# SATURN S-IVB-502 STAGE
# ACCEPTANCE FIRING REPORT

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## ABSTRACT

This report presents an evaluation of the Saturn S-IVB-502 stage acceptance firing that was conducted at the Sacramento Test Center on 28 July 1966. Included, are stage and ground support equipment deviations associated with the acceptance firing configuration.

The acceptance firing test program was conducted under National Aeronautics and Space Administration Contract NAS7-101, and established the acceptance criteria for buyoff of the stage.

## DESCRIPTORS

Saturn S-IVB-502 Stage

Saturn S-IVB/V Stage

Saturn S-IVB-502 Stage Test Evaluation

J-2 Engine

Beta Complex

Saturn S-IVB-502 Acceptance Firing

Saturn S-IVB-502 Stage Test Configuration

Sacramento Test Center

Countdown Operations

Sequence of Events

28 September 1966

# PREFACE

The purpose of this report is to document the evaluation of the Saturn S-IVB-502 stage acceptance firing as performed by Douglas personnel at the Sacramento Test Center.

This report, prepared under National Aeronautics and Space Administration Contract NAS7-101, is issued in accordance with the contractual requirements of Douglas Report No. SM-41410: Data Submittal Document, Saturn S-IVB System, dated 1 December 1965.

This report evaluates stage test objectives, instrumentation, and configuration deviations of the stage, test facility, and ground support equipment.

28 September 1966

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# 1. INTRODUCTION

## 1.1 General

This report was prepared at the Douglas Huntington Beach Space Systems Center by the Saturn S-IVB Test Planning and Evaluation (TP&E) Committee for the National Aeronautics and Space Administration under Contract NAS7-101.

Activities connected with the Saturn S-IVB-502 stage included prefiring checkout and the acceptance firing. Checkout started at the subsystem level and progressed to completion with the integrated systems test and the simulated static firing. The information contained in the following sections documents and evaluates all events and test results of the acceptance firing which was completed on 28 July 1966. The tests were performed at the Sacramento Test Center (STC) Complex Beta Test Stand I.

The confidence firing tests of the two auxiliary propulsion system (APS) modules were performed at the Gamma Complex Facility. The tests encompassed propellant loading, pressurization, firing, and system securing operations.

## 1.2 Background

The S-IVB-502 stage was assembled at the Huntington Beach Space Systems Center. A checkout was performed in the vertical checkout laboratory (VCL) prior to shipping the stage to STC. The stage was installed on the test stand on 6 June 1966 and was ready for acceptance firing on 26 July 1966.

The APS modules were shipped to the manufacturing and assembly (M&A) building at STC for leak and functional checks. The APS modules were then sent to the Gamma Complex for confidence firing tests. After firing, the modules were returned to the M&A building for cleaning and purging prior to shipment to Kennedy Space Center (KSC) with the S-IVB-502 stage.

Table 1-1 lists the milestones of the Saturn S-IVB-502 stage events and dates of completion.

## 1.3 Objectives

All test objectives outlined in Douglas Report No. SM-47378B, Saturn S-IVB-502 Stage Acceptance Firing Test Plan, dated April 1966 and revised July 1966 were successfully completed.

Stage acceptance objectives which provided maximum system performance evaluation were as follows:

a. Countdown control and operation capability verification

b. J-2 engine system performance verification

c. Oxidizer system performance verification

d. Fuel system performance verification

e. Pneumatic control system performance verification

f. Propellant utilization system performance verification

g. Stage data acquisition system performance verification

h. Stage electrical control and power system performance verification

i. Hydraulic system and J-2 engine gimbal control performance verification

j. Structural integrity verification

k. APS stage interface compatibility verification.

APS confidence objectives which defined modules acceptance criteria were as follows:

a. Propellant loading and system pressurization

b. Module 1 and 2 system performance verification during confidence firings.

Research and development objectives which are not acceptance criteria but were included to obtain data information were as follows:

a. Determination of stage thermodynamics during the acceptance firing program

b. Determination of acceptance firing vibration and acoustic environment.

TABLE 1-1
MILESTONES, SATURN S-IVB-502 STAGE

| EVENT | COMPLETION DATE |
|---|---|
| Tank Assembly | 6 August 1965 |
| Proof Test | 1 October 1965 |
| Insulation and Bonding | 30 December 1965 |
| Stage Checkout and Join J-2 Engine | 18 February 1966 |
| Systems Checkout | 10 May 1966 |
| Ship to STC | 31 May 1966 |
| Stage Installed on Test Stand | 6 June 1966 |
| Confidence Firing, APS Module 1 | 19 July 1966 |
| Confidence Firing, APS Module 2 | 27 July 1966 |
| Ready for Acceptance Firing | 26 July 1966 |
| Acceptance Firing | 28 July 1966 |
| Stage Received at VCL | 16 August 1966 |
| All Systems Test | 13 September 1966 |
| Ready to Ship to KSC | 23 September 1966 |

## 2. SUMMARY

The S-IVB-502 stage was successfully acceptance fired on 28 July 1966 during countdown 614067 at Sacramento Test Center, Complex Beta Test Stand I. The mainstage firing duration was 149.758 sec for 1st burn and 290.533 sec for 2nd burn, satisfying all objectives of the test plan.

### 2.1 Countdown Operations

Countdown 614067 was a satisfactory acceptance firing with no major problems.

### 2.2 J-2 Engine System

Chilldown and conditioning systems performed satisfactorily, although excessive heating of the engine start sphere during simulated orbital coast required that it be vented, rechilled, and pressurized before 2nd burn. Engine performance was as expected, satisfying all requirements.

### 2.3 Oxidizer System

The LOX tank pressurization system met all design criteria throughout the acceptance firing. The stage LOX pressurization system maintained the ullage pressure between 38.0 and 39.7 psia throughout 1st and 2nd burn except during the engine start transient. The engine pump inlet conditions were well within the required limits.

### 2.4 Fuel System

The fuel system satisfactorily supplied LH2 to the engines during the firing. The NPSH was above the required levels until 2nd burn engine cutoff. Tank pressurization was adequate; pump chilldown and engine supply were satisfactory.

### 2.5 Pneumatic Control and Purge System

The pneumatic control and purge system performed satisfactorily throughout the acceptance firing. The helium supply to the system was adequate for both pneumatic valve control and purging, and the regulator pressure was

maintained within acceptable limits. All components functioned normally.

## 2.6 Auxiliary Propulsion System

The two APS modules were each successfully test fired, and both modules performed within design specifications.

## 2.7 Propellant Utilization (PU) System

The PU system operated satisfactorily throughout the acceptance firing and sufficient data for system analysis and flight calibration was obtained.

## 2.8 Data Acquisition System

The performance of the data acquisition system in the gathering, conditioning, and transmission of data was adequately demonstrated. During the countdown there were 475 measurements which were expected to provide valid data. Data evaluation disclosed that 24 of these measurements failed resulting in a measurement efficiency of 95.0 percent.

## 2.9 Electrical System

The electrical control and power system performed satisfactorily throughout the acceptance firing. All objectives were satisfied and all system variables operated within design limits.

## 2.10 Hydraulic System

The hydraulic system operated properly and supplied pressurized fluid to the servo-actuators. During the simulated orbital coast, the hydraulic system was operated without benefit of auxiliary pump mode pressurization for 77 min and 19 sec. Test plan objectives were satisfied and all system variables operated within design limits.

## 2.11 Flight Control System

The dynamics response of the thrust vector control system was measured while the J-2 engine was gimbaled during the acceptance firing. Acceptable actuator frequency response, engine slew rates, and minimal cross-coupling were exhibited during the acceptance firing. All specified test objectives were achieved and no system variable exceeded its design limits.

## 2.12 Structural System

Structural integrity of the stage was maintained for the vibration, temperature, and thrust load conditions of the acceptance firing. Minor irregularities and debondings occurred but were readily corrected. All test objectives were verified.

## 2.13 Thermoconditioning and Purge System

The aft skirt environmental control system supplied thermally conditioned GN2 to the aft skirt area throughout the acceptance firing. The GN2 purge was initiated prior to LOX loading and was terminated after completion of propellant tank purges. The temperature remained within the design range of 87 $\pm$5 deg F. The forward skirt GN2 purge was initiated prior to LOX loading and continued throughout the firing until completion of tank purges at a flowrate of 500 to 600 cfm with a temperature range of 50 $\pm$2 deg F. The thermoconditioning system servicer circulated thermally-conditioned fluid through the 16 cold plates throughout the acceptance firing.

## 2.14 Acoustic and Vibration Environment

There were a total of 52 vibration, 14 acoustical, and 2 static pressure measurements planned for the acceptance firing. Four vibration and three acoustical measurements were deleted prior to the firing due to problems in the measurement system. Of the remaining 61 active measurements, two vibration measurements and one acoustical measurement provided no usable data due to instrumentation malfunctions. Some of the stage component vibration exceeded the test specification; however, there were no problems indicated during the firing.

## 2.15 Stage Thermodynamics

An analysis was performed to determine the effective thermal conductivity of the stage internal insulation during the propellant loading. The results indicate that the insulation performance will be satisfactory from a thermal standpoint during flight.

## 2.16 Reliability and Human Engineering

All malfunctions of flight critical items were investigated and documented. A human engineering evaluation has been conducted in support of the acceptance firing. Recommendations for changes to the operation have been adopted.

# 3. TEST CONFIGURATION

This section describes the stage and ground support equipment (GSE) deviations and modifications from the flight configuration affecting the acceptance firing. Additional details of specific system modifications are discussed in appropriate sections of this report. Details of the S-IVB-502 stage configurations are presented in DAC Report No. 1B63789, S-IVB-502 Stage End-Item Test Plan.

Figure 3-1 is a schematic of the S-IVB-502 stage propulsion system and shows the telemetry instrumentation transducer locations from which the test data were obtained. The functional components are listed in table 3-1. Hardwire measurements are noted on the appropriate subsystem schematics included in this report. The propulsion system orifice characteristics and pressure switch settings are presented in tables 3-2 and 3-3. J-2 engine S/N 2042 was installed.

The propulsion GSE (figure 3-2) consisted of pneumatic consoles "A" and "B," two propellant fill and replenishing control sleds, a vacuum system console, and a gas heat exchanger.

## 3.1 Configuration Deviations

Configuration deviations required for the acceptance firing are discussed in DAC Report No. SM 47378B, Saturn S-IVB-502 Stage Acceptance Firing Test Plan. Significant configuration changes to the stage and GSE are discussed in the following paragraphs.

### 3.1.1 Engine Restrainers

J-2 engine unlatch restrainer link kit. Model DSV-4B-618, was installed to restrain the engine during start transient side loads.

### 3.1.2 Quick Disconnects

The stage-mounted portions of the pneumatic and propellant umbilical quick disconnects were replaced by hardlines.

### 3.1.3 Engine Diffuser

A water-cooled converging diffuser, Model DSV-4B-639 engine bell extension service unit, was installed to the engine thrust chamber exit to reduce the nozzle area ratio and the probability of jet-separation-induced side loads.

### 3.1.4 Auxiliary Pressurization

An auxiliary propellant tank pressurization system was installed and was supplied from a GSE ambient helium source.

### 3.1.5 Propellant Fast Fill Sensors

Propellant loading fast fill sensors were installed on the instrumentation probes but were used in the indicating mode only.

### 3.1.6 LH2 Continuous Vent System

The nozzles were removed from the LH2 tank continuous vent system, and all stage propellant vent and bleed systems were connected to the facility vent system.

An interim use LH2 continuous vent module P/N 1B51753-501 was used. This module lacks the bypass function.

An interim use duct assembly was installed in place of the quality meter which was deleted from the stage hardware requirements.

### 3.1.7 Chilldown System

The chilldown shutoff valves P/N 1A49965-511 and -513 were used instead of the redesigned valves -515 and -517.

### 3.1.8 Forward Skirt Cooling

The forward skirt thermoconditioning system coolant was supplied by a Model DSV-4B-359 servicer, rather than the flight source in the instrument unit.

### 3.1.9 Aft Interstage

The stage was mounted on a Model DSV-4B-540 dummy aft interstage instead of the flight interstage.

### 3.1.10 Fire Detection System

A resistance wire fire detection system was installed in critical areas of the stage, GSE, and facilities.

### 3.1.11 GH2 Detectors

GH2 leak detectors were installed in critical areas of the stage, GSE, and facilities.

### 3.1.12 Blast Detectors

Blast detectors were installed in the test area to monitor an overpressure range of 0 to 25 psi overpressure.

### 3.1.13 Auxiliary Propulsion System (APS)

The flight APS modules were not installed. Instead, the Model 188C APS Simulator was connected to positions 1 and 2 to receive commands and close the control circuitry.

### 3.1.14 Telemetry System

Those telemetry channels that were left blank when various parameters were disconnected to be recorded by other means were either left open or were simulated.

### 3.1.15 Hardwire Transducers

The Marshall Space Flight Center firing measurement (Scope Change 1195A) program hardwire transducers were installed for the acceptance firing. These measurements will be removed before the stage leaves STC.

### 3.1.16 Forward Stage/Instrumentation Unit (IU) Interface

The IU was not available at the Sacramento Test Center; therefore, the IU and S-IB electrical interfaces were simulated by GSE.

### 3.1.17 Electrical Umbilicals

The electrical umbilicals remained connected throughout the acceptance firing.

### 3.1.18 Data Acquisition System

The stage data acquisition system was defined in drawing 1B43567, Instrumentation Program and Components List, Saturn S-IVB-502, except as called out in section 12.

### 3.1.19 Confidence Firing APS

Engine aspirators were installed for extinguishing engine after-burning which may occur during firing at sea level.

TABLE 3-1 (Sheet 1 of 4)
S-IVB-502 STAGE HARDWARE LIST

| *ITEM NO. | PART NO. | NAME |
|---|---|---|
| 1 | 7851861-1 | Disconnect, LH2 Tank Pressurization |
| 2 | 1B53817-501 | Valve, Hand, 3-Way, LOX Vent and Relief Valve Purge |
| 3 | 1B40824-505 | Valve, Check, LH2 Prepressurization Line |
| 4 | 1A57350-505 | Module, Control Helium Fill |
| 5 | 1A49990-1 | Sphere, Control Helium Storage, 4.5 scf |
| 6 | 1B43657-507 | Module, Pneumatic Power Control |
| 7 | 7851823-503 | Disconnect, Ambient Helium Fill |
| 8 | 1B51361-1 | Valve, Check, Ambient Helium Fill |
| 9 | 1A48857-1 | Plenum, Control Helium, 100 sci |
| 10 | 1A48848-505 | Disconnect, LH2 Tank Vent |
| 11 | 1B53817-501 | Valve, Hand, 3-Way, Nonpropulsive Vent, Continuous Vent, LH2 Chilldown Valve and Fill and Drain Valves Purge |
| 12 | 1B40622-507 | Orifice, LH2 Chilldown Valve Purge Line |
| 13 | 1B51361-1 | Valve, Check, LH2 Fill and Drain-Valve, Nonpropulsive Vent and Continuous Vent Purge |
| 14 | 1B51361-1 | Valve, Check, Nonpropulsive Vent and Continuous Vent Purge Line |
| 15 | 1B65292-501 | Module, Actuation Control, LH2 Continuous Vent Valve |
| 16 | 1B40622-509 | Orifice, LH2 Continuous Vent Valve Purge |
| 17 | 1B51753-501 | Module, LH2 Continuous Vent |
| 18 | 1B52861-1 | Meter, Quality |
| 19 | 1B44557-1 | Nozzle, Continuous Vent |
| 20 | 1B44557-1 | Nozzle, Continuous Vent |
| 21 | 1B40622-501 | Orifice, Continuous Vent Purge Line |
| 22 | 1B65292-501 | Module, Actuation Control, LH2 Fill and Drain Valve |
| 23 | 1B40622-505 | Orifice, LH2 Fill and Drain Valve Purge |
| 24 | 1A49978-503 | Disconnect, LH2 Fill and Drain |
| 25 | 1A48240-503 | Valve, LH2 Fill and Drain |
| 26 | 1B41065-1 | Disconnect, Common Bulkhead Vacuum System |
| 27 | 1A49970-503 | Disconnect, LOX Fill and Drain |
| 28 | 1B51361-1 | Valve, Check, LOX Fill and Drain Valve Purge Line |
| 29 | 1B40622-505 | Orifice, LOX Fill and Drain Valve Purge Line |

* Indicates location in figures 3-2 and 3-3

TABLE 3-1 (Sheet 2 of 4)
S-IVB-502 STAGE HARDWARE LIST

| *ITEM NO. | PART NO. | NAME |
|---|---|---|
| 30 | 1B48240-503 | Valve, LOX Fill and Drain |
| 31 | 1B65292-501 | Module, Actuation Control, LOX Fill and Drain Valve |
| 32 | 1B57781-501 | Module, Cold Helium Fill |
| 33 | 1B40824-503 | Valve, Check, Cold Helium Fill Line |
| 34 | 1B42290-503 | Module, LOX Tank Pressure Control |
| 35 | 7851844-501 | Disconnect, Cold Helium Fill and LOX Tank Prepressurization |
| 36 | 1B40824-503 | Valve, Check, Cold Helium Fill and LOX Prepressurization Line |
| 37 | 1A49991-1 | Plenum, LOX Tank Pressurization, 250 sci |
| 38 | 7851830-517 | Switch, Pressure, LOX Tank Pressurization Regulator Backup, P/U 465 +10, -15 psia, D/O 350 +15, -10 psia |
| 39 | 1B63047-525 | Orifice, LOX Tank Pressurization Heat Exchanger Primary |
| 40 | 1B63046-525 | Orifice, LOX Tank Pressurization Heat Exchanger Bypass |
| 41 | 1A49958-519 | Disconnect, Thrust Chamber Jacket Purge and Chilldown |
| 42 | 1B51361-1 | Valve, Check, Thrust Chamber Jacket Purge Line |
| 43 | 1B64443-505 | Module, LH2 Tank Pressure Control |
| **44 | 1B64443-523 | Orifice, LH2 Tank Pressurization Step |
| **45 | 1B64443-523 | Orifice, LH2 Tank Pressurization Normal |
| **46 | 1B64443-523 | Orifice, LH2 Tank Pressurization Control |
| 47 | 1B63437-1 | Orifice, LH2 Tank Repressurization Line |
| 48 | 1B40622-501 | Orifice, LH2 Nonpropulsive Vent Purge Line |
| 49 | 1A89881-501 | Orifice, Nonpropulsive Vent |
| 50 | 1A89881-501 | Orifice, Nonpropulsive Vent |
| 51 | 1A49988-1 | Valve, Directional Control, LH2 Vent |
| 52 | 7851860-539 | Switch, Pressure, LH2 Tank 1st Burn Flight Control, P/U 31 psia Max, D/O 28 psia Min |
| 53 | 7851860-537 | Switch, Pressure, Prepressurization, 2nd Burn Flight Control, Repressurization, and Ground Fill Valve Control, P/U 34 pisa, Max, D/O 31 psia Min |
| 54 | Deleted | |
| 55 | 10414087 | Valve, 3-Way, LH2 Tank Instrumentation Shutoff |
| 56 | 1A49591-521 | Valve, LH2 Tank Relief, Crack 38 psia Max, Reseat 35 psia Min |

* Indicates location in figures 3-2 and 3-3
** Module part number
P/U = Pickup
D/O = Dropout

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TABLE 3-1 (Sheet 3 of 4)
S-IVB-502 STAGE HARDWARE LIST

| *ITEM NO. | PART NO. | NAME |
|---|---|---|
| 57 | 1A48257-507 | Valve, LH2 Tank Vent and Relief, Crack 37 psia Max, Reseat 34 psia Min |
| 58 | 1A79382-1 | Diffuser, LH2 Tank Pressurization |
| 59 | 1A48858-1 | Sphere, Cold Helium, 8 each, 3.5 scf |
| 60 | | Probe, LH2 Temperature Sensor |
| 61 | 1A48431-501 | Probe, LH2 Mass Sensor |
| 62 | 1A49421-503 | Pump, LH2 Chilldown |
| 63 | 1A48854-1 | Orifice, LOX Chilldown Pump Purge |
| 64 | 1A58347-505 | Module, LOX Chilldown Pump Purge |
| 65 | 1A49423-505 | Pump, LOX Chilldown |
| 66 | 1A49964-501 | Valve, Check, LOX Chilldown Return Line |
| 67 | 7851847-535 | Switch, Pressure, LOX Chilldown Pump Purge Regulator Backup, P/U 53 psia Max, D/O 49 psia Min |
| 68 | 114-109 (PESCO) | Valve, Relief, LOX Chilldown Pump Motor Container, Crack and Reseat 65 to 85 psia |
| 69 | 1A67913-1 | Valve, Vent, LOX Chilldown Pump Motor Container |
| 70 | 1A49965-513 | Valve, Shutoff, LOX Chilldown Pump Discharge |
| 71 | 1A89104-501 | Flowmeter, LOX Chilldown Pump Discharge |
| 72 | 1A49968-509 | Prevalve, LOX |
| 73 | 1A59098-013-3 | Valve, Check, LOX Chilldown Pump Discharge |
| 74 | 1A59098-013-5 | Strainer, LOX Chilldown Pump Discharge |
| 75 | 10414087 | Valve, Shutoff, 3-Way, LOX Tank Pressure Switch |
| 76 | 1B39201-501 | Switch, Pressure, LOX Translunar Vent Termination, P/U 38 psia Max, D/O 34 ±1 psia |
| 77 | 7851847-531 | Switch, Pressure, LOX Ground Fill Valve Control, Prepressurization, Flight Control, and Repressurization, P/U 41 psia Max, D/O 38 psia Min |
| 78 | 1B65292-501 | Module, Actuation Control, Directional Vent Valve |
| 79 | 1B65292-501 | Module, Actuation Control, LH2 Tank Vent and Relief Valve |
| 80 | 1A49964-501 | Valve, Check, LH2 Chilldown Return Line |
| 81 | 1A49965-511 | Valve, Shutoff, LH2 Chilldown Pump Discharge |
| 82 | 1A49968-503 | Prevalve, LH2 |
| 83 | 1A59098-013-5 | Strainer, LH2 Chilldown Pump Discharge |

* Indicates location in figures 3-2 and 3-3

P/U = Pickup
D/O = Dropout

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TABLE 3-1 (Sheet 4 of 4)
S-IVB-502 STAGE HARDWARE LIST

| *ITEM NO. | PART NO. | NAME |
|---|---|---|
| 84 | 1A59098-013-3 | Valve, Check, LH2 Chilldown Pump Discharge |
| 85 | 1A89104-501 | Flowmeter, LH2 Chilldown Pump Discharge |
| 86 | 1B65292-501 | Module, Actuation Control, Prevalves, and Chilldown Valves |
| 87 | 1B56653-501 | Module, Control, LH2 Tank Repressurization |
| 88 | 1B53920-501 | Valve, Check, LH2 Tank Pressurization |
| 89 | 1B56653-501 | Module, Control, LOX Repressurization |
| 90 | 1A49990-501 | Sphere, LOX Repressurization, 2 each |
| 91 | 1B51361-1 | Valve, Check, LH2 Repressurization Module Supply |
| 92 | 1A49990-1 | Sphere, LH2 Repressurization, 7 each |
| 93 | 1B64052-1 | Orifice, LOX Repressurization Line |
| 94 | 1B40824-505 | Valve, Check, LOX Repressurization Line |
| 95 | 1B51361-1 | Valve, Check, LOX Vent and Relief Valve Purge |
| 96 | 1B63206-1 | Orifice, LOX Vent Relief Valve Purge |
| 97 | 1A49590-509 | Valve, Relief, LOX Tank, Crack 45 psia Max, Reseat 42 psia Min |
| 98 | 1A48312-503 | Valve, LOX Vent and Relief, Crack 44 psia Max, Reseat 41 psia Min |
| 99 | 1B65292-501 | Module, Actuation Control, LOX Vent and Relief Valve |
| 100 | 1A58347-507 | Module, Control, Engine Pump Purge |
| 101 | 1A67002-509 | Switch, Pressure, Engine Pump Purge Regulator Backup, P/U 130 psia Max, D/O 105 psia Min |
| 102 | 1A49958-521 | Disconnect, Start Sphere Vent and Relief Valve Drain |
| 103 | 1A49958-515 | Disconnect, Engine Control Helium Sphere Fill |
| 104 | 1A49958-523 | Disconnect, Engine Start Sphere Fill |

* Indicates location in figures 3-2 and 3-3
P/U = Pickup
D/O = Dropout

TABLE 3-2 (Sheet 1 of 3)
S-IVB-502 STAGE AND GSE ACCEPTANCE FIRING ORIFICES

| ITEM* NO. | DESCRIPTION | ORIFICE SIZE OR NOMINAL FLOWRATE | COEFFICIENT OF DISCHARGE | EFFECTIVE AREA (in.$^2$) |
|---|---|---|---|---|
| | Stage | | | |
| 16 | Continuous vent module purge | 300 scim at 3,000 psid | -- | Sintered |
| 21 | LH2 continuous vent system purge | 1 scim at 3,200 psid | -- | Sintered |
| 23 | LH2 fill and drain valve purge | 15 scim at 3,200 psid | -- | Sintered |
| 29 | LOX fill and drain valve purge | 15 scim at 3,200 psid | -- | Sintered |
| 39 | LOX tank pressurization heat exchanger bypass | 0.166 in. dia | 0.89 | 0.0192 |
| 40 | LOX tank pressurization heat exchanger primary | 0.196 in. dia | 0.89 | 0.0268 |
| 46 | LH2 tank pressurization overcontrol - 1st burn | 0.204 in. dia | 0.86† | 0.0870† |
| 44 | LH2 tank pressurization overcontrol - 2nd burn | 0.204 in. dia | 0.87† | 0.0882† |
| 45 | LH2 tank pressurization undercontrol | 0.296 in. dia | 0.86 | 0.0593 |
| 47 | LH2 repressurization control | 0.102 in. dia | 0.86 | 0.0070 |
| 48 | LH2 tank nonpropulsive vent purge | 1 scfm at 3,200 psid | -- | Sintered |
| 49 | Nonpropulsive vent No. 1 | 2.180 in. dia | -- | -- |
| 50 | Nonpropulsive vent No. 2 | 2.180 in. dia | -- | -- |
| 63 | LOX chilldown pump purge | 37 scim at 475 psid | -- | Sintered |
| 64 | LOX chilldown pump purge module | 0.00166 lbm/sec at 475 psig IN and 85 psig OUT | -- | -- |

* Indicates location in figures 3-2 and 3-3.

† Discharge coefficient and effective area are calculated for overcontrol and undercontrol orifices in combination.

TABLE 3-2 (Sheet 2 of 3)
S-IVB-502 STAGE AND GSE ACCEPTANCE FIRING ORIFICES

| ITEM* NO. | DESCRIPTION | ORIFICE SIZE OR NOMINAL FLOWRATE | COEFFICIENT OF DISCHARGE | EFFECTIVE AREA (in.$^2$) |
|---|---|---|---|---|
| 93 | LOX repressurization control | 0.036 | 0.91 | 0.00092 |
| 95 | LOX tank vent and relief valve purge | 65 scfm at 3,000 psid | -- | -- |
| 99 | Engine pump purge module | 0.00166 lbm/sec at 475 psig IN and 85 psig OUT | -- | -- |
| | Console A | | | |
| A9538 | LH2 tank repressurization supply | Union | -- | 0.0033 |
| A9537 | Pressure switch checkout, high pressure | 0.032 in. dia | -- | -- |
| A9536 | Pressure switch checkout, low pressure | 1.2 scfm | -- | Sintered |
| A9535 | LH2 tanks and umbilical purge supply | 0.260 in. dia | 0.88 | 0.0467 |
| -- | All console A stage bleeds | Variable | -- | -- |
| A9515 | Pressure actuated valve and mainstage pressure switch supply | 1.2 scfm | -- | Sintered |
| A9533 | LH2 system checkout supply | 1.2 scfm | -- | Sintered |
| A9534 | LOX system checkout supply | 2.0 scfm | -- | Sintered |
| A9539 | Console GN2 inerting supply | 0.013 in. dia | -- | -- |
| A9526 | J-box inerting supply | 0.013 in. dia | -- | -- |
| | Console B | | | |
| -- | All console B stage bleeds | Variable | -- | -- |
| A9529 | LOX tank and umbilical purge system | 0.305 in. dia | -- | -- |
| -- | Turbine start sphere supply | Union | -- | -- |

* Indicates location in figures 3-2 and 3-3.

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TABLE 3-2 (Sheet 3 of 3)
S-IVB-502 STAGE AND GSE ACCEPTANCE FIRING ORIFICES

| ITEM* NO. | DESCRIPTION | ORIFICE SIZE OR NOMINAL FLOWRATE | COEFFICIENT OF DISCHARGE | EFFECTIVE AREA (in.$^2$) |
|---|---|---|---|---|
| A9527 | LH2 tank prepressurization supply | 0.113 in. dia | 0.94 | -- |
| A9348 | Console GH2 inerting supply | Manifold | -- | -- |
| A9540 | J-box inerting supply | 0.013 in. dia | -- | -- |
| A0553 | Cold GH2 vent | Variable | 0.84 | 0.00433 |
| A9550 | Engine continuous sphere supply vent | -- | -- | -- |
| A9552 | Turbine start sphere supply vent | 0.081 in. dia | 0.83 | 0.00574 |
| A9526 | Thrust chamber jacket purge and chilldown system | 0.072 in. dia | 0.89 | 0.00362 |
| A9525 | Engine Control Sphere supply | 0.125 in. dia | 0.84 | 0.01031 |
| -- | LOX tank prepressurization supply | 0.096 | 0.94 | |

* Indicates location in figures 3-2 and 3-3.

TABLE 3-3
S-IVB-502 STAGE PRESSURE SWITCHES

| NAME | PART NO. | DESIGN (PSIA) | | PREFIRING (PSIA) | | POSTFIRING (PSIA) | |
|---|---|---|---|---|---|---|---|
| | | PICKUP | DROPOUT | PICKUP | DROPOUT | PICKUP | DROPOUT |
| LH2 Tank | | | | | | | |
| First Burn Flight Control | 1B52624-1 | 31 max | 28 min | 31.156 | 29.024 | 31.456 | 29.217 |
| Second Burn Ground Fill, Repressurization and Pre-pressurization | 1B52624-501 | 34 max | 31 min | 34.064 | 31.932 | 34.328 | 32.084 |
| LOX Tank | | | | | | | |
| LOX Flight Control and Ground Fill | 1B52624-503 | 41 max | 38 min | 40.82 | 39.41 | 40.76 | 39.46 |
| LOX Pressurization System | | | | | | | |
| Cold Helium Regulator Backup | 1B52624-509 | 465 $^{+20}_{-15}$ | 350 $^{+20}_{-15}$ | 465.5 | 376.1 | 449.6 | 363.2 |
| Pneumatic Power System | | | | | | | |
| Control Helium Regulator Backup | 1B52624-507 | 600 $\pm$15 | 490 $\pm$25 | 555.0 | 500.2 | 564.3 | 488.7 |
| Engine Pump Purge | 1B52623-513 | 130 max | 105 min | 124.37 | 118.40 | NA | NA |
| LOX Chilldown Pump Purge | 1B52624-503 | 41 max | 38 min | 39.98 | 38.62 | 40.14 | 38.89 |
| J-2 Engine System | | | | | | | |
| Mainstage OK No. 1 | NA5-27453-1 | 515 $\pm$30 | Pickup Minus 75 $\pm$25 | 514.77 | 487.75 | 518.12 | 453.18 |
| Mainstage OK No. 2 | NA5-27453-1 | 515 $\pm$30 | Pickup Minus 75 $\pm$25 | 525.42 | 459.86 | 516.07 | 458.40 |

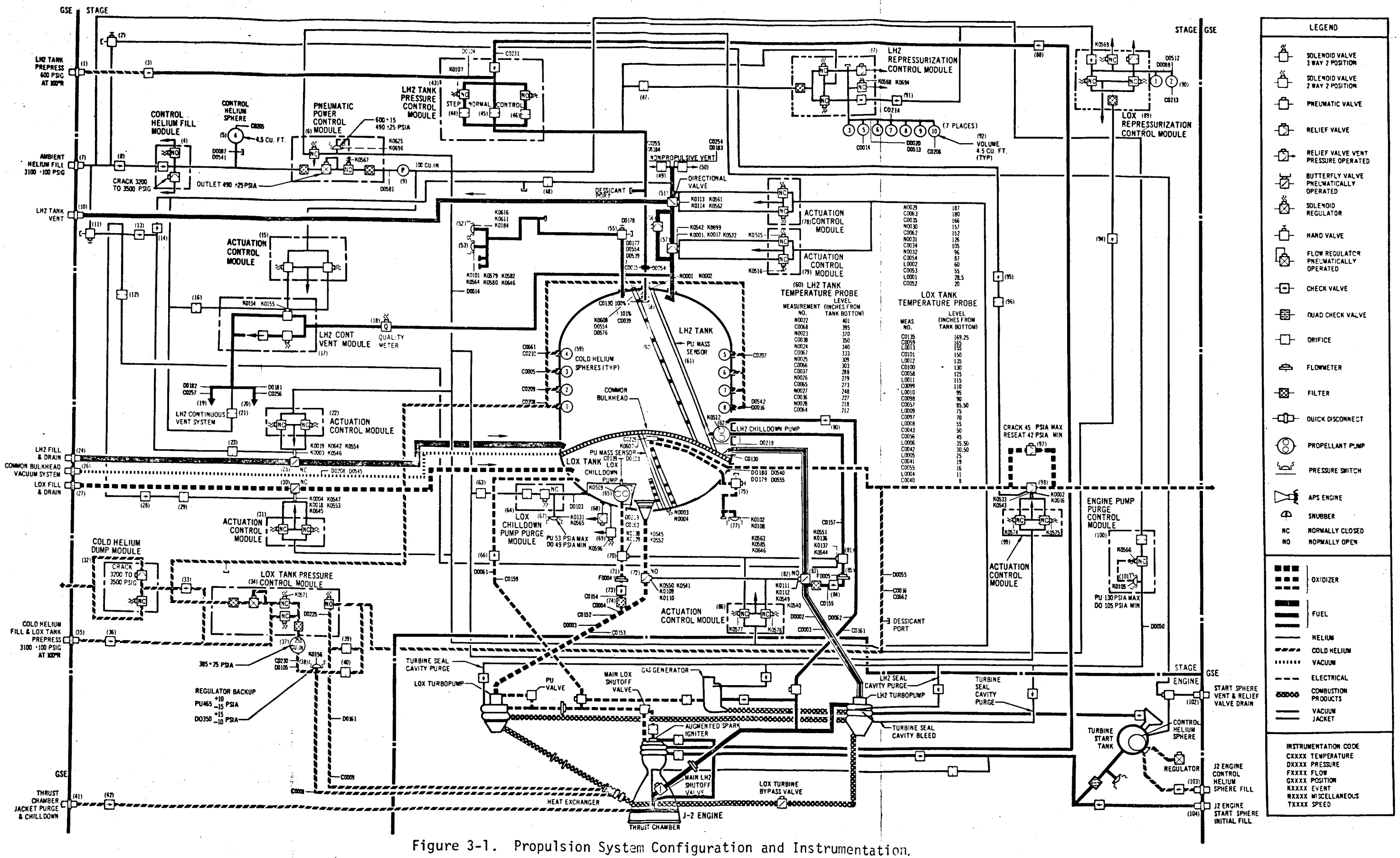


Figure 3-1. Propulsion System Configuration and Instrumentation.

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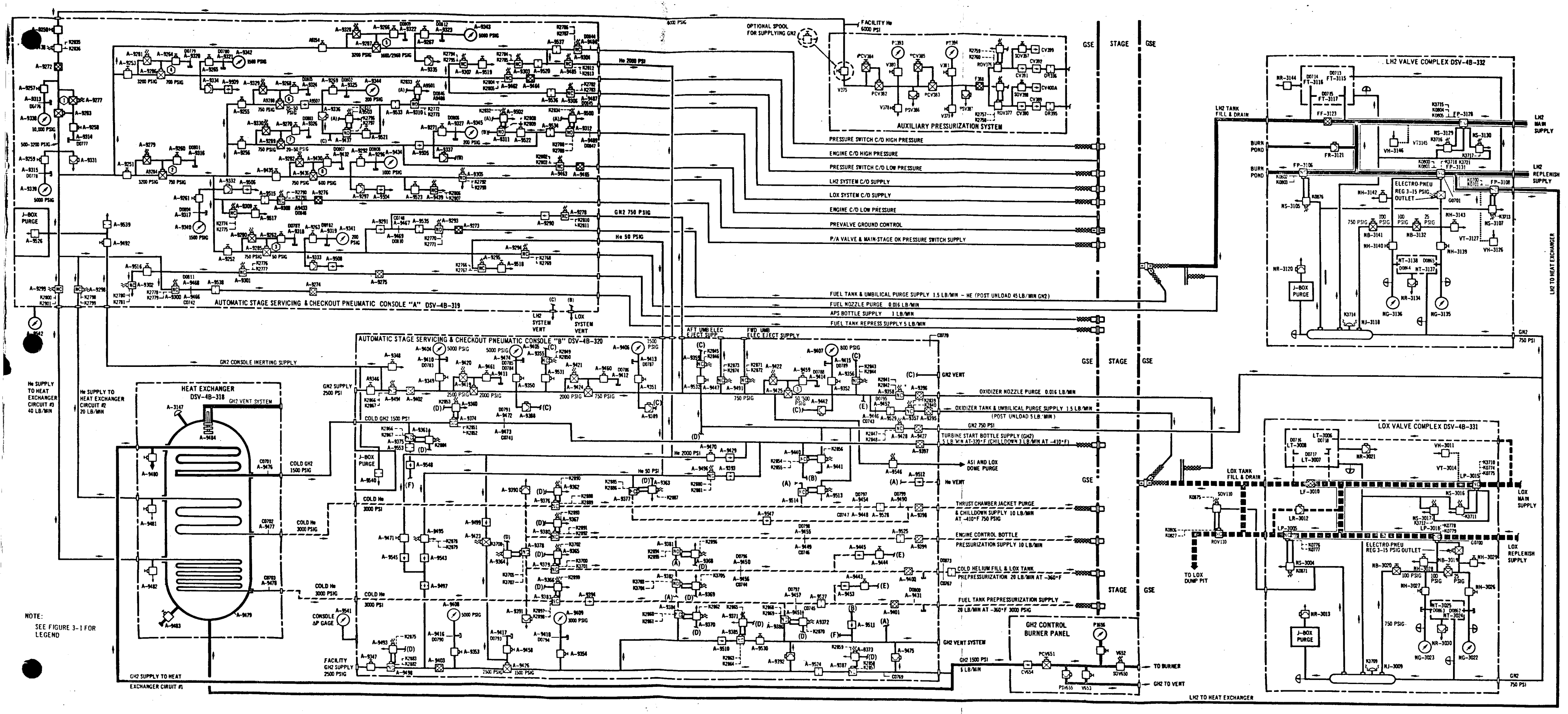


Figure 3-2. Facility Propellant and Pneumatic Loading Systems

# 4. TEST OPERATIONS

The S-IVB-502 stage is the second flight stage of the S-IVB/V stage series. Its primary mission includes placing the Apollo payload in a circular orbit. After one to three orbits, the stage J-2 engine will be restarted to place the Apollo payload in an elliptical earth orbit.

The stage was successfully acceptance fired on 28 July 1966 with no major problems. The terminal countdown (CD 614067) was initiated on 27 July 1966 and was conducted in accordance with the Douglas countdown manual, drawing No. 1B70263. In addition, APS modules 1 and 2 were confidence fired during CD 624360 and CD 624368.

Details of the acceptance firing are presented in the following paragraphs including discussions of the propellant loading, ground support equipment (GSE), and facility operation.

## 4.1 Countdown Operations

### 4.1.1 Countdown 614067

Countdown 614067 was initiated on 27 July 1966 and proceeded smoothly through 1st and 2nd burns and the simulated orbit. The test was successfully completed on 28 July 1966 with no major problems.

After a successful 1st engine burn, an orbital coast period was simulated. An excessive temperature developed in the engine start sphere; the sphere was vented, rechilled, and pressurized to obtain proper conditions for the 2nd burn engine start.

The major events of the acceptance firing occurred at the following times:

| EVENT | TIME |
|---|---|
| Terminal Countdown Initiated | 1339:40 PDT |
| Simulated Liftoff | 1411:50 PDT |
| Engine Start Command - 1st Burn | SLO +511 sec |
| Engine Cutoff Command - 1st Burn | SLO +664 sec |
| Engine Start Command - 2nd Burn ($T_2$ -0) | 1553:40 PDT |
| Engine Cutoff Command - 2nd Burn | 1558:30 PDT |

### 4.1.2 APS Module 1 (CD 624360)

APS module 1 was successfully confidence fired on 19 July in accordance with Test Request (TR) 2077, and the performance was as expected. Propellant loading and helium pressurization were accomplished before the firing program was initiated. The program consisted of an S-IB APS confidence firing sequence which was run once with and once without the ullage engine firing. The module was then flushed with Freon MF and removed.

### 4.1.3 APS Module 2 (CD 624368)

APS module 2 was successfully confidence fired on 27 July in accordance with TR 2078. The propellant loading, system pressurization, and confidence firing activities were similar to those of module 1. Further details of the confidence firings of both modules are presented in section 10.

## 4.2 Checkout

The modifications, procedures, and checkouts performed for the acceptance firing were initiated on 2 July 1966 upon receipt of the stage at Sacramento Test Center, and continued through 26 July. The handling and checkout procedures that were used for the prefiring and postfiring checkouts are described in Douglas Report DAC-56353, S-IVB-502 Stage Narrative End Item Report.

The integrated systems test was performed on 8 July to check out the automatically controlled equipment of the stage, pneumatic consoles, and propellant sleds. The simulated static firing was performed on 22 July to verify the countdown procedure. The test proceeded satisfactorily with only minor problems.

## 4.3 Cryogenic Loading

The S-IVB-502 stage was successfully loaded with LOX, LH2, and cold helium. No difficulties or irregularities occurred and satisfactory levels were attained in all systems.

### 4.3.1 LOX Loading

The LOX loading procedures were conducted as specified in Task 41 of the Countdown Manual. The computer controlled loading operation was completed satisfactorily, although at 98 percent load the main LOX fill valve did not go from the full open position to the topping position within the required 10 sec. The system was automatically secured with no incidents. Loading data are presented in table 4-1 and figure 4-1.

### 4.3.2 LH2 Loading

The LH2 loading procedures were conducted as specified in Task 42 of the Countdown Manual and completed without incident. During fast fill, the LH2 flowrate averaged 2,830 gpm instead of the desired 3,000 gpm; during topping it was 530 gpm. Loading data are presented in table 4-2 and figure 4-2.

### 4.3.3 Cold Helium Loading

Cold helium was loaded after the completion of LH2 loading. Satisfactory temperatures and pressures were obtained. Data are presented in table 4-3 and figure 4-3.

## 4.4 GSE Performance

### 4.4.1 GH2 Supply System

The GH2 supply system performed adequately by cooling the engine start sphere to within the start limits of 290 $\pm$30 deg R. Ambient GH2 from the facility was supplied at 2,500 psia to console B, where it was regulated to approximately 1,230 psia. The GH2 was then cooled by routing it through the No. 1 (GH2) circuit in the heat exchanger and returning it to pneumatic console B for control and distribution to the engine start sphere. Start sphere chilldown (figure 4-4) was accomplished by flowing the cold GH2 into the engine GH2 start sphere and out the sphere vent valve. The high flowrate and small vent size caused the sphere pressure to be maintained at approximately 1,100 psia during the chilldown.

In order to meet the required temperature in the engine start sphere at engine start (290 ±30 deg R), it was necessary to regulate the GH2 flow through the heat exchanger. A 0.081-in. dia orifice was installed in the GH2 supply vent line. By opening the supply vent, the flow through the heat exchanger could be increased; therefore, a higher temperature GH2 could be supplied to the start sphere when necessary.

The average chilldown flowrate after temperature and pressure had stabilized was 8.1 lbm/min. Start sphere temperature and pressure were 273 deg R and 1,350 psia at 1st burn Engine Start Command (figure 4-4).

Due to heating conditions in the start sphere during the simulated orbital coast (paragraph 6.1.3), it was necessary to vent and rechill the start sphere prior to 2nd burn. This was satisfactorily accomplished with an average chilldown flowrate of 8.7 lbm/min and a pressure and temperature of 1,320 and 264 deg R in the sphere at Engine Start Command (figure 4-5).

### 4.4.2 Helium Supply System

The helium supply system functioned adequately. Propellant tank prepressurization, thrust chamber chilldown, and loading of the cold helium spheres and the stage and engine pneumatic control sphere were all satisfactorily accomplished.

Ambient helium from a 6,000-psi supply was regulated by the pneumatic console A, stage I regulator to approximately 3,100 psia and distributed to perform chilldown and pressurization functions. The helium supply pressure (D0778) profile was normal. At initiation of the thrust chamber chilldown, the pressure was 3,100 psia; it remained at that level until the start of prepressurization (figure 4-6). The regulated pressure then increased to 3,250 psia by the end of prepressurization (figure 4-7).

During the terminal countdown prior to simulated liftoff, the cold helium supply for pressurizing the engine control sphere and chilling down the thrust chamber was satisfactory. At engine start the control sphere pressure was 3,345 psia, and the temperature was 289 deg R as a result of heat transfer from the start sphere during sphere loading (figure 4-4).

The cold helium flowrate during thrust chamber chilldown (figure 4-8) varied from 7.0 to 11.7 lbm/min. Both heat exchanger outlet temperatures (figure 4-7) reacted as expected. The temperature at the four-coil outlet (C0702) was stabilized at 88 deg R and the eight-coil outlet (C0703) at 93 deg R during chilldown and before LOX and LH2 tank prepressurization was completed. After simulated liftoff, the temperature at the thrust chamber jacket chilldown control orifice (C0747) was relatively steady at 95 deg R (figure 4-8).

Prior to 2nd burn, GSE helium was utilized for LOX tank prepressurization (figure 4-9) and thrust chamber chilldown (figure 4-10). As expected, the engine control sphere and stage control helium sphere did not require repressurization after the coast period.

The cold helium flowrate during 2nd burn thrust chamber chilldown varied between 7.0 and 11.7 lbm/min with an orifice inlet temperature that decreased to 95 deg R at engine start. Heat exchanger temperature response is presented in figure 4-9.

## 4.5 Terminal Countdown

The major events of the 1st burn terminal countdown were engine conditioning and final replenishing and prepressurization of the propellant tanks. This portion of the countdown started with the automatic sequence at SLO -20 min 30 sec; final propellant replenishing was completed by SLO -60 sec. The stage was isolated from GSE at SLO -13 sec, approximately as planned.

During simulated orbital coast, the engine start sphere was vented to ambient (paragraph 6.1), and it was necessary to rechill and pressurize the sphere during the 2nd burn terminal countdown. LOX tank prepressurization, thrust chamber chilldown, and final LOX tank replenishing were accomplished as planned. The auxiliary pressurization system was used to ensure proper ullage pressures in the LOX and LH2 tanks prior to 2nd burn. The stage satisfactorily accomplished propellant tank repressurization, engine pump purge, and engine pump chilldown prior to 2nd burn Engine Start Command (table 4-4).

