M-CP-P (R40)

AUG. 27. 1963

GEORGE C. MARSHALL SPACE FLIGHT CENTER

HUNTSVILLE, ALABAMA

MSFC
MANNED SPACE FLIGHT
PROGRAM STATUS
FOR
AUGUST 27, 1963
MANAGEMENT COUNCIL MEETING

Available to NASA Offices and
NASA Centers Only.

M-CP-P (R40)

National Aeronautics and Space Administration

MSFC
MANNED SPACE FLIGHT
PROGRAM STATUS
FOR
PRESENTATION TO THE
MANAGEMENT COUNCIL

August 27, 1963

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Note:

This is material prepared in support of Dr. von Braun's presentation for the August 27, 1963, Management Council Meeting - Agenda Item 2, "MSFC Status Report."

Presentation material consists of slides, a film report and narrative back-up information to support the presentation.

OUTLINE

MSFC MANNED FLIGHT PROGRAMS

		Number of Slides
1.	SA-5 STATUS	1 Film - 14 Min.
2.	SA-5 VOICE ORBITAL TRANSMITTER	2
3.	INTEGRATION EFFORT	31

SA-5 STATUS

SLIDES

1. SA-5 Status

2. Film - Acceptance Firing S-IV-5 (14 min.)

SA-5 STATUS

- ON AUGUST 12 DOUGLAS CONDUCTED A SUCCESSFUL S-IV-5 ACCEPTANCE FIRING TO LOX DEPLETION - 477 SECONDS
- S-I-5, S-IU-5 AND PAYLOAD ARRIVED AT CAPE CANAVERAL ON AUGUST 21
- S-IV-5 IS SCHEDULED TO ARRIVE AT THE CAPE IN LATE SEPTEMBER

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SA-5 STATUS NARRATIVE

Slide

1. SA-5 STATUS

During August, Douglas successfully completed S-IV-5 acceptance tests with two static firings in SACTO Test Stand 2B. The first test, performed on August 5, followed a successful cold flow turbine spin test on July 29. The countdown, including the final automatic sequence phase, proceeded without incident, and engine ignition was satisfactory. All systems operated within design parameters until 63.3 seconds of firing time, when telemetry signals indicating fire in the engine area and the presence of gaseous hydrogen caused manual termination of the firing. Subsequent investigation revealed that telemetry malfunctions caused the indications and that the stage suffered no damage. Following test stand modification to prevent additional false signals, the test was rescheduled. On August 12, the second acceptance firing was successfully performed for 477 seconds. As planned, cutoff was initiated when the LOX supply reached within 1/2 percent of depletion. Preliminary reduction of telemetry data indicated that all systems performed as planned and all test objectives were obtained. The helium heater system functioned throughout the test, and the backup pressurization system was not required. The propellant utilization system operated well within design specifications.

On August 11, the S-I-5 stage, S-IU-5, SA-5 payload, and SA-5 payload adaptor were shipped from MSFC by the barge Promise. Arrived at Cape Canaveral on August 21. The S-IV-5 stage is presently undergoing post static checkout and modifications at SACTO. It is scheduled for Cape shipment by Pregnant Guppy in the last week of September.

Film ACCEPTANCE FIRING S-IV-5

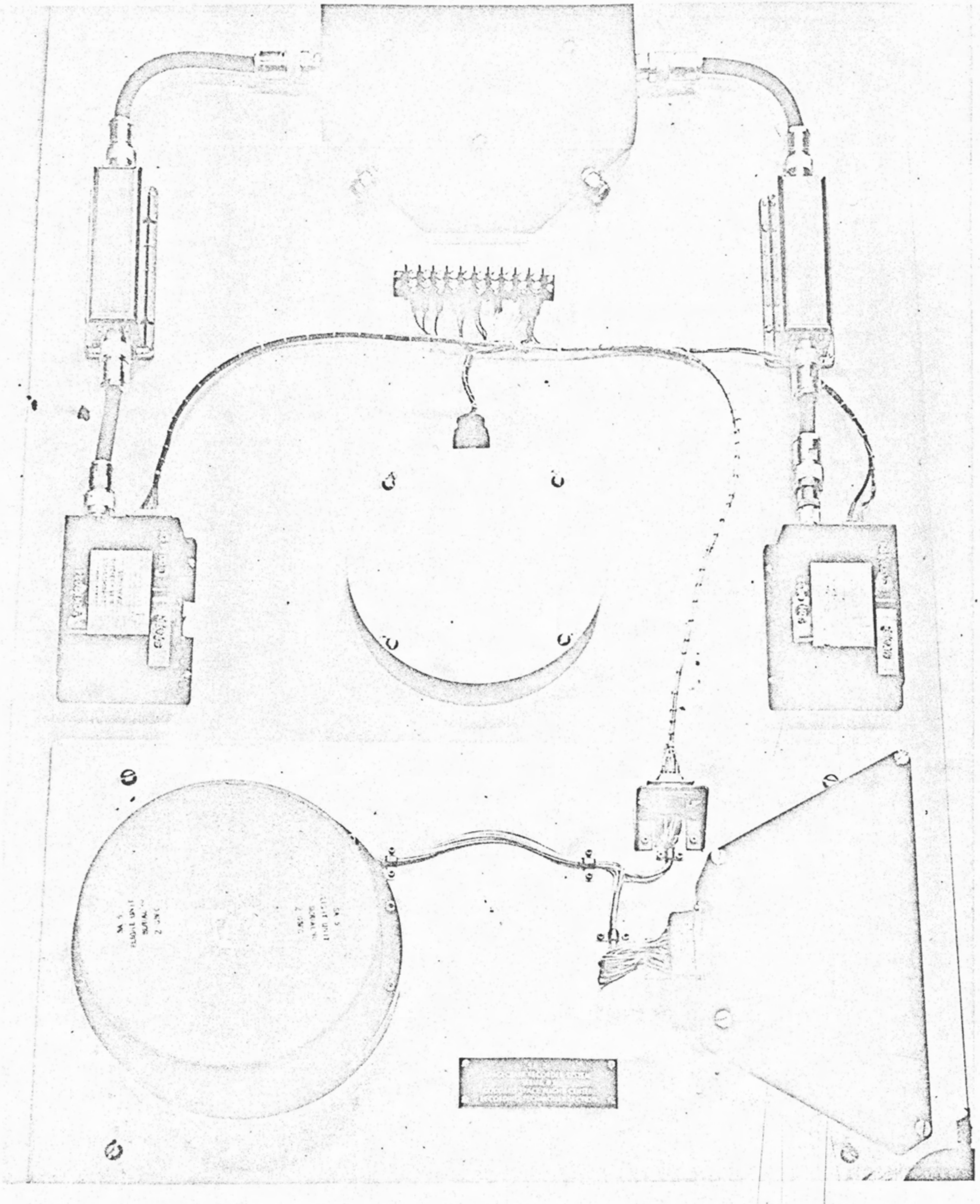
This 14 minute film, prepared by Douglas Aircraft Co., shows the acceptance firing of the S-IV-5 stage at SACTO.

SLIDES

1. SA-5 Voice Orbital Transmitter

2. Public Information Aspects

SA-5 VOICE ORBITAL TRANSMITTER



@ 2 SA-5 VOICE ORBITAL TRANSMITTER

PUBLIC INFORMATION ASPECTS

- DUPLICATE TAPES FOR DISTRIBUTION
- PRERECORDED INTRODUCTION
- ADVAVANCED DISTRIBUTION IN APPROPRIATE LANGUAGES
- NEWS STORY DISTRIBUTION AT WASHINGTON OR LOC
- RADIO AND TELEVISION PICKUP AT RECEPTION POINT

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SA-5 VOICE ORBITAL TRANSMITTER

The payload for SA-5 will contain two transmitting systems. One system will provide temperature and orbital tracking information. The second system, specified as the Voice Orbital Transmitter (VOT), will transmit a prerecorded voice message. It is desirable that the voice to be transmitted be that of the President of the United States. The message should inform the world where the transmission is coming from and that this is the heaviest satellite that has ever been launched into low earth orbit. Headquarters Public Affairs will be responsible for the preparation of copy and for coordinating the recording with the White House. Two copies of this tape will be made available to MSFC at least three (3) weeks prior to launch date of SA-5 for installation. These will be 1/4" magnetic tapes on 7" reels, recorded at 7-1/2" per second.

