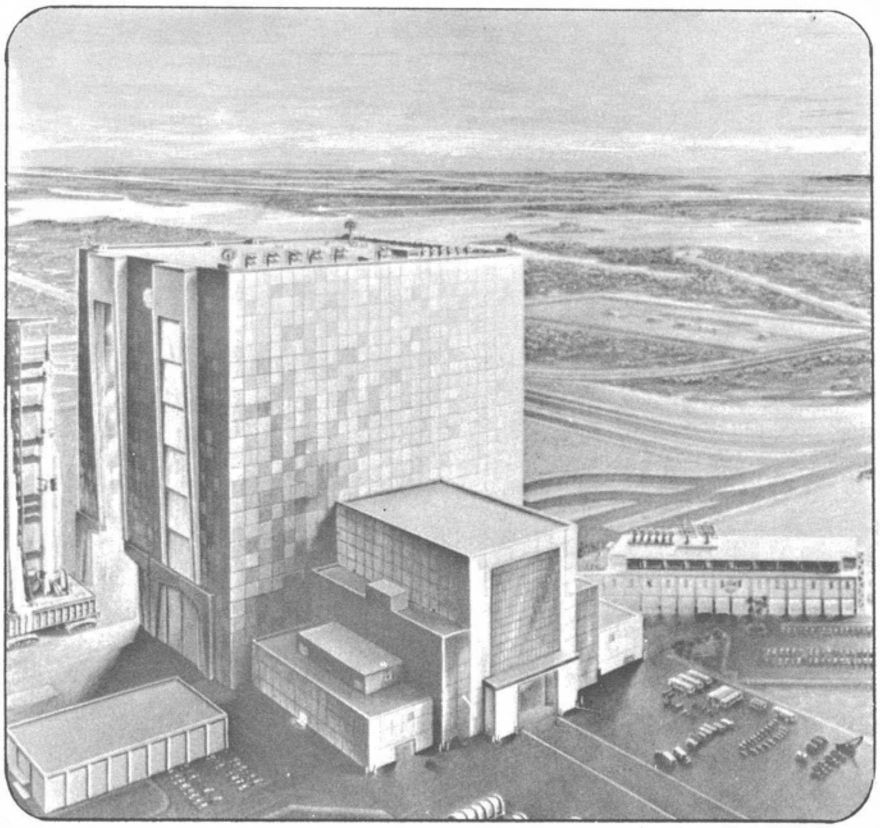
1) Saturn V Program Elements List;
2) Saturn V Master Equipment List;
3) Equipment Allocation Techniques;
4) Problem Resolution Schedules.

The Saturn V/S-IC master equipment list has been placed into computer format and is now stored in the Michoud Computer Office. Updating of this data bank occurs on a monthly basis.

Development of report requirements and planning of computer programming is now in progress.

Responsibility for work covered by TAO 6 was transferred from Boeing Booster Test to Boeing Engineering in March 1963; however, Booster Test is providing support.

VII



LAUNCH OPERATIONS SUPPORT

MERRITT ISLAND LAUNCH AREA LIAISON

The Boeing activities in the Cape Kennedy area were consolidated into one organization during February. Mr. A.M. Johnston was appointed Manager of the Boeing Atlantic Test Center (BATC) reporting directly to Mr. G.H. Stoner, Vice President and General Manager, Launch Systems Branch of the Aero-Space Division, The Boeing Company. Mr. H.W. Montgomery was appointed Manager of Saturn S-IC activities at BATC.

Document D5-11058, "MILA S-IC/Saturn V Checkout and Test Plan," was revised to reflect the Kennedy Space Center (KSC) planning for a fifty eight day cycle of Launch operations. Document D5-11059, "S-IC MILA Equipment List," was released and served as the first guide for MILA use requirements.

Liaison activities included the preparation of document D5-11830, "MILA S-IC Launch Operations Record Systems." The system provides a method of fulfilling the Saturn V vehicle record requirements while maintaining a high degree of compatibility with Boeing records at other locations.

Document D5-11816, "Launch Operations Support Plan S-IC/Saturn V," was prepared during this report period. The plan presented the BATC concept of the Boeing effort to be performed under Part VII of Contract NAS8-5608. The document became the basis for negotiation of task orders to authorize Boeing support effort for KSC for FY '65. The approved task orders will allow for a growth of 100 persons for a total of 123 under this part of the contract.

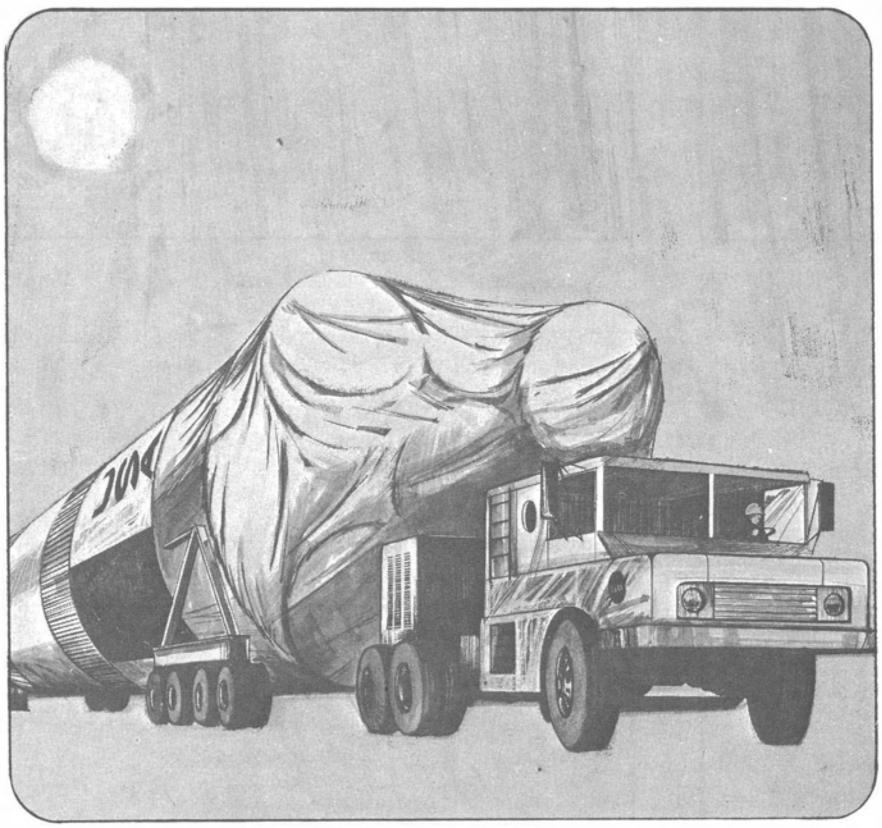
The "BATC Training Plan" is in process with initial release scheduled for October 1, 1964. This plan will serve as the basis for negotiations regarding off-site personnel training and will ultimately support the KSC training plan.

A compilation of all tests to be performed on the S-IC-F stage at MILA is also in process. The initial release, scheduled for August 15, 1964 will be in document form—"S-IC-F Catalog of Tests - MILA."

LAUNCH OPERATIONS PARTICIPATION

Twenty-three BATC personnel are currently assigned to support NASA/KSC Launch Vehicle Operations Activities. Assignments vary with the individual organization supported but cover S-V/S-IC MILA program planning, and participation in Saturn I test activities for familiarization and training purposes. Numerous working-group meetings and design reviews were attended by support personnel during the reporting period. These included meetings of the Instrumentation Working Group reviews covering S-IC transporter and pneumatic systems, Saturn V propellant loading system, propellant dispersion system, RCA 110 computer networks, and thrust-vector control system.

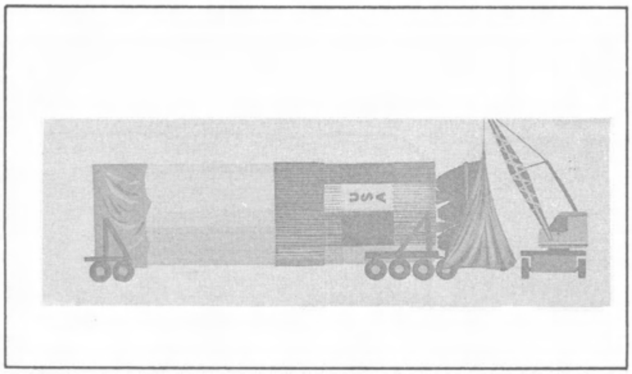
VIII



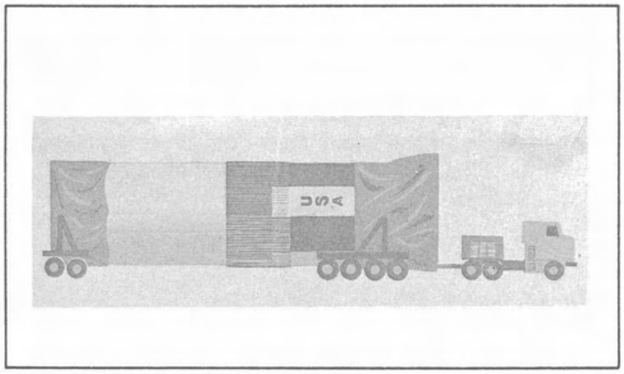
STAGE TRANSPORTATION

STAGE PREPARATION
EQUIPMENT:

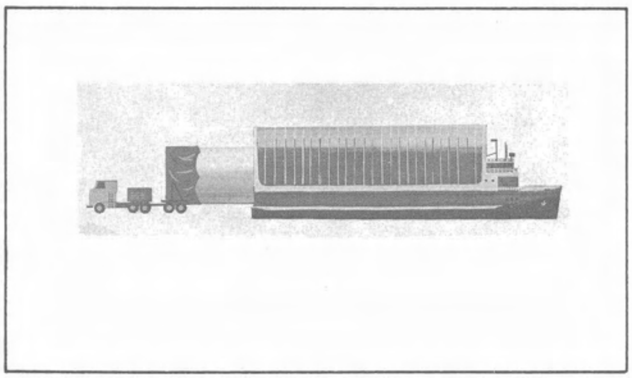
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings



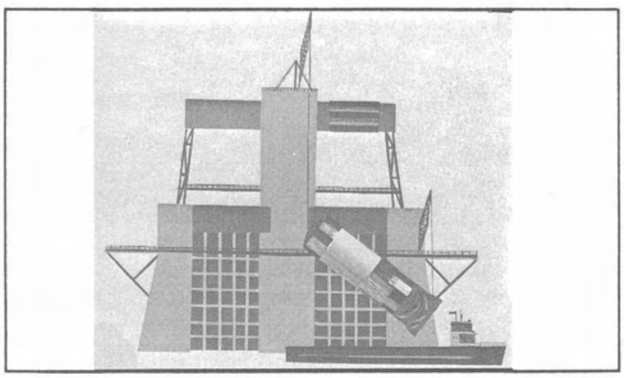
HANDLING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



LAND TRANSPORTATION
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

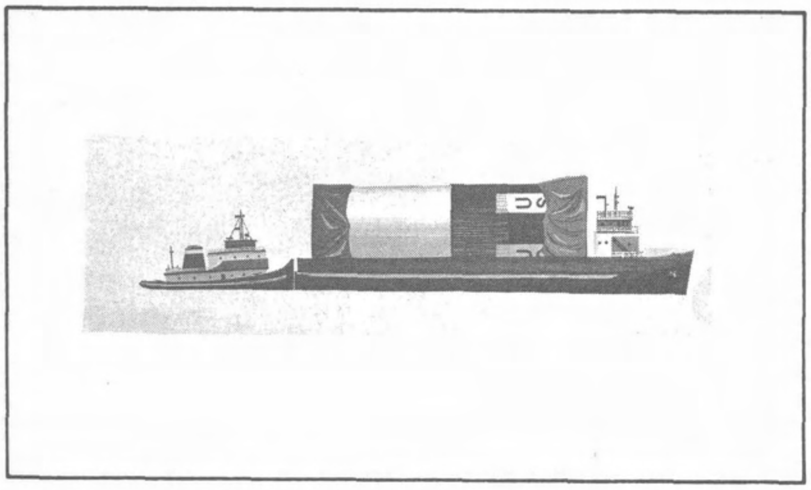


LOADING-UNLOADING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

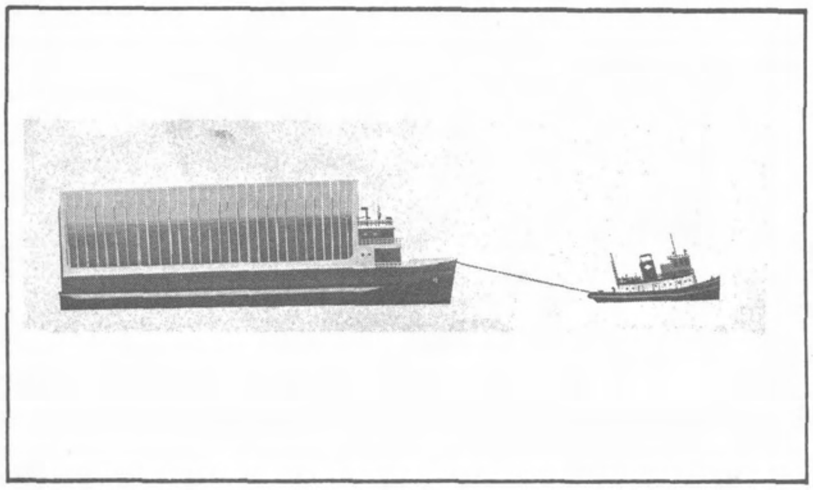


* THE PROTECTIVE COVERS AND PLUGS ARE JOINT BOEING-NASA DESIGNED ITEMS.

WATER TRANSPORTATION — OPEN
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Transportation Accessory Kit
Forward Handling Ring
Stage Attach Fittings



WATER TRANSPORTATION — CLOSED
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



STAGE TRANSPORTATION SEQUENCE

A complete revision to Document D5-11053, "Saturn V S-IC Stage Transportation Plan," has been the prime order of business during this reporting period. This revision encompasses all phases of transportation, identifies the Boeing organizations responsible for each of the transportation functions, and contains the latest schedules and equipment requirements. This document is scheduled for release in September 1964.

Document D5-11763, "Saturn V S-IC Stage Transportation Requirements," is also in process and is a compilation of the detailed requirements for transporting the S-IC Stage in accordance with the above Transportation Plan. This document is scheduled for release in January 1965.

The first barge movement (S-IC-D to MSFC transport sequence shown) is scheduled for August 1, 1965, with no problems anticipated at this time.

IX

MANUFACTURING SUPPORT TO MSFC

S-IC-C TEST FUEL TANK

Boeing support of the ground test program for the S-IC-C test fuel tank involved the fabrication and delivery of stage hardware details and assemblies and fabrication and erection of the tank support structure.

Fabrication and delivery of minor stage hardware, such as tank ring baffles continued during the third quarter of CY'63. During August 1963, the assembly of the one-half intertank was completed in support of the NASA/MSFC test fuel tank requirements. The one-half intertank was delivered to MSFC by barge (Figures IX-1 and -2) on November 16, 1963. Stage hardware deliveres were completed during the last quarter of CY'63.

Effort during the first quarter of CY'64 was directed toward completion of the tank support structure. This activity culminated March 11, 1964 with the installation of the test fuel tank on the support structure.

Figure IX-1 - The Michoud Plant and the Partially Completed Vertical Assembly Building are a Backdrop for the One-Half Intertank Being Towed to the Slip for Shipment to MSFC

S-IC-T STAGE

The Boeing effort on the S-IC-T static test stage encompasses the fabrication of structural hardware details and assemblies (thrust structure, intertank, and tank components), and the procurement and delivery of specialty hardware in support of NASA/MSFC.

Figure IX-2 - The Half Intertank is Carefully Loaded on the Barge at the Dock and Secured by Boeing Mechanics

STRUCTURAL HARDWARE

S-IC-T structural hardware deliveries to MSFC began during the second quarter of CY'63 with the delivery of the fuel tank lower-head apex gores. Deliveries of this hardware (Figures IX-3 and -4) continued through the second quarter of CY'64 with the final major structural hardware deliveries having been completed in May.

The last of the basic structural subassemblies delivered during the reporting period included the GOX and helium distributors, and the LOX tank ring baffles and cruciforms (Figure IX-5). At the close of FY 64, there were 656 items remaining to be delivered to MSFC by Boeing in support of the S-IC-T stage. Delivery of these items, such categories as minor tooling, specialty hardware, and minor structure components (Figure IX-6), will continue through January 15, 1965.

SPECIALTY HARDWARE

Specialty hardware deliveries began in November 1963, and were continuing at the close of FY64. These deliveries consist of both items to be shipped directly from suppliers to MSFC, and items routed through

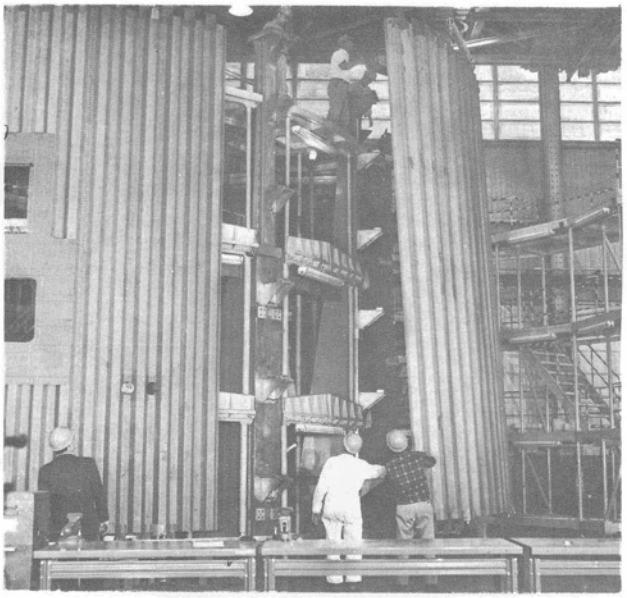


Figure IX-3 - An S-IC-T Intertank Panel is Removed from the Intertank Assembly Fixture

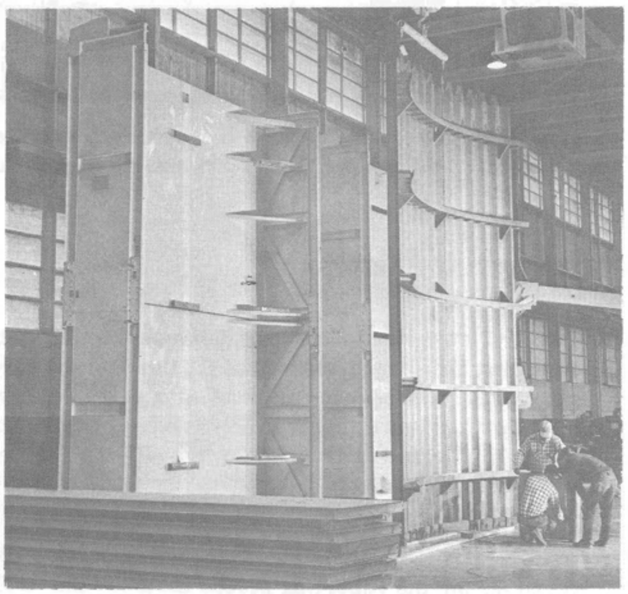


Figure IX-4 - The -T Intertank Panels are Placed in the Shipping Case Vertically

Boeing/Michoud for test and calibration. A need for increased delivery rates during the latter part of FY 64 resulted in concerted efforts by Boeing Management to attain better adherence to delivery schedules by suppliers for critical items. Key members of both NASA/MSFC and Boeing Management were maintaining close liaison through such media as the monthly MSFC/Boeing S-IC-T stage meetings. These meetings were held to ensure that critical areas affecting completion of the S-IC-T stage would receive the proper attention.

Typical of the conditions affecting hardware deliv-

Figure IX-5 - A Cruciform Baffle Segment is in its Assembly Fixture at the Left. Another Baffle Segment is on a Stand.

Figure IX-6 - Segments of Anti-Slosh Cantilever Circumferentials Await Shipment in the Michoud Tank Ring Baffle Pick-up Area for the S-IC-S and -T

eries were changes in design criteria; revised vibration/shock testing requirements; supplier design deficiencies; and over-optimistic delivery capability quotations. Corrective actions initiated by Boeing included overtime authorization; negotiation of unqualified hardware deliveries and direct shipment authorization; establishing resident personnel at supplier locations to expedite design decisions; assistance in resolving production and quality problems; and periodic Boeing Management visits to ensure continuing management awareness of problems and follow-up of remedial action.

S-IC-S STAGE

Boeing support to NASA/MSFC major structural component hardware (S-IC-S) requirements were initially oriented to fabrication, assembly, and delivery of stage hardware details and assemblies to support the assembly of an equivalent structural stage at MSFC. Hardware deliveries from Boeing were to be provided so that the stage could be assembled in two major sections. The first section (upper structural

stage) would include a LOX tank, an intertank, and a forward skirt. The second section (lower structural stage) would include an intertank, fuel tank, thrust structure, fin and fairing assemblies, engine actuator supports, and propellant line supports. Boeing effort is directed toward final delivery of components to MSFC for the lower structural stage by November 31, 1964, and for the upper structural stage by December 14, 1964.

STRUCTURAL HARDWARE

Thrust Structure

Structural components were being fabricated for the thrust structure (Figure IX-7) of the S-IC-S stage during the fourth quarter of CY 63. By the end of the first quarter of CY 64, the fabrication of structural components for the entire S-IC-S stage was about 87 percent complete. They were scheduled to be 92 percent complete but were slightly behind schedule because the fabrication of the S-IC-T stage had priority.

During the first quarter of CY 64, deliveries were made to MSFC for the S-IC-S thrust structure, with the majority of items being scheduled for delivery during the quarter ending July 2, 1964.

Shortly after the beginning of the second quarter of CY 64, Boeing was requested to assume responsibility for complete assembly of the S-IC-S, S-IC-1, and S-IC-2 thrust structures. These structures will be assembled at Michoud, necessitating transfer of previously delivered thrust structure subassemblies and assembly fixtures from MSFC to Michoud. At the close of the reporting period, the S-IC-S stage thrust structure was in the final assembly operation at Michoud. Minor assembly activities are in phase with final assembly requirements. Present status indicates the completed S-IC-S thrust structure willbe delivered to MSFC by September 30,1964, as scheduled.

Intertank

Intertank assembly activities during the fiscal year included two units of the original configuration for the S-IC-S. The first -S intertank assembly was completed, removed from the final assembly fixture, and shipped to MSFC on June 18, 1964. Delivery of this intertank differed from the S-IC-T in that the structure was removed from the assembly fixture in one piece, and shipped as a single unit rather than in sections as occurred on the -T. The second intertank for S-IC-S was then loaded onto the final assembly fixture and is expected to be completed and removed by July 14, 1964. No major problems have been encountered in the assembly of these two units. Current planning calls for two additional intertanks of a revised configuration for S-IC-S to be assembled in the fourth quarter of 1964.

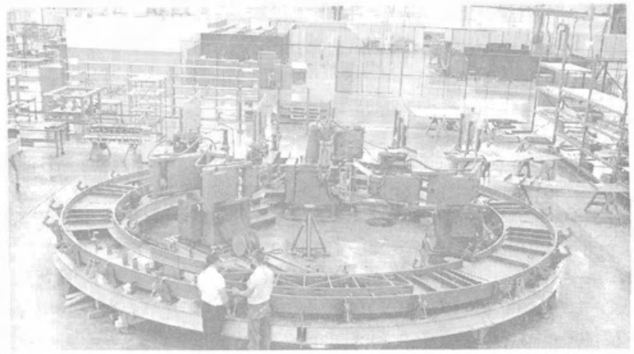


Figure IX-7 - S-IC-S Thrust Ring being Loaded into the Lower Thrust Ring Subassembly Fixture

Forward Skirt

Final assembly of the S-IC-S forward skirt (Figure IX-8) was started in the last week of the reporting period. Assembly activity is progressing on schedule and is to be completed by September 8, 1964.

Figure IX-8 - Skin Panels for the S-IC-S are Assembled in the Fixture at the Left and Held for Shipment as shown

LOX and Fuel Tank

Boeing support of the S-IC-S LOX and fuel tank assemblies consisted of assembly of the forward bulkhead (Figure IX-9) for the LOX tank at Michoud and the delivery of detail tank components to MSFC for subsequent assembly by NASA/MSFC at Huntsville. By the end of the second quarter CY 64, over 500 tank components for the S-IC-S had been delivered to MSFC. At the end of the first quarter of CY 64, the forecast for completion of S-IC-S tank component deliveries was the end of June. Subsequent redirection by NASA/MSFC, altering both quantities and delivery demand dates, has necessitated a re-evaluation of delivery capability. LOX tank component deliveries that were outstanding on July 2, 1964, included 16 ring-baffle segment assemblies, four panel assemblies, four cruciform baffle assemblies, three covers, and one GOX distributor. Fuel tank components still to be delivered included 40 ring-baffle bearings, two cover assembl-

ies, a helium distributor assembly, and a helium cover assembly. Delivery dates through August 17, 1964, have been cited.

The assembly of the forward LOX tank bulkhead at Michoud was to be delivered to MSFC on June 22, 1964, but is behind schedule and is presently forecast for delivery on August 11, 1964. This schedule position is caused by an accumulation of technical problems encountered during the assembly process. Fitting-to-gore welds developed excessive warpage and shrinkage. The gore segments had to be returned to Wichita for rework. Difficulties were then encountered during the gore-to-gore weld operation, and following this the polar cap was determined to be overformed, and a new polar cap had to be fabricated. While this was being produced, the bulkhead was successfully welded to the Y-ring and brackets were welded onto the assembly out-of-sequence in an effort to reduce down time. Assembly completion is predicted for July 25, after which the bulkhead must be prepared for shipment. The bulkhead will then be loaded on a barge and routed to MSFC.

Fin and Fairing

Fin and fairing assembly operations for the S-IC-S are presently scheduled to begin in July 1964. Delivery of the completed assemblies is forecast for the fourth quarter of CY 64.

SPECIALTY HARDWARE

Specialty hardware required of The Boeing Company for the S-IC-S stage is included under four part numbers, which represent a total of twenty parts. The last part is forecast to be on-dock at MSFC by July 28, 1964, which supports MSFC delivery requirements.

S-IC-1 AND S-IC-2 STAGES

Structural component fabrication dominated Boeing efforts in support of the S-IC-1 and the S-IC-2 stages. However, by the end of the reporting period, bulkhead gores were being assembled at Michoud for the S-IC-1 and the assembly for the S-IC-1 base heat shield was about to start. Further assembly activities at Michoud on the S-IC-1 will be paced by the availability of tooling, which is currently loaded with S-IC-S and S-IC-D hardware. Hardware deliveries to MSFC for S-IC-1 and S-IC-2 stages were limited to components for LOX and fuel tanks. Michoud assembly activities and deliveries to MSFC will continue to accelerate as program emphasis swings to the first flight stages, and on-schedule performance is predicted.

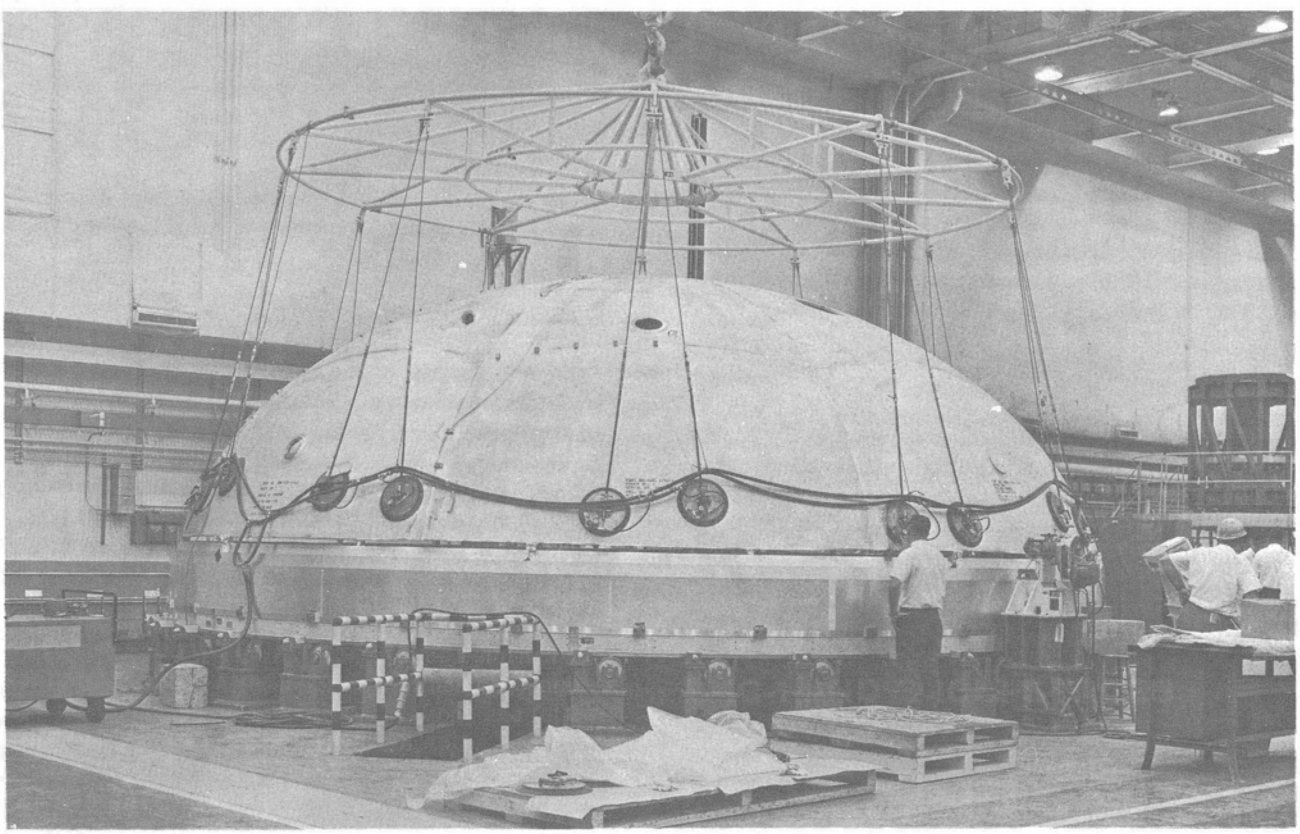
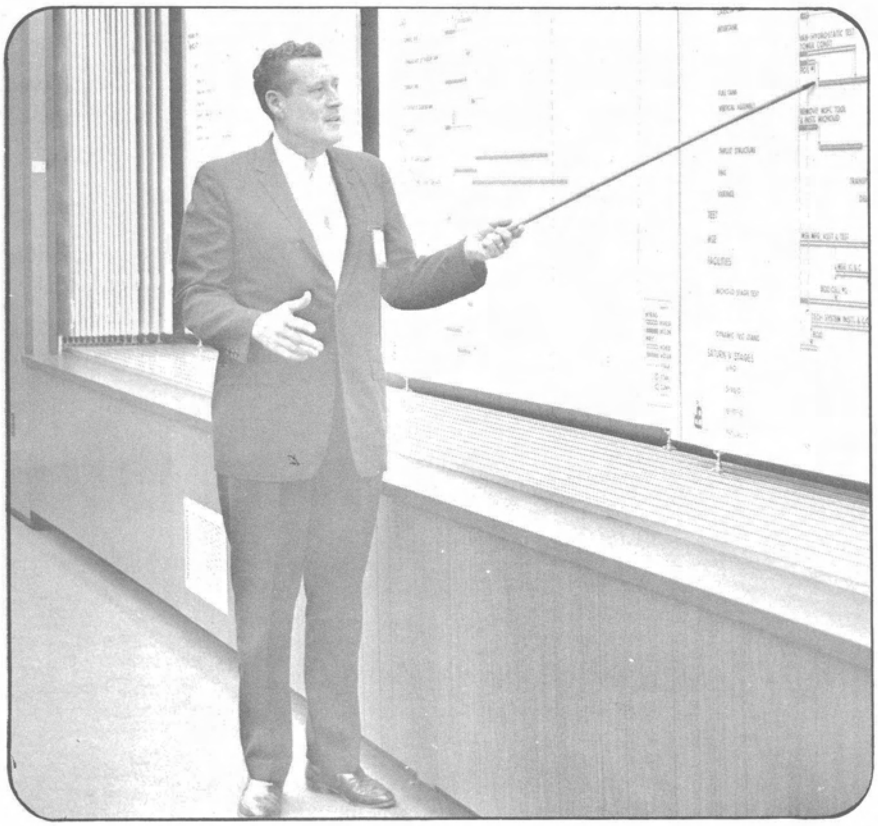


Figure IX-9 - S-IC-S Forward LOX Bulkhead was moved from the Polar Cap Weld Fixture to this Bulkhead-to-Y-ring Weld Turntable by means of the Vacuum Handling Tool shown still Attached

X



PROGRAM MANAGEMENT

CONTRACTING ACTIVITIES

GENERAL

During FY 64, The Boeing Company was actively engaged in the following Saturn V/S-IC stage program contracts with NASA/MSFC:

Contract NAS8-5608--"Long Range Saturn S-IC Stage Program."

Contract NAS8-2577--"Preparatory Effort Leading to a Project for Engineering, Fabrication, Assembly, Checkout, Static Testing, Transportation, and Launch of the Saturn S-IC Stages"

Contract NAS8-5606(F)--"Facilities Required for Saturn S-IC Stage Program."

Contract NAS8-13002--"Saturn V/S-IC Full-Scale Tail-Section Mockup."

The prime contract, Contract NAS8-5608, effective January 1, 1963, was based on Schedule Plan IV. Through negotiations in late 1962 and in early 1963, Boeing's work base was expanded significantly and because of this, official Schedule Plan V was established in May 1963. In late June 1963, in anticipation of FY 64 funding limitations, NASA/MSFC directed Boeing not to add additional personnel to the S-IC program. This restriction was later removed and a manpower schedule recommended by Boeing was substituted.

In December 1963, Schedule Plan VI, consistent with FY 64 funding, was established. A major program redirection in January 1964, necessitated a change from Schedule Plan VI to Schedule Plan VII. Plan VI was never completely negotiated or implemented because of its short duration, (December 20, 1963 through January 22, 1964). Schedule Plan V and the subsequent modifications to it, served as a baseline for the negotiated transition to Plan VII.

Schedule Plan VII was compared to Schedule Plan V (Figure X-1), to reflect program slides in stage deliveries and in completion of Ground Support Equipment and Manufacturing Support Equipment (GSE/MSE). The responsibility for assembly of the S-IC-D dynamic test stage was transferred from MSFC to Boeing/Michoud, and the assembly of the S-IC-2 flight stage was transferred from Boeing to MSFC.

As of January 1, 1964, sufficient Construction of Facilities funds had been obligated to Contract NAS8-5608 to satisfy all construction requirements through FY 64 with the exception of the stage test facility, the high-pressure test facility, and the Vertical Assembly Building. Funding for these facilities was provided by subsequent modifications received prior to FY end.

CONTRACT NAS8-5608

Modification No. 30, effective August 2, 1963, completed negotiation of Schedule Plan V program redirection and substantially increased the contract value. Modification No. 60, dated December 20, 1963, directed a change to the Plan VI delivery schedule. Modification No. 67, dated January 22, 1964, redirected the program to Plan VII, which revised the delivery dates for stages S-IC-D, S-IC-F, S-IC-3 through S-IC-10,

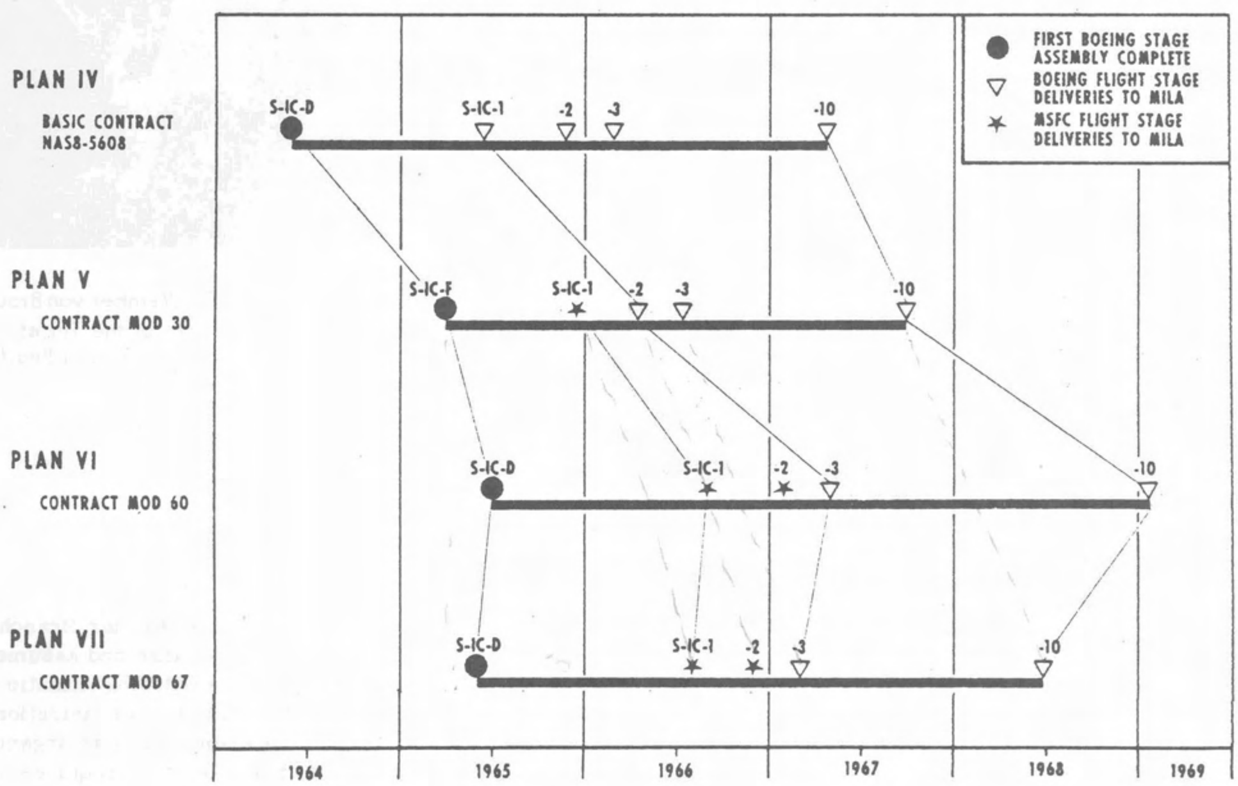


Figure X-1 Comparison of Schedule Plans IV, V, VI & VII for the S-IC Stage

deleted the Boeing responsibility for the assembly of the S-IC-2 stage, and added the S-IC-D stage assembly to Boeing. Modification No. 67 was also significant in that it deleted the manpower clause, Article XVII, which had been the basis of several manpower limitations by NASA. The Boeing proposal for the Modifications 60 and 67 redirections was submitted to NASA on May 25, 1964.

Program obligations of The Boeing Company were substantially increased by Contract Modifications 34, 35, 36, 44, 52, 62, 83, 89, 94, 102, 110 and 113.

Modifications 34, 35, and 36 authorized the design, fabrication, test and qualification of equipment to be used on the Saturn V Launcher Umbilical Tower, and the design, development and documentation of S-IC personnel work platforms for use at Merritt Island Launch Area.

Modification No. 44 shifted the responsibility for the government to provide gaseous nitrogen to Boeing and eliminated the missile-grade air facilities. Modifications 52 and 94 added a Mechanical Automation Breadboard in Building 4708, at MSFC.

Boeing effort to provide Saturn V engineering assistance to NASA/MSFC was extended through December 31, 1964 by Modification No. 62. Modifications 83, 89, 110, and 113 extended Boeing manufacturing and development support to MSFC by 1,950,000 hours for calendar year 1964.

The largest single addition was the S-IC/Mississippi Test Operation (MTO) Activation Task, added by Modification 102 at an increase in contract value of nearly $10 million. This modification added the requirement for activation of one position of an S-IC dual-position test stand at MTO encompassing a stage test and checkout station, stage-to-facility interconnecting equipment, a test control center, and an S-IC storage building. Some modification of design for flight stages S-IC-1 through S-IC-10 was also included.

CONTRACT NAS8-2577

Contract NAS8-2577 was extended to June 30, 1964, to cover existing construction and architectural engieering subcontracts. The Boeing Company has instituted closure action on this contract and no further extensions are anticipated.

CONTRACT NAS8-5606(F)

During the reporting period, Contract NAS8-5606(F) was rewritten, and the concept of incremental funding eliminated. Funding is now based upon actual need established by extracts from the primary requirements document, D5-12374, submitted by The Boeing Company.

The work statement has gradually expanded due to increased facilities equipment requirements added by the modification of Contract NAS8-5608.

CONTRACT NAS8-13002

On January 23, 1964, in response to a request from the NASA/MSFC Contracting Officer, a proposal for a Saturn V/S-IC full-scale tail section mockup (Fig. X-2) for exhibit at the New York World's Fair was submitted. A fixed contract, NAS8-13002, was subsequently negotiated. During the reporting period, the mockup was fabricated and shipped to New York, arriving at the World's Fair Grounds on March 24, 1964. The contract was completed during the week of April 18, 1964, when NASA/MSFC officially accepted the mockup. Contract closure action was in process by The Boeing Company at the close of the fiscal year.

Figure X-2 - NASA/MSFC Director Dr. Wernher von Braun Accepts Title to the World's Fair Model of the Thrust Structure from R. C. Dunigan (right) and Gordon Beall.

ORGANIZATION

On February 21, 1964, the Saturn Booster Branch was renamed the Launch Systems Branch and assumed the responsibility to manage the new Boeing Atlantic Test Center at Cape Kennedy. This new organization provides increased technical capability and an organization that is responsive to S-IC Program requirements at the Kennedy Space Center.

PROGRAM SCHEDULES

January 27, 1964, marked the initial release of Boeing Document D5-11040-3, "Launch Systems Branch Plan VII Program Schedules." (This document was preceded by D5-11040, -1, and -2, which presented schedule plans IV and V, Va, and VI, respectively). Document D5-11040-3 established the Branch scheduling base for the S-IC Research and Development Program currently under contract. Included in this document are: (1) A Saturn V/S-IC Stage Summary schedule (Figure X-3) which displays the assembly, testing, contractual delivery and planned utilization of each S-IC stage under contract, and an F-1 engine demand schedule and other major Saturn V program milestones; and (2) A Saturn V/S-IC Test and Checkout Equipment summary schedule (Figure X-4) depicting MSFC, Michoud, and Mississippi Test Operations requirements.

Since the initial release, major revisions to Document D5-11040-3 have been made to reflect schedule changes: to add a Saturn V/S-IC Phasing Summary Schedule (Figure X-5); to depict a geographical representation of major activities to be performed in support of the program; and to reflect the activation and checkout of S-IC/MTO Position 1 as a Boeing contractual responsibility (Contract NAS8-5608, Modification 102).

S-IC PROGRAM REPORTING AND CONTROL MILESTONES

Document D5-12535, "Launch Systems Branch Reporting Milestones," was developed to identify and define program reporting and control milestones for the Saturn V/S-IC program described by the technical work statement in Contract NAS8-5608. The milestones included in this document provide time-oriented events against which program progress and performance will be measured. Certain of the milestones depicted are contractual and others are utilized for general Branch management of the program. The contractual reporting milestones have been established by coordination with NASA/MSFC.

SUMMARY PROGRAM PLAN

Contract NAS8-5608 stipulated that the "C-5/S-IC Development Program Plan," developed under Contract NAS8-2577, be revised to incorporate the provisions and requirements of Contract NAS8-5608. This was accomplished and released as Boeing Document D5-11960, "Saturn V/S-IC R&D Summary Program Plan," dated November 1, 1963.

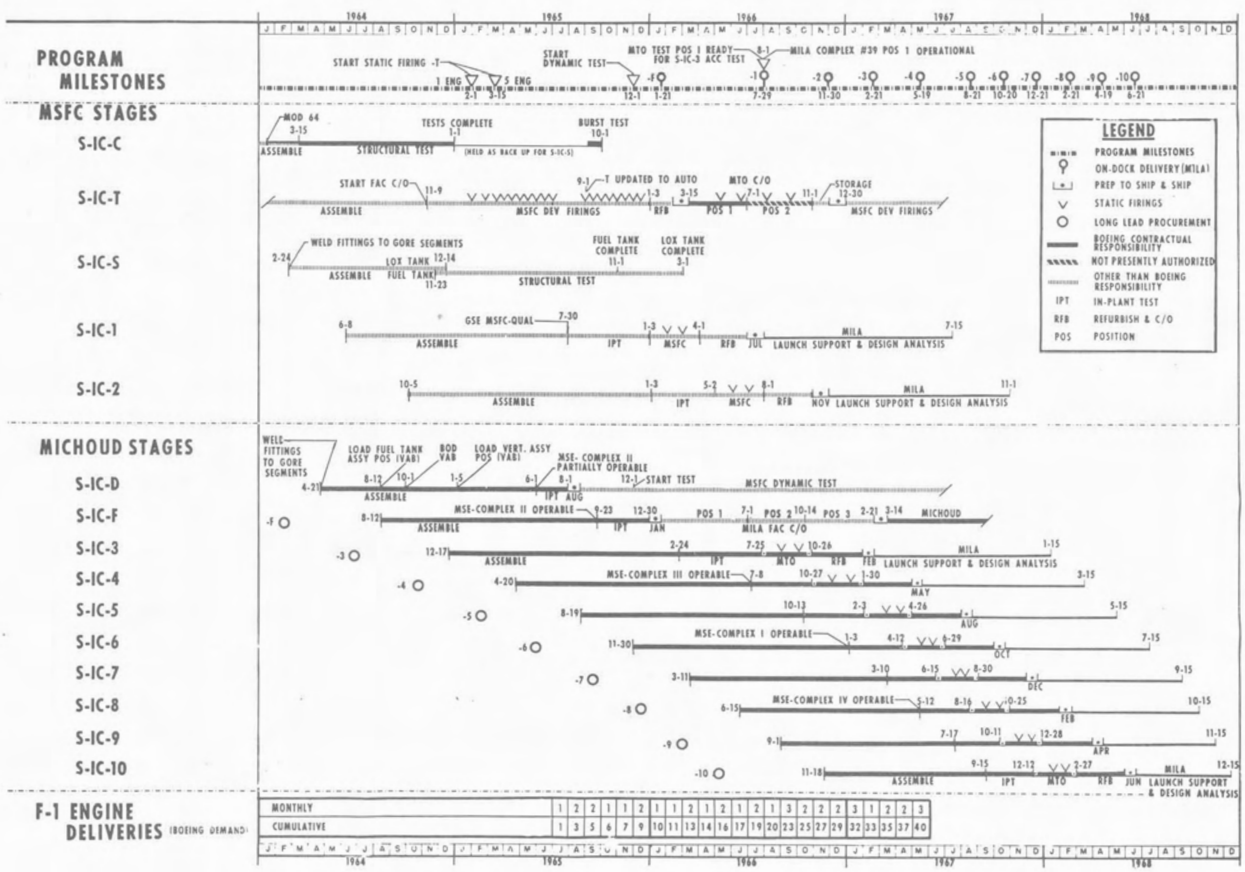


Figure X-3 - Saturn V/S-IC Stage Summary

This summary plan describes the total Boeing task and responsibilities, and provides a firm basis for Boeing Launch Systems Branch planning and management control. Because of the scope and complexity of the program, the Summary Program Plan was made concise and is supported by referenced, detailed plans and other documentation.

PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

During the past year, GSE/MSE networks for all contracted equipment were developed, and networks covering stage electrical and instrumentation systems were completed. This completed the basic PERT coverage of the Boeing S-IC program. During December 1963, NASA/MSFC concurred that the S-IC PERT System was fully implemented.

An improved PERT reporting format was implemented during March 1964. The report was expanded to encompass the Launch Systems Branch assessment of program status trends. During April 1964, Modification No. 100 to Contract NAS8-5608 was received in response to the need for an expanded PERT system. It enlarged the system to approximately 6000 real activities instead of the 1200 limitation specified in the basic contract. This modification was negotiated with NASA/MSFC during June 1964.

Technical Assistance Order (TAO) I-V-S-IC-13 was received in March 1964, authorizing Boeing to develop a PERT system which integrated the PERT reports of the major Saturn/Apollo contractors and government agencies into a single reporting system. The design of the system was completed by Boeing during June 1964.

PROGRAM INFORMATION CENTER (PIC)

The Launch Systems Branch's Program Information Center (PIC) at Michoud has been developed to provide Boeing and NASA management with the necessary program visibility. The PIC presents a display of program plans, schedules, resources, and highlights of significant program events and milestones.

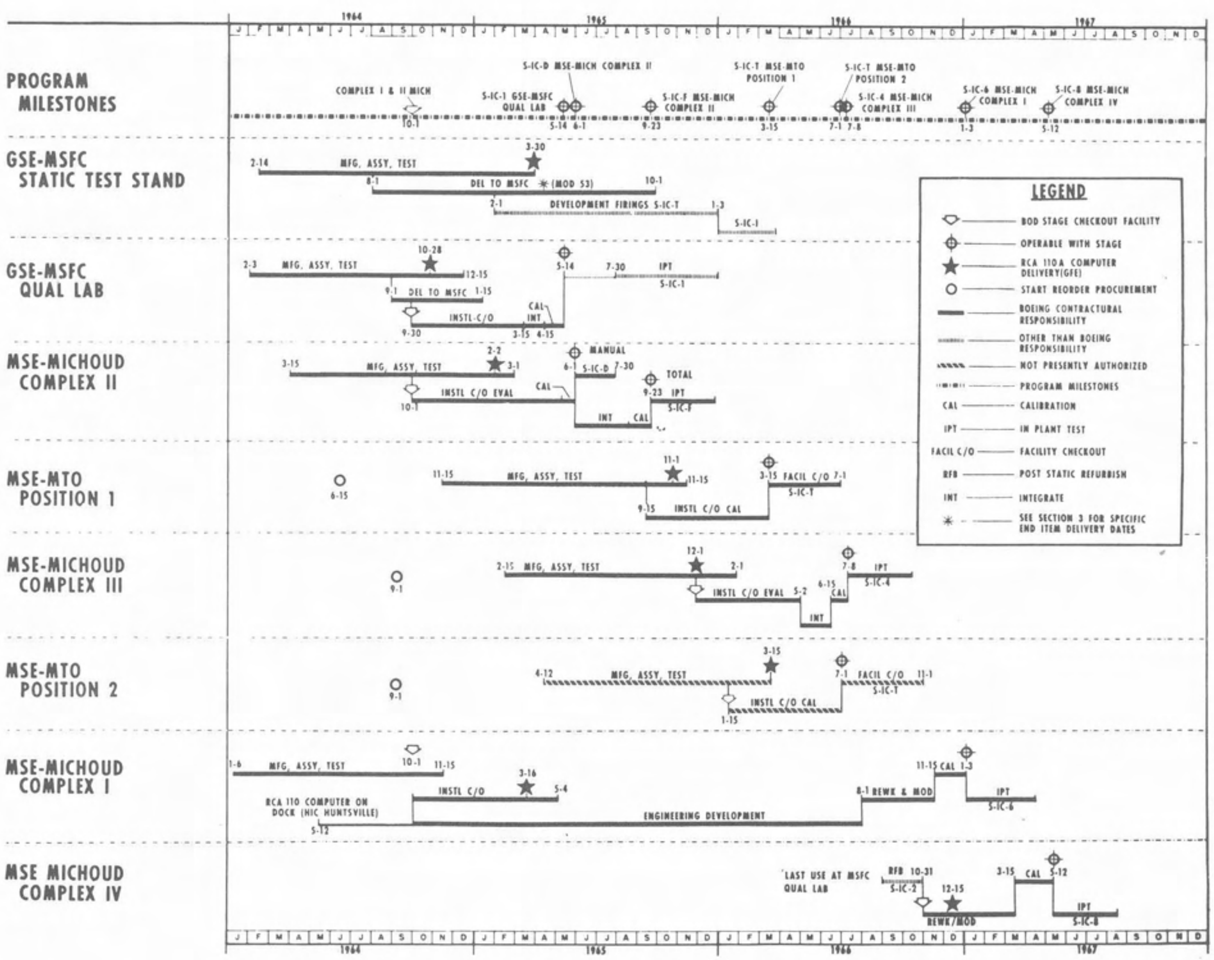


Figure X-4 - Saturn V/S-IC Test & Checkout Equipment Summary

March 1964, marked the go-ahead for the construction of the permanent Michoud PIC. A temporary PIC had been in service since April 1963. The formal opening will be concurrent with the seventh S-IC Quarterly Technical Progress and Program Review currently scheduled for late July 1964. (See Figure X-6.)

SATURN V/S-IC RESPONSIBILITY MATRICES

Saturn V/S-IC Responsibility Matrices were developed to reflect the current status of NASA/Boeing assigned responsibilities for those resolved functional and physical elements required to deliver the S-IC Stage on-dock at MILA. These items were identified to Level 5 in S-IC Program element detail with some facility items identified to Level 6.

SATURN S-IC MAKE-OR-BUY PLAN

A complete revision to Document D5-11413, "Saturn S-IC Make-or-Buy Plan," was approved by NASA/MSFC early in FY 64. Modifications to Contract NAS8-5608 since that time have necessitated numerous revisions to the plan.

Methods for reducing the make-or-buy approval processing time and associated costs have been jointly explored in a series of Boeing-NASA/MSFC meetings during the past year. Documentation of the mutual agreements resulting from these discussions have been transmitted to NASA/MSFC for review and approval.

DOCUMENT CONTROL PROGRAM

A Branch Document Control program was implemented during April 1964, to minimize cost of Branch document preparation and distribution; eliminate redundant documentation; ensure that required documents are prepared; provide management visibility of existing documentation; and ensure that documents are prepared in accord with approved format. This program provides control for that Boeing documentation prepared within

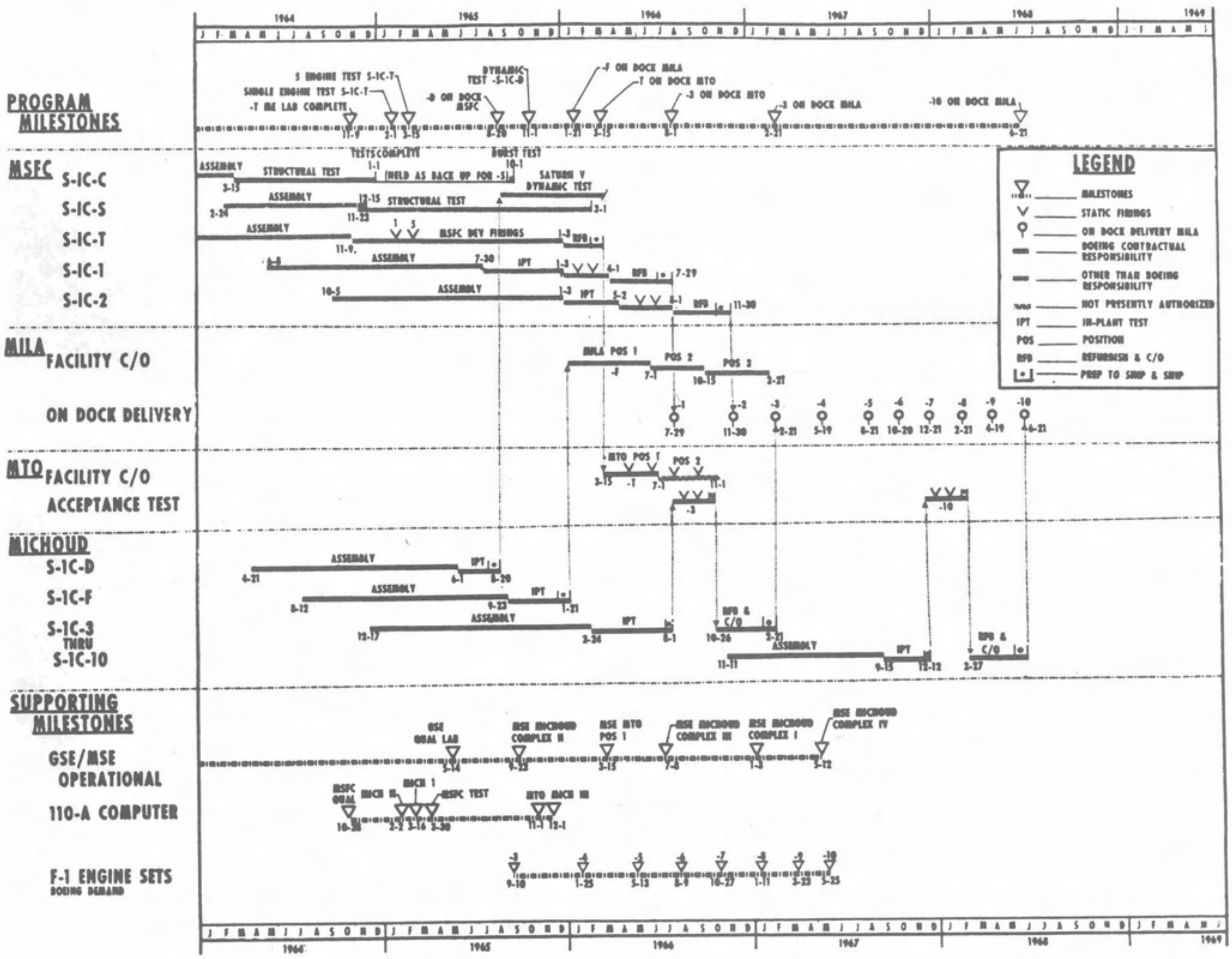


Figure X-5 - Saturn V/S-IC Phasing Summary

the Launch Systems Branch and identified with a "D5" or "T5" prefix to the identification numbers.

BACKUP PROGRAM STUDY

In March 1964, a comprehensive study was initiated to determine where Saturn V/S-IC backup programs were required. Results of this study were submitted to NASA/MSFC on April 1, 1964, by Document D5-11096, "Saturn V/S-IC Backup Program Requirements." This study also identified product improvement and growth items and provided NASA/MSFC the opportunity for review and selection of those items which appear to offer the greatest potential. It also served as a guide to NASA/MSFC for subsequent planning of back-up programs and product improvement funding requirements.

MANPOWER

There were 3782 permanent employees procured for the Launch Systems Branch for the period July 1, 1963, through July 2, 1964. The manpower on-board at all Branch locations on July 2, 1964, was 8684. Of this total, 4391 are transfers from within The Boeing Company, and 4293 are new hires.

TRAINING

Significant training accomplishments during the year by the Launch Systems Branch included the establishment of an employee certification program, activation of the Michoud Training Center, and approval and implementation of major training programs.

FACILITIES AND STAFF

The permanent Boeing Training Center, located in the main factory building at Michoud, was completed in December 1963 (See Figure X-7). Training classes are also held in the Michoud plant welding area (Figure X-8), in various conference rooms at the Michoud Plant, and downtown New Orleans at the 225 Baronne Building and Claiborne Towers. Two permanent classrooms have also been established at the Huntsville Industrial Center.

Thirty-three personnel are actively engaged in developing and presenting S-IC training programs. This staff includes approximately 22 Instructor-Supervisors.

TRAINING PROGRAMS

Training programs within the Branch include Em-

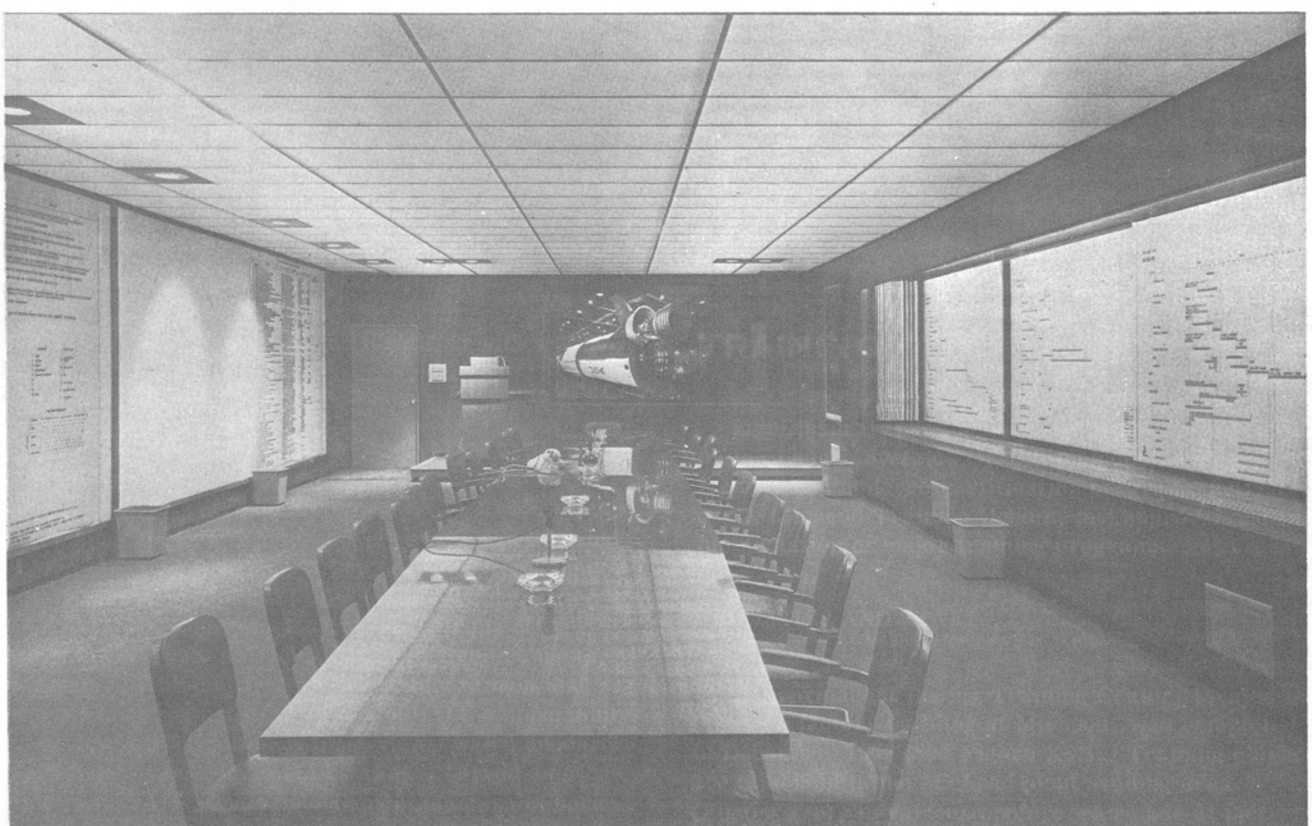


Figure X-6 - Program Information Center

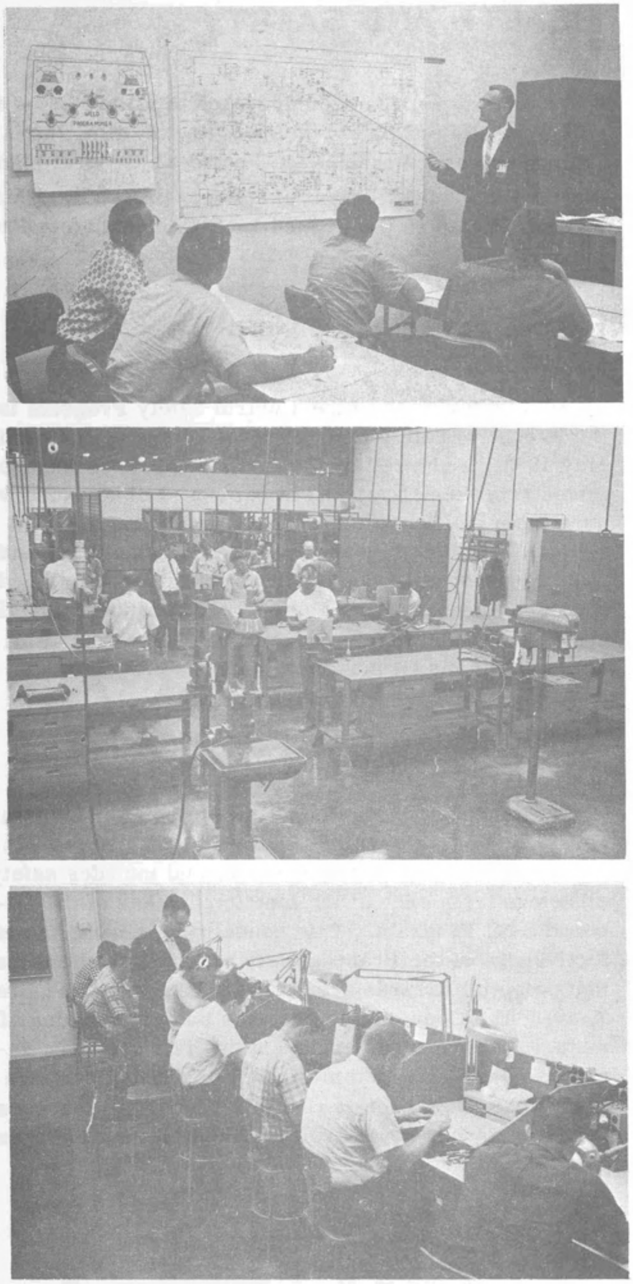


Figure X-7 - Training Classes in the Diverse Skills Needed to Build the S-IC are Being Taught in the Classrooms of the Boeing Training Unit

ployee Certification, Paid-Time Training, Off-Hours Training, and Continuing Education.