## 4.6 Holds

Three operational holds, totaling 10 hr 23 min 25 sec, were called during CD 614067. The clock was advanced 1 hr at T -11 hr 30 min.

a. At T -17 hr 31 min, a 36-min hold was called to turn off stage power to allow troubleshooting of the overcurrent problem on forward bus 2.

b. At T -8 hr, a scheduled hold of 9 hr 30 min was called to complete all outstanding countdown tasks.

c. At T -3 hr 30 min, a 17 min 25 sec hold was called to correct computer problems.

TABLE 4-1
LOX LOADING DATA

| S-IVB STAGE | CD | INITIAL SLOW FILL | | | RAPID FILL | | | FINAL SLOW FILL | | | TOTAL LOAD TIME (sec) | TOTAL MASS LOADED (lbm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TIME (sec) | FLOW-RATE (gpm) | MASS* (%) | TIME (sec) | FLOW-RATE (gpm) | MASS* (%) | TIME (sec) | FLOW-RATE (gpm) | MASS* (%) | | |
| 201 | 614040 | 970 | 332 | 2.5 | 830 | 1,075 | 94 | 215 | 323 | 100 | 2,015 | 192,551 |
| | 614047 | 345 | 141 | 4 | 1,140 | 1,030 | 100 | N/A | N/A | N/A | 1,485 | -- |
| 202 | 614048 | 348 | 157 | 4.5 | 1,135 | 1,007 | 98.5 | 65 | 280 | 100 | 1,548 | -- |
| | 614050 | 345 | 144 | 5.5 | 1,131 | 1,002 | 98.75 | 64 | 235 | 100 | 1,540 | 190,626 |
| | 614054 | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | -- |
| 203** | 614055 | 620 | 126 | 10.4 | 665 | 1,005 | 99.5 | 22 | 165 | 100 | 1,307 | -- |
| | 614056 | 583 | 136 | 12.5 | 650 | 1,025 | 99.5 | 30 | 120 | 100 | 1,263 | 114,319 |
| 204 | 614059 | 373 | 255 | 7.8 | 1,085 | 1,012 | 98 | 94 | 195 | 100 | 1,552 | 187,633 |
| 501 | 614061 | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | -- |
| | 614063 | 531 | 165 | 7 | 1,119 | 1,007 | 97 | 147 | 119 | 98.9 | 1,797 | 187,248 |
| 502 | 614067 | 524 | 168 | 7.2 | 1,193 | 944 | 99.1 | 138 | 80 | 100 | 1,895 | 193,325 |

N/A = Not applicable

DNA = Data not available

* = 100% mass is defined as mass at simulated liftoff

** = 100% mass was considerably less than nominal (62%) for the S-IVB configuration in conjunction with the stage primary mission - the LH2 experiment.

TABLE 4-2
LH2 LOADING DATA

| S-IVB STAGE | CD | INITIAL SLOW FILL | | | RAPID FILL | | | FINAL SLOW FILL | | | TOTAL LOAD TIME (sec) | TOTAL MASS LOADED (lbm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TIME (sec) | FLOW-RATE (gpm) | MASS* (%) | TIME (sec) | FLOW-RATE (gpm) | MASS* (%) | TIME (sec) | FLOW-RATE (gpm) | MASS* (%) | | |
| 201 | 614040 | 1,000 | 815 | 20 | 930 | 3,040 | 94 | 420 | 863 | 100 | 2,350 | 37,079 |
| | 614047 | 260 | 589 | 4 | 1,240 | 2,935 | 99 | | | | 1,500 | -- |
| 202 | 614048 | 292 | 524 | 4 | 1,207 | 3,015 | 99 | | | | 1,499 | -- |
| | 614050 | 300 | 511 | 4 | 1,211 | 3,000 | 99 | | | | 1,511 | 37,587 |
| | 614054 | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | -- |
| 203** | 614055 | 509 | 465 | 5 | 1,445 | 2,910 | 98.3 | 225 | 396 | 100.2 | 2,180 | -- |
| | 614056 | 498 | 495 | 5 | 1,430 | 2,930 | 98 | 200 | 434 | 100 | 2,128 | 44,167 |
| 204 | 614059 | 433 | 690 | 8 | 1,229 | 2,706 | 97 | 133 | 880 | 100 | 1,795 | 36,785 |
| 501 | 614061 | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | DNA | -- |
| | 614063 | 486 | 601 | 7 | 1,387 | 2,887 | 103 | 174 | 335 | 104.4 | 2,047 | 38,792 |
| 502 | 614067 | 533 | 509 | 6.5 | 1,409 | 2,730 | 98.6 | 143 | 409 | 100 | 2,085 | 40,452 |

DNA = Data not available

* = 100% mass is defined as mass at simulated liftoff

** = 100% mass was considerably more than nominal (118%) for the S-IVB/IB configuration (and thus took more time than usual) in conjunction with the stage primary mission, the LH2 experiment.

TABLE 4-3
COLD HELIUM LOADING DATA

| S-IVB STAGE | CD | INITIAL PRESSURE (psia) | TIME TO ACHIEVE 3,000 psia* (sec) | TIME TO ACHIEVE 50°R* (sec) | PRESSURE AT SLO (psia) | TEMPERATURE AT SLO (°R) | LOADED MASS (lbm) |
|---|---|---|---|---|---|---|---|
| 201 | 614040 | 1,500 | 200 | 900 | 3,200 | 40 | 342 |
| 202 | 614047 | 750 | 400 | 860 | 3,240 | 40.4 | 370 |
| | 614048 | 760 | 500 | 920 | 3,190 | 39.5 | 371 |
| | 614050 | 785 | 670 | 1,030 | 3,100 | 38.5 (H/W)<br>41.5 (T/M) | 346 |
| 203 | 614054 | DNA | DNA | DNA | DNA | DNA | DNA |
| | 614055** | 734/1,415 | N/A/1,153 | 716/664 | N/A/2,990 | N/A/41 | 334 |
| | 614056 | 750 | 756 | 940 | 3,000 | 42 | 330 |
| 204 | 614059 | 730 | 300 | 1,000 | 3,165 | 41.2 | 337 |
| 502 | 614067 | 900 | 340 | 1,007 | 3,150 | 40.2 | 336 |

N/A = Not applicable

DNA = Data not available

* = Elapsed time after start of cold helium loading

** = The cold helium spheres were vented to 1,500 psia after attaining 2,920 psia, to permit repairs to the gas heat exchanger relief valves. The spheres were then repressurized.

TABLE 4-4 (Sheet 1 of 3)
TERMINAL COUNTDOWN SEQUENCE

| FUNCTION | TIME FROM SLO (sec) |
|---|---|
| Start Sphere Purge ON | -1,224.1 |
| Start Sphere Chilldown ON | -931.7 |
| Start Sphere Purge OFF | -931.5 |
| Thrust Chamber Purge OFF | -405.9 |
| Thrust Chamber Chilldown ON | -405.7 |
| Start Sphere Pressurization ON | -324.5 |
| LOX Chilldown Pump ON | -203.8 |
| LH2 Chilldown Pump ON | -200.7 |
| LH2 Prevalves CLOSE | -197.0 |
| LOX Prevalves CLOSE | -196.9 |
| LOX Tank Prepressurization ON | -159.5 |
| LOX Vent CLOSE | -159.4 |
| LH2 Vent CLOSE | -111.5 |
| LH2 Tank Prepressurization ON | -108.9 |
| LH2 Fill and Drain Valve CLOSE | -54.8 |
| LOX Fill and Drain Valve CLOSE | -54.5 |
| LH2 Tank Directional Vent to Flight Position | -25.4 |
| Cold Helium Regulator Backup Pressure Switch ENABLED | -25.7 |
| Cold Helium Sphere Supply OFF | -4.8 |
| LH2 Tank Prepressurization Supply OFF | -4.8 |
| Engine Control Sphere Supply OFF | -4.6 |
| LH2 Repressurization Supply OFF | -4.3 |
| Simulated Liftoff | 0 |
| Engine Pump Purge ON | 332.0 |
| Engine Pump Purge OFF | 452.5 |
| Thrust Chamber Chilldown OFF | 488.2 |
| Prevalves OPEN | 508.8 |
| LH2 Chilldown Pump OFF | 510.9 |
| LOX Chilldown Pump OFF | 511.0 |
| Chilldown Shutoff Valves CLOSED | 511.1 |
| Engine Start Command - 1st Burn | 511.9 |
| Cold Helium Shutoff Valve OPEN | 513.1 |

TABLE 4-4 (Sheet 2 of 3)
TERMINAL COUNTOWN SEQUENCE

| FUNCTION | TIME FROM SLO (sec) |
|---|---|
| LOX Tank Flight Pressurization ON | 513.9 |
| Engine Pump Purge ON | 660.2 |
| Engine Cutoff Command - 1st Burn | 665.2 |
| LOX and LH2 Prevalves CLOSED | 665.9 |
| Cold Helium Shutoff Valve CLOSED | 665.9 |
| Thrust Chamber Purge ON | 665.5 |
| LOX Tank Flight Pressurization System OFF | 666.4 |
| LOX and LH2 Prevalves OPENED | 728.7 |
| LOX and LH2 Prevalves CLOSED | 732.1 |
| Chilldown Shutoff Valves OPENED | 732.2 |
| Chilldown Shutoff Valves CLOSED | 734.4 |
| LH2 Continuous Vent Valve OPEN | 755.5 |
| Engine Pump Purge OFF | 1,307.3 |
| LOX Vent OPEN | 1,307.4 |
| | TIME FROM 2ND ESC (sec) |
| 2nd Burn Terminal Count Initiated | -1,362.9 |
| Thrust Chamber Purge OFF | -899.2 |
| Thrust Chamber Chilldown ON | -893.3 |
| Start Sphere Pressurization | -772.3 |
| LOX Chilldown Pump ON | -719.7 |
| LH2 Chilldown Pump ON | -716.8 |
| LOX Tank Prepressurization ON | -700.4 |
| LOX Tank Prepressurization OFF | -552.1 |
| LH2 Tank Continuous Vent Valves CLOSED | -326.1 |
| LH2 Tank Vent Valve CLOSED | -324.8 |
| LH2 Tank Repressurization ON | -326.2 |
| LOX Tank Repressurization ON | -323.2 |
| Engine Pump Seal Purge ON | -180.6 |
| LOX Auxiliary Pressurization | -146.8 |
| LH2 Auxiliary Pressurization | -126.6 |
| Engine Pump Seal Purge OFF | -60.4 |
| Thrust Chamber Chilldown OFF | -23.8 |

TABLE 4-4 (Sheet 3 of 3)
TERMINAL COUNTDOWN SEQUENCE

| FUNCTION | TIME FROM 2ND ESC (sec) |
|---|---|
| Prevalves OPEN | -3.7 |
| Chilldown Shutoff Valves CLOSED | -1.7 |
| LOX Chilldown Pump OFF | -1.6 |
| LH2 Chilldown Pump OFF | -1.5 |
| Engine Start Command - 2nd Burn (1553.05 PDT) | 0 |
| LH2 Pressurization Overcontrol Valve ENABLED | 2.6 |
| LOX Tank Flight Pressurization System ON | 3.3 |
| Engine Cutoff Command - 2nd Burn | 293.7 |

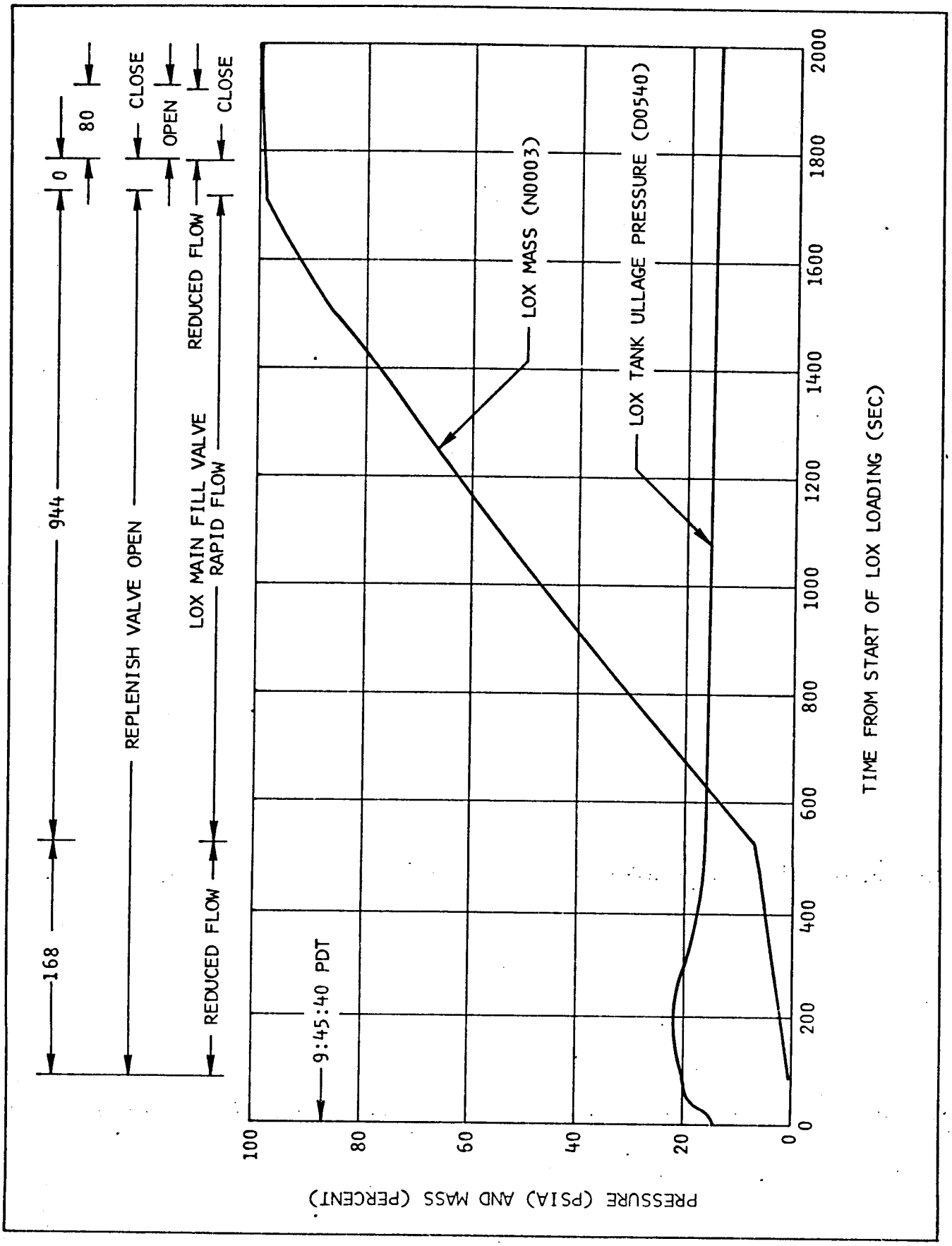


Figure 4-1. LOX Tank Loading

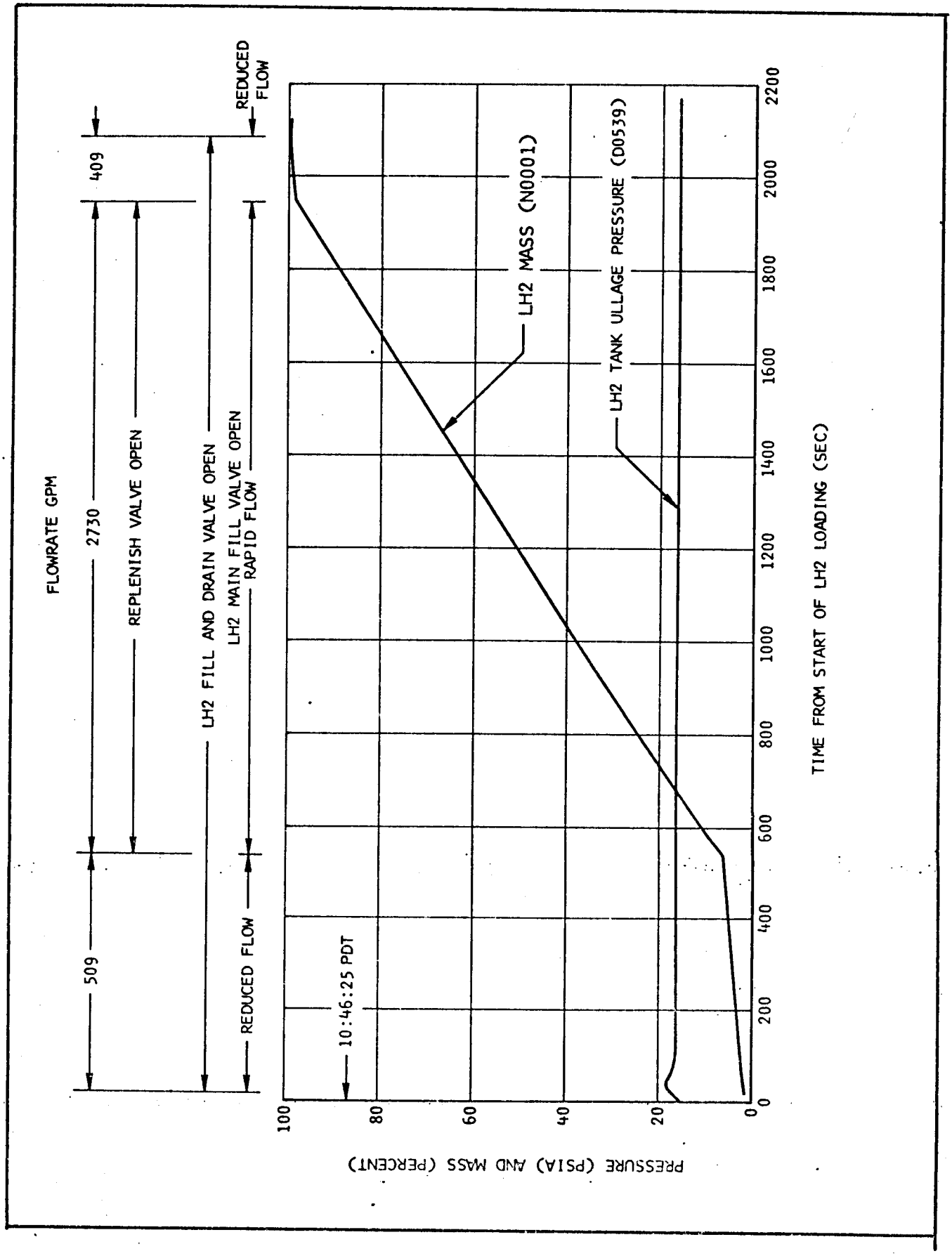


Figure 4-2. LH2 Tank Loading

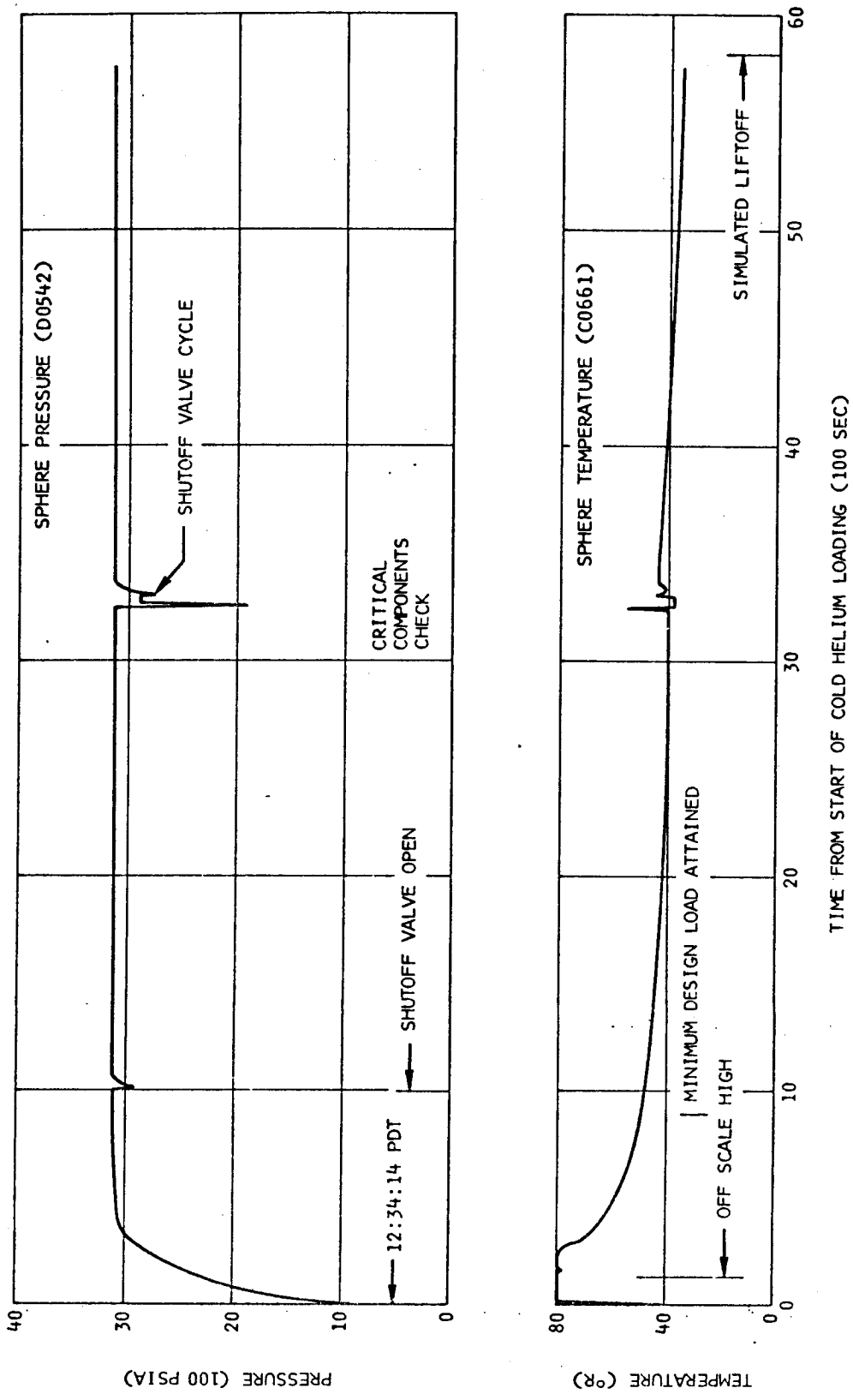


Figure 4-3. Cold Helium System Loading

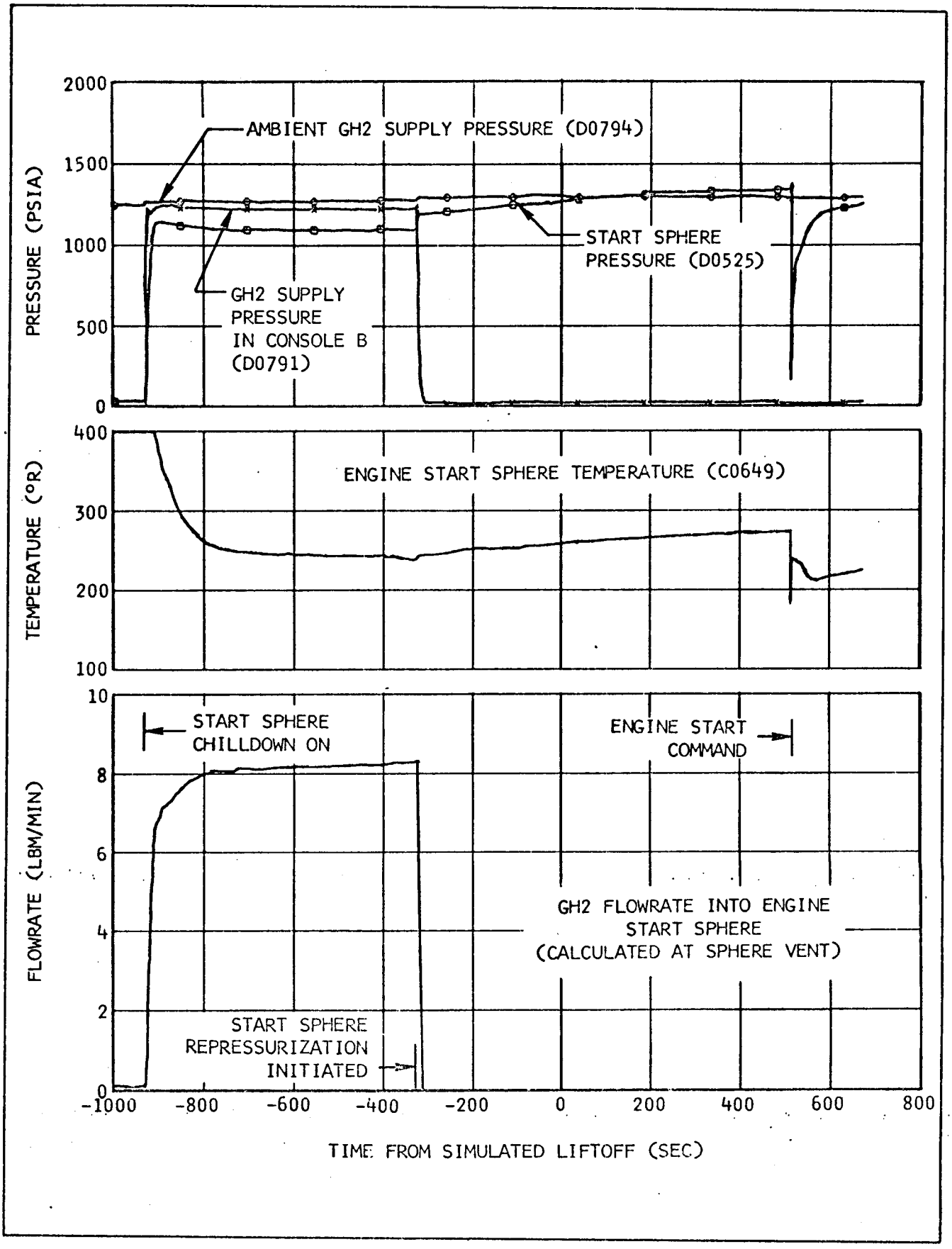


Figure 4-4. GSE Performance During Engine Start Sphere Chilldown - 1st Burn

28 September 1966

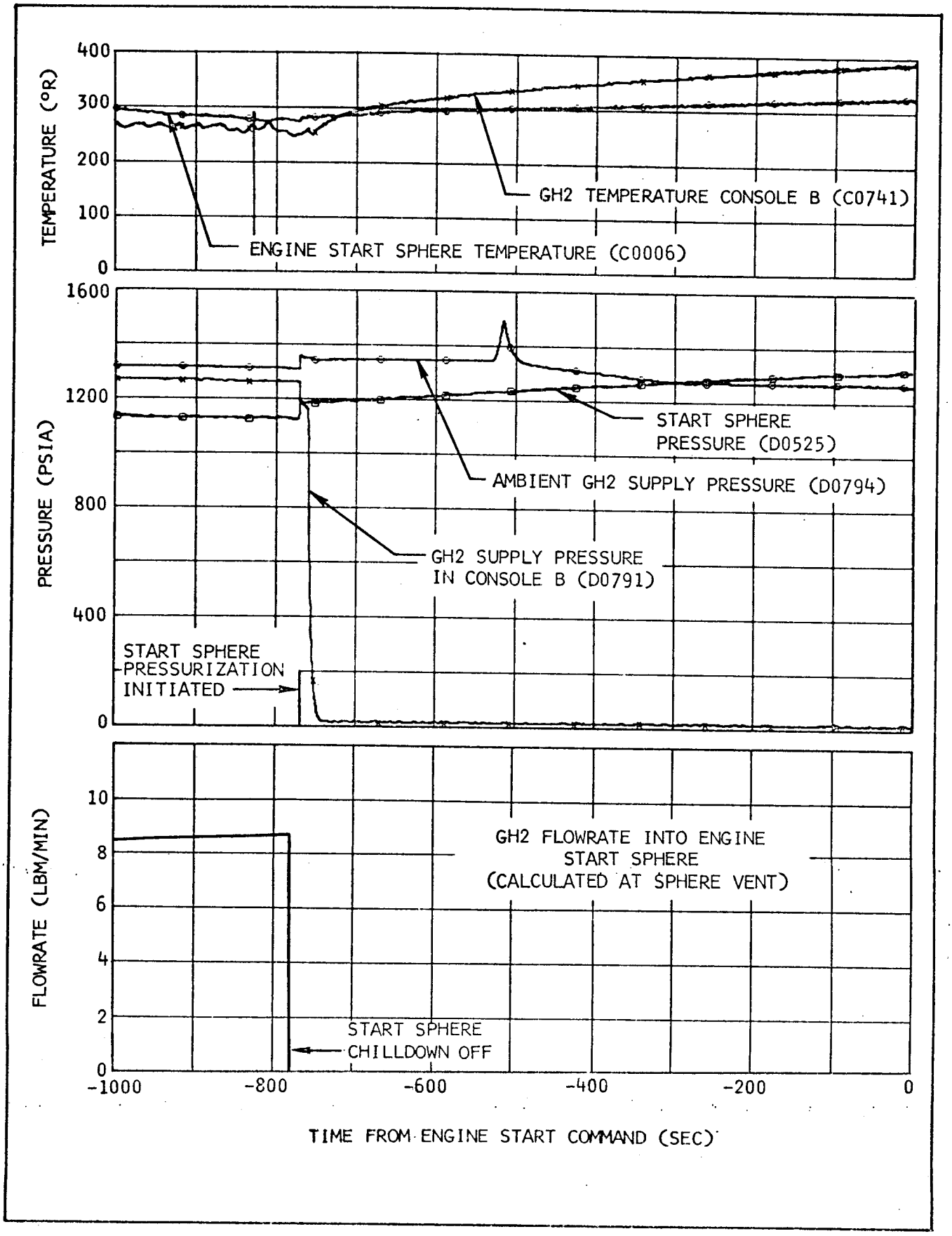


Figure 4-5. GSE Performance During Engine Start Sphere Chilldown - 2nd Burn

28 September 1966

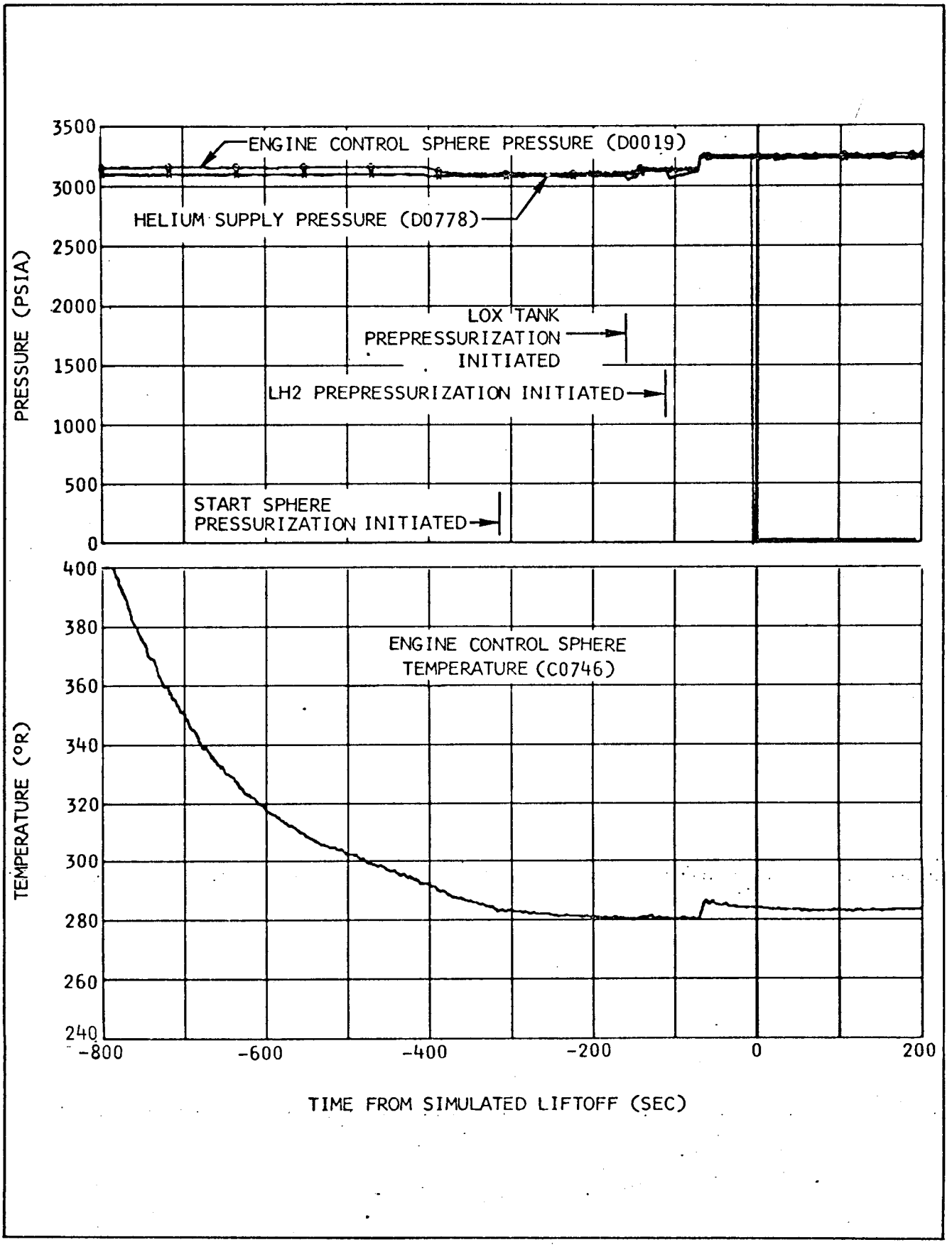


Figure 4-6. Engine Control Sphere GSE Performance - 1st Burn

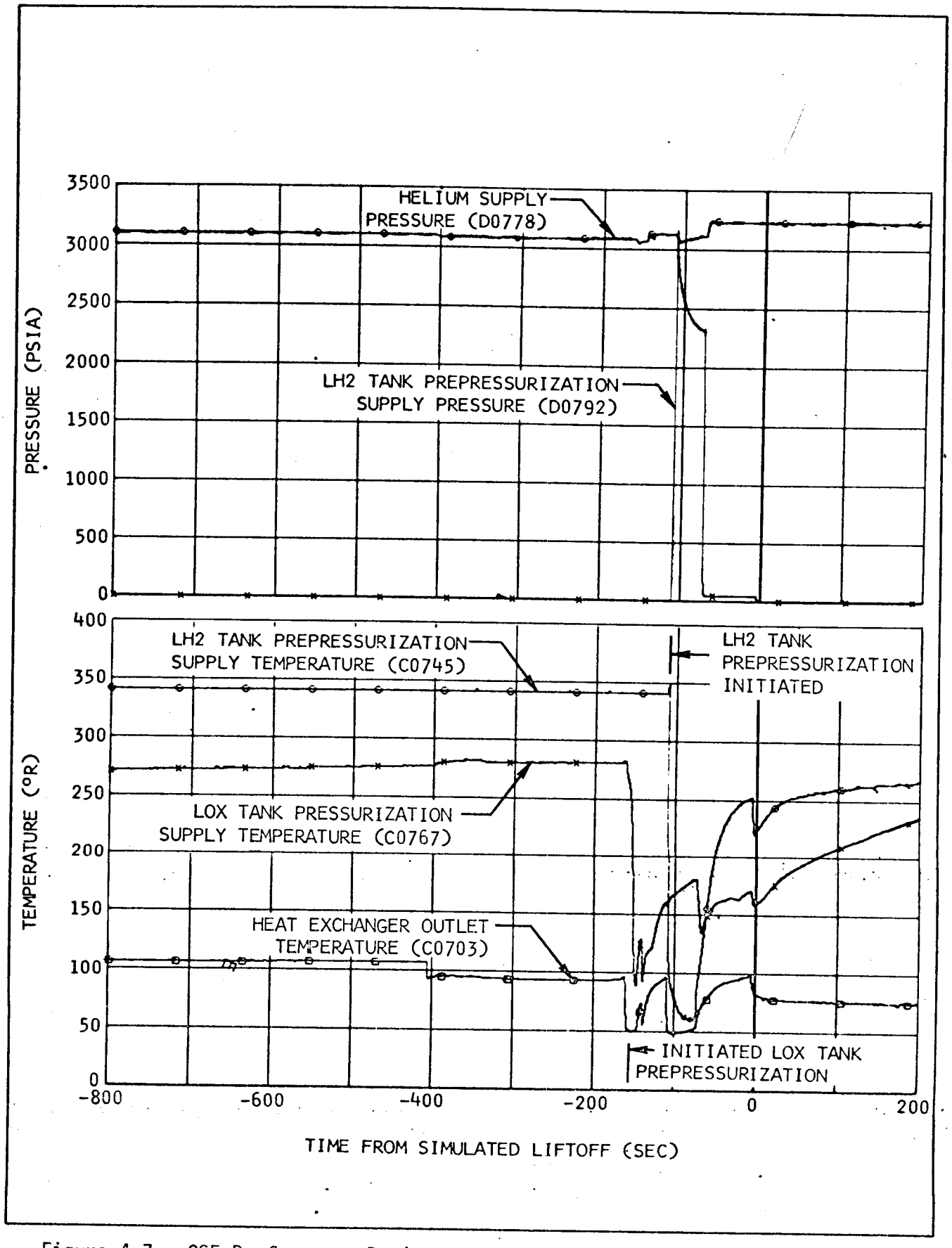


Figure 4-7. GSE Performance During LOX and LH2 Tank Pressurization - 1st Burn

28 September 1966

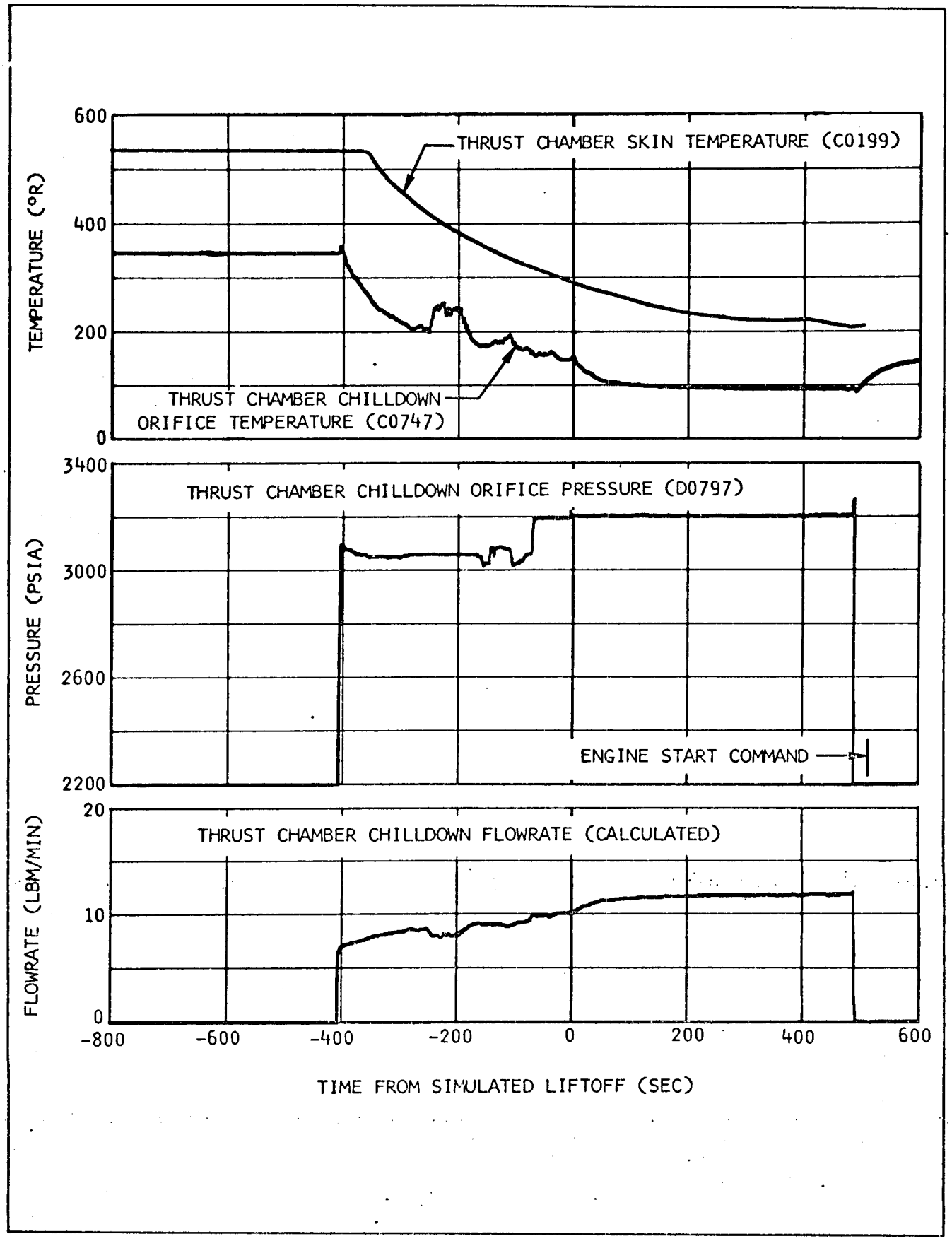


Figure 4-8. GSE Performance During Thrust Chamber Chilldown - 1st Burn

28 September 1966

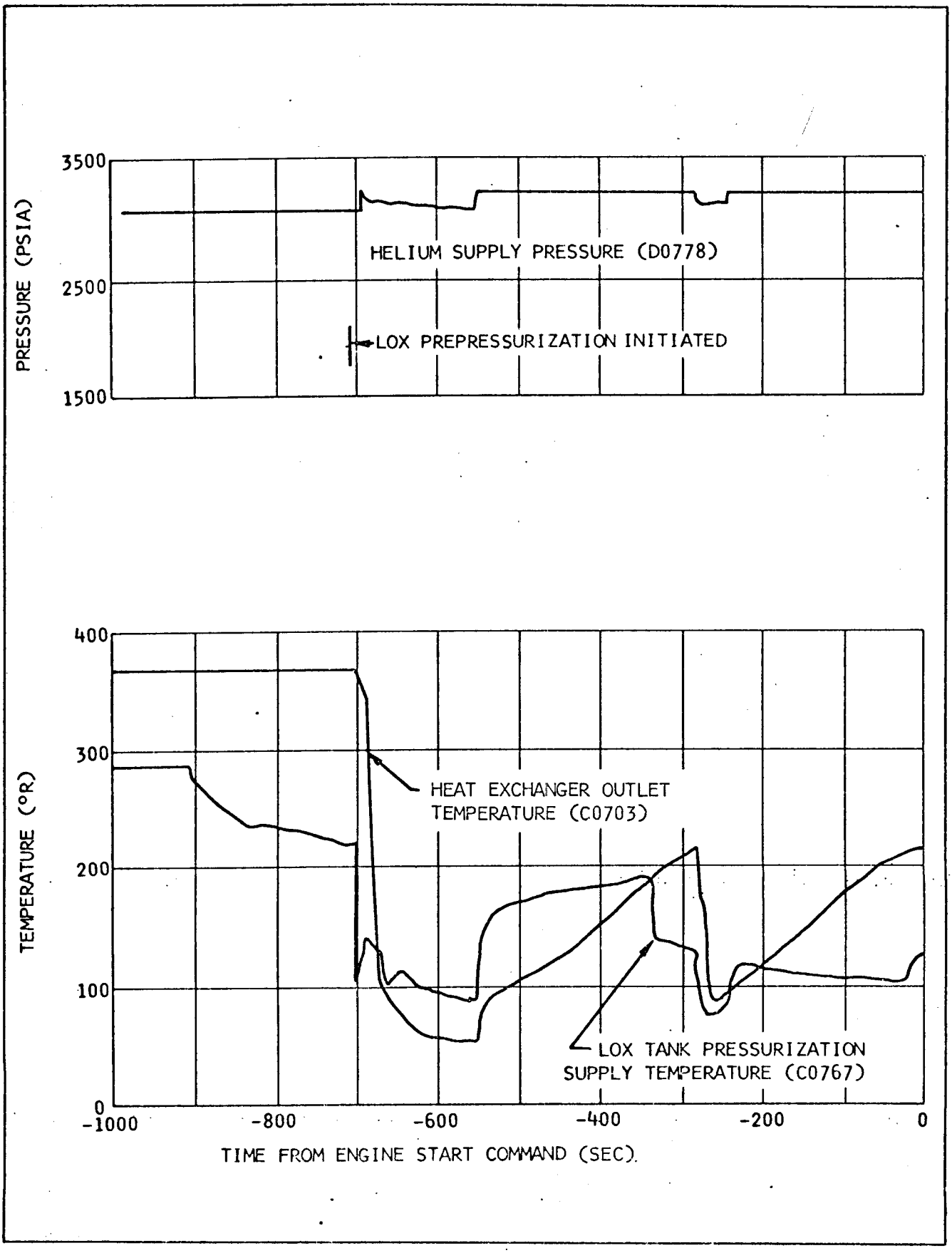


Figure 4-9. GSE Performance During LOX Tank Prepressurization - 2nd Burn

28 September 1966

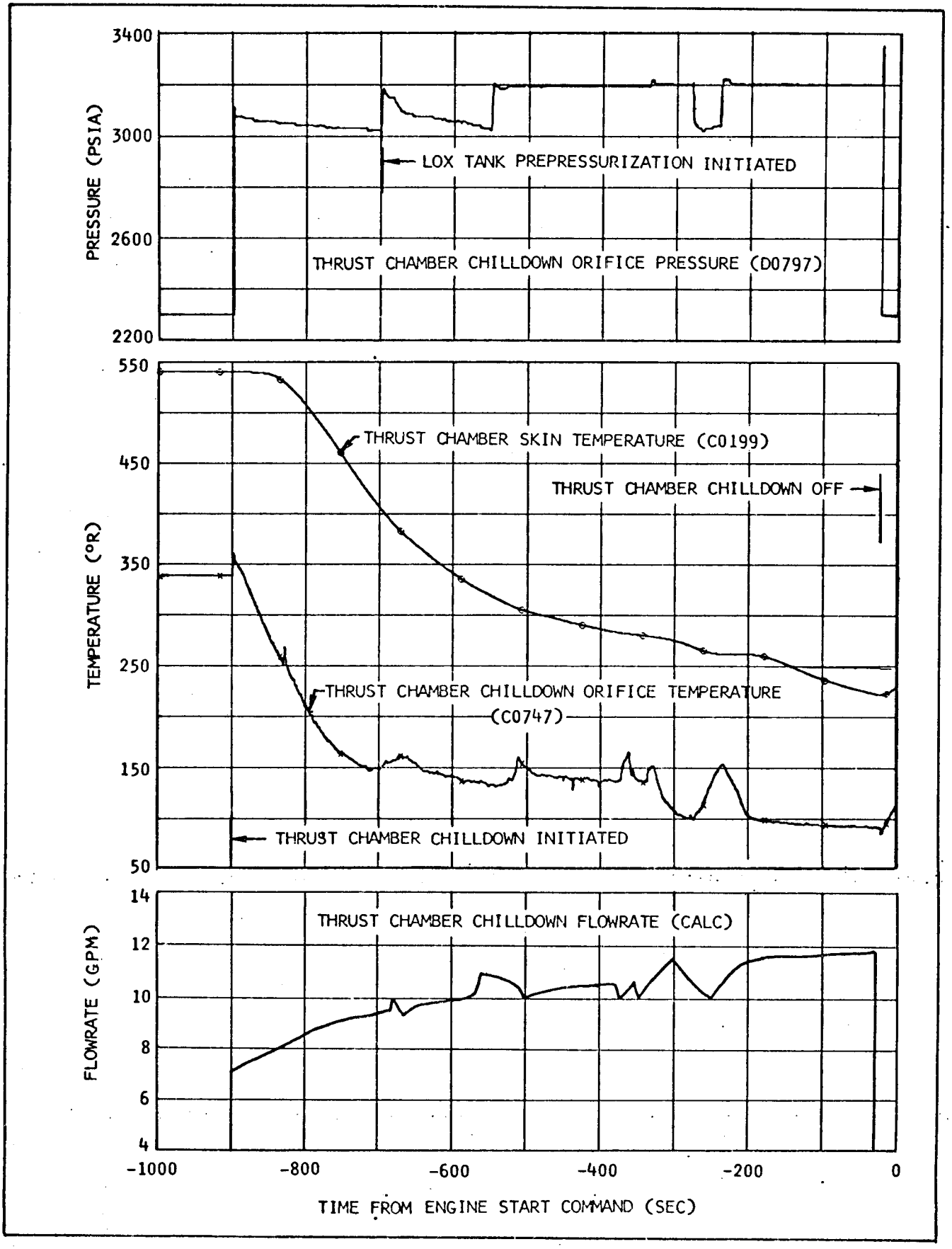


Figure 4-10. GSE Perfomance During Thrust Chamber Chilldown - 2nd Burn

23 September 1966

## 5. SEQUENCE OF EVENTS

The S-IVB-502 stage acceptance firing sequence of events is presented in table 5-I. Event times from five data sources are included in the table. These sources were S-IVB-502 stage telemetry PAM, FM/FM, PCM (CAT 42 and CAT 45 tabulations), Digital Events Recorder (CAT 57), *CAT 37 (generated from the sequence recorder) and switch selector.