Slide

1. SA-5 VOICE ORBITAL TRANSMITTER

Hardware for the Voice Orbital Transmitter has been manufactured and is ready for installation. The system contains a continuous loop tape recorder on which a voice message of two minutes duration will be prerecorded. It will continuously repeat itself until the batteries are exhausted.

The voice message will phase modulate the VOT transmitter. The expected life is approximately eight days for the VOT. The output of the transmitter is filtered and multiplexed through a hybrid ring to two "folded-stub" antennas.

The emanations from the orbiting vehicle will not be receivable by individuals because of the frequency employed, but will be receivable at minitrack stations. This will be coordinated with Goddard Space Flight Center by NASA Headquarters Public Affairs. It will be necessary for stations on the minitrack net to acquire 1/4" tape recordings so that the resultant tape is useable on radio and TV stations. The number and location of stations on the net that will be asked to receive and record will be decided by Headquarters and Goddard. Release of the tapes to electronic communications media in the United States will be made by the Office of Public Information, Headquarters. Release of the tape in foreign countries will be coordinated by the U. S. Information Agency.

Slide

2. <u>PUBLIC INFORMATION ASPECTS</u>

Other public information aspects which must be resolved are:

a. responsibility for duplicating tapes at the worldwide reception points for distribution to radio and TV

b. whether or not a prerecorded introduction should be added to the tape

c. distribution of the text of the tape in all appropriate languages in advance of transmission

d. a news story describing the experiment for distribution by Headquarters, either at Washington or at LOC, at the time of launch

e. determination of whether radio, TV, networks or independent stations will be permitted to pickup "live" from the reception point. (minitrack net stations abroad, GSFC in the United States)

The questions above and others which occur will be discussed at a meeting to be called in Washington within the next several weeks. The meeting will include, but will not necessarily be limited to, representatives of NASA Headquarters, MSFC, GSFC, USIA, State Department and the White House.

INTEGRATION EFFORT

SLIDES

1. MSFC Launch Vehicle Systems Integration Effort
2. The Problem
3. MSFC Approach and Solutions
4. Interdependent Systems
5. Range Safety System
6. Launch Vehicle GSE Requirements
7. GSE Design Analysis
8. GSE Major Problems
9. Solutions of Major Problems
10. Solutions of Major Problems (Cont'd)
11. Solutions of Major Problems (Cont'd)
12. Solutions of Major Problems (Cont'd)
13. Solutions of Major Problems (Cont'd)
14. Technical Management Flow Chart
15. Design Concepts
16. Concept Proposals
17. Evaluation, Selection and Redirection
18. Concept Design "Phase I"
19. Design Review "Phase I"
20. Detailed Design "Phase II"
21. Design Review "Phase II"
22. Equipment Fabrication "Phase III"
23. Engineering Review "Phase III"
24. Equipment Testing "Phase IV"
25. Acceptance and Evaluation "Phase IV"
26. MSFC Working Groups
27. Working Groups Responsibilities
28. Saturn V Interface Document
29. Inter-center Panel
30. Conclusions
31. Conclusions (Cont'd)

MSFC
LAUNCH VEHICLE SYSTEMS
INTEGRATION EFFORT

THE PROBLEM

CREATE A LAUNCH VEHICLE SYSTEM, NOT A GROUP OF SEMI-RELATED STAGES

SPECIFICS

- MANY INTERFACES
- DIFFERENT TIME SCHEDULES
- COMMON DESIGN PHILOSOPHY
- DISPERSED GEOGRAPHICAL LOCATIONS

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MSFC APPROACH AND SOLUTIONS

- EACH STAGE IS DESIGNED TO BE AS SELF-SUSTAINING AS PRACTICAL THUS ALLOWING FOR A MINIMUM INTERFACE WITH ADJACENT STAGES.

INDEPENDENT SYSTEMS

- ELECTRICAL
- INSTRUMENTATION
- SEPARATION
- PROPULSION

INTERDEPENDENT SYSTEMS

- RF COMPATIBILITY
- MECHANICAL MATING
- VEHICLE DYNAMICS
- SEQUENCE AND TIMING
- ATTITUDE CONTROL
- CREW SAFETY
- ORBITAL CHECKOUT
- RANGE SAFETY

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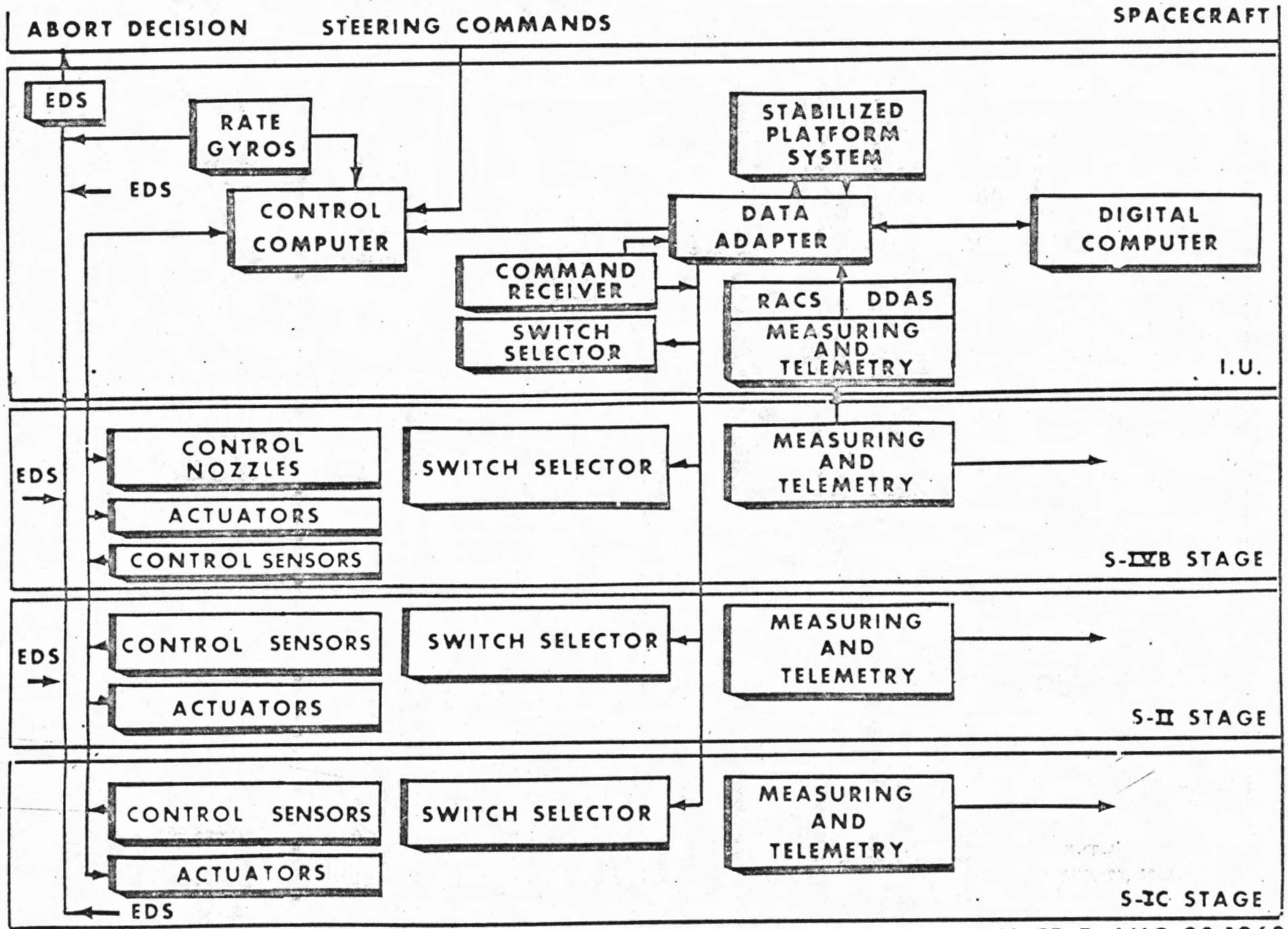
INTERDEPENDENT SYSTEMS