The Certification Program consists of training courses in specialized skill areas (e.g., penetrant inspection, soldering, welding, shot peening, contamination control, radiographic inspection, etc.) for employees who must attain a certain proficiency in their particular work to meet the standards of the S-IC program. During the fiscal year, 420 employees were certified in 12 types of certification courses ranging from 8 to 200 classroom hours each.

During the fiscal year, one hundred forty-two paid-time courses, oriented to improving the skills required in the employee's particular job were started, and 25 off-hours voluntary training courses were begun. In these off-hours courses, 461 employees completed training in subjects ranging from basic mathematics to computer programming.

A continuing-education program is also available for all Branch employees and management. In fiscal year 1964, this program included:

a) Technical Sessions, sponsored by colleges and universities throughout the country;
b) Seminars, Symposiums, and Conferences, sponsored by professional technical societies and organizations;
c) Graduate Study Program, Boeing-funded graduate work at nearby colleges and universities;
d) Cooperative Study Program, sponsored by Boeing, whereby college and university students work within the Branch; and
e) A Management Training Program offering advanced and fundamental management courses.

SCHOOL RELATIONS

Contacts were established with local technical, vocational, and secondary schools to compare their scholastic standards with job requirements.

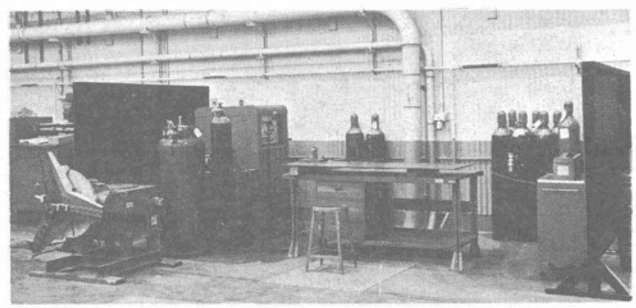


Figure X-8 - Welding Area in the Michoud Plant Where Training Classes are Held

SECURITY ACTIVITIES

Quarterly security inspections by representatives of the Air Force and NASA/MSFC were conducted at Branch facilities in New Orleans and Huntsville. The Boeing Launch Systems Branch Security Program was determined to be satisfactory.

During the past year, an extensive program was implemented to ensure that all classified files and secret control stations within the Launch Systems Branch contain only current and correctly classified documentation. Boeing was commended by NASA/MSFC for their effort and accomplishments on this program. Emphasis was also placed on a security indoctrination program.

FIRE PROTECTION AND EVACUATION CONTROL

Fire brigades have been established at Michoud and Huntsville Launch Systems Branch facilities. These brigades consist of volunteer Boeing employees who receive training in fire prevention and fire fighting (Figure X-9). Monthly fire brigade meetings are held.

The Fire and Evacuation Control Plan for the Branch leased facilities at 225 Baronne Street in New Orleans was put into operation during the year.

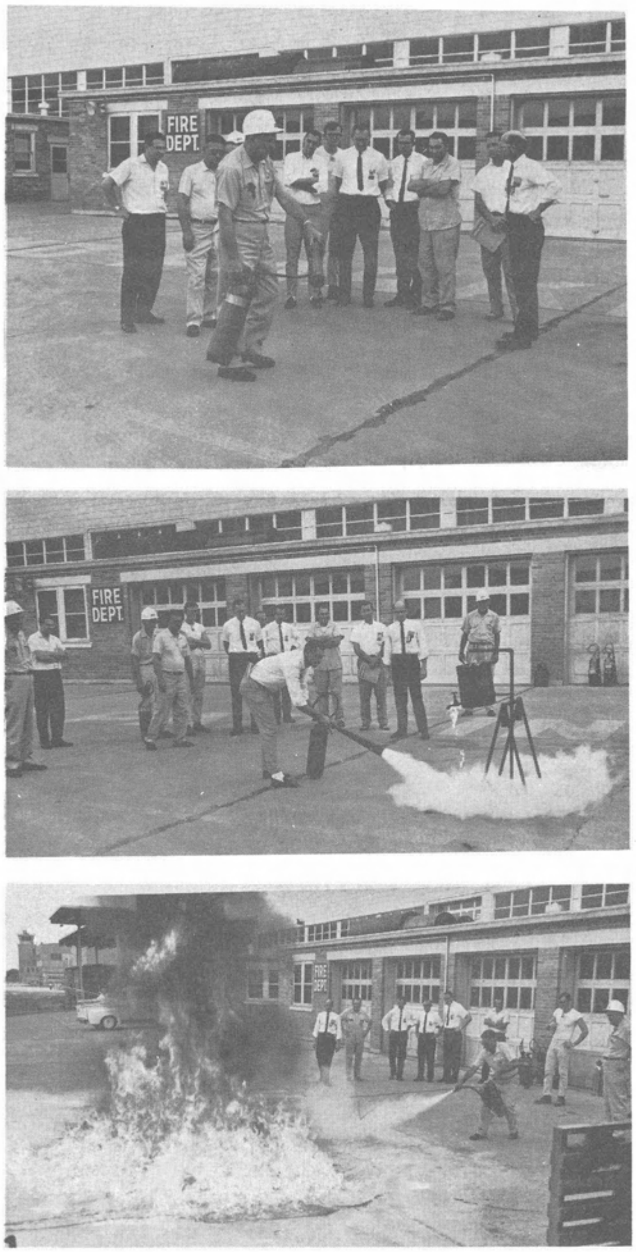


Figure X-9 - Company Personnel Receive Instruction in the Use of Fire Fighting Equipment Under Varying Conditions

HEALTH AND SAFETY

To ensure an organized approach to all problems involving health and safety on the S-IC program, the Launch Systems Branch Vice President-General Manager directed the establishment of a safety program. This was designated as the Branch Line-Control Safety Program.

EXECUTIVE SAFETY COUNCIL

Administering the Line-Control Safety Program is the Executive Safety Council. This Council, formed in May 1963, is chaired by the Assistant Branch Manager, or his representative, and is composed of key supervisors from the Boeing functional organizations.

During the fiscal year, the Council established authority, responsibility, and general policy for safety and accident prevention programs at Michoud and Huntsville, and directed that safety councils be established at all Launch Systems Branch locations.

MICHOUD SAFETY COUNCIL

The Michoud Safety Council was formed in September 1963. This Council is chaired by the Launch Systems Branch Operations Manager, and includes safety directors from each of the functional areas of the Michoud S-IC Program. This council implements the effectiveness of the Branch safety program, and ensures that potential hazards are properly controlled (Figure X-10). The Council also resolves safety problems of mutual concern to the organizations represented. Increased emphasis by this Council on safety practices of Boeing subcontractors resulted in a marked decrease in frequency and severity of accidents during the fiscal year.

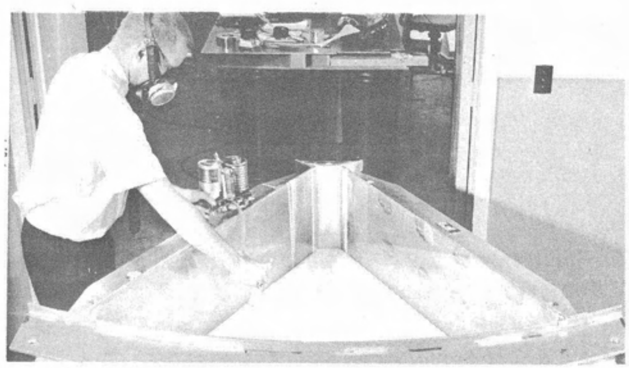


Figure X-10 - A Hygienist Takes a Sample of Toxic Polyurethane Resin Vapors to Determine Their Concentration

HUNTSVILLE SAFETY COUNCIL

The Huntsville Safety Council, chaired by the Boeing

Huntsville-Deputy Manager, was formed in January 1964, and operates on the same principal as the Michoud Safety Council. An MSFC/Boeing agreement has been reached on proper safety coordination where Boeing employees are working in NASA supervised shops.

VISITATIONS

On February 24, 1964, Dr. Wernher von Braun and members of his immediate staff toured the Boeing/Wichita facility (Figure X-11) where they were briefed on the scope of Wichita Saturn support effort, program status, and Boeing/Wichita resources.

Representative Olin Teague, Chairman of the House Subcommittee on Manned Space Flight, toured the Michoud Operations on January 24, 1964.

On March 27, 1964, Virgil I. "Gus" Grissom became the first United States Astronaut to visit the Michoud Operations. Major Grissom was briefed by the Saturn Manager of the Launch Systems Branch, and then toured the Boeing Michoud facilities (Figure X-12).

Figure X-11 - Dr. von Braun and Lt. Col. C. C. Bliss Talk With Boeing Airplane Division Vice-President/ General Manager, J. O. Yeasting, During a Visit to the Wichita Facility

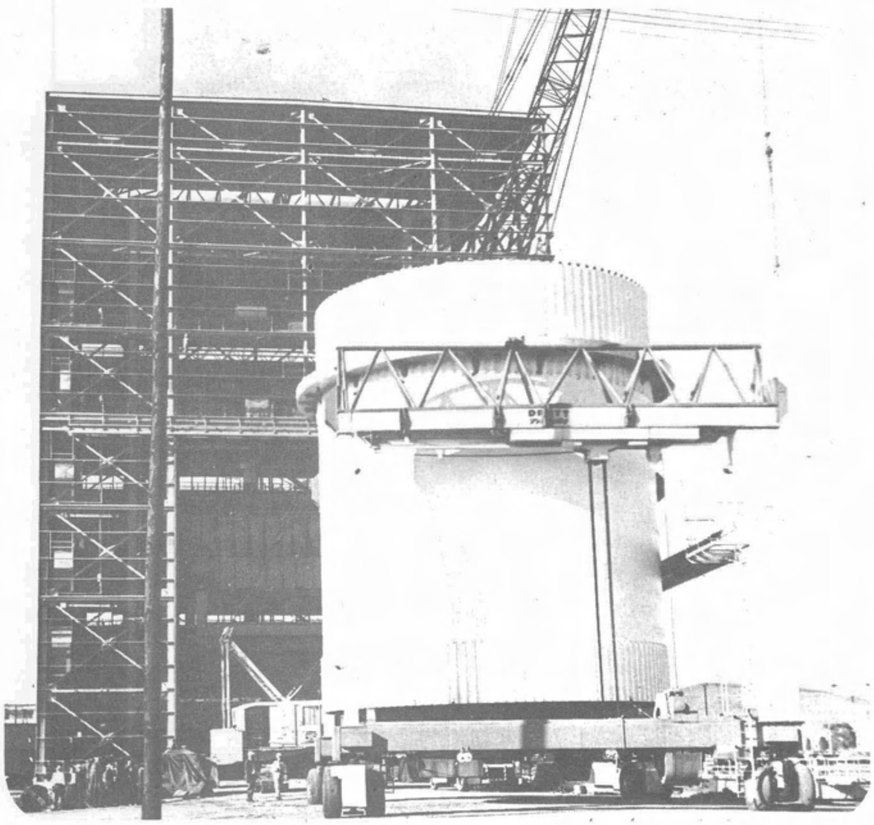
Figure X-12 - Astronaut V. I. "Gus" Grissom is Shown With NASA and Boeing Representatives at the Boeing Michoud Plant

EQUAL EMPLOYMENT OPPORTUNITY

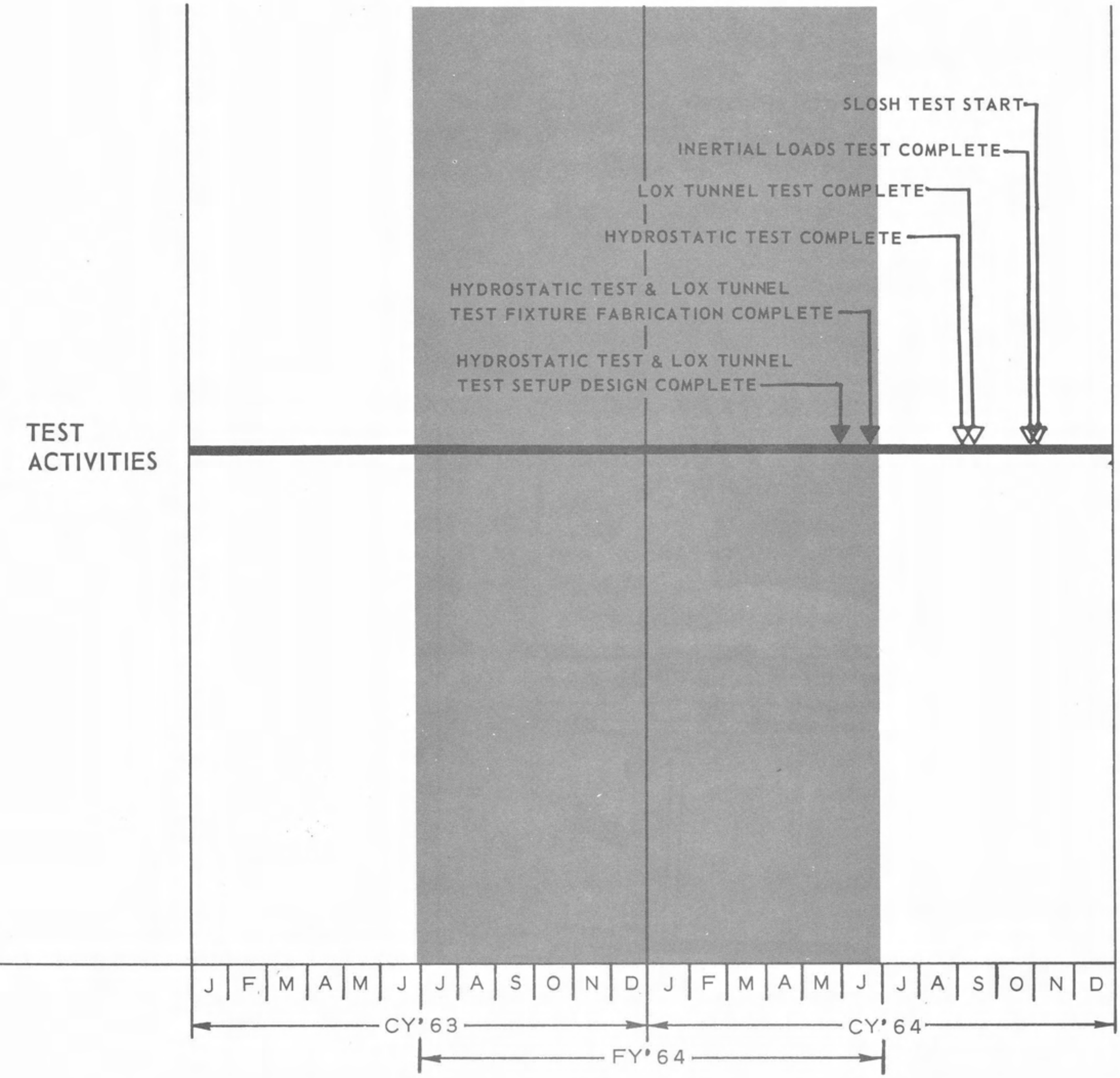
A Plan for Progress Committee, established in May 1963, held bi-monthly meetings to ensure implementation, within the Branch, of the Plan for Progress Agreement signed by Boeing with the President of the United States. A log of the significant activities was reviewed by a government compliance officer in March 1964. Typical activities include: contact with the Urban League on job requirements; presentations on job opportunities at city-wide workshops, senior highschools, and special meetings; review of job classifications to ensure proper placement; and publicizing minority achievement on television and national periodicals.

GOOD NEIGHBOR FUND

A Boeing Good Neighbor Association was established within the Branch. It has pledged funds to the United Givers of New Orleans and the Huntsville United Fund, and has made numerous contributions to charities that do not participate in the United Fund.



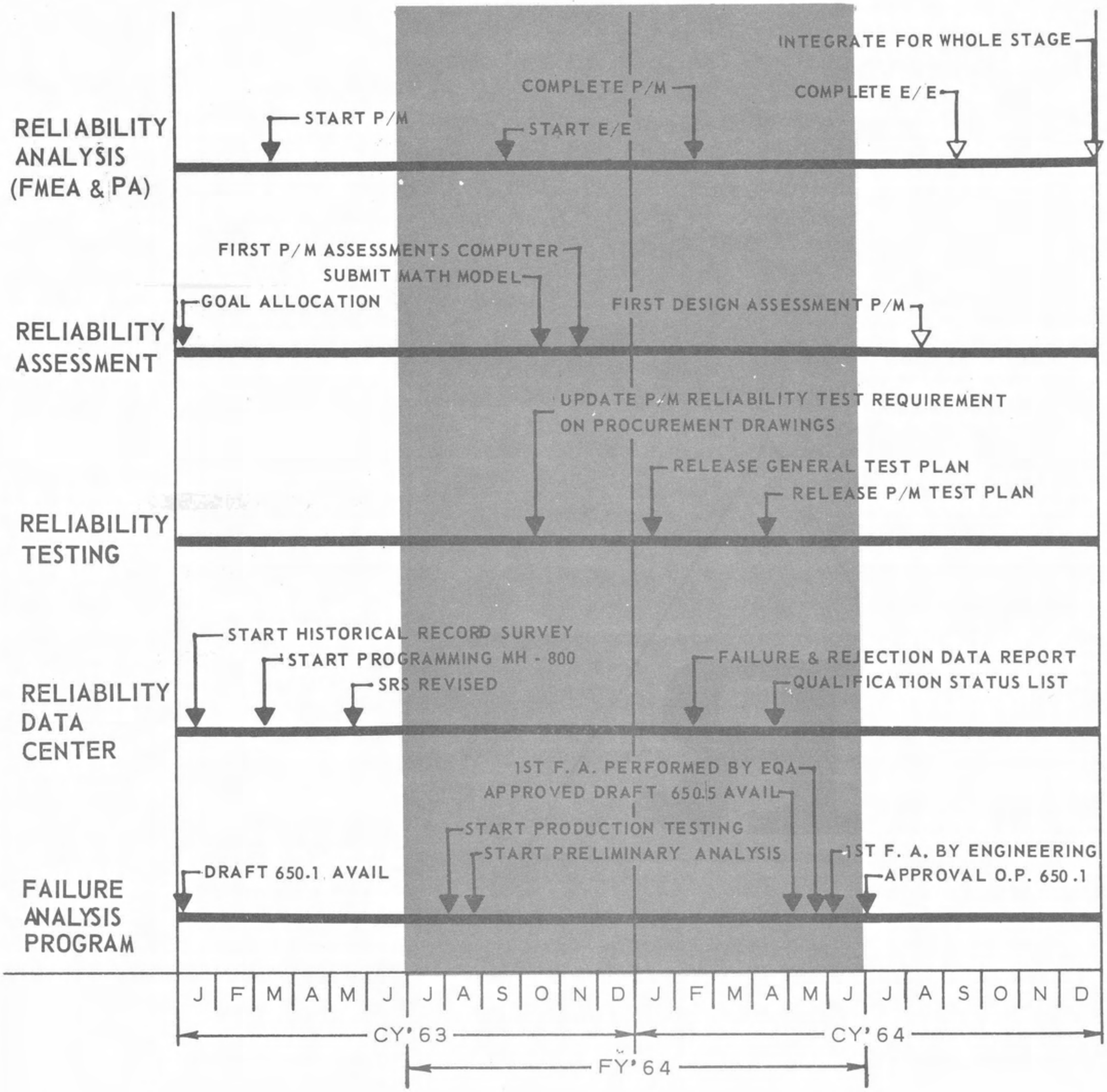
S-IC MISSION SYSTEMS SUPPORT


SLOSH TEST START
INERTIAL LOADS TEST COMPLETE
LOX TUNNEL TEST COMPLETE
HYDROSTATIC TEST COMPLETE
HYDROSTATIC TEST & LOX TUNNEL
TEST FIXTURE FABRICATION COMPLETE
HYDROSTATIC TEST & LOX TUNNEL
TEST SETUP DESIGN COMPLETE
TEST
ACTIVITIES
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

MAJOR COMPONENT STRUCTURAL TEST PROGRAM

Contract Modification No. 64, received January 17, 1964, authorized Boeing to perform the testing of the S-IC-C test fuel tank at MSFC. The tank was fabricated by NASA/MSFC and installed on the test fixture early in March. Preparation for testing was begun. Minor delays, primarily due to delayed receipt of instrumentation towers and to strain-gage bonding problems caused by the severe environmental conditions on the outdoor stand, have been encountered. However, hydrostatic testing will start in July, and the series of structural tests (excluding the burst test) are expected to be completed as scheduled during February 1965. The tank is to be held as a backup for the S-IC-S; therefore, the burst test is not scheduled until September 1965.

RELIABILITY


RELIABILITY ANALYSIS (FMEA & PA)
START P/M
START E/E
COMPLETE P/M
COMPLETE E/E
INTEGRATE FOR WHOLE STAGE
RELIABILITY ASSESSMENT
GOAL ALLOCATION
FIRST P/M ASSESSMENTS COMPUTER
SUBMIT MATH MODEL
FIRST DESIGN ASSESSMENT P/M
RELIABILITY TESTING
UPDATE P/M RELIABILITY TEST REQUIREMENT ON PROCUREMENT DRAWINGS
RELEASE GENERAL TEST PLAN
RELEASE P/M TEST PLAN
RELIABILITY DATA CENTER
START HISTORICAL RECORD SURVEY
START PROGRAMMING MH - 800
SRS REVISED
FAILURE & REJECTION DATA REPORT
QUALIFICATION STATUS LIST
FAILURE ANALYSIS PROGRAM
DRAFT 650.1 AVAIL
START PRODUCTION TESTING
START PRELIMINARY ANALYSIS
1ST F. A. PERFORMED BY EQA
APPROVED DRAFT 650.5 AVAIL
1ST F. A. BY ENGINEERING
APPROVAL O.P. 650.1
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

INTRODUCTION

With the signing of Contract NAS8-5608, The Saturn S-IC Reliability Program was activated in January 1963. This program, based on Document D5-11013, "The Reliability Program Plan," has been revised twice consonant with program changes. Official comments on this plan were received from NASA/Michoud on July 2, 1964. A revised plan will be documented and issued in August 1964.

The stage design reliability analysis which includes failure mode and effect analysis (FMEA) and probability analysis (PA), was started in March of 1963 on the propulsion/mechanical system; this work was completed in February 1964. The electrical/electronic FMEAs and PAs were begun in September 1964, thereby affording the first integrated "single thread" analysis for the whole stage in December 1964.

The design review program, which started in February 1963, has progressed well during the year.

The reliability assessment of the S-IC stage began with goal allocation in early 1963. The math model was submitted for approval to NASA/Michoud and NASA/MSFC in October 1963. The model was programmed into the computer and successful computer runs were made in November 1963, on several propulsion/mechanical systems. Work is continuing on the math model as reliability analyses are completed, and the first complete design assessment for the stage is scheduled for July 1965.

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion Mechanical and Thrust Vector Control Systems," accepted by NASA/Michoud, was released in April 1964.

The Data Center initiated historical record surveys early in 1963 to provide reliability data to designers for part selection. To date, surveys have been made on over 500 components. In addition to inspection reports, unsatisfactory condition reports, and inter-service data exchange program reports, over 700 documents and reports are available concerning the performance of some of these components in past programs.

In March 1963, NASA/MSFC made the decision that their MH800 computer would be used for data recording and analysis rather than the IBM7090, and the Data Center proceeded with the necessary reprogramming. This programming is now about 70-percent complete and all basic programs are scheduled for completion in the first quarter of 1965. Difficulties have been encountered in acquiring computer time to check out and test required computer programs. If sufficient time is not provided, the Data Center programs may be delayed still further. Action has been taken to bring this problem to the attention of NASA/MSFC and Boeing management.

Production testing began during the third quarter of 1963. Reliability approval of all Unplanned Event Records (UER) is now required to ensure that complete and accurate reliability data is provided on discrepancies or failures.

The equipment quality analysis (EQA) laboratory which assesses the quality of purchased components was activated in the first quarter of 1964. The first three EQAs have been conducted and reports were issued.

Reliability auditing of all organizations for compliance with Document D5-11013, "The Reliability Program Plan," continued throughout the year on a quarterly basis.

Reliability oriented training courses were attended by 1077 personnel during the year.

ACTIVITIES

RELIABILITY PLANNING

Document D5-11013, "The Reliability Program Plan." was updated in October 1963 and February 1964, to keep it in line with overall S-IC program changes. Preliminary NASA/Michoud comments on the plan were discussed with NASA/MSFC Reliability personnel in May 1964, and formal NASA/MSFC comments were received by Boeing July 2, 1964. A revised plan will be issued in August 1964.

RELIABILITY ANALYSIS

Considerable progress was made with the S-IC reliability analysis in the following areas.

PROPULSION/MECHANICAL

First reliability analyses of the propulsion/mechanical systems were completed. The analyses were included in Document D5-12572-1, "Saturn S-IC Emergency Detection Parameter Selection Analysis," and submitted to NASA/MSFC in March 1964. Updating of the analyses to include design changes and NASA/Michoud refinements is in progress to meet the quarterly revision date of September 1964.

A preliminary propulsion/mechanical qualitative "single thread" analysis was completed and sent to NASA/Michoud for comment in June 1964. Based on this analsis, development of preliminary emergency detection and malfunction detection systems (EDS/MDS) parameter recommendations was started.

OPERATIONAL ELECTRICAL SYSTEM

Work on the reliability analysis of the operational electrical system was temporarily suspended during March and April 1964. This was to enable the design changes indicated as necessary by the partially completed FMEA to be incorporated in the drawings for the first flight stage. The FMEAs were completed in June 1964. The probability analyses are half completed.

INSTRUMENTATION/RF/TELEMETRY SYSTEM

An analysis was performed on the instrumentation/RF/telemetry system to assess the probability of successful data transmission from the S-IC stage. This was submitted to NASA/Michoud in June 1964, for decision on whether further reliability disciplines should be applied to this system.

RELIABILITY ASSESSMENT

The S-IC reliability assessment math model was programmed in the computer and proven by conducting the first design assessment runs against selected propulsion/mechanical systems. The planned assessment program was presented to NASA/MSFC in January 1964, and it is described in Document D5-11954, "Saturn S-IC Stage Reliability Assessment and Reliability Program," released in July 1964.

RELIABILITY DOCUMENTATION

Document D5-11910, "The Reliability Status Report," was issued in August 1963, and was revised June 1964. This document contains the planning detail for the performance of reliability disciplines at subsystem and component level. It provides for sign-off by Boeing Stage Design Engineering and for the check signatures of either Boeing Reliability Engineering or Booster Technology.

The time/cycle recording requirements of the S-IC stage have been documented in Document D5-12713, "Time/Cycle Recording Requirements."

Current reliability documents, operating procedures, and instructions in use by the Launch Systems Branch are shown in Figure R-1.

RELIABILITY EDUCATION

During the year, 1077 people, representing all levels of Boeing technical manpower, attended reliability courses and training programs.

These training programs encompass the whole spectrum of reliability activity as follows:

1) A 4-hour course on the basic tenets of reliability;
2) Courses, varying in length and intensity, on the Saturn Records System which contain basic reliability discussions and detailed instruction on the completion of SRS forms;
3) An 8-hour reliability analysis course in sufficient detail to enable design and staff engineers to perform FMEA and PA and based on the methods described in Document D5-11944, "Design Reliability Methods."
4) A course on contractual reliability requirements considering each paragraph of the contract reliability work statement (Exhibit A, Part I, H. of Contract NAS8-5608) and relating these paragraphs to the reliability tasks defined in Paragraph IV of Document D5-11013, "Reliability Program Plan."

Recommendations have been made to Boeing Management defining requirements for courses to be initiated this year.

SUPPLIER CONTROL

All procurement specifications of critical propulsion/mechanical components have been revised to include reliability requirements and have been signed-off by Boeing Reliability Engineering.

During the year, more than 200 management review board meetings were held to consider supplier proposals and to select suppliers. All of these were attended by reliability representatives of the Manufacturing organization.

Quality and Reliability Assurance personnel are presently performing source surveys and monitoring at 98 vendors' plants.

PART SELECTION

Proposals were made to NASA/MSFC and NASA/Michoud in February 1964, on a part selection and control program. The presentation was favorably received and Boeing is preparing Document D5-11372, "Saturn S-IC Parts Selection and Control Program" for submittal to NASA in July 1964.

DESIGN REVIEWS

During the year, 35 critical design reviews of crucial components were held either at supplier plants or at Boeing. Critical design reviews at subsystem level were rescheduled so that they would agree with Schedule Plan VII. So far, 13 of these reviews have been conducted and the critical design review program is presently on schedule. The Boeing Manufacturing Reliability organization supported the design review program by attending or coordinating a total of 137 design reviews within the Boeing Operations organization.

RELIABILITY DATA CENTER

The Data Center has analyzed all Unplanned Event Records generated to date to detect existing or potential reliability problem areas. Weekly UER analyses have been issued since November 1963. During late 1963, and early 1964, review of the UERs being received by the Data Center showed that the reliability data contained therein was incomplete. Investigation showed that this was attributable to certain incompatibilities

which existed among various standard operating instructions within Boeing. These differences have now been resolved and compatible instructions will be issued by July 1964. Document D5-11593, "The Saturn Records System," is being revised accordingly.

The Data Center has received only about 10 percent of the computer time required to check out its programs under Schedule Plan VII. All major programs were scheduled to be completed in July 1964, but it has been necessary to slide this to March 1965.

The following contractually required programs are among those which will be delayed; the qualification status list; time and cycle recording; revised UER program to enable NASA/MSFC to retrieve reliability data from the Boeing program; the configuration control program and the reliability mathematical model. This problem has been presented to Boeing and NASA/MSFC management for solution.

EQUIPMENT QUALITY ANALYSIS (EQA)

The first EQA was performed on April 14, 1964, and the first report was published on May 12, 1964. The Boeing EQA Procedure 680.2 has been published, and meetings of an EQA Committee have been held to approve the selection and scheduling of components for EQA during 1964.

TESTING

RELIABILITY TEST PROGRAM

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion/Mechanical and Thrust Vector Control Systems," was completed and released in April 1964. The released document incorporated changes recommended by the NASA/Michoud Reliability Office during a review in February 1964. The documentation was again reviewed with the NASA/Michoud Reliability Office in June. The proposed testing concept was acceptable to NASA/Michoud reliability personnel who are now reviewing test requirements contained in the document preparatory to approving the conduct of the testing.

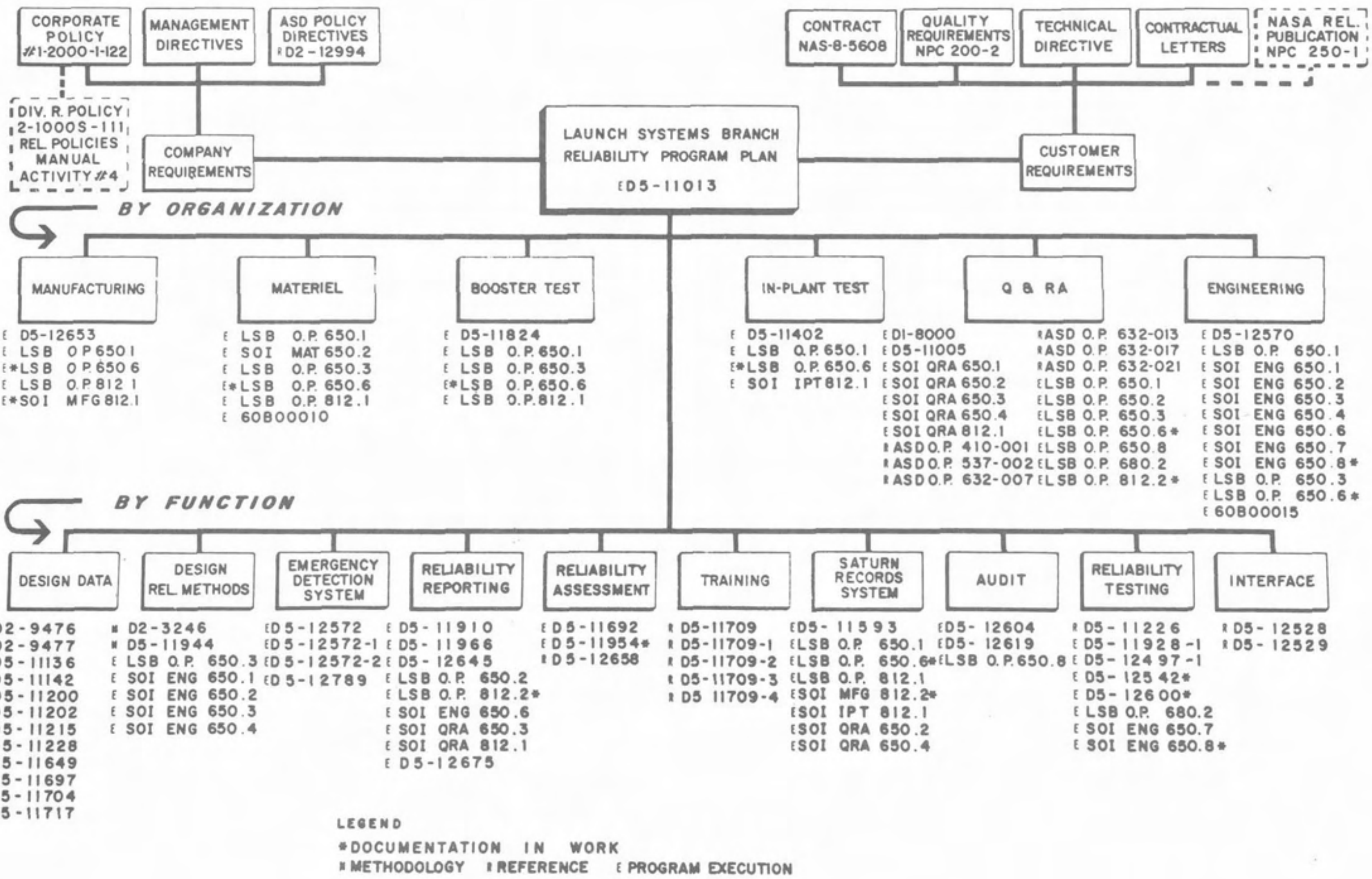


Figure R-1 Reliability Documentation and Procedures

SAFETY CRITICAL ITEMS

The hardware in the S-IC-T critical items list is under study by the Boeing Booster Test organization to determine test requirements and sequences, periodic inspections, and maintenance operations needed to assure safe operation of safety critical items.

MISSISSIPPI TEST OPERATIONS

Saturn Record System Procedures for Mississippi Test Operations have been written, and will be released by Mid-July 1964.

PRODUCTION

Production testing began during the third quarter of 1963. Reliability monitoring of the testing and the resultant handling of Saturn Record System paper work was begun accordingly. These efforts have now progressed to require reliability approval of all initiated UER paper work. This approval is designed to ensure that complete and accurate reliability data is provided on discrepancies or failures.

FAILURE ANALYSIS

The failure analysis program was implemented during the last quarter of the period. Analyses have been conducted both in the Boeing EQA and the Engineering laboratories. The Failure Analysis Operating Procedure, 650.1 was published June 24, 1964.

RELIABILITY AUDITING

The Reliability Audits Operating Procedure, 650.8 was published in June 1964. It establishes that direct audits shall be conducted on a quarterly basis. Since December 1962, audit presentations showing program progress and problems have been made to Boeing management and to NASA/Michoud and NASA/MSFC.

RELIABILITY CHART ROOM

The reliability chart room now has 28 program monitoring charts on display. The charts are frequently used during formal review meetings to show reliability program progress to Boeing and NASA management.

PREDICTION

During the first 6 months of FY 1965, the following significant reliability milestones will be complete:

1) The electrical/electronic reliability analysis will be completed in September 1964.
2) The first integrated "single thread" analysis for the whole stage will be completed in December 1964.
3) The first complete propulsion/mechanical systems design assessment using the computerized reliability mathematical model is scheduled for August 1964.
4) NASA/Michoud comments on Document D5-11013, "The Reliability Program Plan," will be included in the next revision to the plan scheduled for release in August 1964.
5) The Boeing Manufacturing Reliability organization will be fully manned by November 1964. This will enable them to undertake the certification of completed Saturn Record System forms for data validity.
6) The Data Center will complete the following programs: the UER program will be revised by October to enable preliminary UERs to be recorded; the time and cycle recording program will be completed in August 1964; the qualification status listing will be in the computer by September 1964.

GOVERNMENT FIELD PRINTING PLANT
(Under Contract NAS 8-5618)
NASA – MICHOUD OPERATIONS – 1964
NEW ORLEANS 26, LOUISIANA

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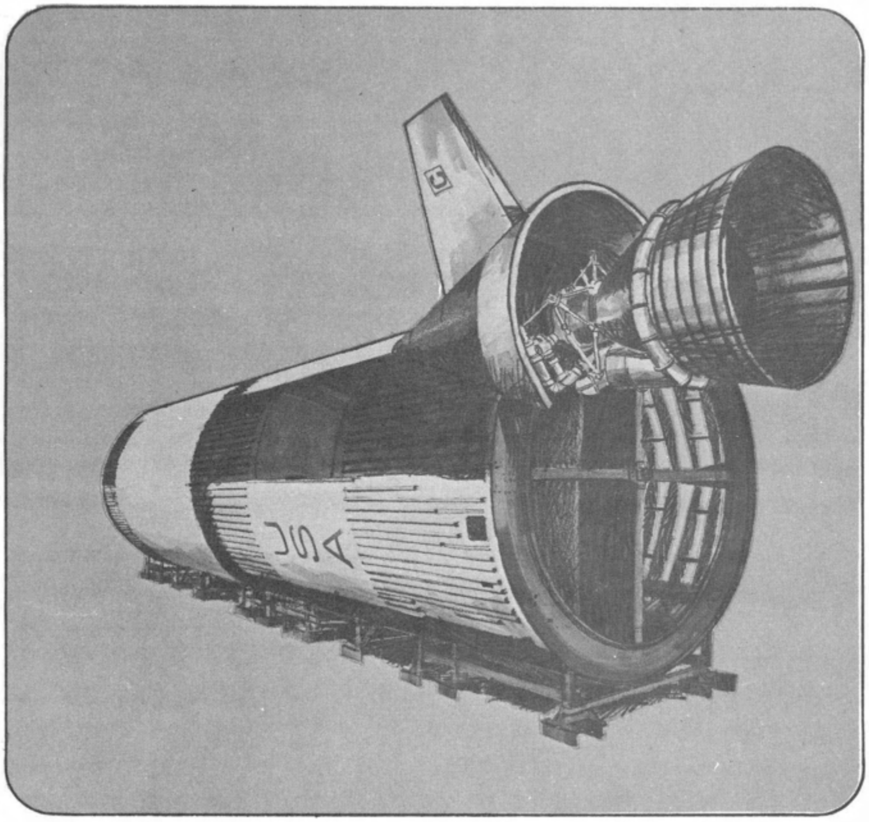

SATURN S-IC FISCAL YEAR 1964 ANNUAL PROGRESS REPORT

Aug 14, 1964

D5-12601-1 [redacted]

LAUNCH SYSTEMS BRANCH

AERO - SPACE DIVISION

THE BOEING COMPANY

THE BOEING COMPANY
LAUNCH SYSTEMS BRANCH, AERO-SPACE DIVISION P. O. BOX 26088, NEW ORLEANS, LA. 70126

July 2, 1964

National Aeronautics and Space Administration
George C. Marshall Space Flight Center

IN REPLY REFER TO

Fiscal year 1964 progress of the Saturn V/S-IC Stage Program has reflected a significant transition from primarily a conceptual to an implementation phase of program activity.

The developmental nature of the S-IC Stage Program has resulted in changes to the program requirements. The most significant change was the change to program schedule Plan VII. Numerous contract modifications have been received which have significantly expanded the scope of the work assigned to The Boeing Company. At the close of FY '64, The Boeing Company capabilities are focused on implementing these new program requirements.

The release of S-IC and GSE/MSE basic design was behind schedule at the beginning of this fiscal year period. Combined action by NASA/MSFC and Boeing in such areas as approval of GSE design criteria and establishment of a streamlined approval release system has significantly improved our schedule position relative to release of design documentation.

Throughout the reporting period, the assembly and manufacturing effort was greatly affected by program changes. At the outset of the fiscal year, the assembly and manufacturing activity was primarily involved with structural component activity per Plan V requirements. Program changes such as the NASA/MSFC redirection from schedule Plan V to Plan VII, the impact of Boeing intertank redesign and the transfer of thrust structure tooling and assembly from NASA/MSFC to Boeing at Michoud has required changes in planning and program phasing. It was a period which saw many adjustments to tool loading schedules and procurement activities. As of the end of June 1964, the Launch Systems Branch had realigned its stage assembly effort in support of the new customer schedule requirements. Launch Systems Branch Michoud-assembled S-IC stages and GSE/MSE for all locations are currently predicted to be delivered per the NASA/MSFC Plan VII schedule requirements. At the same time, an all-out effort is in progress by NASA/MSFC and the Launch Systems Branch to ensure that critical problems affecting the completion of the S-IC-T stage were being properly dealt with.

Behind-schedule activation of various facilities in the Michoud complex created problems during the past year. The use of partial and interim facilities in addition to other work-around techniques has allowed Launch Systems Branch to minimize schedule impact. Permanent facility activations commenced during the fourth quarter of calendar year 1963 and continued through the end of June 1964. The remaining facilities are predicted to be completed during fiscal year 1965.

Many new and varied developmental problems will undoubtedly arise during the next fiscal year. I am confident that Boeing and NASA/MSFC management will overcome these challenges with the same team spirit demonstrated in the past.

THE BOEING COMPANY
Aero-Space Division

R. C. Dunigan

R. C. Dunigan
S-IC Program Executive
Launch Systems Branch

SATURN

S-IC

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ANNUAL PROGRESS REPORT

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LAUNCH SYSTEMS BRANCH
AERO - SPACE DIVISION
THE BOEING COMPANY

FOREWORD

This Annual Progress Report has been prepared by The Boeing Company to fill the requirement under Article XXXI, Paragraph C, of Contract NAS8-5608 as modified by Modification 100. It encompasses the progress made by The Boeing Company on the Saturn S-IC Program for the fiscal year 1964 (from July 1, 1963 through July 2, 1964). The main objective of this report is to serve as an historical presentation stressing Boeing accomplishments and present capabilities under Contract NAS8-5608.

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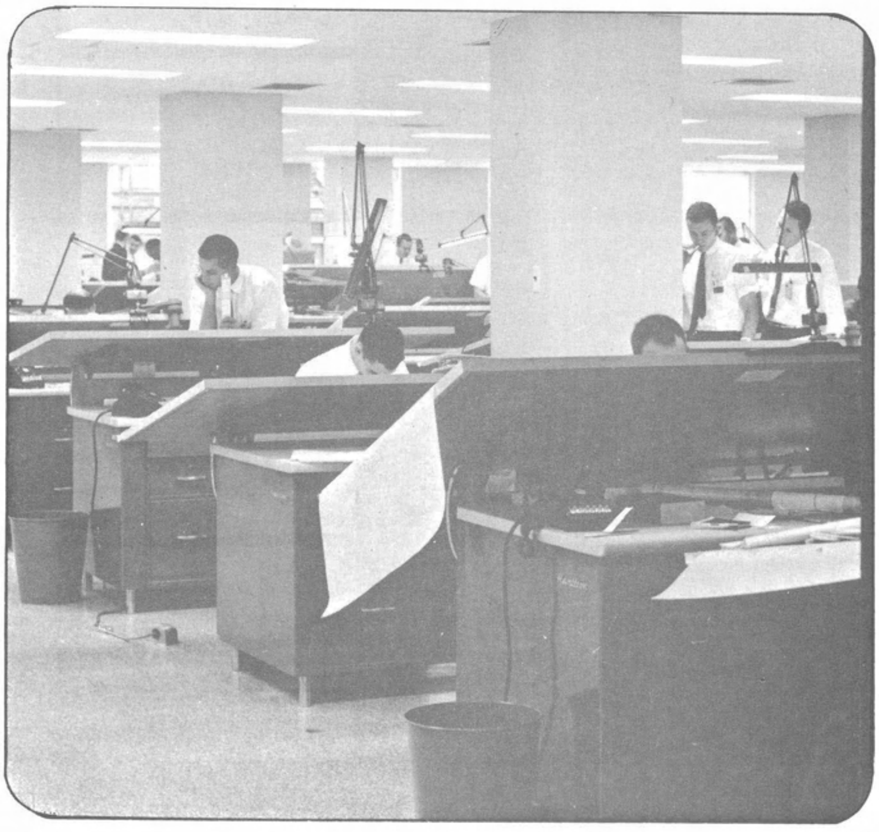
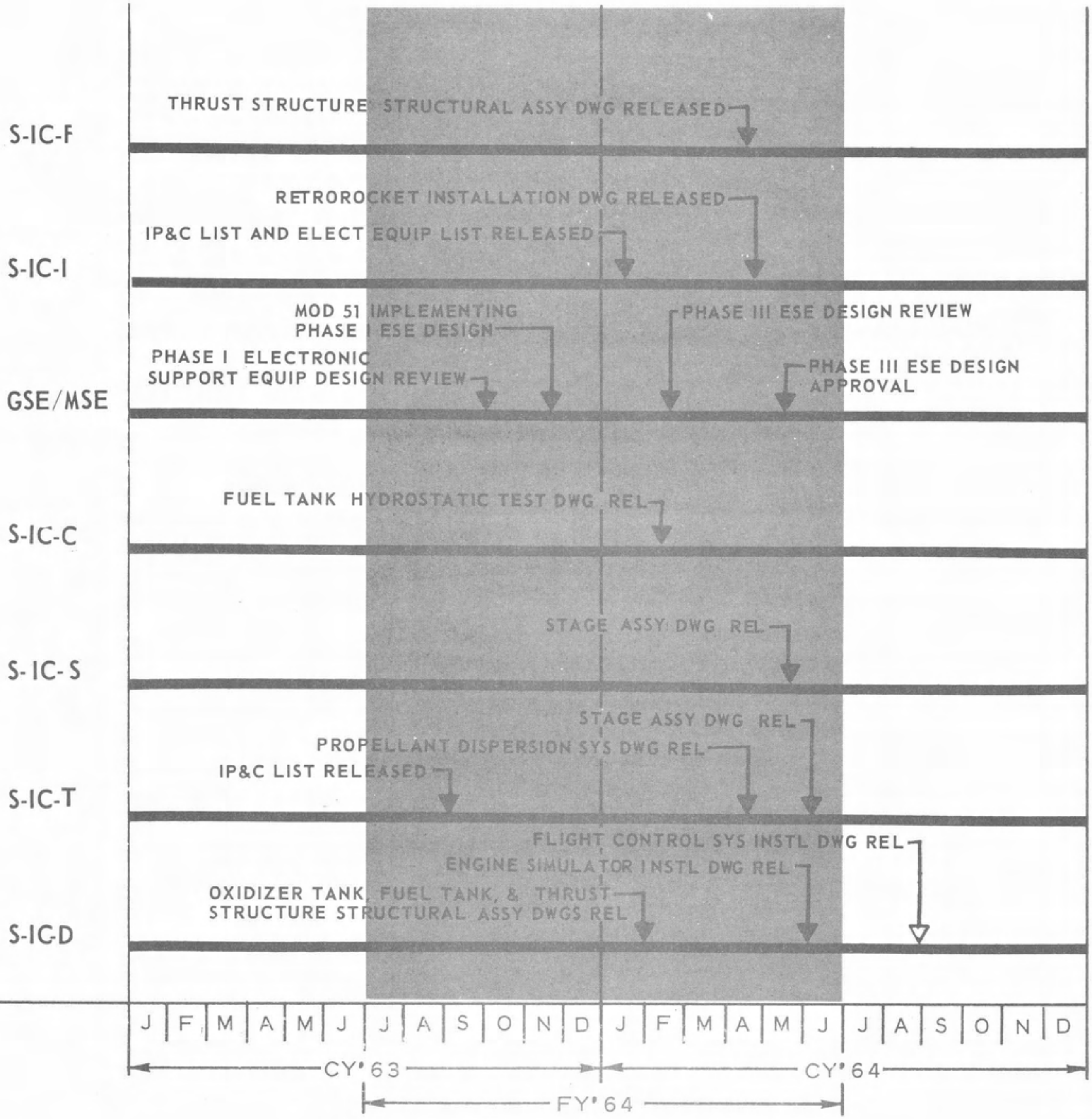


DESIGN AND ENGINEERING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During Fiscal Year (FY) 1964, two major program redirections (NASA/MSFC Plan V and VII) from NASA/MSFC resulted in S-IC stage program schedule changes. This rescheduling reflected changes in phasing as well as an interchange of certain task assignments. Little relief was afforded to the Engineering documentation release schedule, since the S-IC-T release requirements remained unchanged in order to provide early capability for test firings.

The S-IC stage basic design documentation, lagging at the beginning of FY '64, is currently on schedule. The recovery, which was accomplished during the last quarter of the fiscal year, is the result of concentrated effort on the factors that delayed design activity and the streamlining of the design approval process.

On June 4, 1964, the release of the S-IC-T stage assembly drawing completed the basic releases for that test stage. The basic design releases of all major structural elements for subsequent vehicles were also completed during the year.

Change action against released basic design became a substantial design effort during the year. During the last quarter of the reporting period, there was also increased emphasis in technical assistance rendered in solving fabrication problems encountered by NASA/MSFC, Boeing, and the various vendors.

Early in FY '64, release of GSE/MSE drawings was slow because of delays in design criteria approvals. These delays were offset in part by a more detailed design review during the Pre-Phase I and Phase I reviews, making it possible to proceed more accurately and quickly to Phase III or production design releases. This has enabled Boeing to maintain on-schedule status at FY '64 year end.

S-IC STAGE DESIGN

Several variations of the S-IC are being designed by Boeing under specifications and technical direction provided by NASA/MSFC. The configurations being designed and their primary purposes are listed below:

Model	Purpose
S-IC-T	Static test of F-1 engines and engine systems.
S-IC-C	Fuel Tank only—for structural testing.
S-IC-S	All major structural components—for use in structural testing of assembled stage.
S-IC-D	For use in dynamic testing of the assembled Saturn V vehicle. This configuration is further defined under Electrical and Instrumentation Section.
S-IC-F	Facilities checkout at MILA.
S-IC-1 through S-IC-10	Flight vehicles

The progress made on S-IC design and development throughout FY '64 is discussed in the following sections.

DOCUMENTATION

Release of basic design documentation, at the start of the fiscal year, was substantially behind the schedule required to meet hardware program schedules. This documentation was returned to schedule during the second half of the year (Figure I-1). Schedule position was regained by (1) recovery on the design schedule, and (2) reduction of release processing flow time. The design schedule was recovered by concentrated effort in areas where design criteria had caused delayed effort. Release processing time was shortened in March 1964, by reducing flow-time for the approval process, as authorized by Contract Modification 76. Although there were S-IC program schedule changes during the year, there was little effect on documentation release schedules as the S-IC-T schedule was not altered.

Change action against released basic design became a substantial design effort during the year. At the close of FY '64, change documentation release, with only minor exception, was being made in accordance with change commitments established by the joint NASA/MSFC-Boeing Change Board. Documentation has been completed for approximately 200 changes since inception of change action against the S-IC stages. Changes have resulted from design criteria revision, adverse structural test results (intertank), instrumentation requirement additions, and weight saving.

WEIGHT STATUS

There was increasing emphasis during the year on S-IC vehicle weight control and reduction. The first major weight reduction — approximately 4500 pounds — was accomplished during the first quarter through use of a computerized analytical model study of the S-IC thrust structure. The resulting design documentation was issued under Change Action Memo (CAM) 72. Deletion of the requirement for the in-flight LOX dome purge system (CAM 112) shortly thereafter, eliminated 1200 pounds of system weight.

A joint NASA/MSFC-Boeing weight reduction team was established in September 1963, to review and implement weight saving ideas. Under this weight reduction program, eight weight saving changes have been approved by NASA/MSFC to effect an additional total weight reduction of approximately 7000 pounds. The effects of these weight changes are detailed in Figure I-2. Program schedule impact has been minimized by committing the changes to later flight vehicles; however, all presently committed weight reduction changes will be incorporated on vehicles on which payload weight capability will become critical.

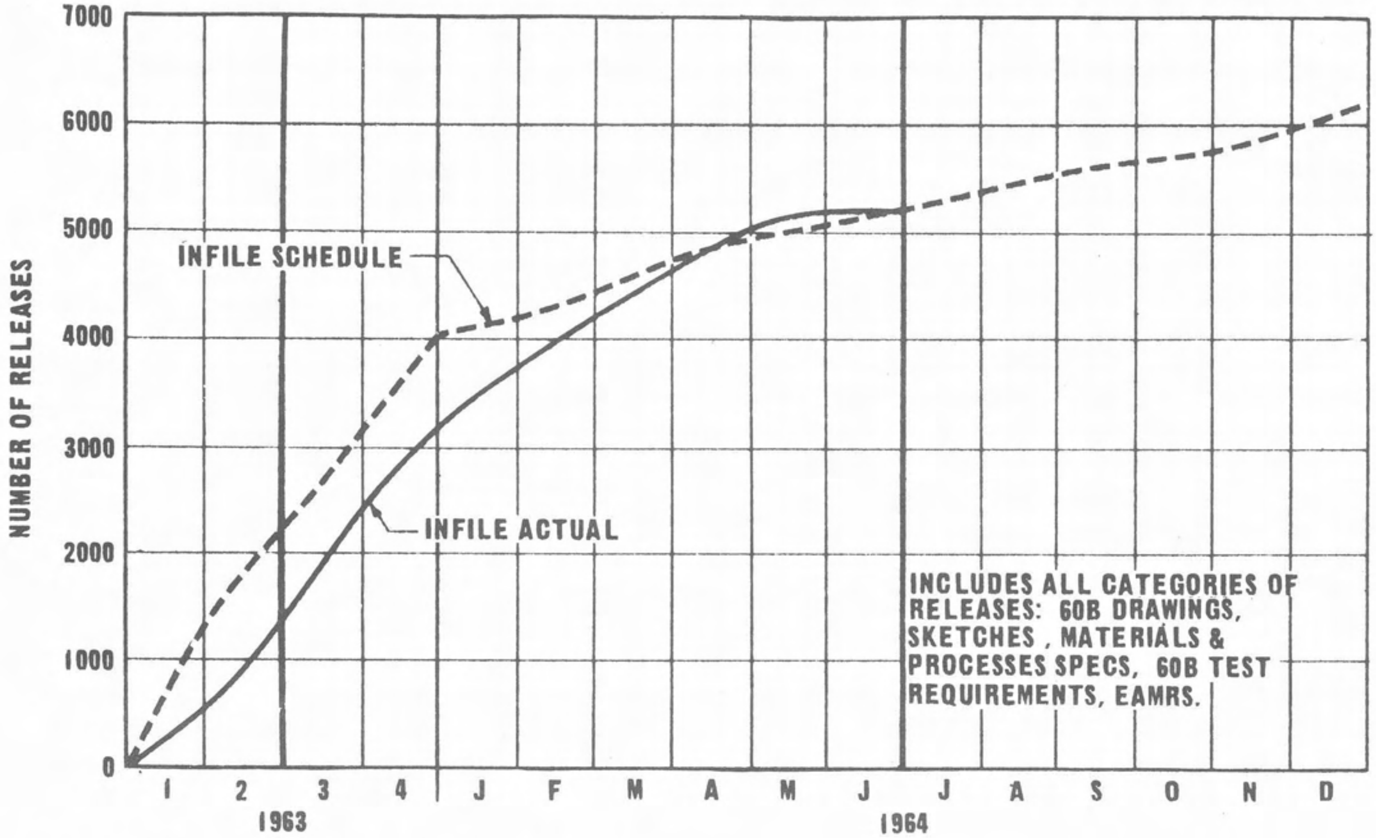
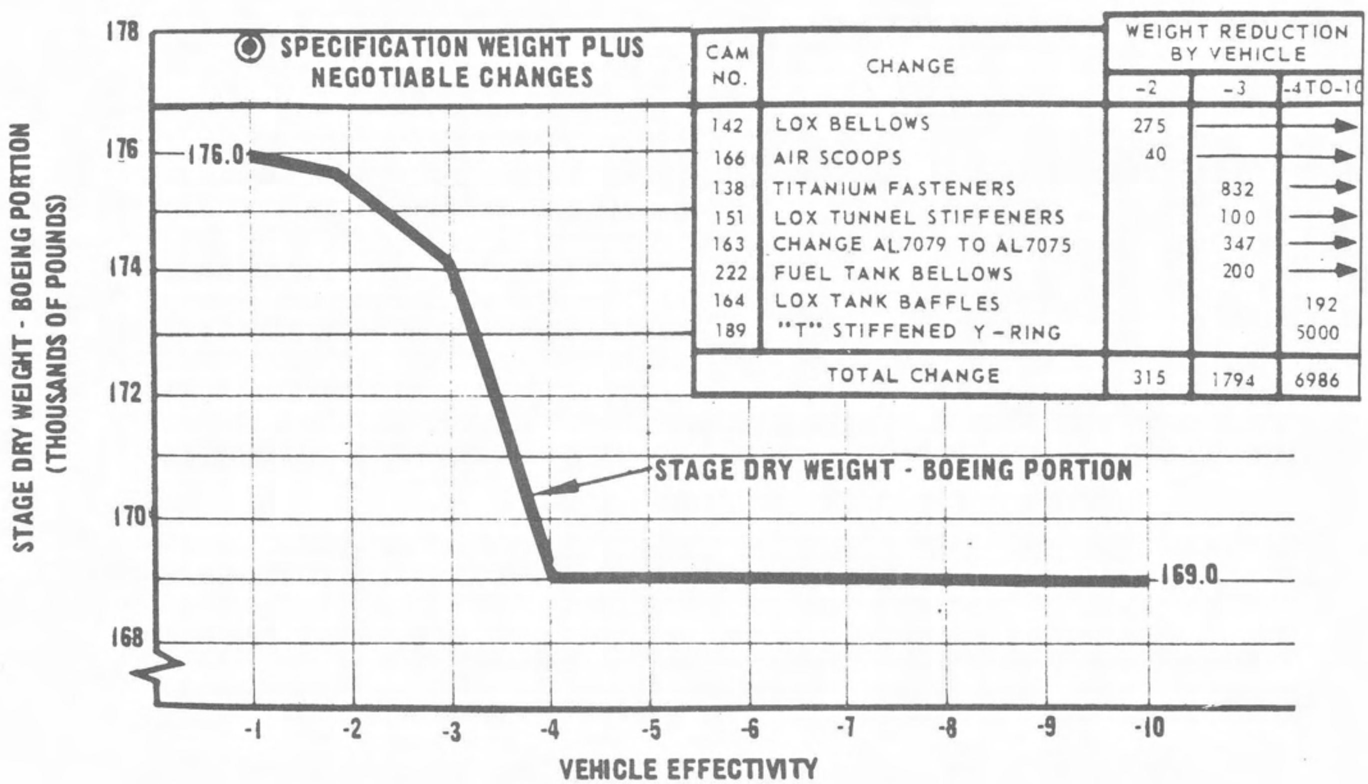


Figure 1-1 - S-IC Stage Basic Release Schedule -- Plan VII



CAM NO.	CHANGE	WEIGHT REDUCTION BY VEHICLE		
		-2	-3	-4 TO -10
142	LOX BELLOWS	275	→	→
166	AIR SCOOPS	40	→	→
138	TITANIUM FASTENERS		832	→
151	LOX TUNNEL STIFFENERS		100	→
163	CHANGE AL7079 TO AL7075		347	→
222	FUEL TANK BELLOWS		200	→
164	LOX TANK BAFFLES			192
189	"T" STIFFENED Y-RING			5000
	TOTAL CHANGE	315	1794	6986

Figure 1-2 - S-IC Weight Reduction Program

The only weight originally specified in Contract NAS8-5608 was the total stage dry weight of 287,000 pounds. To provide a direct basis for evaluation of Boeing weight control performance, a specification allowance for the Boeing-controlled portion of the S-IC was established as 174,282 pounds at a NASA/MSFC-Boeing meeting in March 1964. The specification allowance and the general definition of Boeing responsibility were formalized by Contract Modification 109. The calculated weight for the Boeing-controlled portion of the S-IC at the time of establishment of specification allowance was 172,285 pounds. The weight history of the S-IC-1 is shown in Figure I-3. The effect on weight of changes considered to be negotiable is carried in the specification allowance line subsequent to formal definition of Boeing responsibility.

STRUCTURAL DESIGN

Basic release of documentation for the S-IC-T was completed in early June with the release of the stage assembly drawing. Basic release of all major structural elements for subsequent vehicles was also completed during the last quarter of the fiscal year. The heat shield installations remain to be released, and the stage assembly drawings for S-IC-D and subsequent vehicles will be released following completion of electrical and instrumentation design early in CY'65.

With the completion of most of the basic design activity, emphasis has shifted to change design and technical support of manufacturing, vendors, and the various test activities affecting S-IC structure.

Significant structural design problems were encountered and resolved during the year. The most important of these were a dynamic loading problem and an intertank structural problem.

Early in the fiscal year, analytical studies of stage dynamic loads indicated a possibility that a direct dynamic coupling of transient engine thrust buildup and vehicle release loads would substantially exceed specified load factors for stage structural design. After further study, it was recommended that the stage holddown release mechanism be changed from an instantaneous release device to a system in which holddown restraint is released gradually to avoid sudden application of release loads. This solution was agreed to, and subsequent study, including revised estimates of engine thrust buildup rates, indicated that the holddown mechanism change would eliminate the problem.

A second major problem was encountered during development testing of 1/8-scale models of the intertank structure. The intertank structure consists of a longitudinally corrugated skin with circumferential stiffener rings. Design of the intertank was based on the very

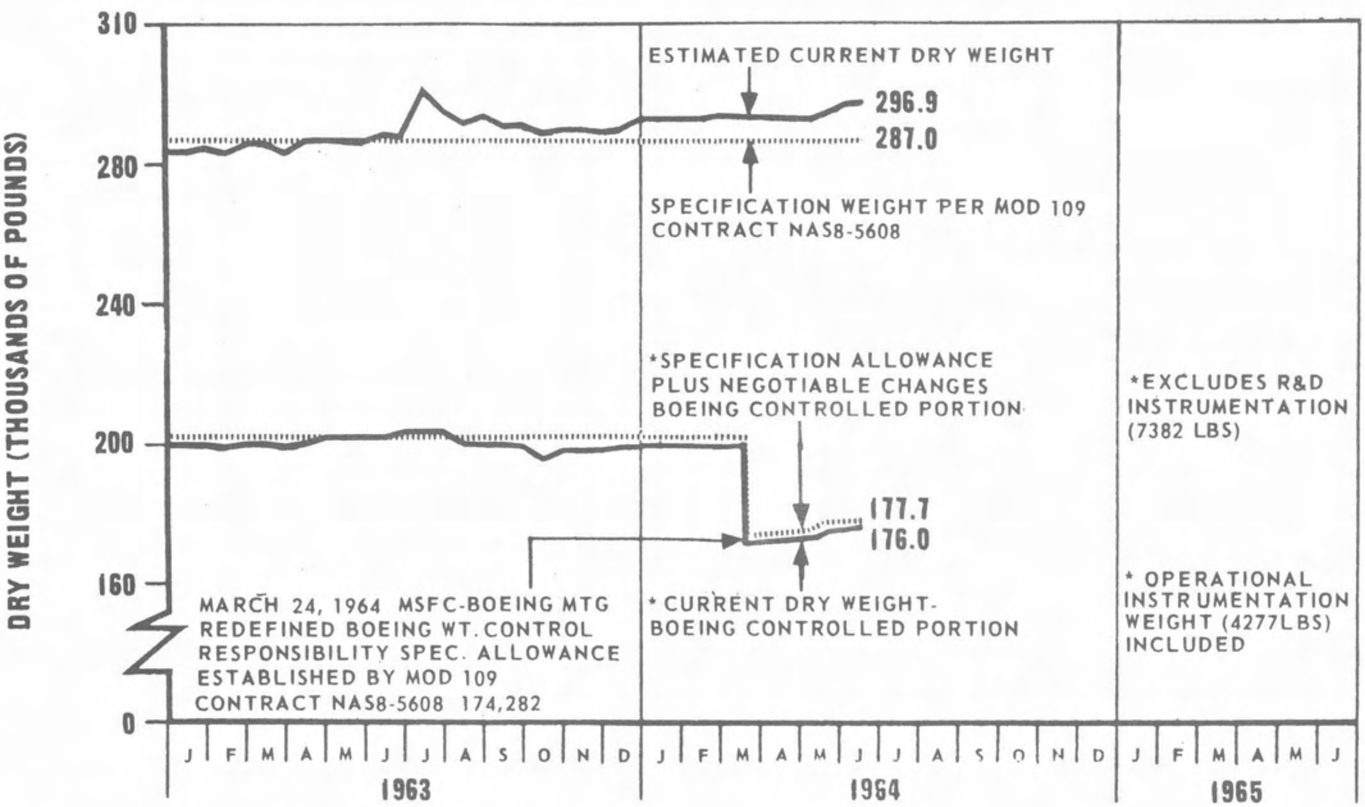


Figure I-3 - S-IC Dry Weight Status

limited experimental data available for this type of structure under compression loading; however, because of the limited data available and because of its questionable applicability to large structures, such as the S-IC intertank, scale-model development testing was essential.