The accuracies of the listed events are as follows:

| DATA SOURCE | ACCURACY |
|---|---|
| **Digital Events Recorder (CAT 57) | +0, -1 ms |
| T/M - FM/FM (worst case) | +0, -40 ms |
| T/M - PAM/FM/FM-Prime Multiplexed | +0, -9 ms |
| Submultiplexed | +0, -84 ms |
| T/M - PCM/FM/FM | |
| CAT 45-Prime "A" Multiplexed | +0, -35 ms |
| "A" Submultiplexed | +0, -335 ms |
| "B" Submultiplexed | +0, -84 ms |
| Prime "B" Multiplexed | +0, -9 ms |
| CAT 42-Discrete Bi-levels | +0, -9 ms |

*Cat 37 data was not processed for this report.
**There was 40 ms delay on Cat 57 events due to the use of an isolation relay in the circuitry.

TABLE 5-1 (Sheet 1 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| Reference Time from $*T_o$ (Simulated Liftoff) | | | | | |
| Engine Cutoff Command ON | | | | -2,114.821 | |
| Auxiliary Hydraulic Pump Flight Mode ON | -607.136 | -607.1 | | | |
| Auxiliary Hydraulic Pump Coast Mode OFF | -607.010 | -607.0 | | | |
| LOX Chilldown Pump ON | -203.785 | -203.8 | | | |
| LH2 Chilldown Pump ON | -200.660 | -200.7 | | | |
| LH2 Prevalve CLOSED | -197.041 | | | -196.955 | |
| LOX Prevalve CLOSED | -196.892 | | | -196.872 | |
| LOX Vent CLOSED | -159.397 | | | -162.151 | |
| LH2 Vent CLOSED | -111.509 | | | -111.486 | |
| LOX Replenish Cycle TERMINATE | -57.470 | | | | |
| LH2 Replenish Cycle TERMINATE | -57.411 | | | | |
| LH2 Fill and Drain Valve CLOSED | -54.636 | | | -54.575 | |
| LOX Fill and Drain Valve CLOSED | -54.785 | | | -54.742 | |
| LH2 Tank Directional Vent to FLIGHT POSITION | -25.370 | | | -25.235 | |
| Aft Bus 1 to INTERNAL | -24.995 | | | | |
| Aft Bus 2 to INTERNAL | -24.745 | | | | |
| Forward Power to INTERNAL | -24.495 | | | | |
| Cold Helium Shutoff Valve CLOSED | -4.802 | | | | |
| Cold Helium Sphere Supply OFF | -4.798 | | | | |

$*T_o$ = 14:11:13.000 range time

TABLE 5-1 (Sheet 2 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| LH2 Tank Prepressurization Supply OFF | -4.778 | | | | |
| LH2 Repressurization Supply OFF | -4.305 | | | | |
| Simulated S-IVB/V Liftoff (*$T_o$) | *±0.00 | | | | |
| Special Calibration Relay ON | | 120.1 | | | |
| Regular Calibration Relay ON | | 120.2 | | | 121.05 |
| Regular Calibration Relay OFF | | 124.8 | | | 123.228 |
| Special Calibration Relay OFF | | 124.9 | | | |
| Engine Pump Purge ON | 331.983 | 332.0 | | | |
| Engine Pump Purge OFF | 452.455 | 452.4 | | | |
| Special Calibration Relay ON | | 490.0 | | | |
| Regular Calibration Relay ON | | 490.1 | | | |
| Regular Calibration Relay OFF | | 494.8 | | | |
| Special Calibration Relay OFF | | 494.9 | | | |
| Fast Record ON | 502.303 | 502.3 | | | |
| LOX Prevalve OPEN | 510.981 | | | 511.029 | |
| LH2 Chilldown Pump OFF | 510.918 | 510.9 | | | |
| LOX Chilldown Pump OFF | ** | 510.9 | | | |
| LH2 Prevalve OPEN | ** | | | 511.279 | |
| LOX Chilldown Shutoff Valve CLOSED | ** | | | 509.053 | |
| Charge Ullage Ignition ON | ** | 508.7 | 508.72 | 511.363 | |
| LH2 Chilldown Shutoff Valve CLOSED | ** | | | 511.477 | |

*$T_o$ = 14:11:13.000 range time
**Digital event recorder timing erroneous during this period of time.

TABLE 5-1 (Sheet 3 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| Charge Ullage Ignition ON | ** | 508.7 | 508.72 | 511.363 | |
| LH2 Chilldown Shutoff Valve CLOSED | ** | | | 511.477 | |
| Fire Ullage Ignition ON | ** | 511.3 | 511.38 | 511.487 | |
| Engine Start Command (ESC) ON | ** | 511.9 | 511.00 | 511.869 | *511.859 |
| Engine Start Command OFF | ** | 512.5 | | 512.227 | |
| Cold Helium Shutoff Valve OPEN | ** | | | | |
| LOX Tank Flight Pressurization ON | ** | 513.9 | | | |
| 1st Burn Relay ON | | 514.5 | | | |
| PU Activate | 518.189 | 518.2 | | | |
| Charge Ullage Jettison 1 ON | | 526.8 | 526.81 | 530.162 | |
| Charge Ullage Jettison 2 ON | | 526.8 | 526.88 | 530.162 | |
| Fire Ullage Jettison 1 ON | | 530.1 | 530.19 | 530.261 | |
| Fire Ullage Jettison 2 ON | | 530.1 | 530.22 | 530.261 | |
| Charge Command Reset | | 533.3 | | | |
| Fire Command Reset | | 533.4 | | | |
| Range Safety Tone 2 Arm & Engine Cutoff ON | 535.259 | | | | |
| Range Safety OFF Enable | | 545.4 | | | |
| Fast Record OFF | 548.995 | 549.0 | | | |
| Auxiliary Hydraulic Pump Flight Mode OFF | 562.367 | 562.1 | | | |
| Auxiliary Hydraulic Pump Flight Mode ON | 611.437 | 611.3 | | | |
| Engine Pump Purge ON | 660.192 | 660.2 | | | |

*ESC = $T_0$ +511.859 sec
**Digital event recorder timing erroneous during this period of time.

TABLE 5-1 (Sheet 4 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| Engine Cutoff Command (ECC) ON | 665.184 | 665.2 | 665.2 | 665.202 | *665.186 |
| APS Ullage Engine ON | | 665.8 | | | |
| Cold Helium Shutoff Valve CLOSED | 665.935 | | | | |
| Coast Period ON | | 666.0 | | | |
| LOX Chilldown Pump OFF | | 666.6 | | | |
| LH2 Chilldown Pump OFF | | 666.7 | | | |
| Engine First Burn OFF | 666.117 | 666.1 | | | |
| PU Activate OFF | 666.294 | 666.3 | | | |
| LOX Tank Flight Pressurization System OFF | | 666.4 | | | |
| LH2 Prevalve CLOSED | 666.387 | | | 666.475 | |
| LOX Prevalve CLOSED | 666.549 | | | 666.558 | |
| Disarm Point Level Sensors | | 668.1 | | | |
| Charging Command Reset ON | | 669.8 | | | |
| Firing Command Reset ON | | 669.9 | | | |
| PU Boiloff Bias OFF | | 670.4 | | | |
| APS Ullage Engines OFF | | 687.9 | | | |
| Auxiliary Hydraulic Coast Mode ON | | 718.0 | | | |
| Auxiliary Hydraulic Flight Mode OFF | | 718.2 | | | |
| LH2 Continuous Vent Valves OPEN | | 755.6 | | | |
| Tape Recorder Playback ON | | 774.3 | | | |
| Tape Recorder Playback OFF | | 821.3 | | | |

*ECC = $T_o$ +665.187

TABLE 5-1 (Sheet 5 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| Slow Record ON (Timing) | 1,300.044 | 1,300.0 | | | |
| Slow Record OFF (Timing) | 1,307.159 | 1,307.2 | | | |
| Slow Record ON (Timing) | 1,307.248 | 1,307.3 | | | |
| Engine Pump Purge OFF | 1,307.353 | 1,307.4 | | | |
| Slow Record OFF | 2,345.346 | 2,345.4 | | | |
| Slow Record ON | 2,345.455 | 2,345.5 | | | |
| Slow Record Relay OFF | 2,405.403 | 2,405.4 | | | |
| LOX Replenish BEGIN | 2,635.660 | | | | |
| Playback ON | | 2,436.2 | | | |
| Playback OFF | | 2,574.9 | | | |
| LH2 Tank Vented to Ambient | 3,765.513 | | | | |
| Reference Time from $*T_2$ ($T_o$ +2,872.212 sec) | | | | | |
| LH2 Chilldown Shutoff Valve OPEN | | | | -1,500.847 | |
| LOX Prevalve OPENED | | | | -1,500.796 | |
| LH2 Prevalve OPENED | | | | -1,500.796 | |
| LOX Chilldown Shutoff Valve OPEN | | | | -1,500.772 | |
| Auxiliary Hydraulic Pump Flight Mode ON | -749.623 | -749.6 | | | |
| Auxiliary Hydraulic Pump Coast Mode OFF | -749.552 | -749.5 | | | |
| LOX Prevalve CLOSED | -744.350 | | | -744.315 | |
| LH2 Prevalve CLOSED | -744.505 | | | -744.398 | |

$*T_2$ = 15:53:05.212 range time

TABLE 5-1 (Sheet 6 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| LOX Chilldown Pump ON | -719.801 | -719.7 | | | |
| LH2 Chilldown Pump ON | -716.892 | -716.8 | | | |
| LOX Fill and Drain Valve CLOSED | -711.841 | | | -711.759 | |
| Cold Helium Sphere Supply OPEN | -700.490 | | | | |
| Cold Helium Sphere Supply CLOSED | -550.965 | | | | |
| APS Ullage Engines ON | | -323.9 | | | |
| LH2 Tank Continuous Vent Valves CLOSED | -324.975 | -324.9 | | -324.948 | |
| LH2 Tank Vent Valve CLOSED | -323.457 | | | -323.373 | |
| LH2 Tank Repressurization ON | | -323.3 | | | |
| LOX Tank Repressurization ON | -323.240 | -323.2 | | | |
| APS Ullage Engines OFF | | -314.1 | | | |
| Cold Helium Sphere Supply OPEN | -278.714 | | | | |
| Cold Helium Sphere Supply CLOSED | -240.968 | | | | |
| Engine Pump Seal Purge ON | -179.492 | -179.4 | | | |
| Engine Pump Seal Purge OFF | -59.230 | -59.2 | | | |
| LH2 Repressurization OFF | | -1.1 | | | |
| LOX Repressurization OFF | 1.043 | -1.0 | | | |
| LOX Prevalve OPEN | -0.981 | | | -0.817 | |
| LH2 Chilldown Pump OFF | -0.935 | -0.9 | | | |
| LOX Chilldown Pump OFF | -0.849 | -0.8 | | | |
| LH2 Prevalve OPEN | -0.836 | | | -0.667 | |
| Engine Cutoff OFF | -0.669 | -0.6 | | -0.564 | |
| LOX Chilldown Shutoff Valve CLOSED | -0.536 | | | -0.417 | |
| LH2 Chilldown Shutoff Valve CLOSED | -0.485 | | | -0.198 | |

TABLE 5-1 (Sheet 7 of 7)
SEQUENCE OF EVENTS

| EVENT | TIME OF OCCURRENCE (sec) | | | | |
|---|---|---|---|---|---|
| | DIGITAL EVENT RECORDER | SELECTOR SWITCH | PAM | PCM | FM/FM |
| Engine Start Command ON ($T_2$) | 0.026 | 0.0 | 0.00 | 0.004 | *0.000 |
| Coast Period OFF | | 0.4 | | | |
| Engine Start Command OFF | 0.638 | 0.7 | | 0.399 | |
| LOX Tank Flight Pressurization System ON | 0.794 | 0.8 | | | |
| 2nd Burn ON | | 2.6 | | | |
| PU Activate | 6.240 | 6.3 | | | |
| Depletion Sensors ARMED | | 286.5 | | | |
| Engine Pump Purge ON | 286.580 | 286.6 | | | |
| Engine Cutoff Command (ECC) ON | 293.611 | 293.8 | 293.7 | 293.662 | **293.665 |
| LH2 Prevalve CLOSED | 294.485 | | | 294.601 | |
| LOX Prevalve CLOSED | 294.679 | | | 294.768 | |
| Auxiliary Hydraulic Pump Coast Mode ON | | 294.8 | | | |
| Coast Period ON | | 295.0 | | | |
| 2nd Burn Relay OFF | | 295.2 | | | |
| PU Activate OFF | 295.222 | 295.3 | | | |
| LOX Flight Pressurization System OFF | | 295.4 | | | |
| Auxiliary Hydraulic Pump Flight Mode OFF | 297.376 | 297.2 | | | |
| Depletion Sensor DISARMED | | 297.3 | | | |
| Pump Purge OFF | 307.745 | | | | |
| Engine Cutoff OFF | 654.891 | | | | |
| Forward Power to EXTERNAL | 883.327 | | | | |
| Aft Bus 1 to EXTERNAL | 886.421 | | | | |
| Aft Bus 2 to EXTERNAL | 889.122 | | | | |

*$T_2$ = 15:53:05.212 range time
**ECC = $T_2$ +293.665 sec

# 6. ENGINE SYSTEM

The S-IVB-502 stage engine system (figure 6-1) consisted of a Rocketdyne liquid hydrogen/liquid oxygen rocket engine (S/N 2042) and a propellant conditioning subsystem.

The engine was received at Douglas A3 on 17 November 1965 and installed on the stage 27 January 1966. Twenty changes were made by Rocketdyne at Douglas A45 prior to the acceptance firing on 23 July 1966, but none affected the performance level of the engine. After the Douglas acceptance firing, the engine had accumulated 809.7 sec of burn time as follows:

| Testing | Burn Time (sec) |
|---|---|
| Rocketdyne (five firings - 4 October to 13 October 1965) | 362.7 |
| Douglas (acceptance firing - 28 July 1966) | |
| 1st Burn | 153.3 |
| 2nd Burn | 293.7 |
| Total | 809.7 |

The changes consisted mainly of those normally made for engine flight configuration and those designed to improve and monitor the operation of the main LOX valve. The electronic control assembly (P/N 502670) was changed prior to acceptance firing because of a defective spark excitor and transistor.

## 6.1 Engine Chilldown and Conditioning

### 6.1.1 Engine Turbopump Chilldown

Chilldown of the engine LOX and LH2 turbopumps was adequate to provide the conditions required for proper engine start on 1st and 2nd burns. An analysis of the chilldown operations is presented in paragraphs 7.3.1 and 8.3.1 for 1st burn and 7.3.2 and 8.3.2 for 2nd burn.

The start sphere refill system demonstrated the ability to recharge the start sphere to a satisfactory restart condition. By 1st ESC +70 sec the sphere was recharged to 1,190 psia from the GH2 injector tapoff and LH2 pump discharge orifice tapoff. The mass in the sphere at engine cutoff was 4.1 lbm.

At approximately 800 sec after the initiation of simulated orbital coast, the start sphere pressure increased to 1,390 psia and the start sphere relief valve opened. Continued relieving of the start sphere decreased the pressure to 1,300 psia. Meanwhile, the temperature increased to 306 deg R by 1st ECC +3,537 sec (figure 6-8). This rate of temperature increase, if projected to 2nd engine start would have resulted in a temperature that was out of the restart box (figure 6-6). An attempt was made to lower the temperature at this time by venting the start sphere to 1,190 psia. When no significant temperature decrease was noted, the sphere was vented to ambient and rechilled.

A comparison of the start sphere data for the S-IVB-501 and 502 stages is presented in the following table:

| Time | S-IVB-501 | S-IVB-502 |
|---|---|---|
| 1st ESC Temperature (°R) | 290 | 272 |
| Pressure (psia) | 1,270 | 1,325 |
| 1st ECC Temperature (°R) | 232 | 225 |
| Pressure (psia) | 1,210 | 1,240 |
| 2nd ESC Temperature (°R) | 248 | 264 |
| Pressure (psia) | 1,280 | 1,300 |
| 2nd ECC Temperature (°R) | 220 | 228 |
| Pressure (psia) | 1,240 | 1,300 |

The above data indicate a close degree of similarity between the two stages.

The heat input rate to the start sphere during the simulated coast period was normal for the prevailing ambient conditions. It would seem that restart conditions cannot be met after a 90-min simulated coast period if present 1st and 2nd burn start requirements are maintained. The present procedure of venting and rechilling the start sphere during the simulated coast will probably be required during future S-IVB/V acceptance firings.

### 6.1.2 Thrust Chamber Chilldown

The engine thrust chamber was satisfactorily chilled down to 215 deg R at 1st burn Engine Start Command (ESC) and 228 deg R on 2nd burn ESC. The thrust chamber skin temperature histories during both chilldown operations are shown in figures 6-2 and 6-3. These temperature traces show the usual interruptions caused by cycling of the cold helium crossover valve and by LH2 and LOX tank prepressurization.

The LH2 pump performance was satisfactory during the start transients of both 1st and 2nd burn with no indication of stall (figures 6-4 and 6-5). Further information on the chilldown operation and GSE supply system is presented in paragraph 4.4.

#### 6.1.2.1 First Burn

Thrust chamber chilldown was initiated at 405 sec prior to simulated liftoff (SLO). The thrust chamber skin temperature (C0199) at chilldown initiation was 535 deg R (figure 6-2). At thrust chamber chilldown termination (SLO +488.9 sec) the temperature was 208 deg R, increasing to 214 deg R at 1st burn engine start. This temperature was within the start requirement of 260 $\pm$50 deg R.

#### 6.1.2.2 Second Burn

The skin temperature returned to ambient at 1st burn engine cutoff, and remained there until chilldown initiation at 900 sec prior to 2nd burn (figure 6-3). The skin temperature was 218 deg R at the end of 2nd burn chilldown (2nd ESC -23 sec), and increased to 227 deg R by 2nd ESC. This was within the required temperature range for restart.

### 6.1.3 Engine Start Sphere Chilldown and Loading

The chilldown and loading of the engine start sphere adequately met the objective of cooling the sphere to 290 $\pm$30 deg R and loading it with GH2 to 1,325 $\pm$75 psia at 1st ESC (figure 6-6). The warmup rate after the sphere was pressurized, and until start sphere blowdown, was 2.15 deg/min, resulting in a temperature and pressure at 1st engine start of 272 deg R and 1,325 psia, respectively (figure 6-7). The GH2 mass in the sphere at this time was 3.60 lbm, of which 3.0 lbm were used during first start sphere blowdown.

After the start sphere had been vented, the same procedure established for the 1st burn terminal count was used to rechill and reload the sphere for 2nd start. At 2nd ESC -770 sec, the start sphere vent valve was commanded closed by the computer, and the sphere pressure increased from 1,100 psia to 1,160 psia (figure 6-9).

Because of heat transfer, the sphere self-pressurized to 1,300 psia by 2nd engine start. The sphere temperature at this time was 262 deg R which was within the 2nd burn start region (figure 6-6). During 2nd burn engine firing, the sphere was recharged again to a restart condition. The GH2 supply system performance during start sphere chilldown and loading for 1st and 2nd burns is described in section 4.

### 6.1.4 Engine Control Sphere Chilldown and Loading

The engine control sphere conditioning was adequate to meet the objective of cooling the sphere to 290 ±30 deg R and pressurizing it to 3,000 ±200 psia. At 1st burn engine start, the pressure was 3,345 psia and the temperature was 289 deg R giving a helium mass of 2.09 lbm (figure 6-7), of which 0.18 lbm were required at engine start and an additional 0.06 lbm during the firing. For the 2nd burn, 0.16 lbm were required at engine start and an additional 0.11 lbm during the firing.

The indicated helium usage during engine firing has varied significantly from stage to stage. This is explained by the differences in the LOX turbopump intermediate seal cavity purge orifice. Although the purge requirements of 2,600 to 7,000 scim have been met, the orifices are calibrated to allow the flowrate to be anywhere within these limits, and the difference between 2,600 and 7,000 scim can cause a variation of 0.3 lbm of helium usage during engine burn.

The warmup data from the control sphere are not available for the entire simulated orbital coast since the start sphere was vented and rechilled prior to 2nd engine start. Extrapolation of available data (figure 6-8) for a 90-min simulated orbital coast indicates a pressure of 3,570 psia with a temperature of 360 deg R. These conditions do not exceed the structural limitations of the sphere. There was little or no leakage during the orbital coast as verified from mass calculations after 1st engine cutoff and prior to 2nd engine start.

During initiation of 2nd burn start sphere chilldown, the pressure in the control sphere increased (figure 6-9) because of heat transfer from the relatively warmer GH2 entering the start sphere during the first 14 sec of chilldown; however, as noted, the control sphere temperature started to decrease and it was not necessary to vent the control sphere. The conditions in the sphere at 2nd engine start were 2,750 psia, 275 deg R, and 1,87 lbm. At the end of 2nd burn, the remaining mass in the sphere was 1.56 lbm.

The total helium consumption for 1st burn, coast, and 2nd burn, was 0.53 lbm.

## 6.2 J-2 Engine Performance

Engine performance was calculated by use of computer programs AA89, G105-3, and F823. These programs use various measurements and predetermined correlations to reconstruct the test, giving performance parameters and their profiles. A description of the operation and a comparison of the results of each program is presented in table 6-1.

The F823 and G105-3 programs had been modified to include LH2 and LOX boiloff rates and LH2 pressurization flowrates in the propellant depletion rates. Another modification was made so that the thrust coefficient ($C_f$) used in both G105-3 and F823 was calculated by correcting the theoretical $C_f$ with an efficiency factor instead of the linear bias previously used. The efficiency factor is calculated as a function of thrust chamber mixture ratio, using reference values taken from the engine log book. This method will be used on all future acceptance firing evaluations.

A 15-psi negative bias was applied to the combustion chamber pressure measurement in G105-3 and F823 to compensate for the instrument probe purge on this measurement. In addition to the chamber pressure bias, G105-3 had flowmeter biases as follows: On 1st burn, LOX flowrate was biased -9.5 gpm and LH2 flowrate was biased -18.84 gpm; while on 2nd burn, LOX flowrate was biased -8.14 gpm and LH2 flowrate was biased -19.38 gpm. These flowrate biases were based upon a pip count analysis of raw test data.

### 6.2.1 First Burn

Program mixture ratio produced a high mixture ratio engine operation during the 1st burn, as planned. First burn was terminated at a predetermined time of approximately 153 sec. The average performance between the time of 90 percent thrust and cutoff was 424.02 sec of specific impulse at a thrust level of 229,585 lbf and a mixture ratio of 5.433. A total impulse of 34.38 x $10^6$ lbf-sec was produced between engine start and engine cutoff command.

### 6.2.2 Second Burn

The 2nd burn was initiated after the simulation of a three-orbit coast was completed with LH2 boiloff of 3,150 lbm (paragraph 8.2.5). Average performance from the time of 90 percent thrust to engine cutoff command was 427.09 sec of specific impulse at a thrust level of 212,447 lbf and a mixture ratio of 5.135.

### 6.2.3 Engine Analysis

#### 6.2.3.1 Start Transient (1st Burn)

The J-2 engine start transient was satisfactory. The LH2 lead (from engine start to start tank discharge valve open) was 0.902 sec. The thrust buildup to the 90 percent mainstage level (thrust chamber pressure at 618 psia) occurred at ESC +3.564 sec. Figure 6-10 shows the thrust chamber pressure during the start transient and the thrust buildup to the 90 percent main stage level as determined by computer program F839. The impulse developed to the 90-percent-mainstage-thrust level was 202,543 lbf-sec, as compared to the log book value of 153,500 lbf-sec. The maximum observed rate of thrust increase during the start transient was 6,470 lbf/10 ms which occurred at approximately ESC +1.10 sec. This is within the maximum design limit of 40,000 lbf/10 ms. There was no thrust overshoot during the start transient. Figure 6-11 presents the start transients of several engine parameters.

Conditions at the LOX pump outlet were 14.9 deg subcooled at engine start, which was well above the minimum Rocketdyne recommendation of 3 deg.

6.2.3.2 Start Transient (2nd Burn)

The J-2 engine start transient was satisfactory. The LH2 lead was 0.912 sec. Thrust buildup to the 90 percent mainstage level occurred at ESC +3.133 sec. Figure 6-12 shows the thrust chamber pressure during the start transient and the thrust buildup to the 90 percent mainstage level as determined by program F839. The impulse developed until the 90 percent mainstage level was 160,785 lbf-sec, as compared to the log book value of 153,500 lbf-sec. The maximum observed rate of thrust increase during the start transient was 5,735 lbf/10 ms which occurred at approximately ESC +1.6 sec. This was within the maximum design limitation of 40,000 lbf/10 ms. There was no thrust overshoot during the start transient. Figure 6-13 presents the start transients of several engine parameters. Conditions at the LOX pump outlet were 13.7 deg subcooled at engine start, which was well above the minimum Rocketdyne recommendation of 3 deg.

6.2.3.3 Steady-State Performance (1st Burn)

The J-2 engine performance was satisfactory throughout the 1st burn. The propellant loads were such that when the PU system was activated at ESC +6.854 sec, the PU valve moved to the closed position and remained there for the duration of the 1st burn as planned. This mode of operation was required in order to demonstrate ability to recharge the engine start sphere in flight (paragraph 6.1.3). Plots of selected data used as inputs to the engine performance computer programs are presented in figure 6-14 through 6-18.

In the closed position, the PU valve causes the engine to operate at the high mixture ratio with correspondingly high thrust. The chamber pressure was 99 percent restabilized due to PU activation at ESC +15 sec and from that time until cutoff (ESC +153.322 sec), the average engine thrust was 230,479 lbf. The average specific impulse and mixture ratio over the same time period were 423.92 sec and 5.456, respectively. These values agreed with the prediction within 0.07 percent for thrust, 0.02 percent for specific impulse, and 1.9 percent for mixture ratio. A summary of

the overall 1st burn average performance from 90 percent thrust to cutoff is shown in the following table:

| Parameter | Value | Predicted | % Deviation |
|---|---|---|---|
| Thrust (lbf) | 229,585 | 229,096 | 0.21 |
| Total Flow (lbm/sec) | 541.47 | 540.34 | 0.21 |
| Mixture Ratio | 5.433 | 5.528 | 1.7 |
| Specific Impulse (sec) | 424.02 | 424.0 | 0.005 |
| Total Impulse (lbf-sec) | $34.38 \times 10^6$ | $34.36 \times 10^6$ | 0.08 |

All values mentioned in this paragraph can be described as site performance with altitude thrust. Plots of the performance are shown in figure 6-19.

Thrust oscillations during 1st burn are presented in table 6-2. Time period is reported for the PU fully closed operation. The magnitudes and rates of thrust oscillations are within acceptable limits for all values. The maximum deviation between predicted and actual thrust level during first burn was a maximum of 1,000 lbf thrust.

6.2.3.4 Steady-State Performance (2nd Burn)

The propellant loads after the orbital coast simulation were such that at PU activate (ESC +6.296 sec) the PU valve went to the closed position, as planned, and remained there until ESC +75 sec. At this time the load error signal was reduced to the minimum necessary to hold the valve closed and the valve returned to null position at ESC +122 sec; thereafter, it operated within 4 deg of the null position as predicted. It was predicted that the valve would remain in the closed position until ESC +85 sec and then return to the null at approximately ESC +145 sec; however, the flight PU activate time (ESC +11.4 sec) was used for the prediction displacing the predicted curve +5.1 sec; therefore, the true deviation between the actual and the predicted was 4.9 sec. This deviation is well within the accuracy limits of the present technique of predicting the acceptance PU valve profile. The accurate cutback time is supported by very close agreement of flow integral and indicated loads.

The J-2 engine performance was very satisfactory during the 2nd burn. The performance level while the PU valve was closed showed practically no deviation from the 1st burn performance. During this period the average performance values were 230,787 lbf thrust, 5.532 mixture ratio and 424.17 sec specific impulse. After the cutback the average performance level to cutoff was 204,336 lbf thrust, 4.986 mixture ratio, and 428.36 sec specific impulse. Plots of selected data used as inputs to the engine performance computer programs are presented in figures 6-20 through 6-24. The overall 2nd burn performance level from 90 percent thrust to cutoff (ESC +293.666) as compared to the predicted is shown in the following table:

| Parameter | Value | Predicted | % Deviation |
|---|---|---|---|
| Thrust (lbf) | 212,447 | 214,085 | 0.7 |
| Total Flow (lb/sec) | 497.58 | 501.66 | 0.8 |
| Mixture Ratio | 5.135 | 5.22 | 1.6 |
| Specific Impulse (sec) | 427.09 | 426.89 | 0.05 |
| Total Impulse (lb-sec) | $61,72 \times 10^6$ | $62.79 \times 10^6$ | 1.0 |

The above values are site performance at altitude thrust. Plots of the performance profile can be seen in figure 6-25.

The 2nd burn was terminated by an observed LH2 NPSH cutoff. Data near cutoff indicated an impending LH2 depletion. An analysis of this undesirable situation revealed that, as the LH2 level neared the suction duct entrance, the temperature of the LH2 in the duct became appreciably higher than the temperature of the remaining bulk. The higher vapor pressure associated with the high inlet temperature reduced the NPSH at such a rapid rate that the LH2 NPSH had decreased below the minimum allowed (6 psi) before cutoff could be initiated (paragraph 8.4.2). The effect of the NPSH dropoff on the LH2 turbopump was the same as an LH2 depletion in that the pump speed inlet temperature increased rapidly. As the LH2 flowrate decreased, the mixture ratio increased in both the thrust chamber and gas generator, causing high flame temperatures. The redline values

applicable in this case are a pump overspeed of 28,400 rpm and a GG temperature of 1,885 deg R; however, LH2 pump speed and GG temperature, as indicated by the LH2 turbine inlet temperature, were below these limits at engine cutoff (26,600 rpm and 1,652 deg R).

Thrust oscillations during 2nd burn are shown in table 6-2. Time periods are reported for the PU fully closed operation, PU valve cutback +50 sec to ECC -70 sec, and ECC -70 sec to engine cutoff. The magnitude and rates of thrust oscillations are within acceptable limits for all values except for the mean slope and maximum rate of change during the last 70 sec of burn. Deviations from predictions in mean slope and maximum rate were due primarily to variations in stage inlet conditions effects and differences between actual and predicted PU valve movement (paragraphs 6.4.10 and 11.6). The primary stage system effect other than PU system effect on thrust oscillation deviation in rate and amplitude was due to the effect of the variation in helium pressurant flowrate to the LOX tank. The influence of helium pressurant on engine performance was not available at the time predictions were generated for this acceptance firing.

The maximum deviation between predicted and actual thrust level during the hard over portion of 2nd burn was a maximum of 1,000 lbf thrust. The maximum deviation during the active PU portion of the burn, disregarding the cutback transient period, was a maximum of 3,000 lbf thrust.

6.2.3.5 Cutoff Transient (1st Burn)

The time lapse between engine cutoff signal received at the J-2 engine and the thrust decay to 11,250 lbf was 780 ms, which is within the allowable limit of 800 ms as specified by the engine data log book. The cutoff impulse was 58,330 lbf-sec* (figure 6-26) which was slightly greater than the 43,400 ±6,780 lbf-sec value specified in the Rocketdyne Manual R-3885-1 for cutoff impulse with the PU valve at the full closed position (high EMR).

*It should be noted that cutoff impulse as calculated by measured chamber pressure is suspected to be lagging up to 40 ms thereby making the calculated impulse higher than actual. This problem has not been resolved and is under study by the engine manufacturer.

The increased cutoff impulse was due partly to the increased main LOX valve closing time (paragraph 6.4.2). Figure 6-27 presents the thrust chamber pressure data for the cutoff transient and the cutoff thrust to the zero lbf thrust level as computed by program F839.

6.2.3.6 Cutoff Transient (2nd Burn)

The time lapse between engine cutoff signal received at the J-2 engine and the thrust decay to 11,250 lbf was 705 ms, which was within the allowable limit of 800 ms as specified in the engine data log. The cutoff impulse was 49,405 lbf-sec* (figure 6-26) which was slightly greater than the 38,400 ±6,000 lbf-sec value specified in the Rocketdyne Manual R-3825-1 for cutoff impulse with the PU valve at the null position. The increased cutoff impulse was a result of the increased main LOX valve closing time (paragraph 6.4.2). Figure 6-28 presents the combustion chamber pressure data for the cutoff transient and the cutoff thrust to the zero lbf thrust level as computed by program F839. It is noted that the cutoff signal was initiated by observer action when the LH2 NPSH value decreased below the minimum allowable limit (paragraph 8.4.2).

## 6.3 Engine Sequence

The J-2 engine start and cutoff were satisfactory for 1st and 2nd burns. All events occurred on a schedule that was compatible with the engine logic and, with the exception of main LOX valve OPEN during 2nd burn start and main LOX valve CLOSED during 1st and 2nd burn cutoffs, fell within tolerance limits as shown in table 6-3 and figures 6-11 and 6-13. The main LOX valve opened slower during 2nd burn than during 1st burn (paragraphs 6.4.1 and 8.6.4.2). Since the environmental temperature was approximately the same for both burns, the slower main LOX valve time apparently was not caused by a lower valve temperature during 2nd burn start. The LOX pump discharge pressure, however, was higher during 2nd burn start transient (figures 6-11 and 6-13), a condition which can result

*It should be noted that cutoff impulse as calculated by measured chamber pressure is suspected to be lagging up to 40 ms thereby making the calculated impulse higher than actual. This problem has not been resolved and is under study by the engine manufacturer.

in a slower main LOX valve opening time. This condition was also present during S-IVB-501 acceptance firing 2nd burn start and may be the result of higher start tank energy levels during 2nd burn starts than during 1st burn starts.

Hardware changes were made which updated the engine to the current production configuration as closely as possible. Three changes affected either the start or cutoff transients.

a. An orifice was installed in the gas generator valve to cause a delay in the rise in LOX pump discharge pressure. This change resulted in LOX valve opening times comparable to those recorded for the S-IVB-501 stage, which also had the gas generator orifice change.

b. A temperature compensating (thermostatic) orifice was installed in the main LOX valve second stage control cylinder to provide a shorter main LOX valve opening time under cold environmental conditions. This orifice may also have resulted in the slow main LOX valve closing times during S-IVB-502 acceptance firing 1st and 2nd burn cutoffs.

c. A rapid shutdown valve was installed to provide fast venting of the gas generator valve actuation cylinder, which in turn causes a rapid closure of the gas generator valve. This resulted in the reduction of gas generator flowrates prior to the closing of the main LOX valve and thus decreases the possibility of a high mixture ratio in the gas generator at cutoff.

## 6.4 Component Operation

### 6.4.1 Main LOX Valve (1st Burn)

During 1st burn, the main LOX valve performed adequately and met nominal opening time specifications for a 70 deg F dry valve (table 6-4). Total closing time was approximately 30 ms longer than specified but did not contribute to any significant reduction in cutoff transient performance.

### 6.4.2 Main LOX Valve (2nd Burn)

The main LOX valve (MOV) 1st stage travel and plateau times during valve opening were acceptable but 2nd stage travel opening time exceeded the nominal time specification for a 70 deg F dry valve by approximately 150 ms (table 6-4). The MOV total opening time was longer than expected because more time was required to develop sufficient actuator pressure to move the valve at a time when LOX pump discharge pressure was higher than expected (paragraph 6.3 and figure 6-13). Total closing time for 2nd burn was within specification.

### 6.4.3 LH2 Pump (1st Burn)

Both LH2 pump inlet and outlet histories were nominal and pump performance was considered satisfactory. The temperature differential across the pump was essentially constant. LH2 pump discharge pressure responded to normal system fluctuations. LH2 pump speed was satisfactory and agreed within 40 rpm of predicted (paragraph 6.1.2). Figure 6-4 illustrates the discharge pressure vs discharge flow relationship during critical stall period.

### 6.4.4 LH2 Pump (2nd Burn)

LH2 pump performance during 2nd burn was satisfactory. LH2 pump speed, pressures, and temperatures responded to PU system cutback and normal stage inlet conditions and perturbations (paragraph 6.1.2). Figure 6-5 illustrates the discharge flow relationship during critical stall periods.

It should be noted that 2nd burn was terminated by an observer cutoff due to an expected minimum NPSH condition at the LH2 pump inlet.

### 6.4.5 LOX Pump (1st Burn)

LOX pump performance was satisfactory during 1st burn. Pump speed was approximately 70 rpm lower than predicted. Temperature differential across the pump was constant.

### 6.4.6 LOX Pump (2nd Burn)

LOX pump performance was satisfactory for 2nd burn with the exception that LOX pump discharge pressure during start was higher than expected. This delayed main LOX valve opening (paragraph 6.3 and figure 6-13). LOX pump speed, pressures, and temperatures responded to PU system cutback and perturbations.

### 6.4.7 Turbines (1st Burn)

Performance of both LOX and LH2 turbines was satisfactory. No temperature spikes of LH2 turbine inlet temperature (GG chamber temperature) occurred during engine start or cutoff. Temperature and pressure drops across both turbines exhibited nominal values.

### 6.4.8 Turbines (2nd Burn)

During 2nd burn both LOX and LH2 turbines exhibited nominal expected performance. Pressures and temperatures for both turbines responded as expected to PU system cutback and perturbations. No unsatisfactory temperature spikes of LH2 turbine inlet temperature occurred during engine start or cutoff.

### 6.4.9 PU Valve (1st Burn)

During 1st burn, the PU valve was in the high EMR position, and performance was considered to be satisfactory. The PU valve inlet and outlet pressures reflected normal variations in the LOX pump inlet and discharge pressure. Pressure drop across the PU valve during 1st burn was essentially constant due to the fixed PU valve position.

### 6.4.10 PU Valve (2nd Burn)

PU valve performance was satisfactory during 2nd burn. After PU valve cutback, the pressure drop across the valve did not remain constant and a maximum $\Delta P$ of 672 psi occurred. During PU system activation, PU valve inlet pressure (which is slightly lower than LOX pump discharge pressure) responded more severely to PU valve travel than the PU valve outlet pressure. The dampening effect of the PU valve resistance and associated lines account

for the PU valve outlet pressure response characteristics. The time at which PU valve cutback occurred (ESC +75 sec) did not agree with the predicted time of ESC +85 sec due to propellant loading error, PU system nonlinearities and calibration effects (section 11).

### 6.4.11 Gas Generator (1st Burn)

First burn gas generator (GG) performance was adequate; however, the total opening time of the gas generator valve exceeded the maximum recommended by approximately 40 ms, whereas total closing time was within specifications. GG chamber pressure responded to small changes in LH2 and LOX pump discharge pressures. Total GG flowrate during 1st burn was essentially constant (figure 6-29).

### 6.4.12 Gas Generator (2nd Burn)

During 2nd burn, gas generator chamber pressure and total flowrate (figure 6-30) responded to PU system cutback and perturbations. Gas generator overall performance was adequate during 2nd burn but once again total opening time of the gas generator valve was longer than expected. The recommended total opening time was exceeded by approximately 50 ms; total closing time was satisfactory.

TABLE 6-1
COMPARISON OF COMPUTER PROGRAM RESULTS

| PROGRAM | INPUT | METHOD | RESULTS | | |
|---|---|---|---|---|---|
| | | | 1ST BURN | 2ND BURN | UNITS |
| AA89 | LOX and LH2 pump inlet pressures and temperatures, PU valve position, and engine tag values | Influence equations relate nominal inlet conditions to nominal performance. Using actual inlet conditions, PU valve position and engine tag values, the actual performance is simulated. | $F$ = 230444<br>$\dot{W}_T$ = 543.52<br>$I_{sp}$ = 423.98<br>MR = 5.531 | 212049<br>496.05<br>427.61<br>5.147 | lbf<br>lbm/sec<br>sec<br>sec |
| G105 Mode 3 | LOX and LH2 flowmeters, pump discharge pressures and temperatures, chamber pressures, chamber thrust area | Flowrates are computed from flowmeter data and propellant densities. The $C_F$ is determined from equation $C_F = f\ (P_c, MR)$ and thrust is calculated from equation $F = C_F\ A_t\ P_c$. | $F$ = 229265<br>$\dot{W}_T$ = 540.54<br>$I_{sp}$ = 424.19<br>MR = 5.410 | 212578<br>497.55<br>427.39<br>5.104 | lbf<br>lbm/sec<br>sec<br>sec |
| F823 Mode 1 | Thrust chamber pressure, gas generator pressure, LH2 injection temperature, LH2 pump discharge temperature, LH2 turbine inlet temperature | Total flows of the thrust chamber and gas generator are calculated as a function of respective chamber pressures. Mixture ratio of the chamber is calculated as a function of temperature rise of the LH2 in the cooling jacket, and mixture ratio of the GG is calculated as a function of turbine inlet temperature. Thrust is calculated from the equation $F - C_F A_t\ P_c$. | $F$ = 229047<br>$\dot{W}_T$ = 540.35<br>$I_{sp}$ = 423.9<br>MR = 5.358 | 212715<br>499.12<br>426.26<br>5.154 | lbf<br>lbm/sec<br>sec<br>sec |
| F839 | Thrust chamber pressure, chamber throat area | The $C_F$ is computed from equation $C_F =\ \ (P_c)$ and thrust is computed from equation $F = C_F\ A_t\ P_c$. The impulse is determined from integrated thrust. | Refer to paragraph 6.2 | | |

TABLE 6-2
THRUST OSCILLATIONS

| BURN | MEAN SLOPE (lbf/sec) | | | | MAXIMUM RATE (lbf/sec) | | | MAXIMUM AMPLITUDE (0 - peak) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TIME PERIOD | ACTUAL | PREDICTED | ACCEPTABLE | ACTUAL | PREDICTED | ACCEPTABLE | ACTUAL | PREDICTED | ACCEPTABLE |
| 1st | PU fully closed | 0 | 0 | -- | 145 | 20 | 500 | 775 | 200 | 2,500 |
| | PU fully closed | 0 | 0 | -- | 17 | 20 | 500 | 125 | 360 | 2,500 |
| | PU valve cutback +50 sec to ECC -70 sec | 85 | 70 | -- | 450 | 190 | 500 | 2,500 | 1,000 | 7,500 |
| 2nd | ECC -70 sec to engine cutoff | 100 | 55 | 44 | 450 | 170 | 354 | 1,000 | 1,000 | 1,000 |

TABLE 6-3 (Sheet 1 of 5)
ENGINE SEQUENCE

| CONTROL EVENTS | | CONTINGENT EVENTS | | SPECIFIED AND NOMINAL TIMES | ACTUAL RESPONSE TIME (ms) | |
|---|---|---|---|---|---|---|
| MEAS NO. | EVENT AND COMMENT | MEAS NO. | EVENT AND COMMENT | | 1ST BURN | 2ND BURN |
| K0021 | *Engine Start Command P/U | | | 0 | 0 | 0 |
| | | K0007 | Helium Control Solenoid Enrg P/U | Within 10 ms of K0021 | 0 | 0 |
| | | K0010 | Thrust Chamber Spark on P/U | Within 10 ms of K0021 | 0 | 0 |
| | | K0011 | Gas Generator Spark on P/U | Within 10 ms of K0021 | 0 | 0 |
| | | K0006 | Ignition Phase Control Solenoid Enrg P/U | Within 20 ms of K0021 | N/A | 2 |
| | | K0012 | Engine Ready D/O | Within 20 ms of K0006 | 0 | 0 |
| | | K0126 | LOX Bleed Valve Closed P/U | Within 130 ms of K0007 | N/A | 42 |
| | | K0127 | LH2 Bleed Valve Closed P/U | Within 130 ms of K0007 | N/A | 33 |
| | | K0020 | ASI LOX Valve Open P/U | Within 20 ms of K0006 | N/A | 11 |
| | | K0119 | Main LH2 Valve Closed D/O | 60 ±30 ms from K0006 | 58 | 49 |
| | | K0118 | Main LH2 Valve Open P/U | 80 ±50 ms from K0119 | 111 | 112 |
| K0008 | **Ignition Detected | | | Within 250 ms of K0021 P/U | 159 | 179 |
| K0021 | ***Engine Start Command D/O | | | Approx 500 ms from K0021 P/U | 351 | 418 |

* Engine ready and stage separation signals (or simulation) are required before this command will be executed. This command also actuates a 640 ±30 ms timer which controls energizing of the start tank discharge solenoid N0010 (K0096).

** This signal must be received within 1,110 ±60 ms of K0021 P/U or cutoff will be initiated.

*** This signal drops out after a time sufficient to lock in the engine electrical.

D/O = Dropout P/U = Pickup N/A = Not Available

TABLE 6-3 (Sheet 2 of 5)
ENGINE SEQUENCE

| CONTROL EVENTS | | CONTINGENT EVENTS | | SPECIFIED AND NOMINAL TIMES | ACTUAL RESPONSE TIMES (ms) | |
|---|---|---|---|---|---|---|
| MEAS NO. | EVENT AND COMMENT | MEAS NO. | EVENT AND COMMENT | | 1ST BURN | 2ND BURN |
| K0096 | *Start Tank Disc Control Solenoid Enrg | | | 640 ±30 ms from K0021 | 629 | 629 |
| | | K0123 | Start Tank Disc Valve Closed D/O | 100 ±20 ms from K0096 | 770 | 779 |
| | | K0122 | Start Tank Disc Valve Open P/U | 100 ±20 ms from K0123 | 902 | 912 |
| K0005 | Mainstage Control Solenoid Enrg | | | 450 ±30 ms from K0096 | 1,080 | 1,079 |
| | | K0096 | Start Tank Disc Control Solenoid Enrg D/O | 450 ±30 ms from K0096 | 1,080 | 1,079 |
| | | K0121 | Main LOX Valve Closed D/O | 60 ±20 ms from K0005 | 1,128 | 1,138 |
| | | K0116 | Gas Generator Valve Closed D/O | 85 ±25 ms from K0005 | 1,159 | 1,159 |
| | | K0122 | Start Tank Disc Valve Open D/O | 95 ±20 ms from K0096 | 1,178 | 1,186 |
| | | K0117 | Gas Generator Valve Open P/U | 105 ±45 ms from K0116 | 1,340 | 1,350 |
| | | K0124 | LOX Turbine Bypass Valve Open D/O | Within 100 ms of K0121 | 1,260 | 1,272 |
| | | | LOX Turbine Bypass Valve 80% Closed | 400 $^{+150}_{-50}$ ms from K0122 | 1,516 | 1,521 |

* An indication of LH2 injection temperature of -150 ±40 deg F (or simulation) is required before this command will be executed. This command also actuates a 450 ±30 ms timer which controls the start of mainstage.