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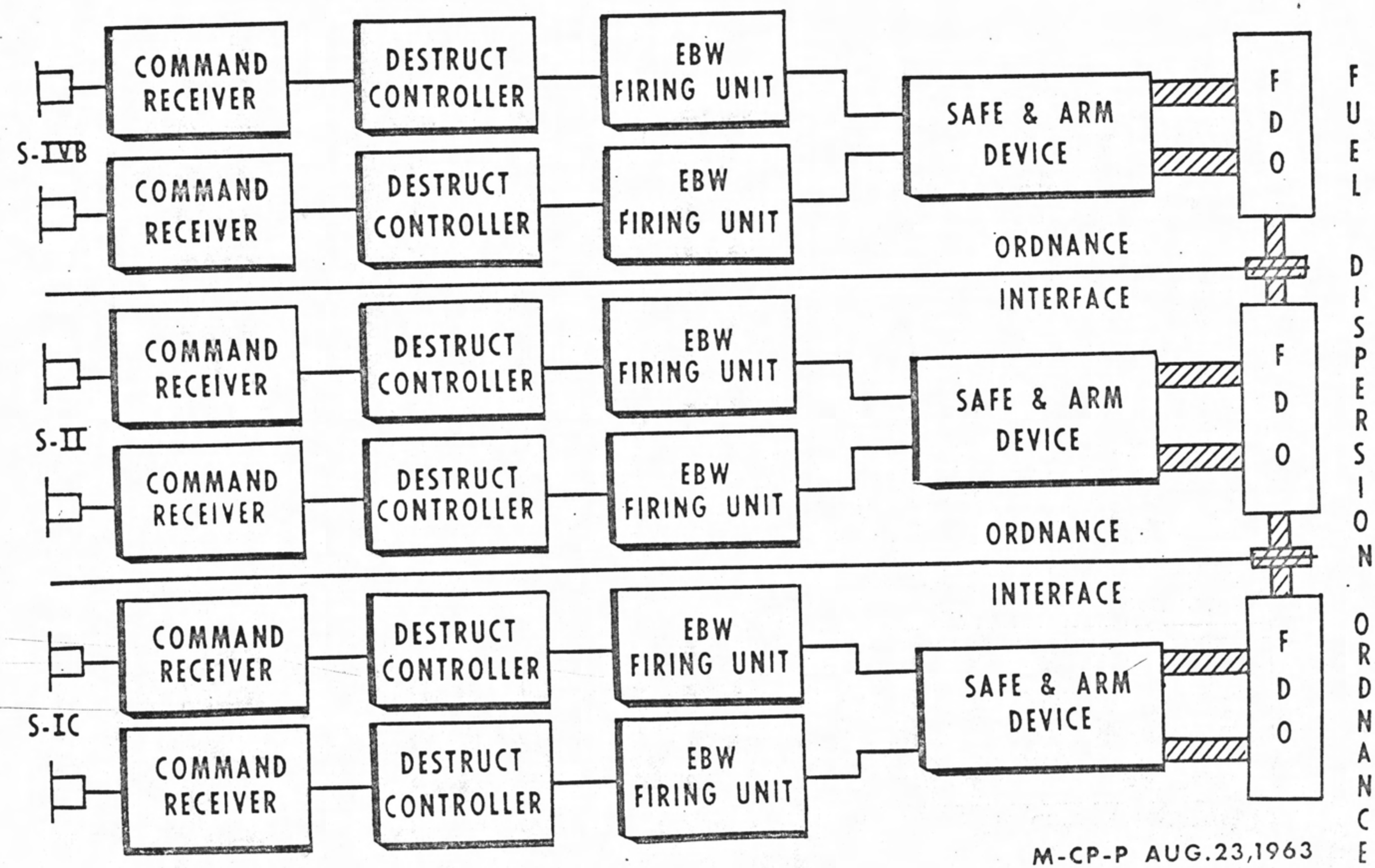
RANGE SAFETY SYSTEM



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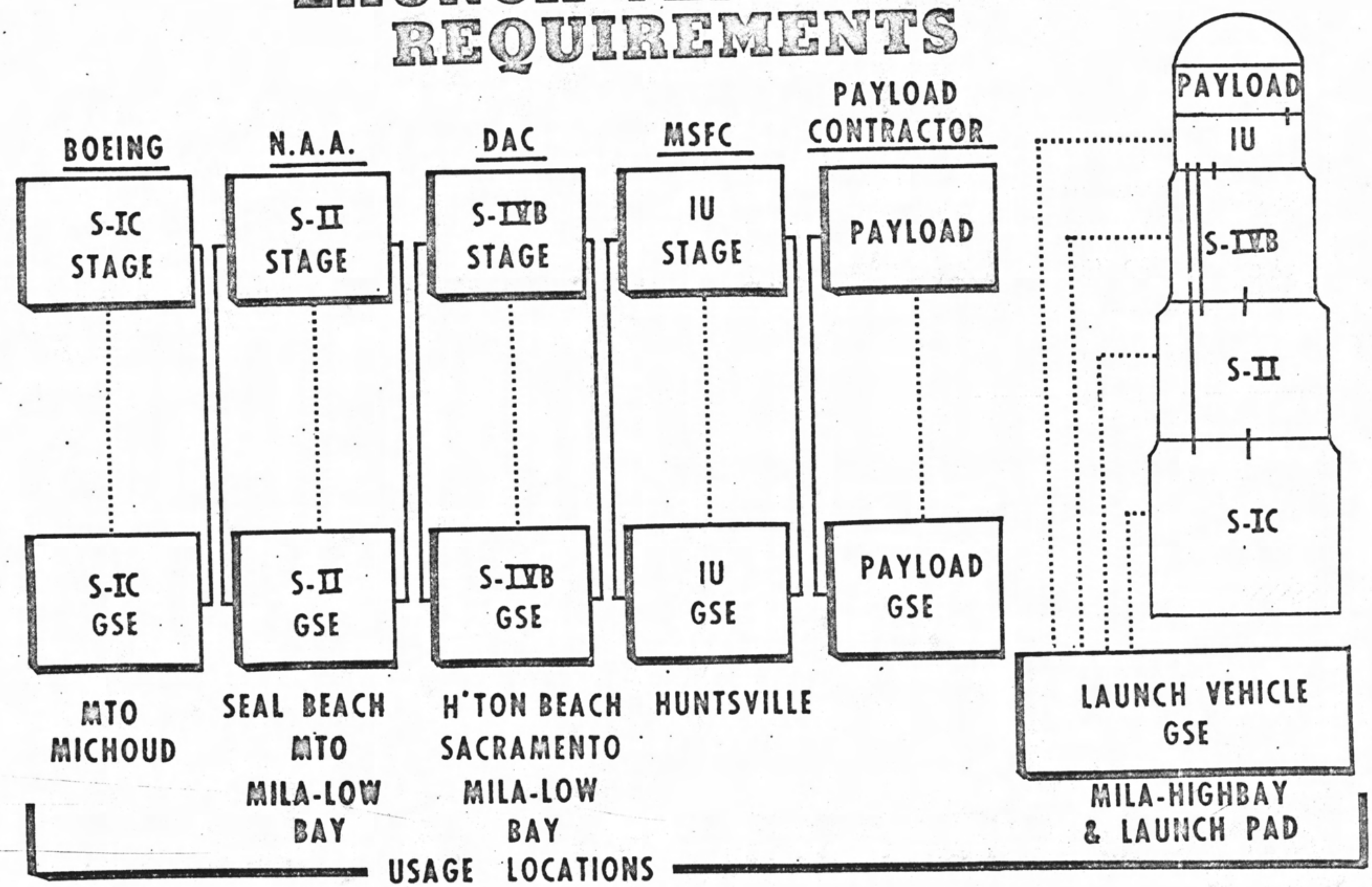
LAUNCH VEHICLE GSE REQUIREMENTS



—— STAGE TO STAGE INTERFACES

······· VEHICLE OR STAGE UMBILICALS TO GSE

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GSE DESIGN ANALYSIS

INSTRUMENT UNIT

- COMPLICATED CHECKOUT
- SIMILAR TO SATURN I & IB UNITS
- BLACK BOX SIMILAR TO THOSE IN PREVIOUS MSFC PROGRAMS

PROPULSION STAGES

- RELATIVELY SIMPLE ELECTRICALLY
- SIMILAR ELECTRICALLY
- SIMILAR TO THOSE IN PREVIOUS MSFC PROGRAMS

CHECKOUT AND LAUNCH EQUIPMENT DESIGN IS NOT A SIGNIFICANT PROBLEM

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GSE MAJOR PROBLEMS

1. IMMENSE TOTAL EFFORT REQUIRED
2. COMMON APPROACH TO STAGE CHECKOUT AND LAUNCH EQUIPMENT DESIGNS
3. TIGHT SCHEDULES AND THE R&D NATURE OF THE PROGRAM
4. OPTIMIZE LAUNCH VEHICLE GSE DESIGN
5. MINIMIZE EXTREME INTERFACES