Initial tests during the second quarter of the year resulted in failures at substantially less than the expected load (as applicable to the scale model). Subsequent testing confirmed the early test results.

A change (CAM 207) has been initiated to redesign the intertank in accordance with NASA/MSFC Technical Directives 180 and 211. The intertanks for the S-IC-T, -D, and -S will use the existing design, since these units will not be subjected to flight vehicle loads. The S-IC-1, -2, and -3 intertanks will be a heavier (approximately 2600 pounds) "minimum risk" unit with thicker skins and stronger ring frames. Such an approach is necessary to avoid program schedule delays, since substantial testing is required to establish a minimum weight design of adequate strength.

As presently planned, the S-IC-4 will incorporate a lighter weight design. One intertank of the present configuration and one intertank of the heavy S-IC-1 configuration will be loaded to destruction to provide data for correlation of full-scale and sub-scale tests, and additional sub-scale tests will be utilized to determine S-IC-4 design. An S-IC-4 configuration intertank will also be loaded to destruction to verify its design.

PROPULSION AND MECHANICAL EQUIPMENT DESIGN

Basic release of documentation for the S-IC-T was completed during the last quarter of the year, with the exception of the F-1 engine conversion drawings, which are scheduled for release early in calendar year 1965. Release of all basic drawings for the S-IC-D, -F, -S, and -1 has also been completed. All component, assembly, and subsystem qualification test requirements have also been released.

As with structural design, emphasis has shifted to change design and technical support of manufacturing, vendors, and the test activities affecting propulsion and mechanical equipment.

ELECTRICAL AND INSTRUMENTATION DESIGN

This S-IC-T basic design was completed during the last half of FY '64. Basic release of S-IC-D test instrumentation, cables, and equipment mass simulators was begun following definition of the S-IC-D configuration in February. Approximately 1100 electrical/instrumentation basic drawings remain to be released for the S-IC-D. The remaining release breakdown includes cable assemblies, equipment and cable installations, mass-simulated equipment, brackets, connectors, and other installation details. The general configuration definition to which S-IC-D basic release is being made is described below:

a) The electrical configuration will be the same as the S-IC-1, except that electrical/electronic equipment and transducers will be omitted. Dummy equipment simulating the mass of the actual equipment will be installed for all items weighing over 20 pounds, and for all shock-mounted equipment.
b) Installation provisions will be made for all instrumentation equipment.
c) All electrical cabling will be installed.
d) Except for the engine servo-actuators, propulsion components weighing over 20 pounds will be simulated by dummies. All flight hardware mounting provisions will be included.

During the latter half of the fiscal year the highest priority was assigned to release of documentation for CAM 177, which provides the Systems "A" Basic and the Research and Development Measurement systems for the S-IC-T vehicle. System "A" measurements are defined by NASA/MSFC Document SK10-1596 Revision A, "S-IC-T Static Firing Measurement Requirements." Measurement Systems "A" is a system of transducers which will be wired directly to recorders as the primary instrumentation for data gathering during ground test firings. Over 700 items of electrical and instrumentation documentation have been required by CAM 177. Design work was completed on all items by the first of June and all remaining documentation was completed and in release process at the end of the year.

Responsibility for releasing S-IC-1 through S-IC-10 measurement instrumentation program was transferred from NASA/MSFC to Boeing following NASA/MSFC approval of the S-IC-1 Instrumentation Program and Components (IP&C) list late in the second quarter of the fiscal year. Approval of the IP&C list permitted identification of the instrumentation and electrical configuration for the S-IC-1. Instrumentation program and electrical equipment lists will be released individually for S-IC-2 through S-IC-10, with the various releases scheduled through January 1966. Any change between the instrument list for S-IC-1 and subsequent lists will be implemented by change action to revise affected structures, propulsion, and electrical documentation.

Direction to proceed with design and development of a visual instrumentation installation was received late in the third quarter of the fiscal year by Modification 75 to the contract. The visual instrumentation consists of two television cameras viewing the engine turbo pumps and four ejectable and recoverable movie cameras, two to record liquid movement in the oxidizer tank and two to record stage separation (separation view cameras will be omitted from the S-IC-T). Development was well under way at the end of the fiscal year, with preliminary drafts of procurement drawings for the LOX tank optical system (fiber optics bundles, lenses, etc.) and the photo-optics timer specification distributed to potential suppliers. Preliminary drafts of procurement drawings for other components are nearing completion. The NASA/MSFC breadboard of the photo-optics strobe light has been received at Michoud and is under test.

Some difficulties and delays were encountered during the year in the development of the various propellant measuring systems for the S-IC. These systems consist of the fuel and LOX loading probes (for determination of loading completion), the LOX and fuel engine cutoff sensors, and the R&D instrumentation for liquid level and fuel slosh measurement. All of these systems are to be installed in the S-IC-T. Despite the delays encountered, all are expected to be delivered in time to be installed in the S-IC-T, and all parts are expected to be qualified before the S-IC-T is placed on the test stand.

GSE/MSE DESIGN

Simulated flight tests and static firing tests of the S-IC stage will be accomplished primarily through application of automatic digital programing and evaluation techniques. Ground support equipment (GSE) will evaluate the performance and integrity of a completely assembled stage at R-Qual and R-Test. Manufacturing support equipment (MSE) will accomplish the same goals at Michoud and the Mississippi Test Operations (MTO). Tests conducted on the S-IC stage will be fully automated except when automation is impractical for economic or technical reasons. Automated testing is the goal to which engineering design effort is being directed. Boeing design concepts developed early in the program were reviewed during the first half of the reporting period; subsequent redirection culminated in Modification 51 to Contract NAS8-5608 on November 21, 1963.

DOCUMENTATION RELEASE

Early in FY '64, release of drawings was slowed as a result of delay in the approval of the design criteria. These delays were offset, in part, by a more detailed design review. By achieving greater definition of detail during the Prephase I and Phase I (System Design Concept) reviews, it was possible to proceed more accurately and quickly to Phase III (Production Design) releases and maintain schedule (Figure I-4). Contract Modification 51 directed incorporation of the Phase I design changes. This was followed by the Phase III design submittal on February 25, 1964. NASA/MSFC gave approval on May 15, 1964 based on incorporation of comments resulting from the design review. The majority of comments fell within the contract scope and did not significantly affect overall design. Action has been initiated to incorporate all items which were within the scope of the contract. Change Action Memos have been initiated for nine recommended design improvement items which are beyond the scope of the contract.

On June 2, 1964, Boeing was given limited direction to resume work on the MTO design, temporarily suspended in December 1963. Interim funding was provided until Modification 102 officially became part of the

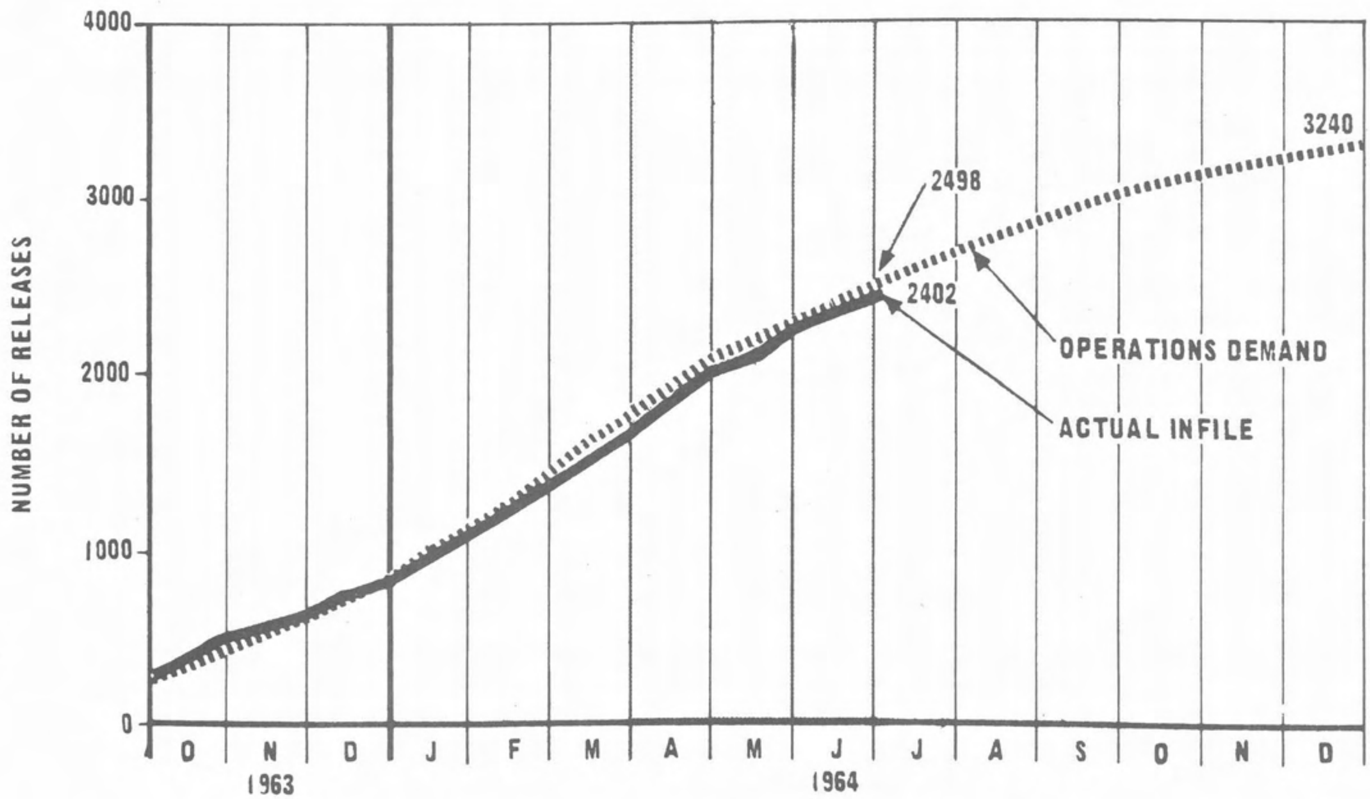


Figure I-4 - Engineering Basic Release Schedule-- GSE/MSE

contract. Work is now in progress detailing the design requirements for the MTO test and checkout complexes.

TEST AND CHECKOUT EQUIPMENT DESIGN

Substantial changes have been made to the original concept of the test and checkout complexes during the year. These changes resulted from the Prephase I and Phase I design reviews and had a major impact on the degree of automation and capability of the test and checkout complexes. Some of these changes are described briefly below.

The original test and checkout equipment concept called for centralized control of testing. This has been modified to add provision for switching test control to test operators at the individual test stations within the test and checkout complex.

Another expansion of capability has been incorporated in the area of data recording. Originally, records were to be stored within the computer for printout later. The new design retains computer storage and adds the ability to store data in direct writing recorders.

Capability of the mechanical test control equipment has also been increased. In the original concept, testing could be conducted on a limited one-at-a-time basis. The expansion of equipment adds flexibility and permits simultaneous testing of components.

Equipment sharing has been eliminated. At the Michoud complex, instead of using one computer plus a switching distributor to control testing on two vehicles, inidividual computers will be used in the testing of each vehicle. These are representative of the Prephase I and Phase I design changes. In general, test and checkout capabilities have increased with a necessary accompanying increase in equipment design effort.

The test and checkout complexes (Figure I-5) are composed of a control and monitor station, a computer station, a mechanical test station, a data systems test station, the related interconnection equipment, checkout calibration, and maintenance equipment. Test personnel direct and control the execution of tests performed by the digital computer. Computer codes allow full automatic and semi-automatic operations as well as local control from the test stations. Each test station contains the stimuli generators and control circuitry necessary to test the stage system with the computer. Error detection and fault isolation techniques are employed to make more effective usage of the test equipment and to reduce operating time on stage systems.

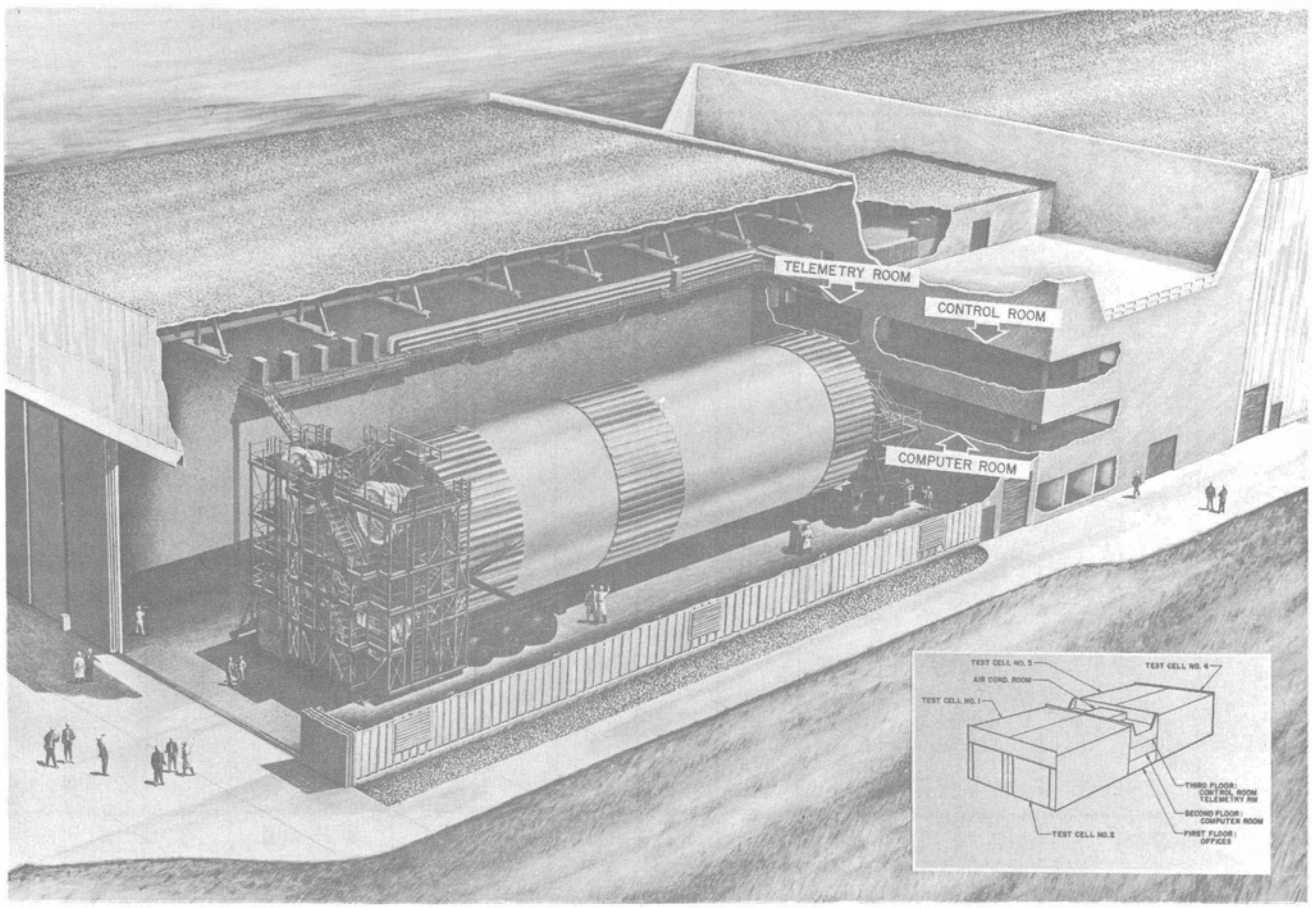


Figure I-5 - Test and Checkout Complex

Control and Monitor Station

The Control and Monitor Station (Figure I-6) includes the control and monitor console, the audio communication equipment, the closed-circuit TV equipment, and the cathode ray tube (CRT) interface and control logic equipment. The console provides control of the computer-directed test system and furnishes stage and test system status information. Design of all portions of the console has been completed, with assembly drawings and wiring schematics released for procurement of equipment.

The CRT display incorporated in the console, provides display capability for subsystem testing, troubleshooting, maintenance, and for presentation of supplementary information during normal testing (Figure I-7). Preliminary design of the CRT was completed during the first quarter of this reporting period along with construction of a feasibility model. Since then, checkout of the model has been completed and demonstrations of its capabilities have been made to NASA/MSFC personnel on several occasions. Late in April, authorization to proceed with the Boeing-Raytheon CRT display system was received for the NASA/MSFC Quality Division and Michoud Test and Checkout Complexes, and a contract was let to Raytheon on June 3, 1964, to proceed with production of five units.

The audio communications systems consist of the general area paging system, local area paging system, and the intercommunications system. Design of each of these systems has been completed, specification drawings have been released, and equipment is now beginning to arrive at Michoud from suppliers.

A closed-circuit TV system is provided for each test cell to enable the test engineers to monitor activity on and around the stage. Design in this area is 95 percent complete, with some equipment already receiveed, functionally tested, and prepared for storage until ready for assembly into the system.

Computer Station

The Computer Station (Figure I-8) utilizes the RCA-110A digital computer. Under control of its internal program and guided by the test conductor, the computer generates digital words, analogs, and discretes as required to program the individual test stations and stage under test.

Design of the Computer Station, including the equip-

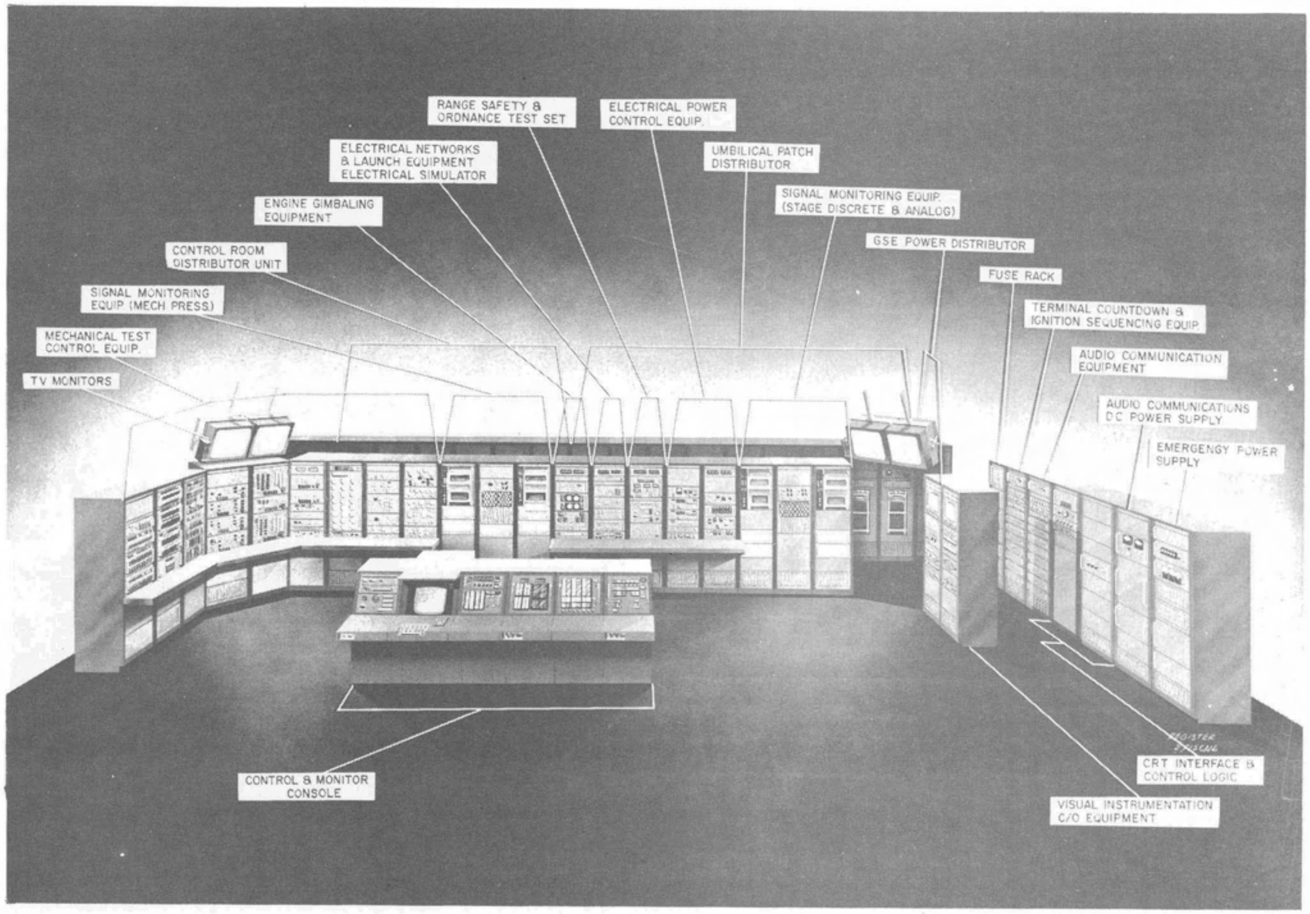


Figure I-6 - Control and Monitor Station

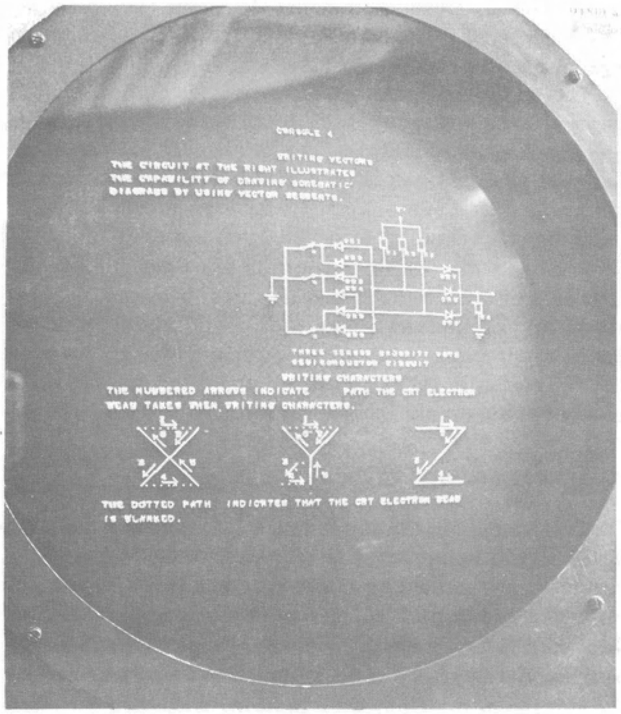


Figure I-7 - Typical CRT Presentation

ment necessary to generate special inputs required by the ground computer system and that equipment necessary to ensure computer interface compatibility with other test and checkout equipment, has been completed. Information recently received from RCA reveals significant differences in the 110A computer interface. Modifications are necessary to include additional interface circuits. Redesign will be initiated as soon as firm data is obtained from RCA. Specification and assembly drawings have been released for some of the associated equipment, and procurement is under way.

The Boeing Company has been using NASA/MSFC computer facilities a few hours each week for program development, training, and coding of automatic test procedures and processors including the MSFC specified Acceptance Test or Launch Language (ATOLL) translator . Use of the NASA/MSFC facilities has been an interim measure necessitated by the lack of an RCA 110A computer. NASA/MSFC has since supplied an RCA 110 computer which was installed at the Boeing Engineering Evaluation Laboratory in Huntsville. Installation took place in late May and checkout continued through early June. On June 11, the computer became operational. Shortly after that, the CRT display feasibility model was interfaced with the computer for continued developmental research.

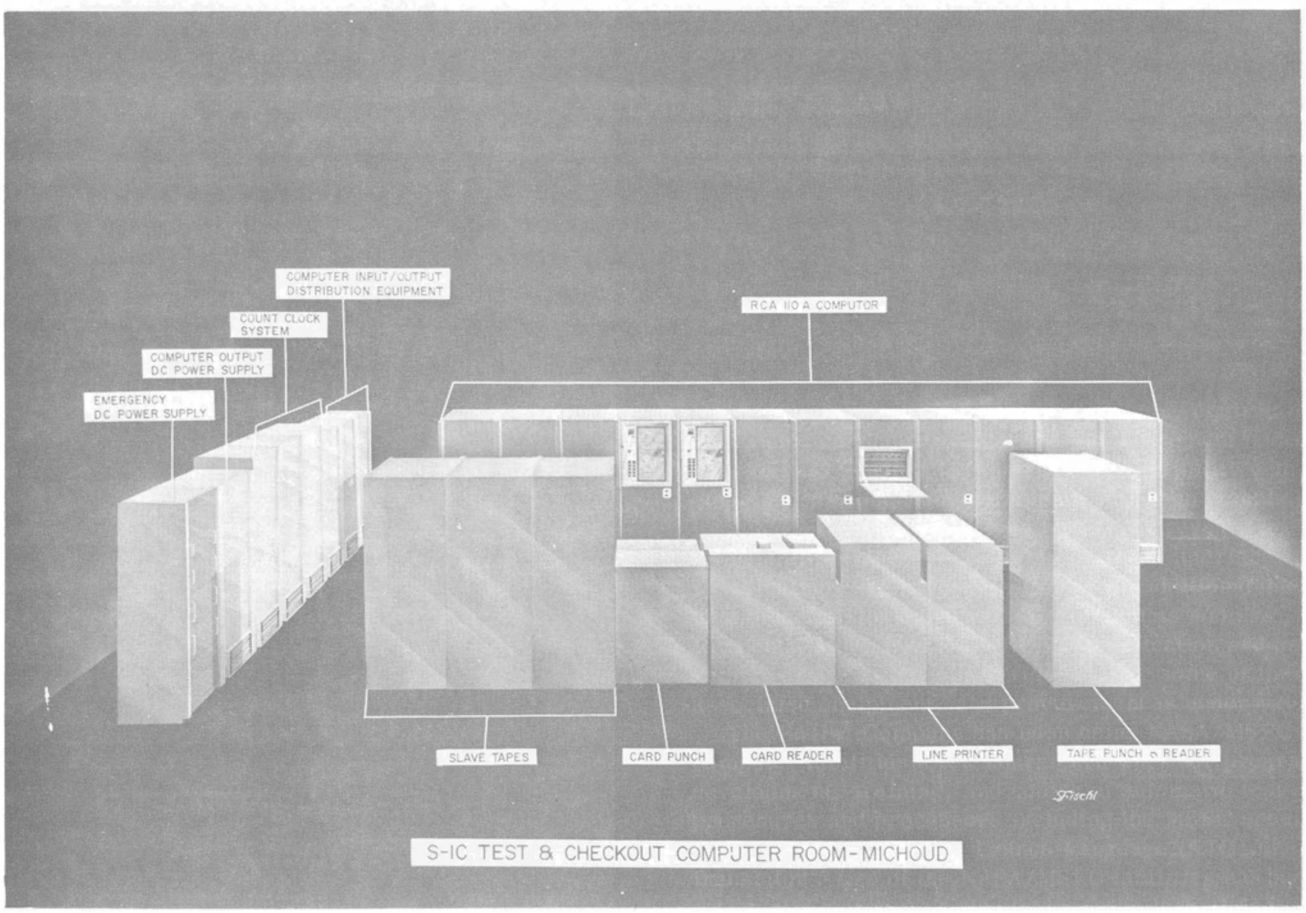


Figure I-8 - Computer Station

In December 1963, Modification 59 was incorporated, adding timing equipment for the Michoud computer stations. The NASA/MSFC design has been completed and the Boeing revised drawings are in process of being released.

Electrical Power Station

The Electrical Power Station consists of the 60-cycle AC ground power supply, the stage DC ground power supplies, the overall test battery supply, emergency DC power supplies, the GSE DC power supply, the computer output DC power supply, and the audio communication equipment power supply. The overall test battery supply provides ground power to the stage battery bus in lieu of vehicle battery power during test and checkout. In the event that power from a DC ground supply is lost, an emergency DC power supply will provide power to the stage and to essential test and checkout control equipment necessary to place the stage in a safe condition and proceed with an orderly shutdown. The GSE DC power supply provides the 28-volt DC power required by the test and checkout equipment for switching, indication, display, and control functions necessary to program the electrical and the mechanical test stations, either in the manual or automatic mode. The computer output DC power supply provides the minus 28-volt DC power required to operate relays in the computer discrete output distribution rack. Power required by the audio communication equipment for the entire test complex is provided by the audio communication equipment power supply.

Design for the Electrical Power Station has been completed. Specification drawings have been released and contracts have been let for all power supplies. Acceptance test procedures are being prepared, with the first of the tests beginning at the end of June 1964. Design of the 400-cycle AC ground power supply was cancelled with the decision to substitute an ignition system, operating from a 750-volt AC system, for the S-IC-F, -D, and flight stages. The S-IC-T will use a 28-volt DC pyrotechnic ignitor.

Electrical Test Station

The Electrical Test Station consists of the range safety and ordnance test rack, the range safety transmitting antenna equipment, the exploding bridge wire (EBW) pulse sensor equipment, the electrical networks test sets, the electrical power control equipment, the signal monitoring equipment, and the terminal countdown and ignition sequencing equipment.

The stage range safety and ordnance systems are tested after they are installed in the fully assembled S-IC stage. The EBW pulse sensor equipment analyzes the voltage output of the EBW firing units, and determines if the firing unit is acceptable. The electrical networks test rack consists of the local control panel, the upper stage electrical networks substitute, the switch selector control equipment, the launch equipment electrical simulator, the emergency detection system checkout equipment, the engine gimballing equipment, and the portable engine gimballing equipment. The upper stage electrical networks substitute provides all the necessary terminations and control signals normally provided to the S-IC stage by the upper stages. Switch selector control equipment provides signals to program the stage switch selector. Simulation of various launch functions which are not available as part of the factory and pre-static firing checkout procedure is provided by the launch equipment electrical simulator. The emergency detection system checkout equipment checks out the emergency detection system of the S-IC stage. The engine gimballing equipment, both rack mounted and portable, provides signals for testing the engine servo-actuators on the S-IC stage, the stage hydraulic system, and the associated stage electrical wiring. Central control for all major GSE power and GSE stage power is provided by the electrical power control equipment. Signal monitoring equipment is provided to record selected stage pressures and analog signals. The terminal countdown sequencer provides signals, in the proper sequence and time relationships to control the launch functions required during countdown and static firing. The ignition sequencer provides signals in the proper sequence and time relationships to control the ignition and shutdown of the five engines of the S-IC stage.

Design for all portions of the Electrical Test Station has been completed. The major portion of specification and assembly drawings have been released, and procurement of equipment has begun.

Mechanical Test Station

The Mechanical Test Station consists of test and test-related equipment and its control equipment, to provide control and monitor functions for propulsion testing. The station is controlled by the computer to perform mechanical tests which normally consist of the following:

1) Application of turbo-pump heater power, allowing the thermostat to cycle, and evaluation of the results;
2) Performance of all valve operation, timing, and sequencing;
3) Activation of pressure switches, and evaluation of results;
4) Application of pneumatic and hydraulic pressures to the stage, in the sequence necessary to perform overall performance tests, such as simulated launch, cutoff, and abort.

The mechanical test control equipment consists of control and display equipment (switches, indicator lights, sequential displays, and communications equipment) to control the Mechanical Test Station.

The test display and control panel indicates the system under test, test status, malfunction indication,

and control mode. Certain major test parameters are also displayed, such as hydraulic pressure and flow rates, pneumatic supply pressure, and station power supply voltage. Controls include those required for manual control tests and certain emergency or panic stop controls.

The pneumatic supply unit, pneumatic pressure test racks, and flowmeters, provide and control high-pressure helium, nitrogen, or dry air to pressurize and test the fuel and LOX feed systems, the fuel and LOX tanks, and the ullage systems. Design has been completed for the pneumatic equipment, and drawings have been released for procurement and assembly.

The hydraulic power supply units provide hydraulic fluid to the S-IC to provide flow to both the engine start valves and the engine gimballing system. Design for all the hydraulic equipment has been completed, critical design reviews have been held, and the majority of drawings have been released. Design has also been completed on the hydraulic control interconnection equipment.

Data System Test Station

The Data System Test Station (Figure I-9) consists of the digital data acquisition system (DDAS), integrated telemetry ground equipment, RF terminal equipment, remote automatic calibration unit, DDAS tape recorder, instrumentation calibration equipment, telemetry digitizing equipment, and the visual instrumentation checkout equipment. A relatively new technique is being employed in the test and checkout of the Saturn V stages. This is the use of the airborne telemetry system as a ground test tool. The DDAS, a development of NASA/MSFC, makes use of airborne pulse-code-modulation telemetry system components for sampling and encoding data which is then transmitted over a coaxial link via a carrier frequency. This data is used for prelaunch checkout and sent by the DDAS ground equipment to the computer and to various test stations for evaluation. The integrated telemetry ground equipment receives, demultiplexes, and decodes telemetry signals from the stage during factory checkout. The RF terminal equipment serves as a distribution center for all telemetry RF and video signals arriving from the test cells. The stage and its associated ground support equipment incorporates a remote automatic calibration of instrumentation transducers. This system provides a capability to test the measuring transducers required for monitoring functional readiness of the vehicle from a remote position. The instrumentation calibration equipment provides and controls power and calibration signals to the telemetry equipment on the stage. The telemetry digitizing equipment receives the analog out-

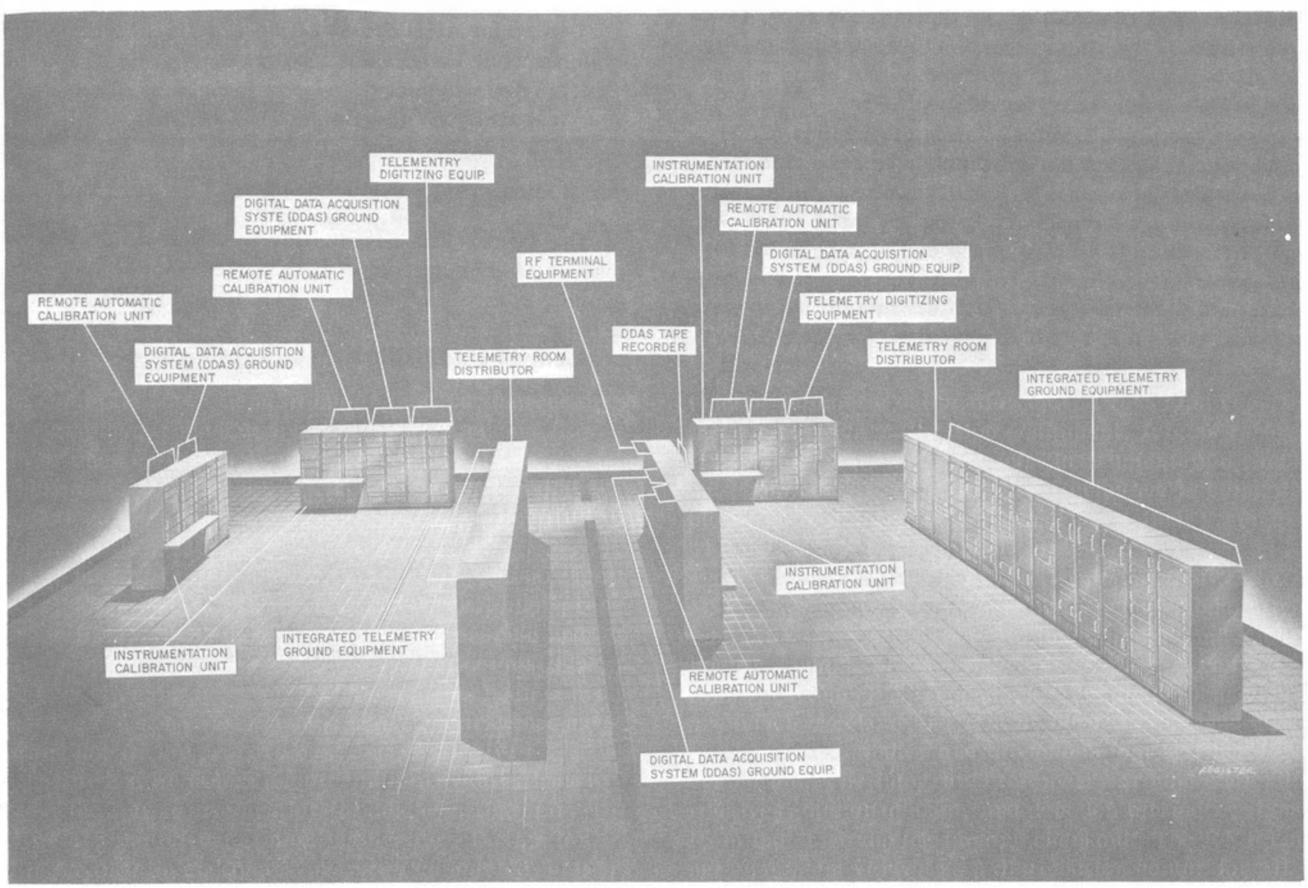


Figure I-9 - Data System Test Station

puts of the telemetry discriminators for digitizing and programing into the stage DDAS format. This permits computer analysis of identical data transmitted via the DDAS and the telemetry measurement links. The TV instrumentation and film camera checkout equipment controls and monitors the application of power and control signals, and evaluates TV picture quality.

Design for the Data System Test Station has been completed. Specification and assembly drawings have been released and vendors have been selected for all items. Fabrication is already in progress at the vendor locations and at Michoud for the Boeing-made items.

Interconnection Equipment

Equipment to interconnect the test and checkout equipment to itself and to the stage provides the capability of transferring electrical power, test instrumentation data, hydraulic power, and pneumatics to and from the S-IC stage during test and checkout. Design of this equipment has been completed and specification and fabrication drawings have been released to initiate procurement and manufacture of parts.

Checkout Auxiliary Equipment

The checkout auxiliary equipment is that equipment which is not a part of the automated test complex, but which is also required to checkout a completely assembled stage. This includes the pneumatic leak detection set to detect pneumatic leaks in the stage propulsion system, an antenna checkout set, stage weighing equipment, area contamination detection equipment to detect RP-1, RJ-1, and trichloroethylene vapors and monitor the content of oxygen in specific locations, internal access equipment, and other assorted equipment for sensing and measuring. Boeing design in this area is in progress and is expected to be complete in the near future. In addition, Modification 36 directed Boeing to design and fabricate two sets of work platforms and bulkhead protection equipment for use at MILA. Design of this equipment is currently in progress.

HANDLING AND TRANSPORTATION EQUIPMENT

Equipment required to move and position the stage and its components during assembly and test consists of the forward handling ring, the stage attach fittings, the fin and fairing cradles, retrorocket handling equipment, and component handling equipment. The forward handling ring (Figure I-10) provides a method for raising or lowering the S-IC stage to the vertical or horizontal position, and enables the assembled stage to be towed on the stage transporter. Final assembly of the initial forward handling ring was begun during the first quarter, with completion and testing occurring during the second quarter. Testing revealed inadequacies in the towing beam, necessitating redesign of that portion. The modified version of the handling ring, incorporating the redesigned towing beam, completed all testing

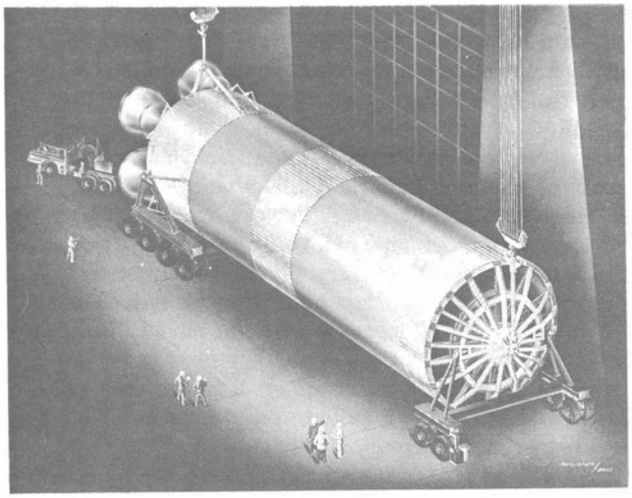


Figure I-10 - Forward Handling Ring With Stage

satisfactorily, and was shipped to NASA/MSFC in the early part of February 1964. A second handling ring has since been completed and shipped to NASA/MSFC for use with the weight simulator (Figure I-11) and handling of the S-IC stages to be assembled and tested there. Design for the stage attach fittings and the fin and fairing cradles has been completed, with design of the retrorocket handling equipment and component handling equipment to be completed in the near future. Design is also in progress for the stage pressure control and monitor system that will maintain positive pressure in the fuel and LOX tanks during transportation of the stage.

A listing of the major handling and transportation equipment of Boeing design is shown in Part VIII of this report.

OPERATING AND SERVICE EQUIPMENT

Basic release on all umbilical assemblies including umbilical plates, ground carriers, simulators, and substitutes was completed in April 1964. Shortly after,

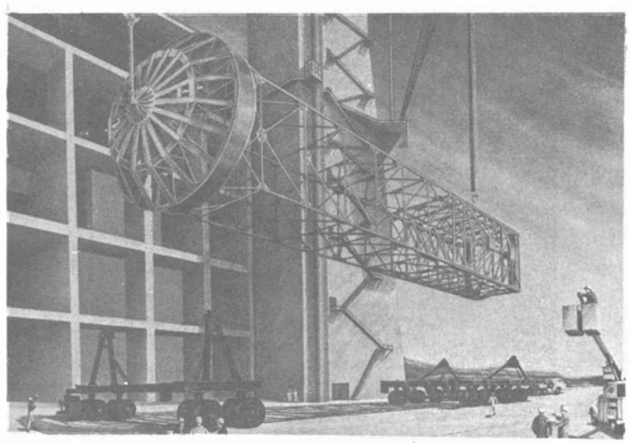


Figure I-11 - Forward Handling Ring With Weight Simulator

on May 26, 1964, the unqualified first article aft No. 1 ground carrier assembly, the aft vehicle skin panel assembly, and the aft flight assembly were delivered to NASA/MSFC.

During the reporting period, Modifications 34 and 35 were received for umbilical equipment to be used at the Merritt Island Launch Area. Modification 34 called for Boeing to design and build four sets of pneumatic equipment for the Saturn V launcher umbilical tower. Phase I approval has been granted by NASA/MSFC, and work is proceeding with the Phase III portion. Modification 35 required the design of umbilical carriers, plates, and associated equipment. Design in this area has been completed, and drawings have been released for fabrication of parts.

MECHANICAL AUTOMATION BREADBOARD (MAB)

During the second quarter of this reporting period, Boeing received Modification 52, calling for design of the MAB (Figure I-12). Modification 94 directed Boeing to manufacture the MAB. The MAB is intended to prove out the automated mechanical checkout concept, and to provide a checkout of the stage peculiar mechanical GSE for the S-IC stages. By utilizing flight equipment, including one F-1 engine, a complete fuel and LOX delivery system, a control pressure system, and limited purge system components, stage systems are duplicated for checkout of the associated GSE. The F-1 engine and four electrically simulated engines will be gimballed and subjected to simulated flight loads. The engine will also be capable of accepting all automated prestart and testing operations. Fuel and LOX tank ullage space will be simulated, and pressurization will be effected as necessary during fuel and LOX loading checkout and launch. Fill and drain functions will be simulated by timing devices in conjunction with operational hardware.

Design of the fuel, LOX, and control pressure/purge subsystem were released to NASA/MSFC for review and approval. Also released were preliminary data on the F-1 engine, hydraulic subsystem, and interconnection equipment Design comments have been received from NASA/MSFC and are being incorporated into the hardware design.

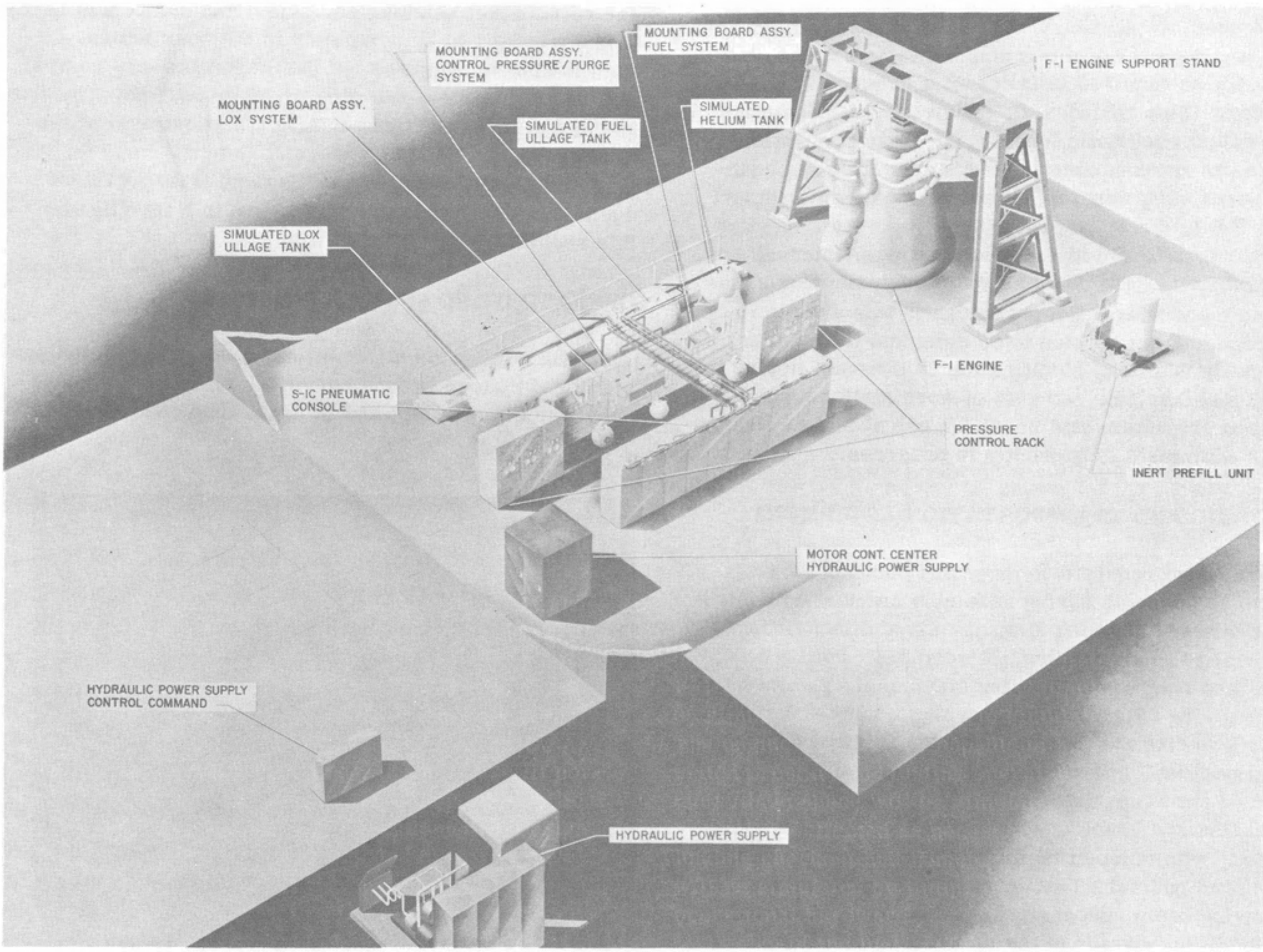
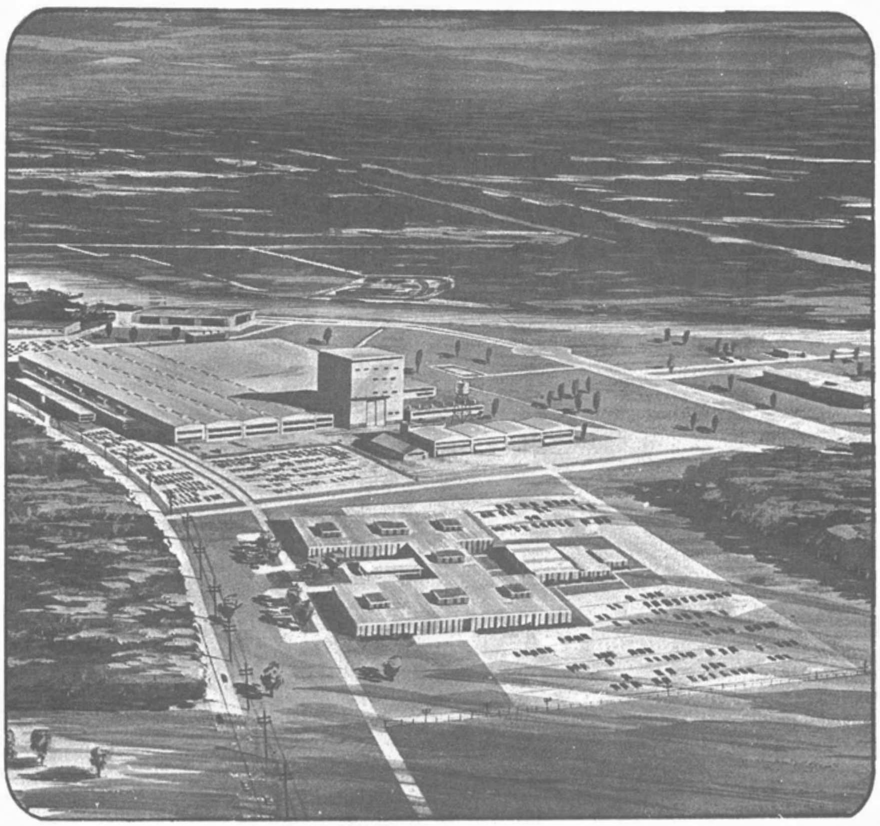
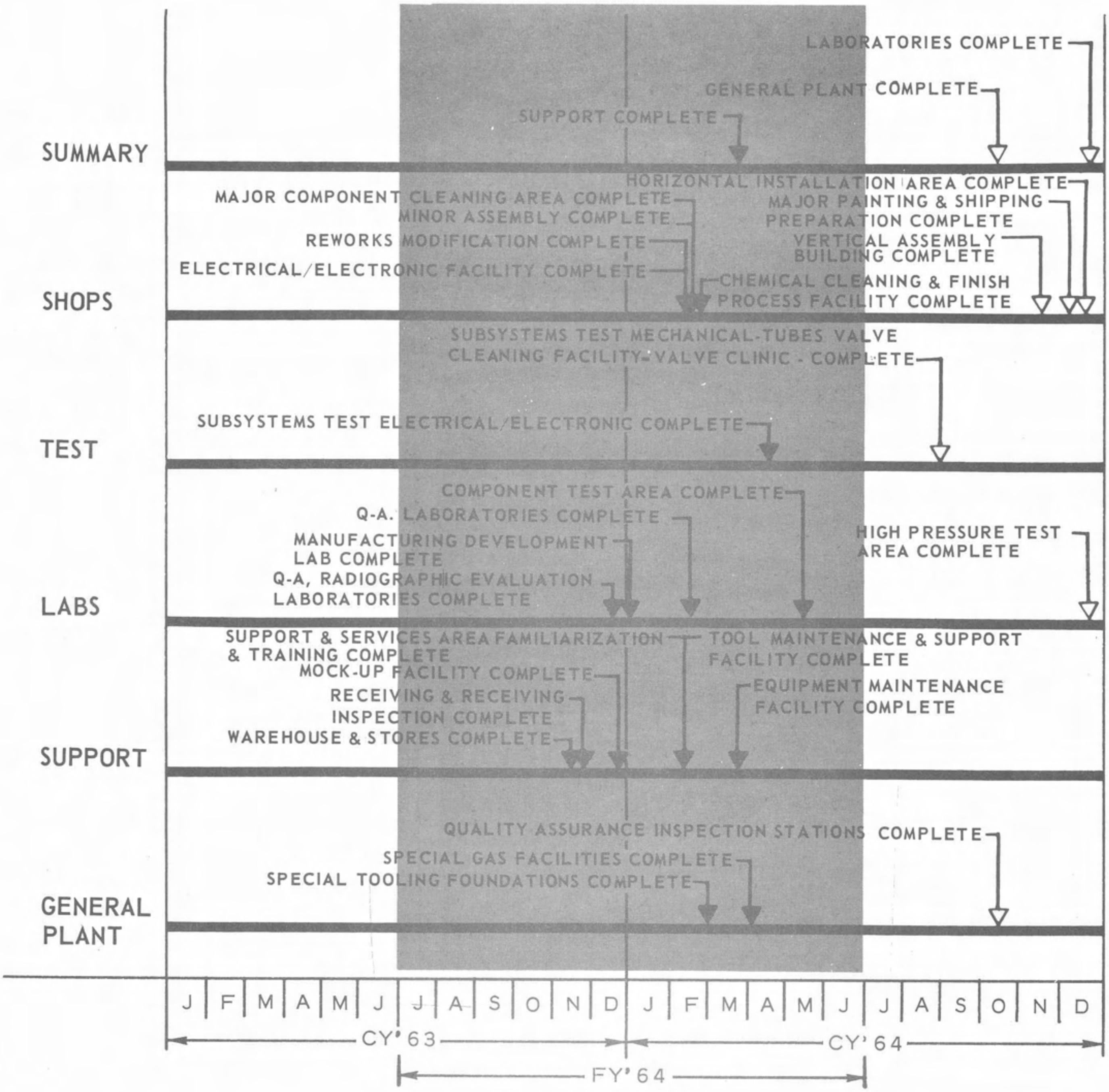


Figure I-12 - Mechanical Automation Breadboard Mockup

II



FACILITIES PLANNING AND ACTIVATION


SUMMARY
LABORATORIES COMPLETE
GENERAL PLANT COMPLETE
SUPPORT COMPLETE
SHOPS
HORIZONTAL INSTALLATION AREA COMPLETE
MAJOR COMPONENT CLEANING AREA COMPLETE
MINOR ASSEMBLY COMPLETE
MAJOR PAINTING & SHIPPING PREPARATION COMPLETE
REWORKS MODIFICATION COMPLETE
VERTICAL ASSEMBLY BUILDING COMPLETE
ELECTRICAL/ELECTRONIC FACILITY COMPLETE
CHEMICAL CLEANING & FINISH PROCESS FACILITY COMPLETE
TEST
SUBSYSTEMS TEST MECHANICAL-TUBES VALVE CLEANING FACILITY-VALVE CLINIC - COMPLETE
SUBSYSTEMS TEST ELECTRICAL/ELECTRONIC COMPLETE
LABS
COMPONENT TEST AREA COMPLETE
Q-A. LABORATORIES COMPLETE
MANUFACTURING DEVELOPMENT LAB COMPLETE
HIGH PRESSURE TEST AREA COMPLETE
Q-A, RADIOGRAPHIC EVALUATION LABORATORIES COMPLETE
SUPPORT
SUPPORT & SERVICES AREA FAMILIARIZATION & TRAINING COMPLETE
TOOL MAINTENANCE & SUPPORT FACILITY COMPLETE
MOCK-UP FACILITY COMPLETE
EQUIPMENT MAINTENANCE FACILITY COMPLETE
RECEIVING & RECEIVING INSPECTION COMPLETE
WAREHOUSE & STORES COMPLETE
GENERAL PLANT
QUALITY ASSURANCE INSPECTION STATIONS COMPLETE
SPECIAL GAS FACILITIES COMPLETE
SPECIAL TOOLING FOUNDATIONS COMPLETE
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

Significant progress toward total activation of the facilities complex at Michoud was made during fiscal year 1964, in preparation for full-scale assembly of both ground test and flight stages.

NASA/MSFC and Boeing personnel held discussions during the initial portion of the reporting period to establish mutual agreement on the use of interim and partial facilities in addition to other workaround techniques required to support Plan Va schedule.

Boeing subcontractors experienced an electricians strike during the third quarter of CY '63. This hampered facilities activation efforts but the use of partial and interim facilities lessened program impact and allowed Boeing to continue its support of NASA/MSFC ground test requirements in an orderly manner. The completion of Phase V of special tooling foundations was accomplished during this quarter.

During this fourth quarter of CY '63, six facilities were activated. They included: the Receiving and Receiving Inspection, Quality Assurance Radiographic Evaluation Laboratories, mockup facility, tank farm, warehouses and stores, and special tooling foundations—Phase VI. The activation of such facilities reduced the need for interim and partial facilities.

The change in program schedules from NASA/MSFC Schedule Plan V to Plan VII highlighted the commencement of the first quarter (CY '64). The change from Plan V to Plan VII as related to facilities activation impact consisted of changes in demand dates and resulted in subsequent schedule revisions for some facilities.

The user demand dates of five facilities were changed as a result of the transition from Plan V to Plan VII. This resulted in revisions to facilities activation schedule requirements.

Facility	Demand Dates Plan V	Demand Dates Plan VII
Major Component Cleaning Facility	10-15-63	2-17-64
Engine Buildup	8-3-64	11-1-64
Horizontal Installation	11-16-64	1-14-65
Major Painting & Shipping Preparation	7-1-64	9-15-64
Stage Test Positions 1, 2, 3, and 4	8-1-64	10-1-64

Significant progress was realized during the first quarter of CY '64, with the continuing activation of complete facilities and the corresponding reduction in partial and interim facilities. Through the combined efforts and discussions between NASA/MSFC and Boeing, funding problems were overcome on the stage test facility and Phase II construction activities for this facility were initiated. The Tool Maintenance and Support facility, Familiarization and Training area, Support and Services areas, and the Equipment Maintenance Facility were completed during this period, thereby completing the support areas activation for the Michoud Complex. In addition, five facilities in the Shop category were completed. They include Chemical Cleaning and Finish Process Facility, Major Component Cleaning Area, Electrical/Electronic Facility, Rework and Modification Facility, and Minor Assembly. The following facilities within the Lab category were also completed: Manufacturing Development Lab, the remaining Quality Assurance Labs, and the Component Test Materials and Process Lab. During this same period, Phases VII and VIII of Special Tooling Foundation were also completed.

Late in the first quarter of CY '64, NASA/MSFC and Boeing concentrated on eliminating potential stage delivery impact items which were resulting from funding problems on the completion of construction of the Vertical Assembly Building, and problems of definition of criteria for the Major Painting and Shipping Preparation facility.

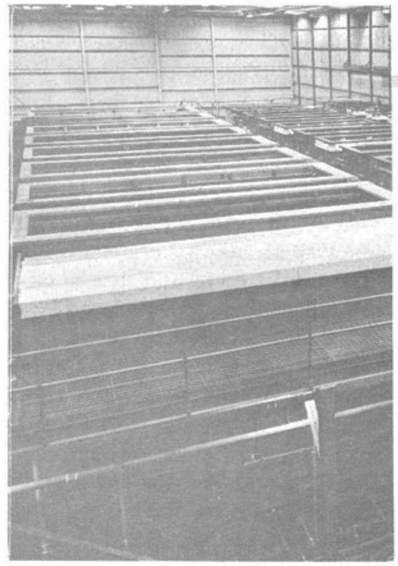
During the second quarter of CY '64, the funding problem for the completion of the Vertical Assembly Building was resolved and construction work was started on May 5, 1964, with a scheduled completion of November 18, 1964. A firm definition of criteria was established for the Major Painting and Shipping Preparation Facility and the design is scheduled to be complete on August 7, 1964 with the total facility completion scheduled for December 11, 1964.

Nine construction contracts were completed during the second quarter of CY '64, with eight contracts continuing in work and four contracts pending NASA/MSFC approval as of July 2, 1964.

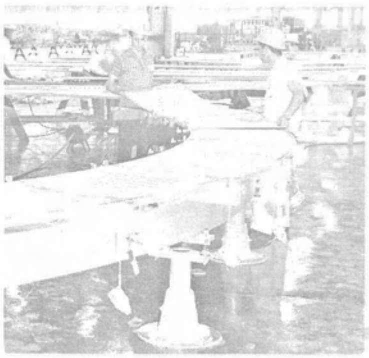
Facilities activated during the same quarter include Subsystems Test Electrical/Elctronic Facility, and Phase I of the Stage Test Facility under the Test category. Component Test Propulsion and Mechanical Lab and Structural Test were completed in the Laboratories category. In the General Plant Area, Special Gas Facilities was also completed. These achievements have reduced the use of interim and partial facilities and accomplished another milestone toward total completion of the Michoud Complex

It has been established that the impact to stage deliveries has been minimized by the use of interim and partial facilities in operation or work-around methods. The cumulative effect of utliizing interim and partial facilities, and a large number of work-around methods, could delay scheduled deliveries of S-IC stages.

During fiscal year 1965 it is predicted that the remaining facilities will be completed: Horizontal Installation Facility, Engine Buildup Facility, and the Major Painting and Shipping Preparation Facility and the Vertical Assembly Building in the Shops category. Also the High-Pressure Test Facility and Quality Assurance Inspection Stations in the Laboratories area will be completed. Subsystems Test Mechanical, and Stage Test Facility Phase II are the remaining facilities to be completed in the Test category.

