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ENGINEERING COURSE FOR SATURN S-II STAGE SYSTEMS FOR NASA AND HEROICRELICS.ORG

VOLUME 1
INTRODUCTION

November 1968

Approved by

D. L. Roelands
Manager, Systems Integration and Reliability

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

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FOREWORD

This is one of four volumes comprising the Engineering Course on Saturn S-II Systems for NASA (SD 68-654). It is to be used only in conjunction with the classroom presentation. The course is being presented in accordance with Change Order 1497 to Contract NAS7-200.

TECHNICAL REPORT INDEX/ABSTRACT

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ENGINEERING COURSE FOR SATURN S-II STAGE SYSTEMS FOR NASA (VOLUMES 1 THROUGH 4) (TITLES LISTED BELOW)

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SATURN S-II ENGINEERING

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DESCRIPTIVE TERMS

*APOLLO PROJECT, *SATURN S-II STAGE, *SYSTEM AND SUBSYSTEM DESCRIPTION, *TRAINING COURSE, *MISSION DESIGN, *OPERATIONAL CHARACTERISTICS, *EXPECTED PARAMETERS, *S-II-3 FLIGHT PERFORMANCE

ABSTRACT

THIS SERIES OF DOCUMENTS CONSISTS OF TRAINING COURSE REFERENCE MATERIAL COMPILED IN RESPONSE TO MCR 6068, CHANGE ORDER 1497. EACH VOLUME DESCRIBES OPERATIONAL AND MISSION CHARACTERISTICS OF THE S-II STAGE, WITH SPECIFIC REFERENCE TO TIME FRAME T + 11 SEC THROUGH S-II/S-IVB SEPARATION. THE TOTAL PRESENTATION DESCRIBES THE SYSTEMS AND SUBSYSTEMS THAT COMPRISE THE S-II STAGE OF THE SATURN V LAUNCH VEHICLE. INDIVIDUAL VOLUME TITLES ARE AS FOLLOWS:

1. INTRODUCTION
2. PROPULSION & MECHANICAL SYSTEMS
3. INSTRUMENTATION SYSTEM
4. ELECTRICAL SYSTEM

CONTENTS

INTRODUCTION

This publication has been requested by the Manned Spacecraft Center. Data contained in the following pages are oriented toward flight mission rules.

Discussion relates to stage performance, from T + 11 seconds through S-II/S-IVB separation.

Also provided in the following text are a description and pertinent discussion of stage operational characteristics. This includes displays from actual flight data and critical performance predictions.

COURSE ORGANIZATION

The Engineering Course for Saturn S-II stage systems for NASA has been programmed according to the following four major sections:

Propulsion and Mechanical (without the J-2 engine)

Instrumentation

Electrical

Question and answer session

AGENDA

The following personnel have been appointed to conduct the Engineering course:

R. A. Magin - Introduction
B. Botfeld - Propulsion and Mechanical
F. H. Knowlden - Instrumentation
J. Livingston - Electrical