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SOLUTIONS OF MAJOR PROBLEMS

PROBLEM 1

- IMMENSE TOTAL EFFORT REQUIRED

SOLUTION

- DIVIDE JOB INTO LOGICAL PARTS

- GSE REQUIREMENTS RESPONSIBILITY OF STAGE DESIGN ORGANIZATION

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SOLUTIONS OF MAJOR PROBLEMS (CONT)

PROBLEM 2

- COMMON APPROACH TO STAGE CHECKOUT AND LAUNCH EQUIPMENT DESIGNS

SOLUTION

- PROVIDE BASIC CONCEPTS, SPECIFICATIONS, AND STANDARDS
- REVIEW SYSTEMS EARLY IN DESIGN PHASE
- BASE CHECKOUT AND LAUNCH SITE EQUIPMENT DESIGNS ON STAGE GSE DESIGNS

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SOLUTIONS OF MAJOR PROBLEMS (CONT)

PROBLEM 3

- TIGHT SCHEDULES AND THE R & D NATURE OF THE PROGRAM

SOLUTION

- ESTABLISH CLEAR-CUT RESPONSIBILITIES FOR GSE DESIGNS
- MINIMIZE INTERFACES
- DESIGN EQUIPMENT TO PROVIDE FOR EASY CHANGE CAPABILITY
- ESTABLISH PROPER MANAGEMENT CHANNELS

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SOLUTIONS OF MAJOR PROBLEMS (CONT)

PROBLEM 4

- OPTIMIZE LAUNCH VEHICLE GSE DESIGN

SOLUTION

- TREAT LAUNCH VEHICLE AS ONE PROBLEM
- UTILIZE COMMON HARDWARE
- TAKE ADVANTAGE OF THE PROVEN HARDWARE IN MSFC DESIGNS FOR SATURN I AND IB STAGES AND INSTRUMENT UNIT EQUIPMENT
- PROVE NEW DESIGNS PRIOR TO IMPLEMENTATION
- TAKE ADVANTAGE OF BRAINS AND TALENT EXPENDED IN STAGE CONTRACTOR GSE DESIGNS

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SOLUTIONS OF MAJOR PROBLEMS (CONT)

PROBLEM 5

- MINIMIZE EXTREME INTERFACES

SOLUTION

- MSFC GSE PERSONNEL ARE DESIGNING THE INSTRUMENT UNIT GSE
- MSFC GSE PERSONNEL HAVE ESTABLISHED CLOSE RELATIONSHIP WITH STAGE CONTRACTORS
- MSFC GSE PERSONNEL HAVE ESTABLISHED CLOSE RELATIONSHIP WITH LOC AND LVO ON LAUNCH VEHICLE GSE INTERFACES
- MSFC GSE PERSONNEL HAVE ESTABLISHED ALL NECESSARY INTIMATE INTERFACES
- MSFC GSE DESIGNERS HAVE SUCCESSFULLY DESIGNED AND IMPLEMENTED THE REDSTONE, JUPITER, JUNO, PERSHING, SATURN I GSE SYSTEMS.
- CONCLUSION

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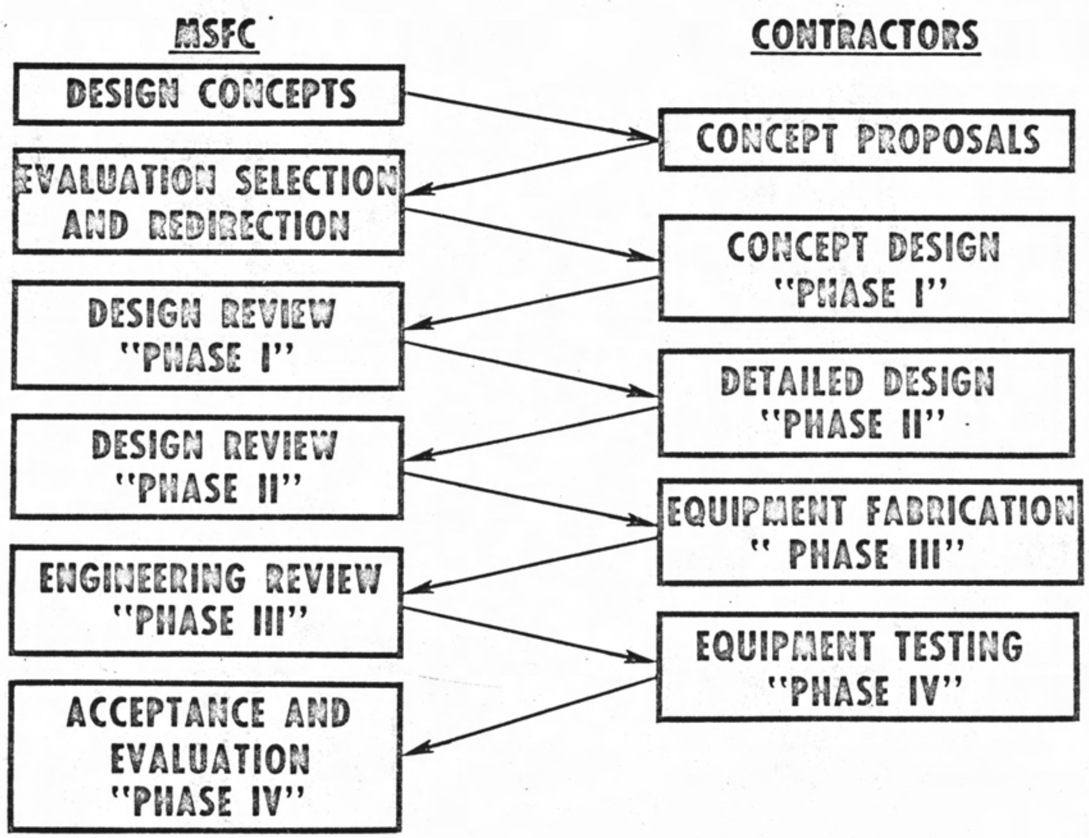
TECHNICAL MANAGEMENT FLOW CHART



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DESIGN CONCEPTS

→ TO CONTRACTOR

MSFC

- DESIGN STUDIES
- PROGRAM PLAN
- DESIGN CONCEPTS
- DESIGN STANDARDS AND REQUIREMENTS
- HARDWARE STANDARDS AND PREFERRED PARTS
- REQUESTS FOR QUOTES

WORK STATEMENT

SCHEDULES

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TO MSFC ←

CONCEPT PROPOSALS

CONTRACTOR

PROGRAM PLANNING DOCUMENTS

- PROGRAM PLAN
- MANAGEMENT PLAN
- MODEL SPECIFICATION
- MANUFACTURING PLAN
- DATA SUBMITTAL DOCUMENT
- TEST PLAN
- MAKE OR BUY STRUCTURE
- SPECIFICATION DEVIATION DOCUMENT

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EVALUATION, SELECTION AND REDIRECTION → TO CONTRACTOR

MSFC

- REVIEW AND EVALUATION OF PROPOSALS
- SELECTION OF CONTRACTOR
- REVISE THE PROPOSALS FOR SYSTEM COMPATIBILITY
- INDICATE AREAS FOR STANDARDIZATION
- REDIRECT CONTRACTOR

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CONCEPT DESIGN
PHASE I

TO MSFC ←

CONTRACTOR

- INITIATE DESIGN
- EVALUATE REDIRECTION
- REQUEST DEVIATIONS TO STANDARDS
- PRODUCE PHASE I DOCUMENTATION REQUIREMENTS (LAYOUTS, SCHEMATICS, FLOW DIAGRAMS, ETC.)
- PRESENT PHASE I DESIGN

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DESIGN REVIEW "PHASE I" → TO CONTRACTOR

MSFC

- REVIEW PHASE I DOCUMENTATION
- PARTICIPATE IN DESIGN PRESENTATION
- COMPARE DESIGN FOR COMPATIBILITY WITH OTHER STAGES AND SYSTEMS
- EVALUATE FOR BEST DESIGN PRACTICES
- DETERMINE ECONOMICAL AREAS FOR STANDARDIZATION
- GIVE NECESSARY REDIRECTION