D/O = Dropout
P/U = Pickup

TABLE 6-3 (Sheet 3 of 5)
ENGINE SEQUENCE

| CONTROL EVENTS | | CONTINGENT EVENTS | | SPECIFIED AND NOMINAL TIMES | ACTUAL RESPONSE TIMES (ms) | |
|---|---|---|---|---|---|---|
| MEAS NO. | EVENT AND COMMENT | MEAS NO. | EVENT AND COMMENT | | 1ST BURN | 2ND BURN |
| | | K0123 | Start Tank Disc Valve Closed P/U | 250 ±40 ms from K0122 | 1,458 | 1,440 |
| | | K0125 | *LOX Turbine Bypass Valve Closed P/U | | 1,580 | 1,573 |
| K0158 | Mainstage Press. Switch No. 1 Depress. D/O | | | | 2,858 | 2,550 |
| K0159 | Mainstage Press. Switch No. 2 Depress. D/O | | | | 2,858 | 2,550 |
| K0191 | **Mainstage OK | | | | | |
| | | K0120 | Main LOX Valve Open P/U | 2415 ±240 ms from K0005 | 2,860<br>3,609 | 2,585<br>3,868 |
| | | K0010 | Thrust Chamber Spark on D/O | 4390 ±260 ms from K0010 P/U | 4,377 | 4,393 |
| | | K0011 | Gas Generator Spark on D/O | 4390 ±260 ms from K0011 P/U | 4,378 | 4,394 |
| K0507 CSS-22 | PU Activate Switch P/U | | | | 6,854 | 6,296 |
| K0013 | Engine Cutoff PU (New time reference) | | | 0 | 0 | 0 |
| | | K0005 | Mainstage Control Solenoid Enrg D/O | Within 10 ms of K0013 | 19 | 18 |
| | | K0006 | Ignition Phase Control Solenoid Enrg D/O | Within 10 ms of K0013 | 18 | 18 |

* Within 5,000 ms of K0005 (Normally = 500 ms)
** One of these signals must be received within 4,410 ±260 ms from K0021 P/U, or cutoff will be initiated. Signal occurs when LOX injection pressure is 500 ±30 psig.
D/O = Dropout
P/U = Pickup

TABLE 6-3 (Sheet 4 of 5)
ENGINE SEQUENCE

| CONTROL EVENTS | | CONTINGENT EVENTS | | SPECIFIED AND NOMINAL TIMES | ACTUAL RESPONSE TIMES (ms) | |
|---|---|---|---|---|---|---|
| MEAS NO. | EVENT AND COMMENTS | MEAS NO. | EVENT AND COMMENT | | 1ST BURN | 2ND BURN |
| | | K0020 | ASI LOX Valve Open D/O | | 16 | 17 |
| | | K0120 | Main LOX Valve Open D/O | 60 ±15 ms from K0005 | 77 | 77 |
| | | K0117 | Gas Generator Valve Open D/O | 75 +25, -35 ms from K0006 | 67 | 79 |
| | | K0118 | Main LH2 Valve Open D/O | 90 ±25 ms from K0006 | 97 | 92 |
| | | K0121 | Main LOX Valve Closed P/U | 120 ±15 ms from K0120 | 278 | 242 |
| | | K0116 | Gas Generator Valve Closed P/U | 500 ms from K0006 | 187 | 185 |
| | | K0119 | Main LH2 Valve Closed P/U | 225 ±25 ms from K0118 | 406 | 362 |
| K0158 | *Mainstage Press switch A, Depress P/U | | | | 187 | 116 |
| K0159 | Mainstage Press Switch B, Depress P/U | | | | 187 | 115 |
| K0191 | Mainstage OK D/O | | | | 210 | 184 |
| K0007 | Helium Control Solenoid Enrg D/O | | | 1000 ±110 ms from K0013 | 998 | 994 |
| SS-22 K0507 | PU Activate Switch D/O | | | | 1,106 | 1,606 |

* Signal drops out when pressure reaches 425 ±25 psig.
D/O = Dropout
P/U = Pickup

TABLE 6-3 (Sheet 5 of 5)
ENGINE SEQUENCE

| CONTROL EVENTS | | CONTINGENT EVENTS | | SPECIFIED AND NOMINAL TIMES | ACTUAL RESPONSE TIMES (ms) | |
|---|---|---|---|---|---|---|
| MEAS NO. | EVENT AND COMMENTS | MEAS NO. | EVENT AND COMMENT | | 1ST BURN | 2ND BURN |
| | | K0125 | LOX Turbine Bypass Valve Closed D/O | | 218 | 214 |
| | | K0124 | LOX Turbine Bypass Valve Valve Open P/U | 10,000 ms from K0005 | 843 | 822 |
| K0126 | LOX Bleed Valve Closed D/O | | | | 2,863 | 2,880 |
| K0127 | LH2 Bleed Valve Closed D/O | | | | 3,007 | 2,756 |

TABLE 6-4
MAIN LOX VALVE OPENING TIMES

| SECTION | *NOMINAL TIME (ms) | 1st BURN (ms) | DEVIATION FROM NOMINAL (ms) | 2nd BURN (ms) | DEVIATION FROM NOMINAL (ms) |
|---|---|---|---|---|---|
| First Stage Travel | 50 ±25 | 60 | 10 | 70 | 20 |
| First Stage Plateau | 480 ±120 | 540 | 60 | 570 | 90 |
| Second Stage Travel | 1,825 ±75 | 1,890 | 65 | 2,110 | 225 |
| Total | 2,855 ±220 | 2,490 | 135 | 2,750 | 395 |

*These nominal times are based on a "dry" valve at 70 deg F.

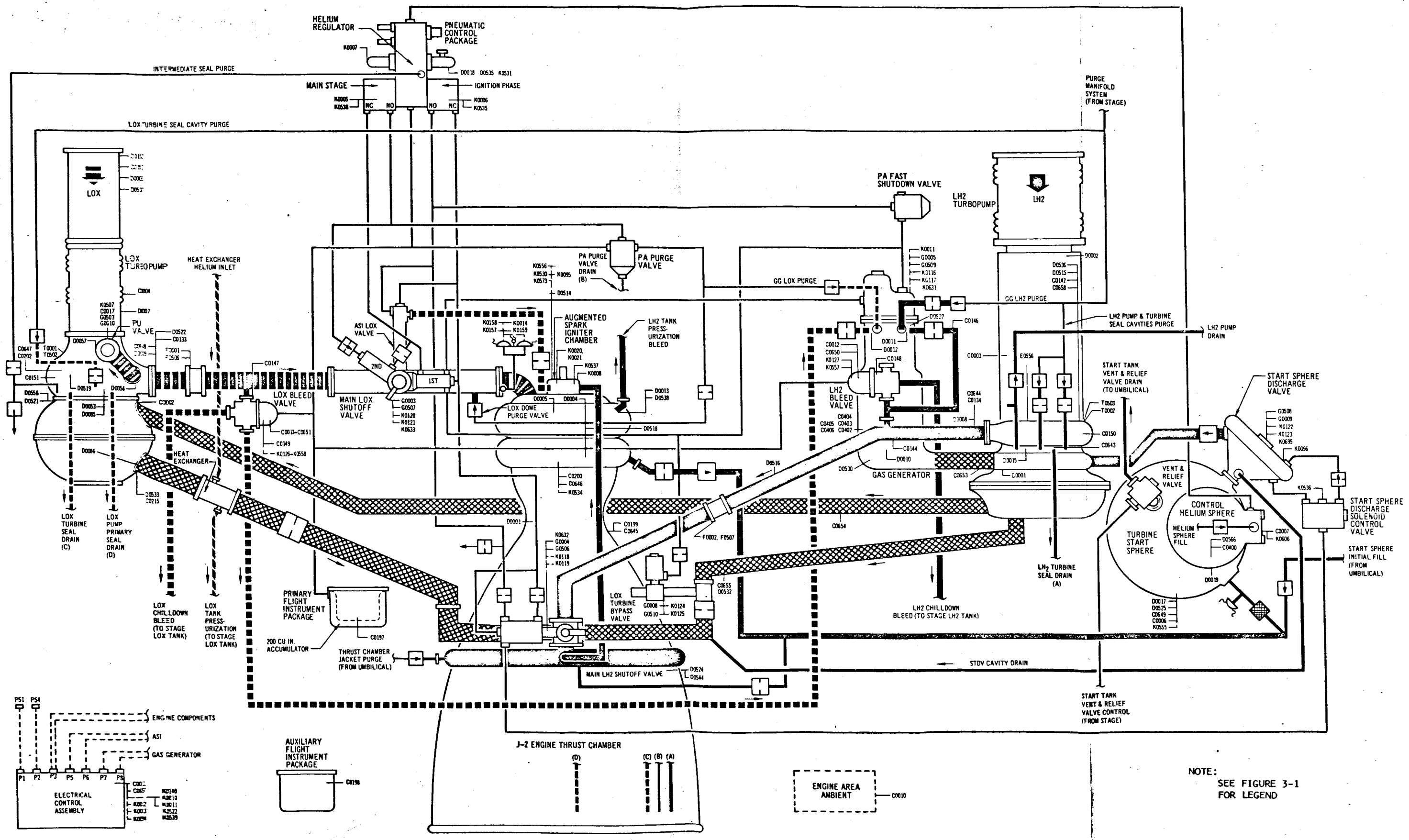


Figure 6-1. J-2 Engine System and Instrumentation

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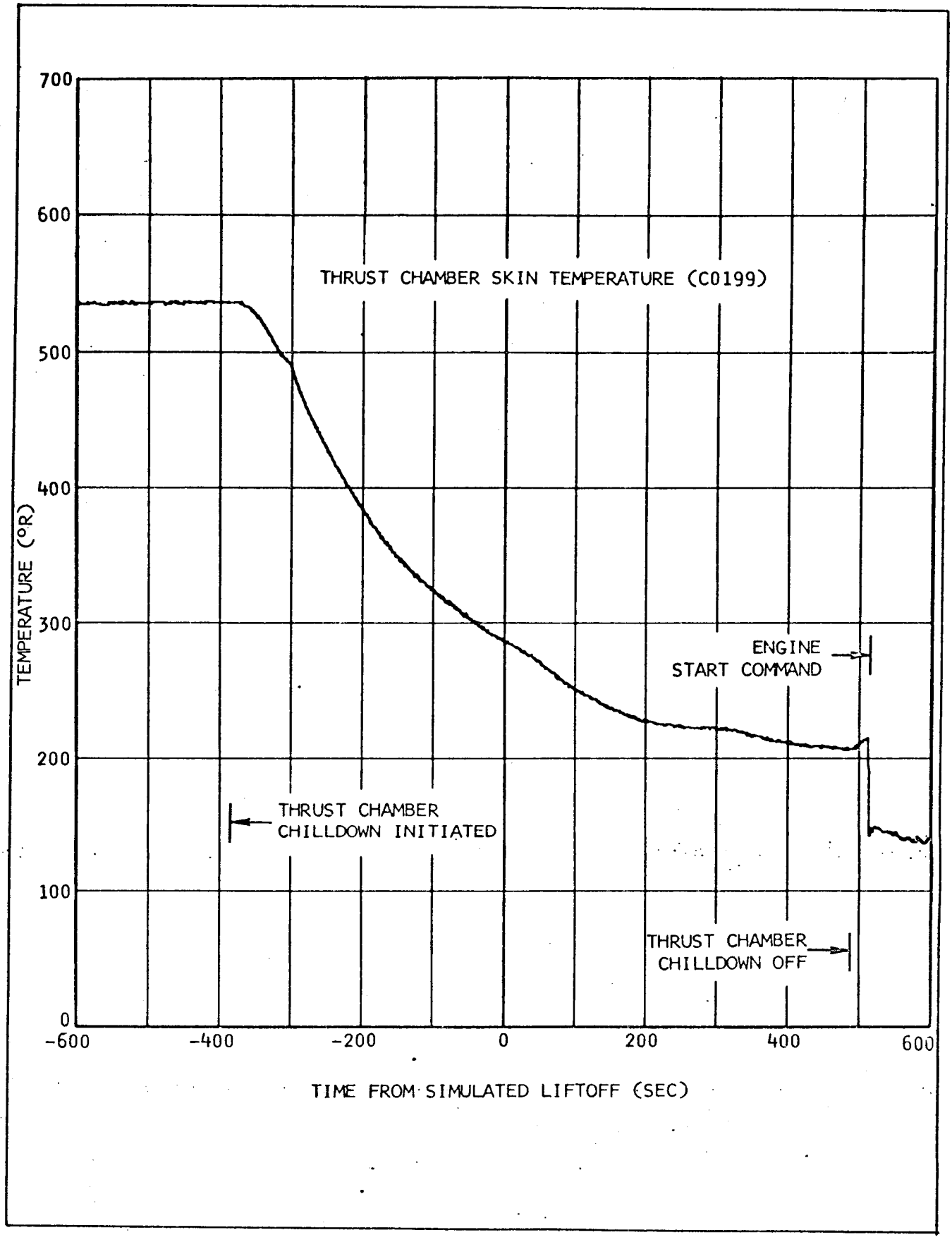


Figure 6-2. Thrust Chamber Chilldown - 1st Burn

28 September 1966

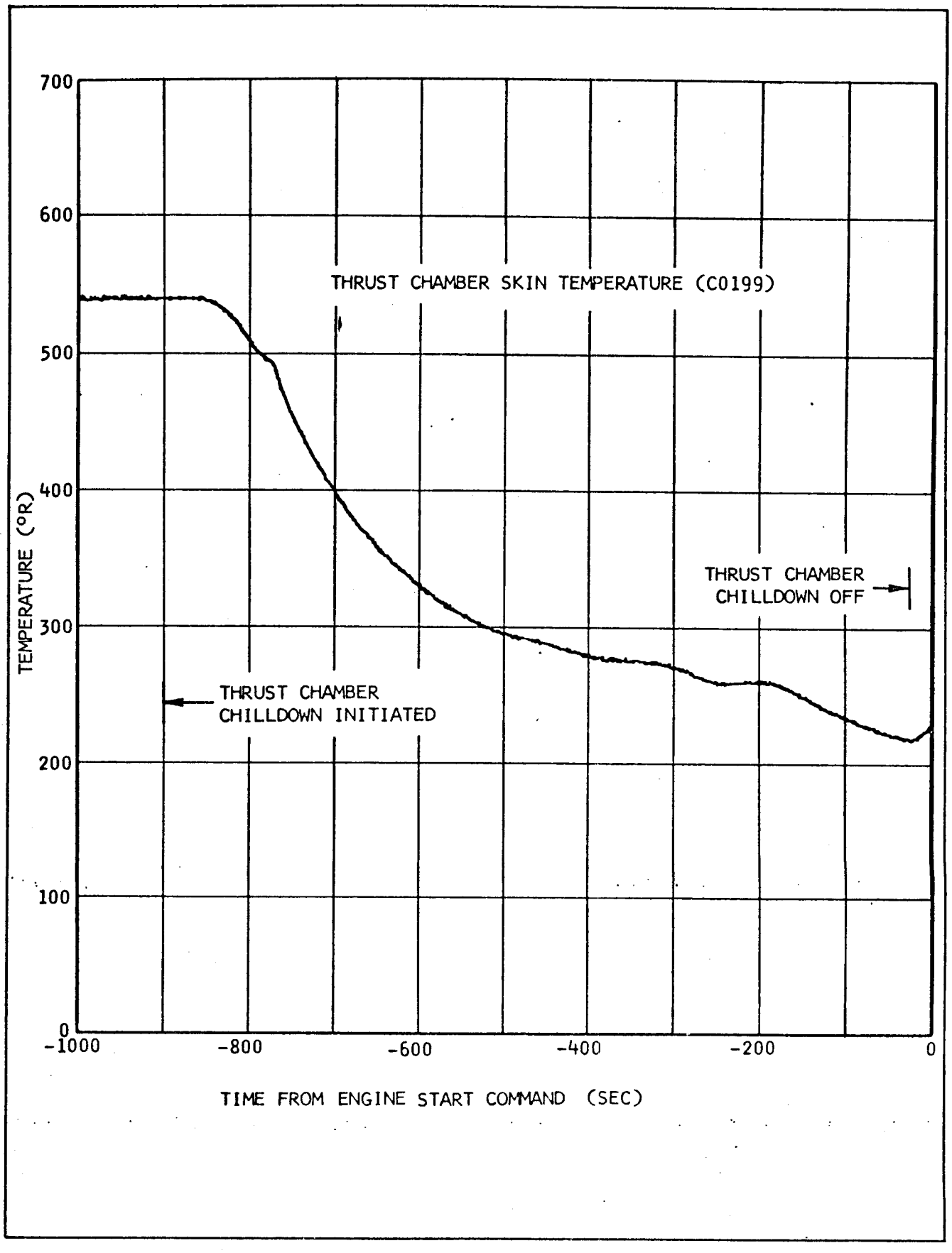


Figure 6-3. Thrust Chamber Chilldown - 2nd Burn

28 September 1966

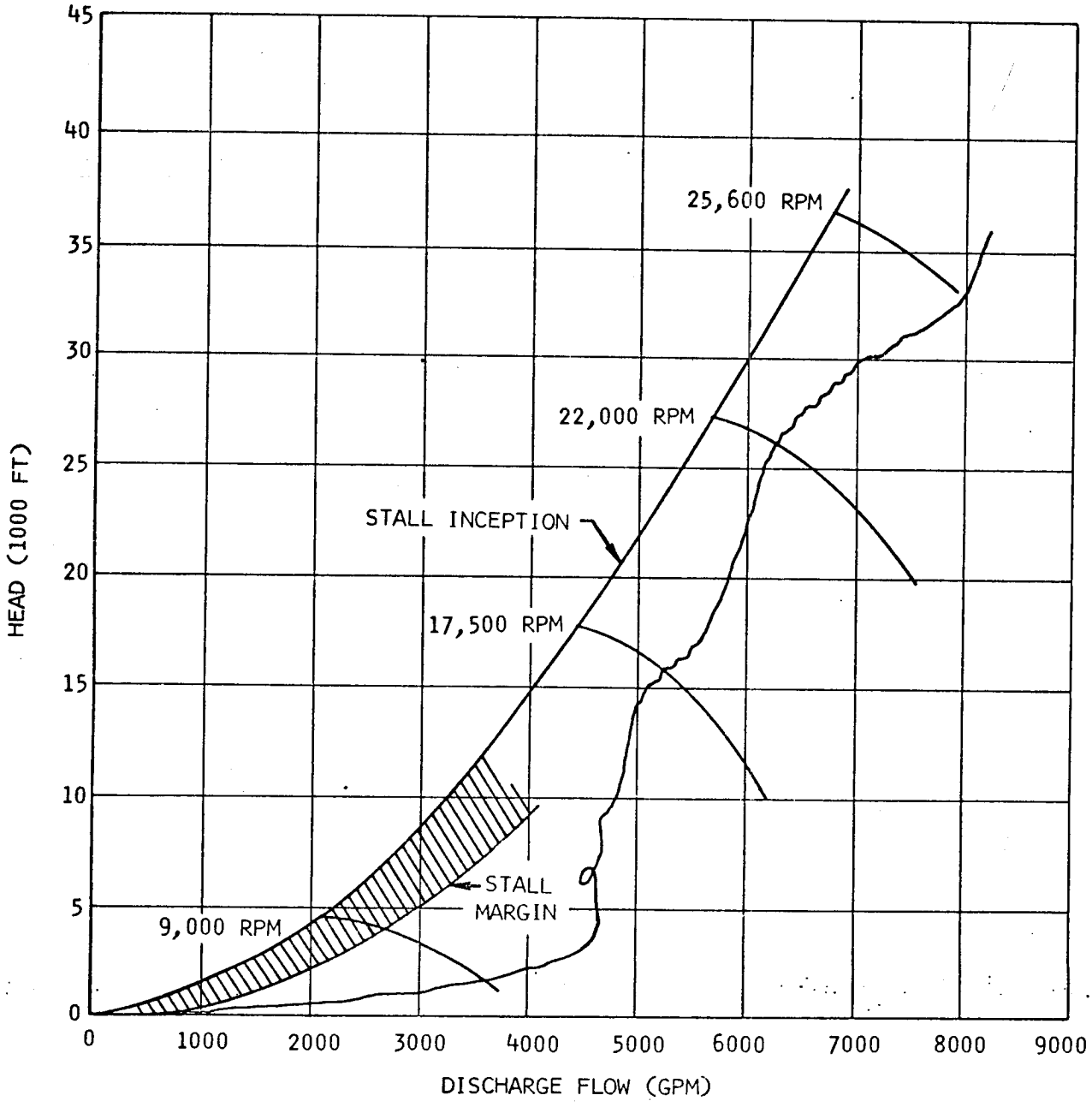


Figure 6-4. LH2 Pump Performance During Engine Start - 1st Burn

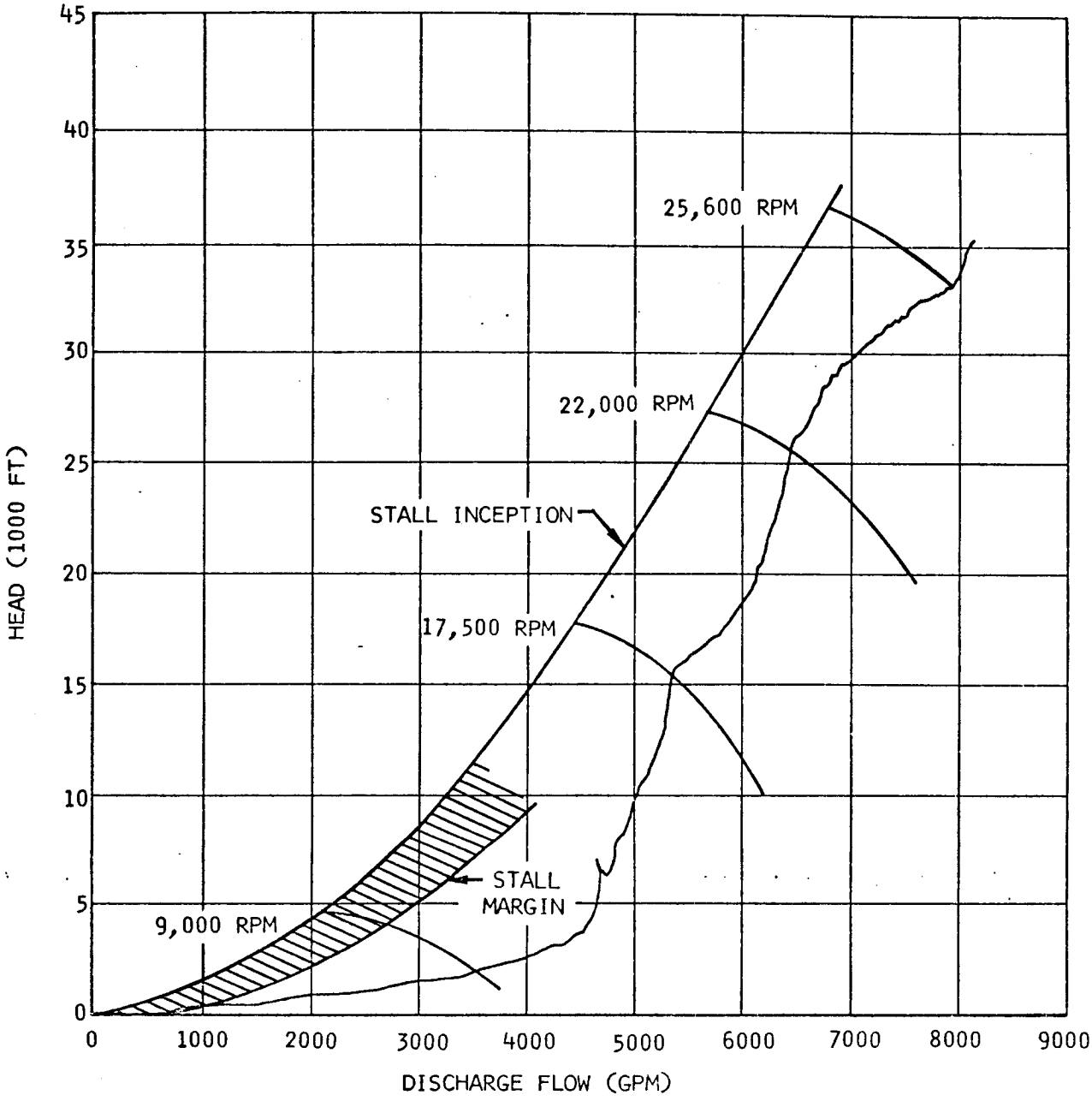


Figure 6-5. LH2 Pump Performance During Engine Start - 2nd Burn

28 September 1966

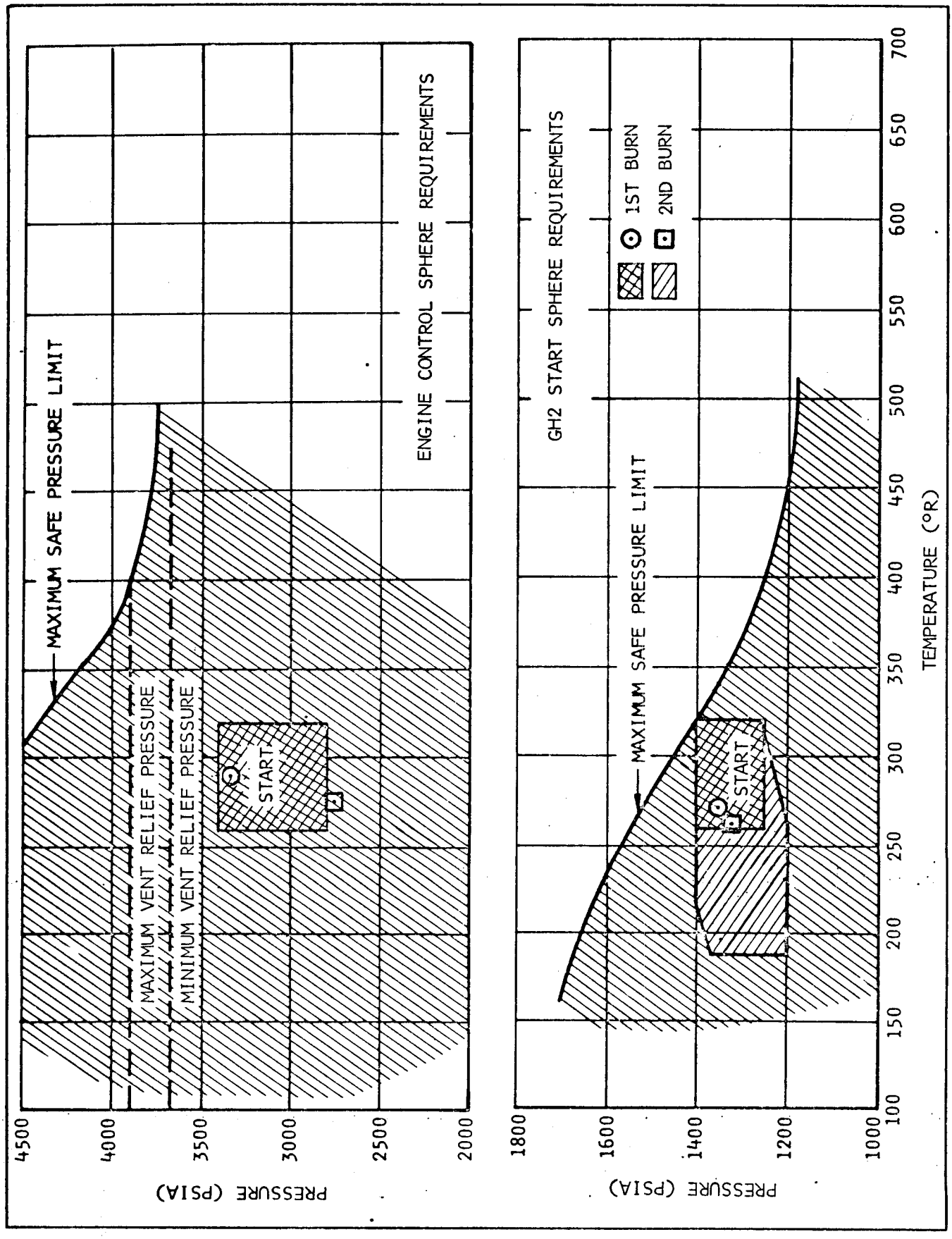


Figure 6-6. Engine Start and Control Sphere Prestart Requirements and Conditions

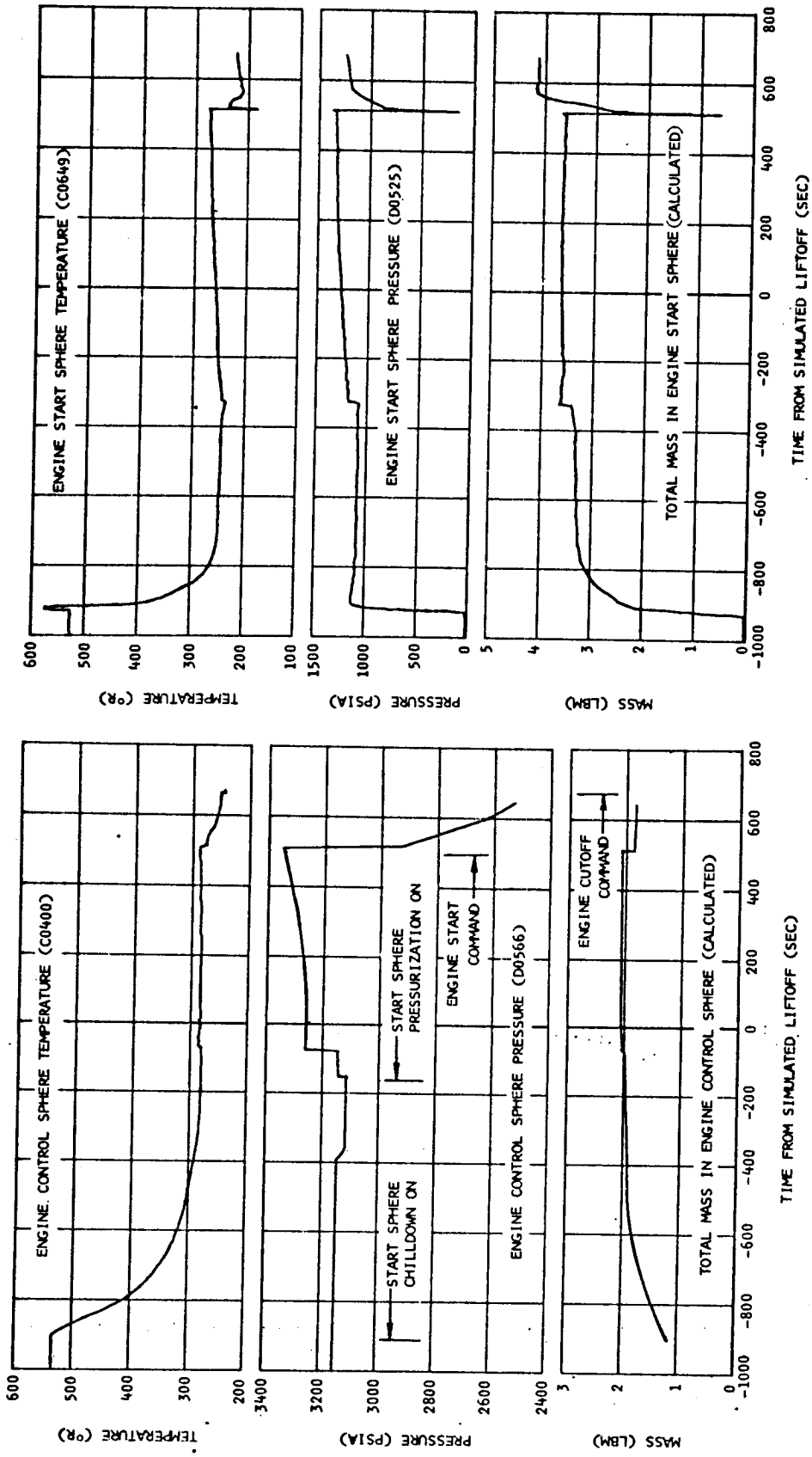


Figure 6-7. Engine Start and Control Sphere Performance - 1st Burn

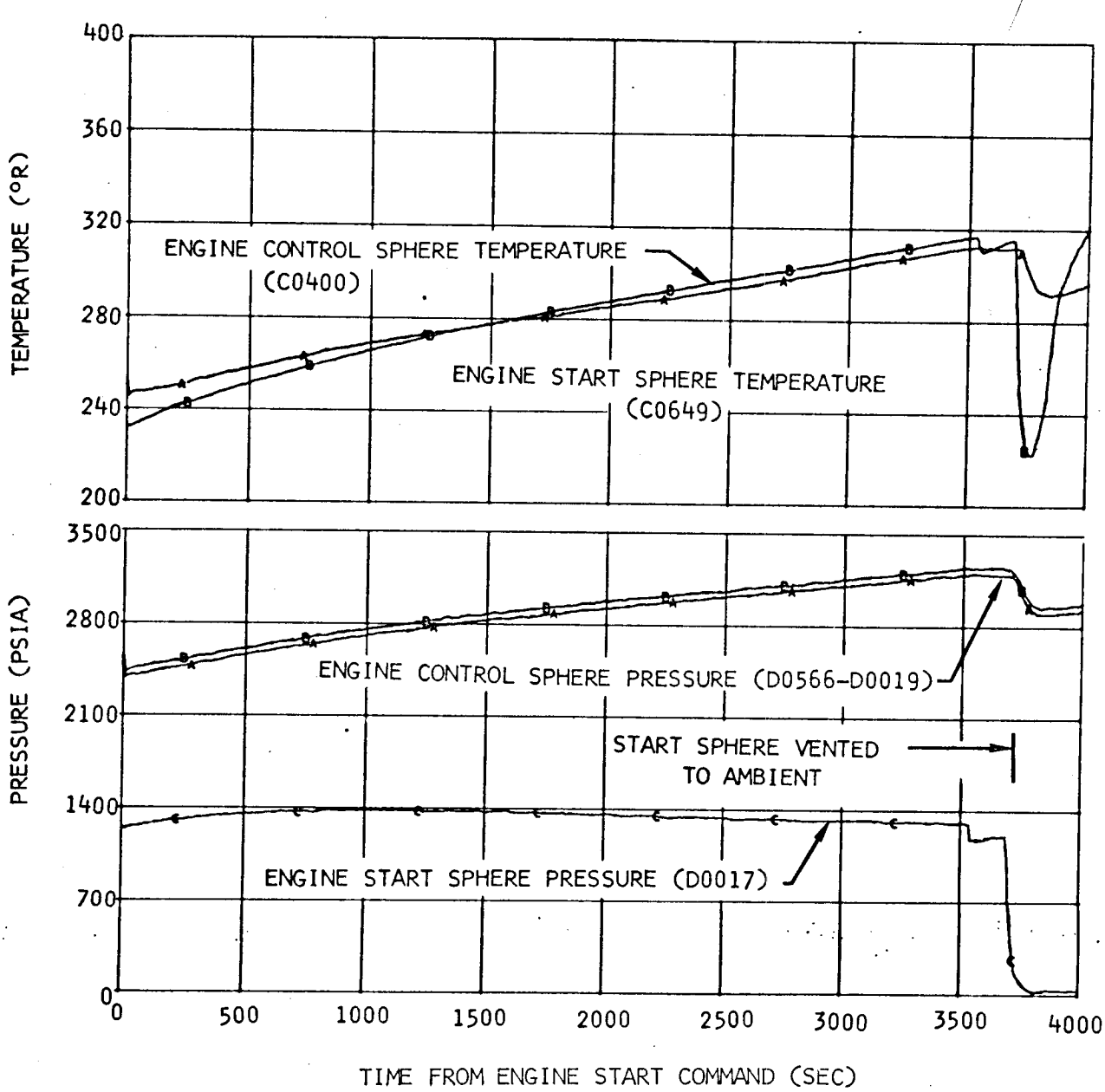


Figure 6-8. Engine Start and Control Sphere Conditions - Simulated Orbital Coast

28 September 1966

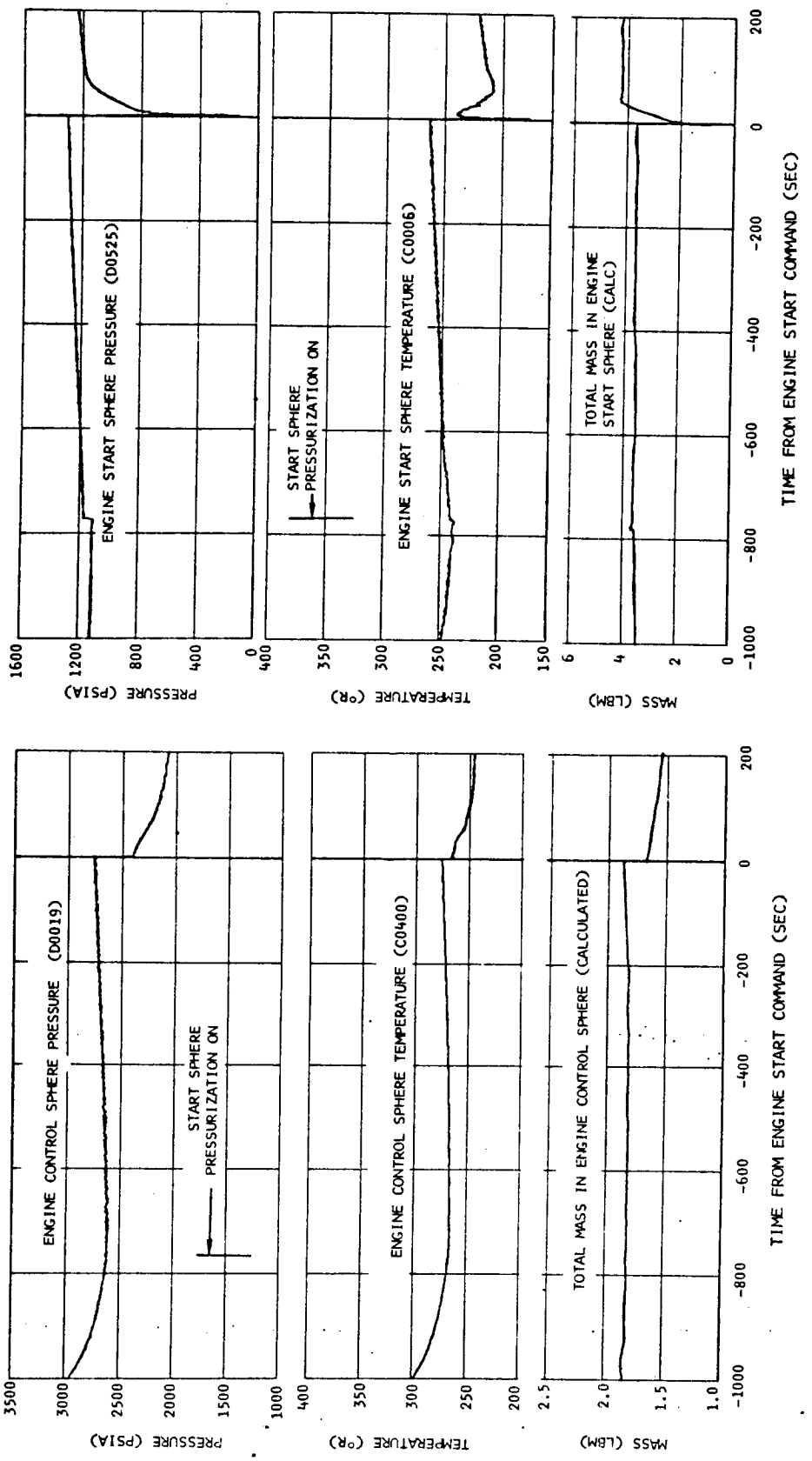


Figure 6-9. Engine Start and Control Sphere Performance - 2nd Burn

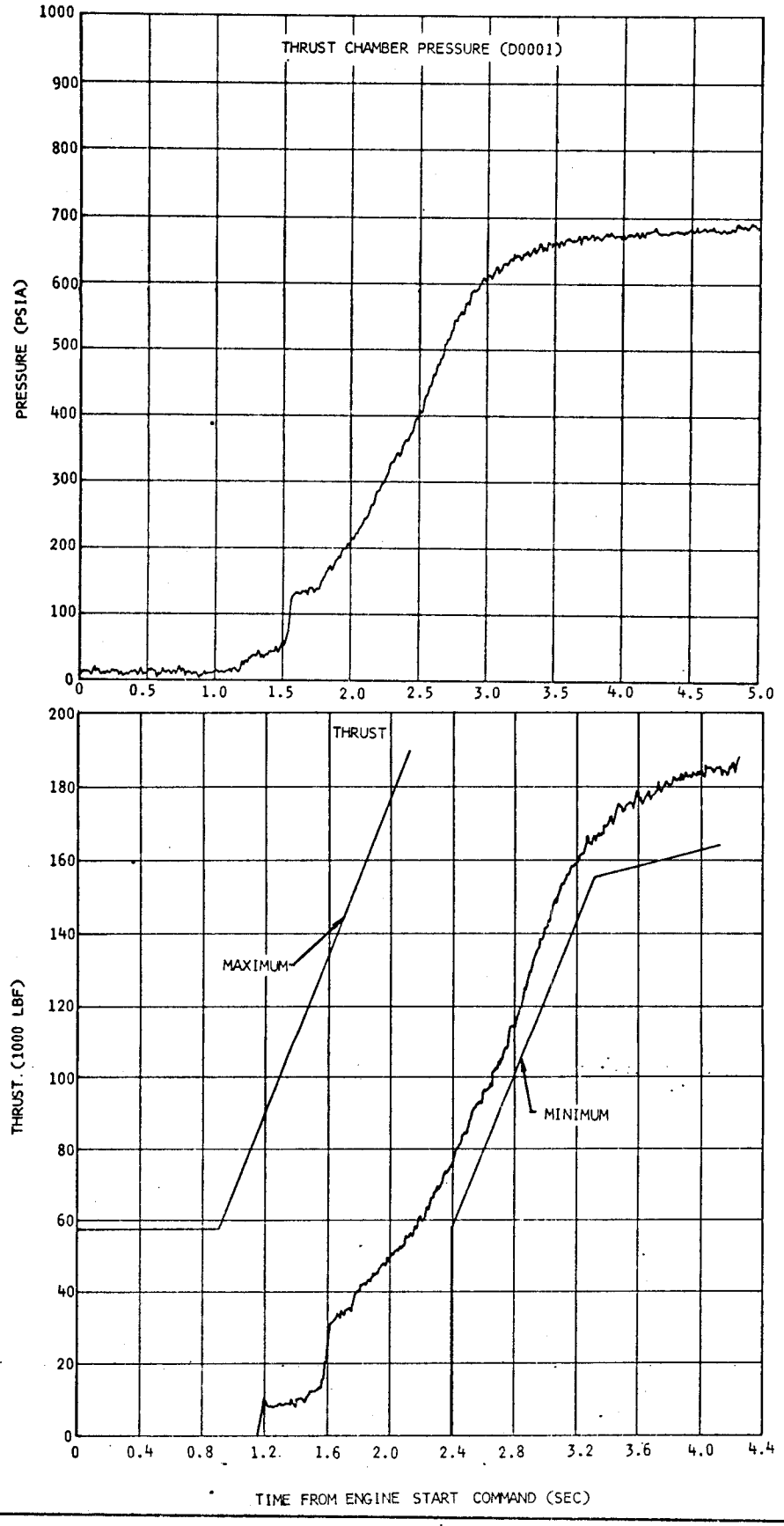


Figure 6-10. Engine Start Transient Characteristics - 1st Burn

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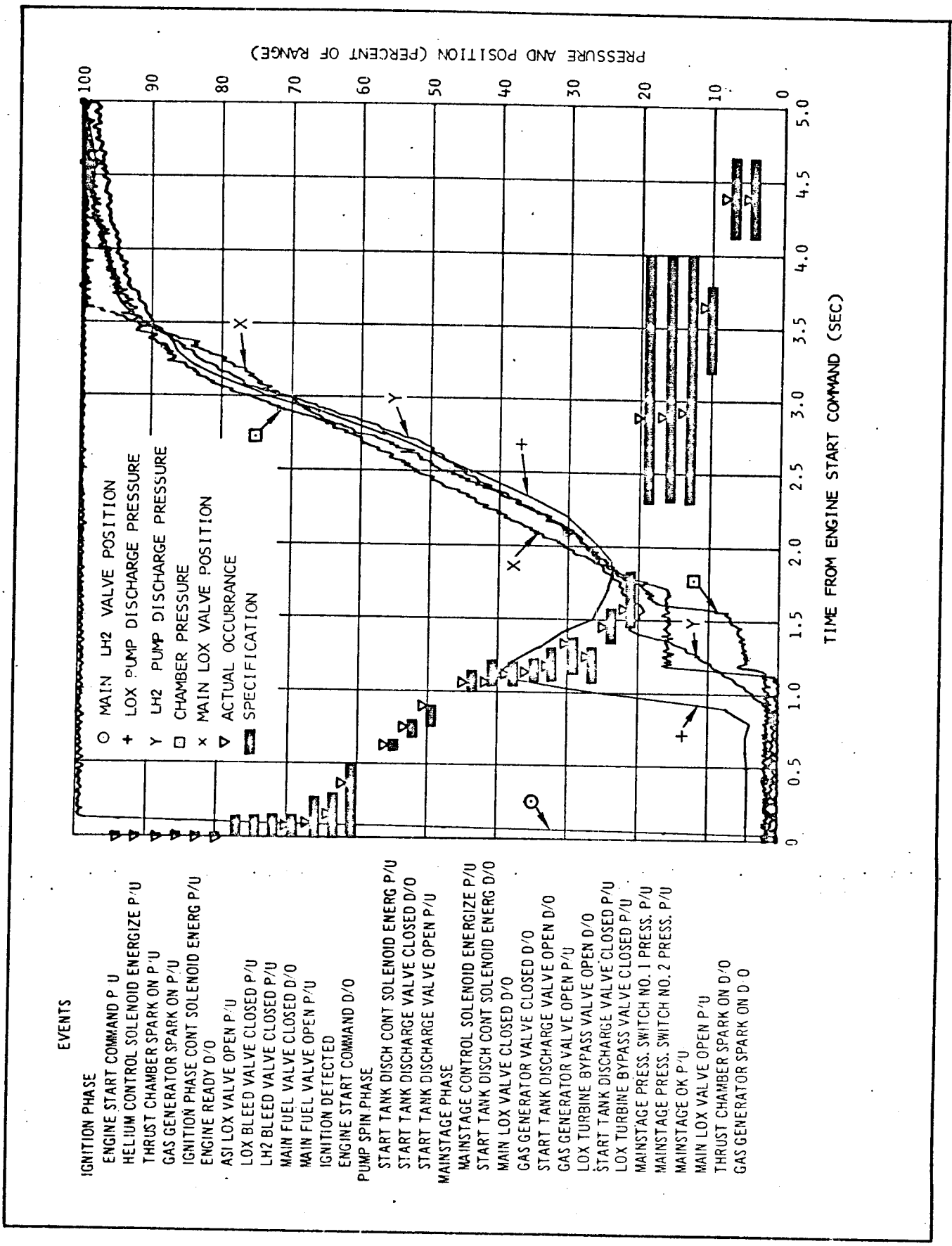