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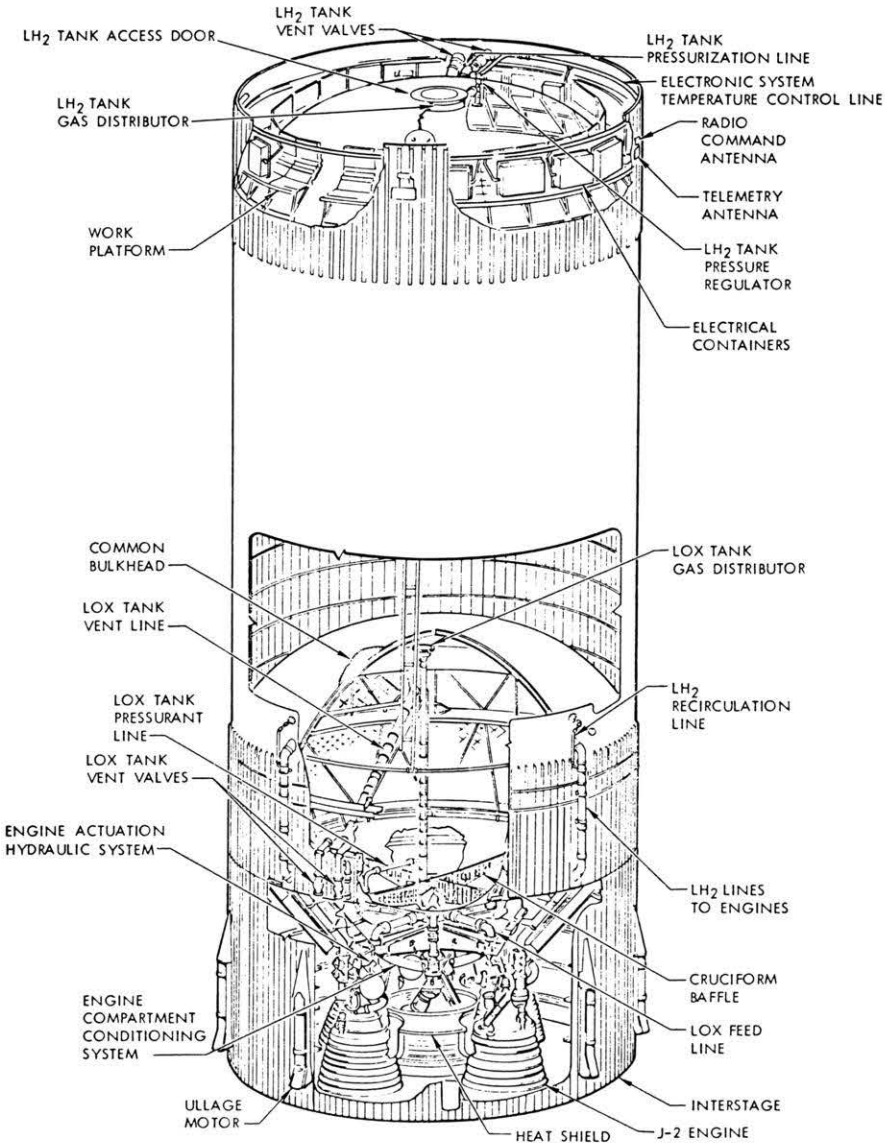
STAGE DESCRIPTION

The Saturn S-II stage is 81 feet and 6 inches long x 33 feet in diameter. The forward skirt is fabricated from 7075-T6 aluminum alloy skin reinforced with extruded stringers. The forward bulkhead is formed in an ellipsoidal contour by welding 2014-T6 aluminum alloy segments together. The LH_2 tank is of integral stiffened 2014-T6 skin with 2014-T6 frames fabricated by riveting. The common bulkhead assembly is formed by laminating an ellipsoidal forward facing sheet to an aft facing sheet (both 2014-T6) with a honeycomb fiberglass core as insulation. The aft LOX bulkhead is a membrane shell stiffened by "waffle" ribs (2014-T6) in the equatorial section. The thrust structure is composed of skins and extruded stringers of 7075-T6, longerons of 7079-T6 and a frame of 2024-T3 and 7075-T6. The aft interstage is also composed of 7075-T6 skins, extruded stringers and frame. Tank insulation is a laminate of tedlar, nylon fabric, and isocyanate foam in honeycomb construction with purge capability (Figure 1).

	Figure 1. S-II Stage Description	DATE _____ SPEAKER _____ CONTROL NO. _____



S-II-3 OPERATIONAL MODES FROM LAUNCH

Flight objectives are met through the mission sequence of events and are therefore provided in some detail from launch and S-IC boost mode through S-IC/S-II-3 separation, S-II-3 boost mode, S-II-3/S-IVB separation mode, and finally the terminal mode of S-II-3 post-separation coast.