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TO MSFC ←

DETAILED DESIGN
"PHASE II"

CONTRACTOR

- EVALUATE REDIRECTION
- INITIATE DETAILED DESIGN
- PRODUCE THE DETAILED DESIGN DOCUMENTATION FOR PHASE II REVIEW (DETAILED LAYOUTS, ADVANCED SCHEMATICS, CABLE AND PIPING DIAGRAMS)

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DESIGN REVIEW "PHASE II"

→ TO CONTRACTOR

MSFC

- REVIEW PHASE II DOCUMENTATION
- PARTICIPATE IN DESIGN PRESENTATION
- COMPARE DESIGN FOR COMPATIBILITY WITH OTHER STAGES AND SYSTEMS
- EVALUATE FOR BEST DESIGN PRACTICES
- DETERMINE ECONOMICAL AREAS FOR STANDARDIZATION
- GIVE NECESSARY REDIRECTION

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TO MSFC ←

EQUIPMENT FABRICATION "PHASE III"

CONTRACTOR

- PREPARE MANUFACTURING DOCUMENTATION
- SUBMIT MANUFACTURING DOCUMENTATION FOR PHASE III REVIEWS (DETAILED LAYOUTS, ADVANCED SCHEMATICS, CABLE AND PIPING DIAGRAMS)
- FABRICATE THE HARDWARE

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ENGINEERING REVIEW "PHASE III" → TO CONTRACTOR

MSFC

- REVIEW PHASE III DOCUMENTATION FOR COMPATIBILITY, DISCREPANCIES, RELIABILITY AND STANDARDIZATION
- MAINTAIN CONTINUOUS DESIGN SURVEILLANCE

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EQUIPMENT TESTING "PHASE IV"

TO MSFC ←

CONTRACTOR

- PRESENT ACTUAL HARDWARE STATUS PRIOR TO SYSTEMS ACCEPTANCE TESTING
- PERFORM PRELIMINARY TESTING
- CORRECT ERRORS AND DISCREPANCIES
- PERFORM ACCEPTANCE TESTING

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ACCEPTANCE AND EVALUATION "PHASE IV"

MSFC

- FINAL DESIGN EVALUATION
- PARTICIPATION IN ACCEPTANCE TESTING AND EVALUATION
- SUGGEST IMPROVEMENTS FOR POSSIBLE REDESIGN

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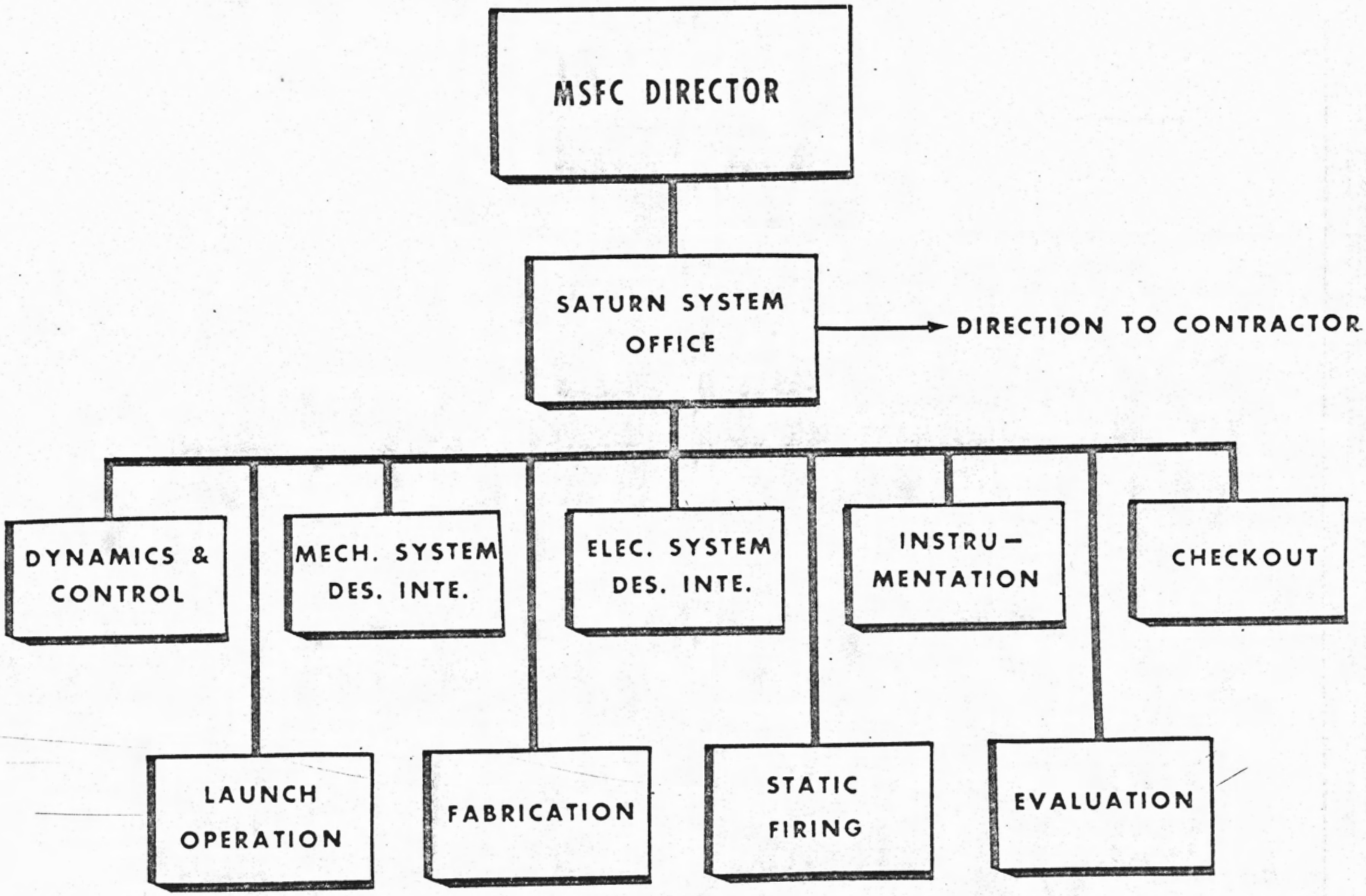
MSFC WORKING GROUPS



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WORKING GROUPS RESPONSIBILITIES

- SUPERVISION OF DESIGN REVIEWS
- FOLLOW-UP OF ACTION ITEMS TECHNICAL AND MANAGERIAL
- CLEARING HOUSE FOR DESIGN ORGANIZATIONS IN DIRECTIONS TO STAGE CONTRACTORS
- CONTROL OVER INTERFACE DOCUMENTATION: STAGE TO STAGE, STAGE TO GSE