Figure 6-11. Engine Start Sequence - 1st Burn

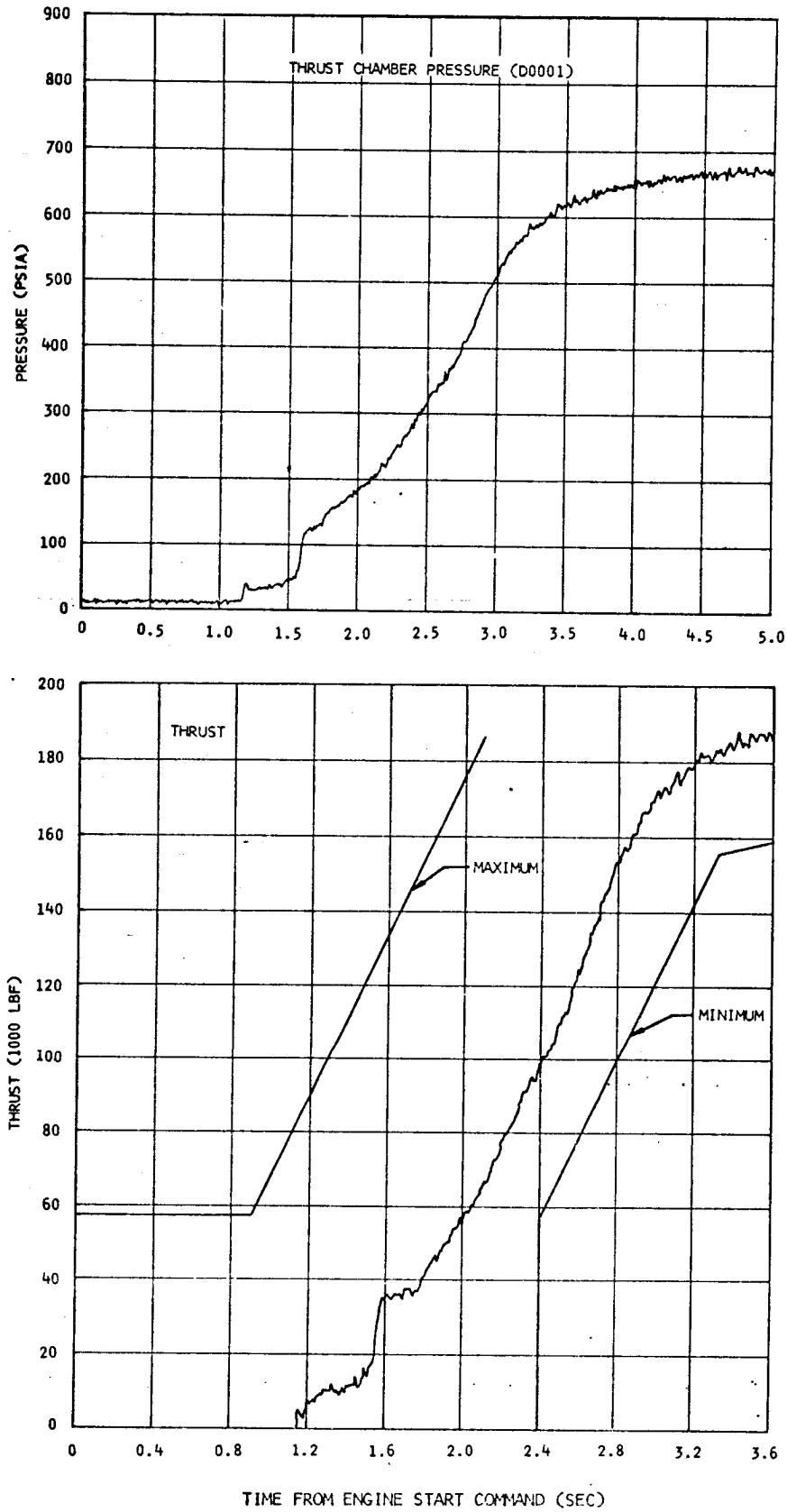


Figure 6-12. Engine Start Transient Characteristics - 2nd Burn

28 September 1966

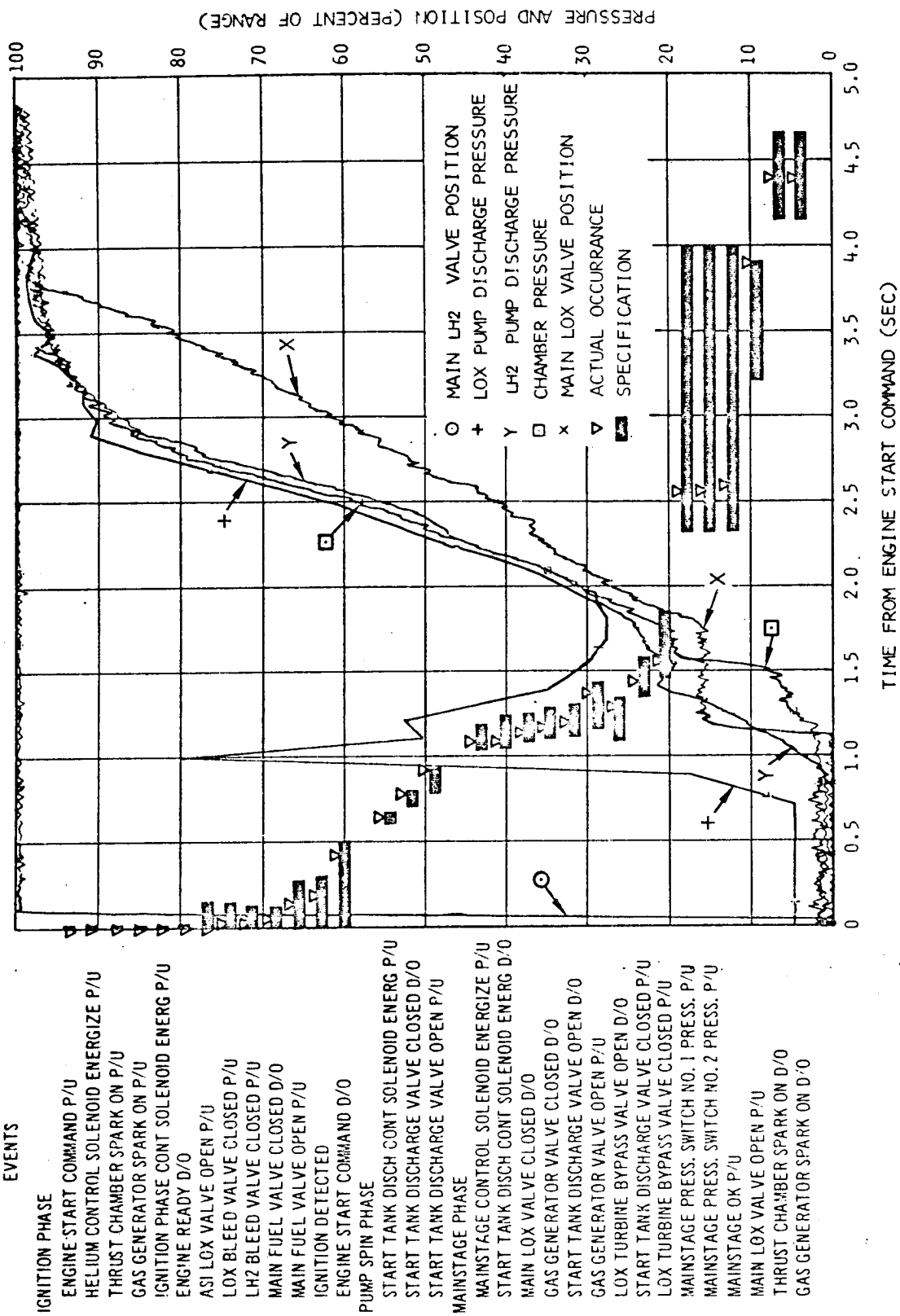


Figure 6-13. Engine Start Sequence - 2nd Burn

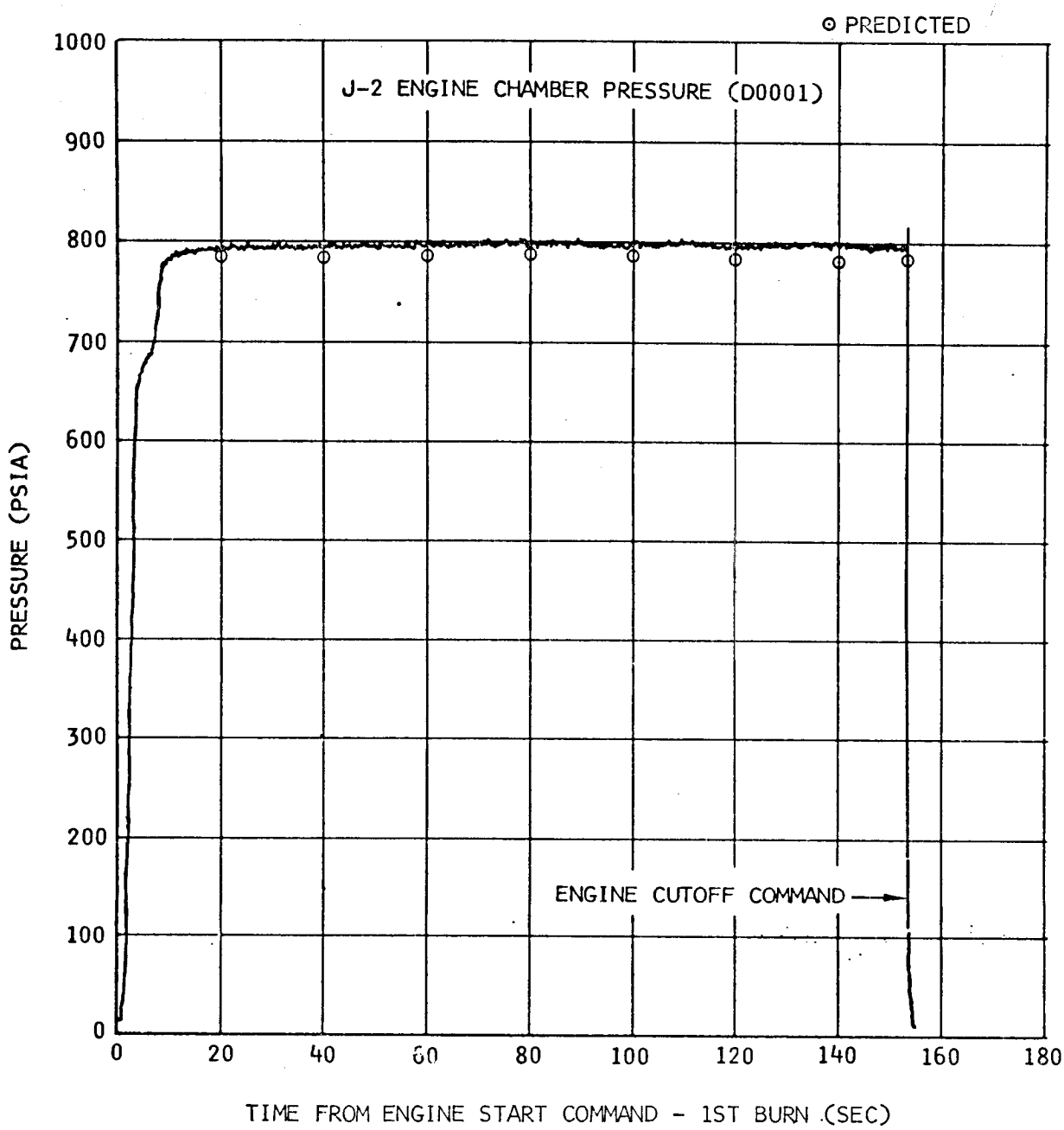


Figure 6-14. J-2 Engine Chamber Pressure - 1st Burn

28 September 1966

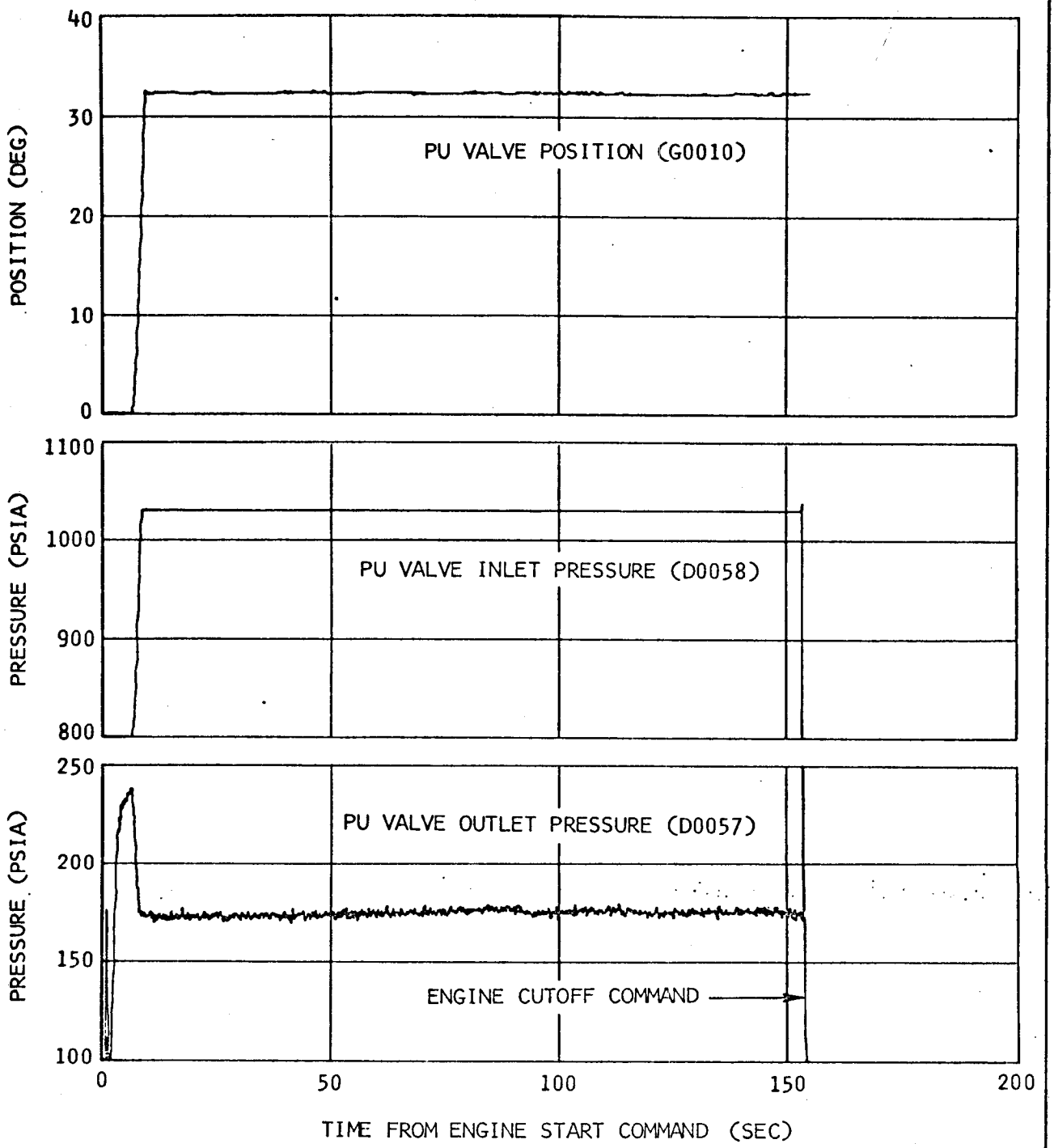


Figure 6-15. PU Valve Operation - 1st Burn

28 September 1966

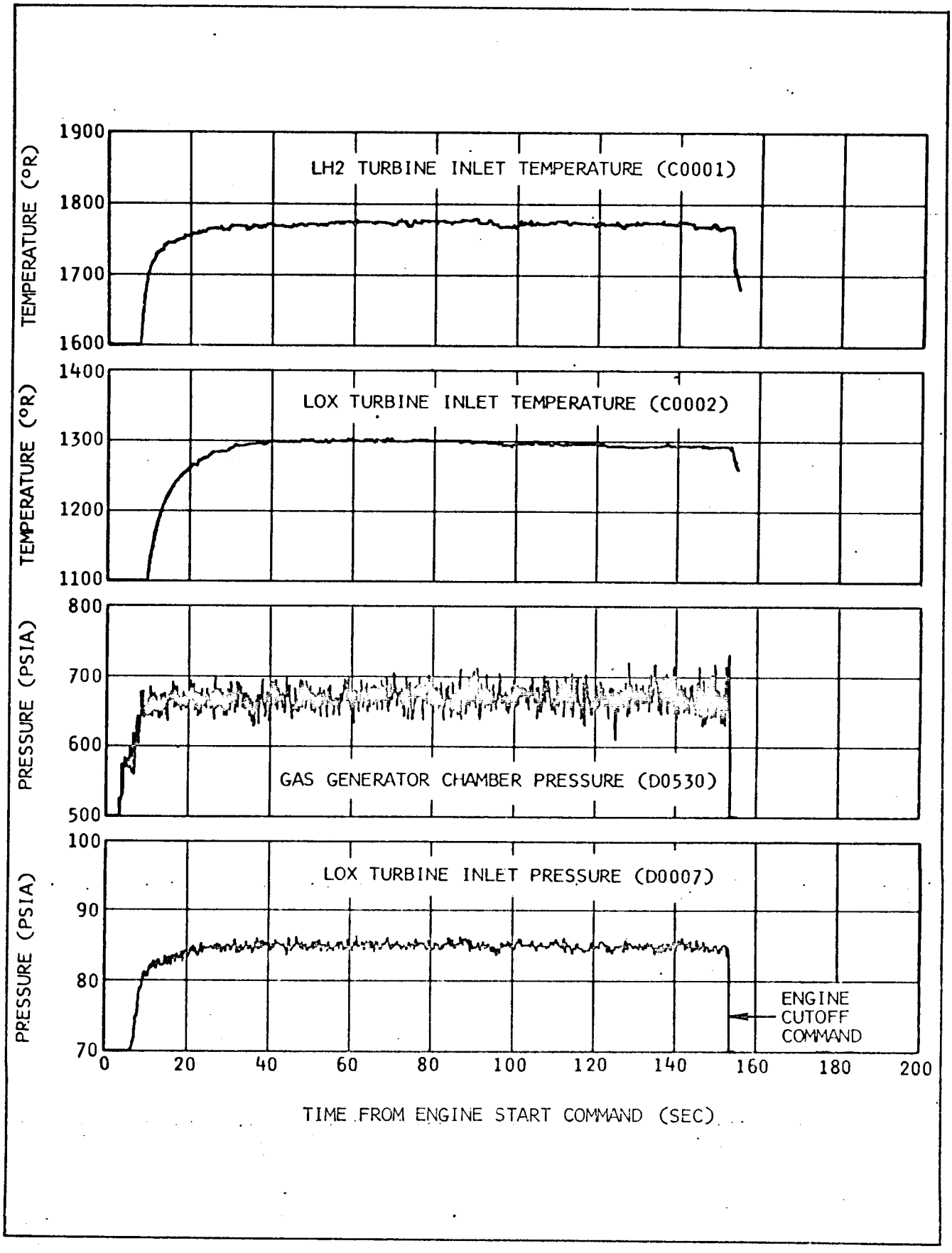


Figure 6-16. Turbine Inlet Operating Conditions - 1st Burn

28 September 1966

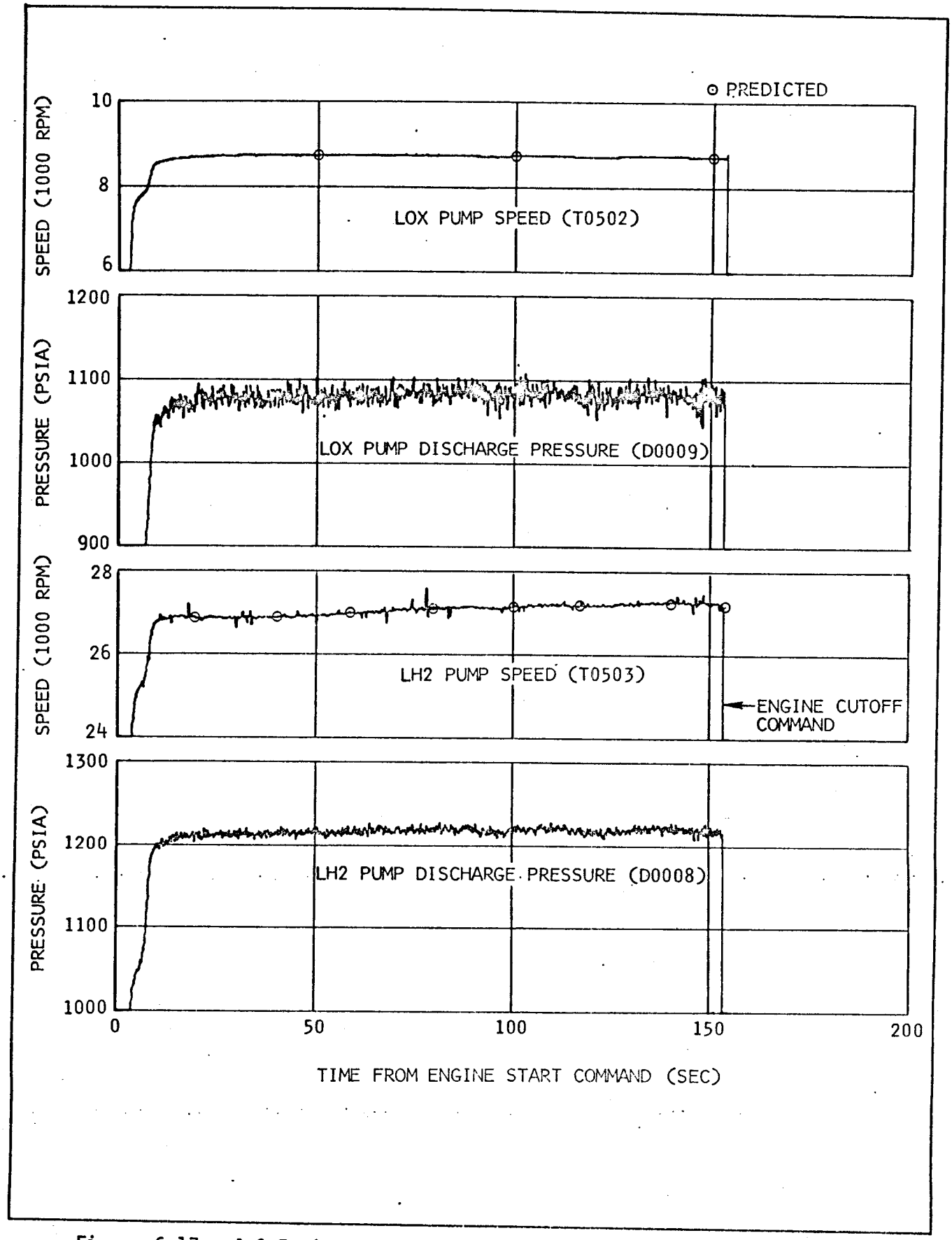


Figure 6-17. J-2 Engine Pump Operating Characteristics - 1st Burn

28 September 1966

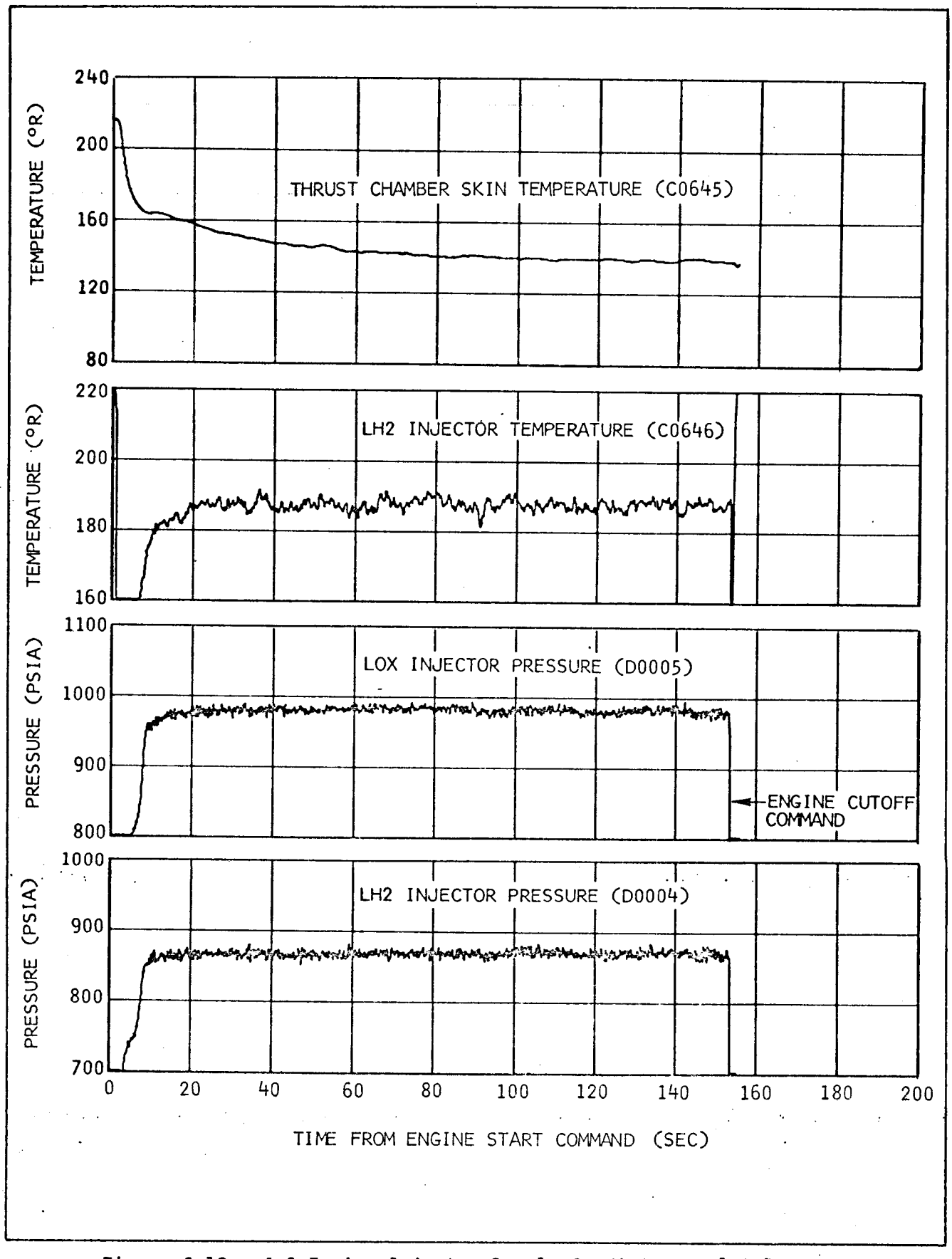


Figure 6-18. J-2 Engine Injector Supply Conditions - 1st Burn

28 September 1966

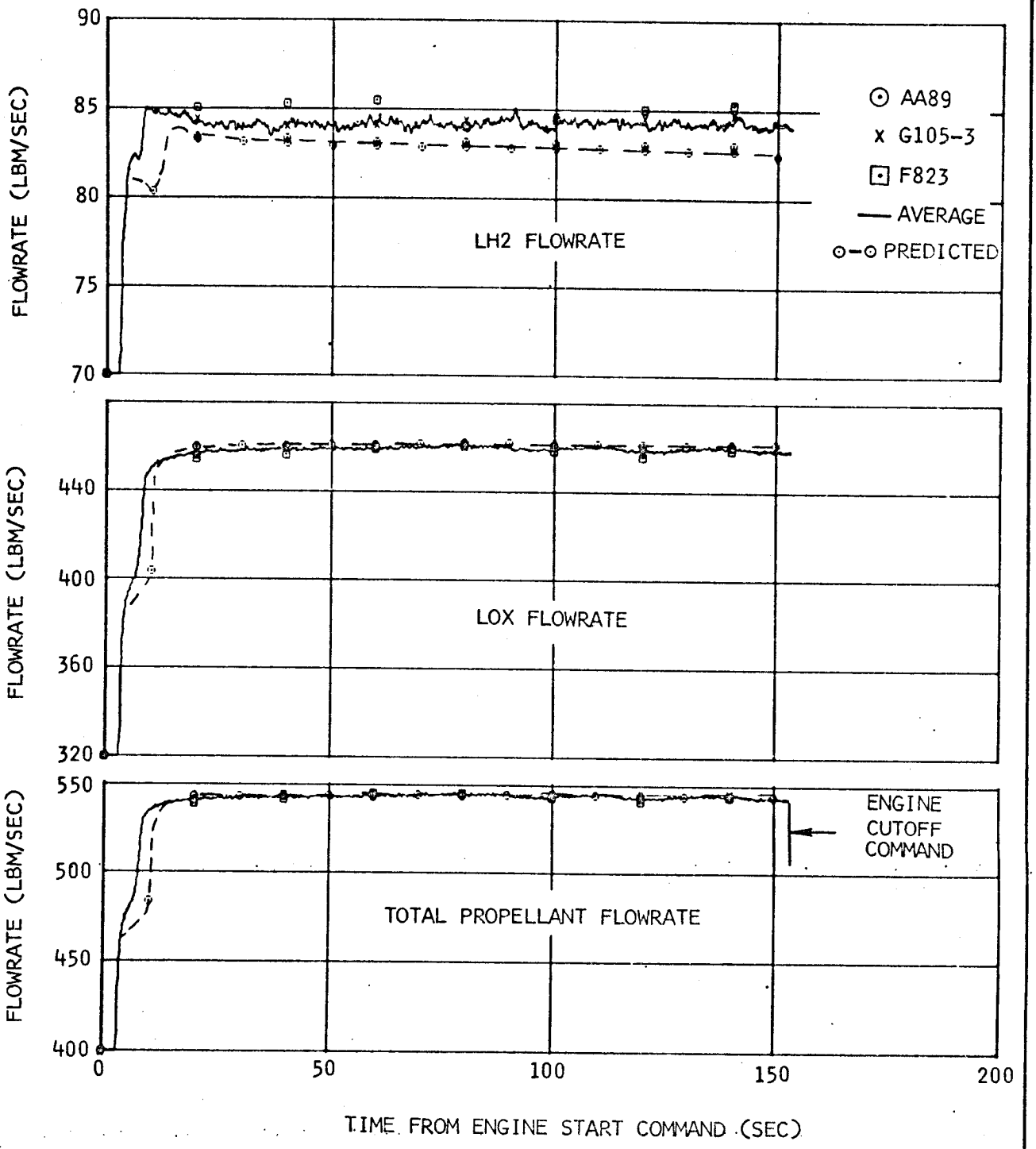


Figure 6-19. Engine Steady State Performance - 1st Burn (Sheet 1 of 2)

28 September 1966

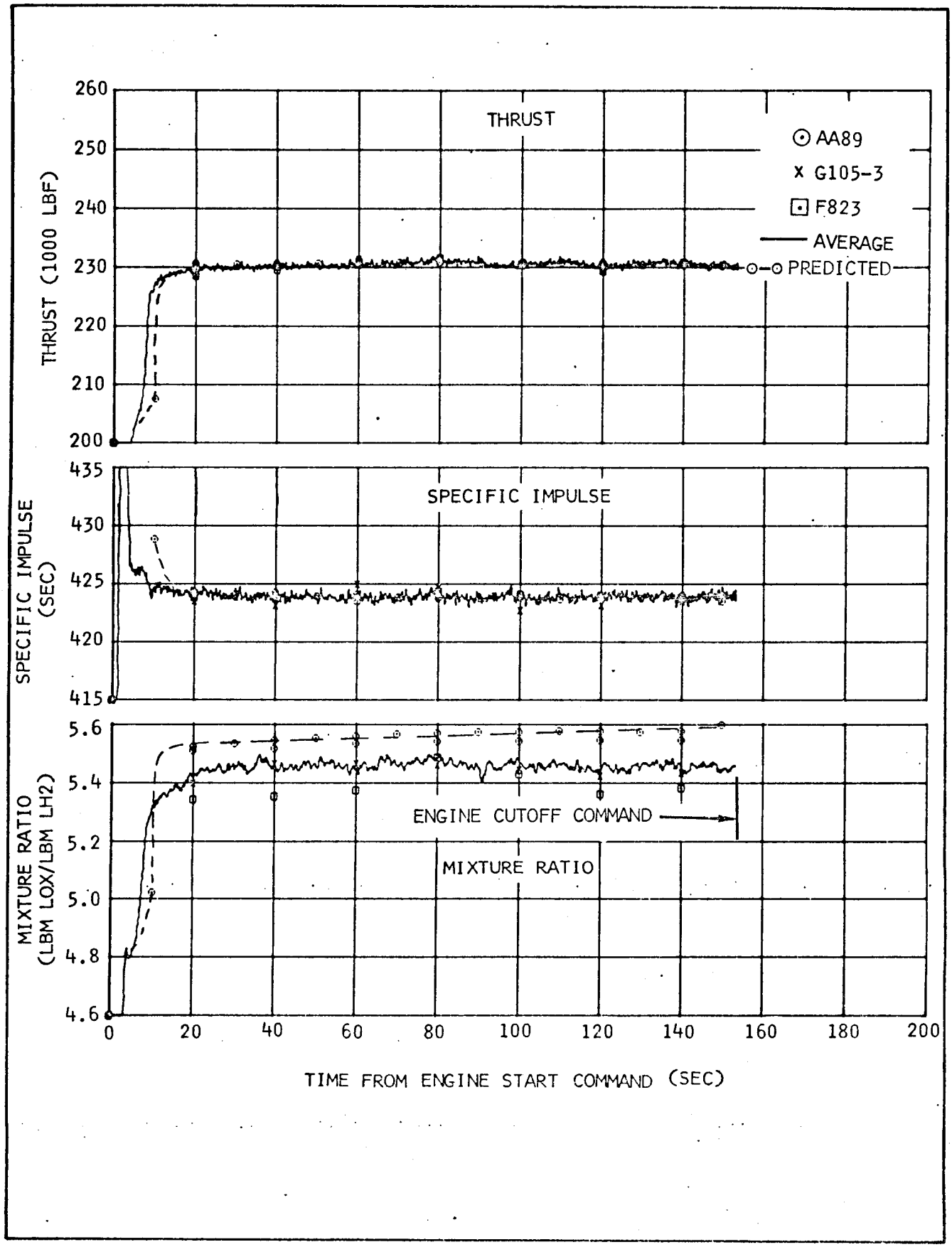


Figure 6-19. Engine Steady-State Performance - 1st Burn (Sheet 2 of 2)