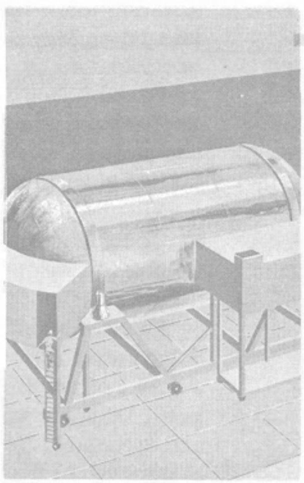


Chemical Cleaning and Finish Process Facility

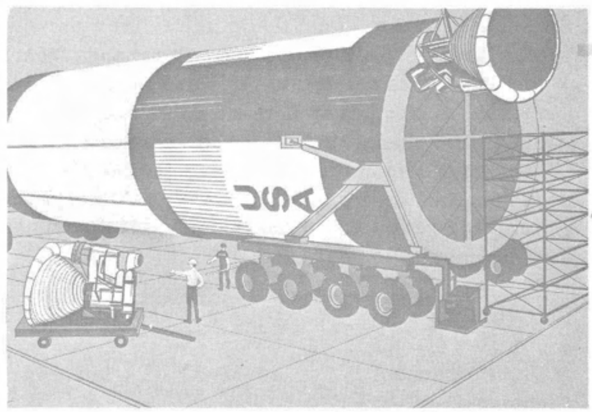


Minor Assembly

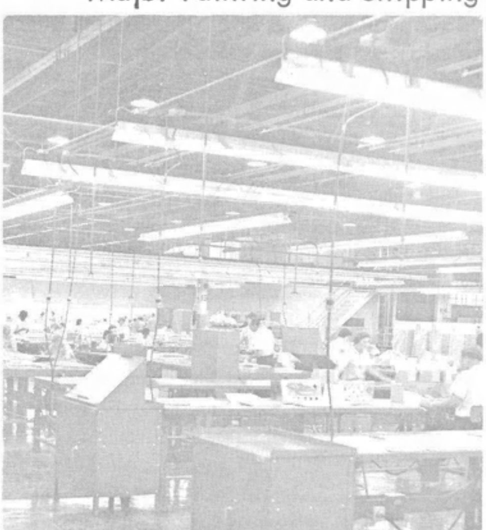
FACILITIES/SHOPS



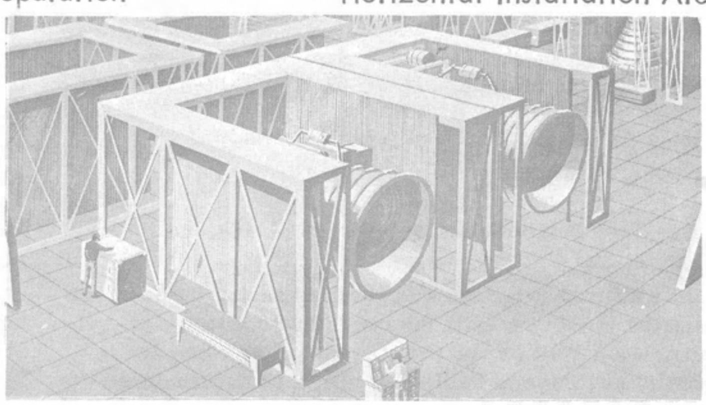
Major Painting and Shipping Preparation



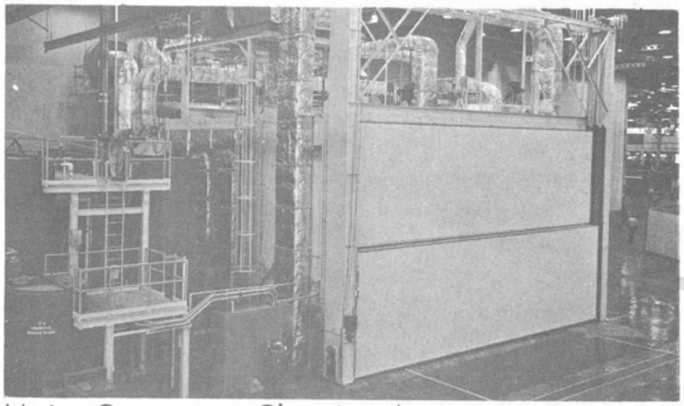
Horizontal Installation Area



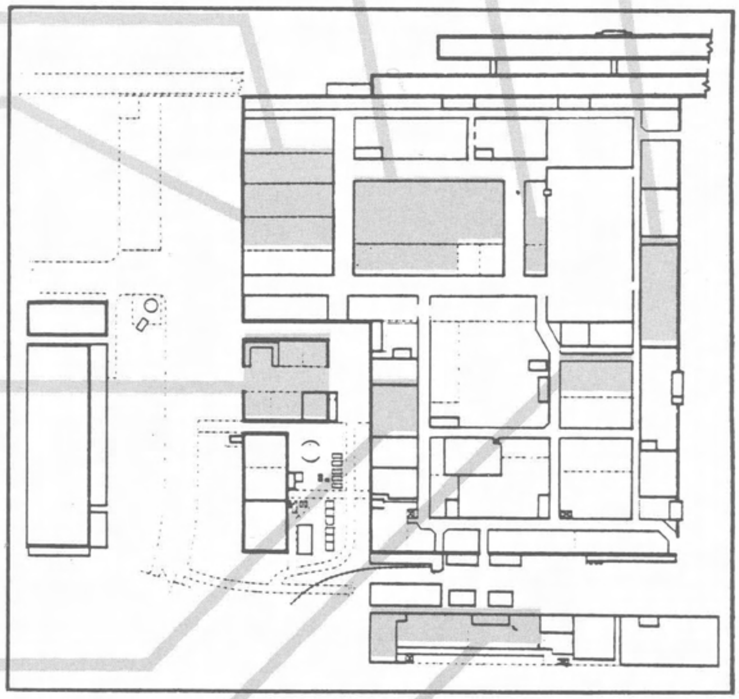
Electrical/Electronic Facility

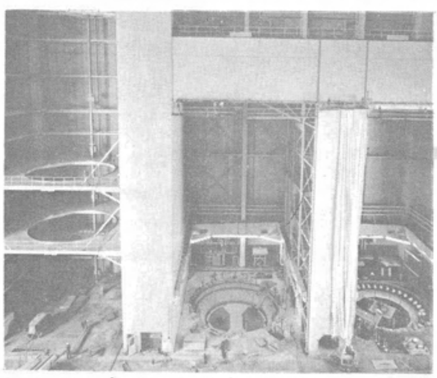


Engine Build-up Facility



Major Component Cleaning Area





Vertical Assembly Building

Rework
and Modification

ELECTRICAL/ELECTRONIC FACILITY

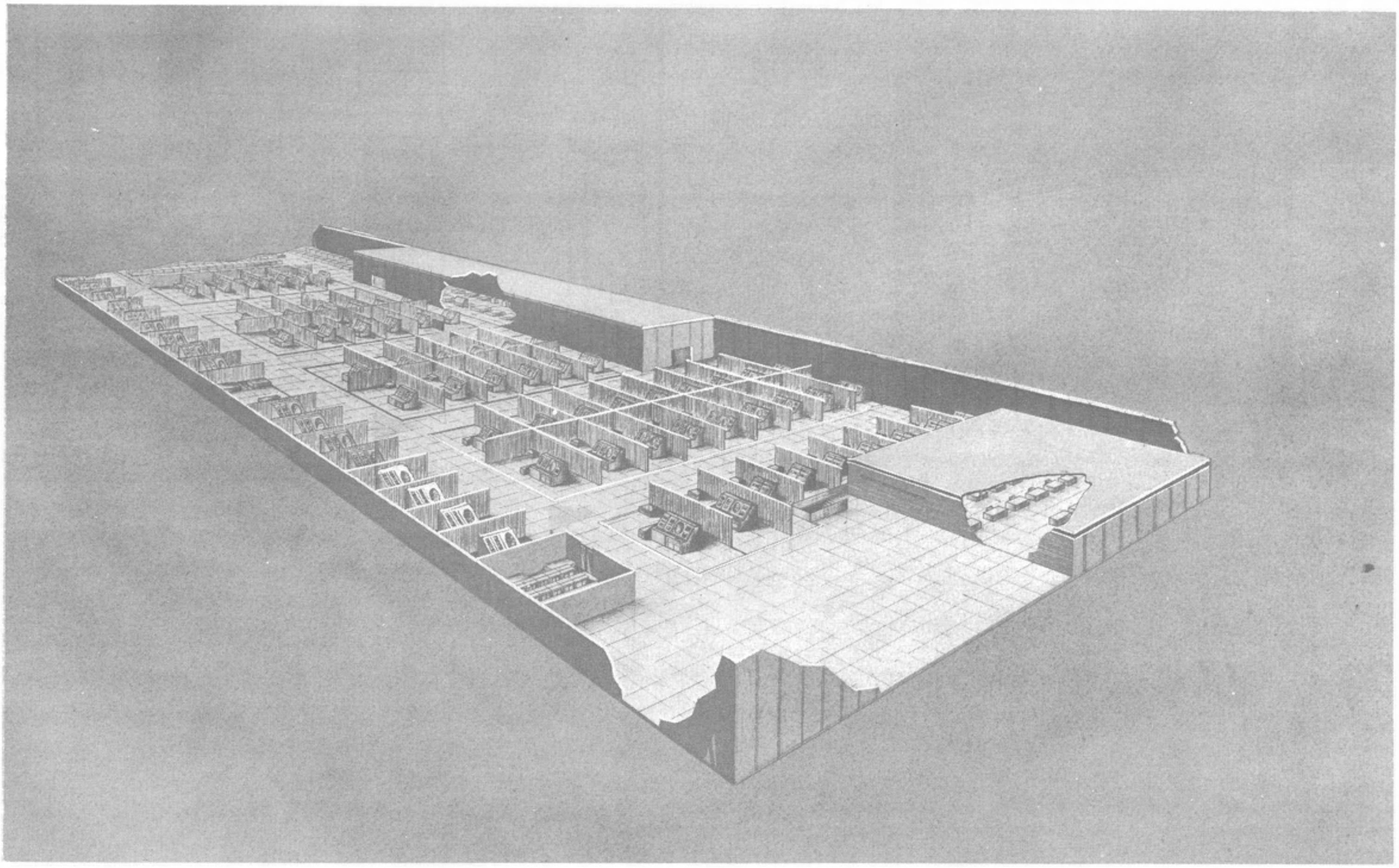
Function - The Electrical/Electronic facility is used to fabricate, assemble and rework electrical and electronic components and assemblies for the S-IC stage and GSE. The facility consists of the following areas: 1) Electrical Fabrication; 2) Electronic Fabrication; 3) GSE Console Assembly.

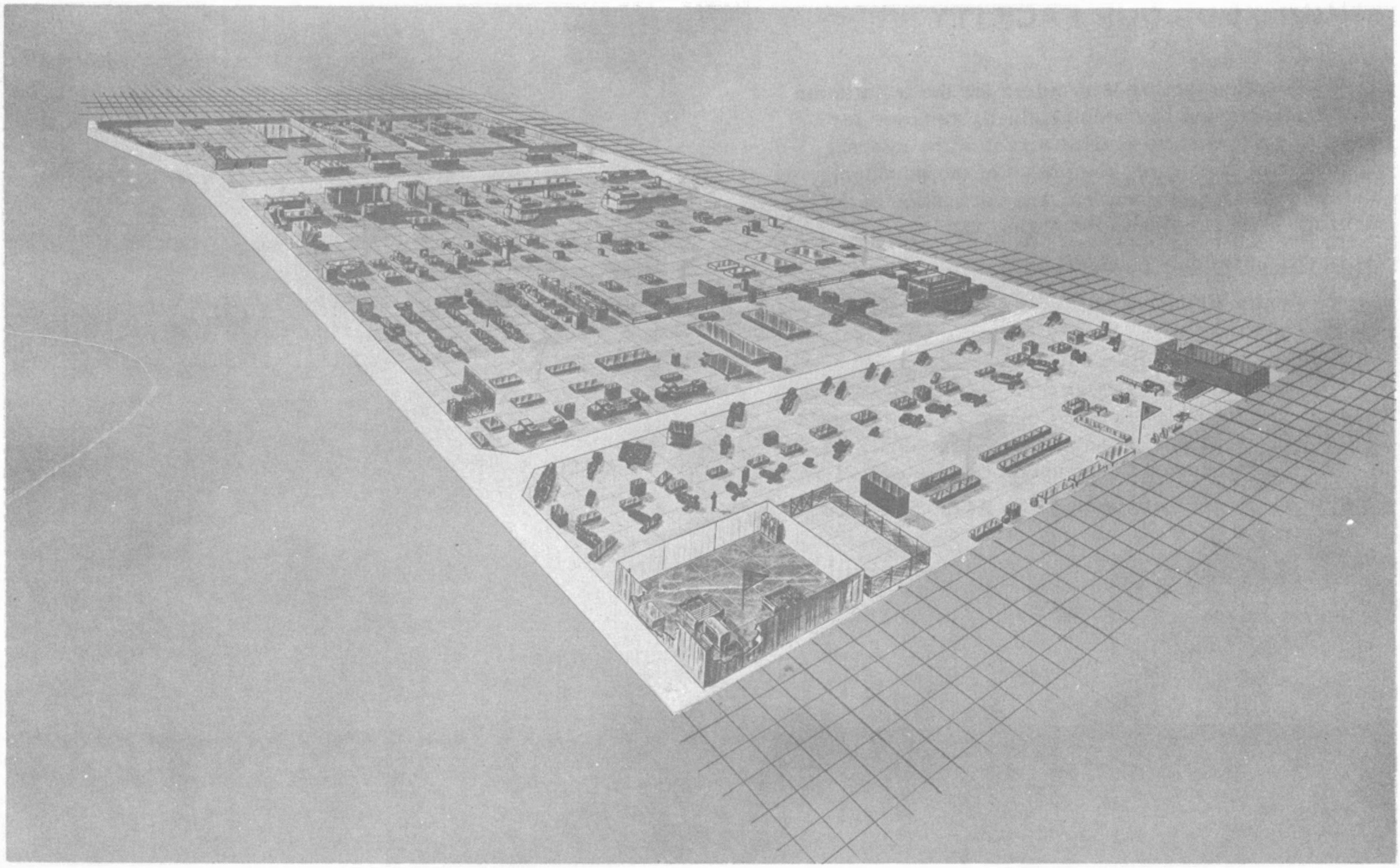
Using Organization - Manufacturing

Area - Electrical/Electronics facility - 51,000 sq. ft.

Milestones - Design Complete ------- 6-21-63
Construction Started ---- 7-18-63
Construction Complete -- 1-3-64

Contracts - 63-24 -- A&E
63-47 -- Construction





REWORK & MODIFICATION – TOOL MAINTENANCE

Function -- This area consists of a "blue streak" type shop which is capable of producing small parts as required for program changes, late or misplaced items, and emergency repairs as required to support both the S-IC booster production and tool maintenance programs This area consists of the following:

1. Rework and Modification facility consisting of the following areas: a) Tube Bending; b) Sheet Metal; c) Machining; d) Fixture Bore; e) Heat-Treat and Non-Metals; f) Woodwork and Plaster; and g) GSE/MSE Assembly and Maintenance.
2. Tool Maintenance and Support Facility composed of the following areas: a) Welding; b) Bench Assembly; and c) Fixture Maintenance.

Using Organization - Manufacturing

Area - Rework and Modification -- 75,844 sq. ft.
Tool Maintenance -------- 21,672 sq. ft.
TOTAL ----------------- 97,516 sq. ft.

Milestones - Design Complete ------------7-12-63
Truss Modification ----------7-8-63
Construction Started ---------7-22-63
Truss Modification Complete--9-20-63
Construction Complete -------2-14-64

Contracts - 62-4 --- A&E
62-9 --- Construction
63-6 --- Construction
63-40 -- Construction
63-48 -- Construction
63-59 -- Construction
63-62 -- Construction

ENGINE BUILDUP FACILITY

Function - This facility is required for the installation of components that had been originally removed for shipping purposes, re-establishment of the internal alignment of the engine, the preset of the actuator, and the assembly, inspection, and verfication of the fit of the skirt relative to the engine nozzle.

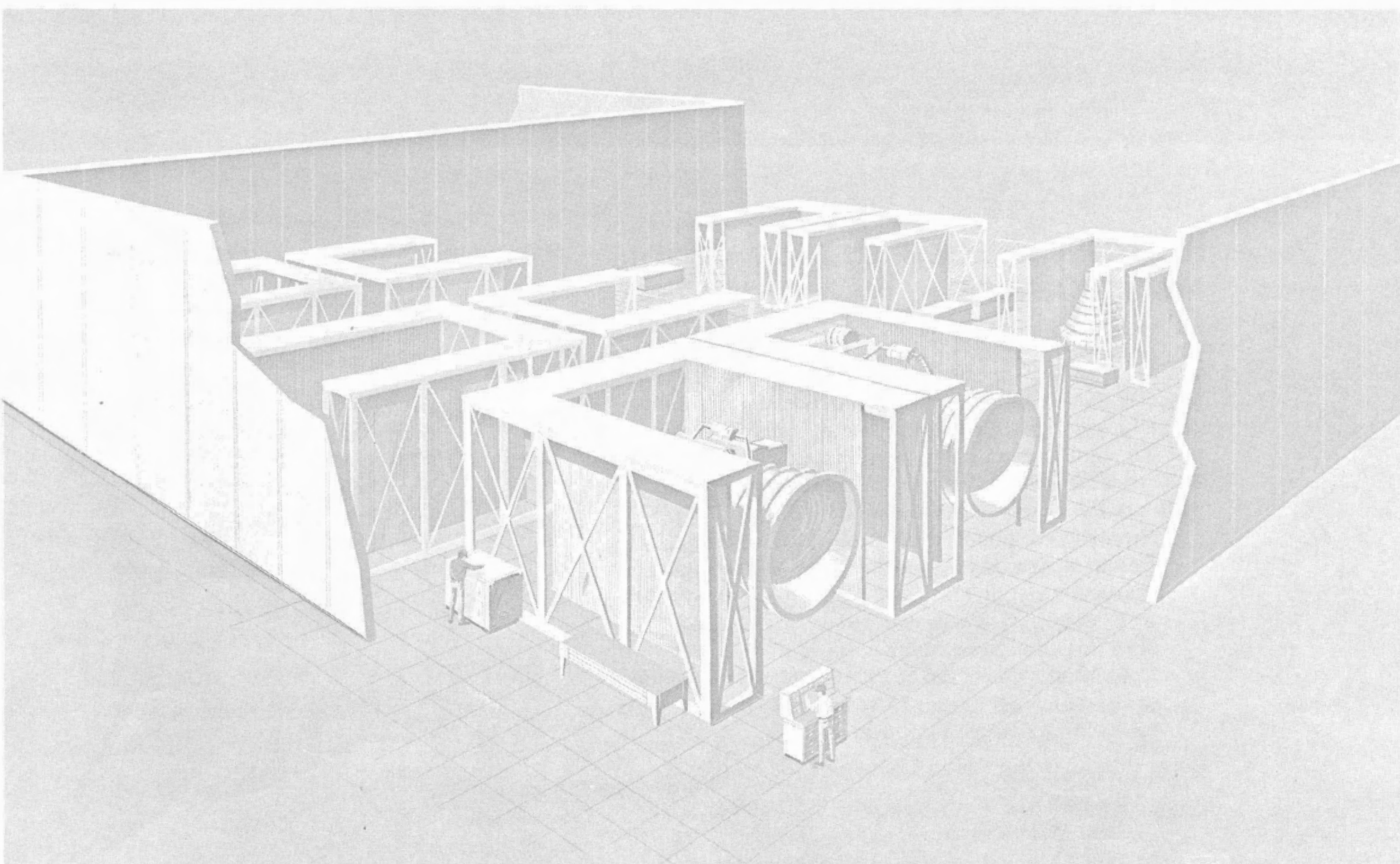
Using Organization - Manufacturing

Area - Engine Buildup Facility -- Approximately 12,960 square feet

Milestones - (Boeing effort only)

Scheduled Design Start --------- 8-21-64
Scheduled Design Complete ----- 11-9-64
Scheduled Construction Start ---- 12-22-64
Scheduled Construction Complete -3-23-65

Contracts - No numbers assigned to A&E or Construction Contracts



VERTICAL ASSEMBLY AREA

Function - This facility is required to assemble the complete S-IC stage in a vertical position. In addition, the area will be used to assemble tanks, install baffles, assemble tank connection sections, perform hydrostatic testing, clean flight vehicle LOX piping and RP-1 fuel tanks.

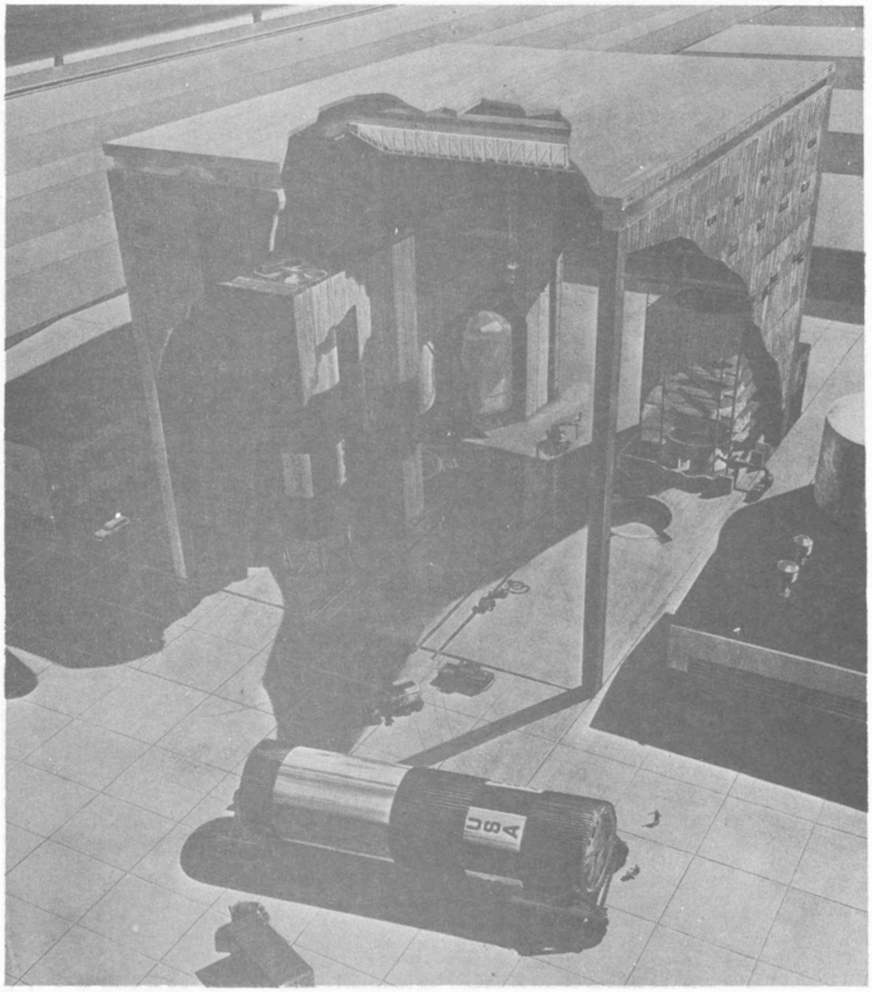
Using Organization - Manufacturing and In-Plant Test

Area - 44,414 square feet

Milestones

63-4 Tank Farm --	Design Started ------ 9-15-62 Design Complete ---- 3-1-63 Construction Started--4-27-63
63-64 Phase I ---- (Tank Assembly Position 1 & 2 including structural 90 ft. & 155 ft. towers)	Design Started ------ 8-9-63 Design Complete ---- 10-28-63 Construction Started--12-10-63 Construction completion scheduled for 6-8-64, but due to schedule slide anticipated completion early in the third quarter, CY '64
64-8 Phase II ----- (Tank Farm Distribution, Complete 155 ft. Tower, Hydrostatic Test Tower, Hydrostatic Test Position)	Design Started --------6-3-63 Design Complete ------2-6-64 Construction Started ---5-4-64 Construction Complete--10-19-64

Contracts - 63-64 -- A&E
62-12 -- Hydrostatic Test Position and Final Assembly Construction
64-8 --- Tank Positions 1 & 2 Construction
63-4 --- Tank Farm Construction



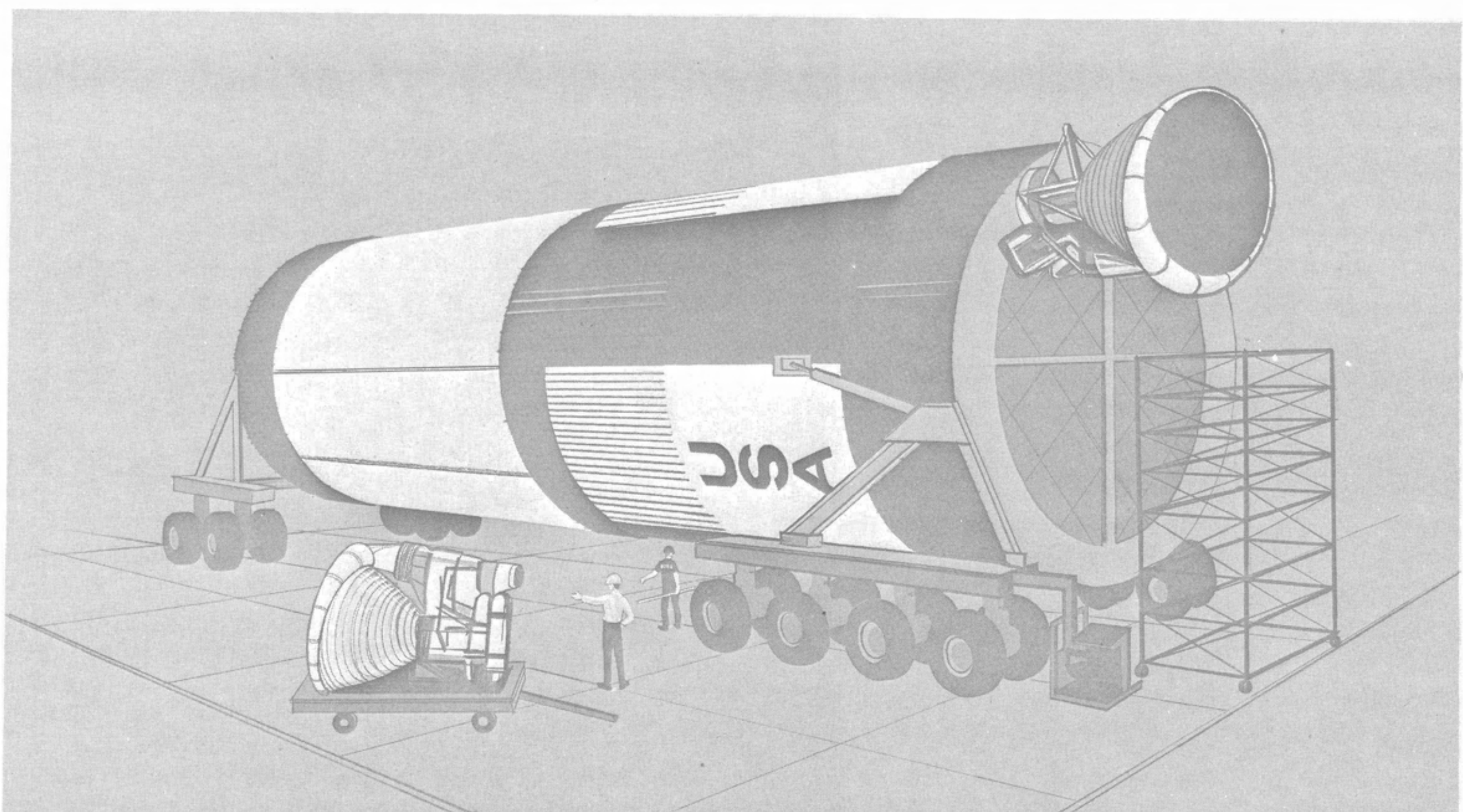
HORIZONTAL INSTALLATION AREA

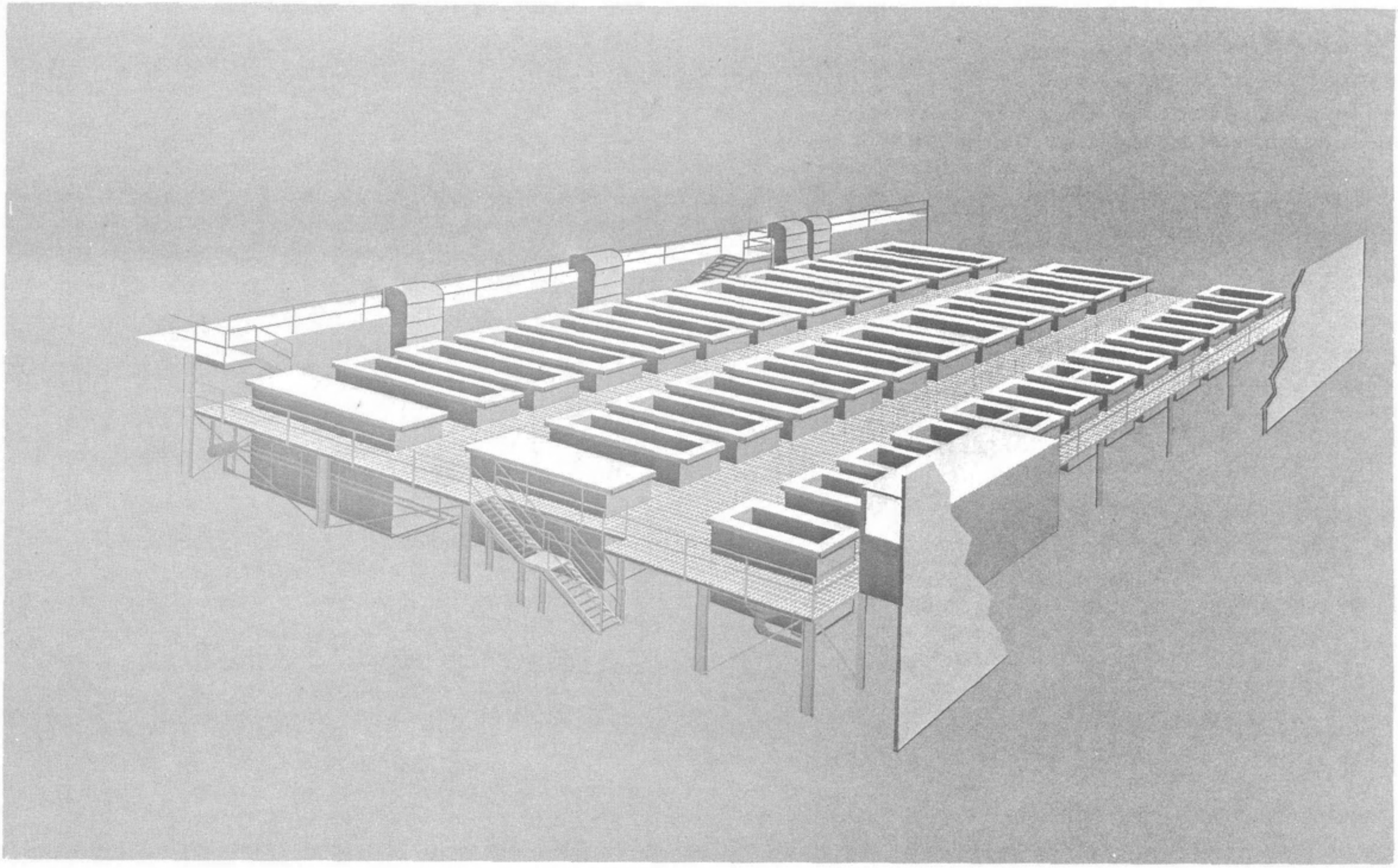
Function - This facility will be used to install the F-1 engines and associated hardware on the S-IC stage in the horizontal position and to refurbish the engines after static testing.

Area - 51,976 square feet

Milestones - Scheduled Design Start -------- 6-22-64
Scheduled Design Complete ---- 8-14-64
Scheduled Construction Start --- 9-16-64
Scheduled Construction Complete -12-21-64

Contracts - 64-18 -- A&E





CHEMICAL CLEANING AND FINISH PROCESS FACILITY

Function - This facility provides the capability for chemical cleaning of aluminum and steel segments in unfinished and semi-finished form. In general, this applies to all stage and ground support equipment components not considered contamination sensitive.

This area is a manual, semiautomatic facility consisting of an aluminum cleaning line of 10 tanks and a steel cleaning line of 11 tanks.

Using Organization - Manufacturing

Area - Chemical Cleaning and Finish Process facility -- 25,100 square feet

Milestones - Tank Design Started -------------3-19-63
Aluminum Line Design Complete --7-8-63
Steel Line Design Complete -------8-1-63
Aluminum Line Construction Complete -----------------------2-26-64
Steel Line Construction Complete--2-26-64

Contracts - 63-31 -- A&E
63-15 -- Tank Fabrication
63-46 -- Tank Fabrication
63-44 -- Construction Aluminum Clean Line
63-54 -- Construction Steel and Plating Line
63-11 -- Crane Fabrication and Erection

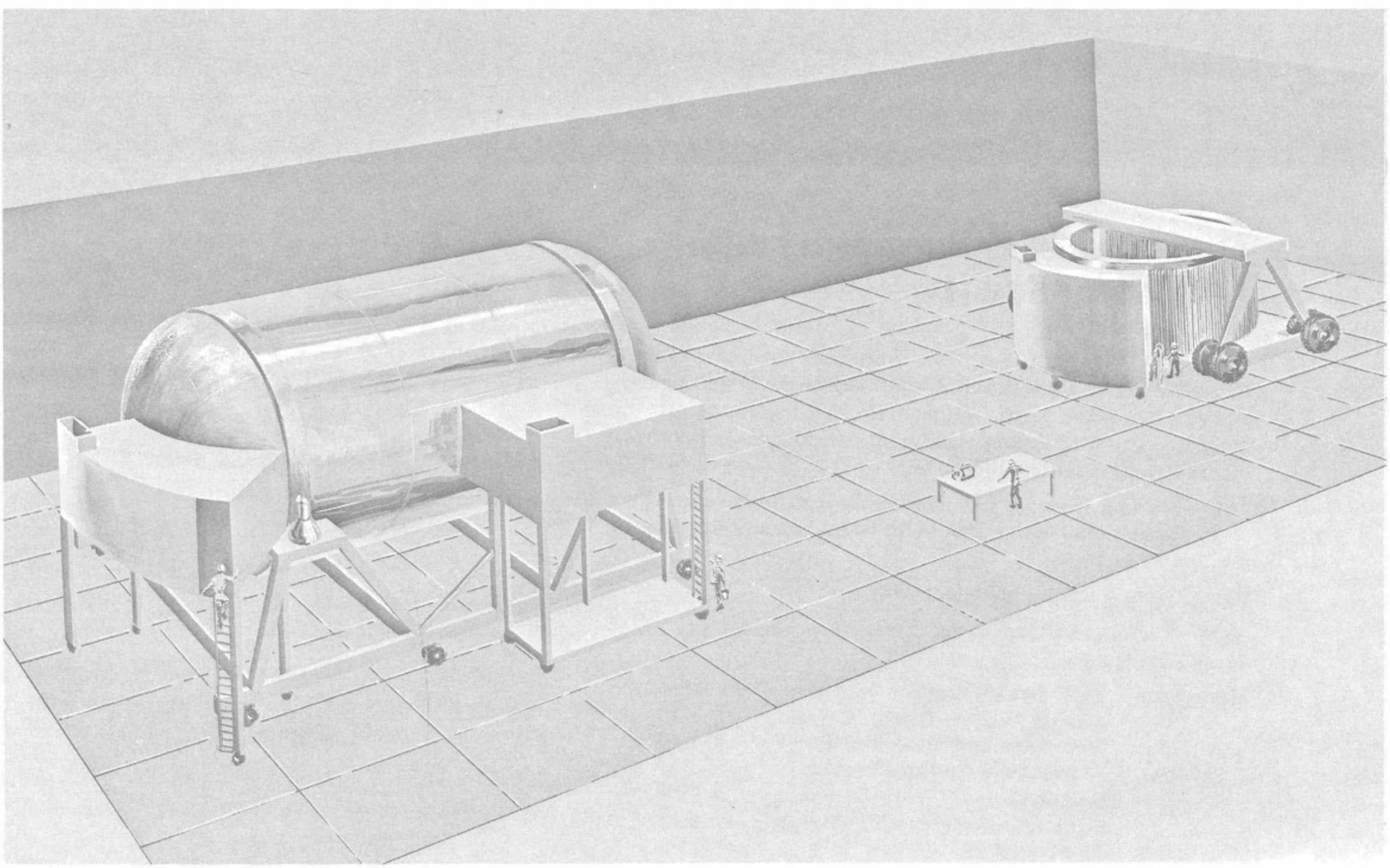
MAJOR PAINTING AND SHIPPING PREPARATION

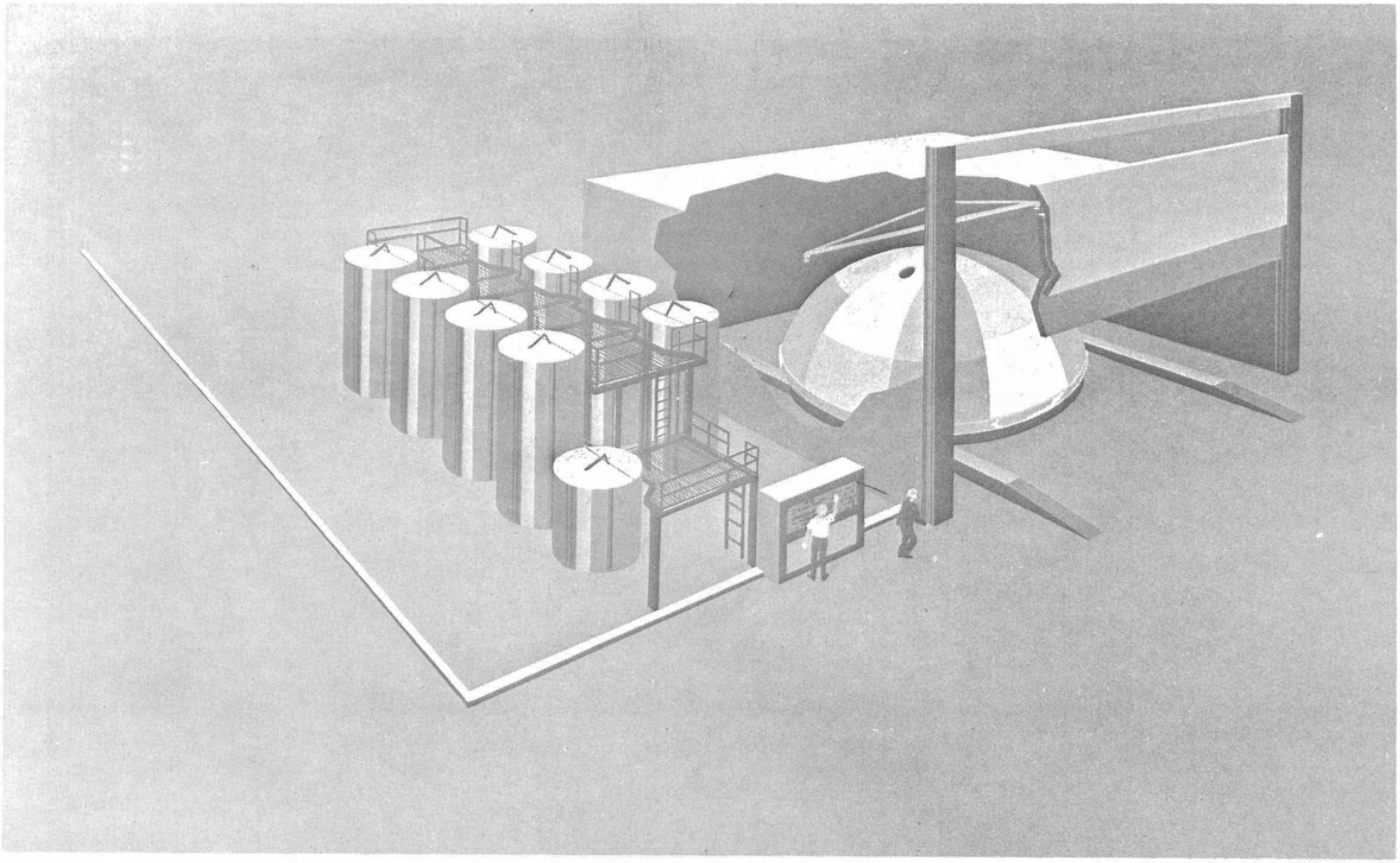
Function - This facility is required for final preparation of the booster for shipment. This preparation includes painting, decal application, protective coating, dust sealing and systems draining.

Area - 16,800 square feet

Milestones - Design Started ---------------- 6-10-64
Scheduled Design Complete ----- 8-7-64
Scheduled Construction Started - 9-8-64
Scheduled Construction Complete-12-11-64

Contracts - 64-19 -- Design





MAJOR COMPONENT CLEANING AREA

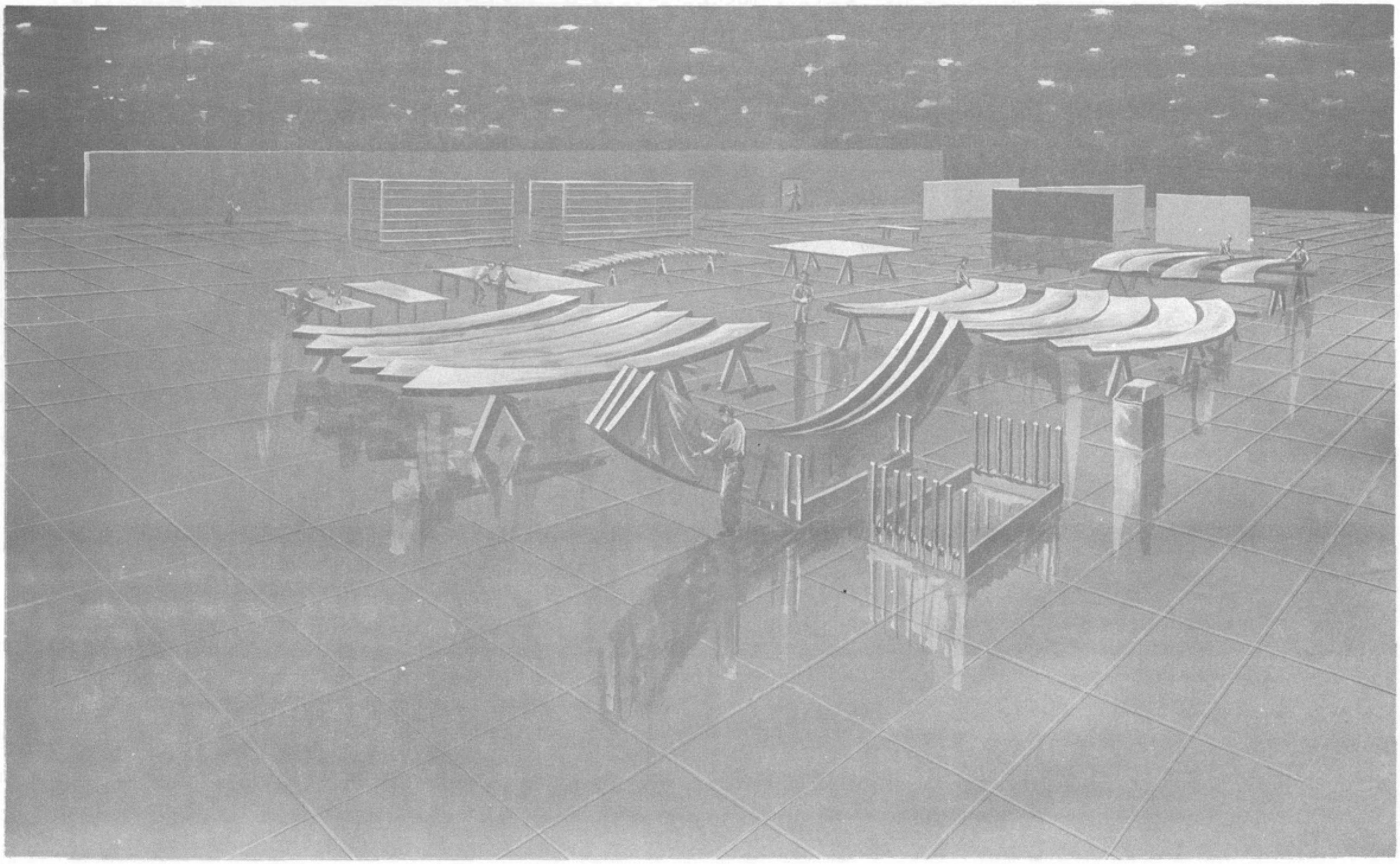
Function - This area is used for the cleaning and conversion coating of bulkheads, baffles, and other tank components too large for the immersion cleaning line. Skin sections and Y-rings are also cleaned in this area. Systems required to perform the cleaning and coating operations include: trichloroethylene, alkaline cleaning solution, deodorizer, iridite, and demineralized water distribution.

Using Organization - Manufacturing

Area - Major Component Cleaning facility -- 4,560 sq. ft.

Milestones - Design Started ------------- 4-15-63
Design Complete ----------- 8-7-63
Construction Started -------- 10-10-63
Tank Fabrication Complete -- 1-21-64
Construction Complete ------ 2-19-64

Contracts - Design -- In-house
63-41 --- Pile Driving
63-46 --- Tank Fabrication
63-57 --- Construction



MINOR ASSEMBLY AREA

Function - The Minor Assembly Area provides facilities to assemble vehicle components prior to major assembly. This includes provisions for welding, machining and mechanical fabrication.

Using Organization - Manufacturing

Area - 238,516 square feet

Milestones

63-40 Truss Mod ----- Started ---- 1962
Complete -- 10-31-63

63-11 Cranes Fabrication & Installation -------- Started ---- 4-9-63
Complete -- 2-21-64

63-62 Crane Access Platforms -- Started ---- 10-25-63
Complete -- 11-20-63

Special Tooling Foundations Phases 5, 6, 7 & 8

63-35 -- Started ---- 1963
Complete -- 9-27-63

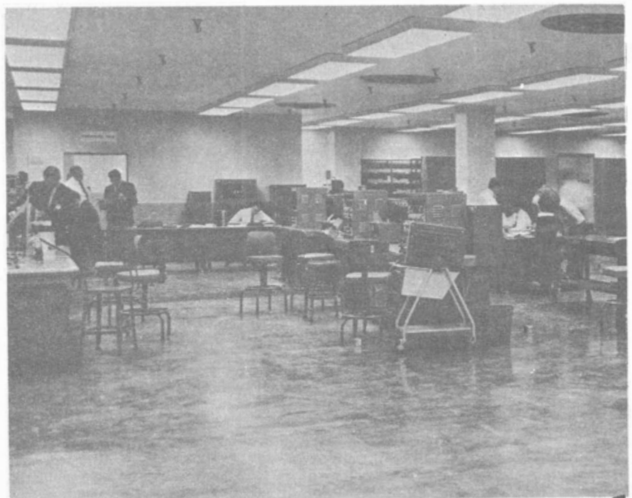
63-55 -- Started ---- 1963
Complete -- 10-31-63

63-61 -- Started ---- 1963
Complete -- 2-29-64

63-67 -- Started ---- 1963
Complete -- 3-1-64

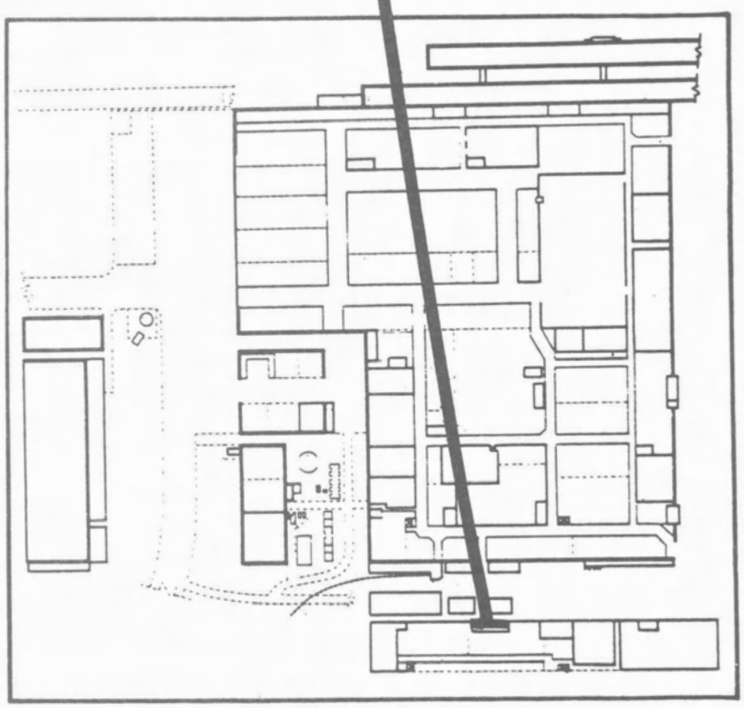
Contracts - 62-4 --- A&E Gray Box
63-40 -- Truss Mod
63-11 -- Cranes Fabrication & Installation
63-33 -- Y-ring Weld Area
63-62 -- Crane Access Platforms
63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8

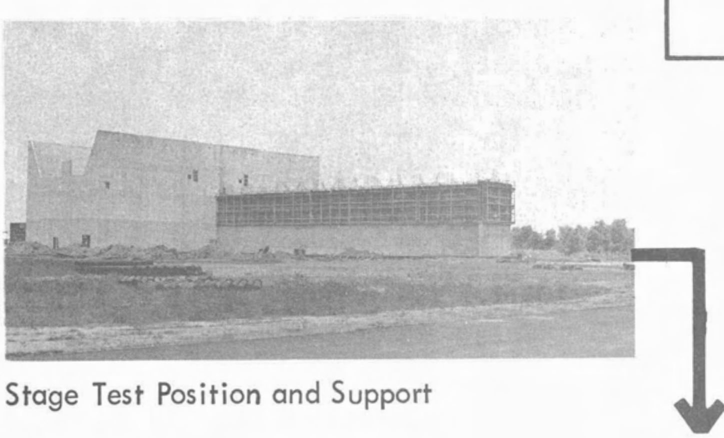
(The illustration shows a typical area)



Subsystems Test Electrical/Electronic

FACILITIES/TEST





Stage Test Position and Support

SYSTEMS TEST

ELECTRICAL/ELECTRONIC

Function - All electrical and electronic components, and subsystems of Ground Support Equipment and Saturn S-IC flight electrical and electronic systems are tested in this area. The subsystems Test electrical/electronic area is comprised of the: 1) Instrument Test Area; 2) Bench Test Area; 3) Telemetry Ground Station; 4) RF and TV Test Area; 5) Development and Special Test Area. These areas provide the capability for performing the following: testing of sensing devices, printed circuit cards, electronic chassis, various electrical and electronic components, subsystems, telemetry systems and electromagnetic radiating devices.

In addition, the facilities will provide the capability for: 1) developing special test equipment; 2) performing component and subsystems test; 3) compatibility testing between GSE and flight instrumentation and the resolution of any discrepancies disclosed in such testing.

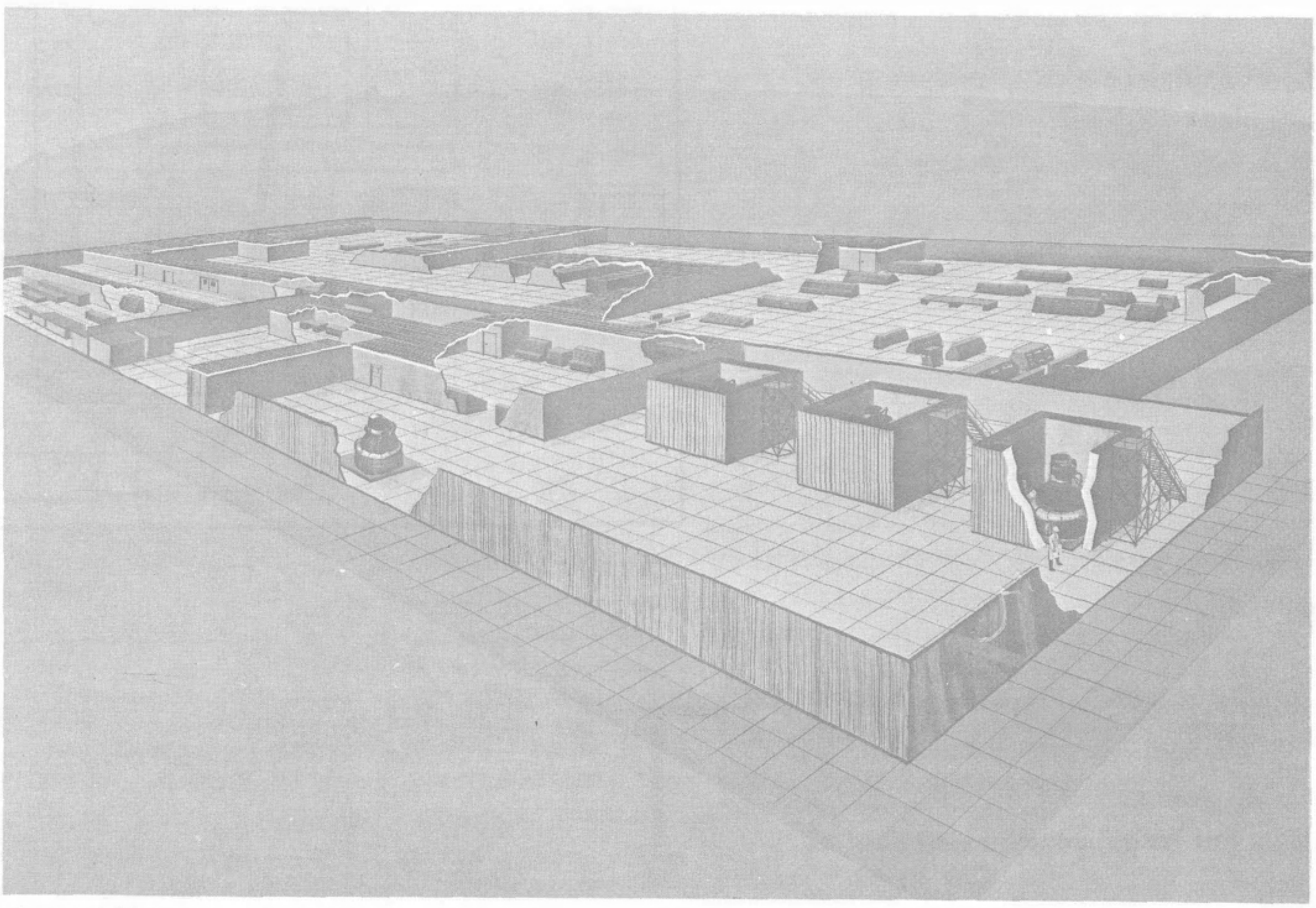
Using Organization - In-Plant Test

Area - Subsystems Test Electrical/Electronic - 14,252 square feet.

Milestones - Design Start ----------- 9-18-63
Design Complete ------- 10-23-63
Construction Start ------ 12-6-63
Construction Complete -- 4-17-6'

Contracts - In-House -- Design
63-69 ----- Construction

(The artist concept depicts the electrical/electronic area of subsystems test.)



Electrical/Electronic Area of Subsystems Test

SUBSYSTEMS TEST

MECHANICAL

Function - The Mechanical Subsystems Test area shall provide the capability of testing S-IC vehicle mechanical subsystems and components, vendor furnished items, and subsystems which have failed in static-firing or upper-level checkout. This shall include testing and measuring instruments, testing components and subassemblies that must operate at extremely low temperatures, test and proof of pressure pneumatic system components, check valve cracking pressures, and testing the LOX and fuel systems flight hydraulic components and subassemblies of the F-1 engine. Shops included in this area are: 1) Engine Test Cell; 2) Hydraulic Test Area; 3) Cryogenic Test Area; 4) Pneumatic Test Area; 5) Tool Crib; 6) Testing Staging Area, and 7) Hydrostatic Test Area.

Using Organization - In-Plant Test

Area - 27,192 square feet

Milestones - Design Start ------- 6-10-63
Design Complete --- 12-27-63
Construction Start -- 6-17-64

Anticipated completion early in the third quarter CY '64.

Contracts - 62-13 -- A&E
64-1 --- Construction

VALVE CLINIC

Function - The Valve Clinic is used for dismantling and reassembling valves. All inoperable valves, orifices, regulators, etc., are to be dismantled as required and inspected to determine the cause and extent of damage or malfunction.

Using Organization - Manufacturing

Milestones — Design Started------------6-10-63
Design Complete----------12-27-63
Construction Started ------2-11-64

Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design

TUBE AND VALVE CLEANING FACILITY

Function - The Tube and Valve Cleaning facility is required for the cleaning of fuel, LOX, and pneumatic components to the cleanliness levels required for the system. Tubing will be flushed with the proper cleaning agents, dryed, and packaged at this location. Valves and components are to be cleaned and rinsed in ultrasonically energized fluids, placed in vacuum ovens for drying, and flushed to certify the cleanliness levels.

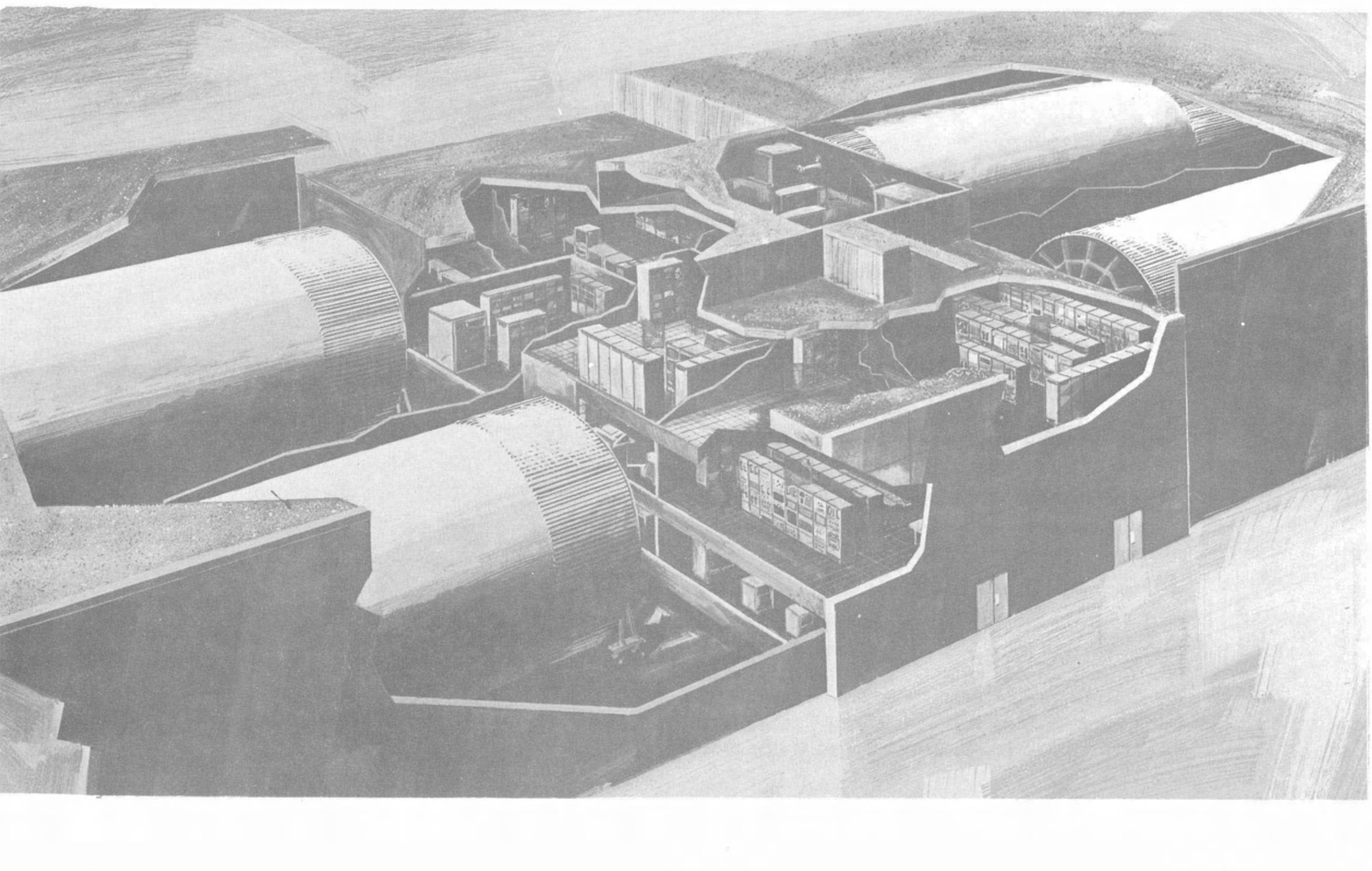
Using Organization - Manufacturing

Area - 6,670 square feet

Milestones - Design Started ---------- 6-10-63
Design Complete -------- 12-27-63
Construction Start -------2-7-64

Anticipated completion early in the third quarter CY '64.

Contracts - 64-1 -- Construction
In-House -- Design



STAGE TEST POSITION AND SUPPORT

Function - The Stage Test Position is necessary to fulfill requirements of the final stage checkout program of the S-IC stage. This will be accomplished in four stage test positions for performing various tests on the pneumatic, hydraulic, mechanical, telemetry and electrical systems of the S-IC stage to ensure system integrity.

Using Organization - In-Plant Test

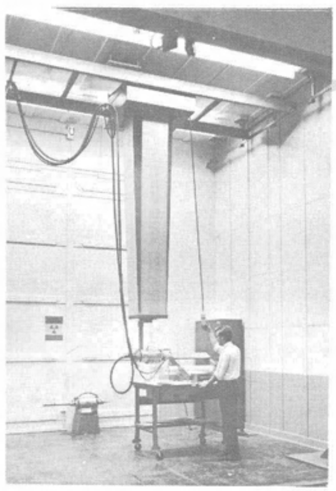
Area - 114,432 square feet (66,120 Test Cells; 48,312 support facility).

Milestones - Contract 63-71 Phase I
Design Started ----------5-24-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Construction Complete ---Is basically completed except for seeding and secondary road work which cannot be accomplished until November 1, 1964.

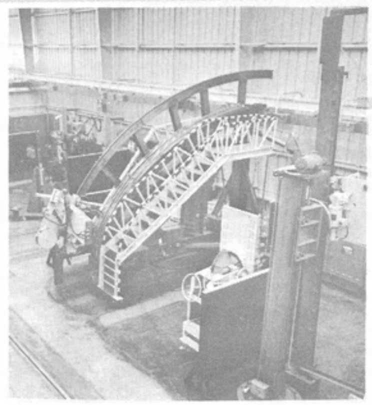
Contracts — 63-71 -- Phase I Construction
64-9 --- Phase II Construction
63-29 -- A&E

Contract 64-9 Phase II
Design Started ----------10-2-63
Design Complete --------12-5-63
Construction Started -----1-13-64
Scheduled Construction Completion -------------1-4-65

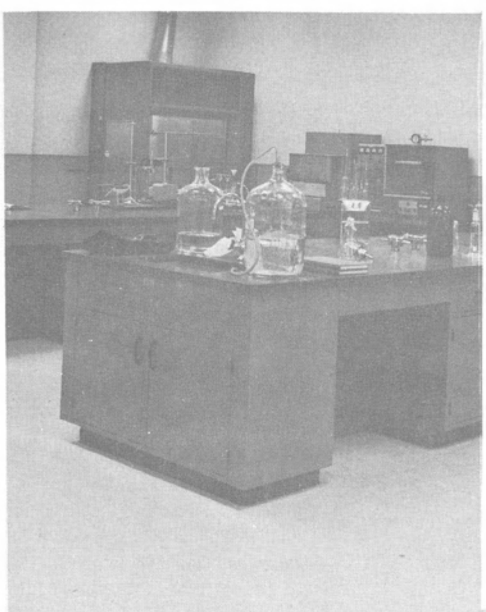
FACILITIES/LABORATORIES



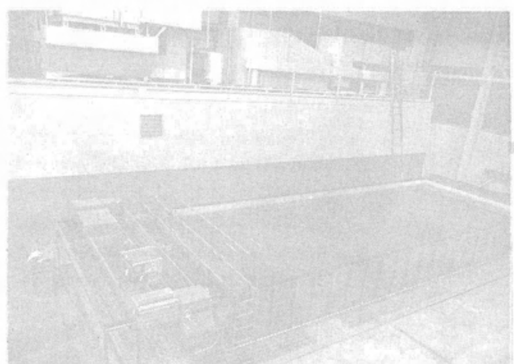
Quality Assurance
Radiographic Evaluation Laboratories



Manufacturing Development Laboratory

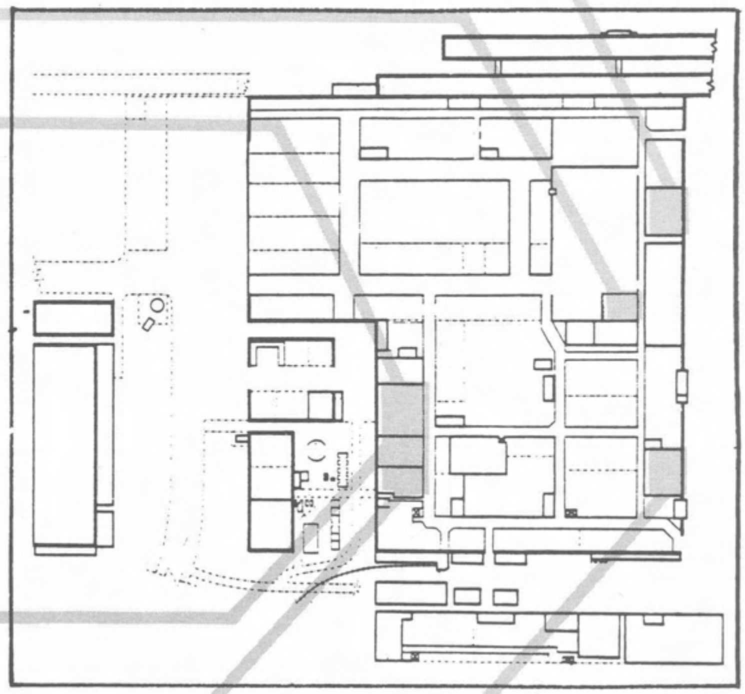


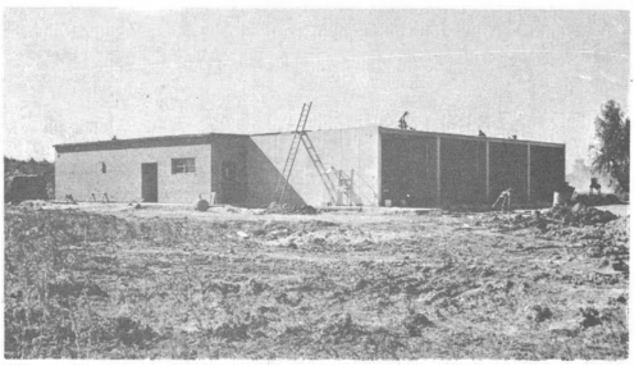
Measurement Control Laboratories



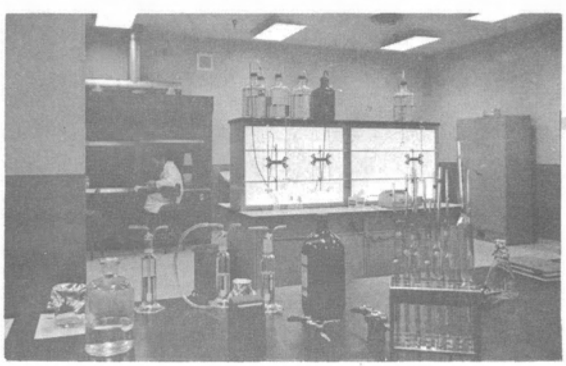
Non-Destructive Test Laboratory

Component Test Area
(Material and Processes Laboratory)





High Pressure Test Area (Remote from Plant)



Quality Evaluation Laboratories

MANUFACTURING DEVELOPMENT LABORATORY

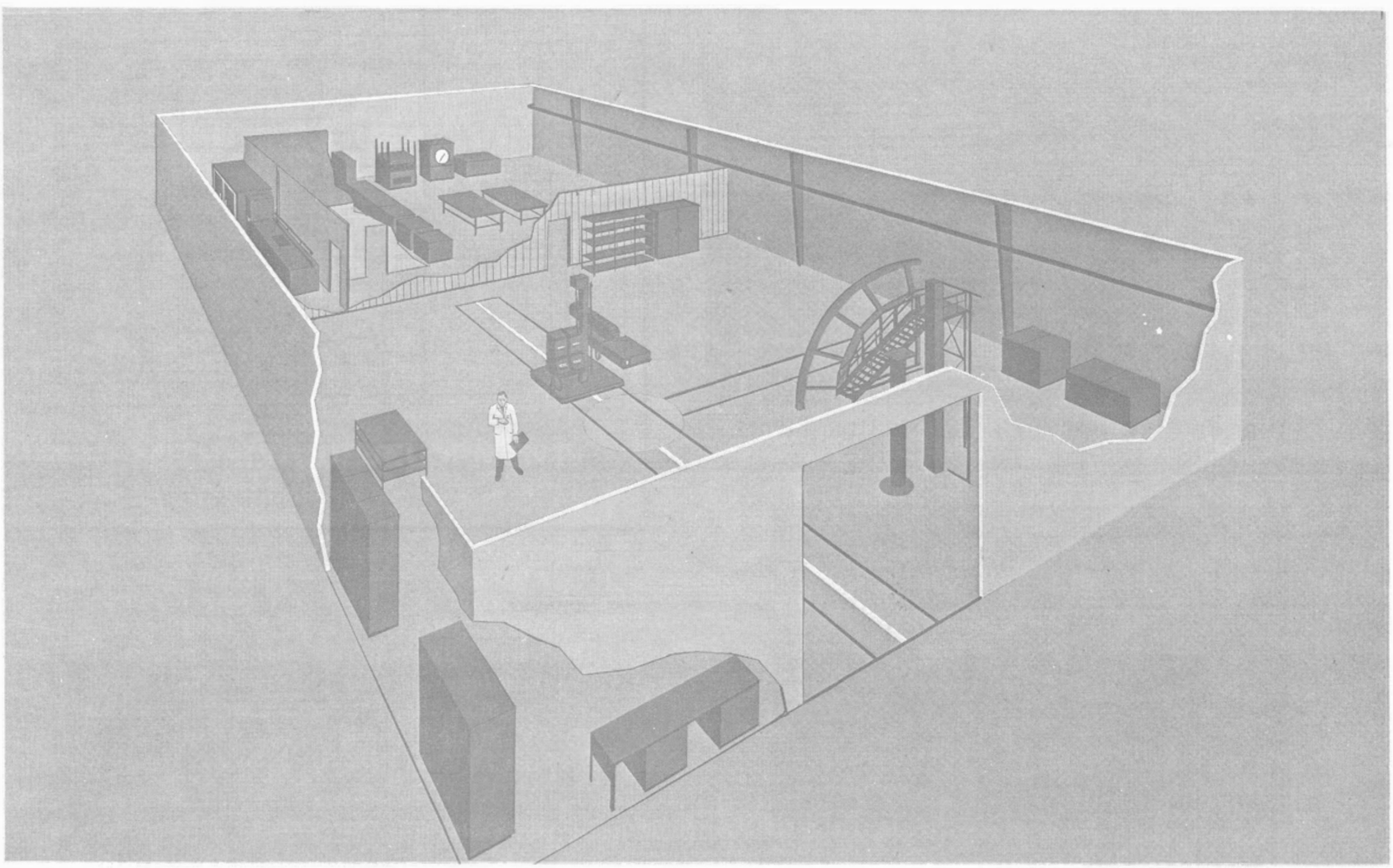
Function - This area is used for the development of new production processes, refining of existing techniques and to eliminate production problems. It also serves to train personnel in new welding methods. This laboratory is subdivided into five totally enclosed sections: 1) Welding Area, 2) Radiation Area, 3) Specimen Preparation Shop, 4) Wire and Instrument Control, and 5) NASA Office.