S-II-3 MODES OF OPERATION FROM LAUNCH

The modes of operation of the S-II-3 stage are categorized as follows:

1. Launch and S-IC boost
2. S-IC/S-II separation
3. S-II boost
4. S-II/S-IVB separation
5. Post-separation coast

LAUNCH AND S-IC BOOST

During this operational mode, the S-II stage and its subsystem must withstand dynamic loads imposed by the ignition, liftoff and powered flight of the S-IC stage. Additionally, the following significant S-II stage events are occurring:

1. Recirculation system operating
2. Engine preconditioning
3. Internal power On
4. Initiate arming of second plane separation and S-II ullage rocket ordnance
5. LH_2 and LOX tanks pressurization

S-IC/S-II SEPARATION MODE

This operational mode begins with the signal to shut down the outboard engines of the S-IC stage and terminate with an aft interstage separation. Significant S-II events are:

1. Ullage rocket fired (3.75 second firing)
2. Separation at Station 0 (first plane)
3. J-2 engine start
4. Separation at Station 196 (interstage removal)

S-II BOOST

This mode is considered to begin with the J-2 engine start. It overlaps the S-IC/S-II separation mode for a short period due to the dual plane method of separation. It terminates with the J-2 engine cutoff signal. Significant S-II events occurring are:

1. All engines operating
2. Data recorders On
3. Initiate launch escape system jettison
4. LH_2 step pressurization
5. S-II/S-IVB ordnance armed

S-II/S-IVB SEPARATION

This mode begins with J-2 engine shutdown signal and terminates with S-II/S-IVB separation. S-II significant functions are:

1. Trigger S-IVB ullage rocket
2. Retrorocket ignition and LSC signal to S-IVB
3. Pitch and yaw control within 1 degree until thrust decays to 10 percent of rated thrust

POST-SEPARATION COAST

The mode begins with S-II/S-IVB separation. Significant S-II function is:

1. Data recorder play back. Covers key events from S-IC/S-II separation through S-II/S-IVB separation.

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S-II-3 STAGE PARAMETERS

The S-II-3 stage parameter displays at MSC are shown in the following listing. As the course progresses to the subsystems level, an attempt will be made to relate these parameters with actual systems performance during flight.

S-II DISPLAYS AT MSC

1. Engine Main Fuel Injection Pressure (all)
2. Engine Thrust Chamber Pressure (all)
3. Valve Actuation He Bottle Pressure
4. Valve Actuation Regulator Outlet Pressure
5. Engine Inlet LOX Pressure (all)
6. Engine Inlet LH_2 Pressure (all)
7. Engine Hydraulic Accumulator Pressure (all)
8. Engine Hydraulic Reservoir Pressure (all)
9. LH_2 Tank Ullage Pressure EDS 1
10. LH_2 Tank Ullage Pressure EDS 2
11. LOX Tank Ullage Pressure
12. LOX Tank Ullage Pressure
13. Engine Hydraulic Reservoir Piston Position (all)
14. Engine PU Valve Position (all)
15. Main Dc Bus Voltage
16. Main Battery Current

17. Instrumentation Dc Bus Voltage
18. 5 Volt Reference (VXM037-209)
19. 5 Volt Reference (VXM039-224)
20. Engine Yaw Actuator Piston Position (all)
21. Engine Pitch Actuator Piston Position (all)
22. Engine 1 Ready
23. Engine 2 Ready
24. Engine 3 Ready
25. Engine 4 Ready
26. Engine 5 Ready
27. LH_2 Vent Valve 1 Closed
28. LH_2 Vent Valve 2 Closed
29. LOX Vent Valve 1 Closed
30. LOX Vent Valve 2 Closed
31. Engine Helium Tank Pressure (all)
32. Engine Start Tank Pressure (all)
33. Engine LH_2 Prevalve Open (all)
34. Engine Mainstage OK Depressurization A (all)
35. Engine Mainstage OK Depressurization B (all)
36. S-II/S-IVB Separation EBW Monitor 1A
37. S-II/S-IVB Separation EBW Monitor 1B