28 September 1966

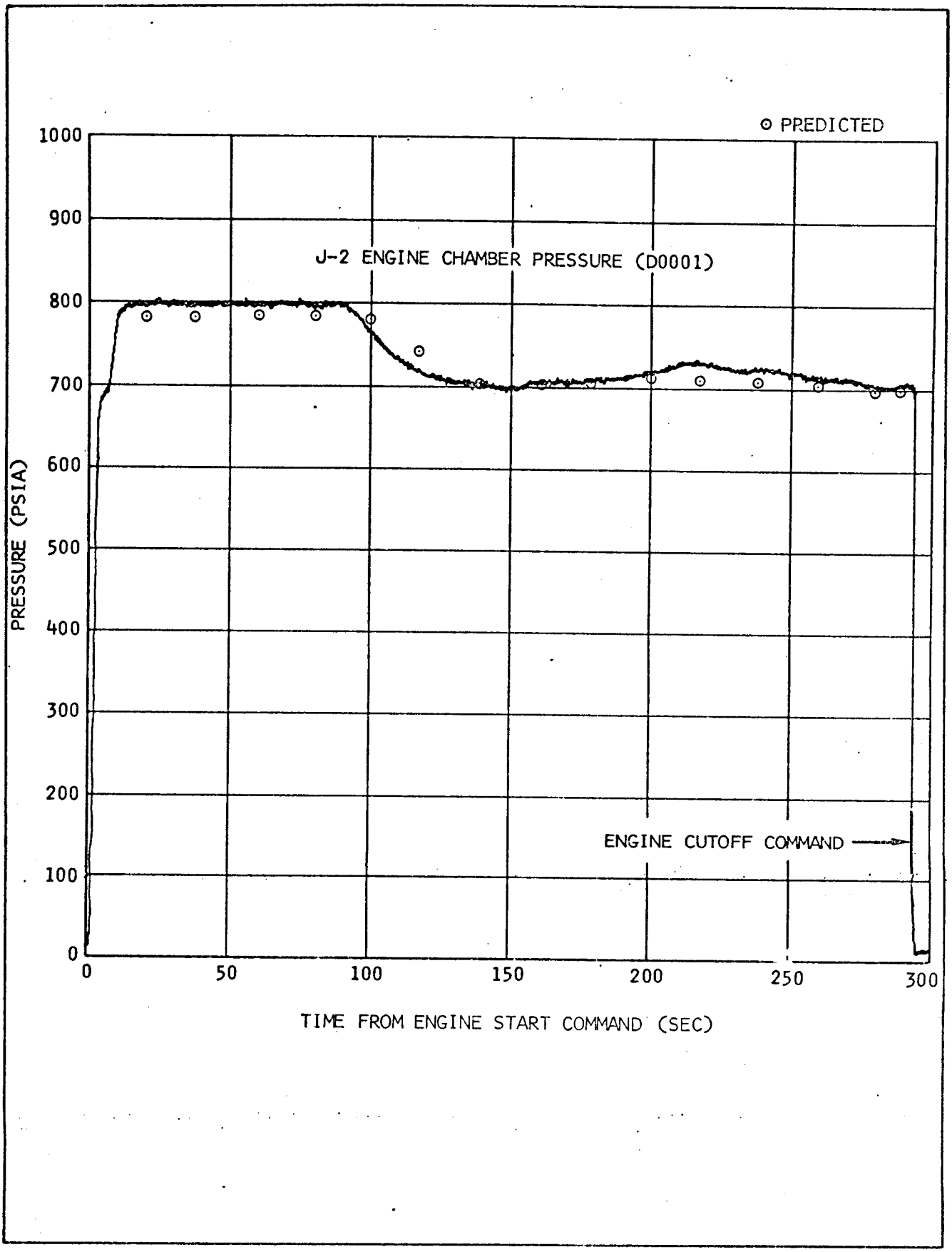


Figure 6-20. J-2 Engine Chamber Pressure - 2nd Burn

28 September 1966

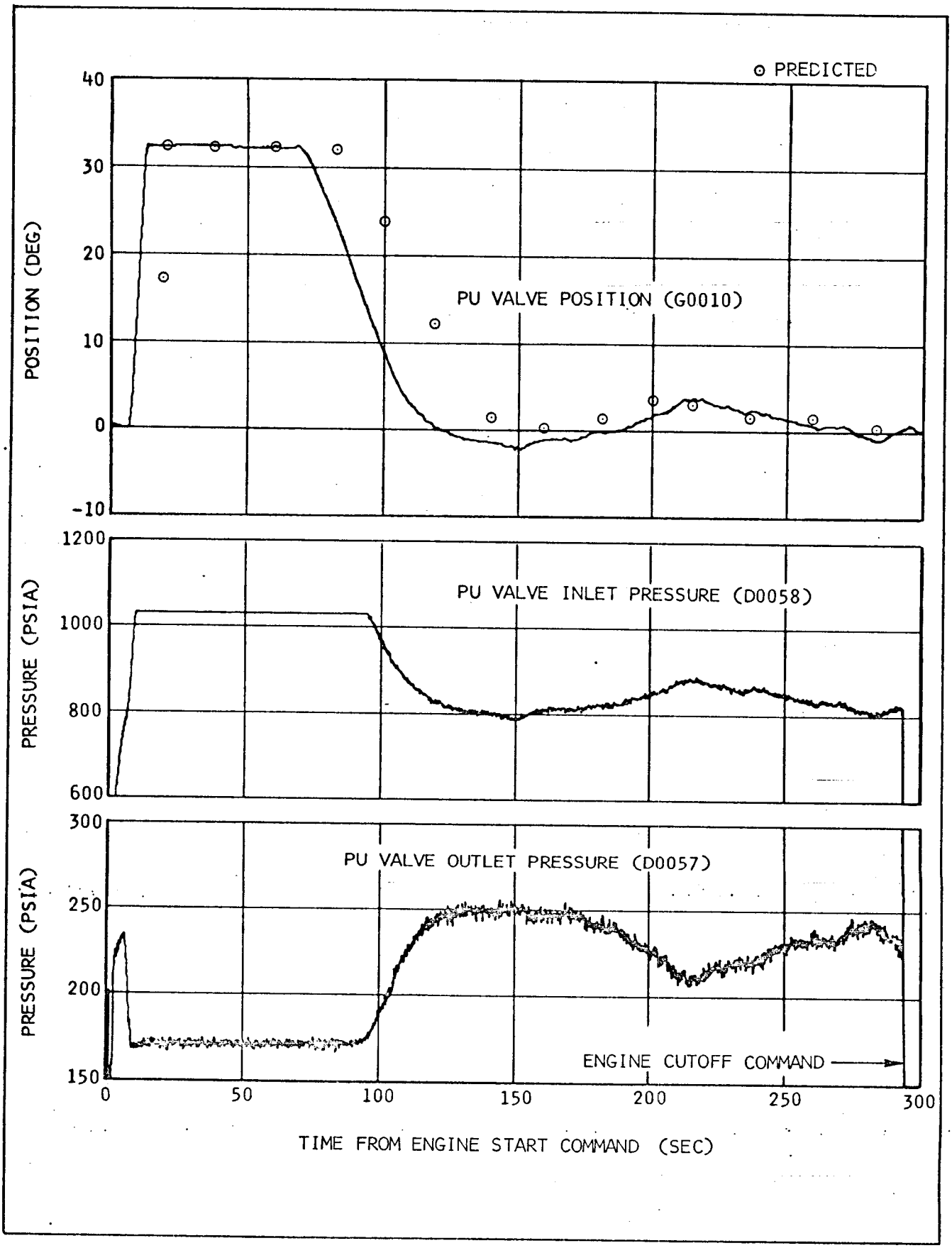


Figure 6-21. PU Valve Operation - 2nd Burn

28 September 1966

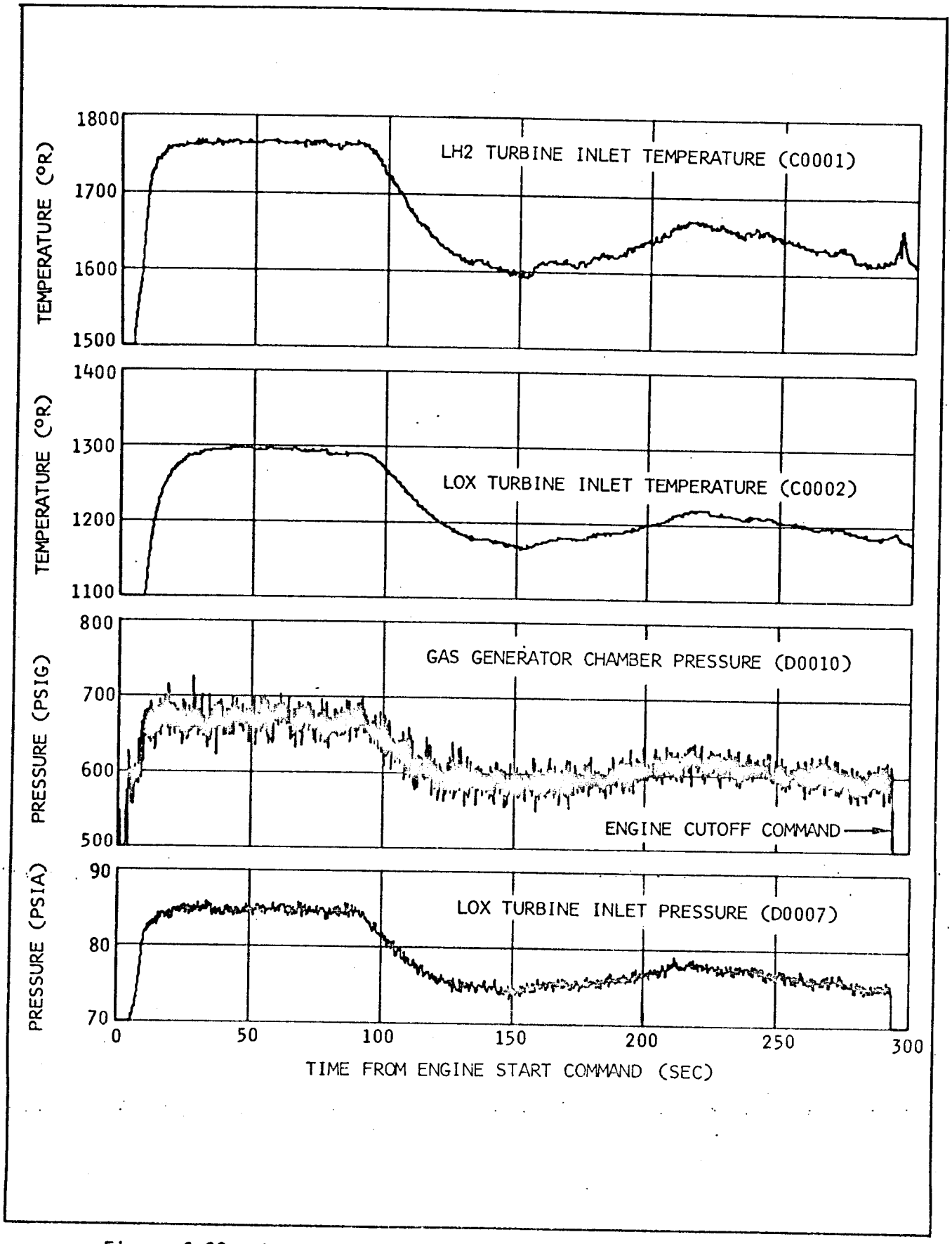


Figure 6-22. Turbine Inlet Operating Conditions - 2nd Burn

28 September 1966

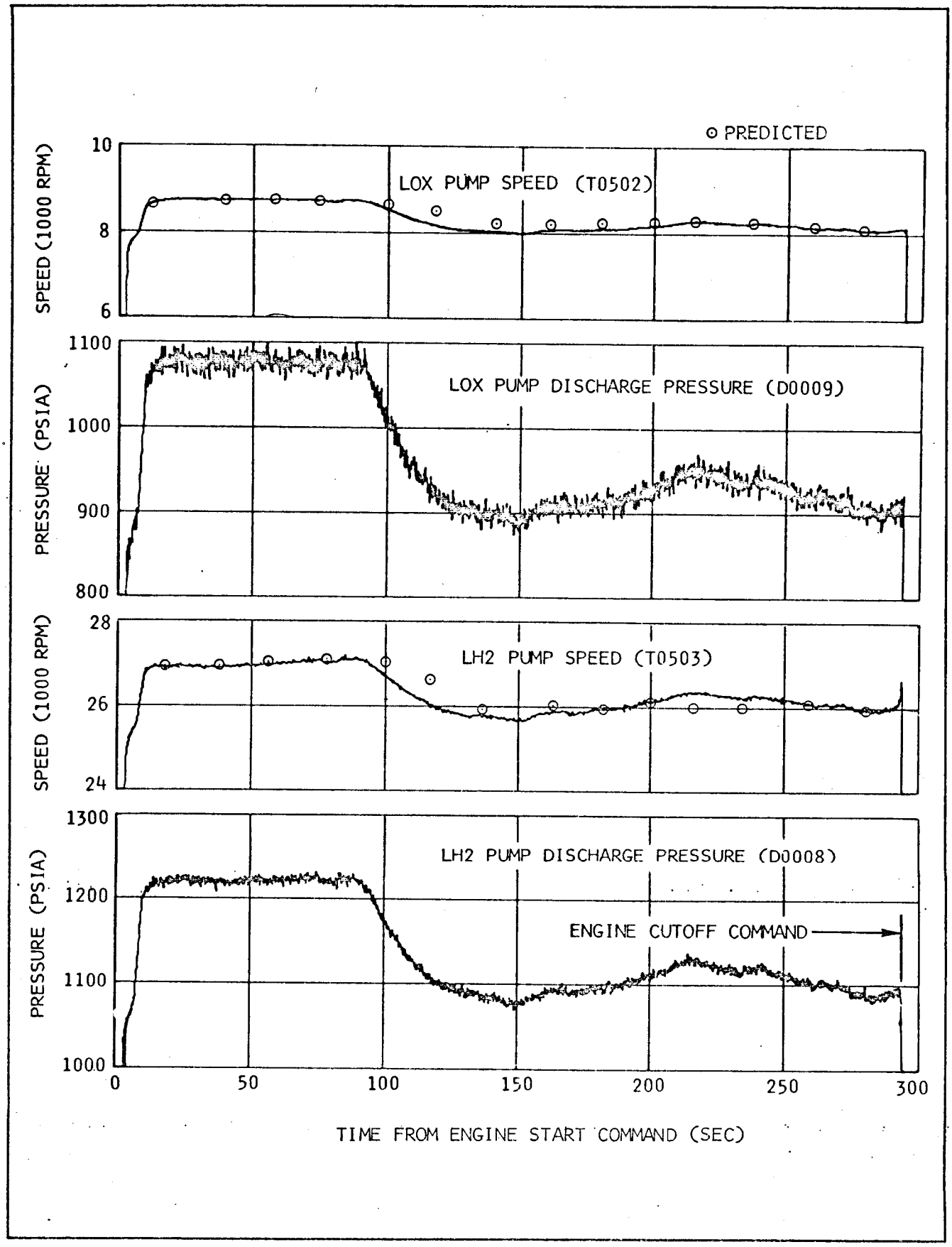


Figure 6-23. J-2 Engine Pump Operating Conditions - 2nd Burn

28 September 1966

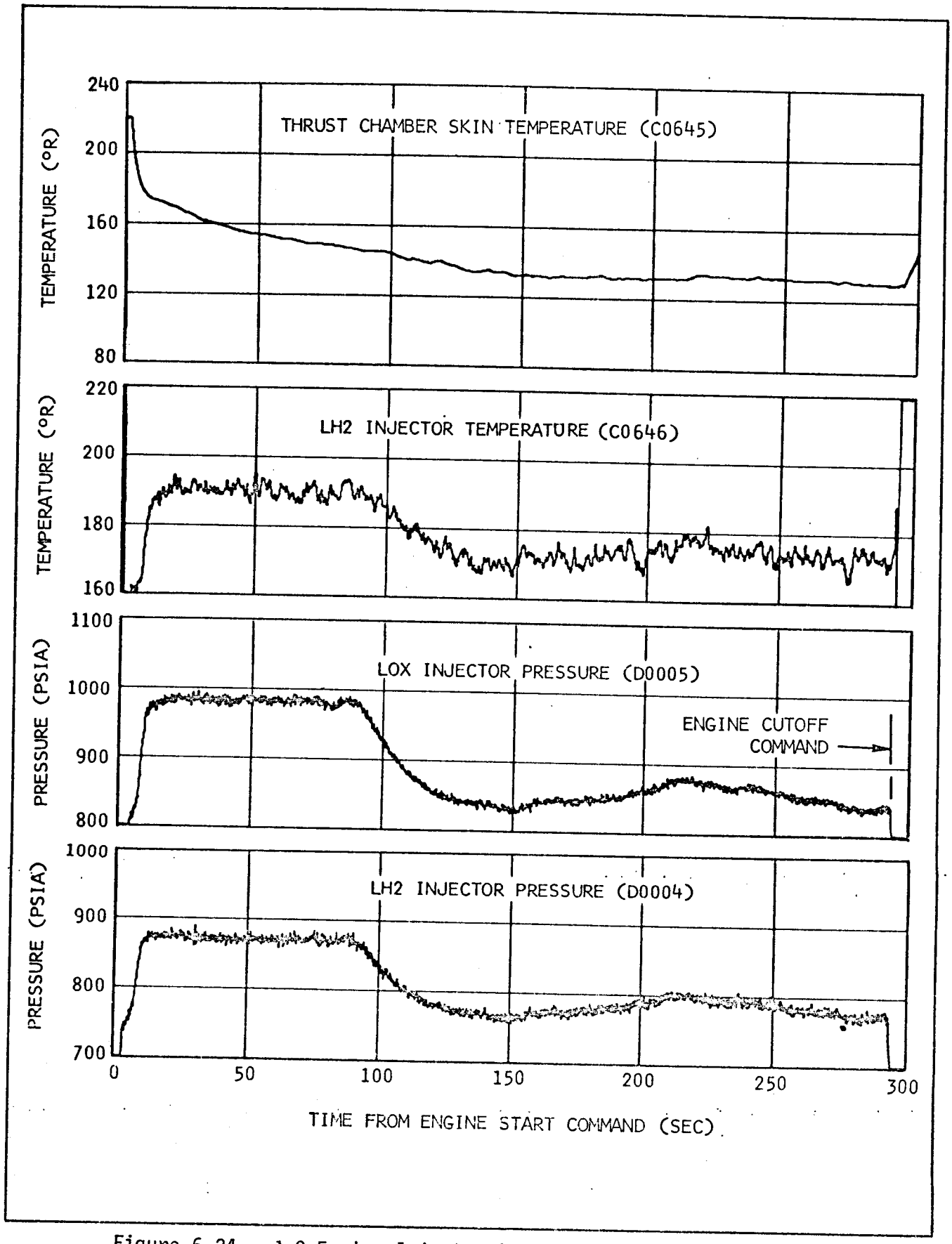


Figure 6-24. J-2 Engine Injector Supply Conditons - 2nd Burn

28 September 1966

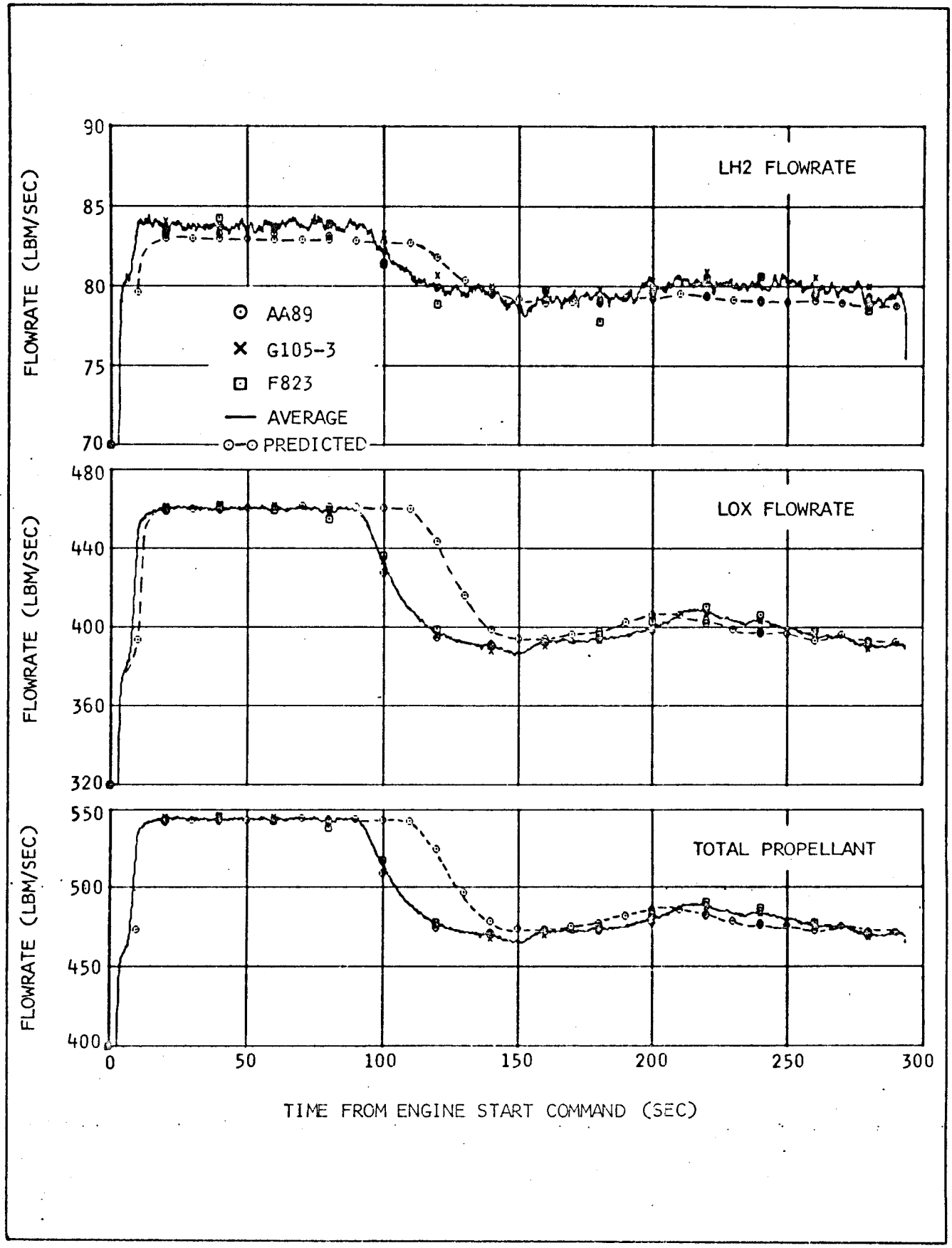


Figure 6-25. Engine Steady State Performance - 2nd Burn (Sheet 1 of 2)

28 September 1966

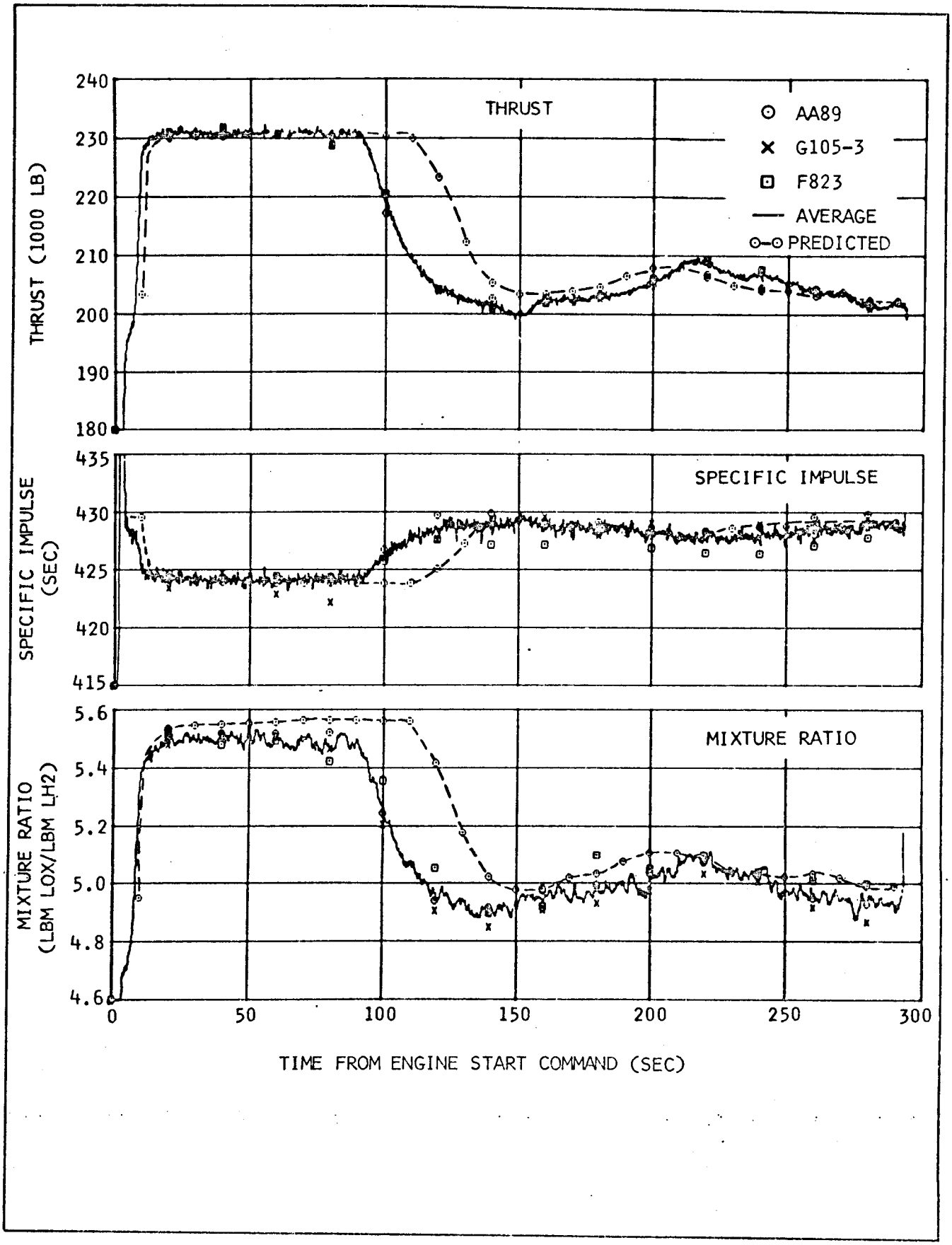


Figure 6-25. Engine Steady-State Performance - 2nd Burn (Sheet 2 of 2)

28 September 1966

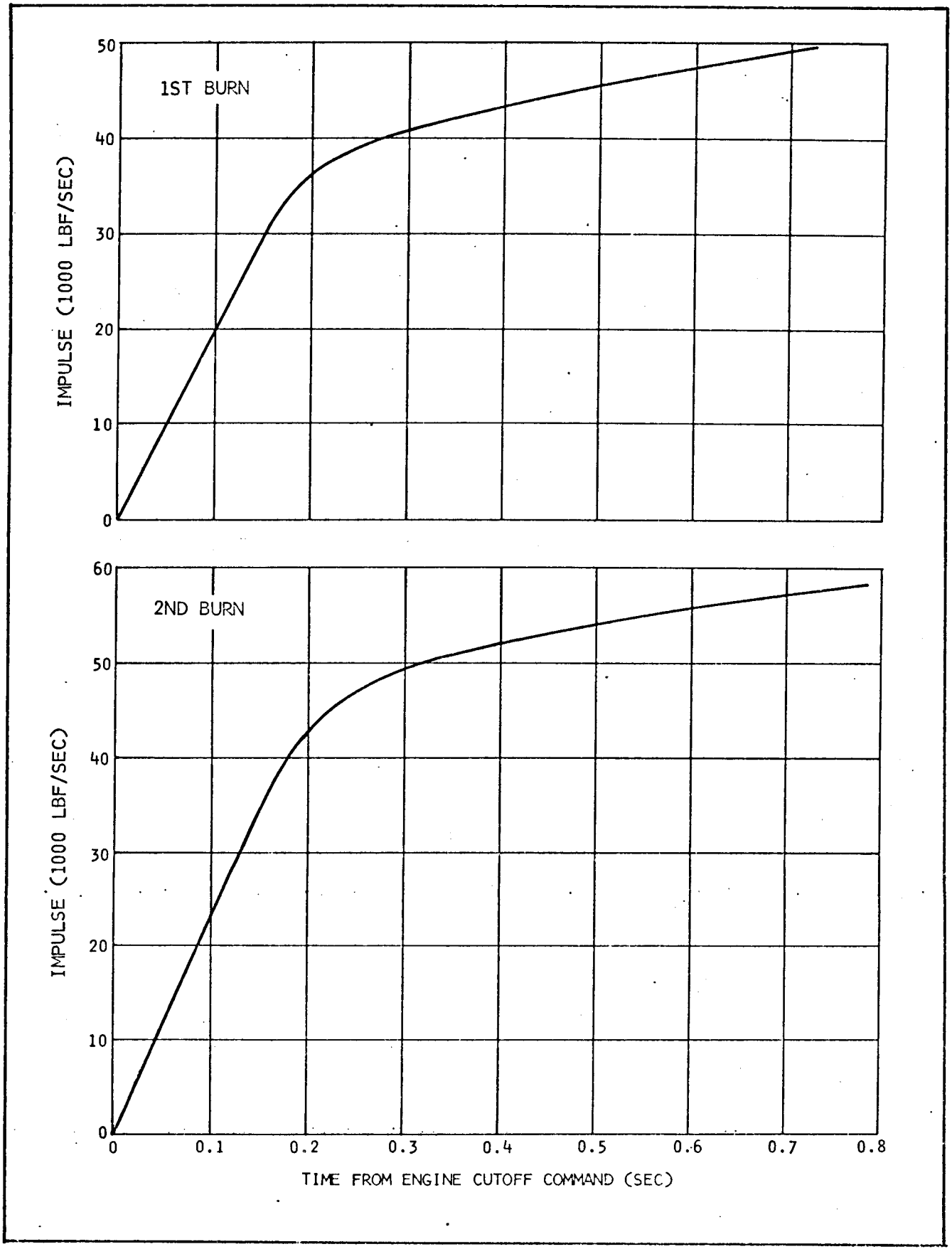


Figure 6-26. Total Accumulated Impulse After Engine Cutoff Command

28 September 1966

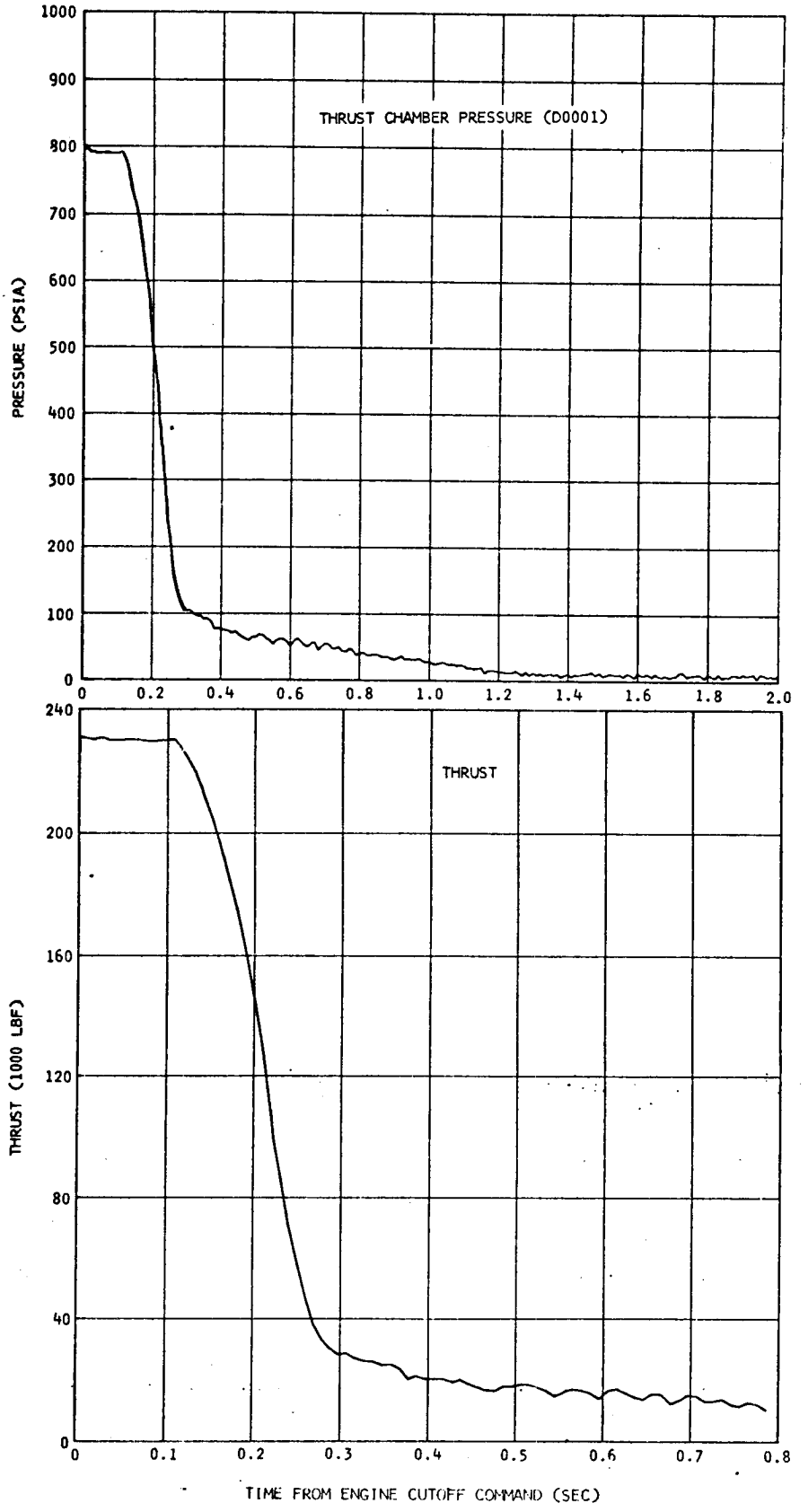


Figure 6-27. Engine Cutoff Transient Characteristics - 1st Burn

28 September 1966

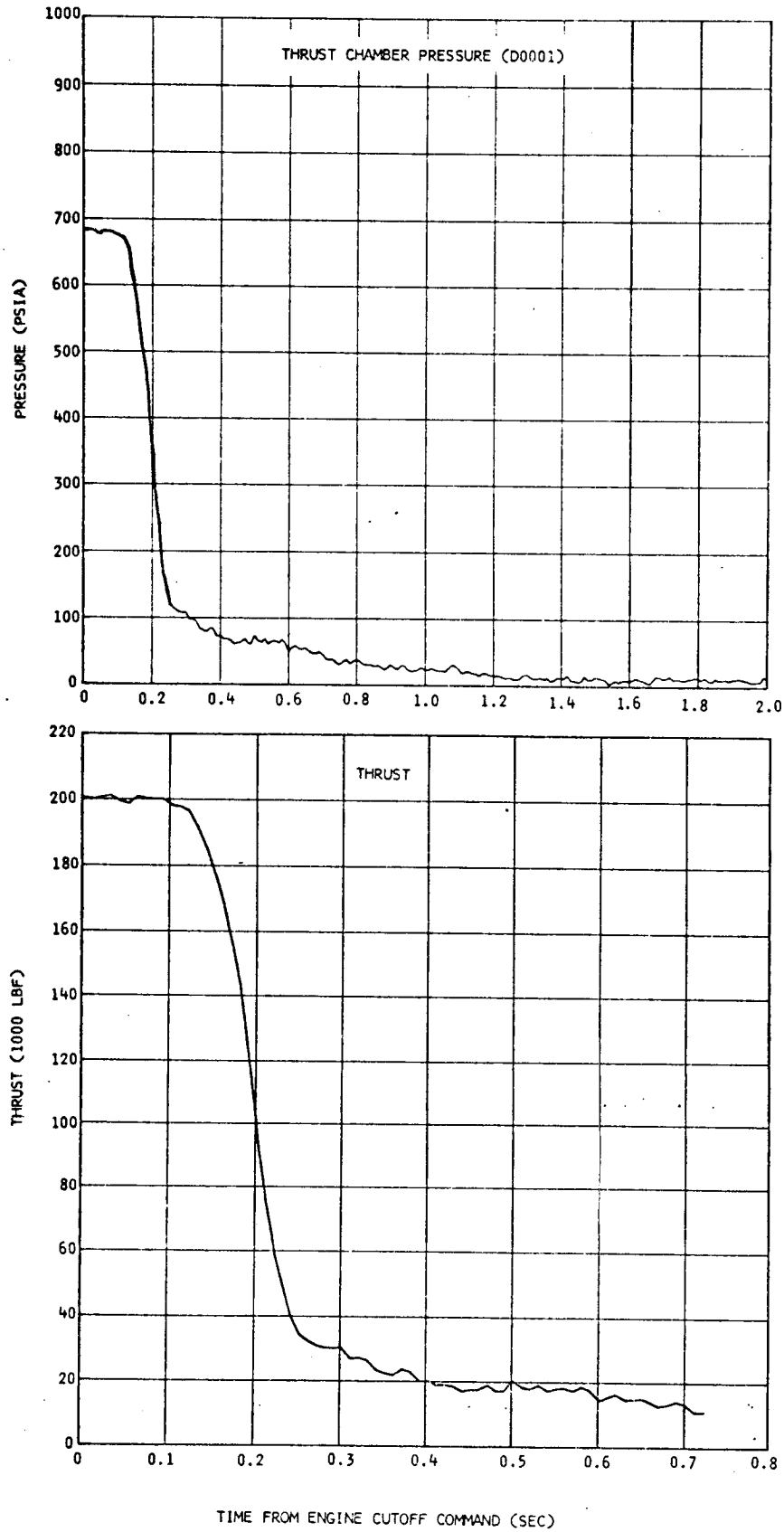


Figure 6-28. Engine Cutoff Transient Characteristics - 2nd Burn

28 September 1966

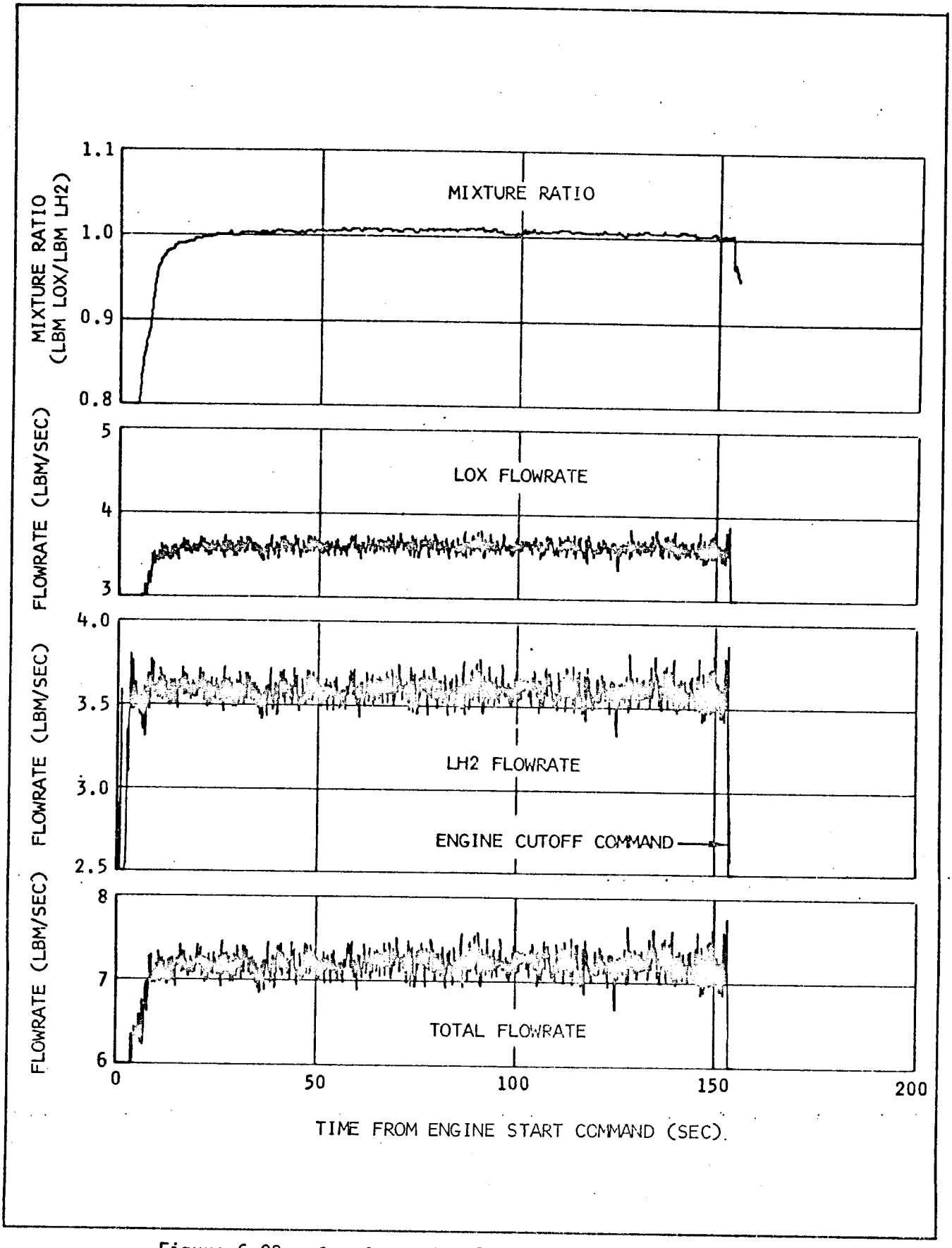


Figure 6-29. Gas Generator Performance - 1st Burn

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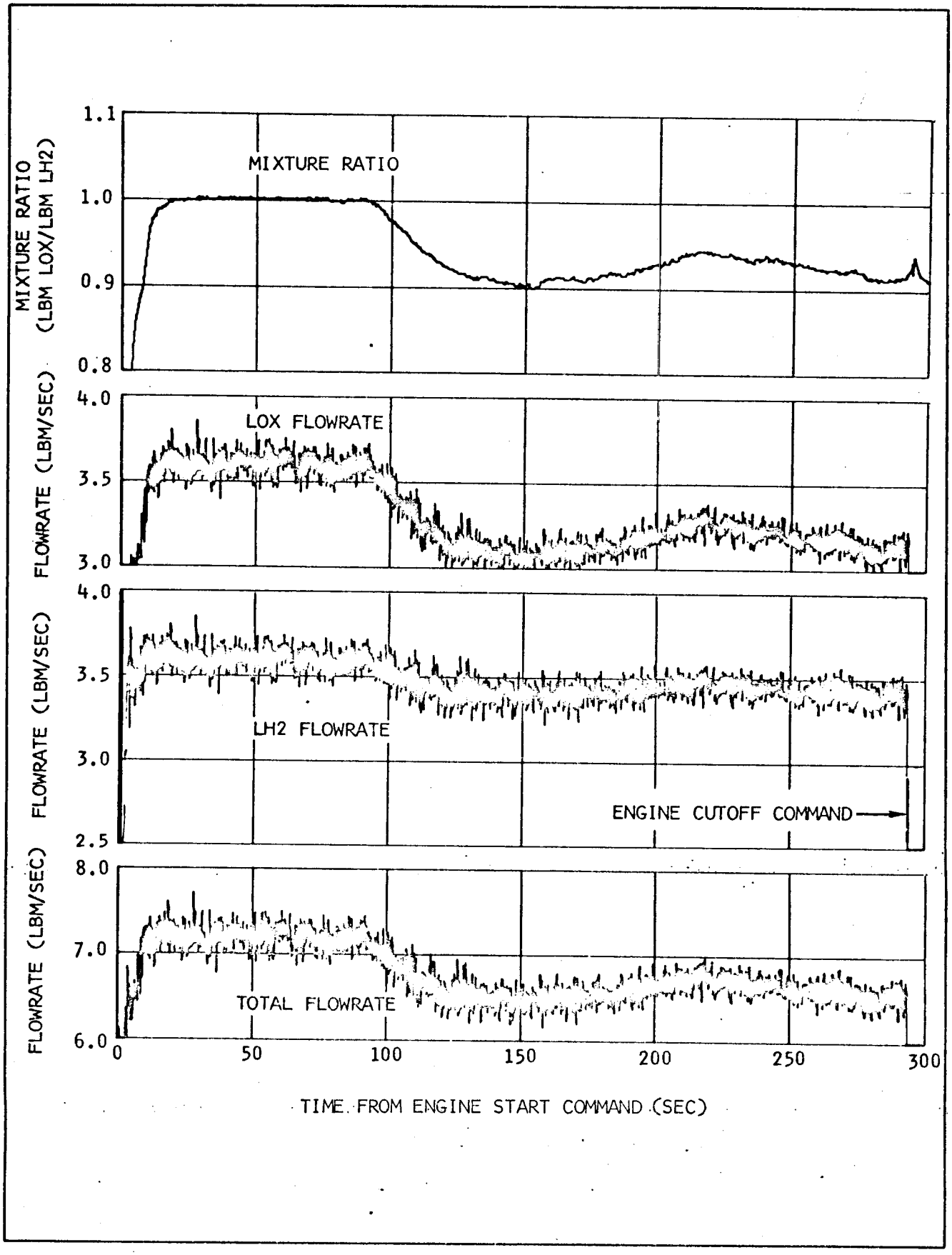


Figure 6-30. Gas Generator Performance - 2nd Burn

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# 7. OXIDIZER SYSTEM

The oxidizer system performed adequately, supplying LOX to the engine pump inlet within the specified operating limits during 1st and 2nd burn. The available NPSH at the LOX pump inlet exceeded the engine manufacturer's minimum requirement at all times.

The LOX recirculation system operated normally during both 1st and 2nd start engine pump conditioning. The tank pressurization system performance was adequate.

## 7.1 Pressurization Control and Internal Environment

The pressurization system (figure 7-1) satisfactorily maintained pressure in the LOX tank during 1st and 2nd burns.

### 7.1.1 First Burn

#### 7.1.1.1 Prepressurization

LOX tank prepressurization was initiated at ESC -674 sec and increased the LOX tank ullage pressure from ambient to 40.3 psia within 19 sec (figure 7-2). One makeup cycle was required to maintain the LOX tank ullage pressure before the ullage temperature stabilized. The pressurization control pressure switch controlled the pressure between 38.5 and 41.0 psia. After the makeup cycle, the ullage pressure began to decrease until the ambient helium purge of the LOX tank vent valve overcame the ullage collapse at approximately ESC -620 sec and increased the ullage pressure to 41.8 psia, at which time the relief valve activated. Following the cessation of the ambient purge at ESC -511 sec (simulated liftoff), the pressure slowly decreased, stabilizing between 37.5 and 37.0 psia for the remainder of simulated boost. During prepressurization, the ullage temperatures responded in a manner similar to that of previous acceptance firings. Significant prepressurization data are presented in table 7-1.

The pressurization flowrates were calculated from temperature and pressure data obtained immediately upstream of the prepressurization control orifice. The flowrate was determined to vary from 0.27 to 0.37 lbm/sec; the quantity of helium added to the LOX tank ullage was calculated to be 6.1 lbm. The makeup cycle contributed an additional 0.57 lbm, giving a total helium mass in the LOX tank ullage of 6.67 lbm at the end of the makeup cycle. The

flowrate was less than on the S-IVB-501 stage because the prepressurization orifice was changed to one with a much smaller area (0.0069 in.$^2$ vs 0.0182 in.$^2$).

7.1.1.2 Pressurization

The LOX tank ullage pressure was 36.8 psia at Engine Start Command (figure 7-3), satisfying the engine start requirements (figure 7-4). During the start transient, the ullage pressure momentarily increased then decreased to a minimum of 33.8 psia before the pressurant flowrate became large enough to increase the ullage pressure. The first overcontrol cycle was terminated by the pressure switch when the ullage pressure reached 39.8 psia. The ullage then cycled between 38.0 and 39.7 psia for the remainder of the firing.

Three cycles were required to maintain the ullage pressure above 38.0 psia. The pressure switch operating limits were within the S-IVB/V limits of 38 to 41 psia.

The ullage temperatures showed a stratified profile similar to those noted during the S-IVB-501 stage acceptance firing.

The pressurization total flowrate varied from 0.38 to 0.40 lbm/sec during overcontrol, and from 0.26 to 0.28 lbm/sec during undercontrol. The variation in total flowrate was caused by a variation of the bypass flowrate and is the normal result of the bypass orifice inlet temperature following the cold helium sphere temperature. The flowrates noted were very similar to those of the S-IVB-501 stage acceptance firing.

The collapse factor reached a maximum of 1.40 at ESC +125 sec and then remained essentially constant until engine cutoff. The collapse factor stabilized because the temperatures of both the pressurant and the ullage stabilized. Since the pressurant was at a higher temperature, it continued to collapse as it entered the LOX tank.

7.1.1.3 LOX Tank Pressurization Control Module

The LOX tank pressurization control module outlet temperature (figure 7-3) was calculated from the J-2 heat exchanger outlet temperature with correction factors obtained from previous test data. It decreased rapidly after

Engine Start Command as the module cooled. The temperature then slowly cycled between 45 and 60 deg R in response to the overcontrol and undercontrol cycles. This temperature was used to calculate the flowrate of the helium bypassing the heat exchanger.

The module outlet pressure data were invalid, and the necessary data were simulated using the heat exchanger outlet pressure (D0161) and correction factors obtained from previous test data. During undercontrol and overcontrol operation, this pressure operated at 425 psia and 390 to 400 psia, respectively, which compares well with previous acceptance firing results of the S-IVB/IB and S-IVB/V stages.

#### 7.1.1.4 Cold Helium Supply

At simulated liftoff, the cold helium sphere conditions were 3,280 psia and an average temperature of 41 deg R (figure 7-5). By Engine Start Command, the sphere pressure and temperature decreased to 3,200 psia and 40 deg R. Calculations indicate that no mass loss from leakage occurred during the simulated boost period.

During engine firing, the sphere pressure decreased to 1,670 psia and the temperatures in all the spheres decreased to an average of 31.5 deg R. The temperature in sphere 4 was not valid.

Calculations using the cold helium sphere temperature and pressure conditions indicate that the spheres were loaded with 345 lbm of helium at Engine Start Command. A summation of helium flowrates, calculated from the control orifice temperature and pressure conditions, indicates a consumption of approximately 50.2 lbm for LOX tank pressurization as compared with 50.4 lbm used for LOX tank pressurization for S-IVB-501.

#### 7.1.1.5 J-2 Heat Exchanger

The J-2 heat exchanger operation data and performance calculations are presented in figure 7-6. Pressure and temperature levels were generally as expected and were very consistent with those noted during the S-IVB-501 acceptance firing.

The maximum LOX tank vent inlet temperature was 550 deg R, and occurred during the initial overcontrol operation. This was slightly higher than the predicted maximum temperature for this parameter.

The LOX diffuser temperature followed the LOX vent inlet temperature but was 30 to 50 deg R higher than the predicted maximum level.

Figure 7-6 also compares the LOX tank vent inlet temperature and the theoretical gas mixture temperature (the temperature that would be obtained by completely mixing the cold bypass gas and the hot gas from the J-2 heat exchanger, neglecting heat transfer with the line wall). This comparison gives an indication of the heat transfer to or from the pressurization lines between the mixing point and the LOX vent inlet. Heat losses in the vent line and the LOX bulk are also presented in figure 7-6.

### 7.1.2 Second Burn

#### 7.1.2.1 Prepressurization and Repressurization

LOX tank prepressurization was initiated from the GSE supply at ESC -700 sec with the LOX tank vent valve opened in order to eliminate the usual warm gas that enters the tank during the first period of flow (figure 7-7). At ESC -630 sec the vent valve was closed and the tank pressure was increased to 32 psia. Prepressurization was shut off and it was hoped that the pressure would stabilize at or very near this value; however, the pressure immediately started to decrease as it did during prepressurization of the S-IVB-501 stage. By ESC -323 sec the pressure had reached 26 psia and the repressurization sphere system was activated. The system orifices had been sized to simulate the expected operational characteristics of the LOX/LH2 burner. The repressurization system served only to halt the LOX tank ullage pressure decrease and did not, as expected, increase the ullage pressure. At ESC -280 sec the ground prepressurization system was reactivated to increase the ullage pressure to 35 psia. At ESC -145 sec the ground pressurization system was again activated to further increase the pressure to 37 psia. By Engine Start Command, the ullage pressure had decreased to 35 psia. This was 1 psi less than the desired minimum start pressure.

The prepressurization flowrate varied from 0.45 to 0.35 lbm/sec, and a total of 52.5 lbm of helium were added to the ullage during the three pressurization cycles. The prepressurization flowrate was higher than that prior to 1st burn because the GSE supply system was precooled by the 60-sec flow to

the LOX tank (while the tank vent valve was open); therefore, the supply orifice temperature was 20 deg lower than encountered during 1st burn prepressurization.

Repressurization was initated at ESC -325 sec and terminated at Engine Start Command (figure 7-7). During this period, 10.25 lbm of helium were added to the LOX tank ullage from the repressurization spheres.

During the attempted repressurization, the sphere pressure dropped from 3,090 psia to 1,220 psia at engine start, with comparable temperatures of 526 and 463 deg R. At Engine Start Command, the ullage contained 63.25 lbm of helium, and the ullage pressure was 35 psia.

7.1.2.2 Pressurization

The LOX tank ullage pressure at 2nd Engine Start Command was at 35 psia, which was less than desired; however, no adverse effects were noted. During this 293-sec firing, the secondary flow was activated three times (figure 7-8), and 105 lbm of helium were added to the ullage, as compared with approximately 93 lbm used by S-IVB-501.

The secondary flow was activated at Engine Start Command as the ullage pressure was 35 psia. The pressure decreased slightly and reached a minimum of 34.6 psia before the pressure and temperature transients of the system stabilized and the pressurant flowrate increased enough to cause the ullage pressure to rise. This is the normal reaction of the ullage pressure during the start transient. The ullage pressure then cycled between 38.0 and 39.8 psia for the duration of the firing. This agrees with the control band range obtained during the 1st burn.

The pressurization cycles were increasingly further apart as the firing progressed, with the last overcontrol period starting at ESC +260 sec. This has been noted on previous S-IVB/IB acceptance firings and is the result of the decrease of pressurant collapse, requiring less gas to maintain the ullage pressure.

In this firing, as in previous acceptance firings, the ullage temperatures presented a stratified profile.

The pressurization total flowrate varied from 0.4 to 0.41 lbm/sec during overcontrol and was 0.28 lbm/sec during undercontrol. Variations in total

flowrate were caused by the variation of the bypass orifice inlet temperature which changes as the cold helium sphere temperature changes and is a normal characteristic. Predicted total flowrates were 0.38 to 0.39 lbm/sec during overcontrol and 0.23 to 0.25 lbm/sec during undercontrol.

The collapse factor reached a maximum of 1.6 at ESC +120 sec, then decreased, reaching 1.45 at engine cutoff. This decrease of the collapse factor was caused by the decreasing spread between the ullage and incoming pressurant temperatures.

#### 7.1.2.3 LOX Tank Pressurization Control Module

The LOX tank pressurization control module outlet temperature was obtained by correcting the heat exchanger inlet temperature using relationships from other acceptance firing data. This temperature (figure 7-8) was used to calculate the flowrate of the helium bypassing the heat exchanger.

The pressurization module outlet pressure data were invalid; therefore, the history of this pressure was constructed by using the heat exchanger outlet pressure (D0161) and relationships derived from previous acceptance firings.

This pressure displayed its normal start transient and operating characteristics. A maximum operating pressure of 430 psia was reached during the final undercontrol cycle. Although this pressure was slightly outside the design band of 400 $\pm$25 psia as measured at the plenum chamber exit, it had no adverse effect on the pressurization system operation.

#### 7.1.2.4 Cold Helium Supply

The cold helium temperature and pressure conditions indicated that 281.8 lbm helium were in the spheres at 2nd Engine Start Command. This compares with 295.2 lbm at the end of 1st burn, or approximately 13.4 lbm helium unaccounted for as leakage or as computational errors resulting from data inaccuracies. During the firing, the spheres cooled as the helium was used to pressurize the tank and then warmed as they became uncovered. The sphere temperatures decreased normally, with the No. 5, 3, 2, and 1 spheres dropping to 46.5, 40, 34.5, and 33 deg R, respectively, at ESC +150 sec (figure 7-9). The sphere pressure was 1,090 psia at engine cutoff.

A summation of helium flowrates calculated from temperature and pressure

conditions at the control orifice indicated a consumption of approximately 105.5 lbm helium.

7.1.2.5 J-2 Heat Exchanger

The J-2 heat exchanger inlet temperature began to decrease immediately after engine start as the line was being cooled. The temperature decreased to 110 deg R at ESC +32 sec and stabilized at 75 deg R during overcontrol and 90 to 95 deg R during undercontrol (figure 7-10). During the start transient, the heat exchanger outlet temperature increased to 970 deg R by ESC +90 sec, decreased to 930 deg R at EMR cutback, then cycled between 900 and 965 deg R for the duration of the firing.

For the ambient conditions registered during 2nd burn, the temperature loss between the heat exchanger outlet and the transducer was estimated to be 17 deg R during overcontrol and 45 deg R during undercontrol. Applying these corrections to the heat exchanger temperature results in close agreement with predictions.

The heat exchanger outlet pressure alternated between 350 and 420 psia during overcontrol and undercontrol, respectively, and was very similar to that noted during both the 1st burn of this stage and the S-IVB-501 acceptance firing. The flow through the heat exchanger was relatively constant at 0.21 lbm/sec during overcontrol and 0.075 lbm/sec during undercontrol. The LOX tank vent inlet pressure reflected the cycling and averaged 47 psia during undercontrol and 64 psia during overcontrol (the same as 1st burn). A maximum vent inlet temperature of 540 deg R occurred during overcontrol. Figure 7-10 compares the vent inlet temperature and the theoretical gas mixture temperature and gives an indication of the heat transfer to or from the line between the mixing point and the vent inlet. The data show that the system was stabilized after ESC +110 sec.

The LOX diffuser temperature continued to increase during the initial extended period of overcontrol operation and reached a maximum of 460 deg R at the end of the first overcontrol cycle. The data show that the minimum temperature during undercontrol was 310 deg R. Figure 7-10 shows the heat lost by the pressurant helium to the LOX bulk as it was flowing through the LOX tank vent line. The changing slope of the top of the data trace

shows the effect of the decreasing LOX head and the heat loss. The calculations of the energy entering the LOX tank ullage, based on the diffuser temperature, was approximately 225 Btu/sec during overcontrol and 110 Btu/sec during undercontrol.

## 7.2 Oxidizer System Conditions During Simulated Orbit

### 7.2.1 Cold Helium Spheres

The cold helium sphere conditions at 1st burn engine cutoff were as shown in figure 7-5. All of the sphere temperatures were appreciably lower than the LH2 bulk temperature because of cooling during the cold helium usage of 1st burn. At engine cutoff, helium consumption from the spheres ceased and the temperatures immediately started to increase toward the bulk temperature. Spheres 4 and 5, being in the warmer ullage gas above the LH2, warmed to a higher temperature. Figure 7-11 shows a normal temperature and pressure profile from engine cutoff until ECC +3,100 sec. The sphere pressure started to decrease from its maximum of 2,350 psia as the ullage temperatures suddenly decreased when the tank was vented and the maximum ullage temperatures became less than the highest sphere temperature. The sphere pressure then remained relatively constant until 2nd burn Engine Start Command.

