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Hard copy (HC) 1.00

Microfiche (MF) .50

DEVELOPMENT OF THE ALL-WELDED COMMON BULKHEAD

FACILITY FORM 808

N65-26406
(ACCESSION NUMBER) (THRU)

74
(PAGES) (CODE)

CV 63436
(NASA CR OR TNX OR AD NUMBER) (CATEGORY)

Monthly Report

Douglas Report DA-47614

MISSILE & SPACE SYSTEMS DIVISION
DOUGLAS AIRCRAFT COMPANY, INC.
SANTA MONICA, CALIFORNIA

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Monthly Report

1 January - 31 January 1965
Douglas Report SM-47814

Prepared for
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Contract No. NAS 8-11696



DOUGLAS



Approved by
A. C. ROBERTSON, Manager
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DOUGLAS MISSILE & SPACE SYSTEMS DIVISION

PREFACE

This is the seventh monthly progress report on the program for "Development of the All-Welded Common Bulkhead." This work is being done for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama, under Contract NAS 8-11696, dated 30 June 1964. This report covers the period from 1 January through 31 January 1965.

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Section 1

INTRODUCTION

The objective of this program is to develop an alternate manufacturing concept in which both faces of the common bulkhead are simultaneously welded from honeycomb sandwich segments to simplify manufacturing of common bulkheads for Saturn V upper stages. The general approach that will be followed is to fabricate gore segments and a dollar segment (skins plus core) and simultaneously weld the inside and outside seams for all welds (the meridian weld, the dollar weld, and the bulkhead attach-angle weld). Simultaneous welding of the inside and the outside skins is essential to the minimization or elimination of distortions.

The program will follow a three-phase approach.

Phase I - Joint Design and Development -- The objective of Phase I of the program is to analyze thoroughly the theoretical and practical aspects of the all-welded segmented bulkhead concept and to develop the attendant fabrication and inspection processes and techniques.

Phase II - Manufacturing and Test of the 18-Ft. Bulkhead -- The objectives of Phase II are (1) design, fabrication, and modification of manufacturing tools, and (2) fabrication and inspection of an 18-ft.-dia. common bulkhead.

Phase III - Preparation of the Test Plan and Manufacturing Specifications -- The objectives of Phase III are (1) preparation of a bulkhead test plan to establish the reliability of the all-welded bulkhead with bonded honeycomb core, and (2) initiation of manufacturing specifications to define the manufacturing techniques that will be used, and their attendant limitations, for the manufacture of the 18-ft.-dia. bulkhead.

The following sections of this report describe the work accomplished to date (Section 2) and the work planned for the coming month (Section 3). Within each of these sections, the discussions are arranged according to the phases and tasks outlined in the contract work statement. A discussion is presented of the accomplishments for the report period, the results obtained, and the analysis and interpretation of those results. Also included is a discussion of the problems encountered, their possible effects on the performance of the program, and the proposed corrective actions.

The purpose of this report is to describe the progress that has been made on the program during the past month.

Section 2

WORK ACCOMPLISHED DURING REPORT PERIOD

The schedule for the entire program is shown in Figure 1. The solid black bars represent the progress to date on each task. Only Task 1.2.1, Flat-Panel Tests; Task 1.2.2, Sandwich-Panel Tests; Task 1.4, Establish Manufacturing Plan; Task 1.5, Establish Inspection Plan; and Task 2.1, Design of the Full-Scale Bulkhead, were scheduled to be under way at this time. Task 2.1.1.1, Meridian Welder Modification has been started ahead of schedule. As of 1 February 1965, as shown in Figure 1, Task 1.2.1 is six weeks behind schedule; Task 1.2.2 is one week ahead of schedule; Task 1.4 is complete; Task 1.5 is four weeks behind schedule; and Tasks 2.1 and 2.1.1.1 are three weeks ahead of schedule.

The completion of Task 1.2.2 is dependent on the modification of a welder. The Change Order to accomplish this modification has been received and the modification equipment ordered. This equipment is scheduled to be shipped to Douglas on March 5, which will incur a 12-week delay in the completion of Task 1.2.2. This situation is discussed in more detail under Task 1.2.2 below. The schedule (Figure 1) has not been revised to reflect this change in the program.

Progress to date is discussed in more detail in the following paragraphs, which are arranged according to the task numbers shown in Figure 1.

Task 1.2.1--Flat-Panel Tests

During the month of January, an equipment failure in the fatigue testing machine resulted in postponing the completion of the fatigue tests. Repair parts have been ordered from suppliers in the East, however, a delivery date has not yet been established. These fatigue tests will be resumed as soon as the essential new parts are received.