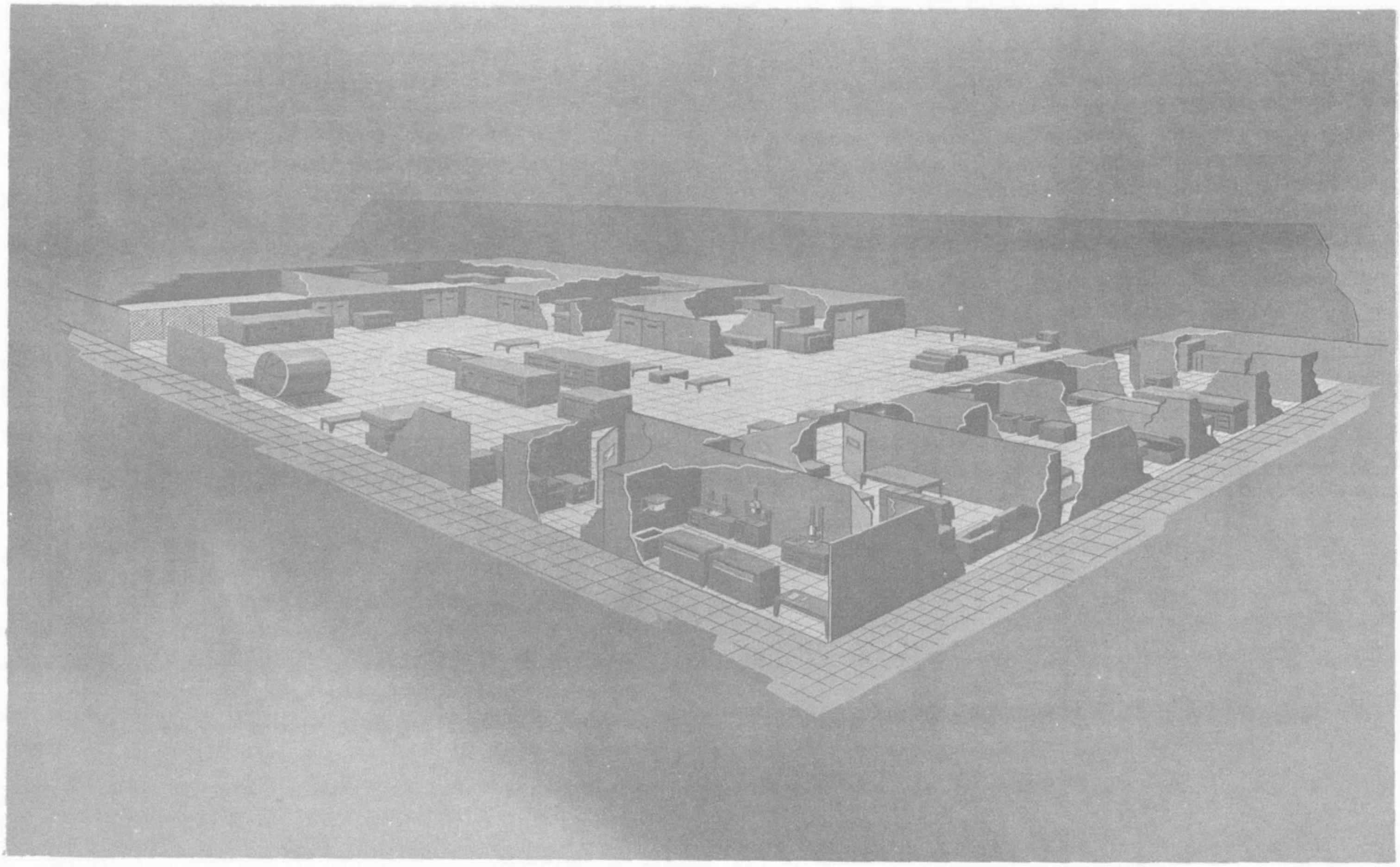
Using Organization - Manufacturing

Area - Manufacturing Development Laboratory -- 6,600 square feet.

Milestones - Design Complete ------- 6-13-63
Construction Start ------ 6-25-63
Construction Complete -- 1-3-64

Contracts - 62-15 -- A&E
63-20 -- Interim Construction
63-25 -- A&E
63-41 -- Construction
63-56 -- Construction





The above illustration shows the Material and Processes Laboratory-Component Test Area

COMPONENT TEST AREA

Function - This area is used to test various mechanical, electrical, and hydraulic components of the S-IC booster to establish and substantiate the design concepts and manufacturing techniques employed. This component testing also provides reliability assurance. Test equipment here is capable of producing, sensing, and recording simulated flight and ground handling conditions (e.g., acceleration, force, vibration, pressure, and temperature environments) to establish the high degree of reliability necessary for the first firing.

Using Organization - Engineering

Area - Component Test Areas -- 73,504 square feet

Milestones - Design Start ----------- 5-15-63
Design Complete ------- 9-26-63
Construction Start ------ 8-12-63
Construction Complete -- 6-15-64

Contracts - 63-32 -- A&E
63-55 -- Construction (Pilings)
63-58 -- Construction
63-66 -- Construction
63-68 -- Construction

HIGH PRESSURE TEST

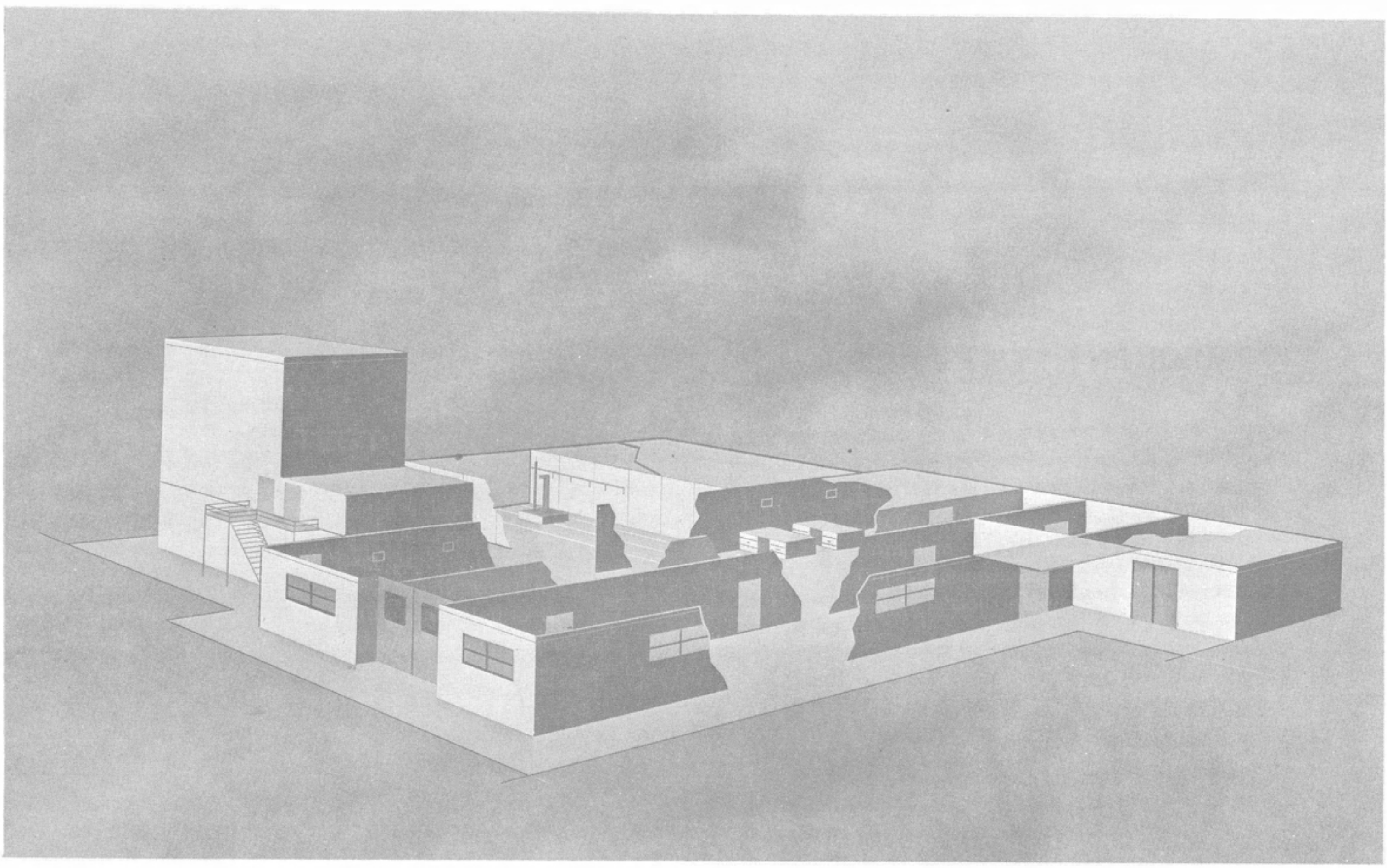
Function - The High-Pressure Test facility will be used to conduct all testing of a hazardous nature for both booster and ground support equipment. Components, subassemblies, subscale test hardware, tanks, and ground support equipment will be subjected to various pressure flow and burst tests to ensure compliance with design requirements under normal and emergency environment and operating conditions.

Using Organization - Engineering

Area - 5,020 square feet

Milestone--

High-Pressure Test:	Design Start ----------	6-12-64
	Design Complete ------	8-3-64
	Construction Start -----	9-8-64
	Construction Complete -	12-22-64
Liquid-Level Test:	Design Start ----------	2-6-64
	Design Complete ------	6-10-64
	Construction Start -----	6-29-64
	Construction Complete -	8-13-64
Helium & Nitrogen Modification:	Technical Support Start -----------------	1963
	Technical Support Complete -------------	4-21-64
	Construction Start -----	5-8-64
	Construction Complete -	10-1-64



QUALITY ASSURANCE LABORATORIES

Function--Quality Evaluation Laboratory - These laboratories are used by the Quality and Reliability Assurance organization to ensure the quality levels of all products and assemblies. Laboratories included in the Quality Evaluation Laboratories are are: 1) Chemical; 2) Metallurgical; 3) Spectro-Analysis; 4) Physical Test; 5) Equipment Quality Analysis; 6) Contamination Control.

Nondestructive Test Laboratory - Nondestructive testing equipment and techniques are maintained and used for such areas as fabrication control and special investigations, in addition to the primary receiving-inspection demands. The equipment and instrumentation of this laboratory is used by technical personnel to perform services such as examination of surface defects, internal defects, discontinuity and porosity in metal parts and welds; and also the detection of cracks and defects in both ferrous and nonferrous materials.

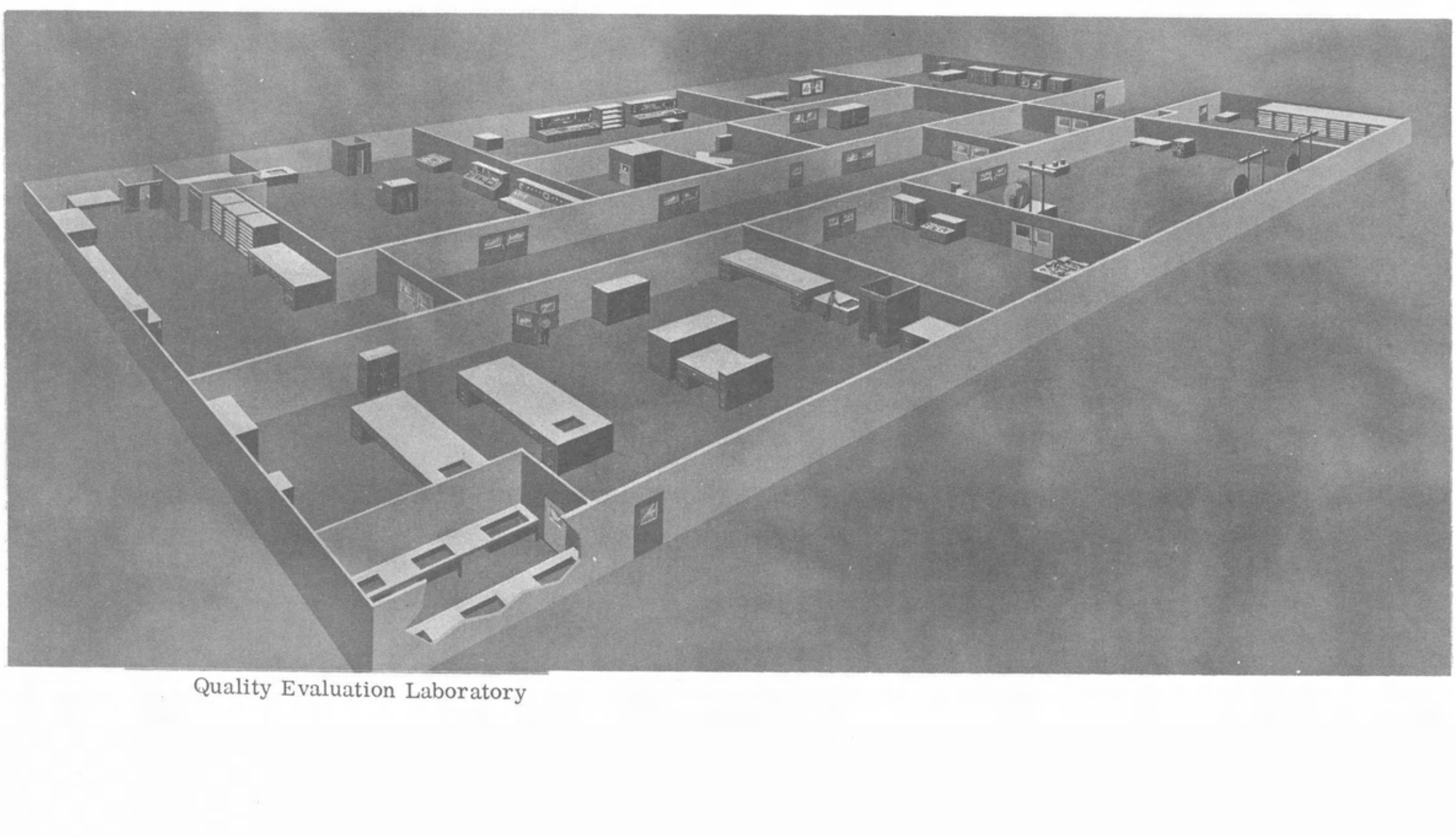
Measurement Control Laboratory - The Measurement Control Laboratory provides the capability to perform initial and periodic calibration and accuracy certification of all measuring and testing equipment used in the Boeing-Saturn Operations at Michoud. In addition, calibration-certification services for transfer standards are performed in this area in accordance with the present agreements between Boeing, Chrysler, and NASA. Laboratories included in the Measurement Control Laboratory area are: 1) Measurement Receiving Area; 2) Micorwave-Electronic Electrical Laboratory; 3) Precision Measurement Laboratory; 4) Pyrometry-Pressure Flow Laboratory; 5) Measurement Office Area.

Using Organization - Quality Assurance

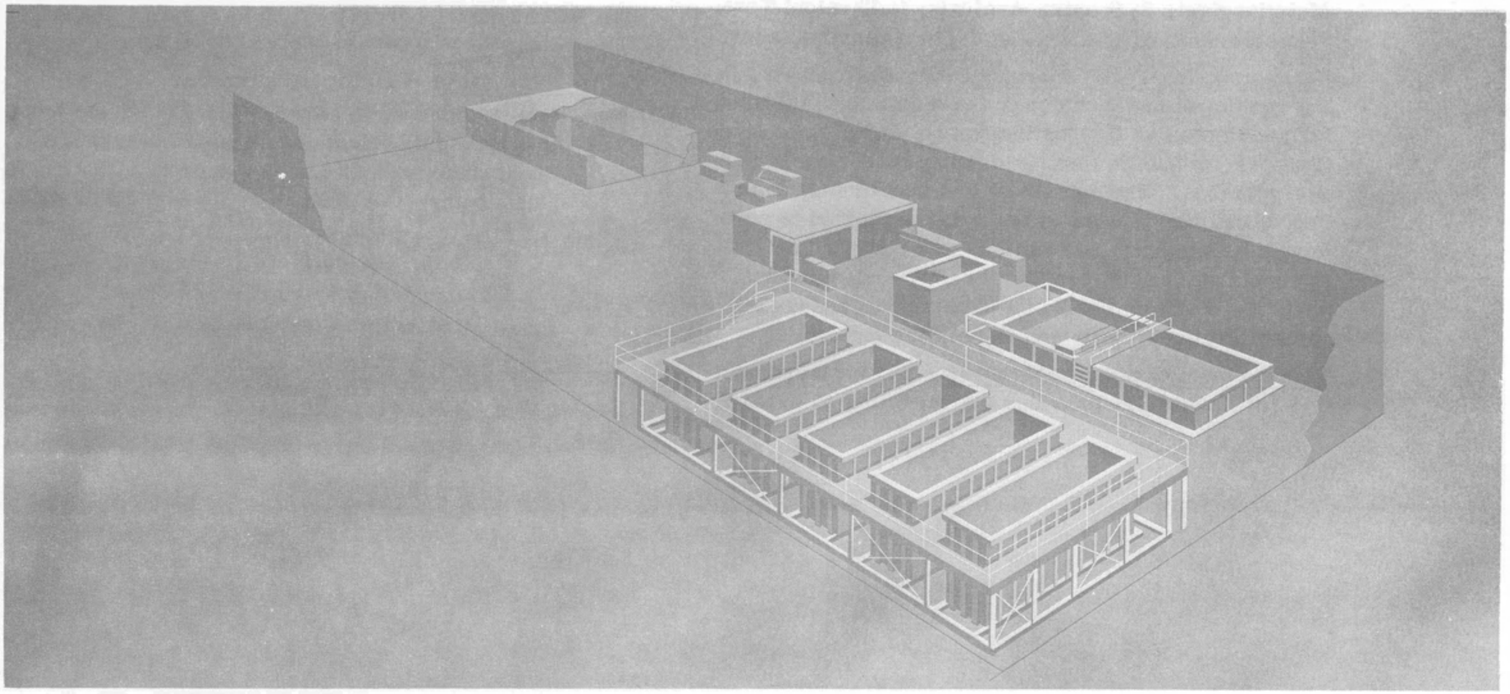
Area - Quality Assurance Labs---- 28,714 square feet
Qualification Evaluation Lab-approx. 8,970 sq. ft.
Nondestructive Test Lab---- approx. 8,000 sq. ft.
Measurement Control Lab---approx. 9,660 sq. ft.

Milestones - Design Started --------- 1-1-63
Design Complete ------- 6-5-63
Construction Started ---- 7-30-63
Construction Complete -- 5-15-64

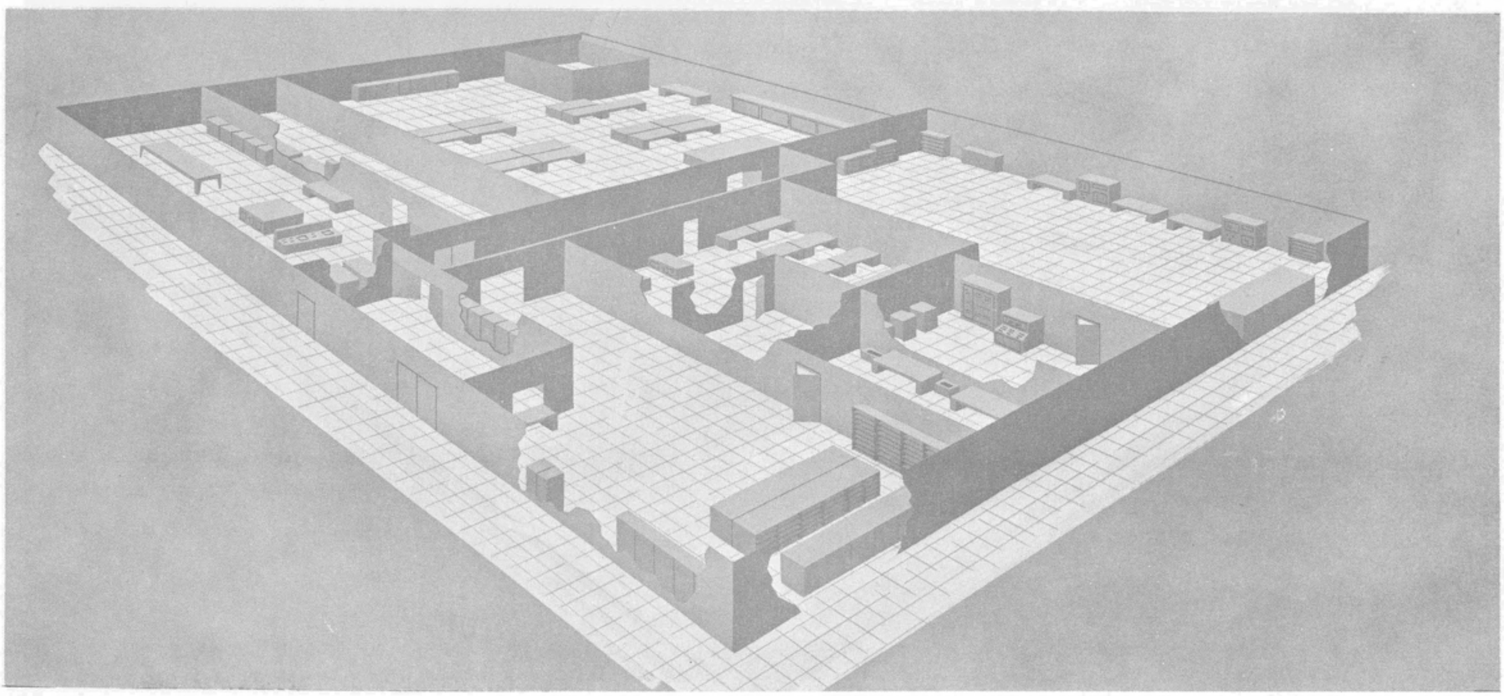
Contracts - 62-11 -- A&E
63-3 --- Construction



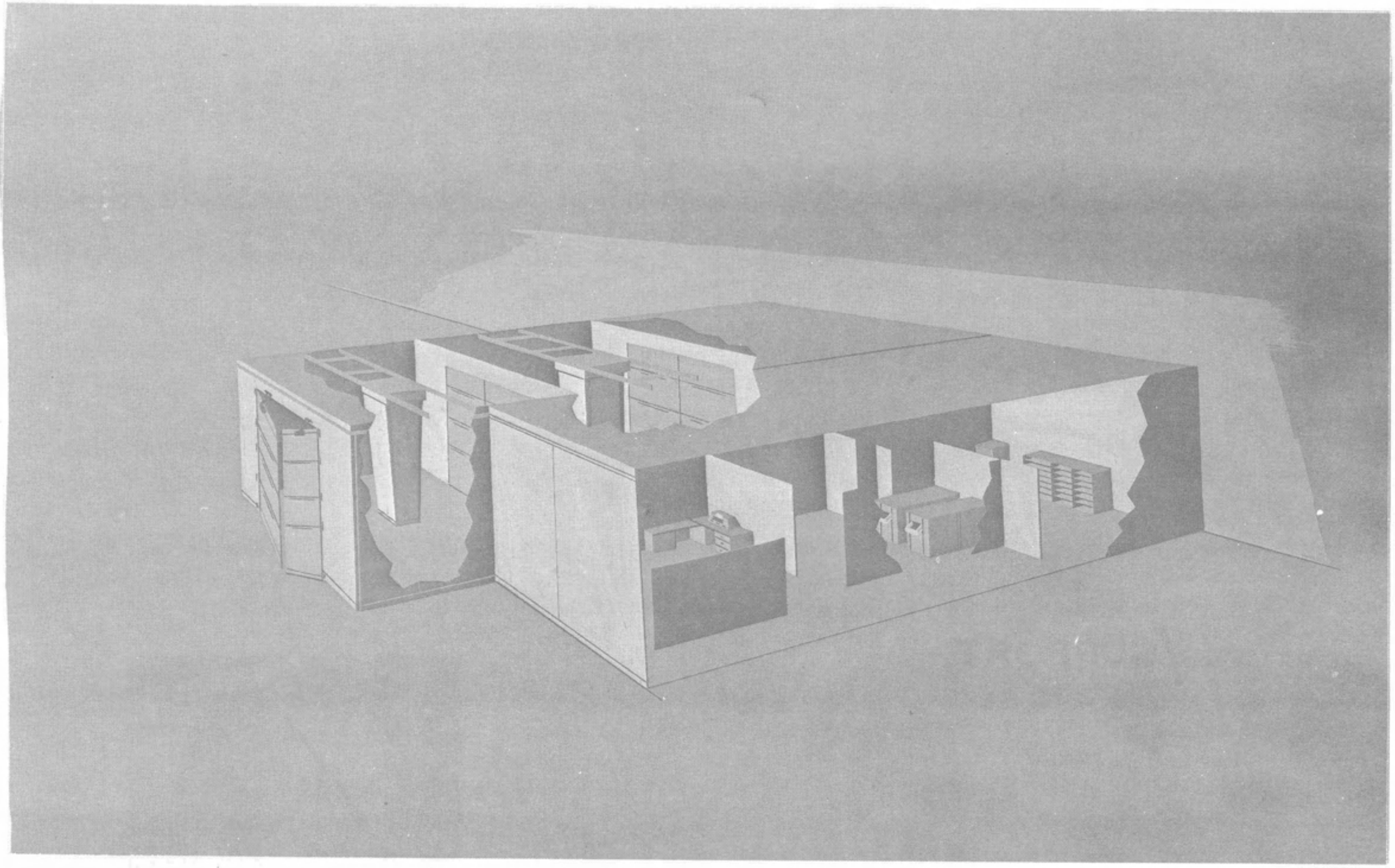
Quality Evaluation Laboratory



Non-Destructive Test Laboratory



Measurement Control Laboratories



QUALITY ASSURANCE RADIOGRAPHIC EVALUATION LABORATORIES

Function - The Centralized Radiographic Evaluation Laboratory provides both X-ray and radio-chemical evaluation support for weld development, weldor certification, and weld and raw material inspection. This laboratory is equipped to detect, evaluate, and record surface and subsurface discontinuities in welds and materials. It also provides for the developing and storage of the permanent X-ray film records for the total S-IC fabrication program.

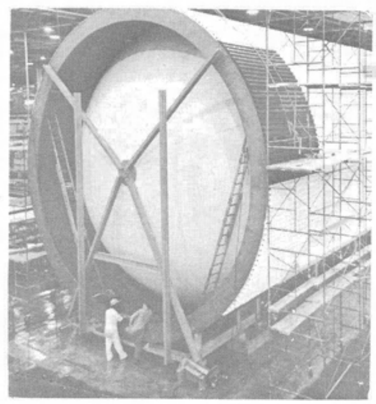
Using Organization - Quality Assurance

Area - Quality Assurance Radiographic Laboratory -- 3,443 square feet.

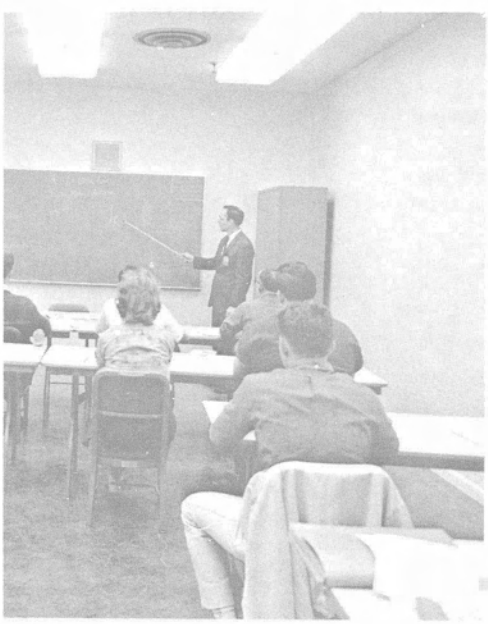
Milestones - Start Redesign ----------- 2-27-63
Partial No. 34 Complete -- 4-10-63
Design Complete --------- 5-29-63
Construction Started ------ 6-19-63
Construction Complete ----12-6-63

Contracts - 62-7 --- A&E and In-house Design
63-45 -- Construction

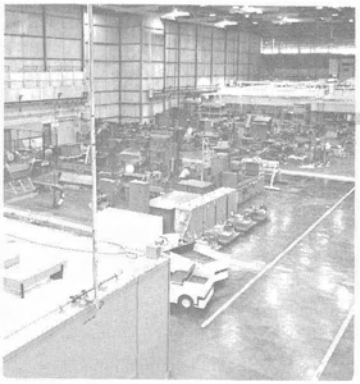
FACILITIES/SUPPORT



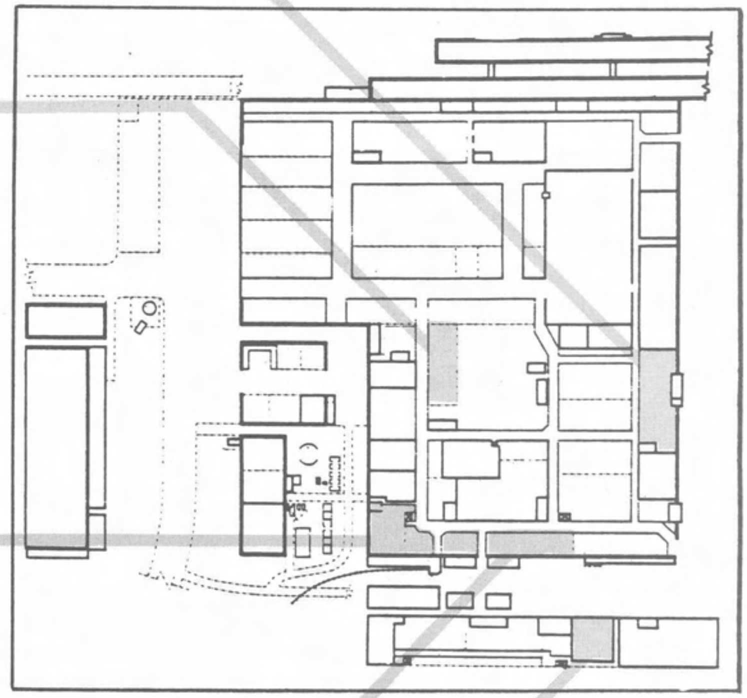
Mockup Facility



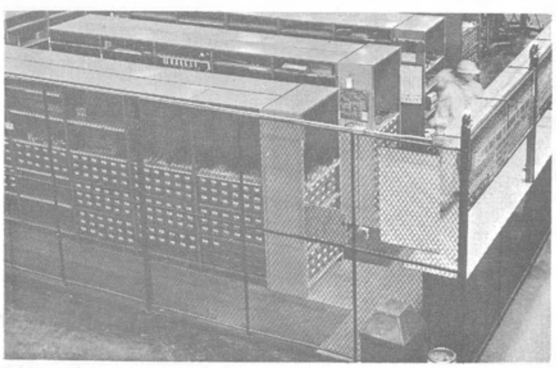
Support and Services Area - Familiarization and Training



Equipment Maintenance Facility



Receiving and Receiving Inspection Facility



Warehouse and Stores

RECEIVING AND RECEIVING INSPECTION FACILITY

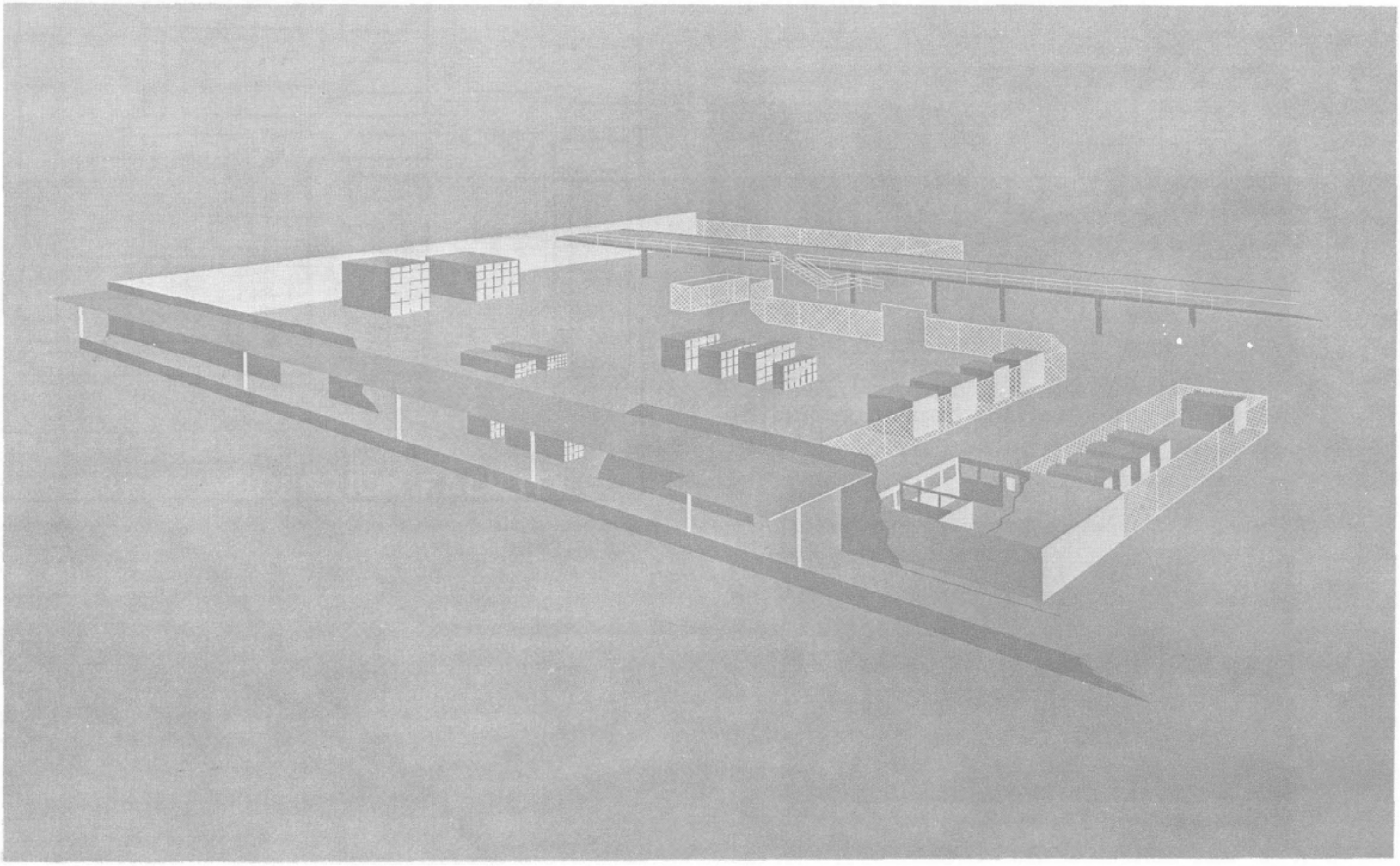
Function - The Receiving-Inspection area receives those components supplied by vendors, subassemblies, raw materials, and test equipment from the general receiving area. These items receive a planned inspection to verify compliance with specifications and general acceptance requirements. Visual and dimensional inspections are performed here with support from the Quality Evaluation Laboratories.

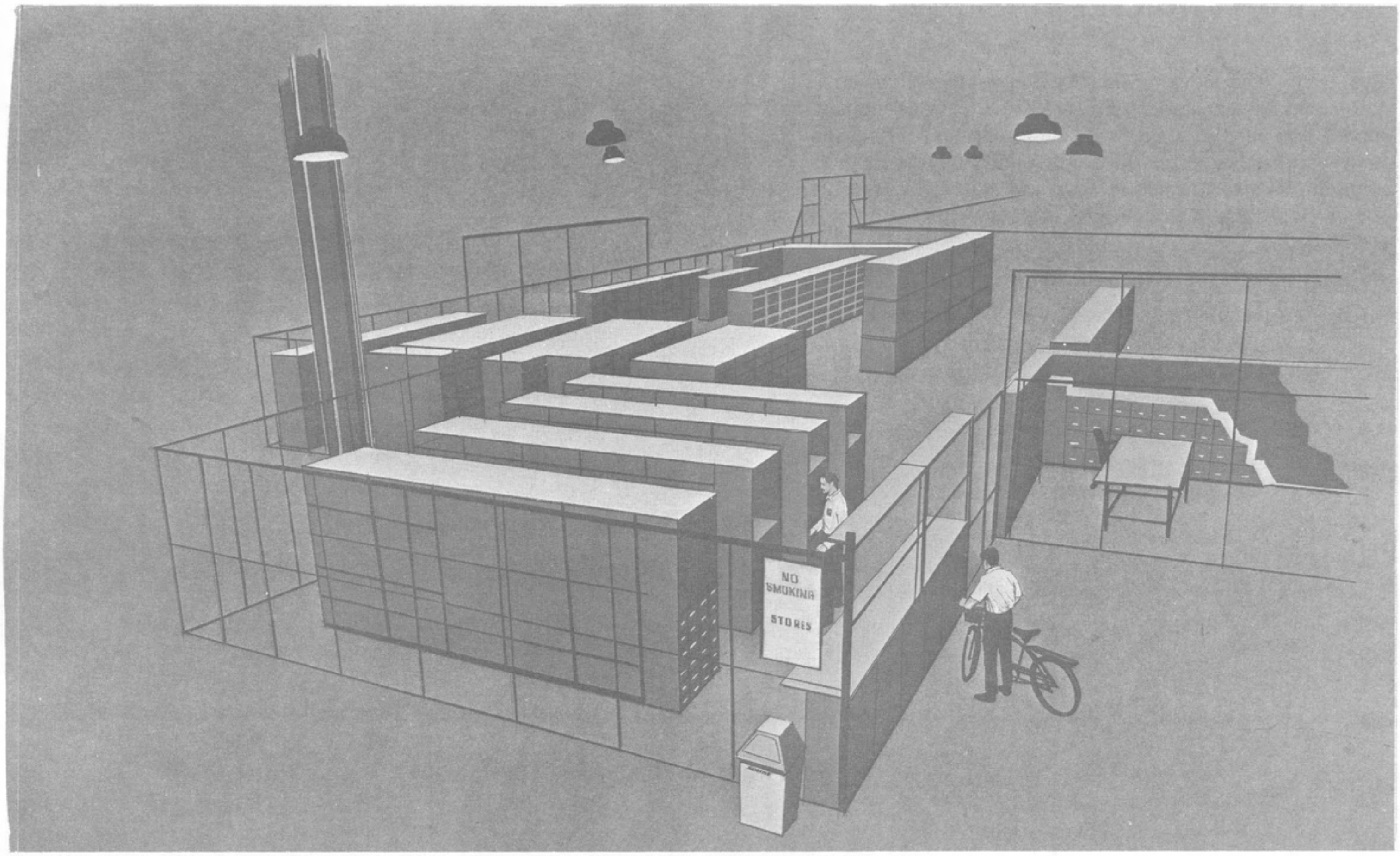
Using Organization - Finance and Quality Assurance

Area - Receiving and Receiving-Inspection Facility -- 24,506 square feet.

Milestones - Design ---------------- 6-20-63
Design Complete --------8-1-63
Construction Start ------ 9-10-63
Construction Complete -- 11-26-63

Contracts - 62-4 -- A&E
63-56 - Construction





WAREHOUSE AND STORES

Function - Foundations must be provided for special tool- the capability to store raw materials and subcontractor supplied items as required to support the manufacture of the S-IC booster.

Using Organization - Materiel

Area - 122,779 square feet

Milestones - Equipment Installation Started - 8-20-63
Equipment Installation Complete - 11-14-63

Contracts - 62-4 -- A&E

MOCKUP FACILITY

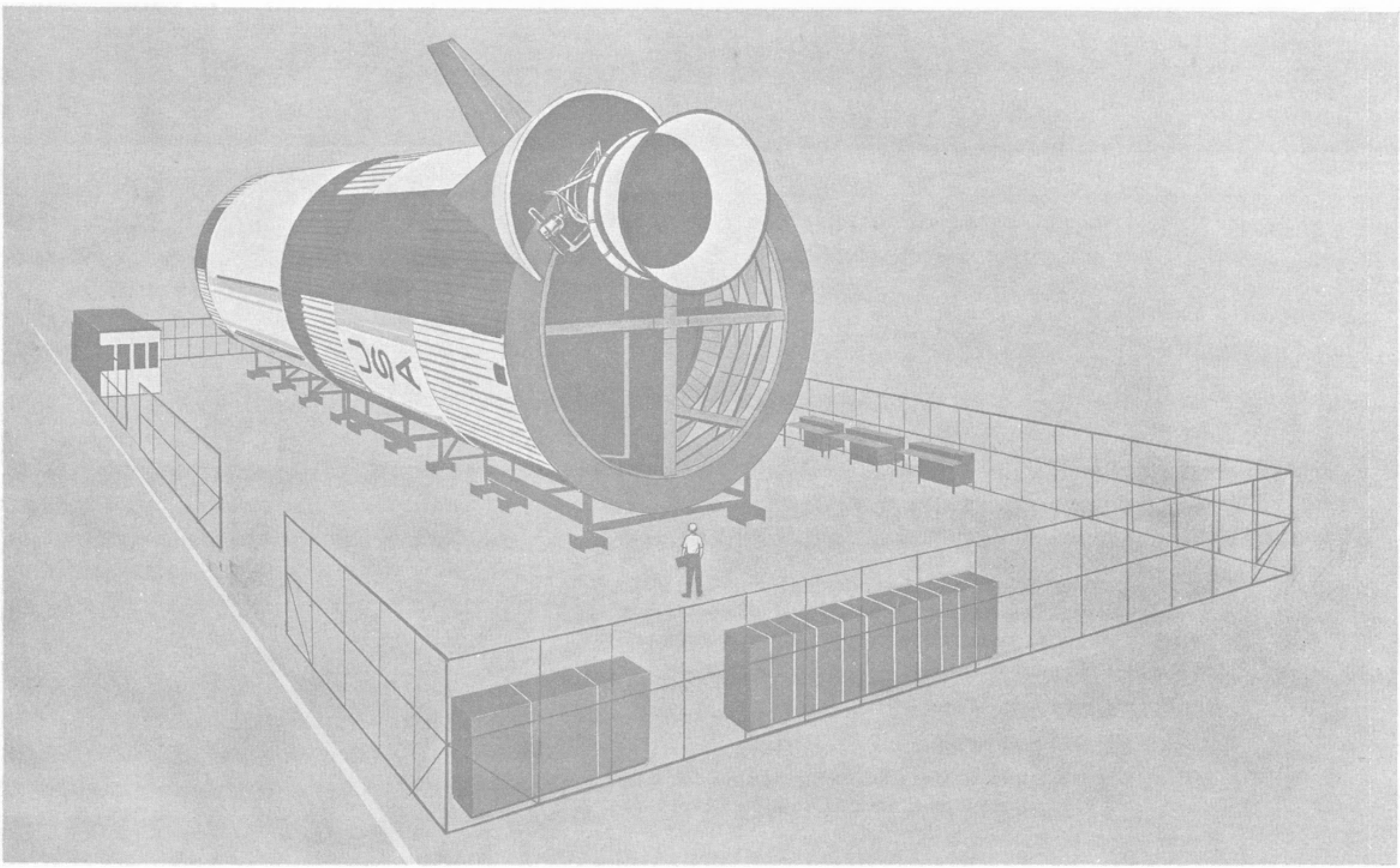
Function - The Mockup Facility houses the Michoud full-scale S-IC manufacturing model. This horizontal model was built to a Class III configuration. It serves as a forming board for developing and fabricating propulsion, electrical, astrionics, and hydraulic systems; for critical tank contours; and for component assembly locations.

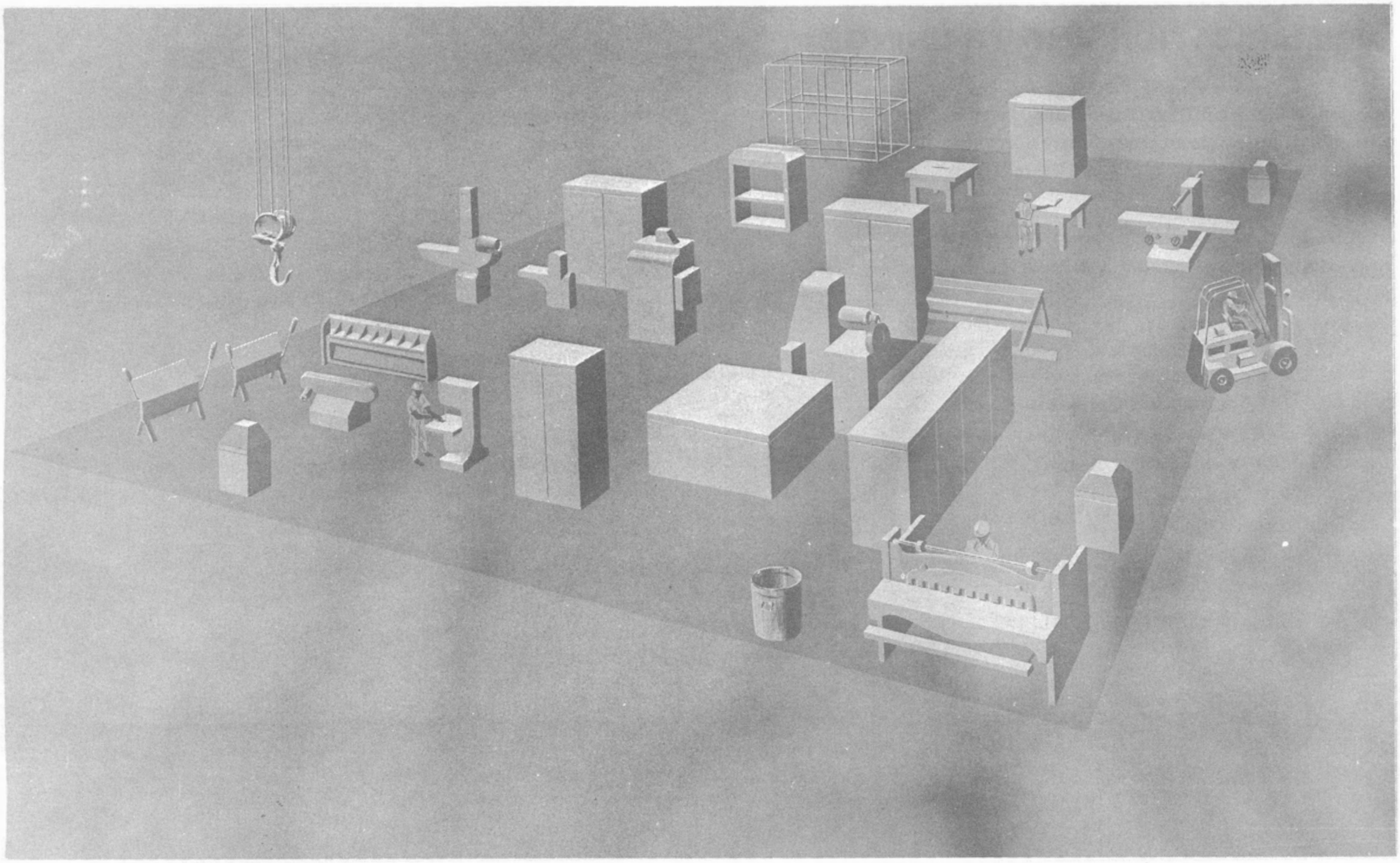
Using Organization - Manufacturing

Area - Full-Scale Model Facility -- 14,400 square feet

Milestones - Design Start ----------- 5-1-63
Design Complete ------- 10-8-63
Construction Start ------ 10-25-63
Construction Complete -- 12-27-63

Contracts - Design -- In-house
63-63 --- Construction





EQUIPMENT MAINTENANCE FACILITY

Function - The Equipment Maintenance facility is required to provide maintenance for general factory and office equipment. It affords the capability of fabricating items that, because of economy or scheduling, are not purchased from vendors; and provides for maintenance of production machine tools, fixtures and other accessory equipment, air-conditioning equipment and systems, metal office equipment, production welders, and general plant items. The facility is capable of housing and providing for maintenance of mobile equipment and consists of the following:

1) Machine Shop
2) Sheet-Metal
3) Woodwork Shop
4) Electrical Shop
5) Paint Shop
6) Transportation
7) Facilities Checkout Equipment
8) Filter Cleaning Facility

Using Organization - Facilities

Area - Equipment Maintenance facility — 23,678 square feet.

Milestones - Design Start ----------- 6-26-63
Design Complete ------- 9-30-63
Construction Start ------ 10-25-63
Construction Complete -- 3-26-64

Contracts - Design -- In-house
63-61 --- Construction

SUPPORT AND SERVICES AREAS
FAMILIARIZATION AND TRAINING

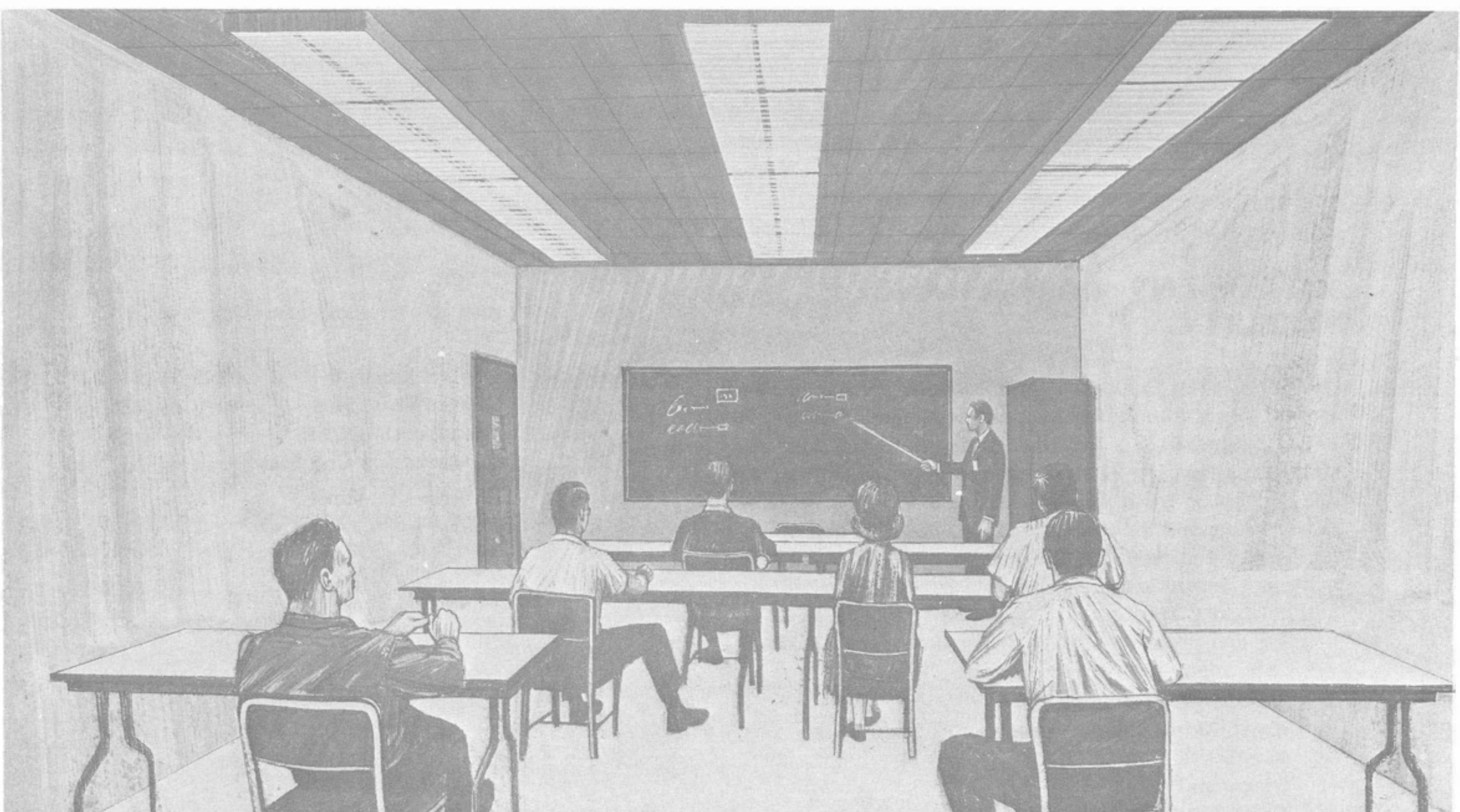
Function - The Familiarization and Training area will be used to train, orient, and certify personnel in sheet-metal assembly work, electrical fabrication, and optical tooling.

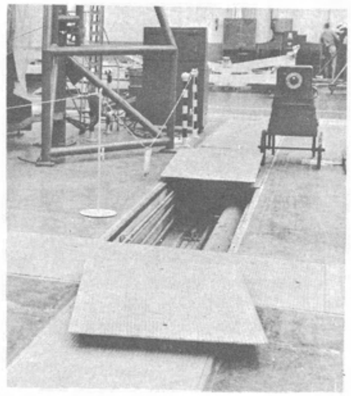
Using Organization - Industrial Relations Organization

Area - Familiarization and Training Facility -- 11,660 square feet.

Milestones - Design Start ----------- 9-15-63
Design Complete ------- 10-28-63
Construction Start ------ 10-28-63
Construction Complete -- 2-14-64

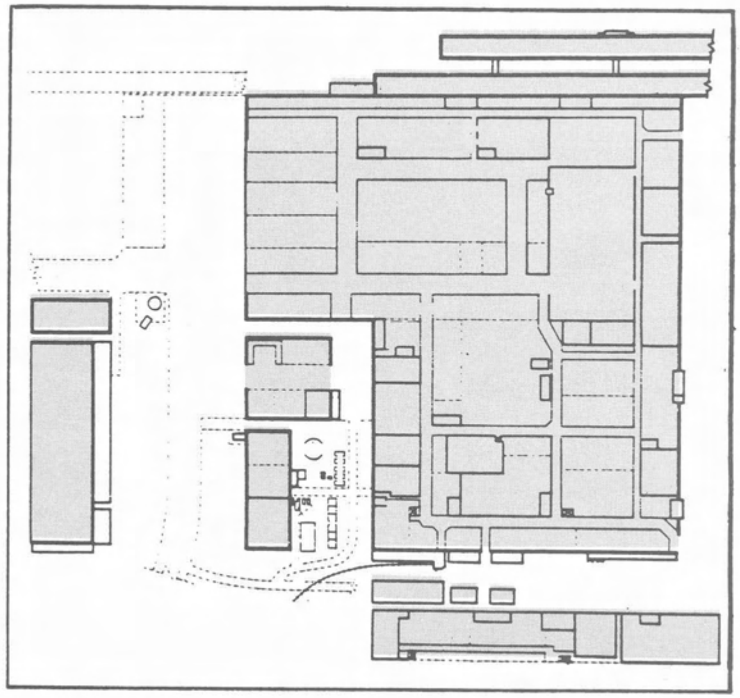
Contracts - 63-27 -- A&E
63-47 -- Construction

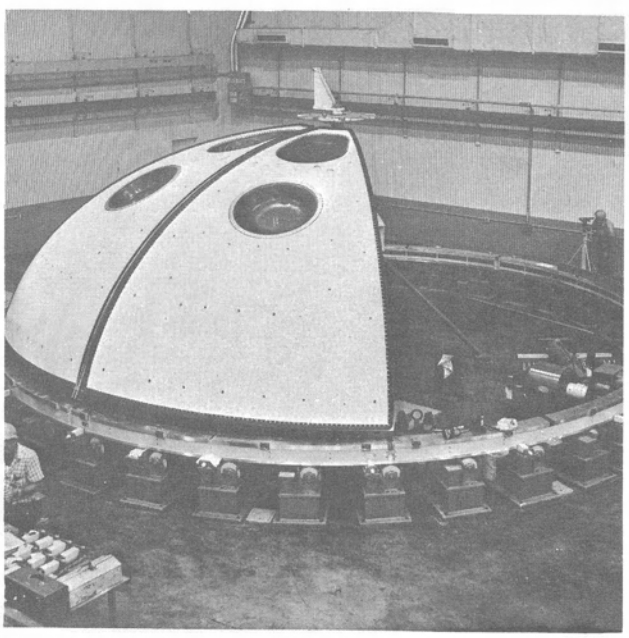




Special Gas Facilities

FACILITIES/**GENERAL PLANT**





Special Tooling Foundations

SPECIAL GAS FACILITIES

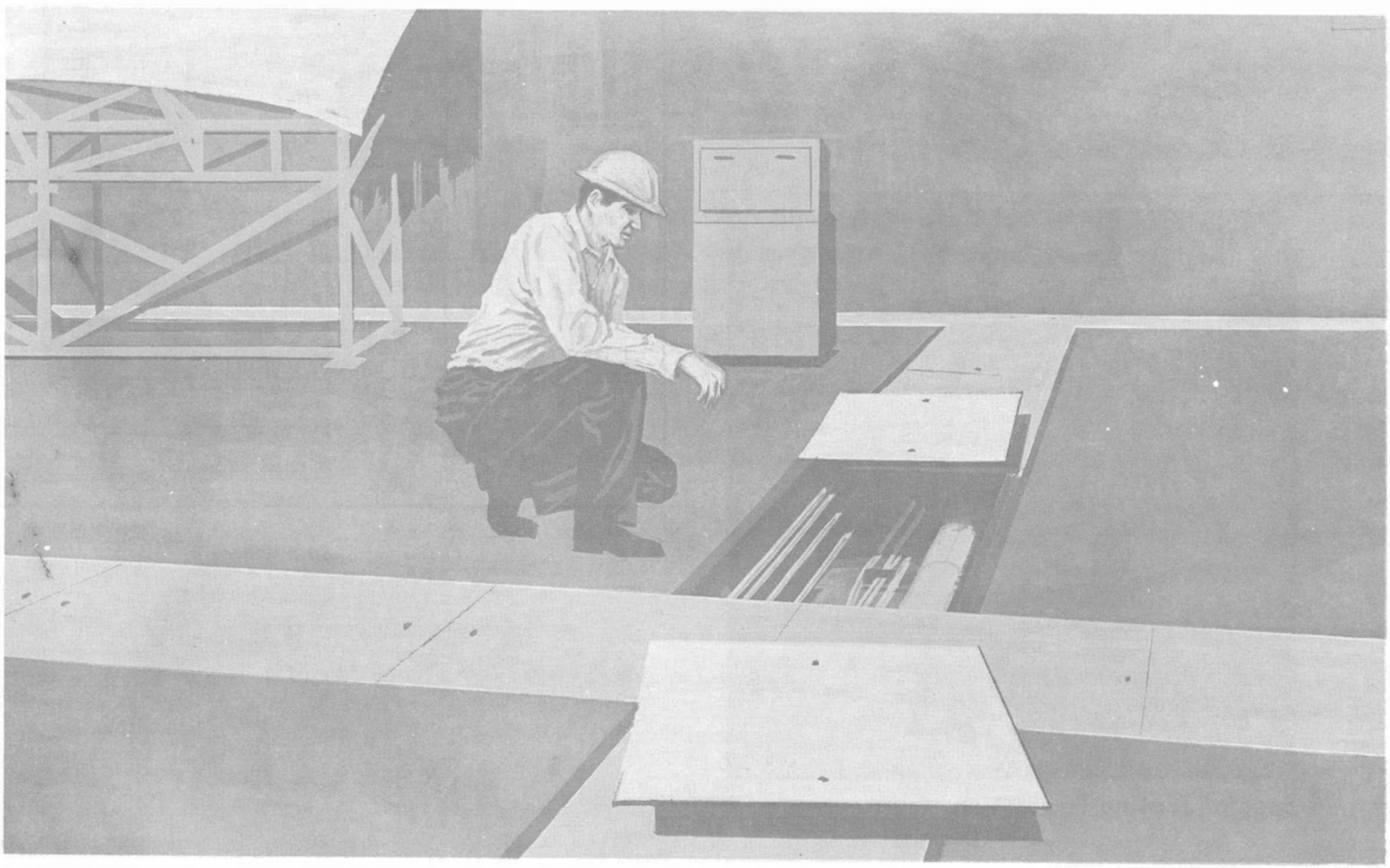
Function - The Special Gas facility will handle piped gaseous nitrogen (GN_2), helium, and argon; and liquid nitrogen (LN_2) stored in pressure vessels. Nitrogen will be used for testing, drying, packaging and purging. Helium will be used for pressurization and to create an inert atmosphere for certain welding processes. The principal use of argon is to be for weld shieldings. Small amounts of bottled CO_2 and CCl_2F_2 (Refrigerant 12) will also be used, primarily for instrumentation testing and other laboratory functions.