At ECC +1,500 sec, LH2 boiloff lowered the surface level of the LH2 sufficiently to partially expose spheres 3 and 6 which caused these two temperatures to show a slight, continuous increase for the duration of the simulated orbital coast (sphere 3 temperature only was recorded). Just prior to prepressurization for 2nd burn, the sphere pressure was stabilized to 2,240 psia. The sphere temperatures at Engine Start Command were 39.5, 39.5, 51, and 58 for spheres 1, 2, 3, and 5, respectively.

### 7.2.2 LOX Tank Ullage Pressure During Simulated Orbit

The LOX tank ullage pressure was 38.0 psia at 1st burn engine cutoff. It decayed, then increased to 35.5 psia at ECC +650 sec at which time the tank vent valve was opened (figure 7- 12. The pressure dropped to 17.7 psia within 10 to 15 sec and slowly decayed to 15.5 psia at ESC +1,500 sec when it stabilized.

During the LOX tank blowdown, the ullage temperatures dropped from 240 - 270 deg R to 160 - 180 deg R within 1,200 sec of the LOX tank vent actuation and then slowly decreased to the saturation level (approximately 164 deg R) at ECC +2,000 sec. The LOX tank vent remained open with stable temperature and pressure conditions in the tank until prepressurization prior to the 2nd engine firing.

## 7.3 LOX Pump Chilldown

The LOX pump chilldown system performance satisfactorily met the engine inlet start conditions for both firing operations.

### 7.3.1 First Burn

At Engine Start Command the pump inlet conditions of 44.8 psia and 165.4 deg R were sufficient to produce an NPSH of 27.6 psi which was well above the minimum requirement of 16.5 psi (figure 7-13).

During loading, the prevalve and gas generator bleed valve were open and allowed LOX to enter the system and cool the engine LOX turbopump and the circulation system before the chilldown pump was started. Recirculation chilldown was started approximately 45 sec before initiation of tank prepressurization and was terminated shortly before engine start when the prevalve was commanded open, with the chilldown pump still running, to remove any bubbles that may have collected under the prevalve during chilldown.

| EVENT | TIME FROM ESC (sec) |
|---|---|
| Prevalve Open Command | -3.13 |
| Prevalve Closed Signal Dropout | -2.19 |
| Prevalve Open Signal Pickup | -0.91 |
| Chilldown Shutoff Valve Closed | -0.571 |
| Chilldown Pump Stopped | -0.88 |

The pump inlet and return line pressures followed the cycling ullage pressure during chilldown. When the prevalve was opened, the chilldown-pump-developed head decreased to a small value while the flowrate increased because

essentially all the flow returned to the tank through the open prevalve. The pump inlet pressure decreased at this time because of the loss of chilldown-pump-developed pressure. The chilldown system fluid temperatures decreased during the initial minute of chilldown, then remained relatively constant until prepressurization at which time the temperature increased because of bulk heating.

During the entire chilldown period the LOX was subcooled throughout the recirculation system. The chilldown flowrate was 38.7 gpm before prepressurization and 40.9 gpm afterwards, with a frictional pressure drop of 8.4 psi through the system. During pressurized chilldown, the system flow coefficient was 14.4 $sec^2/in.^2 ft^3$ which was approximately the same as that found in previous acceptance firings.

The NPSH at the turbopump inlet increased from 4.7 to 13.4 psi when the chilldown pump was started and remained constant until prepressurization was initiated. The NPSH then increased a maximum to 41.2 psi and varied directly with the ullage pressure until the prevalve was opened and caused it to drop from 36.0 to 27.4 psi.

The heat input rate from the tank to the turbopump inlet (section 1), from the pump inlet to the bleed valve (section 2), and from the bleed valve to the tank inlet (section 3) decreased rapidly during the first minute of chilldown and then remained relatively constant during the subsequent chilldown process (figure 7-14). The heating rates are comparable to those of previous acceptance firings and were as follows during steady-state pressurized chilldown:

| SECTION | HEAT INPUT RATE (Btu/hr) |
|---|---|
| 1 | 2,900 |
| 2 | 13,600 |
| 3 | 4,400 |
| Total | 20,900 |

### 7.3.2 Second Burn

At engine start, the pump inlet pressure was 40.2 psia and the temperature

was 165.4 deg R (figure 7-15). The NPSH at engine start was 22.8 psi, satisfying the minimum acceptable limit of 16.5 psi.

After 1st burn engine cutoff, the prevalves were closed. Except for valve cycling approximately 60 sec after cutoff, they remained closed for approximately 3,000 sec during the simulated orbital coast period. During this time, the feed ducts were purged with helium to remove the propellants from the recirculation system. After 3,000 sec the prevalves were opened to allow propellants into the system and partially chill the engine turbopumps before the recirculation was initiated.

The recirculation chilldown pump was started approximately 90 sec before initiation of tank prepressurization.

| EVENT | TIME FROM ESC (sec) |
|---|---|
| Prevalve Open Command | -3.14 |
| Prevalve Closed Signal Dropout | -2.12 |
| Prevalve Open Signal Pickup | -0.91 |
| Chilldown Shutoff Valve Closed | -0.61 |
| Chilldown Pump Stopped | -0.82 |

The chilldown system fluid temperatures decreased during the first minute of chilldown, then remained relatively constant until prepressurization. The temperature increased slightly after prepressurization because of LOX bulk heating.

During the chilldown process the LOX was subcooled throughout the entire recirculation system. When the chilldown pump was started, the flowrate immediately increased to a value of 38.6 gpm as liquid was pumped into the system (figure 7-15). After the initiation of prepressurization the flowrate rapidly attained its steady-state value of 40.9 gpm. The chilldown frictional pressure drop was 6.65 psi prior to prepressurization and 7.71 psi after prepressurization. The flow coefficient was 13.27 $sec^2/in.^2 ft^3$ (figure 7-16), which was comparable to that calculated for the 1st burn.

When the chilldown pump was started, the NPSH at the turbopump inlet increased from 0.30 to 14.04 psi and remained constant until prepressurization occurred.

The NPSH then increased to 29.1 psi and varied directly with the ullage pressure until the prevalve was opened causing the NPSH to drop from 31.8 to 22.8 psi as a result of the decrease in pump inlet pressure.

The heat input rates for the three sections were computed as for the 1st burn operations. The system temperature responses were very similar although the input rates were higher, as noted in the following table.

| SECTION | 1st BURN INPUT RATE (Btu/hr) | 2nd BURN INPUT RATE (Btu/hr) |
|---|---|---|
| 1 | 2,900 | 4,110 |
| 2 | 13,600 | 24,570 |
| 3 | 4,400 | 6,120 |
| Total | 20,900 | 34,800 |

The difference between heat input rates during 1st and 2nd burn chilldown was due to the difference in preconditioning of the recirculation system. Because of the helium purge and subsequent relatively short contact between propellant and hardware prior to recirculation, the latent heat remaining in the hardware at the start of 2nd burn chilldown was greater than it was with 1st burn chilldown.

The LOX supply system (figure 7-17) delivered the necessary quantity of LOX to the engine pump inlet throughout the 1st and 2nd burns and maintained the pressure and temperature conditions within a range that provided a LOX pump NPSH above the minimum requirements of 20.2 psi at high EMR and 14.3 psi after EMR cutback. The minimum available NPSH noted was 17.5 psi which occurred at 2nd burn engine cutoff.

### 7.4.1 First Burn

The LOX pump inlet pressure and temperature were 44.6 psia and 165.5 deg R at engine start. The pressure decreased to 36.4 psia during the start transient (figure 7-18), then cycled with ullage pressure. It varied between 39.0 and 41.4 psia while generally decreasing with time as the LOX in the

tank was consumed, resulting in a decreasing liquid head. The LOX temperature at the pump inlet was 164.7 deg R after the start transient and increased slightly with bulk heating to 165 deg R at engine cutoff.

The available NPSH at the LOX pump inlet increased sharply from 26.5 to 28.7 psi just after engine start as the pump inlet pressure increased from 44.6 to 46.5 psia. It then decreased to a minimum of 22.0 psi during the start transient. The NPSH then cycled with the ullage pressure while generally decreasing with time because of the decreasing liquid head and increasing bulk temperature. At engine cutoff, the NPSH was 24.7 psi. The average frictional pressure drop in the LOX suction duct at the high EMR during the 1st burn was calculated to be 2.6 psi at a flowrate of 462 lb/sec. This pressure drop was within the range of values calculated from previous acceptance firings.

When the LOX pump inlet pressure and temperature were plotted in the engine LOX pump operating region (figure 7-19), they indicated that the engine LOX pump inlet conditions were met satisfactorily throughout the 1st burn engine firing. The trend of the pump inlet temperature, when plotted against the mass remaining in the LOX tank during engine operation (figure 7-20), was very similar to that previously noted during the S-IVB acceptance firing.

### 7.4.2 Second Burn

Operation of the LOX supply system during the 2nd burn was also satisfactory. The LOX pump inlet static pressure was 40 psi at engine start (figure 7-21) and decreased to 35.5 psia at ESC +30 sec. The pressure then, as during the 1st burn, cycled with the ullage pressure between 37.4 and 40.3 psia while generally decreasing with time as the LOX in the tank was consumed. The pressure at engine cutoff was 37.8 psia. The LOX temperature at the pump inlet was 164.5 deg R after the start transient, and increased with bulk heating to a maximum of 169.5 deg R at engine cutoff.

The available NPSH at the LOX pump inlet was 22.6 psi at engine start. It cycled with ullage pressure during the firing while generally decreasing because of decreasing LOX head and increasing LOX bulk temperature. By engine cutoff, the NPSH had decreased to a minimum of 17.5 psi which was well above the allowable minimum of 14.3 psi for that period of time.

The average frictional pressure drop in the LOX suction duct was 2.3 psi during high EMR operation at a LOX flowrate of 462 lb/sec. After EMR cut-back, the pressure drop decreased to 1.65 psi at the LOX flowrate varied between 393 and 408 lb/sec.

When the LOX pump inlet pressure and temperature were plotted in the engine LOX pump operating region (figure 7-22), they indicated that the engine LOX pump inlet operating conditions were met satisfactorily throughout the 2nd burn engine operation. The LOX pump inlet temperatures as a function of the mass remaining in the LOX tank are also shown in figure 7-20.

TABLE 7-1
LOX TANK PREPRESSURIZATION DATA

| ITEM | UNIT |
|---|---|
| Prepressurization Initiation (sec from ESC) | -674 |
| Prepressurization Completion (sec from ESC) | -655 |
| Prepressurization Elapsed Time (sec) | 19 |
| GOX at Start of Prepressurization (lbm) | 25 |
| GOX at Start of Prepressurization (moles) | 0.78 |
| Helium Added during Prepressurization (lbm) | 8.75 |
| Helium Added during Prepressurization (moles) | 2.2 |
| Helium Mass in Ullage (percent) | 25.9 |
| GOX Mass in Ullage (percent) | 74.1 |

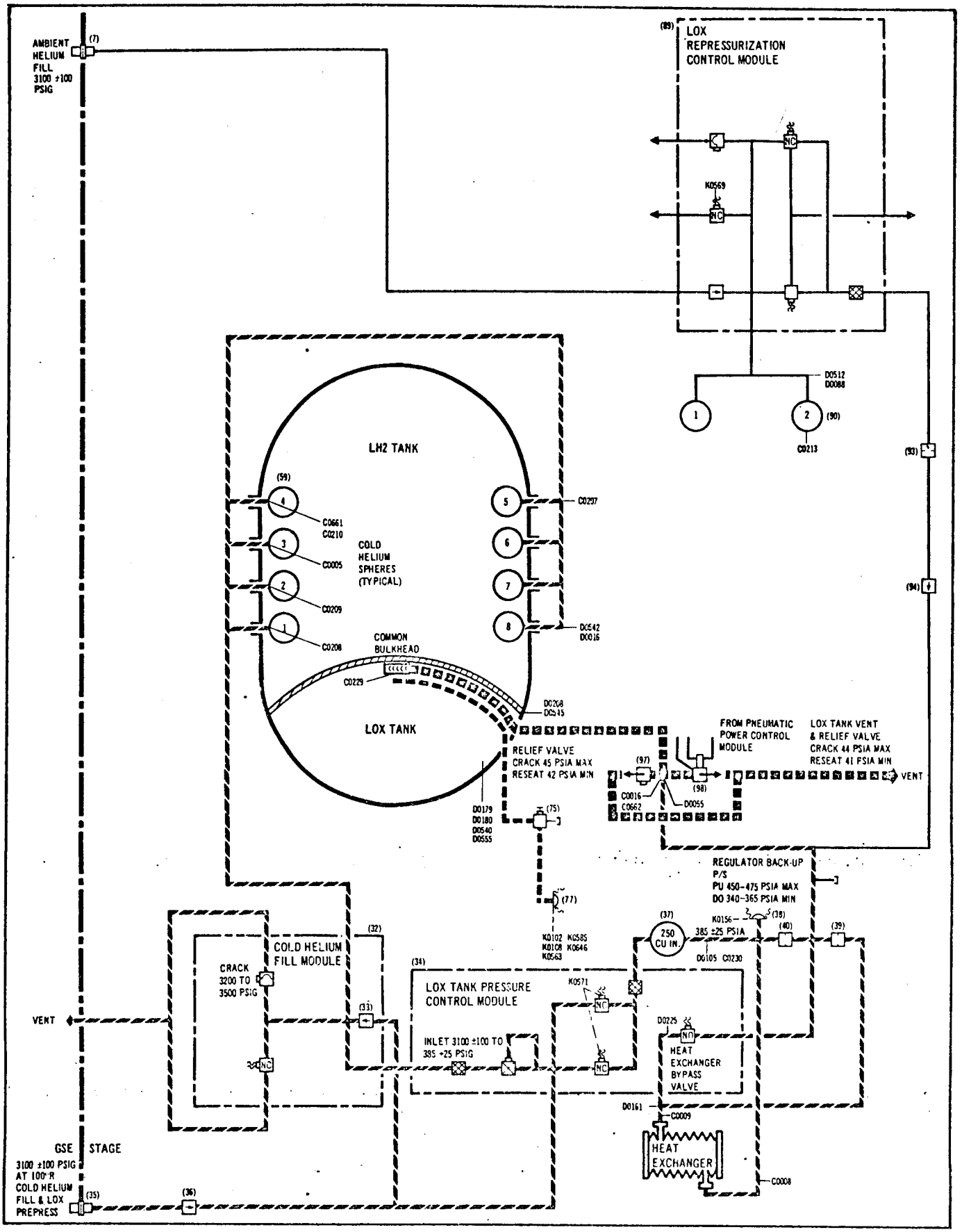


Figure 7-1. LOX Tank Pressurization System

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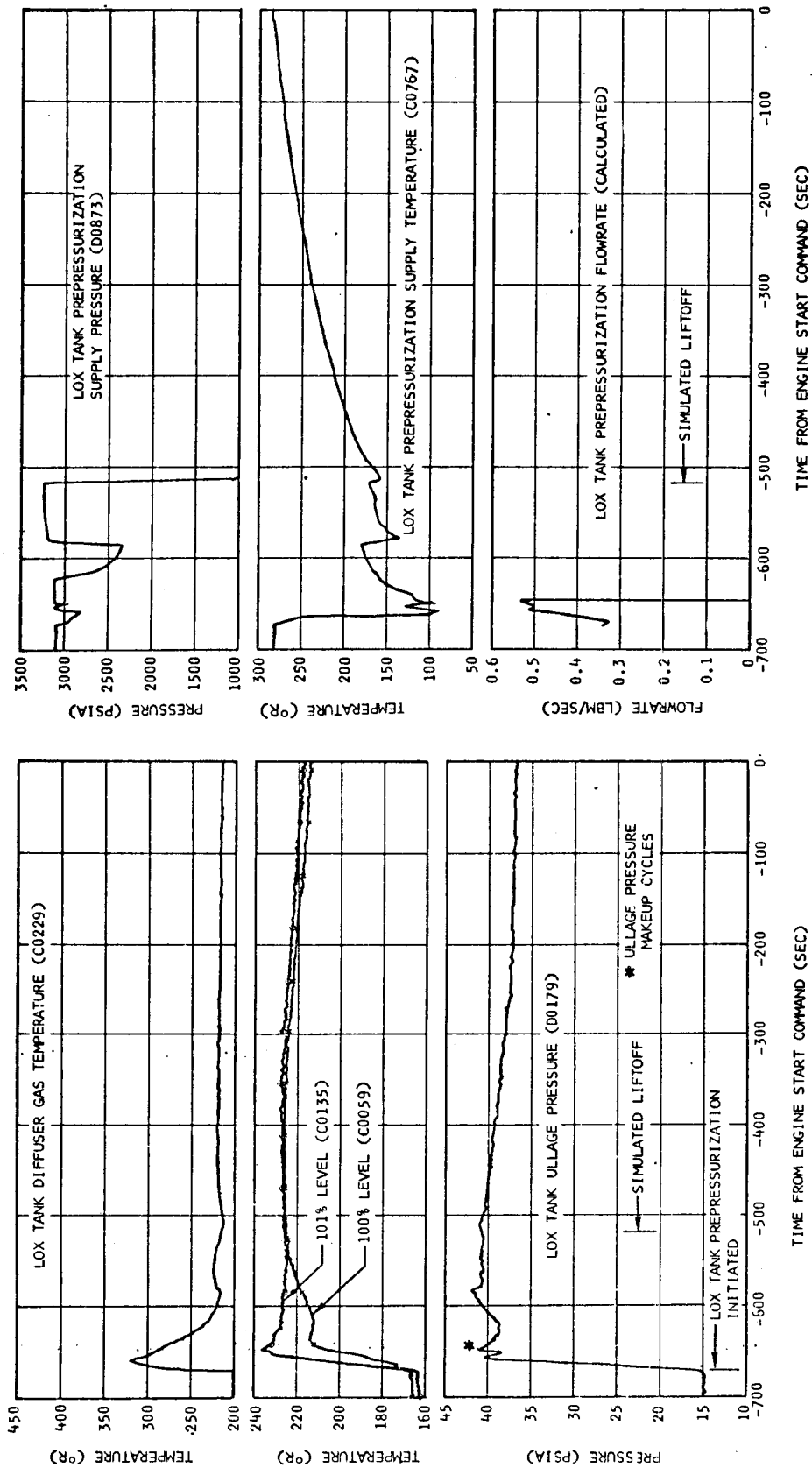


Figure 7-2. LOX Tank Conditions During Prepressurization and Simulated Boost - 1st Burn

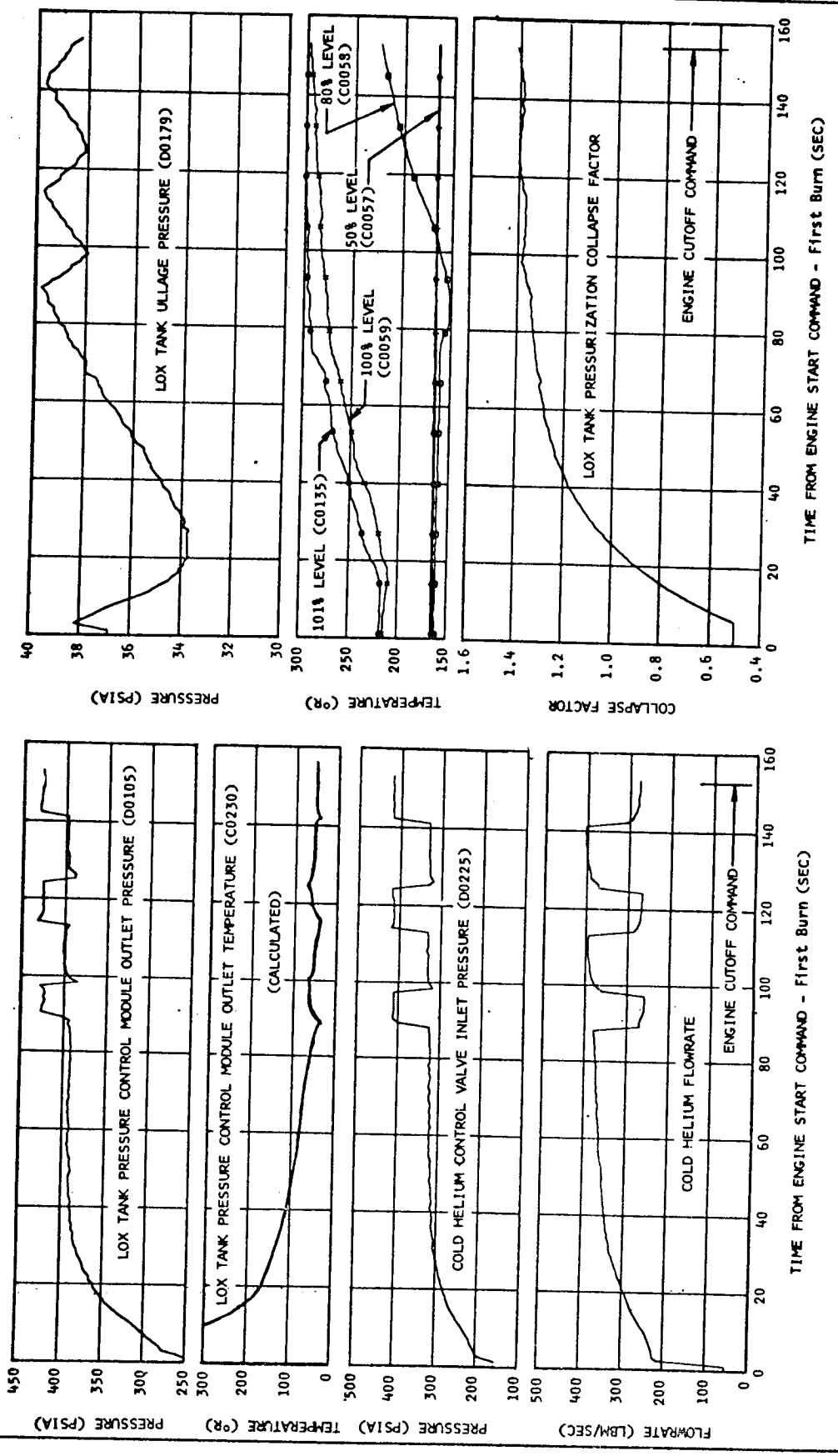


Figure 7-3. LOX Tank Pressurization System Performance - 1st Burn

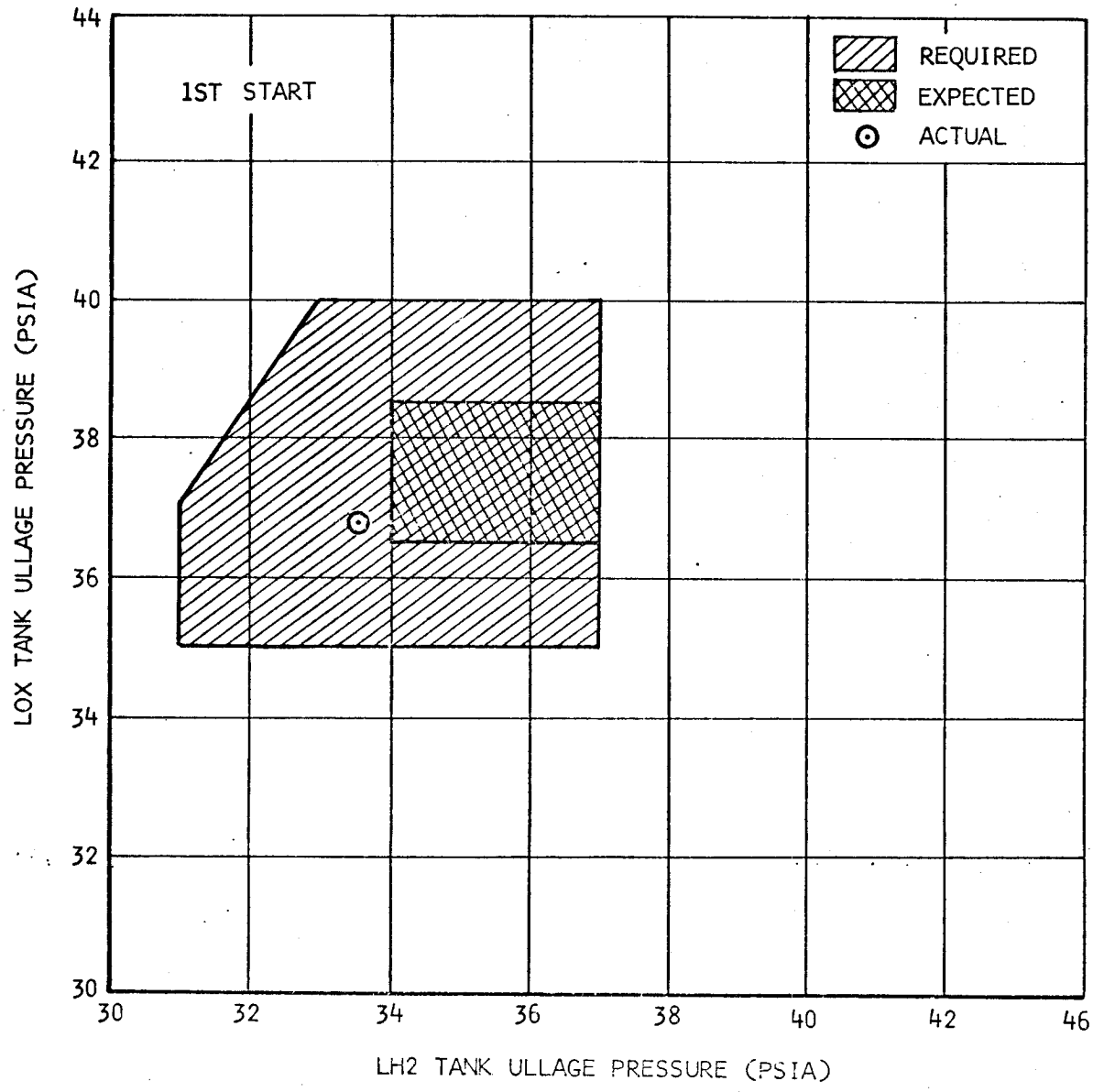


Figure 7-4. Propellant Ullage Prestart Requirements and Conditions

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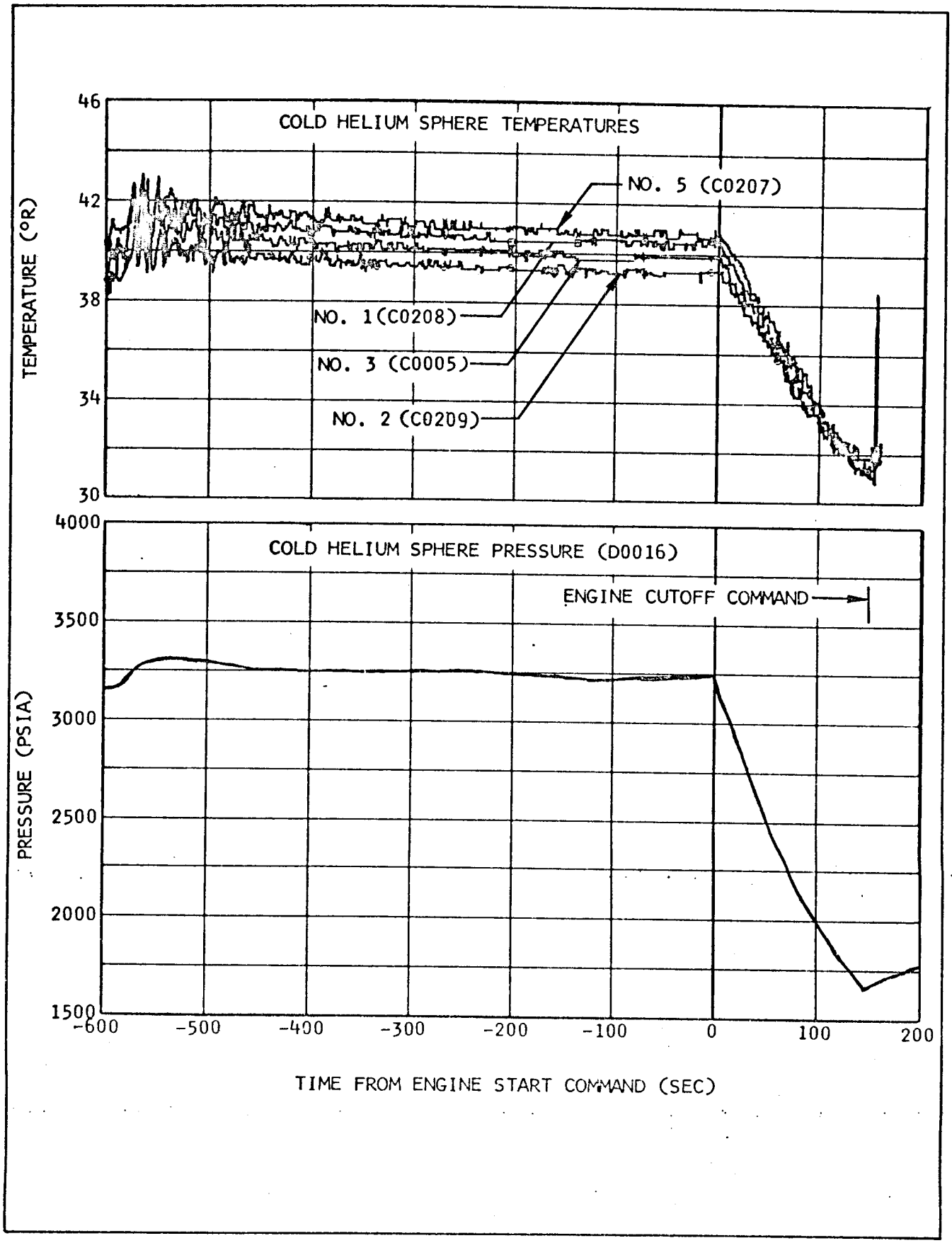


Figure 7-5. Cold Helium Supply - 1st Burn

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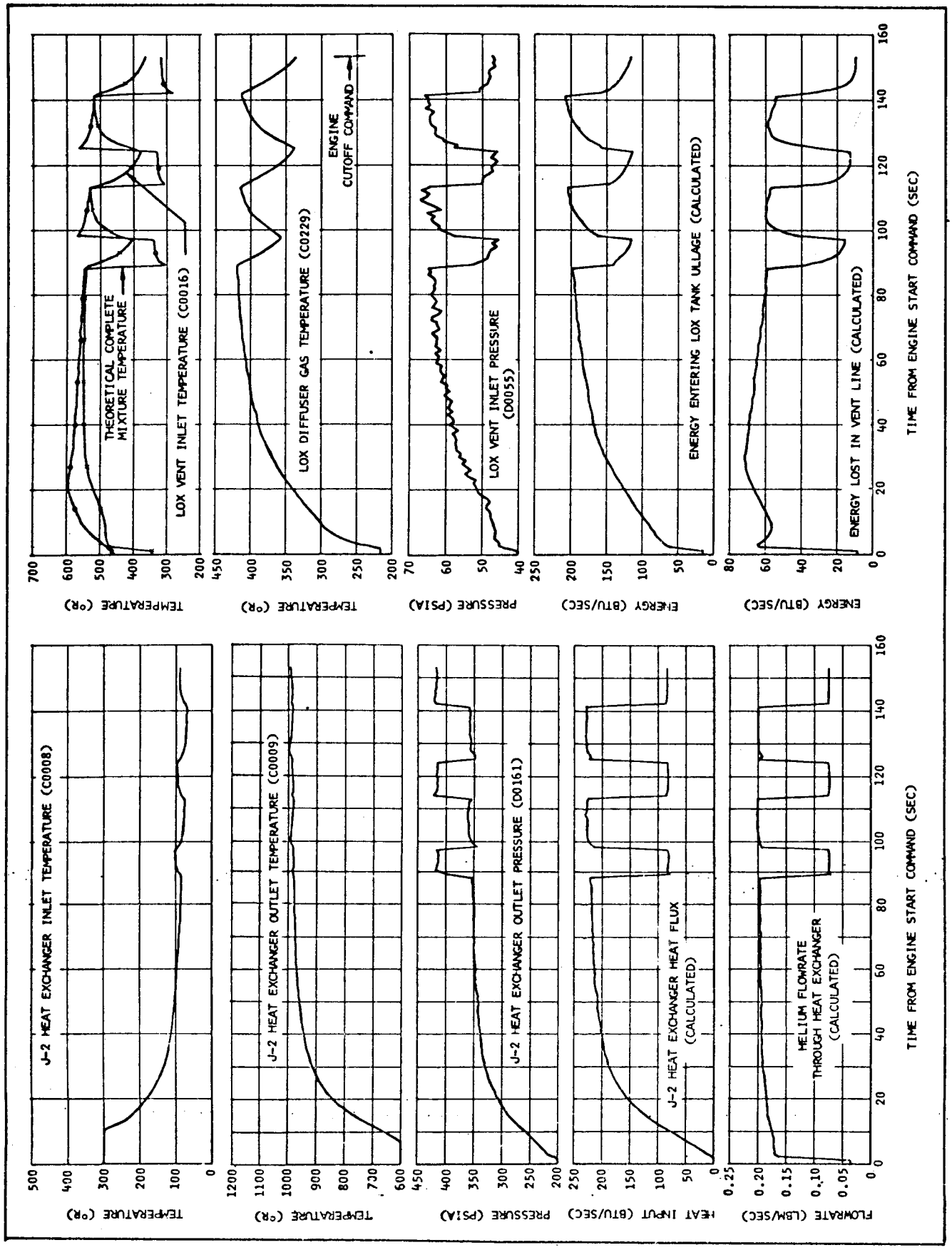


Figure 7-6. J-2 Heat Exchanger Performance - 1st Burn

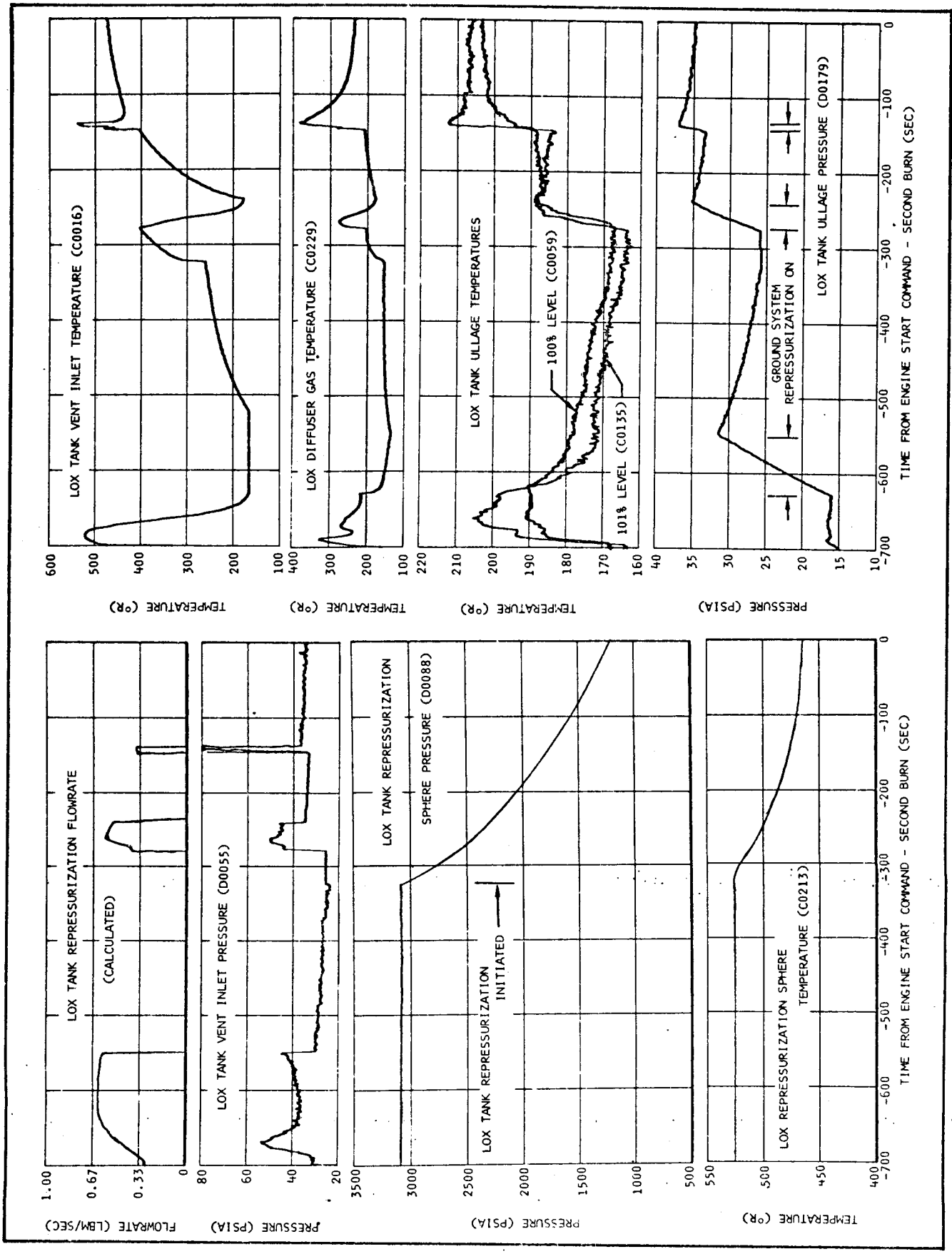


Figure 7-7. LOX Tank Conditions During Repressurization and Prepressurization - 2nd Burn

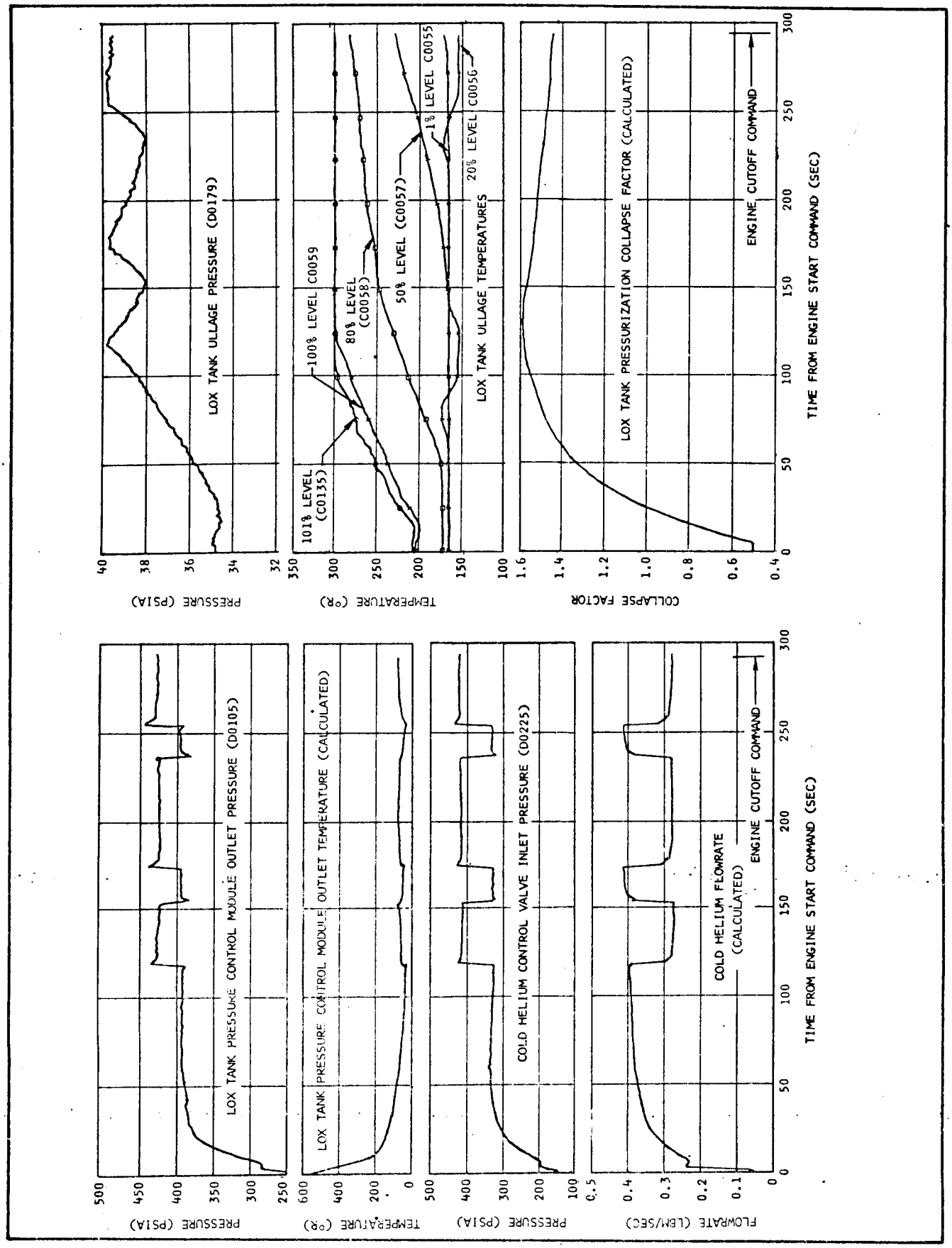


Figure 7-8. LOX Tank Pressurization System Performance - 2nd Burn

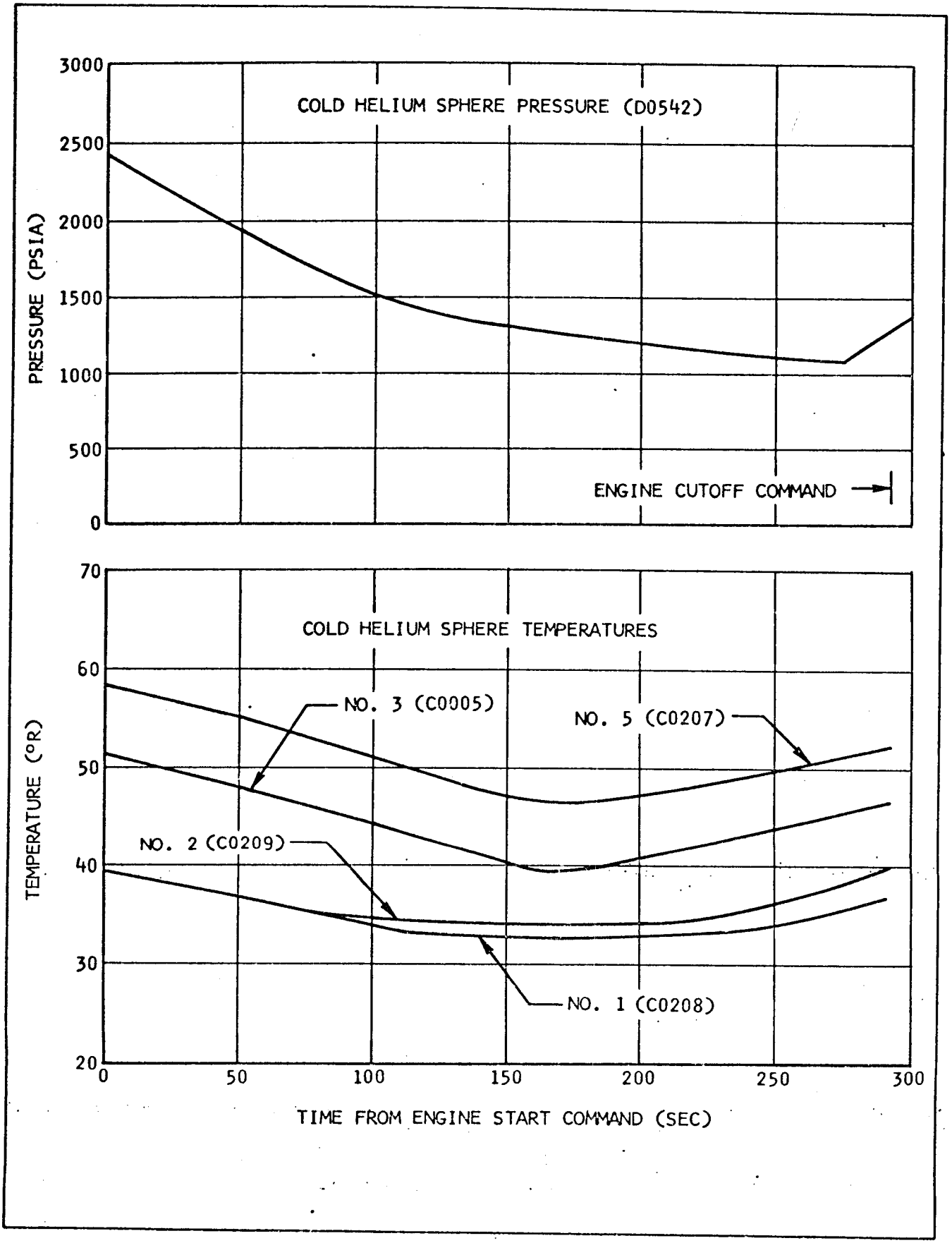


Figure 7-9. Cold Helium Supply - 2nd Burn

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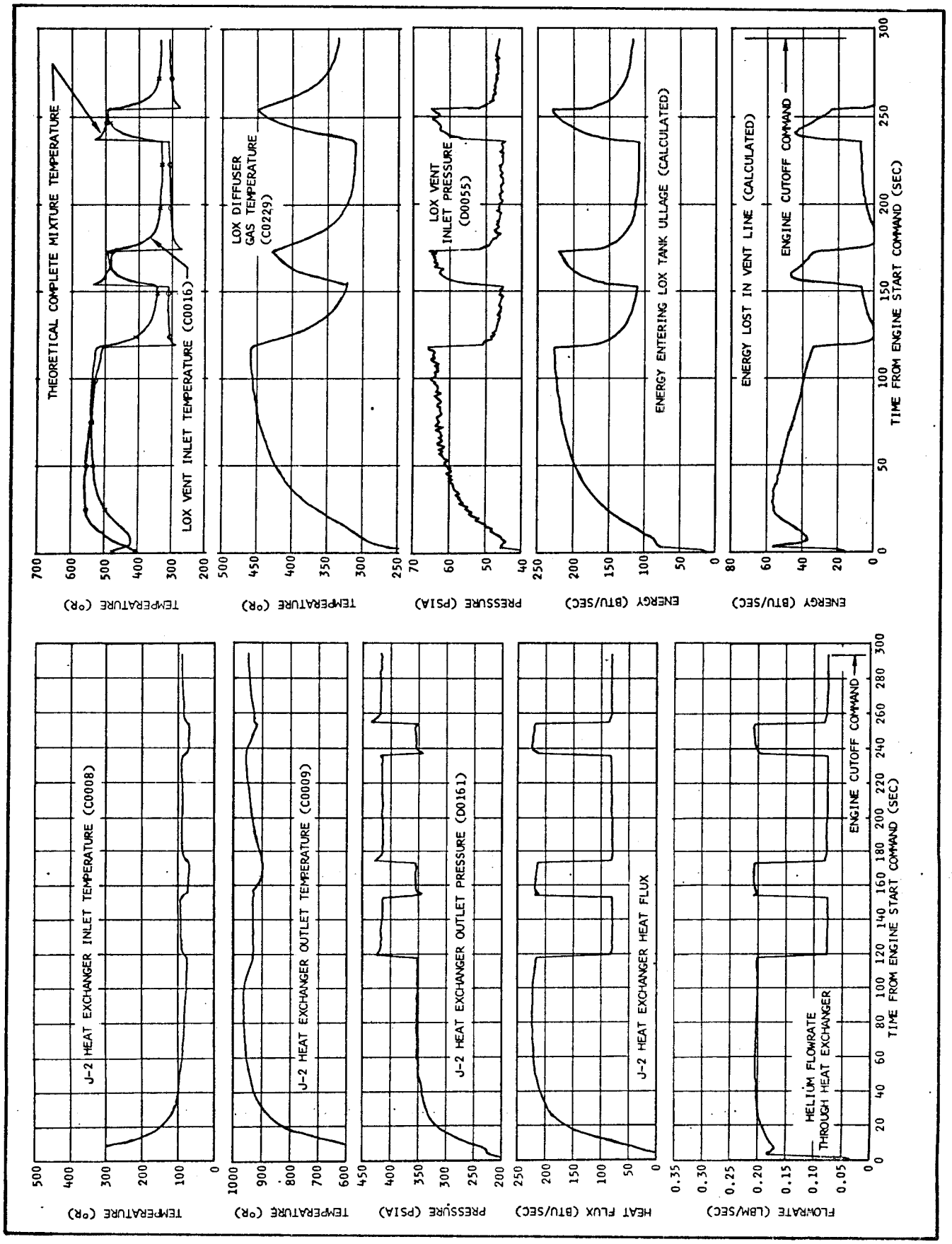