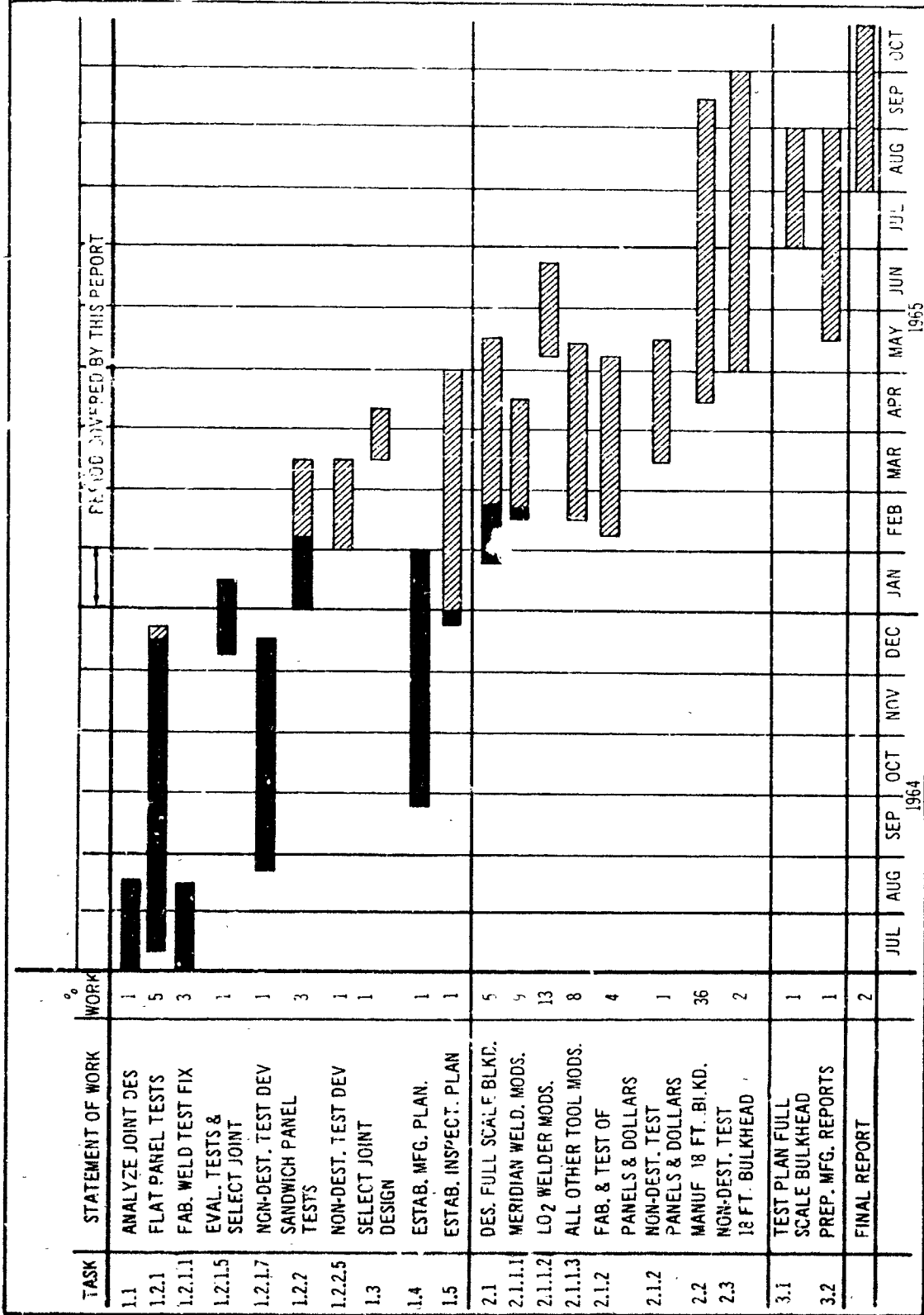


Figure 1 Task Progress Report

Task 1.2.2--Sandwich-Panel Tests

Manufacture of the sandwich panels for this task are complete and ready for welding. However, simultaneous welding of the joints cannot be completed until welder modification is complete. This welder modification is described in SM-48112, "Development of the All-Welded Common Bulkhead," Monthly Report dated 1 December - 31 December 1964, Task 1.2.2.