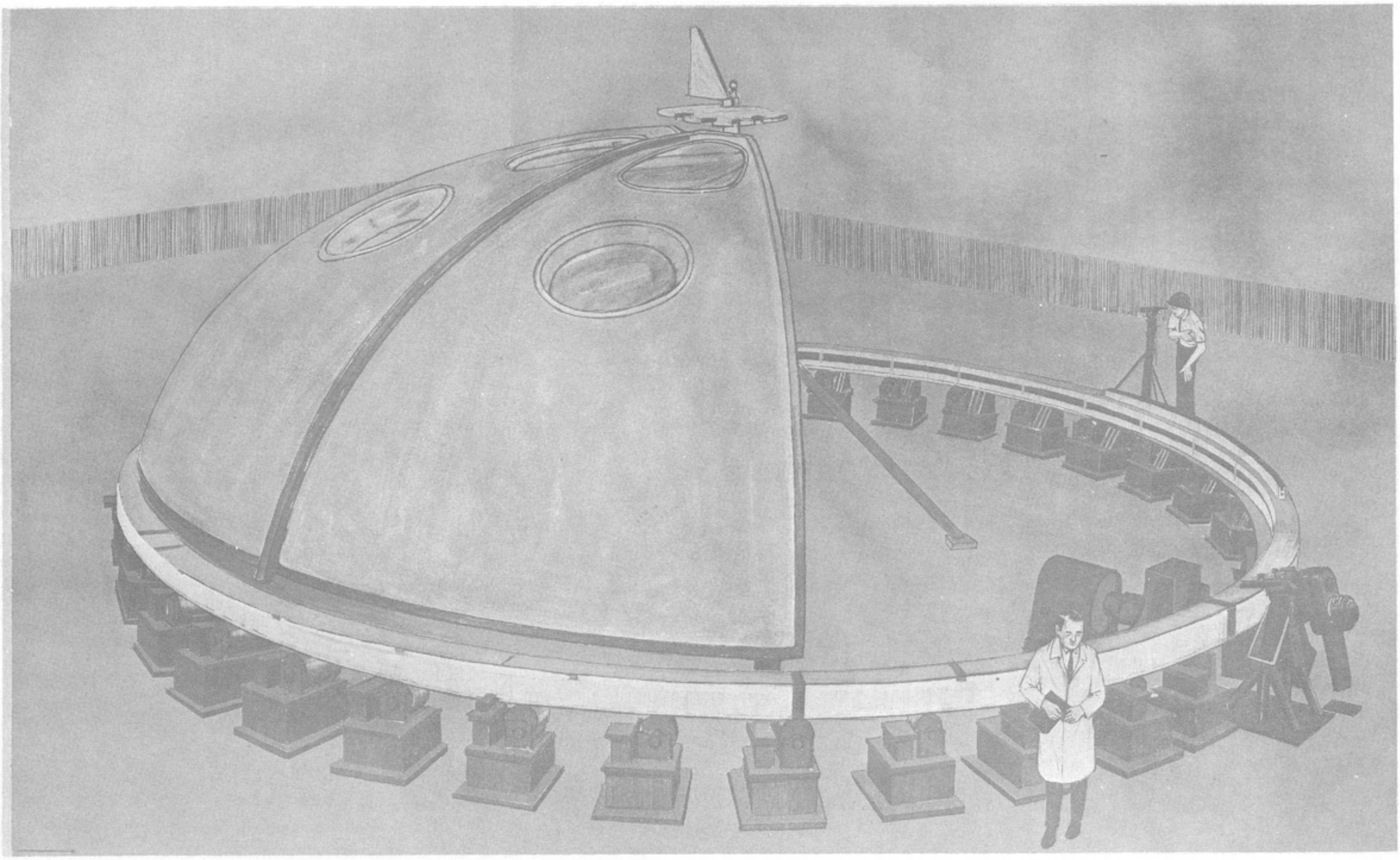
Using Organization - Manufacturing

Area - Not applicable

Milestones - Design Started --------- 1-1-63
Design Complete ------- 8-13-63
Construction Started ---- 12-21-63
Construction Complete -- 4-3-64

Contracts - In-house -- Design
63-53 -----Construction





SPECIAL TOOLING FOUNDATIONS

Function - Foundations must be provided for special tooling required in the assembly and manufacture of the S-IC booster and GSE/MSE.

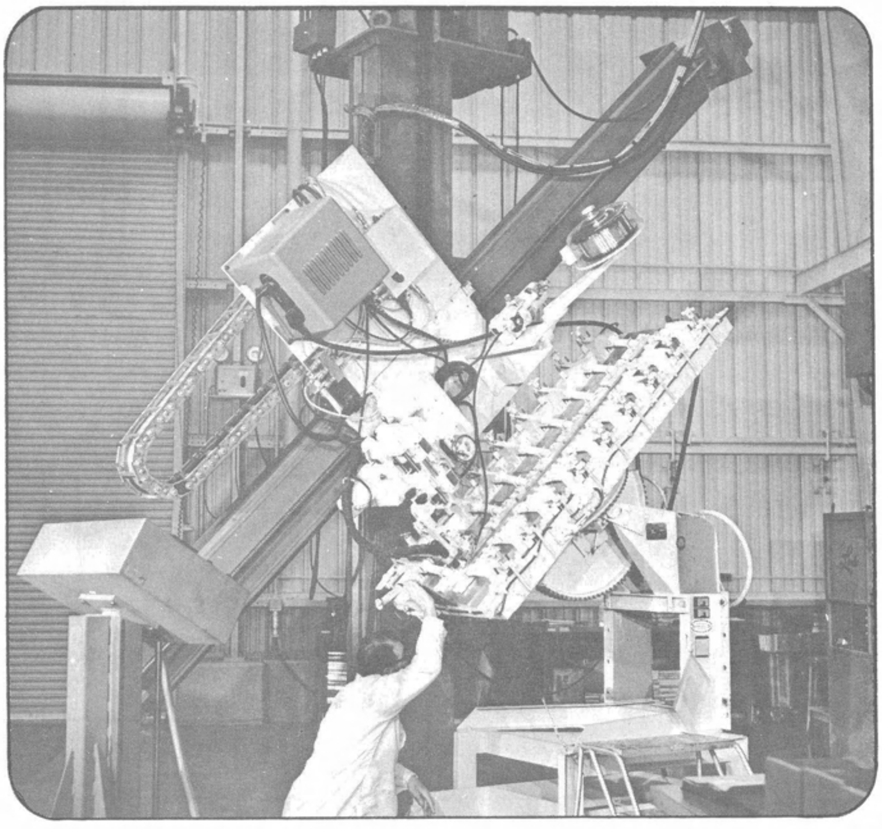
Using Organization - Manufacturing

Area - Not applicable

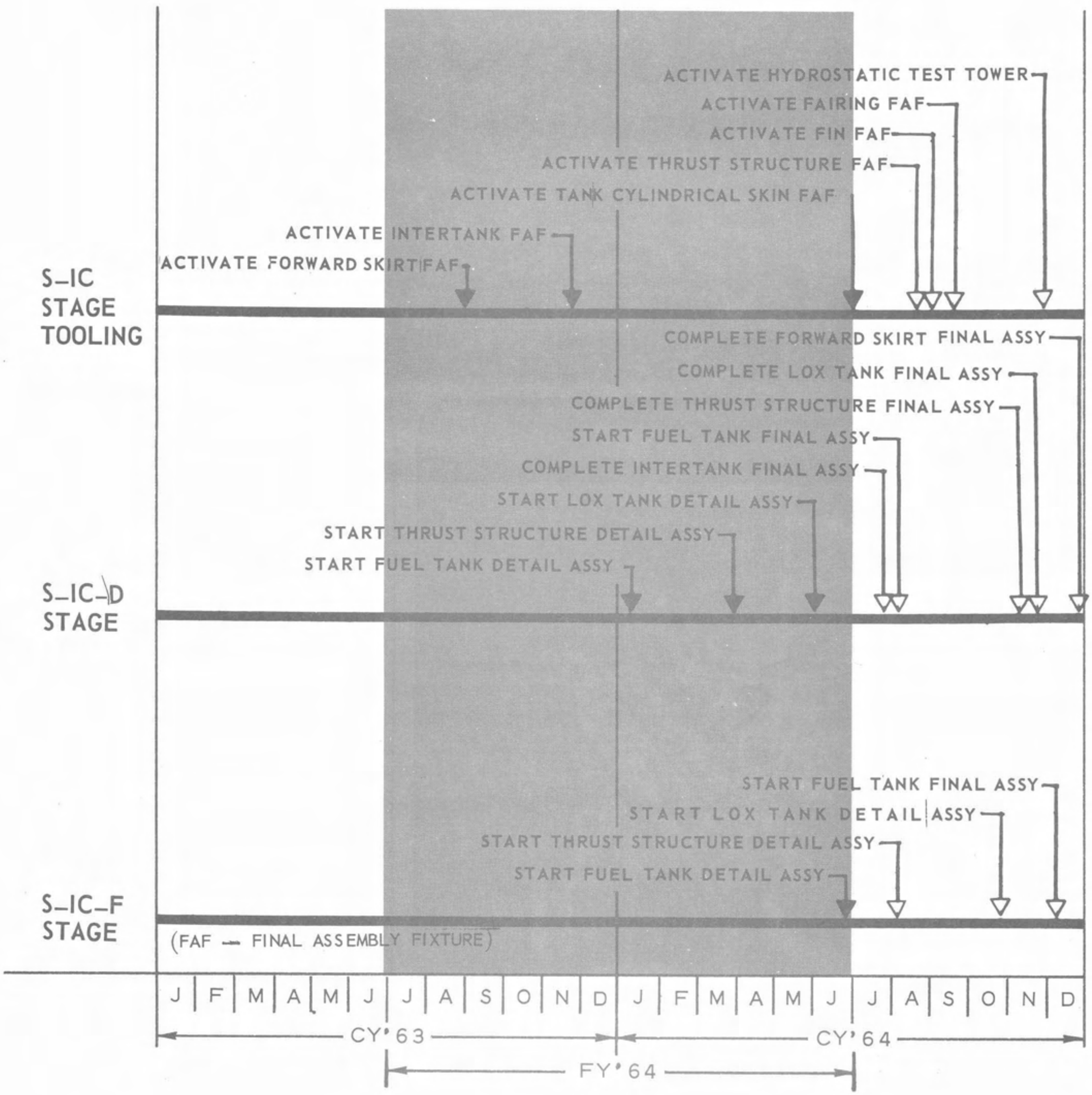
Milestones - Special Tooling Foundations Phases 5, 6, 7, and 8.

Phase 5 Started ---- 1963
Phase 5 Complete -- 9-27-63
Phase 6 Started ---- 1963
Phase 6 Complete -- 10-31-63
Phase 7 Started ---- 1963
Phase 7 Complete -- 2-29-64
Phase 8 Started ---- 1963
Phase 8 Complete -- 3-1-64

Contracts - 63-35 -- Special Tooling Foundations Phase 5
63-55 -- Special Tooling Foundations Phase 6
63-61 -- Special Tooling Foundations Phase 7
63-67 -- Special Tooling Foundations Phase 8



ASSEMBLY AND MANUFACTURING


ACTIVATE HYDROSTATIC TEST TOWER
ACTIVATE FAIRING FAF
ACTIVATE FIN FAF
ACTIVATE THRUST STRUCTURE FAF
ACTIVATE TANK CYLINDRICAL SKIN FAF
ACTIVATE INTERTANK FAF
ACTIVATE FORWARD SKIRT FAF
S-IC STAGE TOOLING
COMPLETE FORWARD SKIRT FINAL ASSY
COMPLETE LOX TANK FINAL ASSY
COMPLETE THRUST STRUCTURE FINAL ASSY
START FUEL TANK FINAL ASSY
COMPLETE INTERTANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-D STAGE
START FUEL TANK FINAL ASSY
START LOX TANK DETAIL ASSY
START THRUST STRUCTURE DETAIL ASSY
START FUEL TANK DETAIL ASSY
S-IC-F STAGE
(FAF — FINAL ASSEMBLY FIXTURE)
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

SUMMARY

S-IC stage assembly and manufacturing activity at the beginning of this reporting period was primarily oriented to structure component manufacture in support of the NASA/MSFC ground test program, and the fabrication and erection of stage tooling at Michoud. During the last three months of 1963, the scope of work was expanded to include increased procurement of stage systems specialty hardware, and components for test and checkout equipment. Ground support equipment (GSE) requirements for the NASA/MSFC ground test program were also defined during the same period, permitting Boeing to assess their capability to deliver equipment for R-Test and R-Qual laboratories at MSFC. By the end of June 1964, firm delivery dates were established for R-Test GSE, and the requirements were formally established for one set of test and checkout equipment to be installed at Mississippi Test Operations.

On January 22, 1964, the program schedule changed from NASA/MSFC Plan V to NASA/MSFC Plan VII. (See Part X of this report for a discussion of this change.) This changed The Boeing Company's responsibilities from providing the S-IC-F stage, and the S-IC-2 through S-IC-10 stages to providing the S-IC-D, the S-IC-F and the S-IC-3 through S-IC-10 stages. In conjunction with these program revisions, assembly and manufacturing activities were rephased to the new Plan VII schedule requirements. By the end of the first quarter of CY'64, Boeing had incorporated Plan VII schedules into its stage production schedules, established a GSE/MSE manufacturing program that supported the defined requirements of both MSFC and Michoud operations, and had made substantial progress in manufacturing development.

At the end of the first quarter of CY'64, delay of construction on the hydrostatic test facility for the Michoud vertical assembly building suggested a slippage in completion of the S-IC-D stage. However, by the end of the reporting period, the condition had been lessened and was no longer considered a problem affecting delivery of the S-IC-D. Other major problems during March 1964, were: indications of major rework to intertank tooling resulting from potential structural changes to intertank hardware; and incompatabilities between Boeing production requirements and delivery schedules proposed by NASA/MSFC for government-furnished F-1 engines, beginning with the S-IC-3 stage. The requirement for redesigned intertank hardware became firm in the second quarter of CY'64 and Boeing assembly and manufacturing schedules were adjusted to absorb two additional intertank assemblies, plus the necessary rework of the assembly tooling. Resolution of the NASA/MSFC-Boeing F-1 engine schedules was still being studied at the close of the reporting period.

At the end of June 1964, The Boeing Company's Contract NAS8-5608 assembly and manufacture activity included assembly operations on S-IC-D hardware and GSE/MSE for all locations. Minor behind-schedule conditions existed in several areas; however, recovery is predicted and all GSE/MSE and S-IC stages are forecast to be delivered per the NASA/MSFC Plan VII schedule requirements.

S-IC-D STAGE

The Boeing Company activity for the S-IC-D stage, Plan V requirements, was directed toward assisting NASA/MSFC in a role similar to that of the S-IC-T stage; namely, that of supplying NASA/MSFC specific assemblies, major components, and hardware items as required. NASA/MSFC Plan VII effected the realignment of The Boeing Company responsibilities to include assembly of the S-IC-D stage at the Michoud facility.

Under Plan VII, the S-IC-D stage is to be delivered to MSFC on August 20, 1965. Assembly and manufacturing activities were rephased to the new Plan VII requirements, and by the end of March 1964, Boeing had completed the incorporation of Plan VII into its production schedules.

Actual production of the S-IC-D stage was initiated during the third quarter of CY'63 with the fabrication of fuel-tank skin ring segments (Figure III-1). In November 1963, procurement activity started with the placing of purchase orders for long lead items. The first quarter of CY'64 was highlighted by an increase in component fabrication for the S-IC-D stage. By the end of the second quarter of 1964, components were available at Michoud for tank assembly. Fittings were being welded in bulkhead gore segments, and weld operations on the S-IC-D fuel tank skin rings were performed. Parts were available for the thrust structure and center-engine support structure (Figures III-2 and III-3), and were scheduled for assembly in the early part of July 1964.

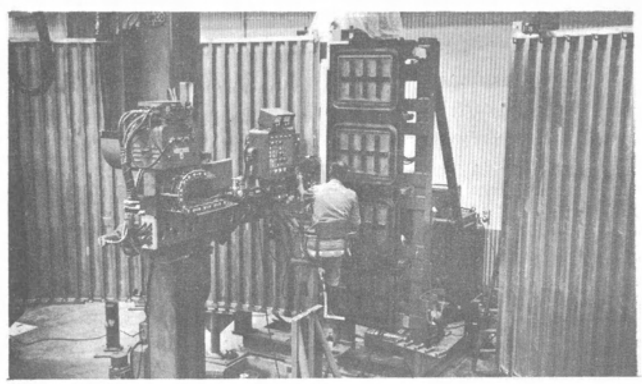


Figure III-1 - Boeing Technician Routing an S-IC-D Tank Skin Ring Segment Prior to Welding in the Environmentally Controlled Minor Assembly Area at Michoud

At the close of the first quarter of CY'64, construction of the hydrostatic test facility in the Michoud Vertical Assembly Building was being delayed. This con-

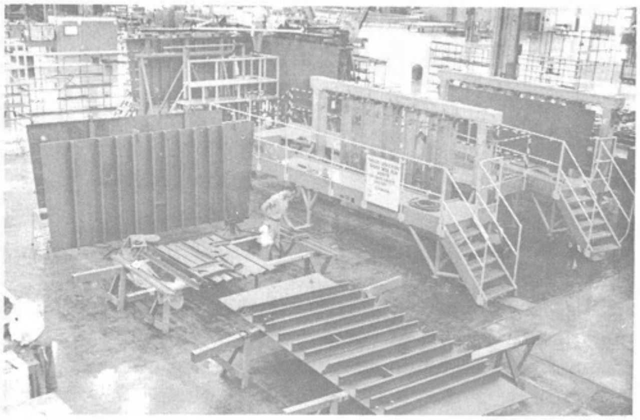


Figure III-2 - Shear Web Panels for the Center Engine Support Assembly (Background) are Being Completed at Michoud

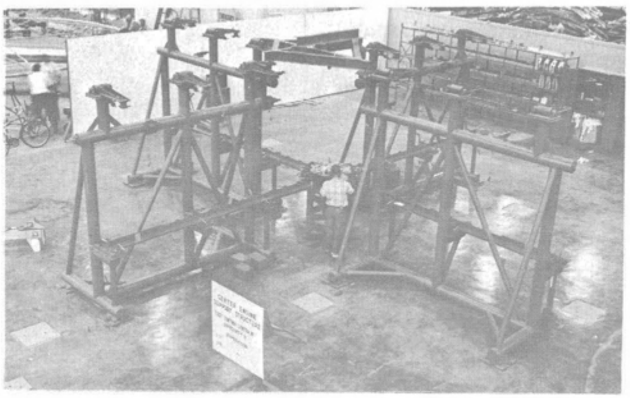


Figure III-3 - Assembly Fixture Used For the Center-Engine Support Nears Completion.

dition threatened completion schedules for the S-IC-D fuel and LOX tanks and resulted in a predicted late delivery of the S-IC-D stage. Close cooperation between NASA/MSFC and Boeing in resolving funding problems allowed Phase II vertical assembly building construction to proceed in April 1964. Although a 17-day behind schedule condition still exists on this construction, the use of work around methods has alleviated this condition and hydrostatic testing is no longer considered a major problem area. Construction progress at this time is shown in Figures III-4 and -5.

As a result of findings derived from tests conducted on a scale model intertank during the early months of 1964, a second problem was discovered. Failure of the scale-model intertank under some loading conditions suggested certain modifications to the intertank structural hardware, which in turn required modification of the intertank assembly tooling. At first, this indicated that the S-IC-D intertank assembly schedule would be adversely affected. Subsequent studies on intertank assembly fixture loadings indicated that both the hardware and tooling could be modified without impairing S-IC-D intertank completion schedules.

At the close of the reporting period Boeing activity in support of the S-IC-D stage was generally supporting NASA/MSFC Plan VII schedules. Delivery of the S-IC-D stage to MSFC on August 20, 1965, is currently expected to occur on schedule.

S-IC-F STAGE

At the outset of the reporting period, Boeing emphasis on the S-IC-F stage was centered on stage tooling design and fabrication requirements. Boeing had completed approximately 60 percent of the tool design and 35 percent of the tool fabrication for the total S-IC-F stage requirements by the end of September 1963.

Working to Plan V schedules, Boeing began fabricating S-IC-F detail parts at Boeing/Wichita, during the fourth quarter of CY'63. Assembly operations were then due to start at Michoud during the first quarter of CY'64. However, when NASA/MSFC Plan VII schedules became effective in January 1964, a revision of S-IC-F stage production schedules was necessary to meet a new NASA/MSFC on-dock delivery date, January 21, 1966, to the Merritt Island Launch Area. Under the new schedule requirements, major assembly activities are to start at Michoud in August 1964. Component fabrication is on schedule in support of this assembly requirement, and the S-IC-F stage is forecast to be completed on schedule.

S-IC-3

Michoud assembly activities in support of the S-IC-3 stage are scheduled to start late in the fourth quarter of CY'64. Plan VII requires delivery of this stage to Mississippi Test Operations on August 1, 1966, for static

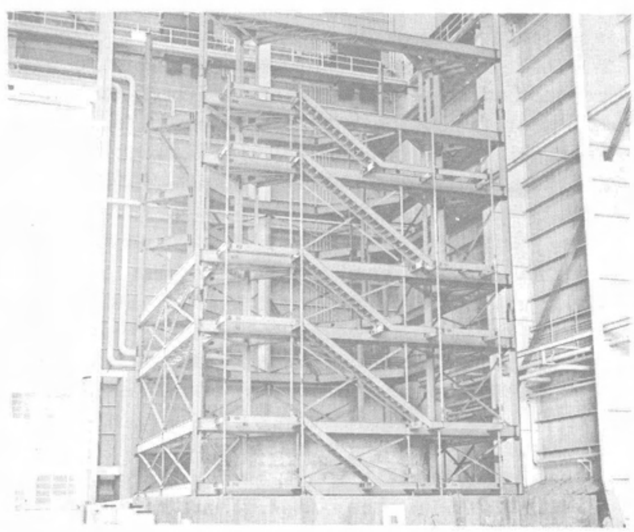


Figure III-4 - Construction Progress on the Hydrostatic Test Tower in the Vertical Assembly Building at Michoud

testing. Following this, the stage is to be returned to Michoud for refurbishment, checkout, and eventual delivery to MILA on February 21, 1967.

Hardware orders for the S-IC-3 were released during the fourth quarter of CY'63, and by the end of the first quarter of CY'64 the fabrication of detail components was underway. By the close of the reporting period, approximately 90 percent of the known structural hardware components had been placed on order.

The only item of concern relative to the S-IC-3 stage is the availability of F-1 engines from Rocketdyne. During the first quarter of CY'64, it became apparent that the NASA/MSFC proposed availability dates of these government furnished engines were not compatible with Boeing engine buildup schedules in support of the S-IC-3 stage assembly. This is currently under study by both NASA/MSFC and Boeing. Although progress is being made, the problem has not been completely resolved. It is anticipated that a satisfactory solution will be effected by either acceleration of engine deliveries to Michoud or the authorization of workaround techniques, so that the Plan VII schedules for delivery of the S-IC-3 stage will be met.

S-IC STAGE TOOLING

Fabrication and erection of tooling for Michoud started during the early months of 1963 and continued through the reporting period. Significant tooling activated during the fiscal year were the intertank, forward skirt, and thrust structure final assembly positions (Figures III-6, III-7, and III-8) along with the necessary supporting subassembly and minor assembly tooling. The LOX and fuel-tank minor assembly tooling, used to assemble bulkheads and cylindrical tank skins (Figure III-9), was certified for the assembly of production hardware. By the end of the reporting period, tank tooling was being installed in the tank final assembly area in the Michoud Vertical Assembly Building.

The change from NASA/MSFC Plan V to Plan VII in January caused considerable adjustments to Boeing tool loading schedules. These adjustments were incorporated into the Boeing schedules by the end of March 1964. During the second quarter of CY'64, it was necessary to further realign tool loading for both the intertank and thrust-structure assemblies.

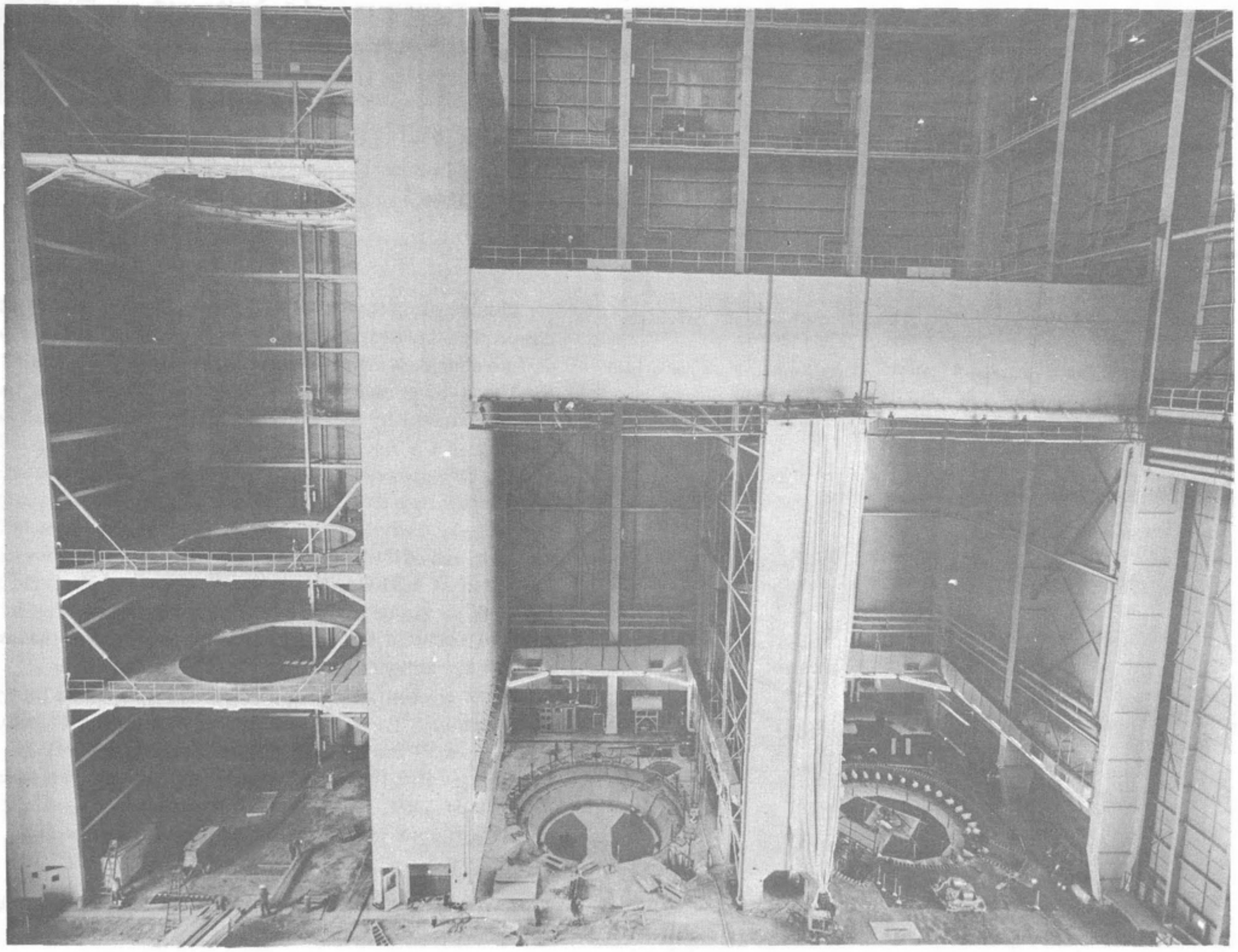


Figure III-5 - Construction Progress on the Vertical Assembly Installations in the Vertical Assembly Building at Michoud.

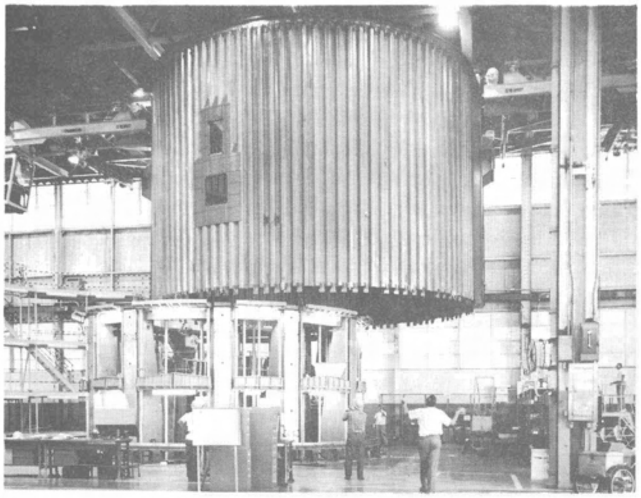


Figure III-6 - Two Overhead Cranes Swing Away the Completed S-IC-S (1) Intertank Assembly at Michoud. The Upper Structure of the Fixture was Removed to Facilitate the Removal.

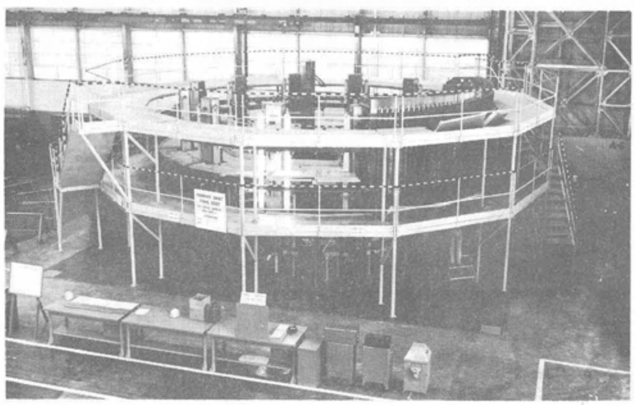


Figure III-7 - Forward Skirt Final Assembly Fixture with S-IC-S Skin Panels

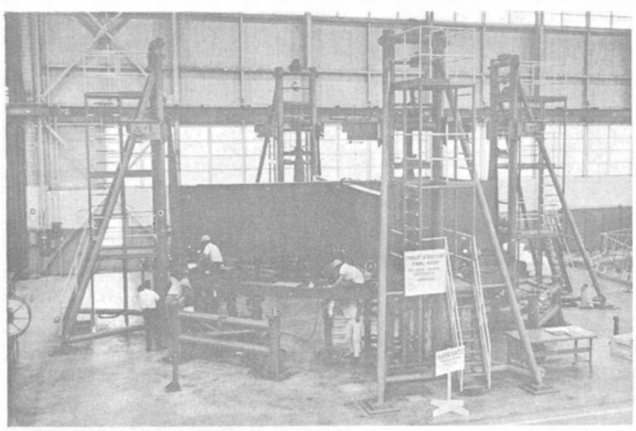


Figure III-8 - First Loading Operation of the No. 1 Thrust-Structure Final Assembly Fixture at Michoud. Lower Thrust Ring, Hold-Down Posts, and Center Engine Support Assemblies are seen Positioned in Fixture

The rearrangement of loading for the intertank resulted from the requirement for two additional intertanks for the S-IC-S stage. These additional intertanks were introduced as a result of engineering recommendations following tests conducted on a scale model intertank. The schedule has been adjusted to allow assembly of the additional intertanks and modification to the intertank tooling. Modification will occur during the third quarter of CY'64, and will not impair Boeing's ability to meet delivery commitments supporting the Plan VII schedule.

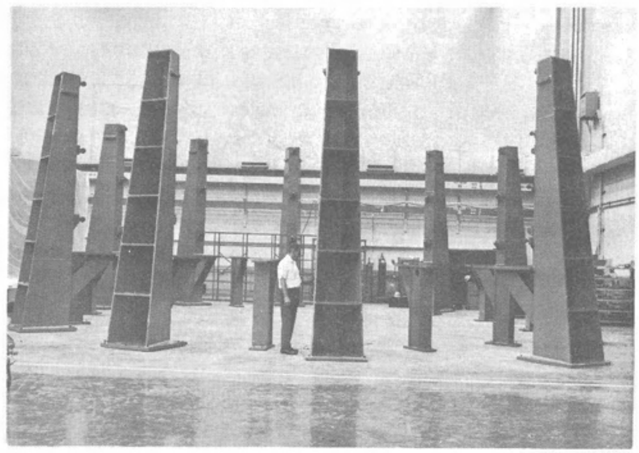


Figure III-9 - Tool Erection of a Tank Cylindrical Skin Assembly Fixture Located in the Environmentally-Controlled Bulkhead Subassembly Area at Michoud

Thrust structure tool erection (Figure III-10) at Michoud was accelerated and tool loading schedules amended so that S-IC thrust structures could be assembled for the S-IC-S and follow-on stages. This was a major change caused by a NASA/MSFC decision, in the second quarter of CY'64, to stop assembling thrust structures at MSFC/Huntsville and transfer both the responsibility and the tooling to Boeing/Michoud for assembly of the S-IC-S, -1, and -2 stage thrust structures from MSFC. At the close of the reporting period, the tooling previously installed at MSFC was being relocated at Michoud while the S-IC-S stage thrust-structure hardware was being used to activate the initial assembly position that was a part of the original tooling plan.

Work is continuing on the tooling still remaining to be activated. Tank assembly will be started in August 1964, as will the fin and fairing (Figure III-11) tooling.

Hydrostatic test will be activated late in the fourth quarter of 1964, and assembly of the S-IC-D stage will activate the vertical assembly position in January 1965.

MANUFACTURING DEVELOPMENT

Manufacturing development effort was moved from

the interim location to the permanent Manufacturing Development Laboratory facility in December 1963. The manufacturing development effort is oriented along: (1) weld development, weld equipment checkout and certification; and (2) process and production technique development and certification. Particular emphasis has been placed in the development of chemical milling production techniques.

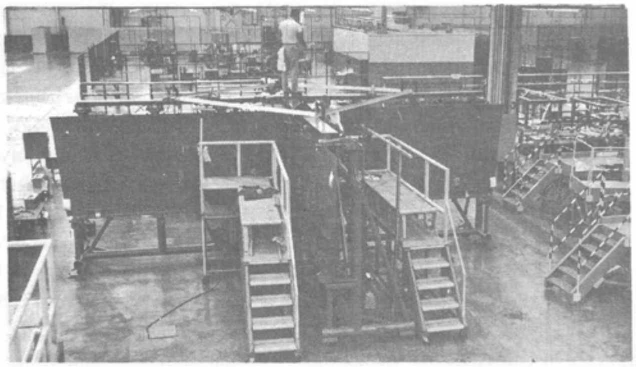


Figure III-10 - Center Engine Support Assembly Fixture at Michoud Showing Shear Web Subassemblies Loaded in the Fixture

Figure III-11 - Engine Fairing Tooling at Michoud

The completion of weld certification activity on bulkhead fitting welds, apex-to-base welds, and actuator supports are typical of weld certification efforts during the period.

Weld development activity (Figures III-12 through III-17) has continued at a high rate in areas such as inert-gas-shielded tungsten-arc (TIG) spot welding, oscillated inert-gas-shielded metal (MIG) arc welding, weld planishing and gore-to-gore welding.

Completing the chemical cleaning and finish process facility in the first quarter of CY'64 allowed process certification to be completed in all operations of the aluminum cleaning and conversion coating line except conversion coating, during March 1964. Certification of conversion coating application was completed in April.

Process and production technique development acti-

Figure III-12 - Shrink Fitting--Temperature Inspection During Freezing of Bulkhead Fitting Prior to Welding Operation

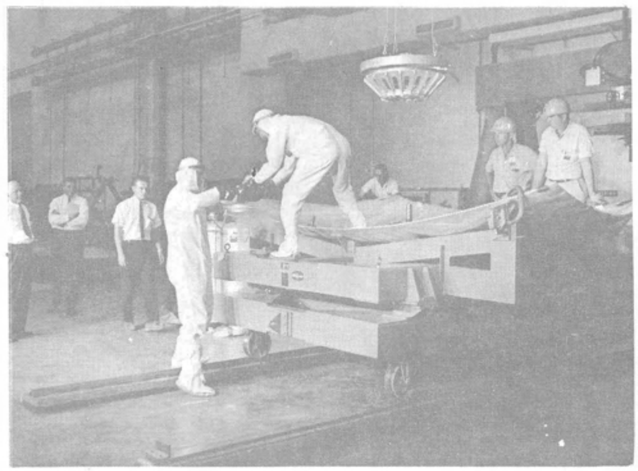


Figure III-13 - Shrink Fitting--Frozen Bulkhead Fitting Being Positioned for Welding to Gore Base

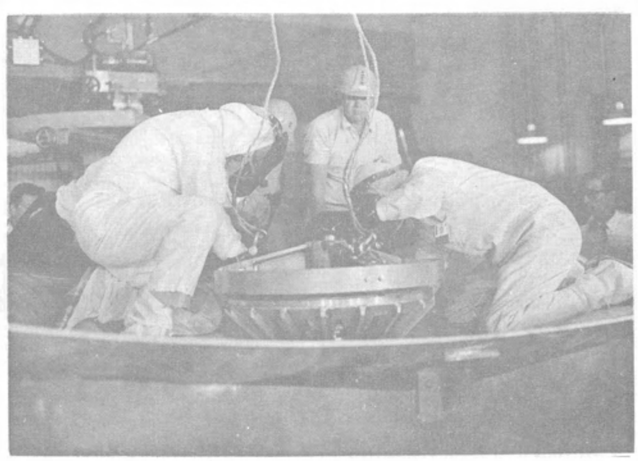


Figure III-14 - Shrink Fitting--Technicians Clamping Frozen Fitting into Place for Welding to Gore Base

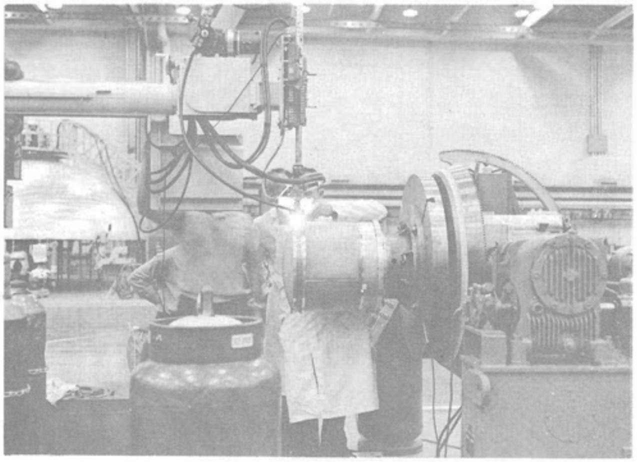


Figure III-15 - Technicians Perform a Weld Operation on a Helium Distributor, in the Bulkhead Minor Assembly Area at Michoud

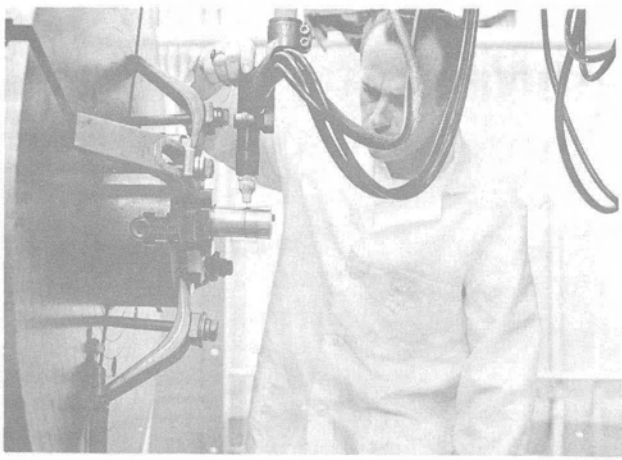


Figure III-16 - A Test Weld Set-Up on Weld Lathe in the Manufacturing Developmental Laboratory at Michoud

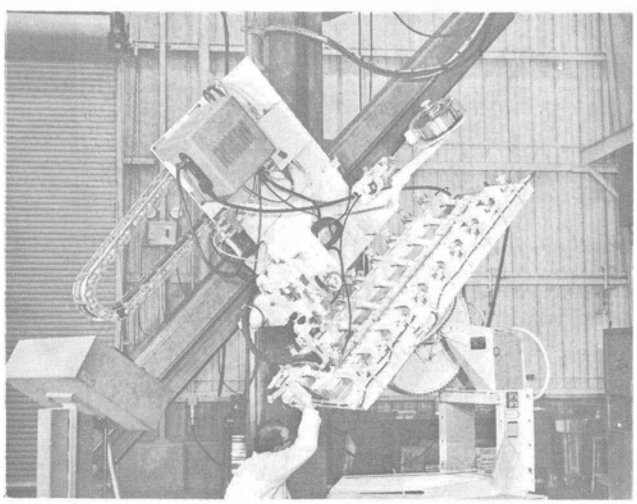


Figure III-17 - Technician Runs Weld Tests Using Inert Gas Process in the Manufacturing Development Laboratories at Michoud

vity was in evidence in such areas as mold dies, thermocouple welding, and stage wiring identification.

The establishment of sufficient chemical milling capability to support program schedules and reliability requirements has accounted for a considerable degree of activity in combined efforts between NASA/MSFC and Boeing. Chemical milling problems have been attributed basically to non-uniform chemical milling etch rates peculiar to 2219-T37 aluminum.

Chemical milling conferences have been held throughout the reporting period with NASA/MSFC, Boeing, prime aluminum fabricators, and nearly all present and potential chemical milling suppliers being represented. Techniques and courses of action to resolve this problem are being discussed and decided upon at these meetings. To date the non-uniform etch-rate problem is being investigated along two lines: (1) improvement of metallurgical homogeneity; and (2) development of a chemical milling etch not sensitive to metallurgical inconsistencies.

Additional developmental effort was expended in the investigation of ram flaring techniques, bonding adhesive, and machining and fastener applications.

In the area of weight reduction, a manufacturing process for pocket milling T-sections in machined Y-rings was under development as part of a 5000-pound-per-vehicle weight reduction proposal.

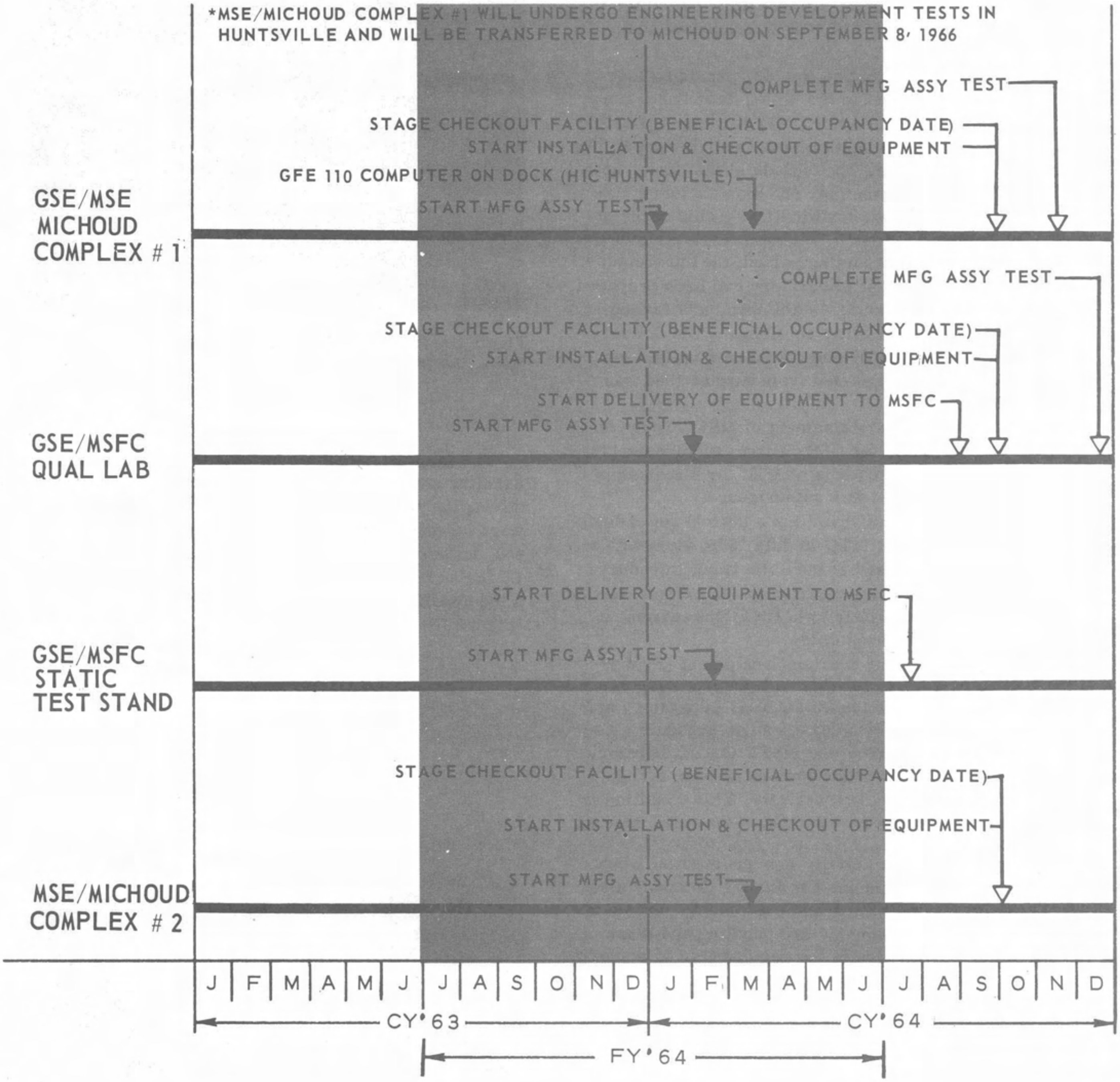
Extensive coordination between The Boeing Company and the Parsons Corporation of Traverse City, Michigan, was conducted to eliminate problems encountered in manufacturing the one-piece LOX tunnel assemblies.

Two major process modifications in the second quarter of 1964 resulted in manhour savings and increased reliability:

1) Conversion Coating Plan for Bulkhead Assemblies--the conversion coating of detail parts was changed to conversion coating of the entire bulkhead by use of the major component cleaning facility. This procedure eliminated the manhours previously required for stripping conversion coating prior to each welding operation;
2) Electrical Conductive Coatings--the process callout on ground support equipment drawings was changed from abrasive cleaning prior to conversion coating to less costly chemical cleaning, resulting in increased reliability.

GSE/MSE

Fabrication of GSE items was hampered during the third quarter of CY'63, pending the result of deliberations between NASA/MSFC and Boeing on GSE Pre-Phase I submittals. Subsequent to these discussions in the following quarter, NASA/MSFC issued authorization to proceed. The agreement on the definition of the functional and physical characteristics of the equipment involved, allowed Boeing to establish delivery capability through an assessment of the required manpower and workloads. As a result of this assessment, Boeing was predicting ability of meeting delivery requirements on


*MSE/MICHOUD COMPLEX #1 WILL UNDERGO ENGINEERING DEVELOPMENT TESTS IN HUNTSVILLE AND WILL BE TRANSFERRED TO MICHOUD ON SEPTEMBER 8, 1966
GSE/MSE MICHOUD COMPLEX # 1
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
GFE 110 COMPUTER ON DOCK (HIC HUNTSVILLE)
START MFG ASSY TEST
GSE/MSFC QUAL LAB
COMPLETE MFG ASSY TEST
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
GSE/MSFC STATIC TEST STAND
START DELIVERY OF EQUIPMENT TO MSFC
START MFG ASSY TEST
MSE/MICHOUD COMPLEX # 2
STAGE CHECKOUT FACILITY (BENEFICIAL OCCUPANCY DATE)
START INSTALLATION & CHECKOUT OF EQUIPMENT
START MFG ASSY TEST
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CY'64
FY'64

the R-Qual Laboratory set by the end of the fourth quarter of CY'63; however, delivery of several items of the Test Division GSE were predicted to be later than required. During the fourth quarter of CY'63, fabrication of subassembly and parts test equipment was initiated. Modification No. 67 to Contract NAS8-5608, which effected NASA/MSFC Plan VII Schedule, called for the simultaneous installation of test and checkout equipment at both the MSFC Quality Laboratory and at Michoud. Since Modification No. 53, providing test and checkout equipment to the MSFC Test Laboratory, was being negotiated in April 1964, it was not possible to determine the full effect on manufacturing capability or schedule adherence. The outlook at that time, however, indicated that assembly and manufacturing activity in support of both modifications would occur at the same time.

By the end of the reporting period, the list of equipment for the MSFC Test Laboratory had been prepared, on-dock date requirements established, and Boeing Company delivery capability confirmed. The delivery of this equipment, finally negotiated as Modification No. 106, will span the period from August 1964 into October 1965.

In addition to the establishment of MSFC Test Laboratory requirements for GSE, a firm requirement for the first of two proposed sets of MSE for Mississippi Test Operations (MTO) was authorized.

An anticipated requirement for a second set of equipment to be available at MTO in July 1966, along with an additional set at Michoud at the same time, introduces the necessity of obtaining contract go-ahead from NASA/MSFC early in the third quarter of 1964 if the equipment is to be available on those dates.

Four sets of test and checkout equipment (Figure III-18) were in work at the close of the reporting period. The equipment for the MSFC Test Laboratory and for the Michoud MSE Complex 2 was on schedule. Assembly and manufacture of the MSFC Qual Laboratory and Michoud MSE Complex 1 equipment were 3 and 6 weeks behind schedule, respectively. This condition is expected to be alleviated by the end of the third quarter of 1964.

Concurrent with the activity in support of the stage test and checkout equipment The Boeing Company also was assembling subsystems test equipment, subassembly and parts test equipment, and handling and transportation equipment. Due to the requirement to perform testing on specialty hardware items for the S-IC-T, it was necessary to activate interim test facilities. At the close of the reporting period the construction of the permanent test facility was not complete; however, the continued use of the interim facility provided the testing required to support S-IC-T schedules.

Twenty-one stations, composed of subassembly and parts test equipment, were scheduled for activation by the end of the reporting period. Only three permanent stations and four of an interim nature were activated at that time, but testing schedules were supported with approved workaround equipment and procedures which will accommodate test activities until the qualified test stations become available.

Figure III-18 - GSE/MSE Drawer and Rack Assemblies Shown Nearing Completion and also Ready for Shipment

The forward handling ring was the major item of handling and transportation equipment to be in work during the reporting period. The first unit of the forward handling ring completed assembly and test, and was delivered to MSFC during the first quarter of 1964. By the end of the second quarter of 1964 a second forward handling ring had been delivered and a third unit (Figure III-19) was being assembled.

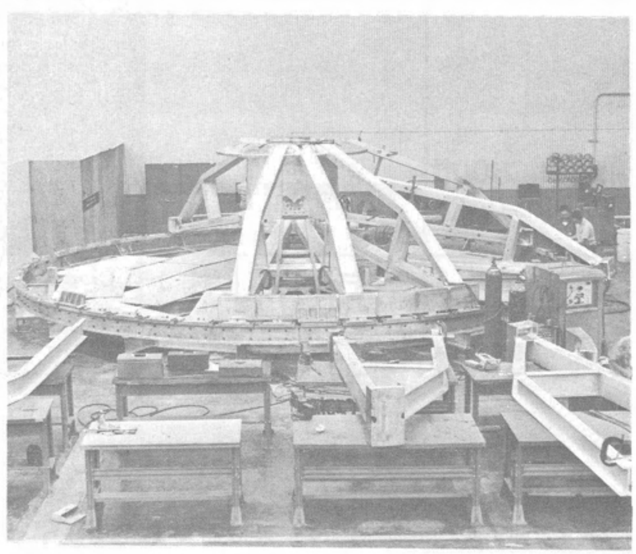
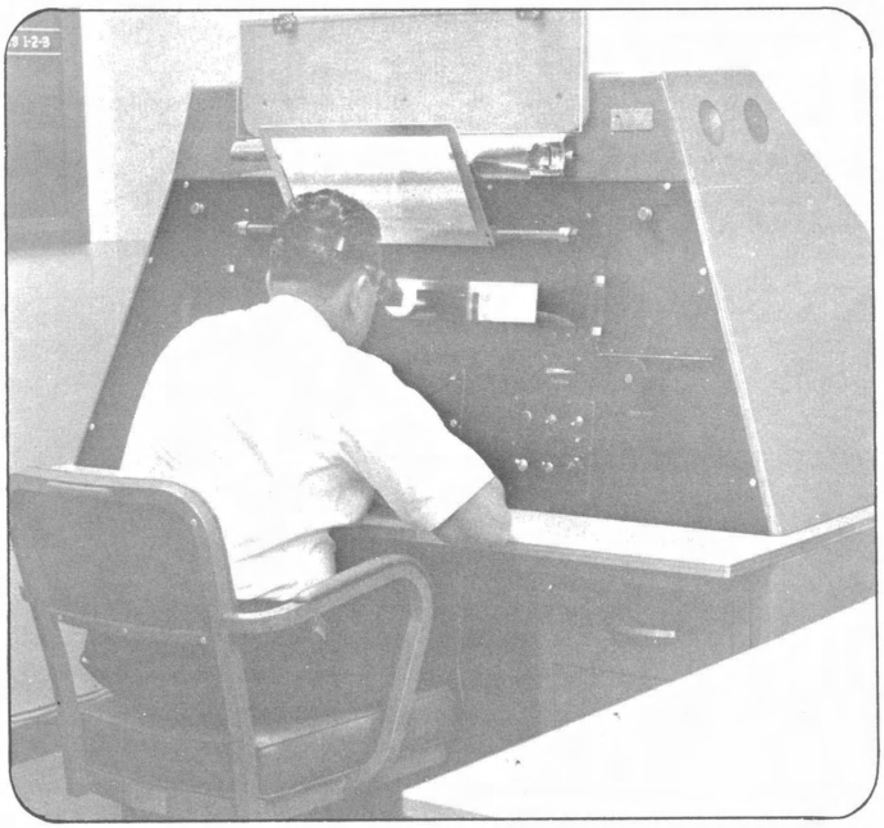


Figure III-19 - Tooling Mechanics Installing Radial Trusses on Third Forward Handling Ring Assembled at Michoud



QUALITY ASSURANCE

Fiscal year 1964 was characterized by significant progress in all basic functions of quality and reliability assurance. In July 1963, interim facilities were in use and numerous workaround measures were used to perform required tasks. Systems, procedures, and techniques were basically conceptual at the beginning of FY 64. By the year's end, they had become operational. Permanent facilities had been activated and refinements had been made in systems, procedures, and techniques as initial deliveries were accomplished on the S-IC-T vehicle components.

QUALITY ASSURANCE CAPABILITY

Significant progress was made during FY 64 in expanding inspection and test capabilities consistent with accelerating hardware schedules. During the early part of FY 64, interim facilities such as those shown in Figures IV-1 and IV-2 were still in use. In January

Figure IV-1 - Interim Quality Assurance Development Laboratory in Use at Michoud in Early FY 64

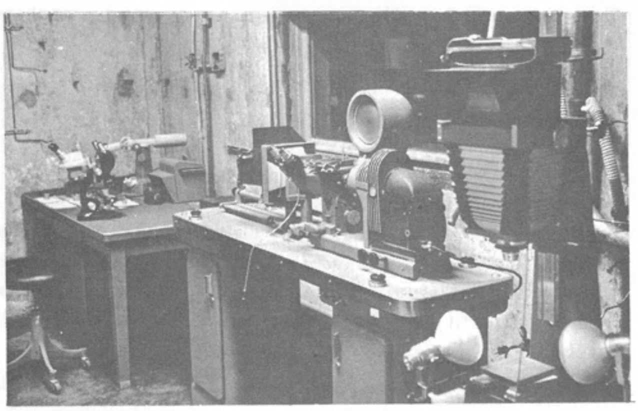


Figure IV-2 - Interior View of Interim Quality Assurance Development Laboratory Facility

1964, final activation of the permanent Quality Evaluation Laboratories was initiated. Figure IV-3 shows the early construction of the laboratory and Figures IV-4

Figure IV-3 - Construction Progress of Permanent Quality Evaluation Laboratories at Michoud

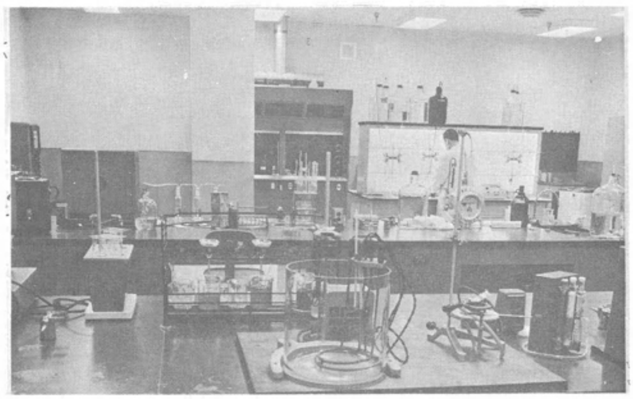


Figure IV-4 - Interior of the Permanent Quality Evaluation Laboratories at Michoud

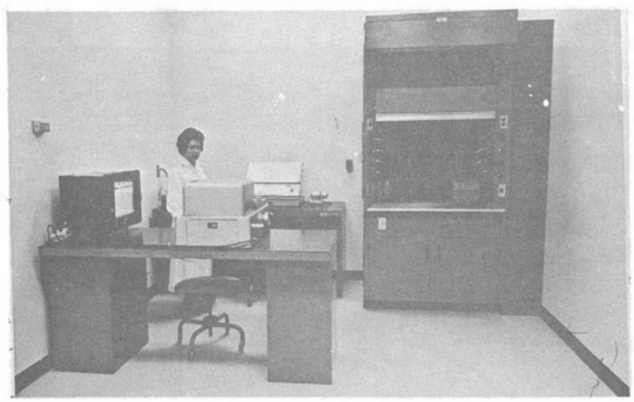


Figure IV-5 - Densitometer Used in Conjunction With Emission Spectrometer in Obtaining Qualitative and Quantitative Analyses of Inorganic Material

through IV-7 show the laboratory at the end of CY '63. Figure IV-8 shows the electrical and electronics area of the permanent Measurement Control Laboratory during initial activation in December 1963. At the close of CY 63, approximately 80 percent of all equipment required had been received. A view of the present laboratory is shown in Figure IV-9. Interim facilities

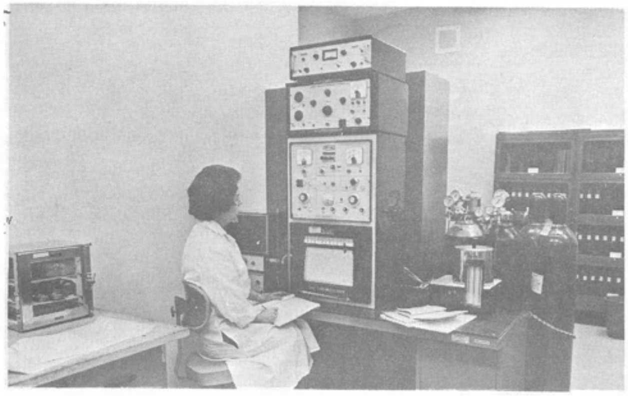


Figure IV-6 - Gas Chromatograph Used in Obtaining Quantitative Analysis of Organic Material

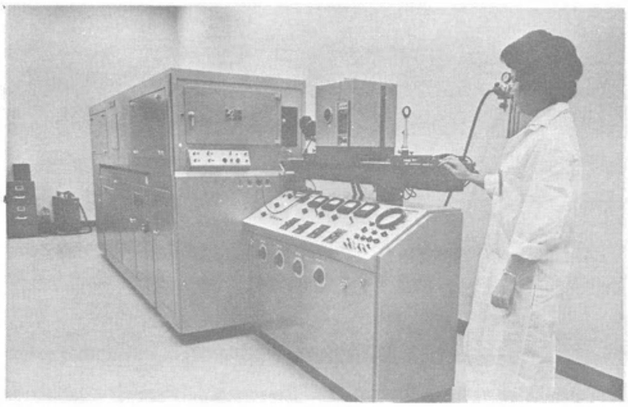


Figure IV-7 - Three-Meter Grating Spectrograph in Quality Evaluation Laboratory

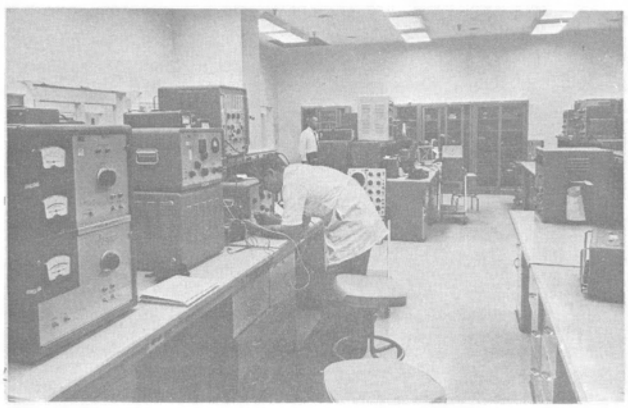


Figure IV-8 - Electrical/Electronics Area of Measurement Control Laboratories at Michoud

such as portable vans (Figure IV-10) that had represented primary capability had been replaced by permanent facilities at the close of CY 63. It is important to note, however, that many interim facilities will continue to be used on a secondary basis to supplement and enhance primary capability in permanent facilities. Following is a brief summary of notable progress:

Figure IV-9 - Pressure, Vacuum Flow, and Mass Area of Measurement Control Laboratories

CENTRAL RADIOGRAPHIC EVALUATION LAB

This laboratory was completed during the early part of FY'64 and its associated mechanized X-ray tooling was activated. In conjunction with mechanized X-ray tooling, this laboratory provides extensive inspection coverage of all stage weldments. It has automatic film processing and mechanized viewing capabilities, three detail inspection vaults, and ancillary processing equipment. At the end of the reporting period, the workload approximated 5,000 X-ray exposures per month. An increase to a peak load in excess of 10,000 feet of film per month is anticipated.

Items of inspection tooling and equipment were developed and activated during the fiscal year that substantially increased radiographic capabilities. Most noteworthy are the gore apex to gore base, bulkhead to Y-ring, polar cap, Y-ring dollies, LOX tunnel and skin ring tools, film paper stripper unit, film viewing console and status board, X-ray suspension system, 300 KV suspension system, 300 KV suspension X-ray machine, and 150 KV suspension X-ray anode machine.

QUALITY EVALUATION AND MEASUREMENT CONTROL LABORATORIES

Brick-and-mortar construction for permanent laboratory facilities was completed in December 1963, and initial activation followed. This acquisition allowed an orderly transition to the operational stage and paved the way for elimination of some workaround measures and retirement of interim facilities to a secondary status.

During the first half of FY '64, flow time for incoming material analysis was excessive because preparation equipment was not available. The transition to permanent facilities, accompanied by acquisition of equipment, enabled a reduction in flow time, and, in many instances, decreased manhour requirements. An example is the lathe (Figure IV-12) necessary for test specimen preparation. Prior to acquisition of this equipment, the Boeing Manufacturing organization assisted in the preparation of test specimens.

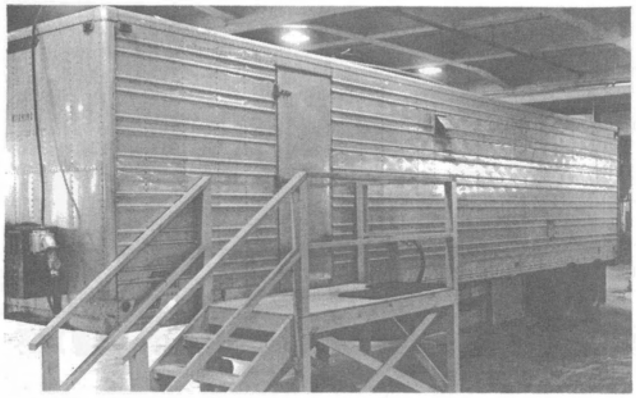


Figure IV-10 - Typical Interim Facility--Pyrometric Van

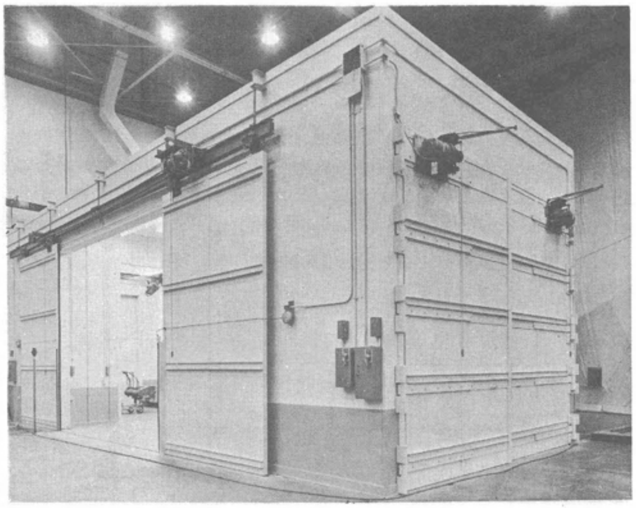


Figure IV-11 - Central Radiographic Evaluation Laboratory Activated in Early FY'64

In January 1964, workaround methods were required to support penetrant inspection of gore segments because the permanent Non-Destructive Test Laboratory was not completed. Portable spray equipment has been used, It is anticipated that automatic spray equipment will be installed early in FY '65.

A LOX impact test facility is being installed to enable appropriate test of components and is expected to be fully integrated during the first half of FY '65.

Capabilities in the Measurement Control Laboratory increased consistent with program demands. New equipment was added each month, and at the close of FY '64, was approximately 80 percent complete. Figure IV-13 shows the Optical Rotary Surface Plate and associated equipment, and the Optical Comparator.

The volume of activity in the Quality Evaluation and Measurement Control Laboratories experienced a significant increase. Orders increased from 1100 to 2900 per month during FY'64. Total orders for the year were about 25,600.

DIMENSIONAL INSPECTION

Dimensional inspection requirements for bulkheads, thrust structures, and intertank assemblies dictated the need for a 34-foot rotary turntable. During FY '64, an area was allocated and the foundation and plans for its installation were completed. At the close of FY '64 Boeing personnel were completing final checkout of the equipment at the vendor's plant.