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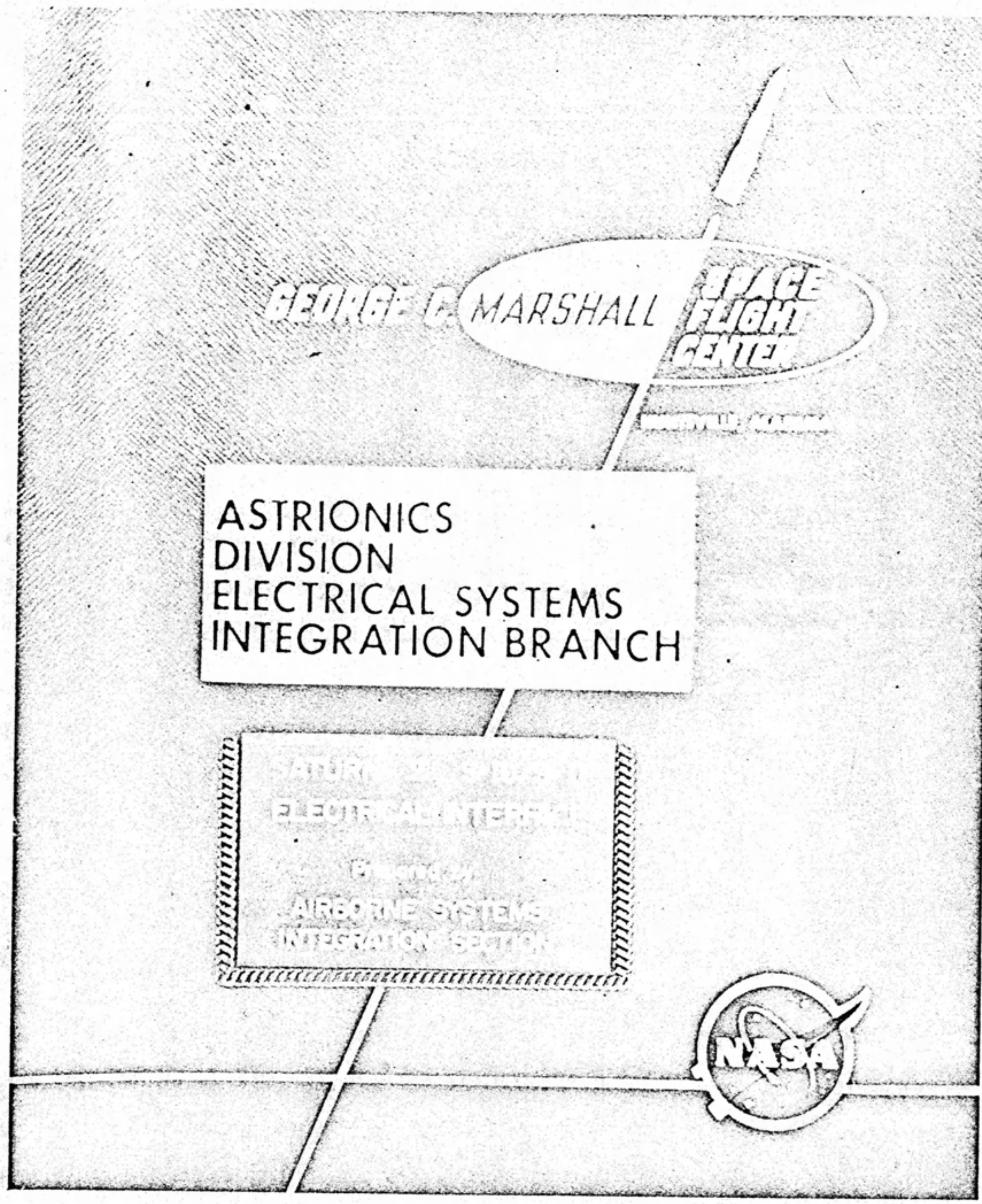
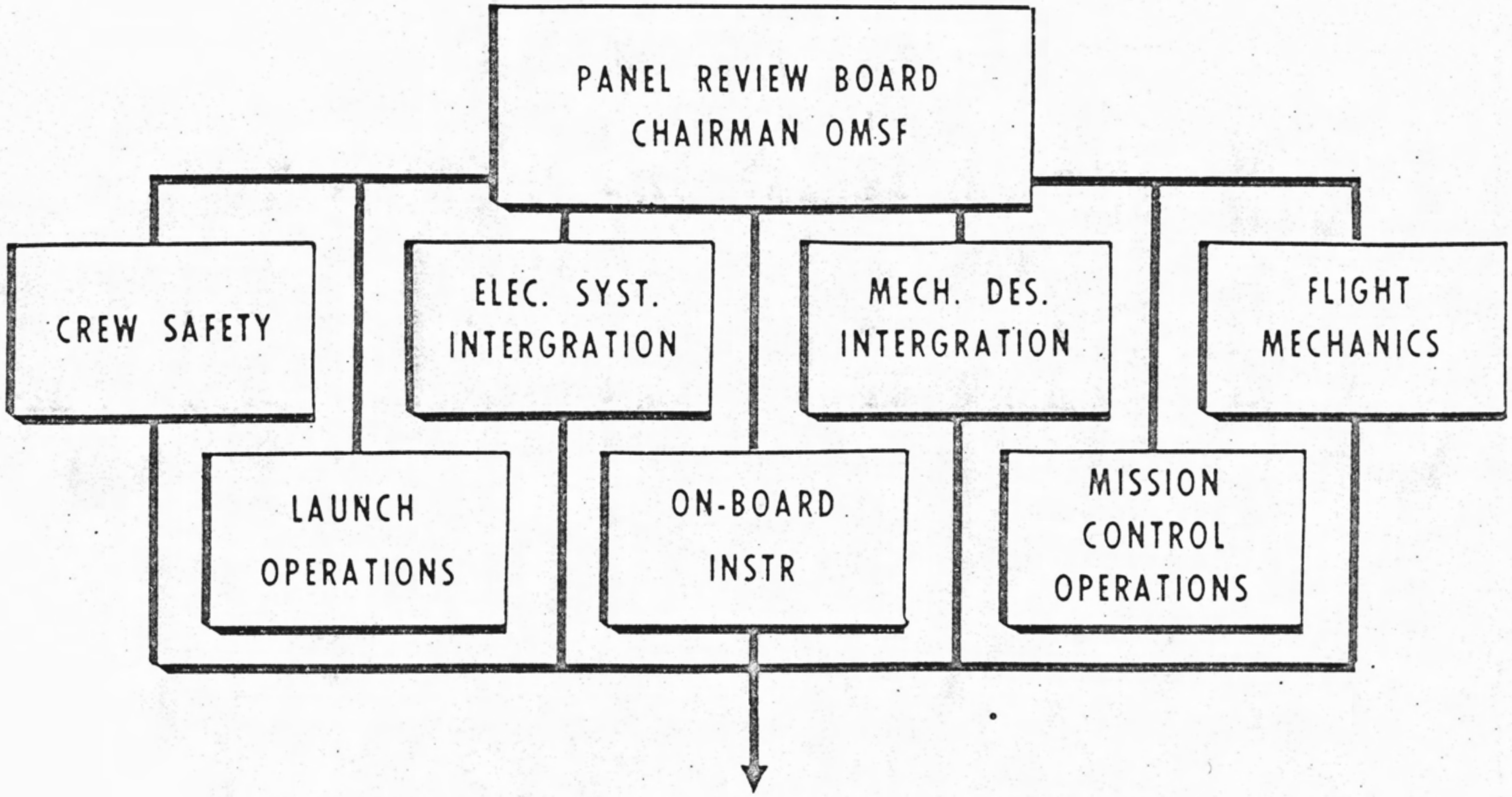


1 SATURN V INTERFACE DOCUMENT

INTER-CENTER PANEL



IMPLEMENTATION OF DECISIONS AND AGREEMENTS
FOR MSFC THRU LINE ORGANIZATIONS AND
SATURN SYSTEMS OFFICE

PANELS COCHAIRED
FROM EACH CENTER

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CONCLUSIONS

- I HAVE DESCRIBED MSFC'S APPROACH TO THE TECHNICAL COMPATIBILITY OF A SYSTEM AS BIG AS SATURN.

- THERE IS NO DOUBT THAT ONE GROUP HAS TO PERFORM THE INTEGRATION TASK, CONSIDERING ALL ASPECTS, <u>VEHICLE</u> AS WELL AS <u>GSE</u>.

- IT IS OBVIOUSLY NOT POSSIBLE TO DIVORCE THE LAUNCH SITE CHECKOUT DESIGN EFFORT FROM STAGE AND STAGE-CHECKOUT DESIGN.

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CONCLUSIONS (CONT)

- NEITHER IS IT POSSIBLE TO INTRODUCE A NEW AGENCY WHICH MUST INTERFACE WITH ALL THE ALREADY EXISTING DESIGN AND OPERATIONAL ELEMENTS OF THE THREE NASA CENTERS.
- MSFC, BY MISSION, IS RESPONSIBLE FOR THE LAUNCH VEHICLE SYSTEM (INCLUDING GSE) AND IS CONTROLLING THE ENTIRE LAUNCH VEHICLE SYSTEM INTEGRATION.
- ANY HELP FOR THIS TREMENDOUS TASK WILL BRING US FASTER TO OUR GOAL. BUT IT MUST BE BY DIRECT SUPPORT TO MSFC.

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INTEGRATION EFFORT NARRATIVE

Slide

1. <u>MSFC LAUNCH VEHICLE SYSTEMS INTEGRATION EFFORT</u>

Title slide.

Slide

2. <u>THE PROBLEM</u>

The problem is to create <u>a</u> launch vehicle system and not a group of <u>semi-related</u> stages. The specific problems are: (1) many interfaces exist such as stage to stage, stage to payload, stage to GSE, GSE to GSE in Mechanical, Electrical, and Instrumentation Systems; (2) the development of the stages, is subjected to different time schedules; (3) a common design philosophy is required for all stages; (4) communication problems exist due to dispersed geographical locations.