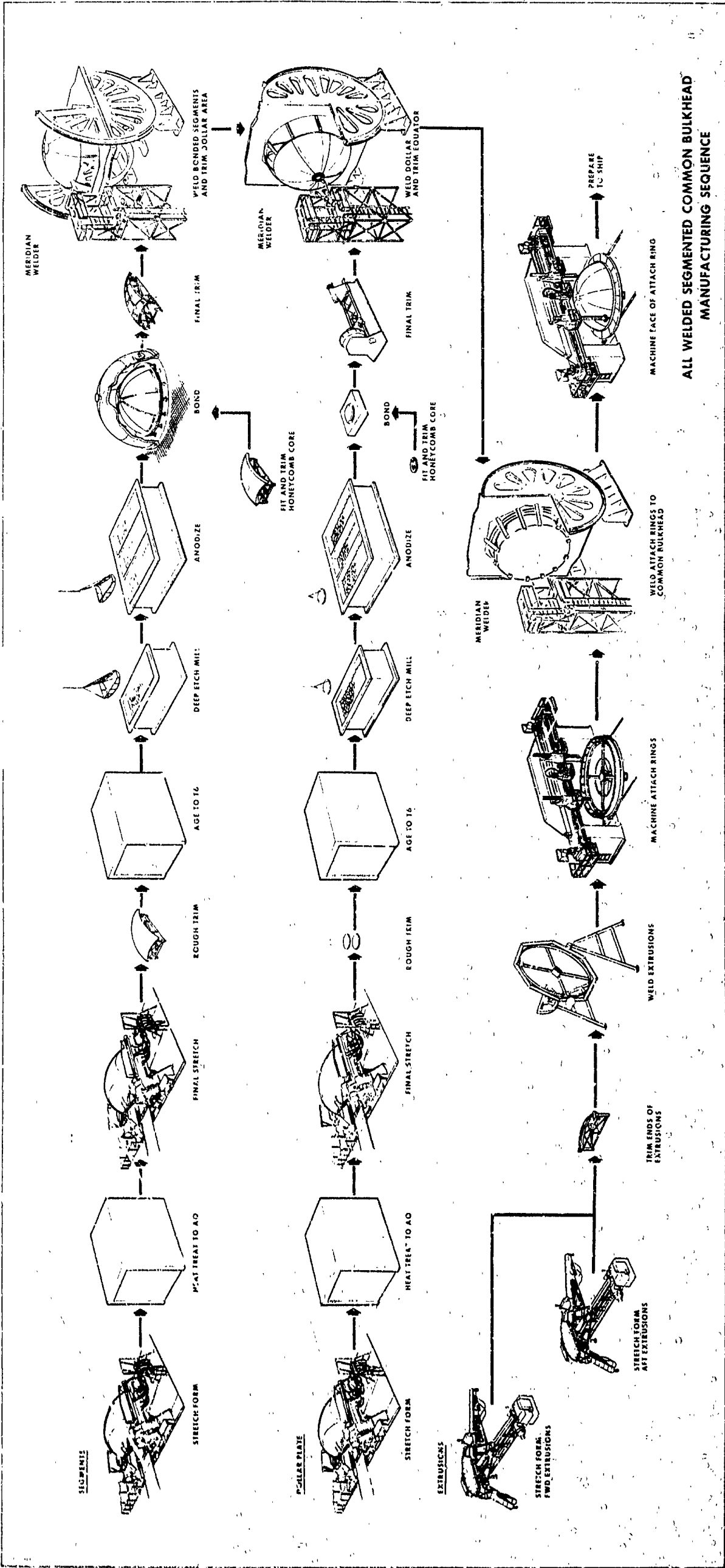
The simultaneous welding of the sandwich panels was originally scheduled to begin on January 3. The modification equipment from Seizky Brothers, Inc., will not be shipped to Douglas until March 5. Four weeks will be required after March 5 to install the equipment in the welder, check it out, certify it, and be ready to initiate sandwich-panel welding. This establishes the start of panel welding as April 5, 12 weeks after the original scheduled date of January 8. The remainder of the program will be rescheduled to reflect the change. Every effort will be made to pick up as much of this schedule slippage as possible.

Task 1.4--Establish Manufacturing Plan

This task outlines the operational sequences, tools, equipment, and procedures used to manufacture an all-welded segmented common bulkhead. The manufacturing sequence, Figure 2, shows the fabrication of details and build-up of sub-assemblies through final assembly.

The manufacturing sequence begins by stretch forming the gore segments, heat treating, final stretching, rough trimming and aging; these operations are performed on existing S-IV tools. Deep-etch milling of the segment will require new etch-mill templates.

After anodize treatment, the gore segments are sent to the bonding area where, the forward and aft bulkhead segments are etch cleaned, the fiberglass honeycomb core is cut and fitted, and the honeycomb, forward and aft bulkhead segments are assembled. Fillers for positioning the honeycomb core are installed on all four sides of the segments and are indexed to the skins by tooling holes. The assembly is then bonded together in the heat and pressure vessel, bonding three or more segments at a time. The fillers are then removed; the bonded segments are trimmed on the sides using existing S-IV tooling, with the exception of a new cutter. The attach rings for the forward and aft domes are stretch formed on reworked



form dies, with new gripper jaws being required for the stretch press. The attach angles are now trimmed and welded into a ring. The attach rings are checked and straightened, then machined on the Niles Boring Mill. The forward and aft attach rings, after machining, are set up and welded together on the LOX tank welder. The bonded bulkhead segments are now ready for welding. They are located in the meridian welder by the tooling holes. This tool will be reworked to allow for the greater thickness of the bonded segments and to accommodate out-of-position welding and simultaneous welding of the inner and outer seams. A support fixture will be built to support the torch for the inside weld. This fixture will protrude through the platform of the meridian welder. A stand will be fabricated to support the torch for the outside weld and, in addition, will support a new cutting tool for trimming the dollar area and the equator after the meridian welding is completed.