The rotary turntable will be located in the factory area as shown in Figure IV-14. This turntable, the first

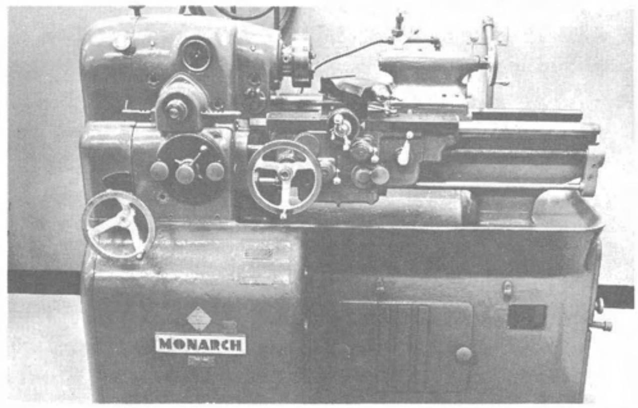


Figure IV-12 - Specimen Preparation Equipment--Monarch Lathe

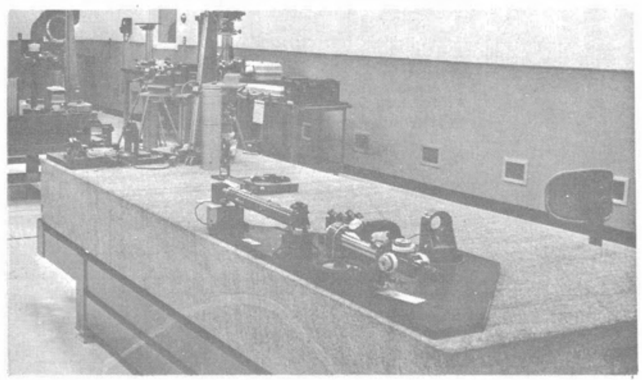


Figure IV-13 - Optical Rotary Table in Measurement Control Laboratories

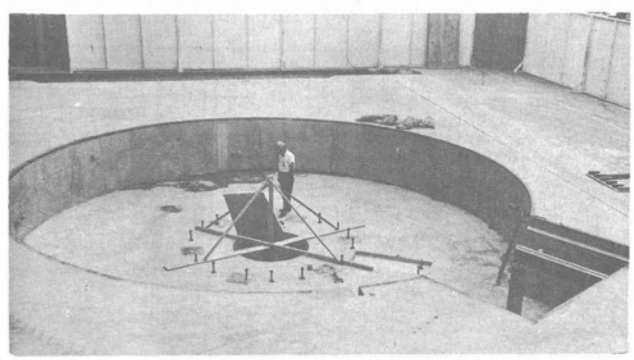


Figure IV-14 - Construction Work Area for 34-Foot Rotary Turntable

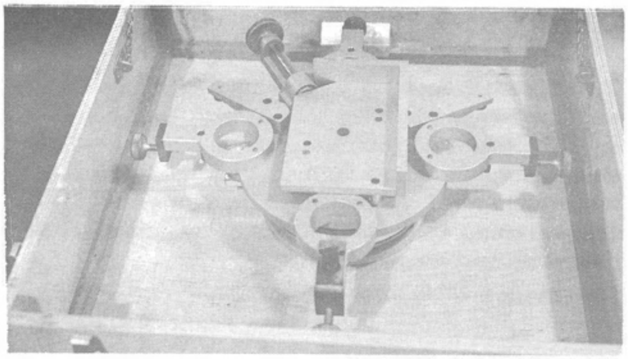


Figure IV-15 - Fitting Optical Target Used for Inspection of Fuel Suction Fittings

Figure IV-16 - Tooling Bars and Associated Optical Tooling Equipment in Use in Michoud Plant

unit of this size with design features necessary to perform precise optical dimensional measurements, will become an integral part of the in-process inspection plan.

Inspection capability for determining critical dimensions increased significantly during the fiscal year. The fitting optical target shown in Figure IV-15 was developed and placed in use. This equipment will be used in inspection of fuel suction fittings.

Tooling bars and associated optical tooling equipment (Figure IV-16) were placed in use during the reporting period.

Unavailability of sufficient tooling equipment during the early part of the FY required some workaround measures. However, at the close of FY'64, the required equipment had been obtained and in -process inspection was being accomplished as planned.

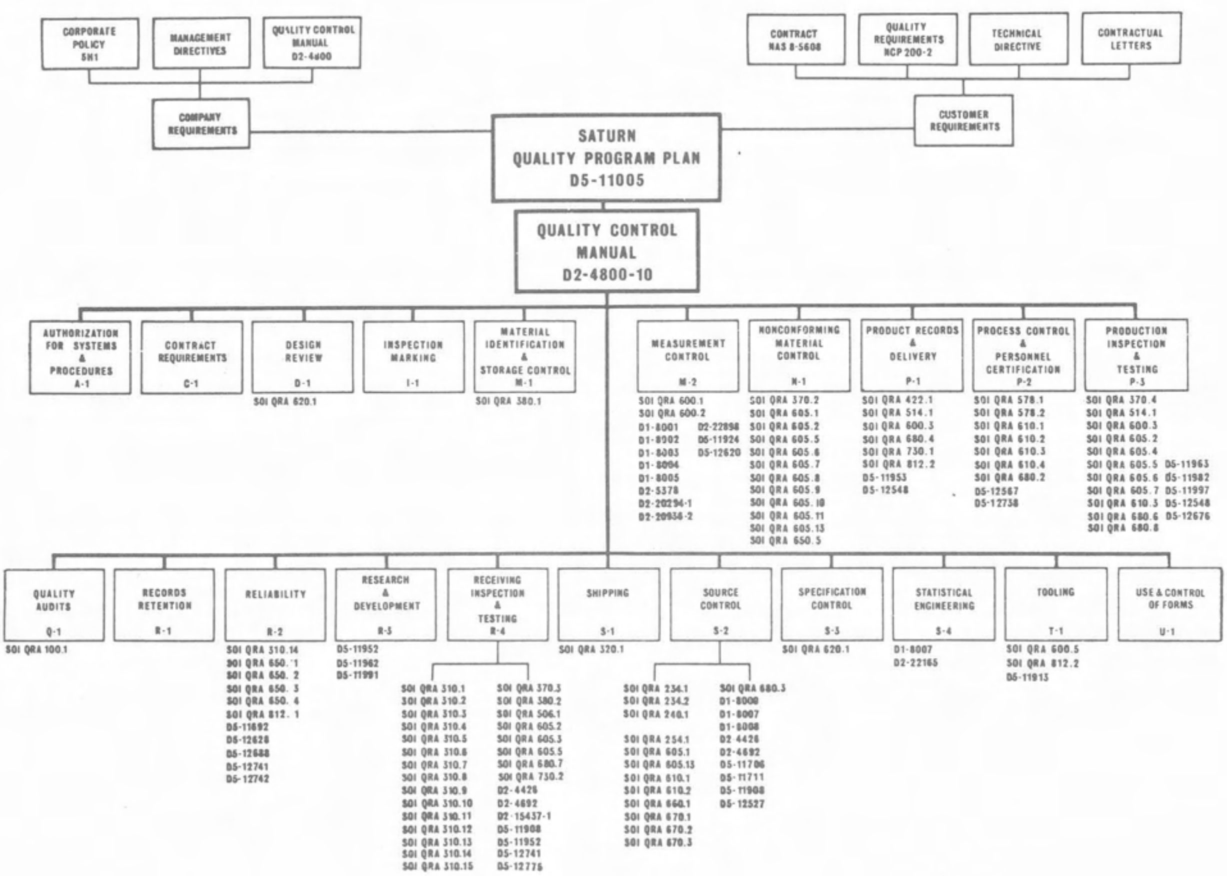


Figure IV-17 - Quality Assurance Program Documentation

QUALITY ASSURANCE SYSTEMS

Fiscal year 1964 saw the evolution of basic systems from a conceptual to an operational stage. Systems involving Quality Engineering, subcontractor control, in-process inspection, and audit reviews were analyzed and refined consistent with product integrity and program schedules.

QUALITY ENGINEERING

The volume of engineering releases increased significantly during FY 64. During the last quarter 4600 releases were reviewed to ensure compliance with NPC 200-2. Coordination with the Engineering organization improved communication of requirements, and, at the end of FY 64, more than 80 percent of the requests submitted had been accepted for incorporation.

Emphasis was placed on quality performance reporting during the year. A system for bi-weekly analysis of stage nonconformances was initiated. A report tabulating nonconformance in Receiving Inspection and major assembly areas is issued to appropriate management.

SUBCONTRACTOR CONTROL

In early July 1963, an interdivisional source control meeting was held to refine the corporate system and ensure full use of resources. As a result of this meeting, the Launch Systems Branch was assigned the responsibility for the survey and surveillance of processing facilities in the states of Alabama, Florida, Kentucky, Louisiana, Mississippi, South Carolina, Tennessee, and Texas.

Numerous surveys of supplier performance were conducted during the FY to ensure compliance with the requirements of NPC 200-3. A notable example was the visit of a combined NASA/MSFC and Boeing team to Los Angeles area suppliers during the latter part of FY 64. Major problems requiring immediate action were multiple inspection by government source inspectors, and misinterpretation of the cleaning requirements of NASA/MSFC Specification 164. Action items were assigned to both MSFC and Boeing personnel to resolve these problems.

The vendor rating system was refined during the FY. All experience is now integrated in the Boeing Aero-Space Division system, ensuring a more complete and

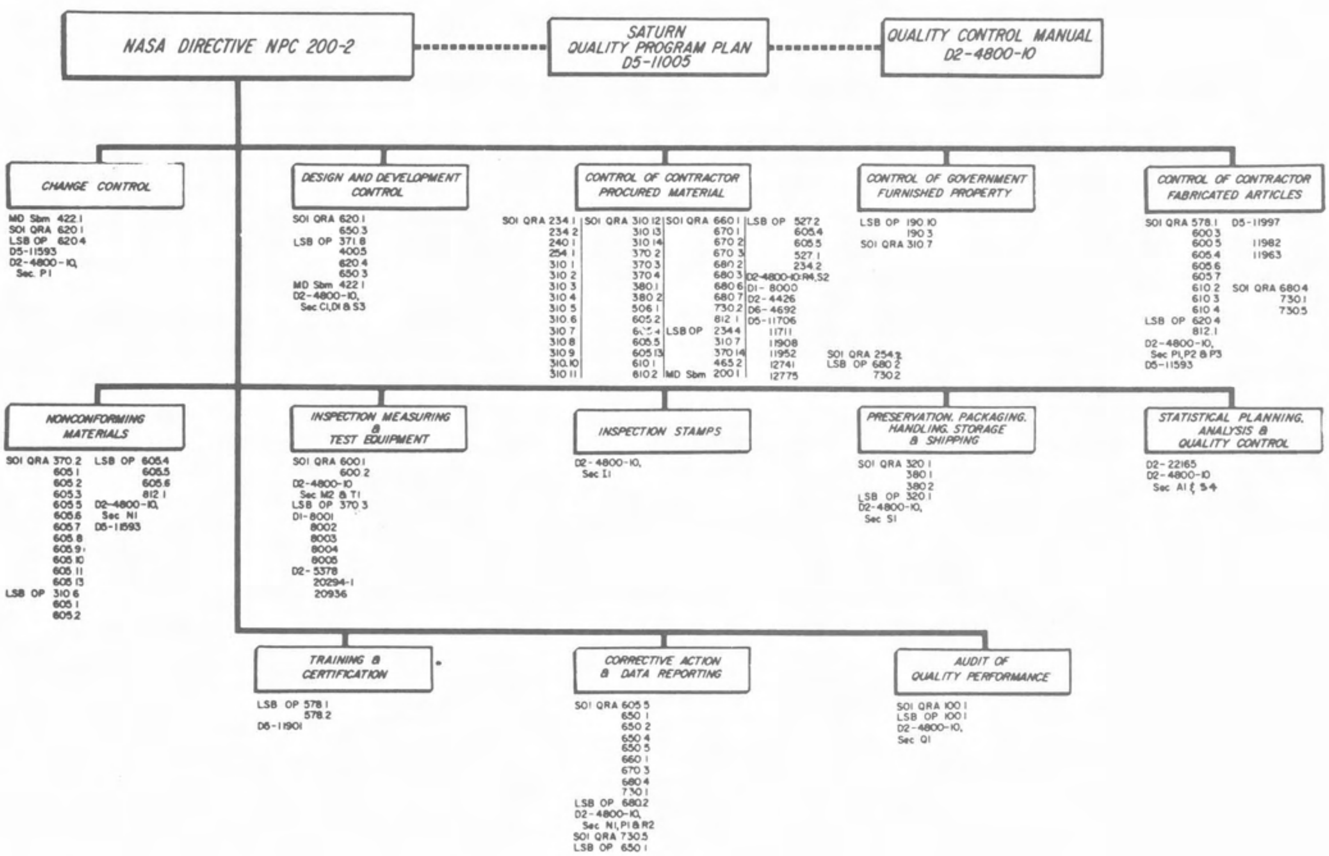


Figure IV-18 - Quality Program Documentation--NPC 200-2

accurate evaluation of all vendor performance data. This, in turn, assures validity of the acceptance sampling system.

During FY '64, 409 proposals involving 102 procurements were evaluated.

A vendor performance reporting system was initiated at Boeing/Huntsville and is being maintained on a current basis. The system is used for items delivered to MSFC and denotes any outstanding problem areas related to tooling items.

IN-PROCESS INSPECTION, TEST, AND DELIVERY

Emphasis of development and refinement of the In-Process inspection system, paced by initial deliveries of S-IC-T stage hardware, was increased during the FY'64. Special inspection processes involving fabrication and assembly operations were reviewed throughout the year.

Interim clean rooms for test inspection of small hydraulic pneumatic and electrical components were activated during the early part of the FY. The first electrical/electronic test inspections were also initiated.

Initial deliveries of hardware allowed refinement of the basic delivery system. Early in the reporting period, coordination with NASA/MSFC Technical Liaison and Contract Administration resulted in the reduction of delivery forms required to accompany stage hardware and tooling items shipped from Boeing/Wichita and Boeing/Seattle. A system to control nonconformance items shipped from outplant areas was also initiated.

QUALITY ASSURANCE TECHNIQUES

Consistent with the transition from a concept to an operational stage, notable progress was made in the development and application of inspection techniques during the year. Following is a brief summary of this progress:

PENETRANT INSPECTION

Considerable progress was made in developing and refining penetrant inspection techniques. A notable example is the extended use of portable spray equipment originally developed for penetrant inspection of Y-rings. This equipment is now being used to inspect gore segments, cylindrical skins, polar caps, and other miscellaneous parts.

OPTICAL TOOLING

The equipment acquisition phase of the Optical Tooling Program neared completion during the FY. Surface tables, tooling bars, alignment scopes and clinometers were obtained and placed in operation. This equipment and techniques were combined to establish an optical tooling program capable of meeting inspection requirements on assemblies completed to date.

RADIOGRAPHIC DEFECT LOCATION AND DEFINITION

Adaptations to mechanized X-ray equipment were accomplished to permit the same accurate three-dimensional location of weld defects as was obtained in manual X-ray systems. The capability was developed to apply this technique to such welds as apex to base, gore to gore and bulkhead to Y-ring.

DIMENSIONAL VERIFICATION

Inspection of large assemblies for dimensional verification was accomplished during the year on such items as a complete intertank, thrust structure components and head assembly components. Experience gained in these areas will be applied to alignment inspection of larger assemblies such as fuel and LOX tanks and a complete stage.

QUALITY ASSURANCE PROCEDURES

Considerable effort was devoted to the development and refinement of operation procedures. Following are specific examples:

SPECIAL INSPECTION PROCEDURES (D5-11982)

This document was completely revised during the year to broaden its scope. D5-11982 will eventually become a multi-volume document encompassing all the unique inspection techniques utilized on the Saturn Program. At the end of FY '63, ten categories of hardware oriented procedures had been written and incorporated into D5-11982.

NON-DESTRUCTIVE TEST APPLICATION TECHNIQUE DEVELOPMENT PLAN (D5-11962)

The Non-Destructive Test Application Technique Development Plan was developed during the year and was being reviewed as the year ended. This document describes the development of application techniques for various non-destructive tests.

DOCUMENTATION

Implementing documentation developed during the year included Standard Operating Instructions, Operating Procedures, and Technical Documents. The need was recognized for a visibility media to portray the documentation released to incorporate the provisions of the Quality Program Plan. Three documents trees were subsequently developed to provide this visibility. These were: 1) Q&RA Program Documentation (Figure IV-17), 2) Reliability Program Documentation, and 3) NPC 200-2 Documentation (Figure IV-18).

QUALITY ASSURANCE AUDITS

Periodic quality assurance audits of all Quality and Reliability Assurance functions and the Launch Systems Branch Training Program were initiated during FY'64. Several special audits were also conducted during the year and included audits of the factory drawing service, inspection stamp control, Saturn records system, and Wichita and Seattle quality functions. Results of audits were documented in the Launch Systems Branch Quarterly Audit Reports and forwarded to the contracting officer in accordance with NASA publication NPC 200-2.

SPECIAL INSPECTION TECHNIQUE DEVELOPMENT

The need was recognized for several specialized inspection tools during 1964 and significant progress was made in developing and acquiring this equipment. Following are notable examples of this specialized equipment.

SUPPLEMENTARY INSPECTION

A supplementary inspection technique was needed to determine actual fusion diameter of spot welds. To do this, an ultrasonic recording scanner was designed. This equipment was initially used to support hardware inspection of bulkhead assemblies.

A proposed new ultrasonic hand scanner was subsequently developed and submitted to NASA for procurement during the latter part of the year. In addition, an improved scanning system for both the hand scanner and the ultrasonic recording scanner was tested and approved for use in both systems. This improved system uses the pulse echo single transducer instead of the double transducer required for the "Pitch and Catch" method.

CONTOUR EVALUATOR PACKAGE

The bulkhead contour evaluator was received from the vendor in June 1964. This equipment will be used with a contour template for final inspection of bulkhead assemblies.

OPTICAL TARGET PACKAGE

This package was completed by the vendor and received June 26, 1964. This equipment will be used for dimensional inspection of fittings and also in conjunction with the 34-foot rotary table during final dimensional inspection of the bulkhead assemblies.

MICROWAVE THICKNESS MEASURING EQUIPMENT

Developmental work was completed during the year on equipment to measure the thickness of gore segments during chemical milling and subsequent operations. The equipment has been ordered and the vendor will deliver it during the first quarter of FY '65.

PREDICTIONS

Quality and Reliability Assurance anticipates continued acceleration of activity consistent with the program demands of FY '65. Fabrication, assembly, and test developmental activity will be particularly significant. Activation of remote sites will also receive considerable attention.

Quality Assurance capability is expected to increase. Specifically the following will be accomplished:

1) The 34-foot rotary table will be installed, checked out, and placed in use to perform critical optical dimensional inspection of bulkheads, thrust structures, and intertank assemblies;
2) The Technical Development Laboratory is expected to be completed and activated. The purpose of the laboratory is to develop non-destructive test techniques, design inspection equipment and perform technical liaison with Manufacturing Development and MSFC;
3) Permanent penetrant inspection facilities, using automatic spray equipment, will be activated and integrated in the inspection plan.

V

SYSTEM AND SUBSYSTEMS TEST

DEVELOPMENT, QUALIFICATION, AND RELIABILITY TESTING

"S-IC Contractor Test Program Summary," Document D5-11928-1, listing development qualification, and reliability testing considered to be Boeing responsibility, was prepared and submitted to NASA/MSFC for comment during the second quarter of the fiscal year (FY). The document was subsequently revised in accordance with NASA/MSFC comments, resubmitted early in February, and made a contractual document by Contract Modification 92, received April 15, 1964.

Development testing, which began during FY'63, continued throughout FY'64, most of the work being accomplished at the Boeing-Seattle and Wichita facilities because of the lack of test facilities and equipment at Michoud. While development testing was substantially behind schedule at the end of the fiscal year, no serious program schedule impact is foreseen, since those tests crucial to design development have been scheduled to provide required information at the time needed.

The qualification and reliability test programs have recently been rescheduled to coincide with late availability of laboratories and test equipment at Michoud. The new schedules are to be provided in the next issue of Document D5-11928-1, and at present still allow for meeting the Plan VII schedule end dates for qualification and reliability testing.

TEST PARTICIPATION-MSFC

Boeing personnel at MSFC have participated in F-1 engine static firings, LOX and fuel systems loading and unloading, and F-1 engine setup and dismantling. Other participation effort during the year, has included the preparation of documents, plans and procedures, and data acquisition planning support; the preparation of installation drawings, wiring diagrams, and operation and maintenance procedures; and design reviews and construction surveillance.

The purpose of this effort is to prepare Boeing personnel to assume full responsibility for the S-IC static firing program at MTO.

MTO ACTIVATION

A June 2, 1964 letter from the NASA/MICHOUD Contracting Office to the Boeing Launch Systems Branch Contract Administration Office gave Boeing limited authorization to proceed with the activation of MTO in an amount not to exceed $570,000 pending receipt of formal NASA Headquarters approved supplemental agreement, "MTO Activation Authorization," Modification No. 102 to Contract NAS8-5608.

Major activities during the reporting period were con-

EVENT	ACTION	DATE
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Submitted to NASA	February 19, 1964
S-IC CONTRACTOR TEST PROGRAM SUMMARY	Modification 92 Received	April 10, 1964
PARTICIPATE IN CHECKOUT OF MSFC TEST STAND	Participation by Boeing	November 9, 1964
MTO ACTIVATION	Go-Ahead	June 2, 1964
MTO ACTIVATION	MTO Activation Plan Complete (D5-11071-3)	August 1, 1964
GOVERNMENT FURNISHED FACILITIES, EQUIPMENT AND SERVICE REQUIREMENTS FOR MTO	Document D5-11061 Complete	July 1, 1964
GENERAL TEST PLAN	Submitted to NASA	November 1, 1964
TEST DATA ANALYSIS	Flight Test Evaluation and Reports Plan Complete (D5-11056)	January 2, 1965

Figure V-1 - Documentation Status

centrated on planning and documentation. Document D5-11071-3, "Plan for Activation and Operation of S-IC Complex at MTO," is in process and scheduled for completion August 1, 1964. The status of significant documentation necessary for the activation program is shown in Figure V-1. At the close of the period, efforts were continuing in design and specification reviews on the S-IC complex and technical systems, and GSE design and installation liaison. Interface common to MSFC and MTO in the brick-and-mortar and equipment areas were also in process.

TEST PLANNING

Major emphasis was placed on the General Test Plan document during this reporting period. The General Test Plan document defines development, qualification, reliability, production, acceptance, prelaunch, flight and special tests for the S-IC stage and GSE from development of components through operational flights. It provides objectives, test descriptions, test progression, concepts, policies and responsibilities. The original effort was started early in the reporting period and resulted in a preliminary draft which was distributed late in December 1963.

Subsequent to joint NASA/MSFC-Boeing reviews the first coordination copy was released on March 26, 1964. The NASA/MSFC comments were reviewed June 4 and 5, 1964, at a joint meeting. The comments are being incorporated into a second coordination copy which is scheduled for release on July 24, 1964.

FLIGHT EVALUATION

TEST ANALYSIS & EVALUATION

A Boeing S-IC Flight Test Evaluation Committee, made up of members from all technical organizations, has been instrumental in defining Boeing analysis requirements for external data submitted for inclusion in the "Engineering Instrumentation Requirements" document.

The committee is presently developing detailed techniques for providing calibration data required by Technical Directive 170, and specifications of calibration data to be used for the linearization of flight test data at Slidell.

CENTRALIZED DATA REDUCTION

On October 4, 1963, formal announcement was made by NASA/MSFC of the establishment of a "Joint Usage Laboratory" at Slidell and Michoud for Boeing and Chrysler test data reduction. Boeing was asked to participate in the establishment of equipment specifications. As a result, the Boeing Data Reduction Steering Committee was established, with the Saturn Booster Test organization manager as the Boeing senior member.

Subsequent to the request from NASA/MSFC for Boeing participation in the establishment of equipment specifications for the Centralized Data Reduction Facility, the Data Reduction Steering Committee established a joint system description and specification which was completed and submitted to NASA/MSFC on January 1, 1964.

By November 26, 1963, the scope of the Centralized Data Reduction activities was defined. The recommendation submitted to NASA/MSFC called for third-party operations at Slidell and Michoud with data user (Boeing or Chrysler) surveillance.

Test Data Reduction facilities will be provided at the Computer Operations Office, Slidell, Louisiana, and the Michoud Engineering Building, New Orleans, Louisiana. The Slidell facility will reduce the various raw telemetry data records, as received from Merritt Island Launch Area (MILA), to a common digital tape format for IBM7094 computer entry. The data records to be reduced will be direct analog wideband FM PAM/FM/FM telemetry tapes, PCM/FM telemetry tapes and predetection recorded magnetic tapes.

The Michoud Data Reduction facility will receive data in recorded form from the various data acquisition sites and from the Slidell facility and will process the data to satisfy the requirements of quick-look preliminary analysis, detailed test analysis, data evaluation and analysis, and test reporting. This facility will also be used quite extensively for vibrational and acoustical analysis.

The vibration and acoustical analysis system will give support in the areas of component test, static test, and flight test data reduction. This system is capable of reducing direct analog magnetic tapes, wide-band FM magnetic tapes, and SS/FM telemetry tapes.

VI

S-V SYSTEMS SUPPORT

SYSTEMS STUDIES

Engineering support under technical assistance orders has steadily increased in scope during the past year. Saturn V studies in aerodynamics, systems design, flight control and test data analysis, mission abort analysis structural design, and wind tunnel testing were conducted. Support to Astrionics and P&VE Laboratories has continued and a number of new tasks has been added. System studies conducted and pertinent results are discussed in the following paragraphs.

SATURN V FLIGHT CONTROL SYSTEM ANALYSIS

Document D5-11240-1, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis," released April 6, 1964, contains an evaluation and comparison of slosh stability, structural coupling, dynamic loads, and vehicle transient responses for various control laws and feedback parameters considered for application to the Saturn V. Control system analysis and specifications for the 4106 configuration of the Saturn vehicle are contained in Document D5-11290-2, "S-IC/Saturn V Launch Vehicle Flight Control System Analysis--Vehicle 4106."

FLIGHT TEST DATA ANALYSIS SYSTEM

Development work was completed on the flight test data analysis system. Significant developmental and supporting documents released were:

a) D5-11247-1, "Saturn Flight Test Data Analysis System Definition";
b) D5-11247-2, "Data Source Comparison Computer Program";
c) D5-11249, "Saturn Flight Test Report Vehicle (I, II, III, and IV) Data Source Comparison," Vol. 1-4;
d) D5-13029, "The Mathematical Development for the AMR Range Data Reduction Computer Program";
e) D5-13025, "Coordinate System Definition in Saturn Flight Test Data Analysis System."

D5-11247-1 defines basic system concepts for the Saturn flight test data analysis system, and D5-11247-2 contains the mathematical and statistical techniques for post-flight data comparison. Four volumes of D5-11249 give tracking data comparisons for flight data obtained from SA-1, SA-2, SA-3, and SA-4 and demonstrate system development. D5-13029 and D5-13025 present the mathematical formulations for conversion of AMR tracking information from tracking station format to vehicle position with respect to station, launch, and inertial coordinates. Portions of this development work were used in Boeing presentations at the NASA/MSFC Flight Evaluation Working Group Meeting and to the Saturn data reduction sub-group panel.

SATURN V FLIGHT PERFORMANCE

Studies and presentations of mission abort were conducted for the powered and unpowered modes. The ability of the vehicle to complete developmental missions after an engine had been shut down was also determined. Significant analyses, with recommendations for mission and abort criteria, are contained in Document D5-11392, "Saturn V Vehicle Abort Analysis and Criteria." Presentations were given to the Aero-Astrodynamics Laboratory and to the MSC/MSFC crew safety panel. Results of a study to define Saturn V flight performance reserve for the LOR mission were presented at the second guidance and performance sub-panel meeting at MSC April 28, 1964.

LAUNCH ESCAPE SYSTEM

A study was conducted to evaluate the capability of the Launch Escape System (LES) to provide protection from booster explosions. It was determined that the Apollo capsule would be subjected to damaging overpressure if the LES is initiated simultaneously with the explosion of the booster. Prior warning time of approximately two seconds is required for the astronaut to escape. Results of this study were presented to the MSC/MSFC crew safety panel.

ASSISTANCE TO LAUNCH SUPPORT EQUIPMENT OFFICE

Technical assistance to the Launch Support Equipment Office, Huntsville, Alabama, and to KSC, includes engineering studies, analysis, and report writing as applicable to: Coordination for Saturn V launch support equipment; Engineering for design, budgeting, and scheduling in the launch equipment area, the propellant area, and the launch system and umbilical equipment reliability area.

MTO ACTIVATION

During this reporting period, on-dock dates for all contractor furnished test and checkout equipment were determined.

Support was provided to NASA/MSFC for the S-IC Complex (MTO) design review. A major revision to Document D5-11061, "Government Furnished Facilities, Equipment and Services for Mississippi Test Operations," was completed. Document D5-11071-2, "Plan for Activation and Operation of the S-IC Complex at MTO," was prepared and released as the work statement to support a request for estimate (RFE) which was issued to cover the MTO Activation Plan. The RFE meeting was held in New Orleans, November 6, 1963, and a presentation to NASA/MSFC was made on December 9, 1963.

Documentation was developed for the Saturn records system procedure, manpower plan, test evaluation and reports plan, activation static firing and special test data plan, and the safety plan.

This resulted in a significant contribution to the Saturn program in that the initial overall requirements for Mississippi Test Operations were defined through this work effort.

EQUIPMENT MANAGEMENT SYSTEM

The establishment and documentation of an equipment management system to cover all ground support equipment (GSE) for the Saturn V program, the development and documentation of an initial Saturn V program elements list, and the development of a preliminary Saturn V GSE list was completed in December 1963.

An S-IC equipment data support group, consisting of full-time representatives from the Launch Systems Branch was organized on September 16, 1963, in Huntsville. This group was assigned the task of reviewing and updating the equipment listed in the data bank established as a result of the task force effort. The first updated S-IC equipment list was completed on October 11, 1963, and a computed version of the S-IC equipment list was completed on November 8, 1963. An outline of the proposed Saturn V equipment management system was documented and was submitted to the Saturn V Project Office for comment on September 24, 1963.

This effort represented an important contribution to the program since it provided program visibility of known equipment requirements and responsibilities, assistance in identifying duplicated or omitted equipment, a basis for equipment accountability, data to identify contract deficiencies, a basis for equipment status reporting, and data for development of installation and checkout packages.

TAO 6 was released December 31, 1963 to ensure continuity of the Saturn V Equipment Management support effort following the expiration of TAO 30.

TAO 6 provides for 20 Boeing technical personnel to support the Saturn V Project Office at NASA/MSFC, for implementation, maintenance and future development of the equipment management system. Specifically, this support consists of follow-on studies for further application of the management system and assistance in the maintenance and further development of:

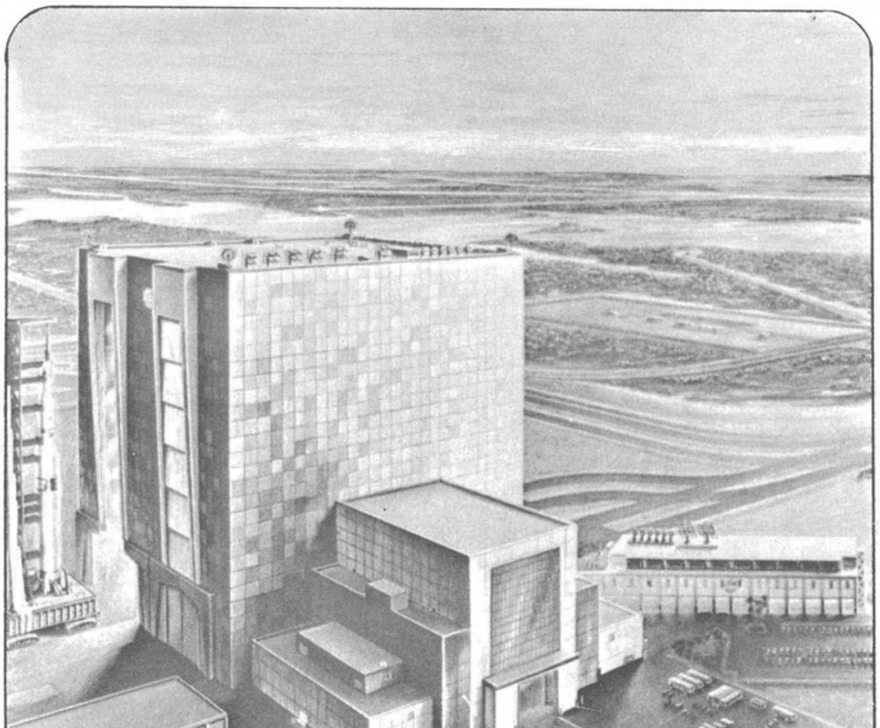
1) Saturn V Program Elements List;
2) Saturn V Master Equipment List;
3) Equipment Allocation Techniques;
4) Problem Resolution Schedules.

The Saturn V/S-IC master equipment list has been placed into computer format and is now stored in the Michoud Computer Office. Updating of this data bank occurs on a monthly basis.

Development of report requirements and planning of computer programming is now in progress.

Responsibility for work covered by TAO 6 was transferred from Boeing Booster Test to Boeing Engineering in March 1963; however, Booster Test is providing support.

VII



LAUNCH OPERATIONS SUPPORT

MERRITT ISLAND LAUNCH AREA LIAISON

The Boeing activities in the Cape Kennedy area were consolidated into one organization during February. Mr. A.M. Johnston was appointed Manager of the Boeing Atlantic Test Center (BATC) reporting directly to Mr. G.H. Stoner, Vice President and General Manager, Launch Systems Branch of the Aero-Space Division, The Boeing Company. Mr. H.W. Montgomery was appointed Manager of Saturn S-IC activities at BATC.

Document D5-11058, "MILA S-IC/Saturn V Checkout and Test Plan," was revised to reflect the Kennedy Space Center (KSC) planning for a fifty eight day cycle of Launch operations. Document D5-11059, "S-IC MILA Equipment List," was released and served as the first guide for MILA use requirements.

Liaison activities included the preparation of document D5-11830, "MILA S-IC Launch Operations Record Systems." The system provides a method of fulfilling the Saturn V vehicle record requirements while maintaining a high degree of compatibility with Boeing records at other locations.

Document D5-11816, "Launch Operations Support Plan S-IC/Saturn V, " was prepared during this report period. The plan presented the BATC concept of the Boeing effort to be performed under Part VII of Contract NAS8-5608. The document became the basis for negotiation of task orders to authorize Boeing support effort for KSC for FY '65. The approved task orders will allow for a growth of 100 persons for a total of 123 under this part of the contract.

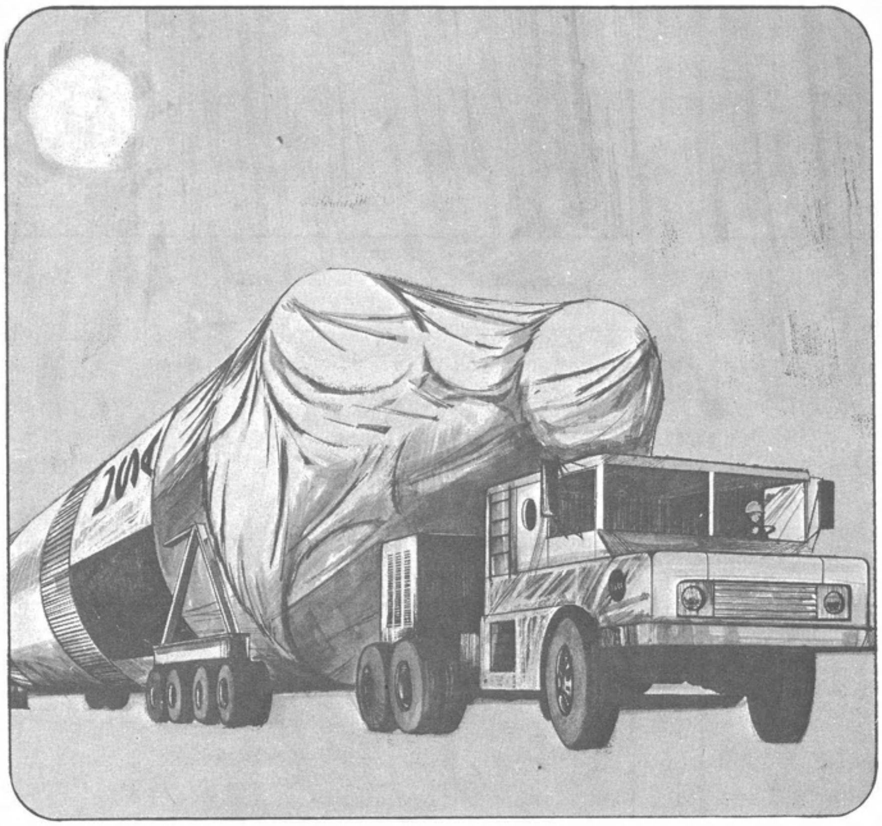
The "BATC Training Plan" is in process with initial release scheduled for October 1, 1964. This plan will serve as the basis for negotiations regarding off-site personnel training and will ultimately support the KSC training plan.

A compilation of all tests to be performed on the S-IC-F stage at MILA is also in process. The initial release, scheduled for August 15, 1964 will be in document form—"S-IC-F Catalog of Tests - MILA."

LAUNCH OPERATIONS PARTICIPATION

Twenty-three BATC personnel are currently assigned to support NASA/KSC Launch Vehicle Operations Activities. Assignments vary with the individual organization supported but cover S-V/S-IC MILA program planning, and participation in Saturn I test activities for familiarization and training purposes. Numerous working-group meetings and design reviews were attended by support personnel during the reporting period. These included meetings of the Instrumentation Working Group reviews covering S-IC transporter and pneumatic systems, Saturn V propellant loading system, propellant dispersion system, RCA 110 computer networks, and thrust-vector control system.

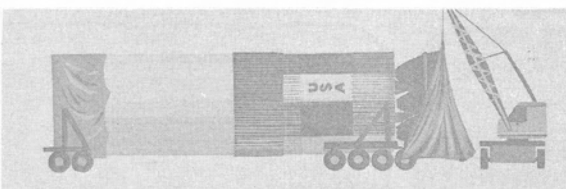
VIII



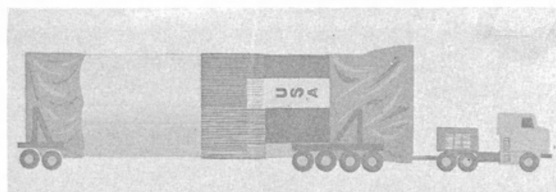
STAGE TRANSPORTATION

STAGE PREPARATION
EQUIPMENT:

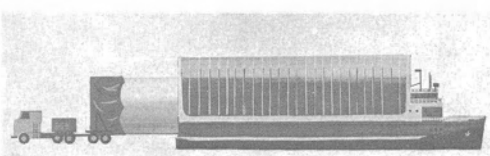
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings



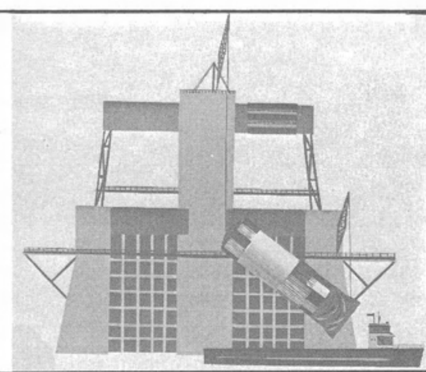
HANDLING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



LAND TRANSPORTATION
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

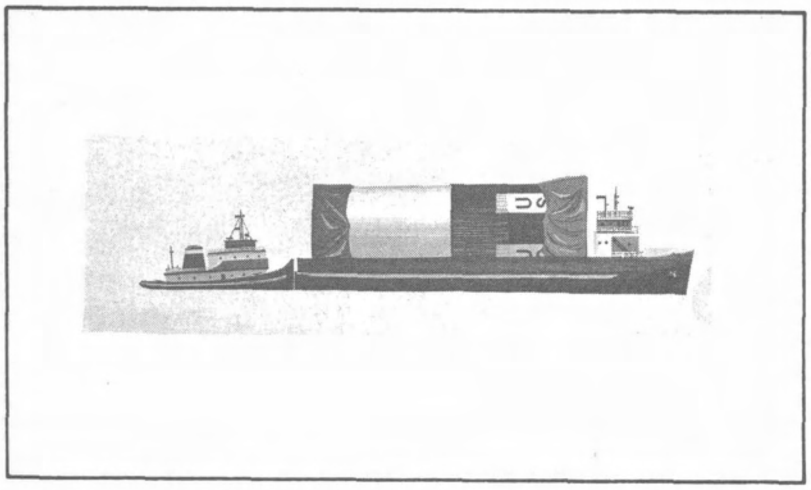


LOADING-UNLOADING
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit

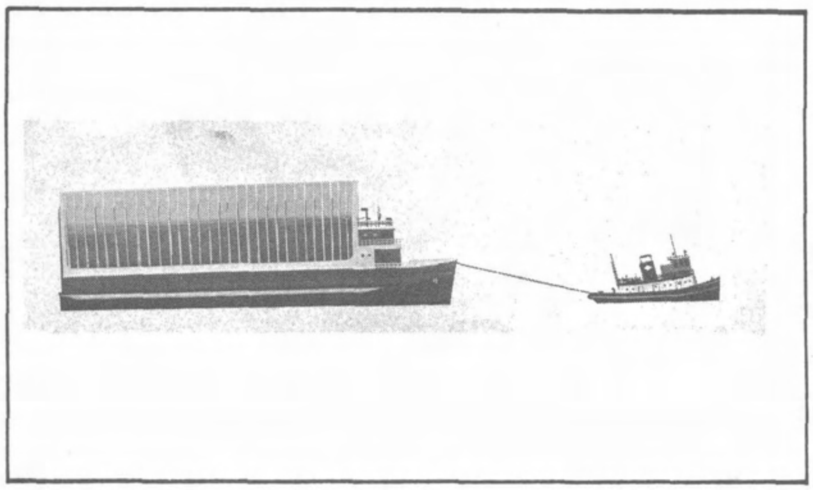


* THE PROTECTIVE COVERS AND PLUGS ARE JOINT BOEING-NASA DESIGNED ITEMS.

WATER TRANSPORTATION — OPEN
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Transportation Accessory Kit
Forward Handling Ring
Stage Attach Fittings



WATER TRANSPORTATION — CLOSED
EQUIPMENT:
Propellant Tank Pressurization Equipment
Protective Covers and Plugs *
Forward Handling Ring
Stage Attach Fittings
Fin Cradle
Fairing Cradle
Transportation Accessory Kit



STAGE TRANSPORTATION SEQUENCE

A complete revision to Document D5-11053, "Saturn V S-IC Stage Transportation Plan," has been the prime order of business during this reporting period. This revision encompasses all phases of transportation, identifies the Boeing organizations responsible for each of the transportation functions, and contains the latest schedules and equipment requirements. This document is scheduled for release in September 1964.

Document D5-11763, "Saturn V S-IC Stage Transportation Requirements," is also in process and is a compilation of the detailed requirements for transporting the S-IC Stage in accordance with the above Transportation Plan. This document is scheduled for release in January 1965.

The first barge movement (S-IC-D to MSFC transport sequence shown) is scheduled for August 1, 1965, with no problems anticipated at this time.

IX

MANUFACTURING SUPPORT TO MSFC

S-IC-C TEST FUEL TANK

Boeing support of the ground test program for the S-IC-C test fuel tank involved the fabrication and delivery of stage hardware details and assemblies and fabrication and erection of the tank support structure.

Fabrication and delivery of minor stage hardware, such as tank ring baffles continued during the third quarter of CY'63. During August 1963, the assembly of the one-half intertank was completed in support of the NASA/MSFC test fuel tank requirements. The one-half intertank was delivered to MSFC by barge (Figures IX-1 and -2) on November 16, 1963. Stage hardware deliveres were completed during the last quarter of CY'63.

Effort during the first quarter of CY'64 was directed toward completion of the tank support structure. This activity culminated March 11, 1964 with the installation of the test fuel tank on the support structure.

Figure IX-1 - The Michoud Plant and the Partially Completed Vertical Assembly Building are a Backdrop for the One-Half Intertank Being Towed to the Slip for Shipment to MSFC

S-IC-T STAGE

The Boeing effort on the S-IC-T static test stage encompasses the fabrication of structural hardware details and assemblies (thrust structure, intertank, and tank components), and the procurement and delivery of specialty hardware in support of NASA/MSFC.

Figure IX-2 - The Half Intertank is Carefully Loaded on the Barge at the Dock and Secured by Boeing Mechanics

STRUCTURAL HARDWARE

S-IC-T structural hardware deliveries to MSFC began during the second quarter of CY'63 with the delivery of the fuel tank lower-head apex gores. Deliveries of this hardware (Figures IX-3 and -4) continued through the second quarter of CY'64 with the final major structural hardware deliveries having been completed in May.

The last of the basic structural subassemblies delivered during the reporting period included the GOX and helium distributors, and the LOX tank ring baffles and cruciforms (Figure IX-5). At the close of FY 64, there were 656 items remaining to be delivered to MSFC by Boeing in support of the S-IC-T stage. Delivery of these items, such categories as minor tooling, specialty hardware, and minor structure components (Figure IX-6), will continue through January 15, 1965.

SPECIALTY HARDWARE

Specialty hardware deliveries began in November 1963, and were continuing at the close of FY64. These deliveries consist of both items to be shipped directly from suppliers to MSFC, and items routed through

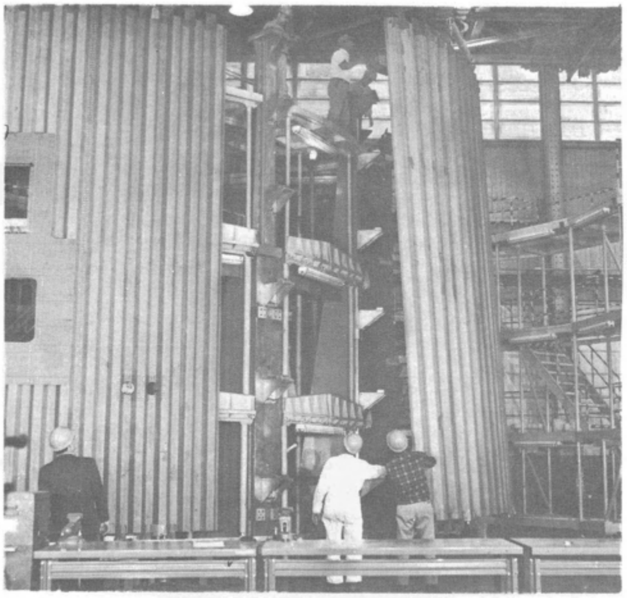


Figure IX-3 - An S-IC-T Intertank Panel is Removed from the Intertank Assembly Fixture

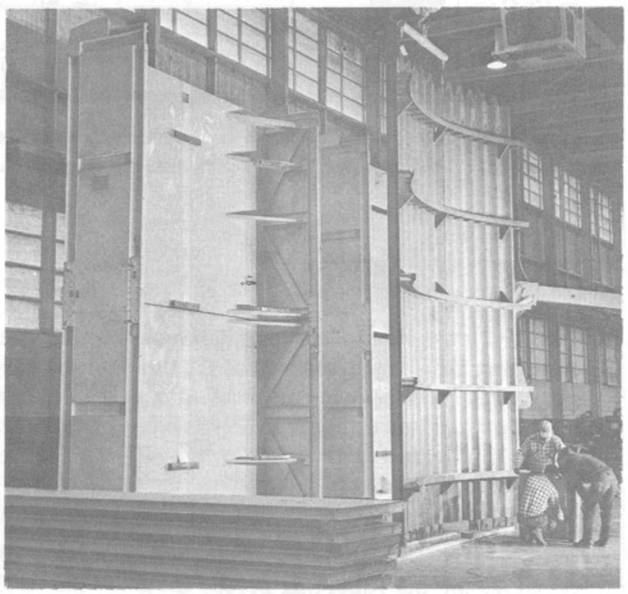


Figure IX-4 - The -T Intertank Panels are Placed in the Shipping Case Vertically

Boeing/Michoud for test and calibration. A need for increased delivery rates during the latter part of FY 64 resulted in concerted efforts by Boeing Management to attain better adherence to delivery schedules by suppliers for critical items. Key members of both NASA/MSFC and Boeing Management were maintaining close liaison through such media as the monthly MSFC/Boeing S-IC-T stage meetings. These meetings were held to ensure that critical areas affecting completion of the S-IC-T stage would receive the proper attention.

Typical of the conditions affecting hardware deliv-

Figure IX-5 - A Cruciform Baffle Segment is in its Assembly Fixture at the Left. Another Baffle Segment is on a Stand.

Figure IX-6 - Segments of Anti-Slosh Cantilever Circumferentials Await Shipment in the Michoud Tank Ring Baffle Pick-up Area for the S-IC-S and -T

eries were changes in design criteria; revised vibration/shock testing requirements; supplier design deficiencies; and over-optimistic delivery capability quotations. Corrective actions initiated by Boeing included overtime authorization; negotiation of unqualified hardware deliveries and direct shipment authorization; establishing resident personnel at supplier locations to expedite design decisions; assistance in resolving production and quality problems; and periodic Boeing Management visits to ensure continuing management awareness of problems and follow-up of remedial action.

S-IC-S STAGE

Boeing support to NASA/MSFC major structural component hardware (S-IC-S) requirements were initially oriented to fabrication, assembly, and delivery of stage hardware details and assemblies to support the assembly of an equivalent structural stage at MSFC. Hardware deliveries from Boeing were to be provided so that the stage could be assembled in two major sections. The first section (upper structural

stage) would include a LOX tank, an intertank, and a forward skirt. The second section (lower structural stage) would include an intertank, fuel tank, thrust structure, fin and fairing assemblies, engine actuator supports, and propellant line supports. Boeing effort is directed toward final delivery of components to MSFC for the lower structural stage by November 31, 1964, and for the upper structural stage by December 14, 1964.

STRUCTURAL HARDWARE

Thrust Structure

Structural components were being fabricated for the thrust structure (Figure IX-7) of the S-IC-S stage during the fourth quarter of CY 63. By the end of the first quarter of CY 64, the fabrication of structural components for the entire S-IC-S stage was about 87 percent complete. They were scheduled to be 92 percent complete but were slightly behind schedule because the fabrication of the S-IC-T stage had priority.

During the first quarter of CY 64, deliveries were made to MSFC for the S-IC-S thrust structure, with the majority of items being scheduled for delivery during the quarter ending July 2, 1964.

Shortly after the beginning of the second quarter of CY 64, Boeing was requested to assume responsibility for complete assembly of the S-IC-S, S-IC-1, and S-IC-2 thrust structures. These structures will be assembled at Michoud, necessitating transfer of previously delivered thrust structure subassemblies and assembly fixtures from MSFC to Michoud. At the close of the reporting period, the S-IC-S stage thrust structure was in the final assembly operation at Michoud. Minor assembly activities are in phase with final assembly requirements. Present status indicates the completed S-IC-S thrust structure will be delivered to MSFC by September 30, 1964, as scheduled.

Intertank

Intertank assembly activities during the fiscal year included two units of the original configuration for the S-IC-S. The first -S intertank assembly was completed, removed from the final assembly fixture, and shipped to MSFC on June 18, 1964. Delivery of this intertank differed from the S-IC-T in that the structure was removed from the assembly fixture in one piece, and shipped as a single unit rather than in sections as occurred on the -T. The second intertank for S-IC-S was then loaded onto the final assembly fixture and is expected to be completed and removed by July 14, 1964. No major problems have been encountered in the assembly of these two units. Current planning calls for two additional intertanks of a revised configuration for S-IC-S to be assembled in the fourth quarter of 1964.

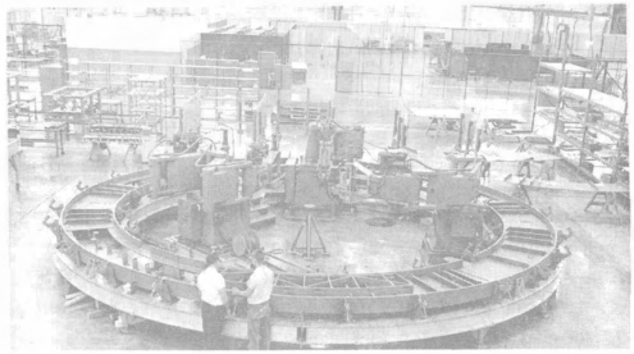


Figure IX-7 - S-IC-S Thrust Ring being Loaded into the Lower Thrust Ring Subassembly Fixture

Forward Skirt

Final assembly of the S-IC-S forward skirt (Figure IX-8) was started in the last week of the reporting period. Assembly activity is progressing on schedule and is to be completed by September 8, 1964.

Figure IX-8 - Skin Panels for the S-IC-S are Assembled in the Fixture at the Left and Held for Shipment as shown

LOX and Fuel Tank

Boeing support of the S-IC-S LOX and fuel tank assemblies consisted of assembly of the forward bulkhead (Figure IX-9) for the LOX tank at Michoud and the delivery of detail tank components to MSFC for subsequent assembly by NASA/MSFC at Huntsville. By the end of the second quarter CY 64, over 500 tank components for the S-IC-S had been delivered to MSFC. At the end of the first quarter of CY 64, the forecast for completion of S-IC-S tank component deliveries was the end of June. Subsequent redirection by NASA/MSFC, altering both quantities and delivery demand dates, has necessitated a re-evaluation of delivery capability. LOX tank component deliveries that were outstanding on July 2, 1964, included 16 ring-baffle segment assemblies, four panel assemblies, four cruciform baffle assemblies, three covers, and one GOX distributor. Fuel tank components still to be delivered included 40 ring-baffle bearings, two cover assembl-

ies, a helium distributor assembly, and a helium cover assembly. Delivery dates through August 17, 1964, have been cited.

The assembly of the forward LOX tank bulkhead at Michoud was to be delivered to MSFC on June 22, 1964, but is behind schedule and is presently forecast for delivery on August 11, 1964. This schedule position is caused by an accumulation of technical problems encountered during the assembly process. Fitting-to-gore welds developed excessive warpage and shrinkage. The gore segments had to be returned to Wichita for rework. Difficulties were then encountered during the gore-to-gore weld operation, and following this the polar cap was determined to be overformed, and a new polar cap had to be fabricated. While this was being produced, the bulkhead was successfully welded to the Y-ring and brackets were welded onto the assembly out-of-sequence in an effort to reduce down time. Assembly completion is predicted for July 25, after which the bulkhead must be prepared for shipment. The bulkhead will then be loaded on a barge and routed to MSFC.

Fin and Fairing

Fin and fairing assembly operations for the S-IC-S are presently scheduled to begin in July 1964. Delivery of the completed assemblies is forecast for the fourth quarter of CY 64.

SPECIALTY HARDWARE

Specialty hardware required of The Boeing Company for the S-IC-S stage is included under four part numbers, which represent a total of twenty parts. The last part is forecast to be on-dock at MSFC by July 28, 1964, which supports MSFC delivery requirements.

S-IC-1 AND S-IC-2 STAGES

Structural component fabrication dominated Boeing efforts in support of the S-IC-1 and the S-IC-2 stages. However, by the end of the reporting period, bulkhead gores were being assembled at Michoud for the S-IC-1 and the assembly for the S-IC-1 base heat shield was about to start. Further assembly activities at Michoud on the S-IC-1 will be paced by the availability of tooling, which is currently loaded with S-IC-S and S-IC-D hardware. Hardware deliveries to MSFC for S-IC-1 and S-IC-2 stages were limited to components for LOX and fuel tanks. Michoud assembly activities and deliveries to MSFC will continue to accelerate as program emphasis swings to the first flight stages, and on-schedule performance is predicted.

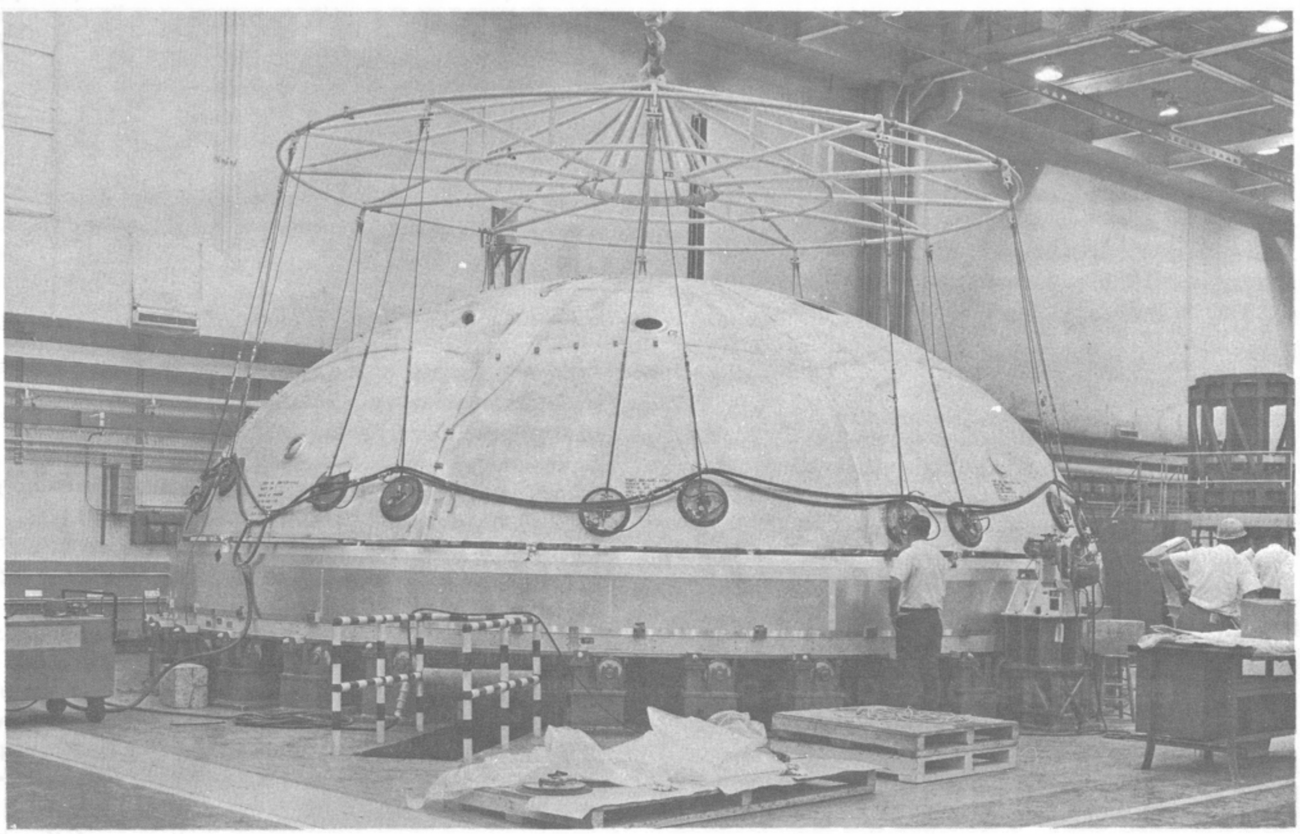


Figure IX-9 - S-IC-S Forward LOX Bulkhead was moved from the Polar Cap Weld Fixture to this Bulkhead-to-Y-ring Weld Turntable by means of the Vacuum Handling Tool shown still Attached

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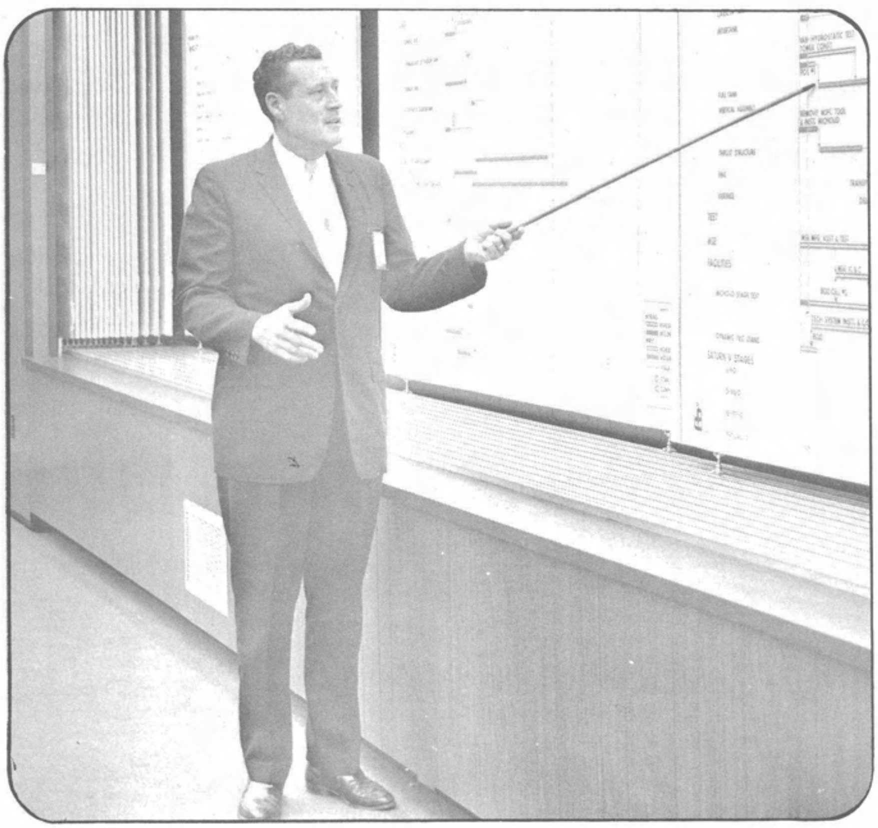


PROGRAM MANAGEMENT

CONTRACTING ACTIVITIES

GENERAL

During FY 64, The Boeing Company was actively engaged in the following Saturn V/S-IC stage program contracts with NASA/MSFC:

Contract NAS8-5608--"Long Range Saturn S-IC Stage Program."

Contract NAS8-2577--"Preparatory Effort Leading to a Project for Engineering, Fabrication, Assembly, Checkout, Static Testing, Transportation, and Launch of the Saturn S-IC Stages"

Contract NAS8-5606(F)--"Facilities Required for Saturn S-IC Stage Program."

Contract NAS8-13002--"Saturn V/S-IC Full-Scale Tail-Section Mockup."

The prime contract, Contract NAS8-5608, effective January 1, 1963, was based on Schedule Plan IV. Through negotiations in late 1962 and in early 1963, Boeing's work base was expanded significantly and because of this, official Schedule Plan V was established in May 1963. In late June 1963, in anticipation of FY 64 funding limitations, NASA/MSFC directed Boeing not to add additional personnel to the S-IC program. This restriction was later removed and a manpower schedule recommended by Boeing was substituted.

In December 1963, Schedule Plan VI, consistent with FY 64 funding, was established. A major program redirection in January 1964, necessitated a change from Schedule Plan VI to Schedule Plan VII. Plan VI was never completely negotiated or implemented because of its short duration, (December 20, 1963 through January 22, 1964). Schedule Plan V and the subsequent modifications to it, served as a baseline for the negotiated transition to Plan VII.

Schedule Plan VII was compared to Schedule Plan V (Figure X-1), to reflect program slides in stage deliveries and in completion of Ground Support Equipment and Manufacturing Support Equipment (GSE/MSE). The responsibility for assembly of the S-IC-D dynamic test stage was transferred from MSFC to Boeing/Michoud, and the assembly of the S-IC-2 flight stage was transferred from Boeing to MSFC.

As of January 1, 1964, sufficient Construction of Facilities funds had been obligated to Contract NAS8-5608 to satisfy all construction requirements through FY 64 with the exception of the stage test facility, the high-pressure test facility, and the Vertical Assembly Building. Funding for these facilities was provided by subsequent modifications received prior to FY end.

CONTRACT NAS8-5608

Modification No. 30, effective August 2, 1963, completed negotiation of Schedule Plan V program redirection and substantially increased the contract value. Modification No. 60, dated December 20, 1963, directed a change to the Plan VI delivery schedule. Modification No. 67, dated January 22, 1964, redirected the program to Plan VII, which revised the delivery dates for stages S-IC-D, S-IC-F, S-IC-3 through S-IC-10,

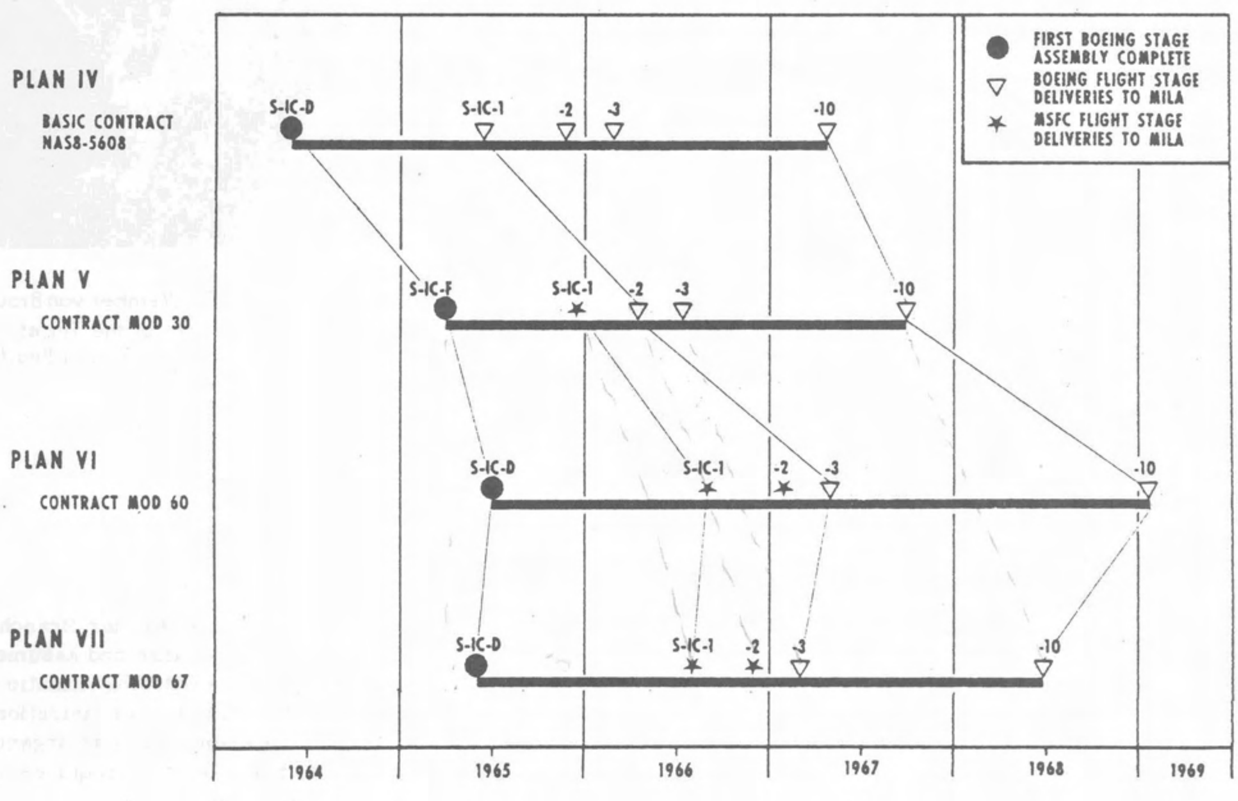


Figure X-1 Comparison of Schedule Plans IV, V, VI & VII for the S-IC Stage

deleted the Boeing responsibility for the assembly of the S-IC-2 stage, and added the S-IC-D stage assembly to Boeing. Modification No. 67 was also significant in that it deleted the manpower clause, Article XVII, which had been the basis of several manpower limitations by NASA. The Boeing proposal for the Modifications 60 and 67 redirections was submitted to NASA on May 25, 1964.