Slide

3. <u>MSFC APPROACH AND SOLUTIONS</u>

When Marshall started planning the Saturn system it was immediately realized that with the number of stages involved there would be a large number of interfaces, thus requiring a design philosophy with minimum inter-relationships between stages and associated systems. Unless this could be accomplished, tremendous coordination and integration activities would completely bog down the program. Realizing this, Marshall decided that each stage would be designed to be as self-sustaining as practical, thus allowing for a minimum interface with adjacent stages.

Four major systems of each stage are designed with practically no interface. These independent systems are: electrical, instrumentation, separation and propulsion.

Each stage operates completely on its own electrical system. In the few cases where a signal is required from another stage an isolated switching circuit is provided allowing complete electrical isolation. MSC shares this philosophy and all signals from the launch vehicle to the spacecraft utilize it.

The instrumentation system of each stage is designed to make all the measurements required for evaluation of that stage. There are a few exceptions to this rule, but these are measurements associated with the interstages and separation sequences. When this situation arises, the lower stage will furnish the instrumentation system but utilize transducers located in the upper stage. These transducers are isolated in order to maintain the isolated electrical system philosophy.

A separation system can be a severe problem if two stage contractors share the separation plane design and hardware responsibility. Marshall, recognizing this problem, chose to allow the stage that is separating from the lower to be responsible for the complete separation system. This allows for a minimum interface between adjacent stages.

The propulsion system of each stage and the associated subsystems, pneumatic, pressurization, propellant feed, propellant utilization, etc., are completely stage-oriented with no interaction between adjacent stages.

It is unfortunate, however, that all systems cannot be as independent as the four I have just discussed. There are quite a few systems interdependent upon the other stages' systems. A few of them are: RF compatibility, mechanical mating, vehicle dynamics, sequence and timing, attitude control, crew safety, orbital checkout, and range safety.

Let us briefly analize Marshall's approach to these interdependent systems. The S-IC, S-II, and S-IVB stages are designed to be only propulsion modules while the Instrument Unit is designed to be the systems integrator or the brain for the launch vehicle.

The Saturn Apollo system has a total of 39 RF systems on board. This presents a potentially serious problem. MSFC working with its contractors and MSC makes a thorough analysis of all frequencies involved and controls their assignments in order to avoid any interference and system problems.

The stages, instrument units, and payloads are never mated until they are assembled in the Vertical Assembly Building at MILA. The fact that a field splice rather than a flight separation plane is chosen for the mating of two parts has simplified the problem. Interface drawings and mating jigs used by adjacent stages solve the remaining problem and no difficulties are anticipated.

The dynamics of the vehicle present a very serious interface for design considerations and final flight mechanics determination. MSFC is the governing body in this area, yet much work is done by the stage contractors. MSFC maintains central control and assures that the contractors are using the latest data. This approach to the problem keeps much of the work at the contractors', yet the entire effort is coordinated.

Slide

4. INTERDEPENDENT SYSTEMS

Now let us examine a chart depicting how the next four systems are handled using a minimum interface and interrelationship between stages.

The sequencing and timing system utilizes the digital computer and data adapter in the Instrument Unit as the central source of intelligence. When an event is required, the computer system addresses one or more of the switch selectors

The stages, instrument units, and payloads are never mated until they are assembled in the Vertical Assembly Building at MILA. The fact that a field splice rather than a flight separation plane is chosen for the mating of two parts has simplified the problem. Interface drawings and mating jigs used by adjacent stages solve the remaining problem and no difficulties are anticipated.

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Slide

4. INTERDEPENDENT SYSTEMS

Now let us examine a chart depicting how the next four systems are handled using a minimum interface and inter-relationship between stages.

The sequencing and timing system utilizes the digital computer and data adapter in the Instrument Unit as the central source of intelligence. When an event is required, the com-puter system addresses one or more of the switch selectors located in each stage. The selector takes the digital address and transforms it into a discrete signal for stage use. This system employs self-checking and fault correction techniques and allows for a possible operation of 113 events in each stage without any interface change. The command receiver in the Instrument Unit is primarily utilized for updating guidance data but has the capability of addressing the switch selectors, thus allowing for ground command if required.

Attitude control is accomplished by the control computer sending engine position commands to the stage under propulsion. The control computer receives its inputs from the stabilized platform, digital computer, rate gyros, etc., in the Instrument Unit and stage located control sensors such as control accelerometers and rate gyros. The system is designed in a manner that all required signals can be routed to and from the Instrument Unit without change to the interfaces or stage design even though the exact control system is not defined at this date.

The crew safety system involves all three centers, LOC, MSC, and MSFC. The emergency detection system is that portion located in the launch vehicle. A thorough failure effect analysis is made of the entire launch vehicle system and those parameters that indicate impending catastrophies are implemented into the emergency detection system. Parameters are sensed in each stage and instrument unit. Those parameters that require automatic abort are triple sensed and voted 2 for 3. This allows for both reliability in mission success and crew safety. Other parameters that allow sufficient time are transmitted to the crew for decision. In the event of an abort, either automatic or crew initiated, the stage under propulsion is shut down. The three centers have reached agreement on the Saturn I emergency detection system and work is under way for the Saturn IB and V systems.

Orbital checkout of the S-IVB and Instrument Unit is required in order to assure the utmost in mission success and crew safety. This requirement imposes almost no additional complexity or interface requirements on the system. The digital computer system will be furnished measuring and telemetry data from the Instrument Unit and S-IVB stage. This requires only the addition of a coaxial circuit. The sequencing and timing system previously described provide adequate commands for checkout while the measuring and telemetry system provides for indication. Utilizing this by either on-board computer program or GSE computer program, the system can be checked out in orbit with no system penality.

Slide

5. RANGE SAFETY SYSTEM

The range safety system for thrust termination and fuel dispersion requires very close control in order to fulfill the AMR safety requirements. This system makes utmost use of common hardware. The present system consists of redundant circuits for thrust termination and fuel dispersion in each stage. Each stage system consists of two antenna systems, two command receivers, two destruct controllers, two exploding bridgewire firing units, one common safe and arming device, and a fuel dispersion ordnance system. All hardware with the exception of antennas and fuel dispersion ordnance are identical in each stage. In addition to the redundancy, an ordnance interface is provided to assure complete fuel dispersion of all stages. At present LOC and MSFC are working in hopes of simplifying the system.

Slide

6. LAUNCH VEHICLE GSE REQUIREMENTS

This slide shows the Launch Vehicle GSE requirements.

On the left you see the individual Saturn V stages and the stage GSE being system tested.

The blue lines interconnect the stage interface circuits to the GSE for testing.

The red lines interconnect the GSE to stage through the stage umbilicals.

At the bottom of the slide you see the various locations where these checkout systems are required.

On the right you see the assembled launch vehicle and an integrated set of launch vehicle GSE.

Slide

7. GSE DESIGN ANALYSIS

An analysis of the GSE design problem brings out the following facts. The instrument unit is the most complicated checkout problem. It is very similar to the Saturn I and IB instrument units. The black box assemblies in the instrument unit are very similar to those in previous MSFC programs. Checkout and launch equipment designs exist for a vast majority of these items.

The propulsion stages are relatively simple electrically. They are very similar electrically and also are similar to the propulsion stages in previous MSFC programs. Checkout and launch equipment designs exist for the previous propulsion stages.

In summary, checkout and launch equipment detailed design is not a significant problem.

Slide

8. GSE MAJOR PROBLEMS

The major problems are: (1) an immense total effort is required; (2) a common approach to the stage checkout and the checkout and launch equipment designs must be provided; (3) the importance and tightness of the schedules and the R&D nature of the program dictates maximum flexibility and minimum time to implement changes; (4) the launch vehicle GSE design must be optimized; (5) the extreme interfaces involved in this design must be minimized.

Slide

9. SOLUTIONS OF MAJOR PROBLEMS

The immense total effort required can be solved by dividing up the job into its logical parts. Let the stage design organization be responsible for GSE requirements at any site where the stage is checked out as an entity. This establishes a very clear line of responsibility and allows maximum flexibility.

Slide

10. SOLUTIONS OF MAJOR PROBLEMS (CONT'D)

The second problem is to provide and assure a common approach to the stage checkout and the checkout and launch equipment designs. This can be solved by providing basic concepts, specifications, and standards. Systems must be reviewed early in the design phase and realigned to a common approach. Design checkout and launch site equipment should be based on stage GSE designs but optimized for the launch vehicle problem.