The forward and aft dollar plates will be stretch formed, heat treated, final stretched, rough trimmed, aged to T6, deep-etch milled and anodized, using existing tools and facilities. The core for the dollar assembly is fitted, trimmed and assembled to the plates. The fillers will be installed and the assembly is indexed together and bonded. The dollar assembly has a final trim and is shipped to the weld area.

The dollar is then welded to both sides of the bulkhead simultaneously. A new support is required for the inside torch. The bulkhead is then removed from the meridian welder and the welder is reworked to accommodate the welding of the attach angles to the common bulkhead. This rework is quite extensive and entails removing the supporting structure for the dome and adding support structure for holding the dome and attach angles in a position with the forward end of the dome downwards. The attach angles are simultaneously welded to the inside and outside of the bulkhead. The integral chill bars are machined-off of all welded joints while in the meridian welder. After this machining operation, the bulkhead is installed on the Niles Boring Mill for machining the face of the attach angles. This completes the fabrication of the common bulkhead assembly.

This completes Task 1.4, Establish Manufacturing Plan.

Task 1.3--Establish Inspection Plan

Completion of the preliminary manufacturing plan, Task 1.4, allows the initiation of the associated inspection plan. This plan is scheduled for completion in March and a first-cut will be reviewed in mid-February. The objectives of this task are to establish inspection requirements and test methods to be used during and after the construction of the 18-ft.-dia. bulkhead.

Task 2.1--Design of the Full-Scale Bulkhead

The design of the full-scale bulkhead has progressed as far as possible at this time. Dimensional control drawings showing joint arrangement for aft attach-rings, collar-plate joint location and general controlling dimensions have been released to the Tooling and Planning departments. Release of these drawings authorizes (1) the design of major tool modifications, and (2) the initiation of the manufacturing plan for the bulkhead. Tool design will now be completed, and actual tool modification will commence when the manufacturing plan is complete.

Time critical materials necessary for the bulkhead fabrication have been ordered. These materials include the special-sized aluminum skins for the forward and aft facings of the gore segments, the special-contoured HFP honeycomb core, and two new extrusions for the rings which attach the bulkhead to the aft dome. Anticipated delivery is nine-ten weeks for the skins and six weeks for the core and extrusions.

Task 2.1.1.1--Meridian Welder Modification

During the past month, particular emphasis was placed on the possibility of using the meridian welder to weld the attach rings to the bulkhead. This may be a significant development; in the original plan, the attach rings were intended to be welded to the bulkhead using the S-IV LOX welder. Modification of the LOX welder to accomplish this task represents the largest single item of tool modification and was estimated to require approximately 3100 man hours. Since the meridian welder is being modified rather extensively, it may be simpler to include the capability of welding the attach rings in the meridian welder rather than modify the LOX welder. Furthermore, the LOX welder is currently being used for "pick up" work on the S-IVB bulkheads and modifying it for this program may

interfere with the S-IV program schedule, or our schedule. For these reasons then, this concept will be evaluated carefully and the cost of this modification compared with the cost of LOX welder modification.

As of this writing, design concepts to accomplish all the bulkhead welding on the meridian welder are progressing satisfactorily.

Section 3

WORK TO BE ACCOMPLISHED DURING COMING MONTH

Task 1.2.1--Flat-Panel Tests

During the next month, it is anticipated that testing equipment will be repaired and this task completed. There remains only ten fatigue specimens to be tested, requiring only about one day of actual testing time. Once the testing machine is in operation, this task will be rapidly completed.

Task 1.2.2--Sandwich-Panel Tests

The final milling operation of the sandwich parts will be completed early in February. These parts will now be ready for simultaneous welding development tests.

Task 1.5--Establish Inspection Plan

During the next month, work will proceed on the first cut of the inspection plan, scheduled for completion by mid-February.

Task 2.1--Design of the Full-Scale Bulkhead

During the coming month, this task will continue with the release of the drawings for forming both the forward and aft skin gore segments and the ring-assemblies for attaching the faces to the aft dome. This task is necessarily curtailed due to the necessity of knowing exactly which joint (integral chill or external chill) to plan for. However, the drawings will be carried as far as possible to allow tooling and planning operations to continue on schedule.

Task 2.1.1.1--Meridian Welder Modification

During the month of February, the design of the welder modification will be continued. By the end of February, the basic layout of the modification will be complete.