Program obligations of The Boeing Company were substantially increased by Contract Modifications 34, 35, 36, 44, 52, 62, 83, 89, 94, 102, 110 and 113.

Modifications 34, 35, and 36 authorized the design, fabrication, test and qualification of equipment to be used on the Saturn V Launcher Umbilical Tower, and the design, development and documentation of S-IC personnel work platforms for use at Merritt Island Launch Area.

Modification No. 44 shifted the responsibility for the government to provide gaseous nitrogen to Boeing and eliminated the missile-grade air facilities. Modifications 52 and 94 added a Mechanical Automation Breadboard in Building 4708, at MSFC.

Boeing effort to provide Saturn V engineering assistance to NASA/MSFC was extended through December 31, 1964 by Modification No. 62. Modifications 83, 89, 110, and 113 extended Boeing manufacturing and development support to MSFC by 1,950,000 hours for calendar year 1964.

The largest single addition was the S-IC/Mississippi Test Operation (MTO) Activation Task, added by Modification 102 at an increase in contract value of nearly $10 million. This modification added the requirement for activation of one position of an S-IC dual-position test stand at MTO encompassing a stage test and checkout station, stage-to-facility interconnecting equipment, a test control center, and an S-IC storage building. Some modification of design for flight stages S-IC-1 through S-IC-10 was also included.

CONTRACT NAS8-2577

Contract NAS8-2577 was extended to June 30, 1964, to cover existing construction and architectural engiieering subcontracts. The Boeing Company has instituted closure action on this contract and no further extensions are anticipated.

CONTRACT NAS8-5606(F)

During the reporting period, Contract NAS8-5606(F) was rewritten, and the concept of incremental funding eliminated. Funding is now based upon actual need established by extracts from the primary requirements document, D5-12374, submitted by The Boeing Company.

The work statement has gradually expanded due to increased facilities equipment requirements added by the modification of Contract NAS8-5608.

CONTRACT NAS8-13002

On January 23, 1964, in response to a request from the NASA/MSFC Contracting Officer, a proposal for a Saturn V/S-IC full-scale tail section mockup (Fig. X-2) for exhibit at the New York World's Fair was submitted. A fixed contract, NAS8-13002, was subsequently negotiated. During the reporting period, the mockup was fabricated and shipped to New York, arriving at the World's Fair Grounds on March 24, 1964. The contract was completed during the week of April 18, 1964, when NASA/MSFC officially accepted the mockup. Contract closure action was in process by The Boeing Company at the close of the fiscal year.

Figure X-2 - NASA/MSFC Director Dr. Wernher von Braun Accepts Title to the World's Fair Model of the Thrust Structure from R. C. Dunigan (right) and Gordon Beall.

ORGANIZATION

On February 21, 1964, the Saturn Booster Branch was renamed the Launch Systems Branch and assumed the responsibility to manage the new Boeing Atlantic Test Center at Cape Kennedy. This new organization provides increased technical capability and an organization that is responsive to S-IC Program requirements at the Kennedy Space Center.

PROGRAM SCHEDULES

January 27, 1964, marked the initial release of Boeing Document D5-11040-3, "Launch Systems Branch Plan VII Program Schedules." (This document was preceded by D5-11040, -1, and -2, which presented schedule plans IV and V, Va, and VI, respectively). Document D5-11040-3 established the Branch scheduling base for the S-IC Research and Development Program currently under contract. Included in this document are: (1) A Saturn V/S-IC Stage Summary schedule (Figure X-3) which displays the assembly, testing, contractual delivery and planned utilization of each S-IC stage under contract, and an F-1 engine demand schedule and other major Saturn V program milestones; and (2) A Saturn V/S-IC Test and Checkout Equipment summary schedule (Figure X-4) depicting MSFC, Michoud, and Mississippi Test Operations requirements.

Since the initial release, major revisions to Document D5-11040-3 have been made to reflect schedule changes: to add a Saturn V/S-IC Phasing Summary Schedule (Figure X-5); to depict a geographical representation of major activities to be performed in support of the program; and to reflect the activation and checkout of S-IC/MTO Position 1 as a Boeing contractual responsibility (Contract NAS8-5608, Modification 102).

S-IC PROGRAM REPORTING AND CONTROL MILESTONES

Document D5-12535, "Launch Systems Branch Reporting Milestones," was developed to identify and define program reporting and control milestones for the Saturn V/S-IC program described by the technical work statement in Contract NAS8-5608. The milestones included in this document provide time-oriented events against which program progress and performance will be measured. Certain of the milestones depicted are contractual and others are utilized for general Branch management of the program. The contractual reporting milestones have been established by coordination with NASA/MSFC.

SUMMARY PROGRAM PLAN

Contract NAS8-5608 stipulated that the "C-5/S-IC Development Program Plan," developed under Contract NAS8-2577, be revised to incorporate the provisions and requirements of Contract NAS8-5608. This was accomplished and released as Boeing Document D5-11960, "Saturn V/S-IC R&D Summary Program Plan," dated November 1, 1963.

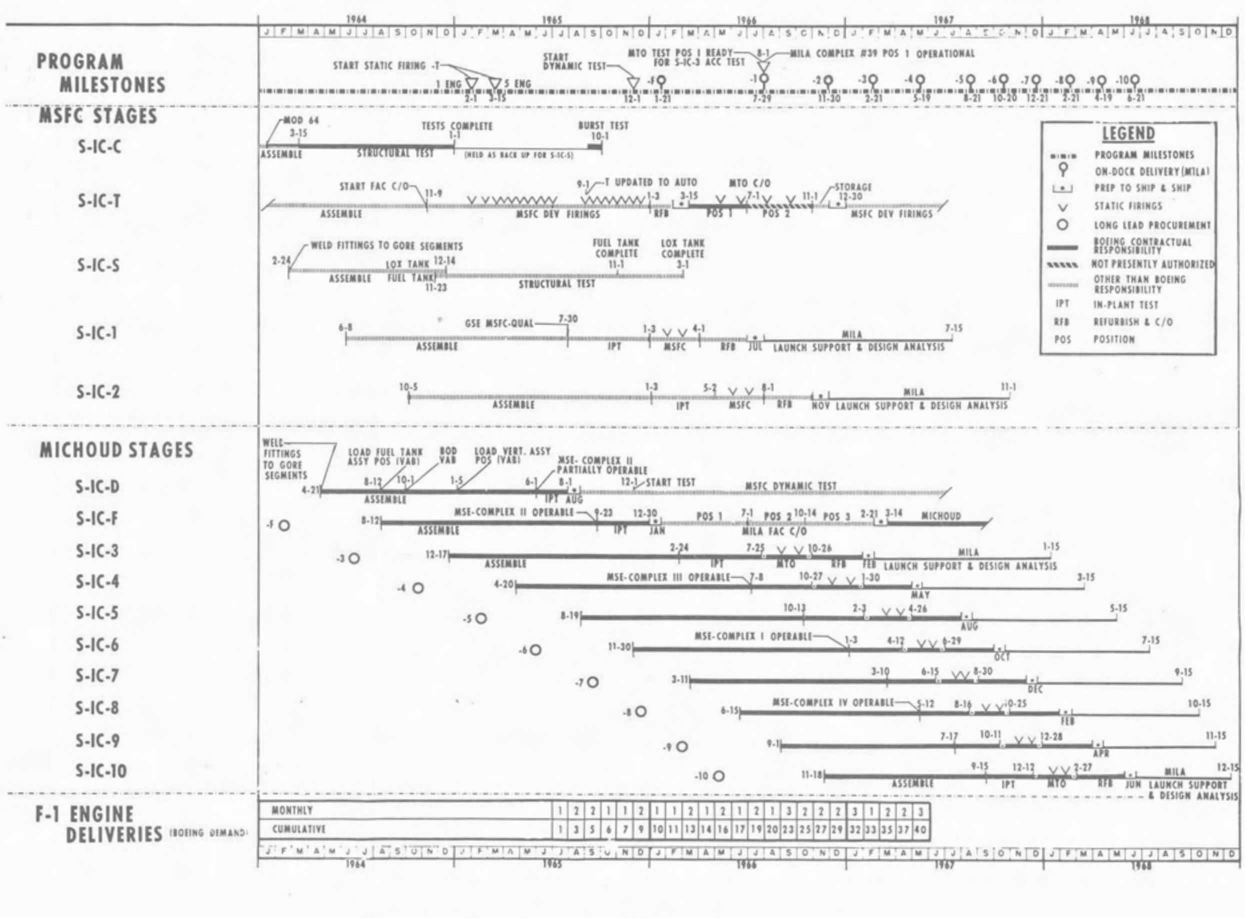


Figure X-3 - Saturn V/S-IC Stage Summary

This summary plan describes the total Boeing task and responsibilities, and provides a firm basis for Boeing Launch Systems Branch planning and management control. Because of the scope and complexity of the program, the Summary Program Plan was made concise and is supported by referenced, detailed plans and other documentation.

PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

During the past year, GSE/MSE networks for all contracted equipment were developed, and networks covering stage electrical and instrumentation systems were completed. This completed the basic PERT coverage of the Boeing S-IC program. During December 1963, NASA/MSFC concurred that the S-IC PERT System was fully implemented.

An improved PERT reporting format was implemented during March 1964. The report was expanded to encompass the Launch Systems Branch assessment of program status trends. During April 1964, Modification No. 100 to Contract NAS8-5608 was received in response to the need for an expanded PERT system. It enlarged the system to approximately 6000 real activities instead of the 1200 limitation specified in the basic contract. This modification was negotiated with NASA/MSFC during June 1964.

Technical Assistance Order (TAO) I-V-S-IC-13 was received in March 1964, authorizing Boeing to develop a PERT system which integrated the PERT reports of the major Saturn/Apollo contractors and government agencies into a single reporting system. The design of the system was completed by Boeing during June 1964.

PROGRAM INFORMATION CENTER (PIC)

The Launch Systems Branch's Program Information Center (PIC) at Michoud has been developed to provide Boeing and NASA management with the necessary program visibility. The PIC presents a display of program plans, schedules, resources, and highlights of significant program events and milestones.

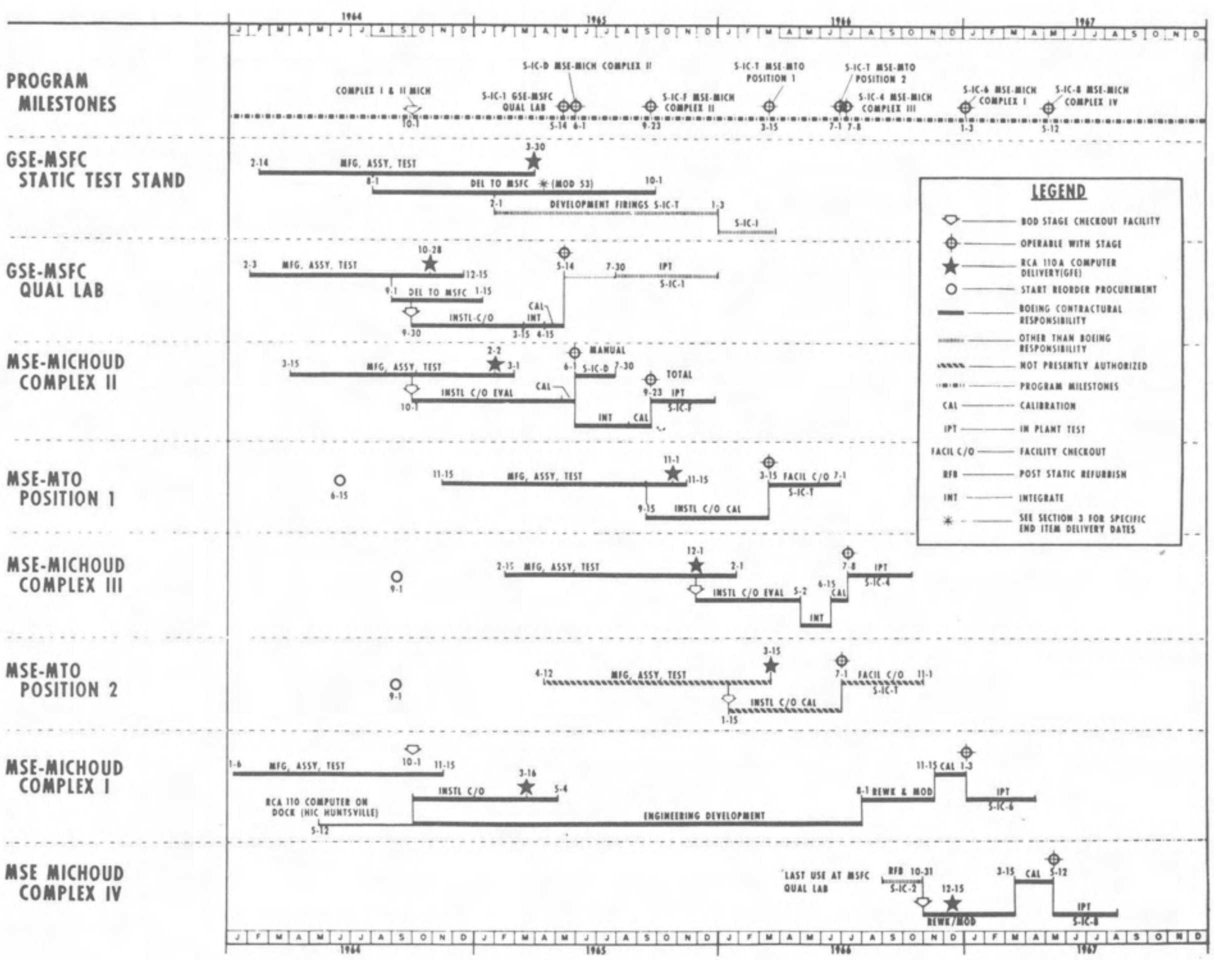


Figure X-4 - Saturn V/S-IC Test & Checkout Equipment Summary

March 1964, marked the go-ahead for the construction of the permanent Michoud PIC. A temporary PIC had been in service since April 1963. The formal opening will be concurrent with the seventh S-IC Quarterly Technical Progress and Program Review currently scheduled for late July 1964. (See Figure X-6.)

SATURN V/S-IC RESPONSIBILITY MATRICES

Saturn V/S-IC Responsibility Matrices were developed to reflect the current status of NASA/Boeing assigned responsibilities for those resolved functional and physical elements required to deliver the S-IC Stage on-dock at MILA. These items were identified to Level 5 in S-IC Program element detail with some facility items identified to Level 6.

SATURN S-IC MAKE-OR-BUY PLAN

A complete revision to Document D5-11413, "Saturn S-IC Make-or-Buy Plan," was approved by NASA/MSFC early in FY 64. Modifications to Contract NAS8-5608 since that time have necessitated numerous revisions to the plan.

Methods for reducing the make-or-buy approval processing time and associated costs have been jointly explored in a series of Boeing-NASA/MSFC meetings during the past year. Documentation of the mutual agreements resulting from these discussions have been transmitted to NASA/MSFC for review and approval.

DOCUMENT CONTROL PROGRAM

A Branch Document Control program was implemented during April 1964, to minimize cost of Branch document preparation and distribution; eliminate redundant documentation; ensure that required documents are prepared; provide management visibility of existing documentation; and ensure that documents are prepared in accord with approved format. This program provides control for that Boeing documentation prepared within

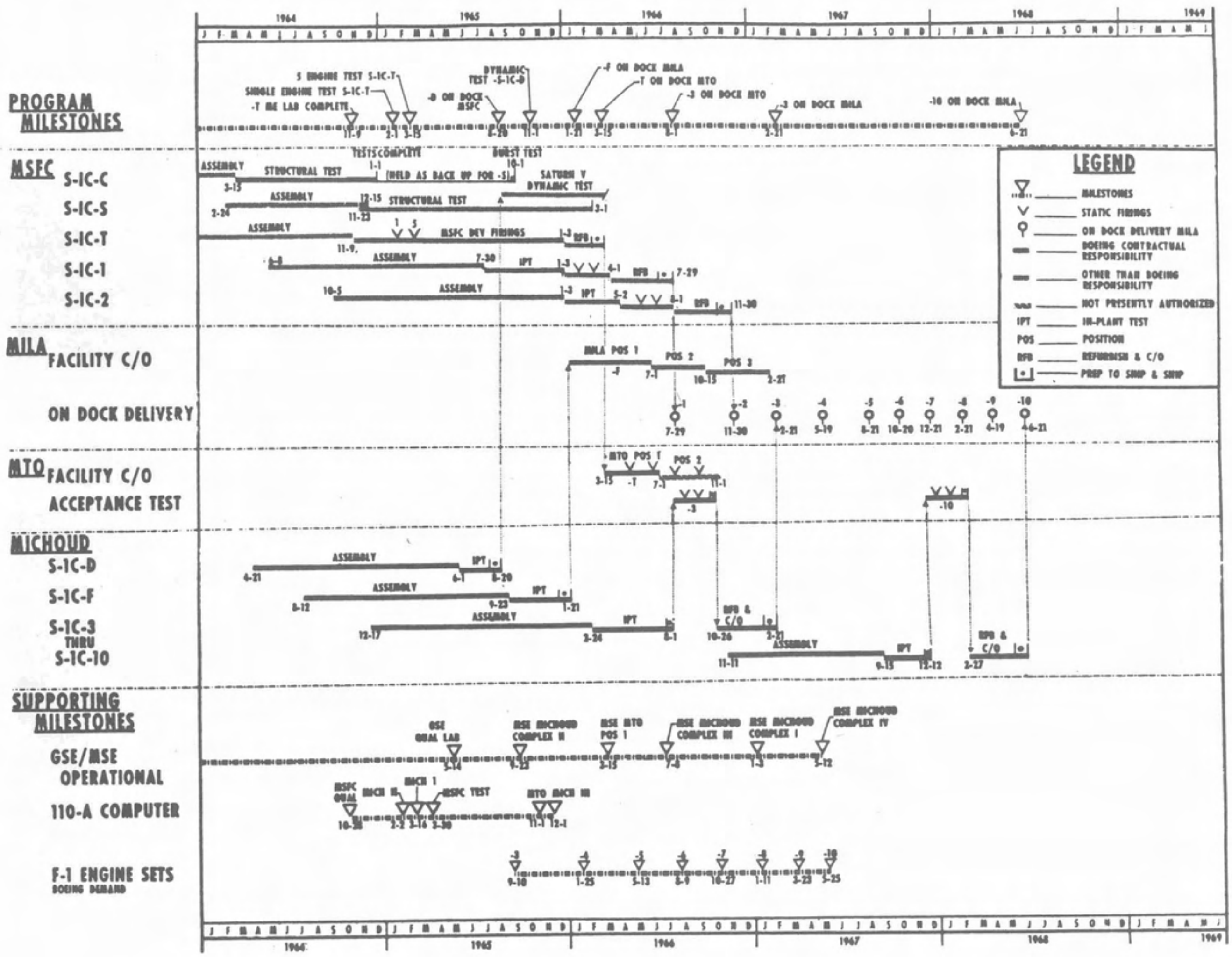


Figure X-5 - Saturn V/S-IC Phasing Summary

the Launch Systems Branch and identified with a "D5" or "T5" prefix to the identification numbers.

BACKUP PROGRAM STUDY

In March 1964, a comprehensive study was initiated to determine where Saturn V/S-IC backup programs were required. Results of this study were submitted to NASA/MSFC on April 1, 1964, by Document D5-11096, "Saturn V/S-IC Backup Program Requirements." This study also identified product improvement and growth items and provided NASA/MSFC the opportunity for review and selection of those items which appear to offer the greatest potential. It also served as a guide to NASA/MSFC for subsequent planning of back-up programs and product improvement funding requirements.

MANPOWER

There were 3782 permanent employees procured for the Launch Systems Branch for the period July 1, 1963, through July 2, 1964. The manpower on-board at all Branch locations on July 2, 1964, was 8684. Of this total, 4391 are transfers from within The Boeing Company, and 4293 are new hires.

TRAINING

Significant training accomplishments during the year by the Launch Systems Branch included the establishment of an employee certification program, activation of the Michoud Training Center, and approval and implementation of major training programs.

FACILITIES AND STAFF

The permanent Boeing Training Center, located in the main factory building at Michoud, was completed in December 1963 (See Figure X-7). Training classes are also held in the Michoud plant welding area (Figure X-8), in various conference rooms at the Michoud Plant, and downtown New Orleans at the 225 Baronne Building and Claiborne Towers. Two permanent classrooms have also been established at the Huntsville Industrial Center.

Thirty-three personnel are actively engaged in developing and presenting S-IC training programs. This staff includes approximately 22 Instructor-Supervisors.

TRAINING PROGRAMS

Training programs within the Branch include Em-

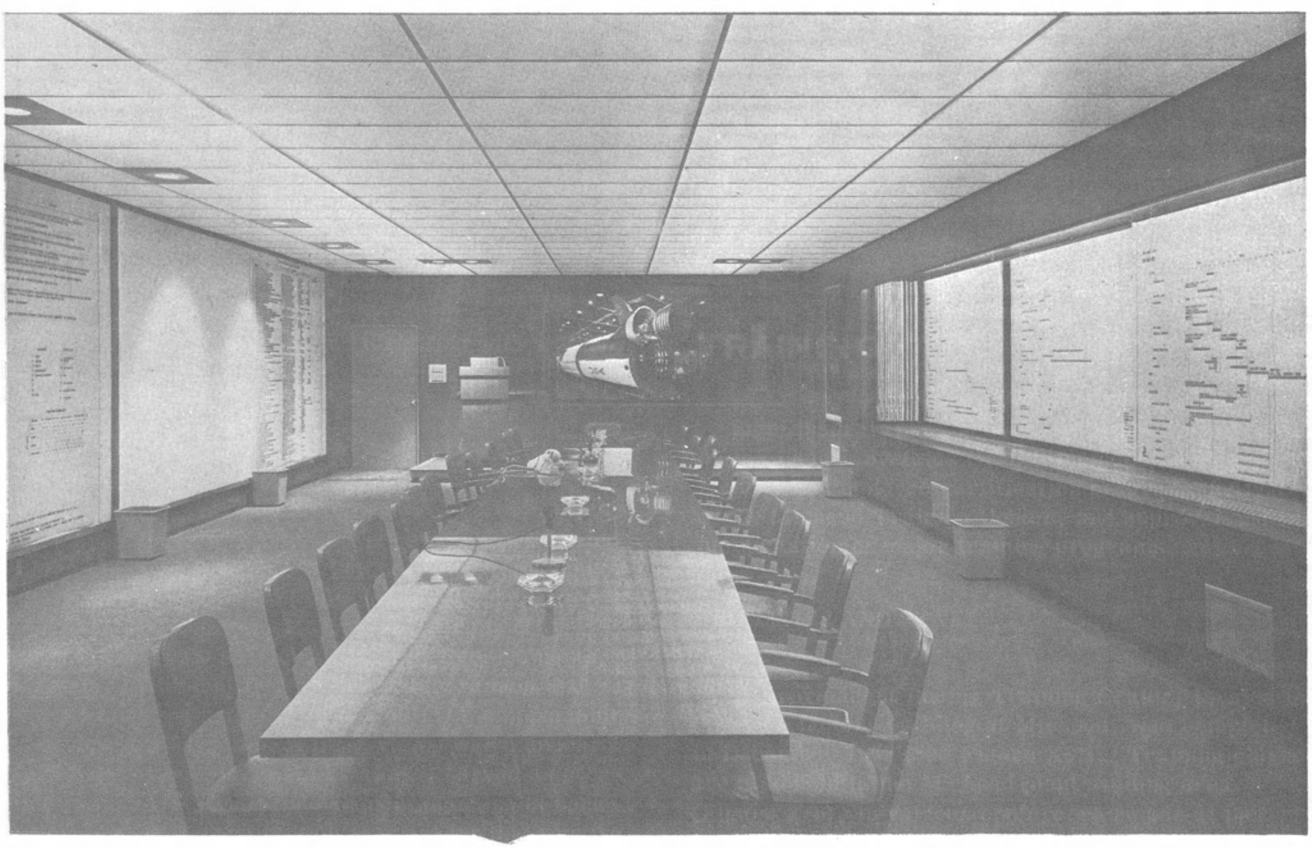


Figure X-6 - Program Information Center

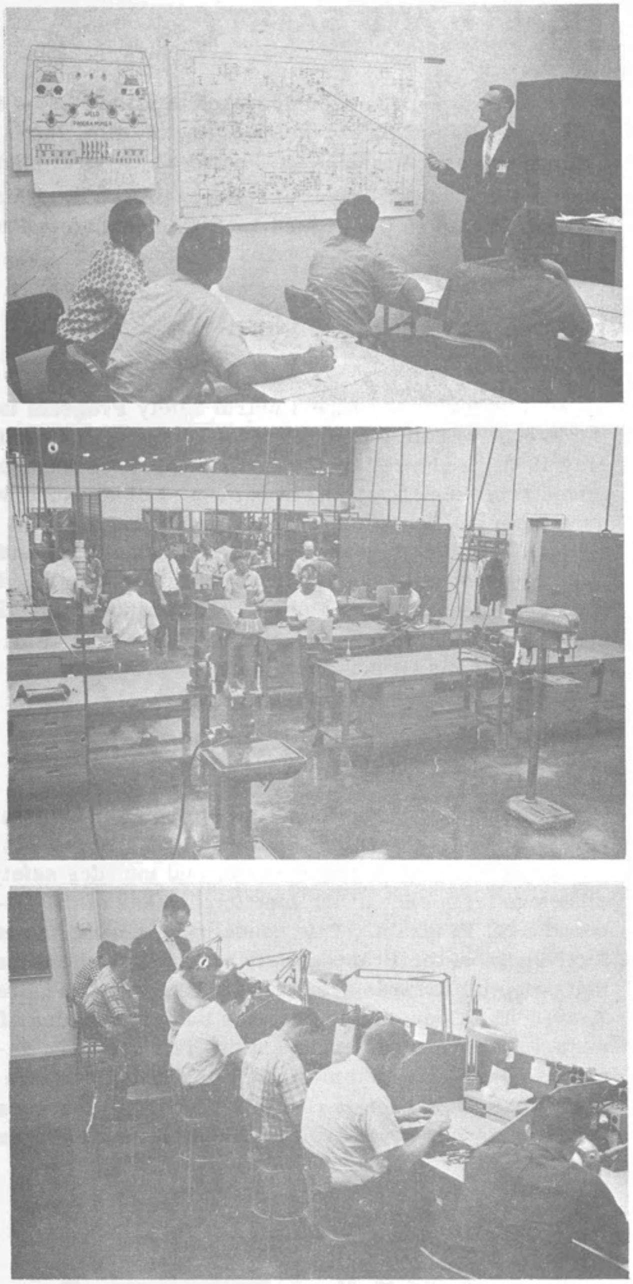


Figure X-7 - Training Classes in the Diverse Skills Needed to Build the S-IC are Being Taught in the Classrooms of the Boeing Training Unit

ployee Certification, Paid-Time Training, Off-Hours Training, and Continuing Education.

The Certification Program consists of training courses in specialized skill areas (e.g., penetrant inspection, soldering, welding, shot peening, contamination control, radiographic inspection, etc.) for employees who must attain a certain proficiency in their particular work to meet the standards of the S-IC program. During the fiscal year, 420 employees were certified in 12 types of certification courses ranging from 8 to 200 classroom hours each.

During the fiscal year, one hundred forty-two paid-time courses, oriented to improving the skills required in the employee's particular job were started, and 25 off-hours voluntary training courses were begun. In these off-hours courses, 461 employees completed training in subjects ranging from basic mathematics to computer programming.

A continuing-education program is also available for all Branch employees and management. In fiscal year 1964, this program included:

a) Technical Sessions, sponsored by colleges and universities throughout the country;
b) Seminars, Symposiums, and Conferences, sponsored by professional technical societies and organizations;
c) Graduate Study Program, Boeing-funded graduate work at nearby colleges and universities;
d) Cooperative Study Program, sponsored by Boeing, whereby college and university students work within the Branch; and
e) A Management Training Program offering advanced and fundamental management courses.

SCHOOL RELATIONS

Contacts were established with local technical, vocational, and secondary schools to compare their scholastic standards with job requirements.

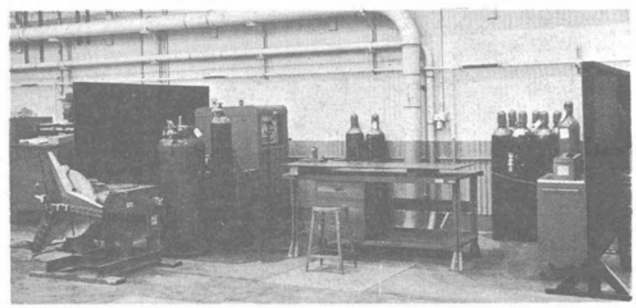


Figure X-8 - Welding Area in the Michoud Plant Where Training Classes are Held

SECURITY ACTIVITIES

Quarterly security inspections by representatives of the Air Force and NASA/MSFC were conducted at Branch facilities in New Orleans and Huntsville. The Boeing Launch Systems Branch Security Program was determined to be satisfactory.

During the past year, an extensive program was implemented to ensure that all classified files and secret control stations within the Launch Systems Branch contain only current and correctly classified documentation. Boeing was commended by NASA/MSFC for their effort and accomplishments on this program. Emphasis was also placed on a security indoctrination program.

FIRE PROTECTION AND EVACUATION CONTROL

Fire brigades have been established at Michoud and Huntsville Launch Systems Branch facilities. These brigades consist of volunteer Boeing employees who receive training in fire prevention and fire fighting (Figure X-9). Monthly fire brigade meetings are held.

The Fire and Evacuation Control Plan for the Branch leased facilities at 225 Baronne Street in New Orleans was put into operation during the year.

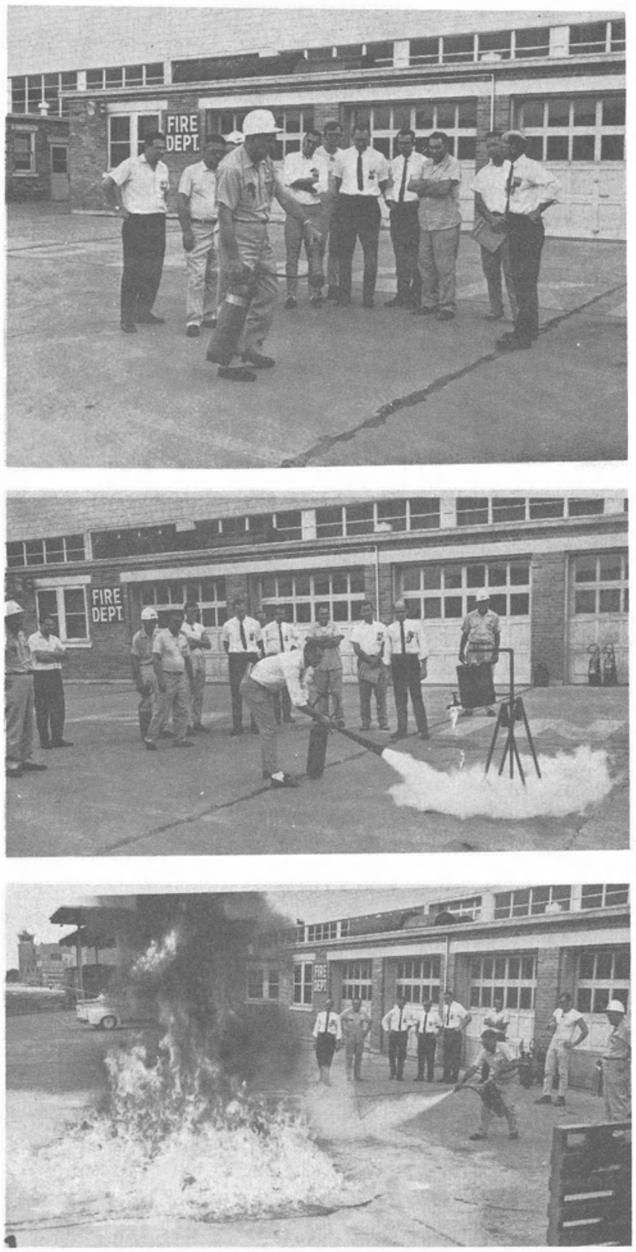


Figure X-9 - Company Personnel Receive Instruction in the Use of Fire Fighting Equipment Under Varying Conditions

HEALTH AND SAFETY

To ensure an organized approach to all problems involving health and safety on the S-IC program, the Launch Systems Branch Vice President-General Manager directed the establishment of a safety program. This was designated as the Branch Line-Control Safety Program.

EXECUTIVE SAFETY COUNCIL

Administering the Line-Control Safety Program is the Executive Safety Council. This Council, formed in May 1963, is chaired by the Assistant Branch Manager, or his representative, and is composed of key supervisors from the Boeing functional organizations.

During the fiscal year, the Council established authority, responsibility, and general policy for safety and accident prevention programs at Michoud and Huntsville, and directed that safety councils be established at all Launch Systems Branch locations.

MICHOUD SAFETY COUNCIL

The Michoud Safety Council was formed in September 1963. This Council is chaired by the Launch Systems Branch Operations Manager, and includes safety directors from each of the functional areas of the Michoud S-IC Program. This council implements the effectiveness of the Branch safety program, and ensures that potential hazards are properly controlled (Figure X-10). The Council also resolves safety problems of mutual concern to the organizations represented. Increased emphasis by this Council on safety practices of Boeing subcontractors resulted in a marked decrease in frequency and severity of accidents during the fiscal year.

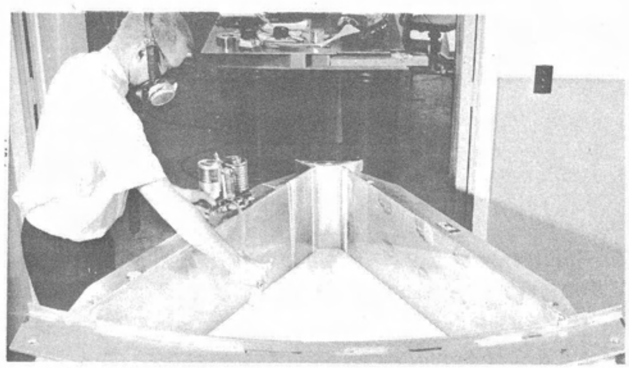


Figure X-10 - A Hygienist Takes a Sample of Toxic Polyurethane Resin Vapors to Determine Their Concentration

HUNTSVILLE SAFETY COUNCIL

The Huntsville Safety Council, chaired by the Boeing

Huntsville-Deputy Manager, was formed in January 1964, and operates on the same principal as the Michoud Safety Council. An MSFC/Boeing agreement has been reached on proper safety coordination where Boeing employees are working in NASA supervised shops.

VISITATIONS

On February 24, 1964, Dr. Wernher von Braun and members of his immediate staff toured the Boeing/Wichita facility (Figure X-11) where they were briefed on the scope of Wichita Saturn support effort, program status, and Boeing/Wichita resources.

Representative Olin Teague, Chairman of the House Subcommittee on Manned Space Flight, toured the Michoud Operations on January 24, 1964.

On March 27, 1964, Virgil I. "Gus" Grissom became the first United States Astronaut to visit the Michoud Operations. Major Grissom was briefed by the Saturn Manager of the Launch Systems Branch, and then toured the Boeing Michoud facilities (Figure X-12).

Figure X-12 - Astronaut V. I. "Gus" Grissom is Shown With NASA and Boeing Representatives at the Boeing Michoud Plant

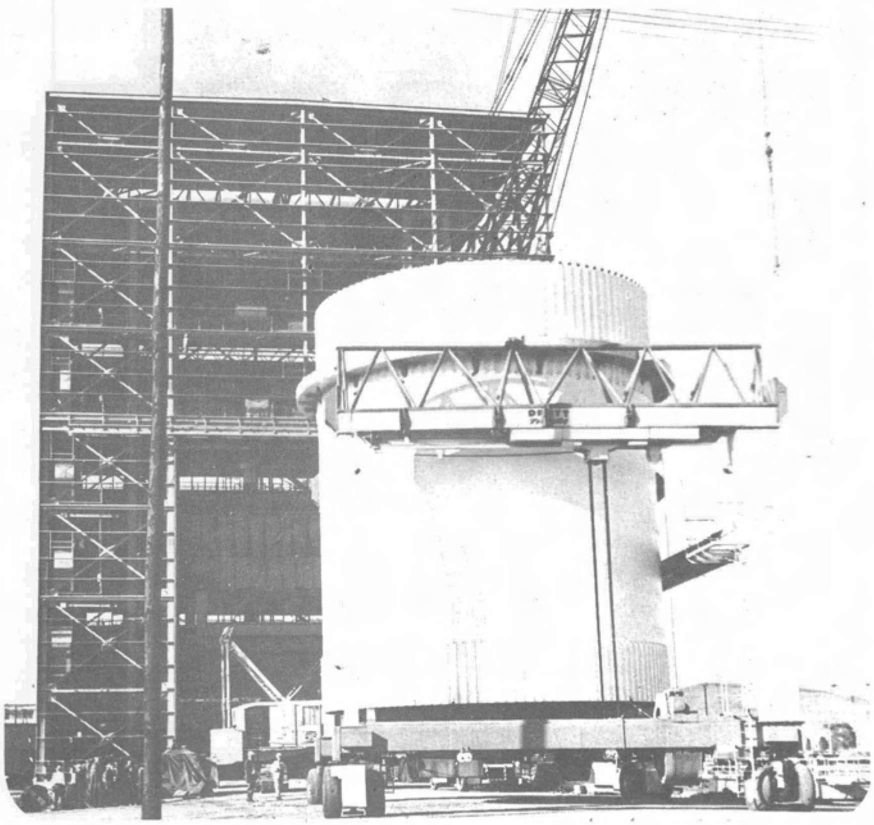
Figure X-11 - Dr. von Braun and Lt. Col. C. C. Bliss Talk With Boeing Airplane Division Vice-President/ General Manager, J. O. Yeasting, During a Visit to the Wichita Facility

EQUAL EMPLOYMENT OPPORTUNITY

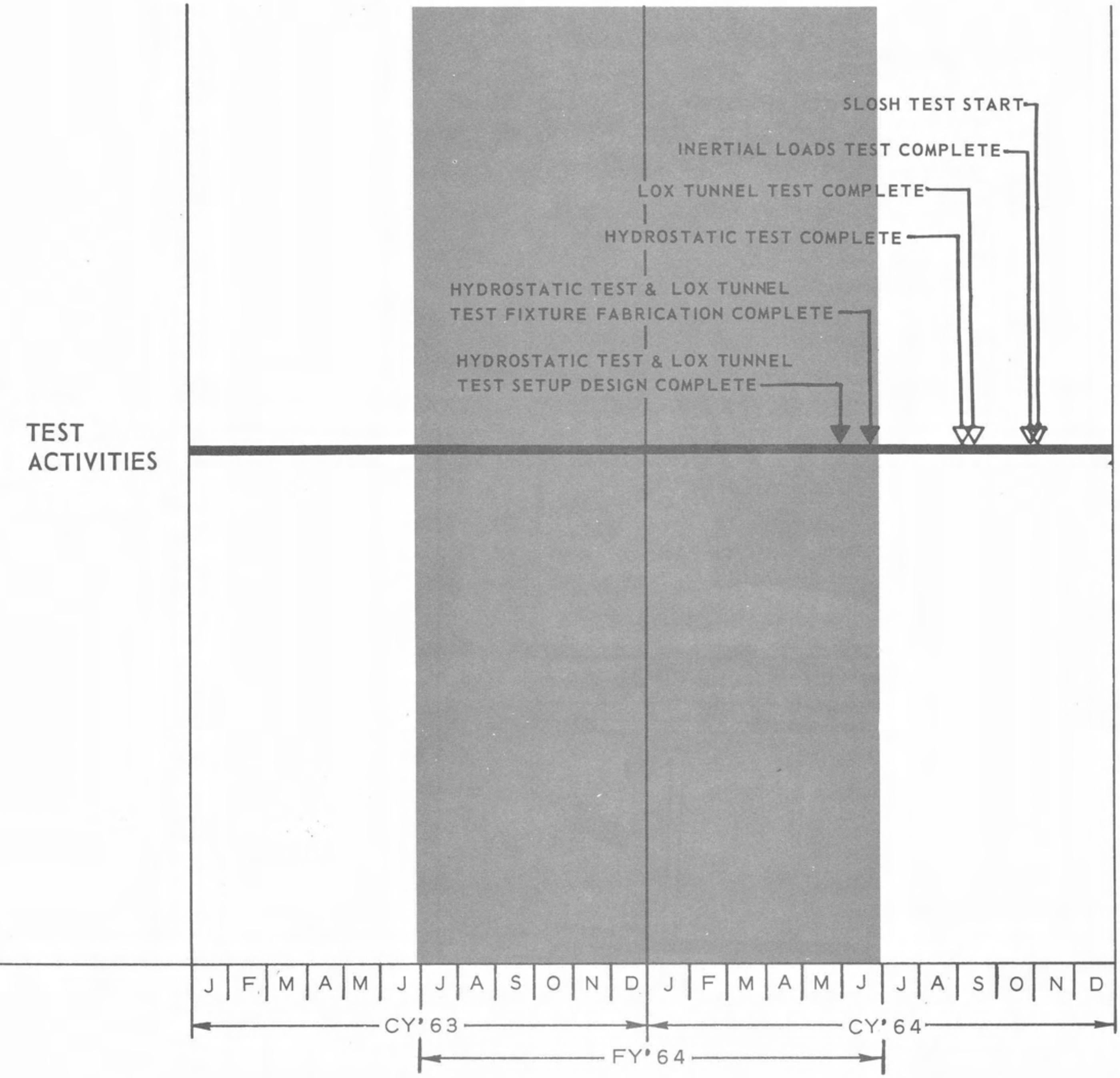
A Plan for Progress Committee, established in May 1963, held bi-monthly meetings to ensure implementation, within the Branch, of the Plan for Progress Agreement signed by Boeing with the President of the United States. A log of the significant activities was reviewed by a government compliance officer in March 1964. Typical activities include: contact with the Urban League on job requirements; presentations on job opportunities at city-wide workshops, senior highschools, and special meetings; review of job classifications to ensure proper placement; and publicizing minority achievement on television and national periodicals.

GOOD NEIGHBOR FUND

A Boeing Good Neighbor Association was established within the Branch. It has pledged funds to the United Givers of New Orleans and the Huntsville United Fund, and has made numerous contributions to charities that do not participate in the United Fund.



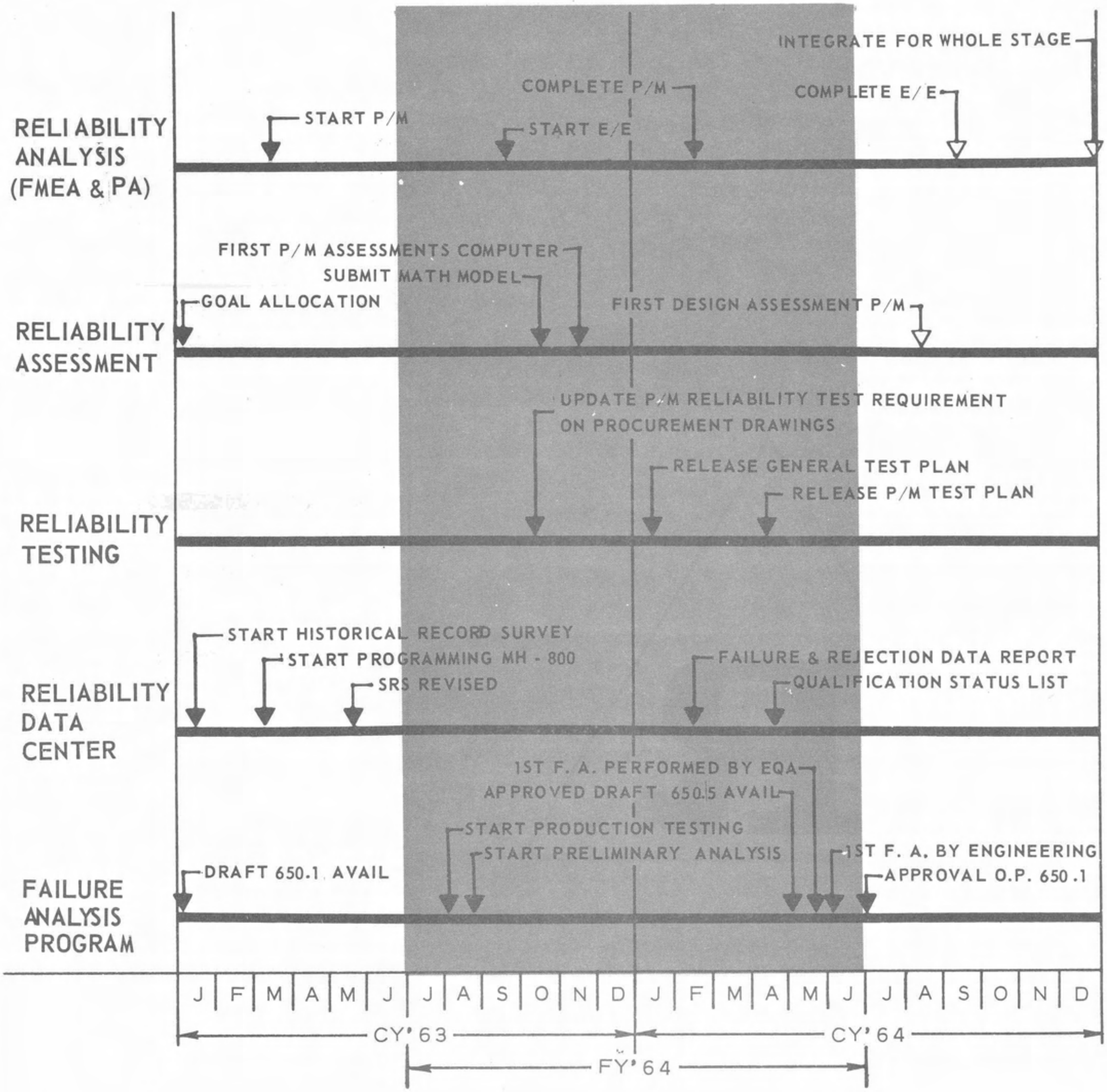
S-IC MISSION SYSTEMS SUPPORT


SLOSH TEST START
INERTIAL LOADS TEST COMPLETE
LOX TUNNEL TEST COMPLETE
HYDROSTATIC TEST COMPLETE
HYDROSTATIC TEST & LOX TUNNEL TEST FIXTURE FABRICATION COMPLETE
HYDROSTATIC TEST & LOX TUNNEL TEST SETUP DESIGN COMPLETE
TEST ACTIVITIES
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

MAJOR COMPONENT STRUCTURAL TEST PROGRAM

Contract Modification No. 64, received January 17, 1964, authorized Boeing to perform the testing of the S-IC-C test fuel tank at MSFC. The tank was fabricated by NASA/MSFC and installed on the test fixture early in March. Preparation for testing was begun. Minor delays, primarily due to delayed receipt of instrumentation towers and to strain-gage bonding problems caused by the severe environmental conditions on the outdoor stand, have been encountered. However, hydrostatic testing will start in July, and the series of structural tests (excluding the burst test) are expected to be completed as scheduled during February 1965. The tank is to be held as a backup for the S-IC-S; therefore, the burst test is not scheduled until September 1965.

RELIABILITY


RELIABILITY ANALYSIS (FMEA & PA)
START P/M
START E/E
COMPLETE P/M
COMPLETE E/E
INTEGRATE FOR WHOLE STAGE
RELIABILITY ASSESSMENT
GOAL ALLOCATION
FIRST P/M ASSESSMENTS COMPUTER
SUBMIT MATH MODEL
FIRST DESIGN ASSESSMENT P/M
RELIABILITY TESTING
UPDATE P/M RELIABILITY TEST REQUIREMENT ON PROCUREMENT DRAWINGS
RELEASE GENERAL TEST PLAN
RELEASE P/M TEST PLAN
RELIABILITY DATA CENTER
START HISTORICAL RECORD SURVEY
START PROGRAMMING MH - 800
SRS REVISED
FAILURE & REJECTION DATA REPORT
QUALIFICATION STATUS LIST
FAILURE ANALYSIS PROGRAM
DRAFT 650.1 AVAIL
START PRODUCTION TESTING
START PRELIMINARY ANALYSIS
1ST F. A. PERFORMED BY EQA
APPROVED DRAFT 650.5 AVAIL
1ST F. A. BY ENGINEERING
APPROVAL O.P. 650.1
J F M A M J J A S O N D J F M A M J J A S O N D
CY'63
CY'64
FY'64

INTRODUCTION

With the signing of Contract NAS8-5608, The Saturn S-IC Reliability Program was activated in January 1963. This program, based on Document D5-11013, "The Reliability Program Plan," has been revised twice consonant with program changes. Official comments on this plan were received from NASA/Michoud on July 2, 1964. A revised plan will be documented and issued in August 1964.

The stage design reliability analysis which includes failure mode and effect analysis (FMEA) and probability analysis (PA), was started in March of 1963 on the propulsion/mechanical system; this work was completed in February 1964. The electrical/electronic FMEAs and PAs were begun in September 1964, thereby affording the first integrated "single thread" analysis for the whole stage in December 1964.

The design review program, which started in February 1963, has progressed well during the year.

The reliability assessment of the S-IC stage began with goal allocation in early 1963. The math model was submitted for approval to NASA/Michoud and NASA/MSFC in October 1963. The model was programmed into the computer and successful computer runs were made in November 1963, on several propulsion/mechanical systems. Work is continuing on the math model as reliability analyses are completed, and the first complete design assessment for the stage is scheduled for July 1965.

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion Mechanical and Thrust Vector Control Systems," accepted by NASA/Michoud, was released in April 1964.

The Data Center initiated historical record surveys early in 1963 to provide reliability data to designers for part selection. To date, surveys have been made on over 500 components. In addition to inspection reports, unsatisfactory condition reports, and inter-service data exchange program reports, over 700 documents and reports are available concerning the performance of some of these components in past programs.

In March 1963, NASA/MSFC made the decision that their MH800 computer would be used for data recording and analysis rather than the IBM7090, and the Data Center proceeded with the necessary reprogramming. This programming is now about 70-percent complete and all basic programs are scheduled for completion in the first quarter of 1965. Difficulties have been encountered in acquiring computer time to check out and test required computer programs. If sufficient time is not provided, the Data Center programs may be delayed still further. Action has been taken to bring this problem to the attention of NASA/MSFC and Boeing management.

Production testing began during the third quarter of 1963. Reliability approval of all Unplanned Event Records (UER) is now required to ensure that complete and accurate reliability data is provided on discrepancies or failures.

The equipment quality analysis (EQA) laboratory which assesses the quality of purchased components was activated in the first quarter of 1964. The first three EQAs have been conducted and reports were issued.

Reliability auditing of all organizations for compliance with Document D5-11013, "The Reliability Program Plan," continued throughout the year on a quarterly basis.

Reliability oriented training courses were attended by 1077 personnel during the year.

ACTIVITIES

RELIABILITY PLANNING

Document D5-11013, "The Reliability Program Plan." was updated in October 1963 and February 1964, to keep it in line with overall S-IC program changes. Preliminary NASA/Michoud comments on the plan were discussed with NASA/MSFC Reliability personnel in May 1964, and formal NASA/MSFC comments were received by Boeing July 2, 1964. A revised plan will be issued in August 1964.

RELIABILITY ANALYSIS

Considerable progress was made with the S-IC reliability analysis in the following areas.

PROPULSION/MECHANICAL

First reliability analyses of the propulsion/mechanical systems were completed. The analyses were included in Document D5-12572-1, "Saturn S-IC Emergency Detection Parameter Selection Analysis," and submitted to NASA/MSFC in March 1964. Updating of the analyses to include design changes and NASA/Michoud refinements is in progress to meet the quarterly revision date of September 1964.

A preliminary propulsion/mechanical qualitative "single thread" analysis was completed and sent to NASA/Michoud for comment in June 1964. Based on this analsis, development of preliminary emergency detection and malfunction detection systems (EDS/MDS) parameter recommendations was started.

OPERATIONAL ELECTRICAL SYSTEM

Work on the reliability analysis of the operational electrical system was temporarily suspended during March and April 1964. This was to enable the design changes indicated as necessary by the partially completed FMEA to be incorporated in the drawings for the first flight stage. The FMEAs were completed in June 1964. The probability analyses are half completed.

INSTRUMENTATION/RF/TELEMETRY SYSTEM

An analysis was performed on the instrumentation/RF/telemetry system to assess the probability of successful data transmission from the S-IC stage. This was submitted to NASA/Michoud in June 1964, for decision on whether further reliability disciplines should be applied to this system.

RELIABILITY ASSESSMENT

The S-IC reliability assessment math model was programmed in the computer and proven by conducting the first design assessment runs against selected propulsion/mechanical systems. The planned assessment program was presented to NASA/MSFC in January 1964, and it is described in Document D5-11954, "Saturn S-IC Stage Reliability Assessment and Reliability Program," released in July 1964.

RELIABILITY DOCUMENTATION

Document D5-11910, "The Reliability Status Report," was issued in August 1963, and was revised June 1964. This document contains the planning detail for the performance of reliability disciplines at subsystem and component level. It provides for sign-off by Boeing Stage Design Engineering and for the check signatures of either Boeing Reliability Engineering or Booster Technology.

The time/cycle recording requirements of the S-IC stage have been documented in Document D5-12713, "Time/Cycle Recording Requirements."

Current reliability documents, operating procedures, and instructions in use by the Launch Systems Branch are shown in Figure R-1.

RELIABILITY EDUCATION

During the year, 1077 people, representing all levels of Boeing technical manpower, attended reliability courses and training programs.

These training programs encompass the whole spectrum of reliability activity as follows:

1) A 4-hour course on the basic tenets of reliability;
2) Courses, varying in length and intensity, on the Saturn Records System which contain basic reliability discussions and detailed instruction on the completion of SRS forms;
3) An 8-hour reliability analysis course in sufficient detail to enable design and staff engineers to perform FMEA and PA and based on the methods described in Document D5-11944, "Design Reliability Methods."
4) A course on contractual reliability requirements considering each paragraph of the contract reliability work statement (Exhibit A, Part I, H. of Contract NAS8-5608) and relating these paragraphs to the reliability tasks defined in Paragraph IV of Document D5-11013, "Reliability Program Plan."

Recommendations have been made to Boeing Management defining requirements for courses to be initiated this year.

SUPPLIER CONTROL

All procurement specifications of critical propulsion/mechanical components have been revised to include reliability requirements and have been signed-off by Boeing Reliability Engineering.

During the year, more than 200 management review board meetings were held to consider supplier proposals and to select suppliers. All of these were attended by reliability representatives of the Manufacturing organization.

Quality and Reliability Assurance personnel are presently performing source surveys and monitoring at 98 vendors' plants.

PART SELECTION

Proposals were made to NASA/MSFC and NASA/Michoud in February 1964, on a part selection and control program. The presentation was favorably received and Boeing is preparing Document D5-11372, "Saturn S-IC Parts Selection and Control Program" for submittal to NASA in July 1964.

DESIGN REVIEWS

During the year, 35 critical design reviews of crucial components were held either at supplier plants or at Boeing. Critical design reviews at subsystem level were rescheduled so that they would agree with Schedule Plan VII. So far, 13 of these reviews have been conducted and the critical design review program is presently on schedule. The Boeing Manufacturing Reliability organization supported the design review program by attending or coordinating a total of 137 design reviews within the Boeing Operations organization.

RELIABILITY DATA CENTER

The Data Center has analyzed all Unplanned Event Records generated to date to detect existing or potential reliability problem areas. Weekly UER analyses have been issued since November 1963. During late 1963, and early 1964, review of the UERs being received by the Data Center showed that the reliability data contained therein was incomplete. Investigation showed that this was attributable to certain incompatibilities

which existed among various standard operating instructions within Boeing. These differences have now been resolved and compatible instructions will be issued by July 1964. Document D5-11593, "The Saturn Records System," is being revised accordingly.

The Data Center has received only about 10 percent of the computer time required to check out its programs under Schedule Plan VII. All major programs were scheduled to be completed in July 1964, but it has been necessary to slide this to March 1965.

The following contractually required programs are among those which will be delayed; the qualification status list; time and cycle recording; revised UER program to enable NASA/MSFC to retrieve reliability data from the Boeing program; the configuration control program and the reliability mathematical model. This problem has been presented to Boeing and NASA/MSFC management for solution.

EQUIPMENT QUALITY ANALYSIS (EQA)

The first EQA was performed on April 14, 1964, and the first report was published on May 12, 1964. The Boeing EQA Procedure 680.2 has been published, and meetings of an EQA Committee have been held to approve the selection and scheduling of components for EQA during 1964.

TESTING

RELIABILITY TEST PROGRAM

Document D5-12497-1, "Reliability Test Program - S-IC Propulsion/Mechanical and Thrust Vector Control Systems," was completed and released in April 1964. The released document incorporated changes recommended by the NASA/Michoud Reliability Office during a review in February 1964. The documentation was again reviewed with the NASA/Michoud Reliability Office in June. The proposed testing concept was acceptable to NASA/Michoud reliability personnel who are now reviewing test requirements contained in the document preparatory to approving the conduct of the testing.

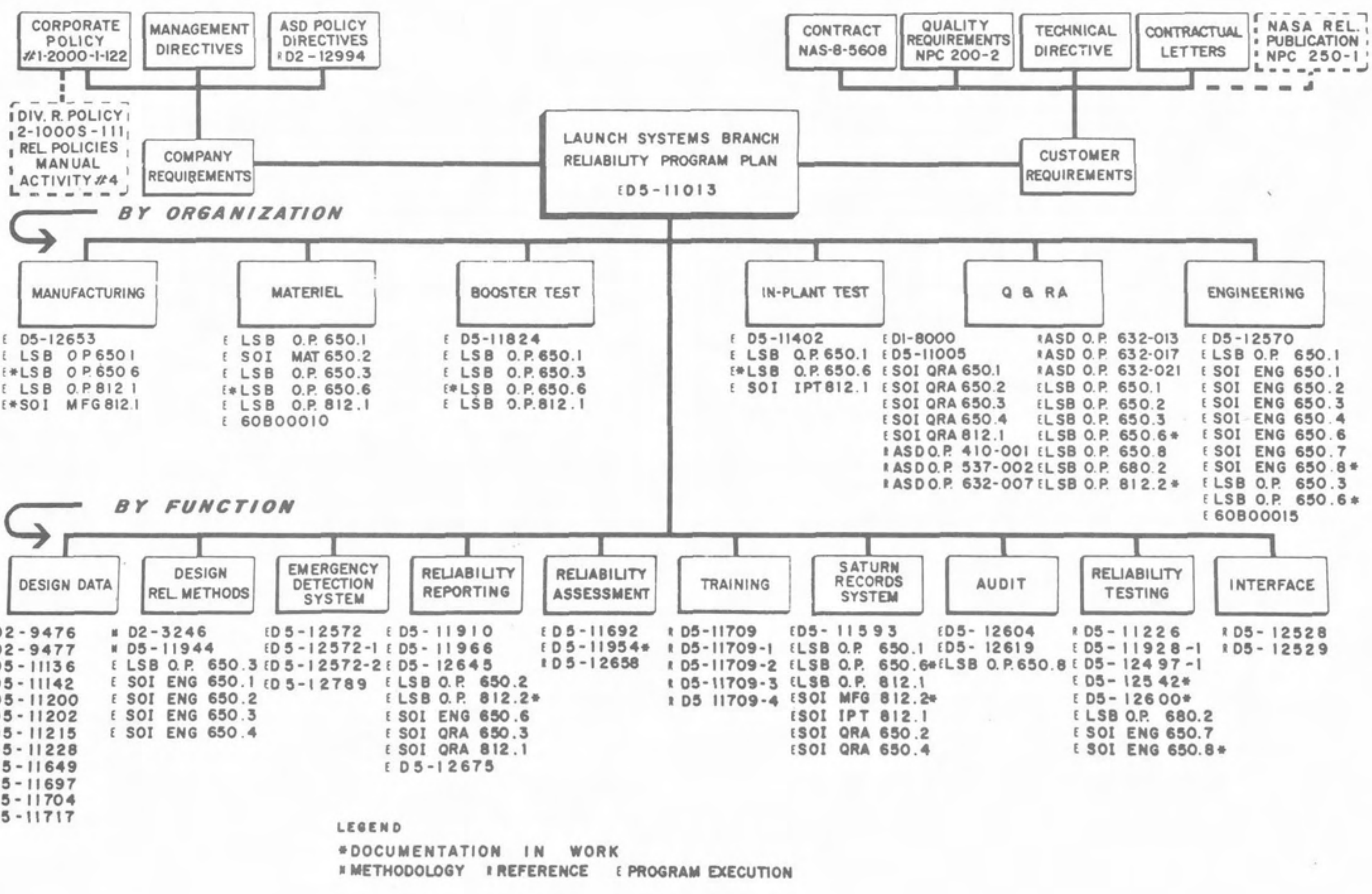


Figure R-1 Reliability Documentation and Procedures

SAFETY CRITICAL ITEMS

The hardware in the S-IC-T critical items list is under study by the Boeing Booster Test organization to determine test requirements and sequences, periodic inspections, and maintenance operations needed to assure safe operation of safety critical items.

MISSISSIPPI TEST OPERATIONS

Saturn Record System Procedures for Mississippi Test Operations have been written, and will be released by Mid-July 1964.

PRODUCTION

Production testing began during the third quarter of 1963. Reliability monitoring of the testing and the resultant handling of Saturn Record System paper work was begun accordingly. These efforts have now progressed to require reliability approval of all initiated UER paper work. This approval is designed to ensure that complete and accurate reliability data is provided on discrepancies or failures.

FAILURE ANALYSIS

The failure analysis program was implemented during the last quarter of the period. Analyses have been conducted both in the Boeing EQA and the Engineering laboratories. The Failure Analysis Operating Procedure, 650.1 was published June 24, 1964.

RELIABILITY AUDITING

The Reliability Audits Operating Procedure, 650.8 was published in June 1964. It establishes that direct audits shall be conducted on a quarterly basis. Since December 1962, audit presentations showing program progress and problems have been made to Boeing management and to NASA/Michoud and NASA/MSFC.

RELIABILITY CHART ROOM

The reliability chart room now has 28 program monitoring charts on display. The charts are frequently used during formal review meetings to show reliability program progress to Boeing and NASA management.

PREDICTION

During the first 6 months of FY 1965, the following significant reliability milestones will be complete:

1) The electrical/electronic reliability analysis will be completed in September 1964.
2) The first integrated "single thread" analysis for the whole stage will be completed in December 1964.
3) The first complete propulsion/mechanical systems design assessment using the computerized reliability mathematical model is scheduled for August 1964.
4) NASA/Michoud comments on Document D5-11013, "The Reliability Program Plan," will be included in the next revision to the plan scheduled for release in August 1964.
5) The Boeing Manufacturing Reliability organization will be fully manned by November 1964. This will enable them to undertake the certification of completed Saturn Record System forms for data validity.
6) The Data Center will complete the following programs: the UER program will be revised by October to enable preliminary UERs to be recorded; the time and cycle recording program will be completed in August 1964; the qualification status listing will be in the computer by September 1964.

GOVERNMENT FIELD PRINTING PLANT
(Under Contract NAS 8-5618)
NASA – MICHOUD OPERATIONS – 1964
NEW ORLEANS 26, LOUISIANA