Slide

11. SOLUTIONS OF MAJOR PROBLEMS (CONT'D)

The importance and tightness of the schedules and the R&D nature of the program dictates maximum flexibility and minimum time to implement changes.

The solution to this problem is to establish clear-cut responsibilities for GSE designs, minimize interfaces, and design equipment to provide for easy change capability. Proper management channels must be established to bring together the responsible technical personnel for rapid decision making and implementation of interfaces and changes.

Slide

12. SOLUTIONS OF MAJOR PROBLEMS (CONT'D)

The launch vehicle GSE design must be optimized. To do this, the launch vehicle must be treated as one problem and not as four individual problems. Common hardware should be utilized where feasible, i.e., a single computer as opposed to one per stage. Take advantage of the proven hardware in MSFC designs for Saturn I and IB stages and the instrument unit equipment. Some examples are: RCA-110 computer, MSFC Digital Data Acquisition System, MSFC relay logic and wire distribution racks, MSFC established man-machine relationship. To elaborate, the checkout equipment needed for the Saturn V stabilized platform is essentially the same as it was on Redstone Vehicle #5 in 1956.

New designs must be proven prior to implementation. Prove new computer operated displays on Saturn I and IB. Prove data link (LUT-LCC, 3-5 miles) on Saturn IB operation. Prove satisfactory man-machine relationship on Saturn I and IB.

We must take advantage of the brains and talent expended in stage contractor GSE designs by utilizing their designs where feasible. Actual hardware should be used where it will fit into the optimized launch vehicle GSE requirements.

Slide

13. SOLUTIONS OF MAJOR PROBLEMS (CONT'D)

The extreme interfaces involved in the design of the launch vehicle GSE must be minimized. MSFC GSE personnel are designing the instrument unit GSE. This is the most complicated part; it is the integrating part of the Saturn V launch vehicle. They have established a very significant and close relationship with each stage contractor in order to fulfill requirements of stage GSE design supervision. A very close and successful relationship has also been established with the facility (LOC) and the operator (LVO) on launch vehicle GSE interfaces. (Redstone, Jupiter, Juno, Pershing, Saturn I)

Over the past years MSFC GSE personnel have established the necessary intimate interfaces with: (1) the instrument unit and propulsion stage blackbox and system designers; (2) the Saturn I and IB stage contractor designers; (3) the Saturn V stage contractor designers; (4) the LVO operators on Redstone, Jupiter, Juno, Pershing and Saturn I programs; (5) the LOC GSE and facility designers on these same programs; and (6) the MSC-POD GSE personnel on the Mercury-Redstone program.

These same MSFC GSE designers have successfully designed and implemented the Redstone, Jupiter, Juno, Pershing, Saturn I GSE systems.

In conclusion, it is important to note that the MSFC GSE designers are in the best position to perform this launch vehicle GSE design with the minimum of interface problems.

They are presently accomplishing this task with the help of GE direct support personnel in Huntsville.

Slide

14. TECHNICAL MANAGEMENT FLOW CHART

This slide illustrates the technical management relationship between MSFC and its contractors. The contents of each step will be covered individually.

Slide

15. DESIGN CONCEPTS

(read from slide)

Slide

16. CONCEPT PROPOSALS

(read from slide)

Slide

17. EVALUATION, SELECTION AND REDIRECTION

(read from slide)

Slide

18. CONCEPT DESIGN "PHASE I"

(read from slide)

Slide

19. DESIGN REVIEW "PHASE I"

(read from slide)

INTEGRATION EFFORT NARRATIVE (CONT'D)

Slide

20. DETAILED DESIGN "PHASE II"

(read from slide)

Slide

21. DESIGN REVIEW "PHASE II"

(read from slide)

Slide

22. EQUIPMENT FABRICATION "PHASE III"

(read from slide)

Slide

23. ENGINEERING REVIEW "PHASE III"

(read from slide)

Slide

24. EQUIPMENT TESTING "PHASE IV"

(read from slide)

Slide

25. ACCEPTANCE AND EVALUATION "PHASE IV"

(read from slide)

Slide

26. MSFC WORKING GROUPS

The problems as outlined are recognized and faced by MSFC since the Saturn program came into being. For proper attention and solution, MSFC established "Working

Groups" as seen on this slide.

They cover the major areas of concern. Established in 1961, the Working Groups represent MSFC and its contractors in joint meetings. This provides the best approaches and solutions to the entire launch vehicle and not just to one stage. The Working Groups today are very effective as management coordination groups. Thru them detail design is carried out by the line organizations.

Slide

27. WORKING GROUPS RESPONSIBILITIES

(read from slide)

"o SUPERVISION OF DESIGN REVIEWS

o FOLLOW-UP OF ACTION ITEMS TECHNICAL AND MANAGERIAL

o CLEARING HOUSE FOR DESIGN ORGANIZATIONS IN DIRECTIONS TO STAGE CONTRACTORS

o CONTROL OVER INTERFACE DOCUMENTATION: STAGE TO STAGE, STAGE TO GSE"

Slide

28. SATURN V INTERFACE DOCUMENT

Interface documents are essential as control documents binding to contractors and center after they are jointly established. Here is such a typical document representing the electrical interface between the S-IC and S-II stages.

The document defines each connector of the interface and functional pin within each connector.

It describes:

Function of signal

Where signal originates

Where signal terminates

If signal is switched

Voltage level of signal

Load

Description of its purpose.

For example, Page 8 of this document gives complete polarity information on engine deflection in regard to vehicle tilt and actuator movements.

The interface document is issued, distributed and maintained by the Working Group after agreement is reached among concerned agencies. Any change after first release can only be initiated thru the Working Group with concurrence of <u>all</u> concerned agencies.

The document serves as the official nomenclature list.

Slide

29. <u>INTER-CENTER PANEL</u>

On a similar basis to solve inter-center problems concerning spacecraft, launch vehicle and launch site facilities, panels are functioning where the members represent as well as commit their respective center in their area of concern.

Again, interface documentation established by the panels serve the same needs to enforce and maintain proper systems approach and definition. This documentation includes launch vehicle to spacecraft and center to center GSE.

All interface documents are kept in a central repository at MSFC and are always up to date for any wanted distribution.

Slide

30. CONCLUSIONS

(read from slide)

"o I HAVE DESCRIBED MSFC'S APPROACH TO THE TECHNICAL COMPATIBILITY OF A SYSTEM AS BIG AS SATURN.

o THERE IS NO DOUBT THAT ONE GROUP HAS TO PERFORM THE INTEGRATION TASK, CONSIDERING ALL ASPECTS, VEHICLE AS WELL AS GSE.

o IT IS OBVIOUSLY NOT POSSIBLE TO DIVORCE THE LAUNCH SITE CHECKOUT DESIGN EFFORT FROM STAGE AND STAGE-CHECKOUT DESIGN.

o NEITHER IS IT POSSIBLE TO INTRODUCE A NEW AGENCY WHICH MUST INTERFACE WITH ALL THE ALREADY EXISTING concerning spacecraft, launch vehicle and launch site facilities, panels are functioning where the members represent as well as commit their respective center in their area of concern.

Again, interface documentation established by the panels serve the same needs to enforce and maintain proper systems approach and definition. This documentation includes launch vehicle to spacecraft and center to center GSE.

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o THERE IS NO DOUBT THAT ONE GROUP HAS TO PERFORM THE INTEGRATION TASK, CONSIDERING ALL ASPECTS, VEHICLE AS WELL AS GSE.

o IT IS OBVIOUSLY NOT POSSIBLE TO DIVORCE THE LAUNCH SITE CHECKOUT DESIGN EFFORT FROM STAGE AND STAGE-CHECKOUT DESIGN.

o NEITHER IS IT POSSIBLE TO INTRODUCE A NEW AGENCY WHICH MUST INTERFACE WITH ALL THE ALREADY EXISTING

DESIGN AND OPERATIONAL ELEMENTS OF THE THREE NASA CENTERS.

- MSFC, BY MISSION, IS RESPONSIBLE FOR THE LAUNCH VEHICLE SYSTEM (INCLUDING GSE) AND IS CONTROLLING THE ENTIRE LAUNCH VEHICLE SYSTEM INTEGRATION.
- ANY HELP FOR THIS TREMENDOUS TASK WILL BRING US FASTER TO OUR GOAL. BUT IT MUST BE BY DIRECT SUPPORT TO MSFC."