Figure 7-10. J-2 Heat Exchanger Performance - 2nd Burn

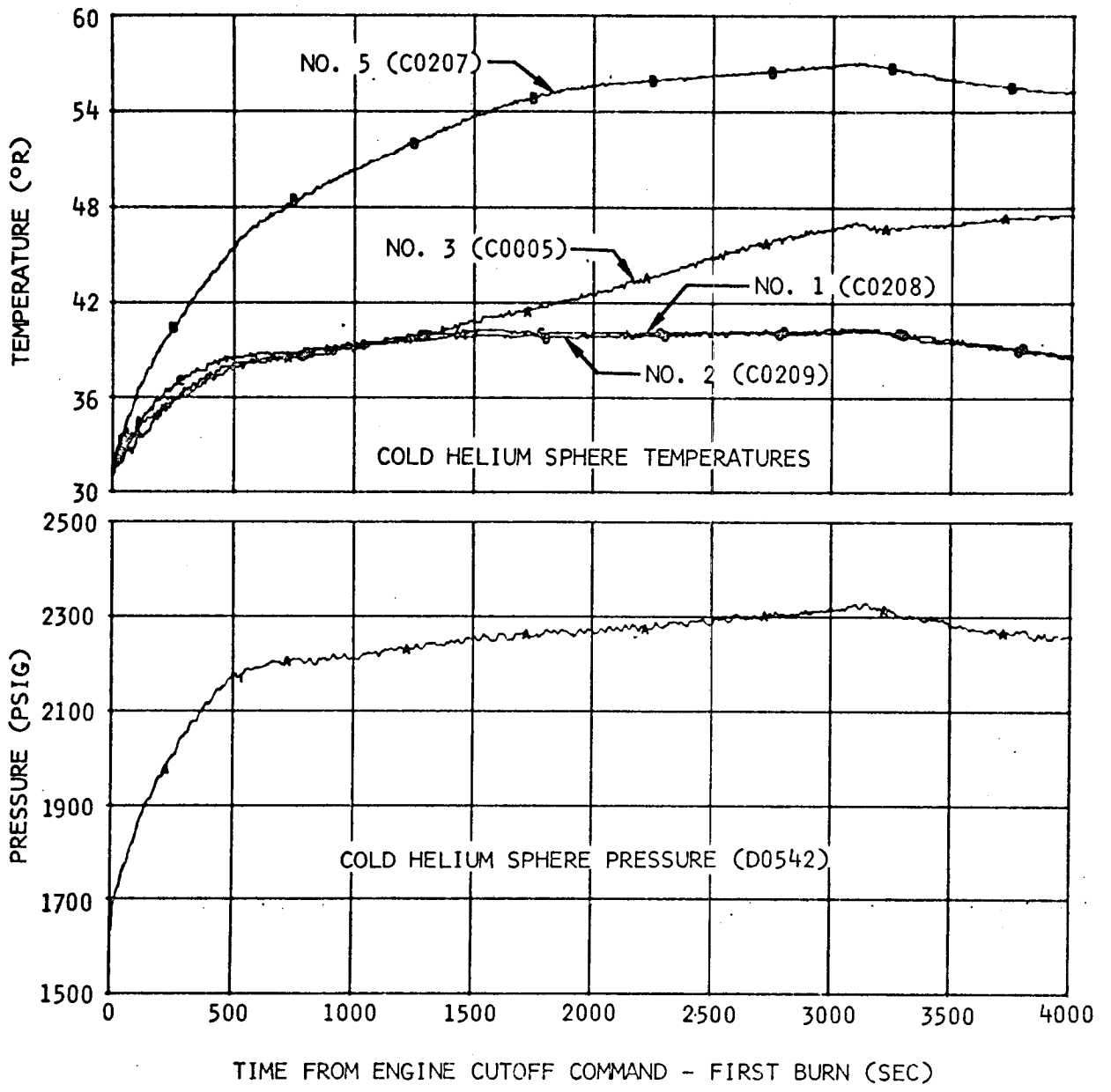


Figure 7-11. Cold Helium Supply - Simulated Orbital Coast

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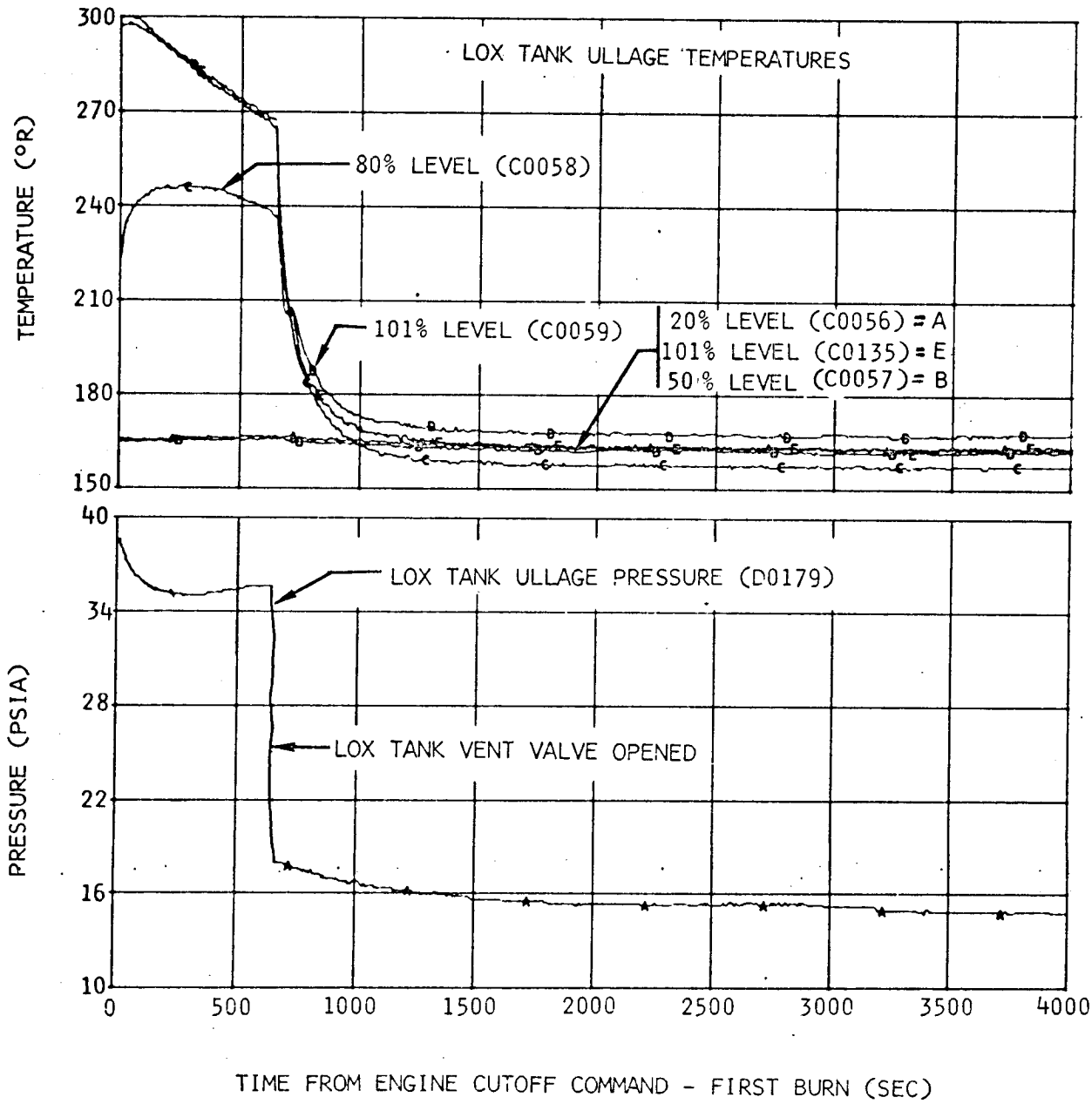


Figure 7-12. LOX Tank Ullage Conditions - Simulated Orbital Coast

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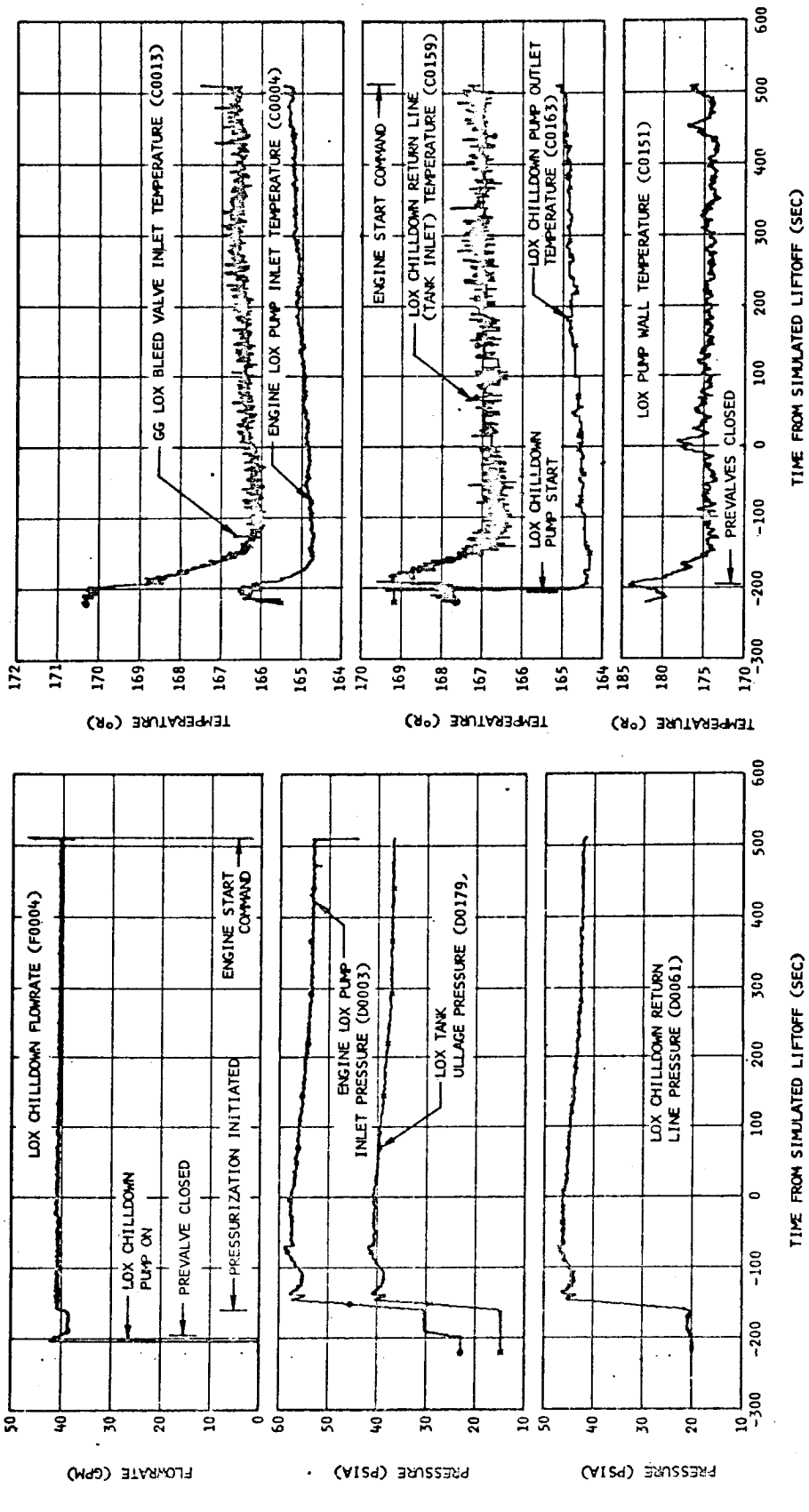


Figure 7-13. LOX Pump Chilldown System Operation - 1st Burn

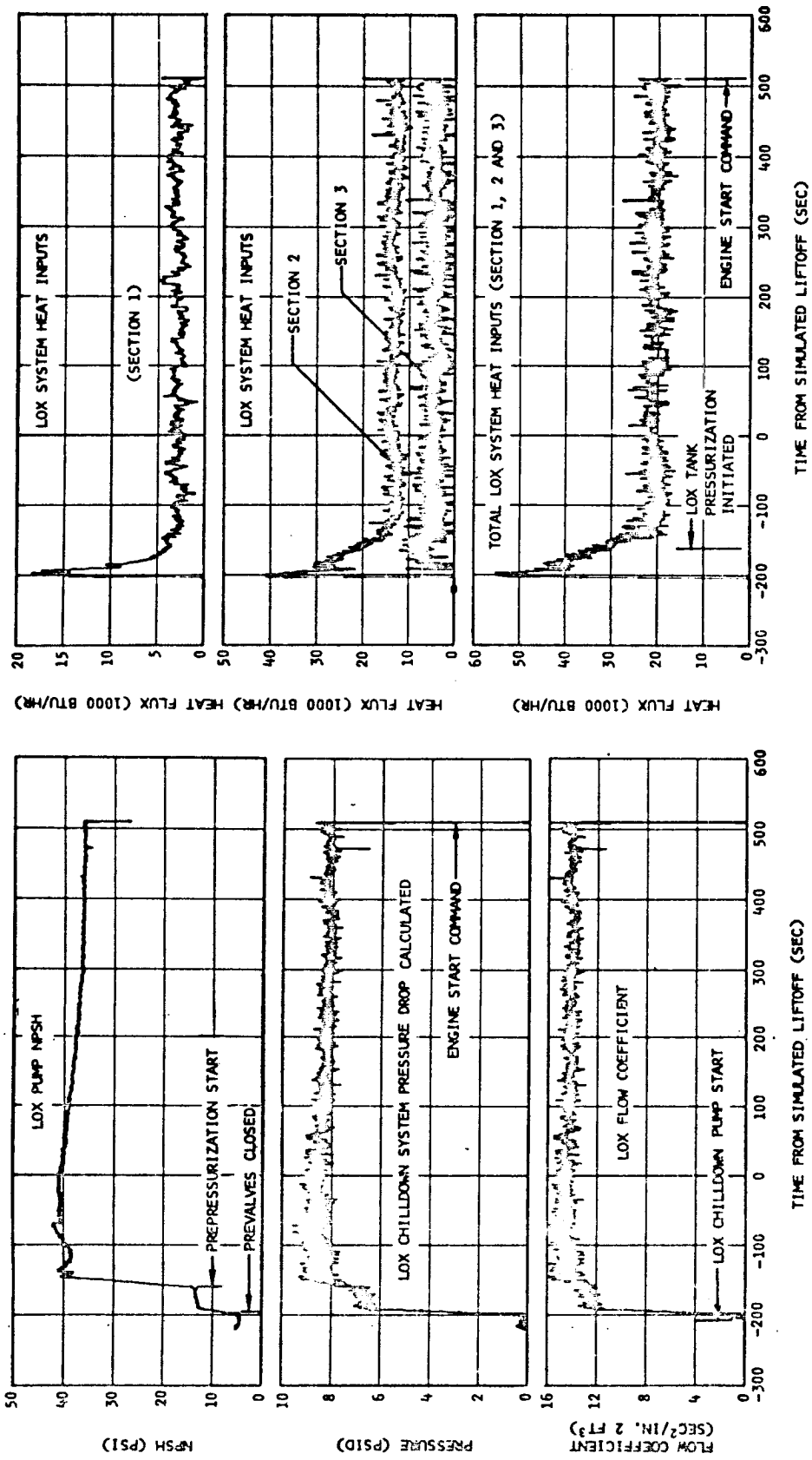


Figure 7-14. LOX Pump Chilldown System Performance - 1st Burn

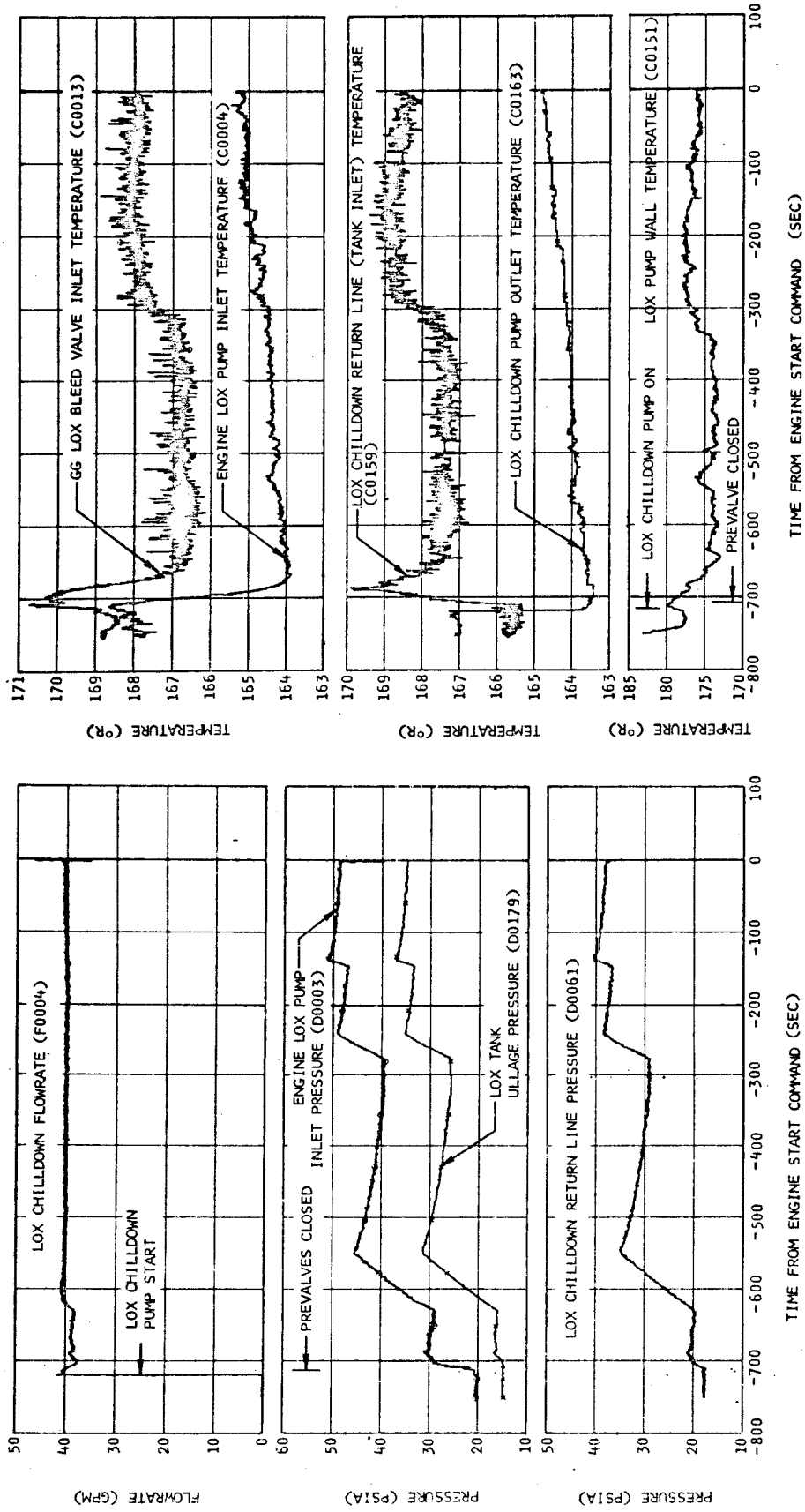


Figure 7-15. LOX Pump Chilldown System Operation - 2nd Burn

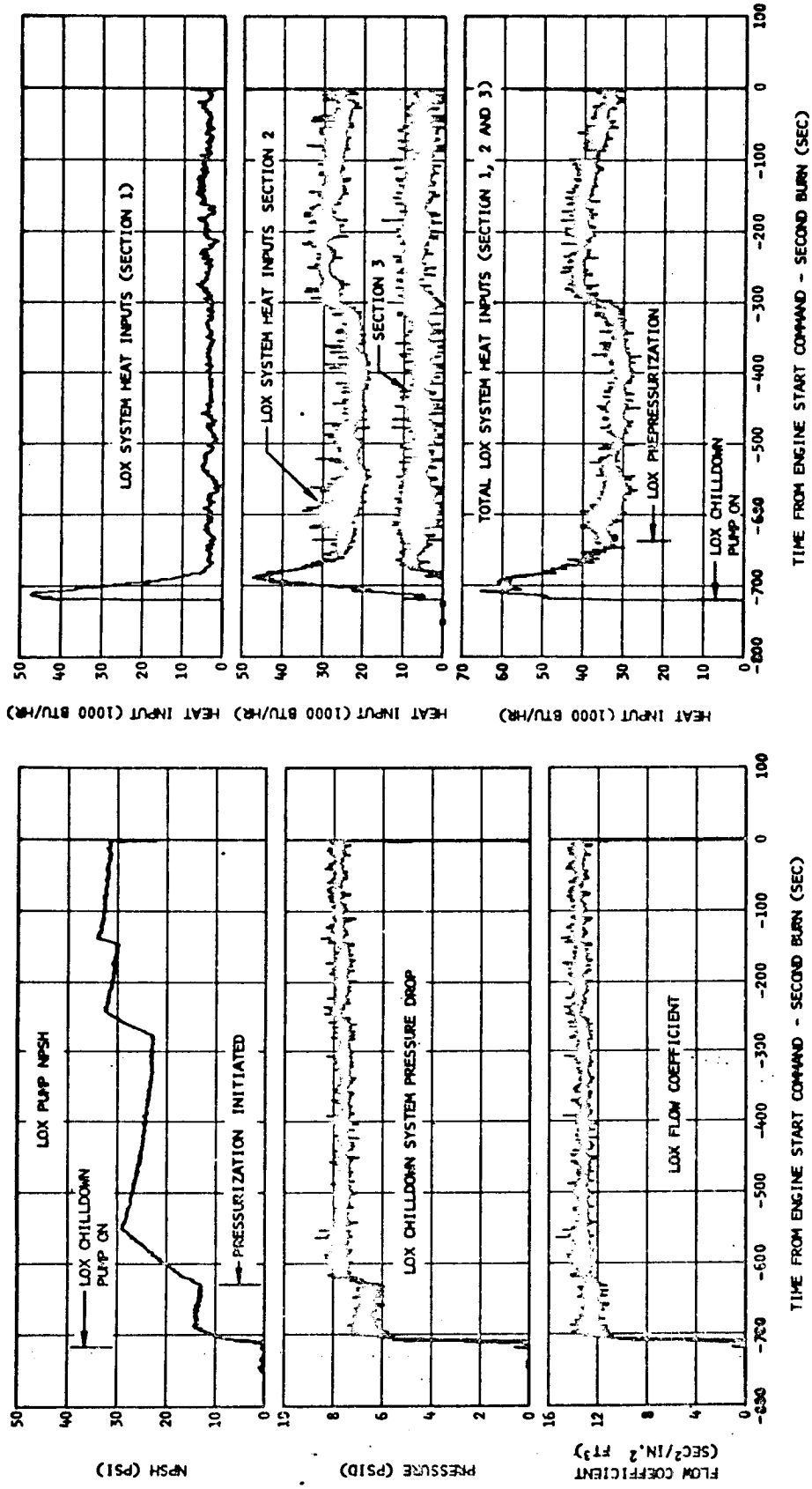


Figure 7-16. LOX Pump Chilldown System Performance - 2nd Burn

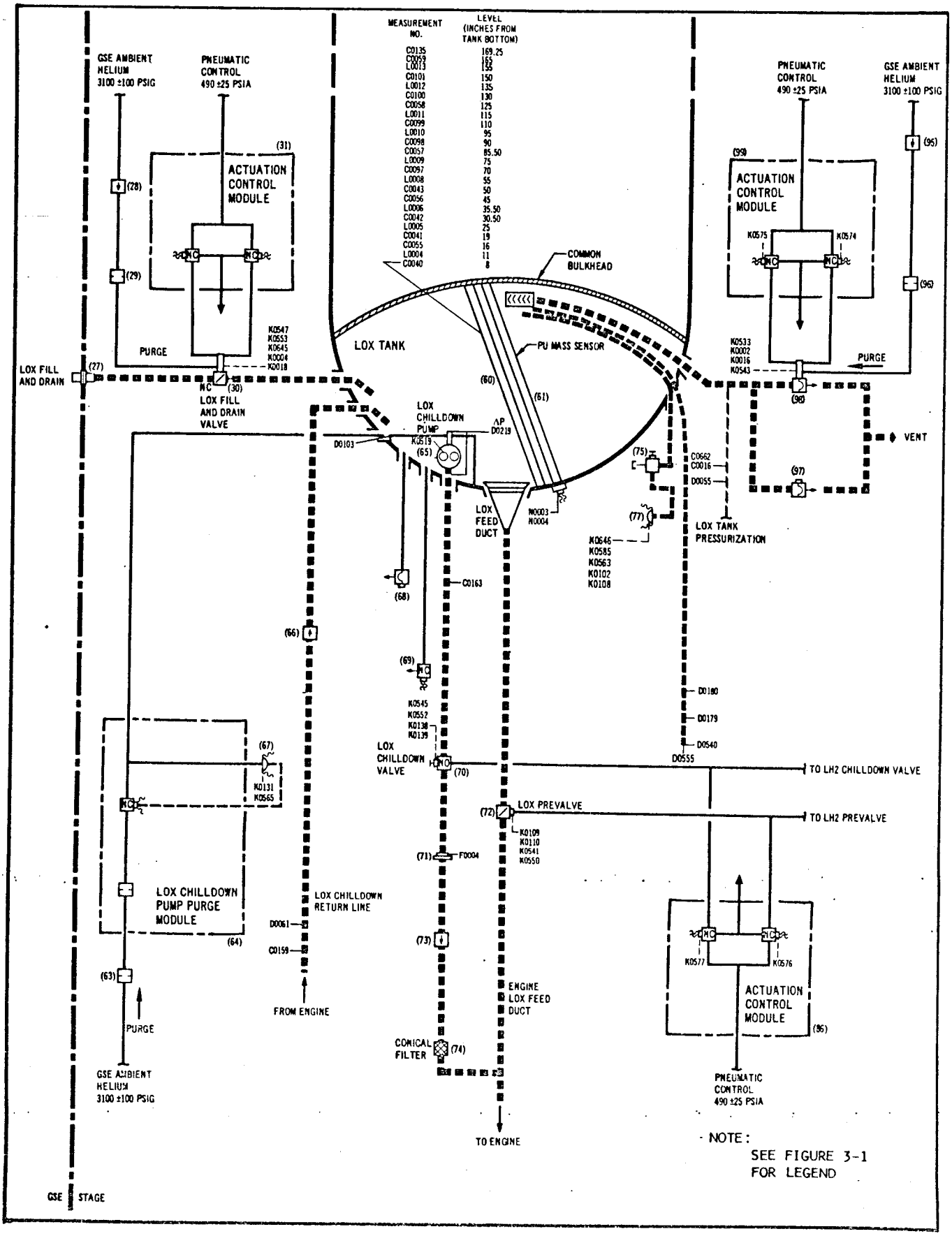


Figure 7-17. LOX Supply System

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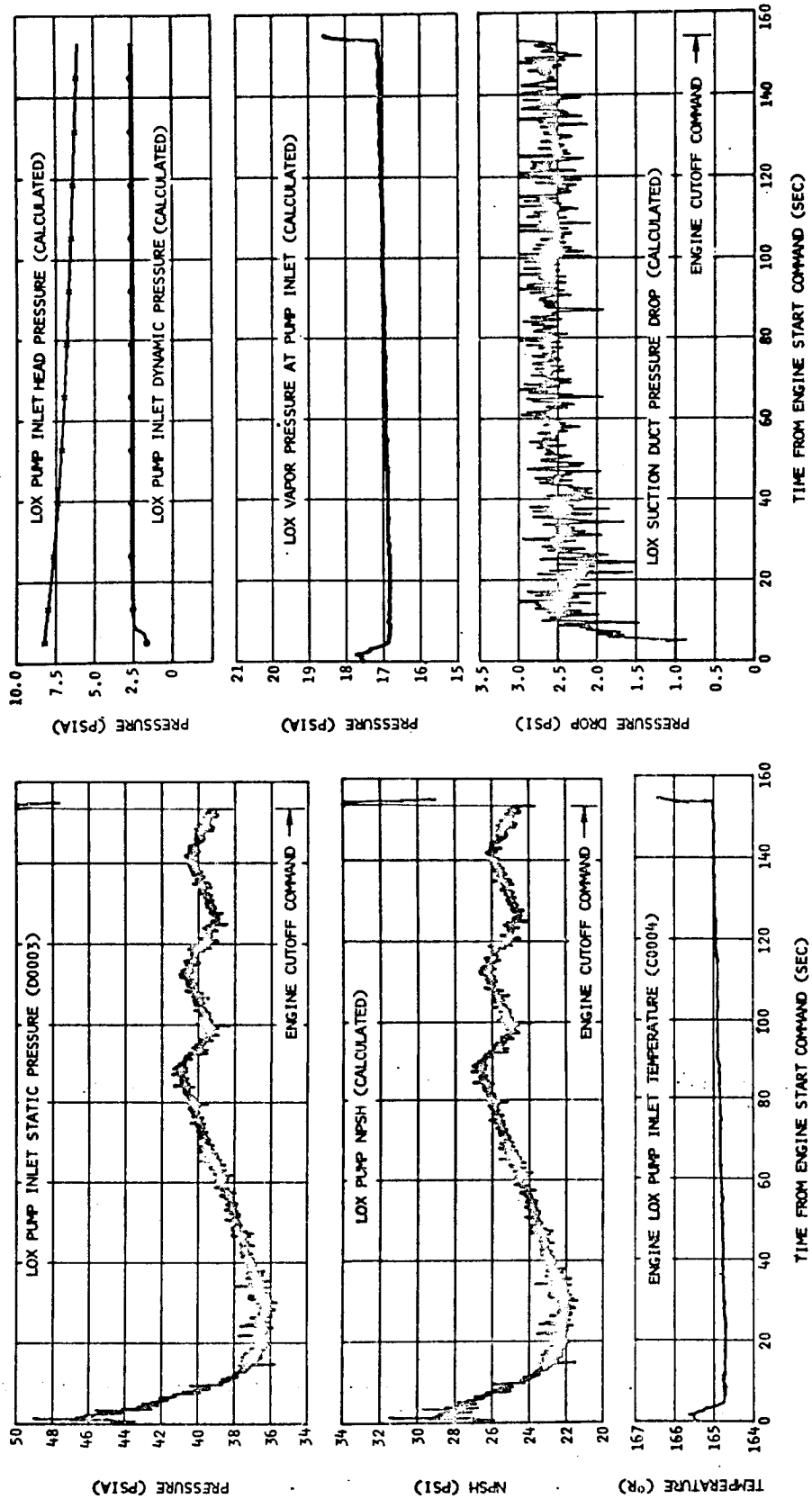


Figure 7-18. LOX Pump Inlet Conditions - 1st Burn

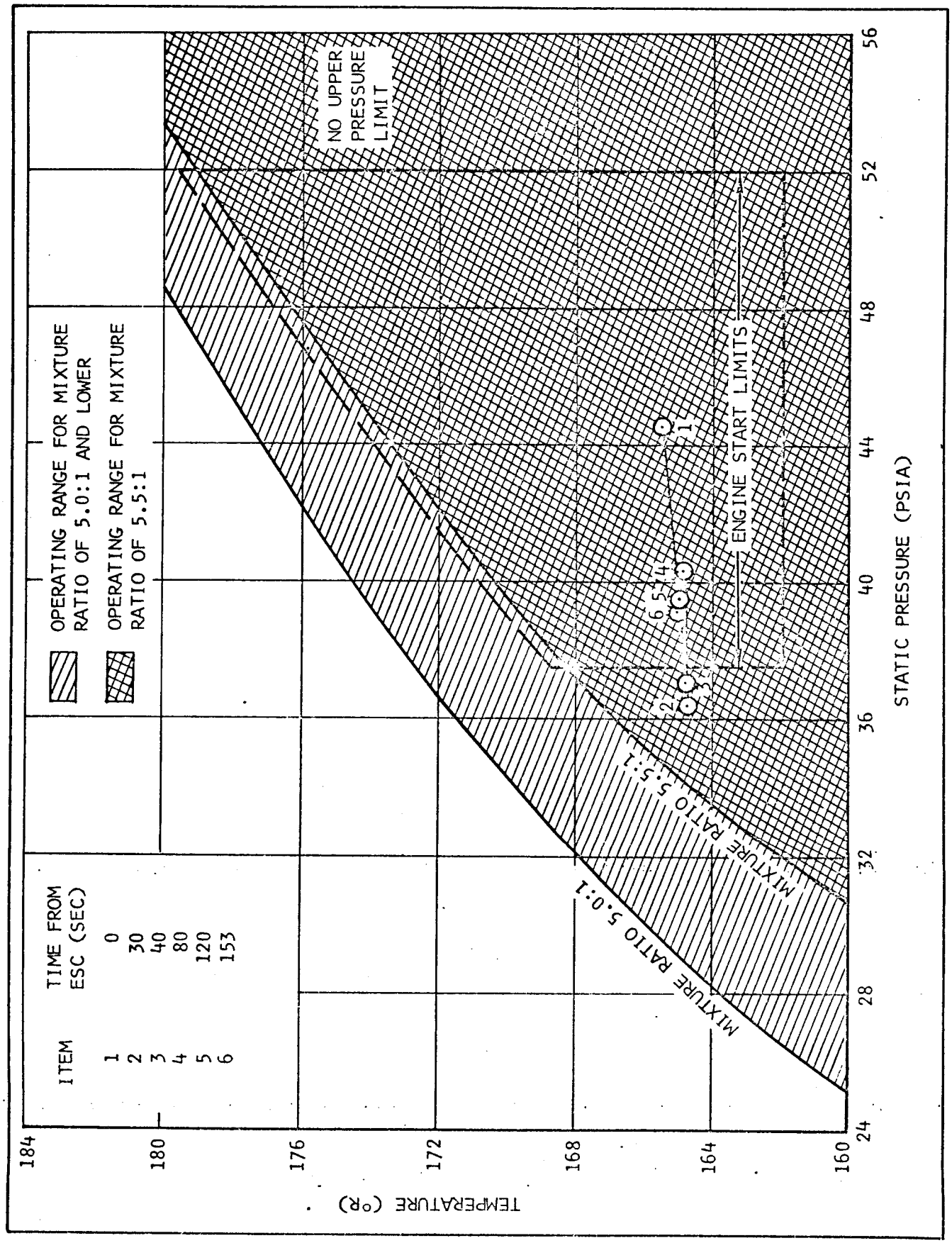


Figure 7-19. LOX Pump Inlet Conditions During Firing - 1st Burn

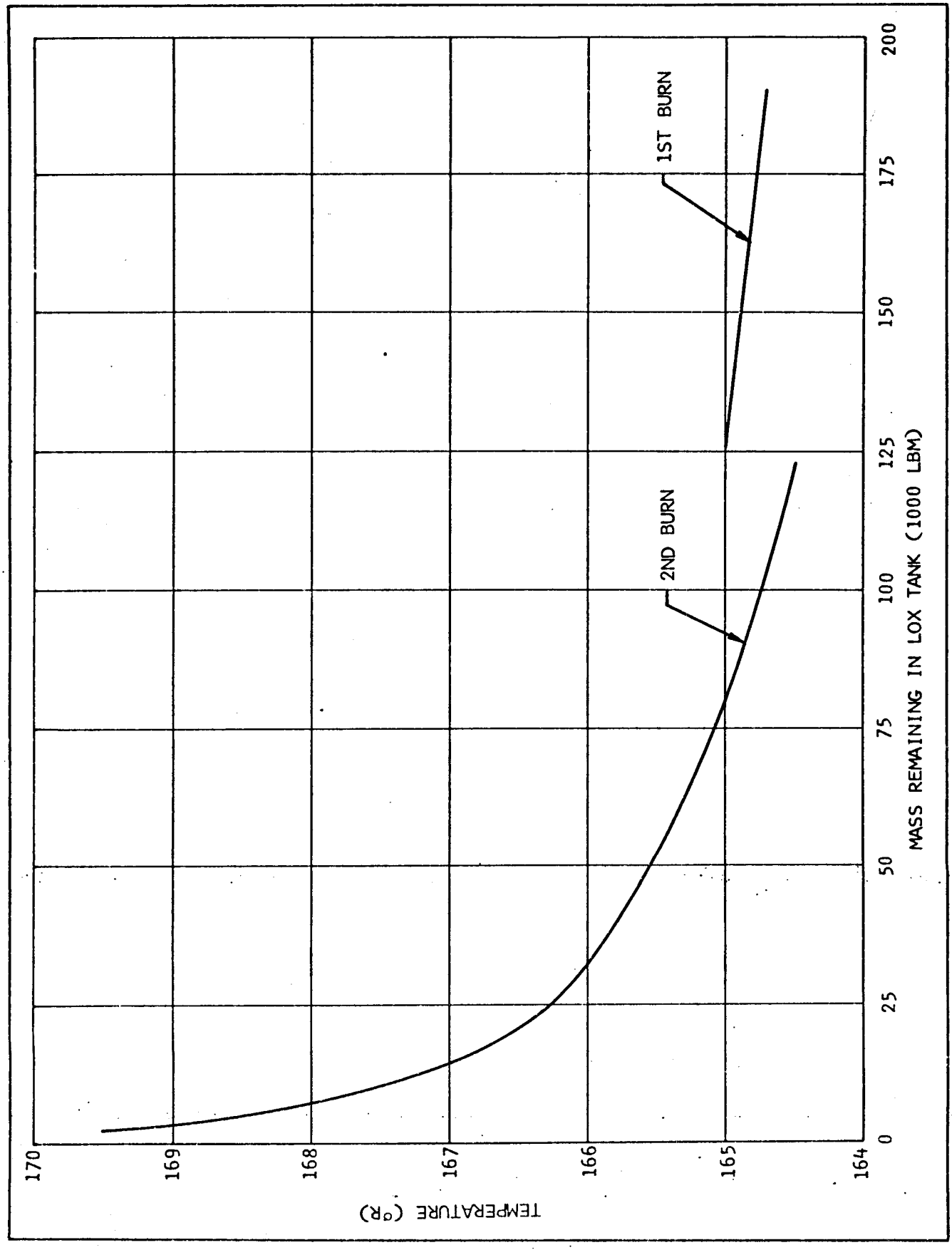


Figure 7-20. Effect of LOX Mass Level on LOX Pump Inlet Temperature

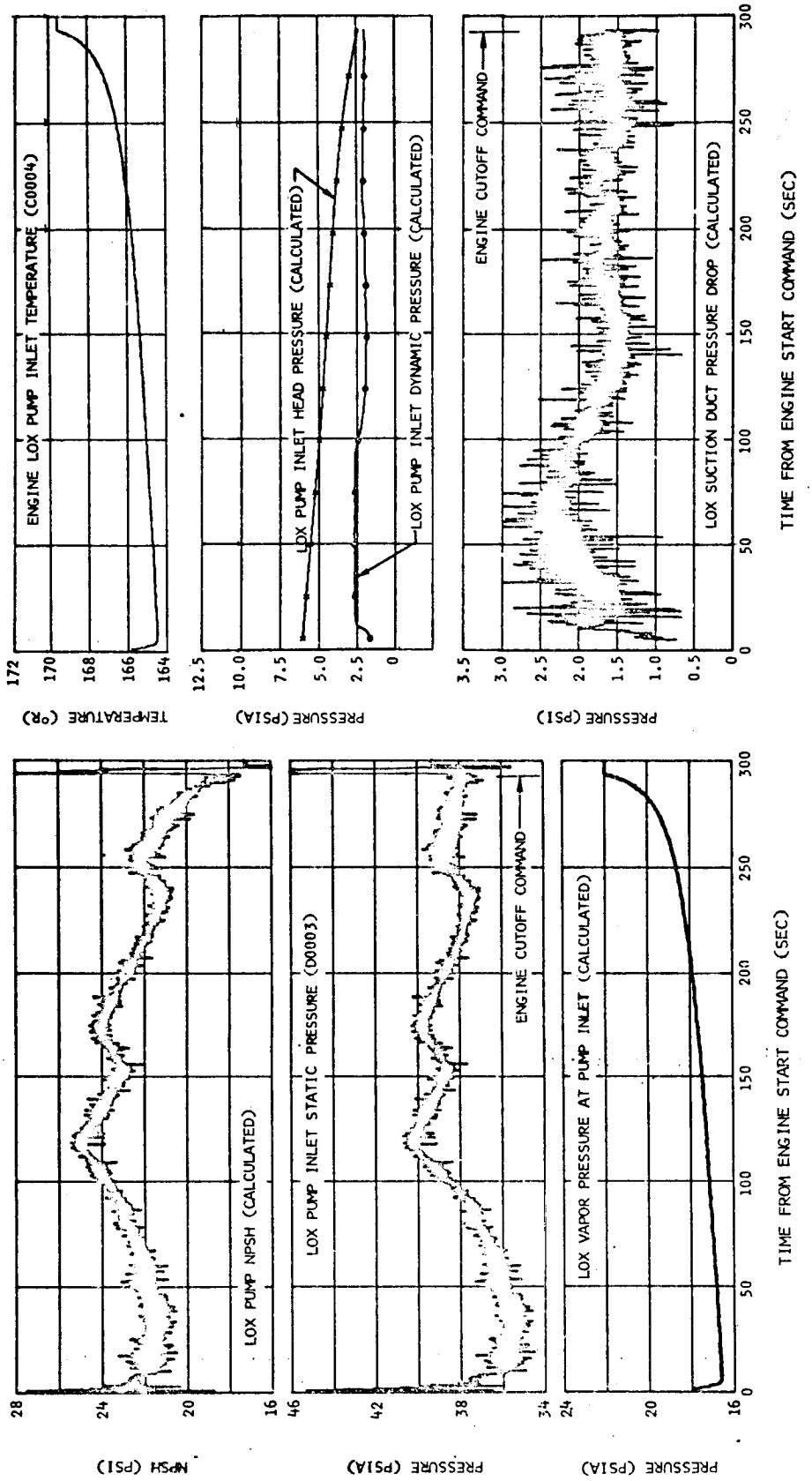


Figure 7-21. LOX Pump Inlet Conditions - 2nd Burn

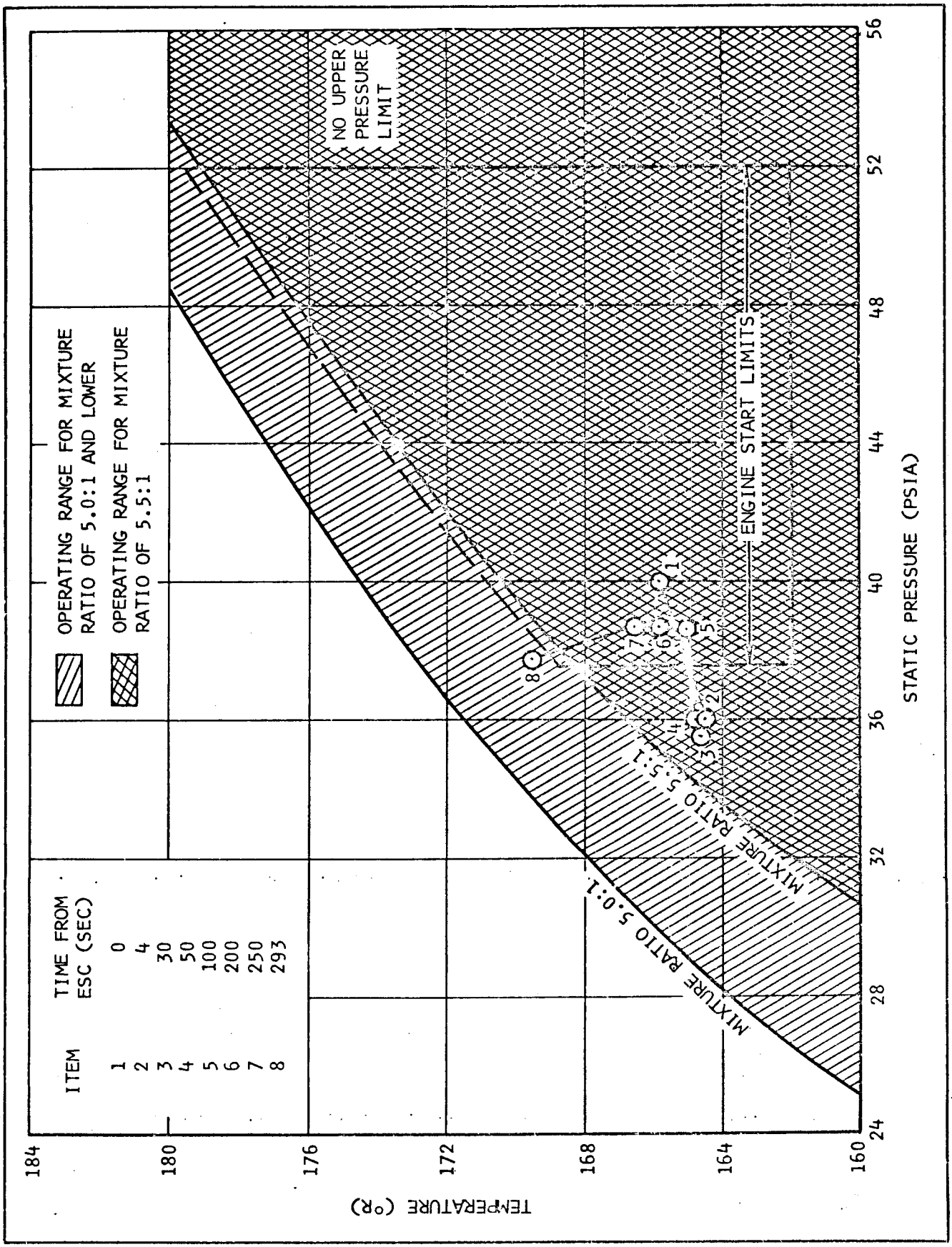


Figure 7-22. LOX Pump Inlet Conditions During Firing - 2nd Burn

# 8. FUEL SYSTEM

The fuel system supplied LH2 to the engine as designed with the available NPSH exceeding the engine manufacturer's requirements until 2nd burn cutoff. The overall system performance closely followed the analytical performance predictions and was consistent with previous acceptance firing results.

## 8.1 Pressurization Control and Internal Environment

The LH2 tank pressurization system (figure 8-1) satisfactorily accomplished prepressurization, 1st burn GH2 pressurization, repressurization, and 2nd burn GH2 pressurization.

### 8.1.1 First Burn

#### 8.1.1.1 Prepressurization

Prepressurization was initiated at ESC -624 sec. The LH2 tank ullage pressure at this time was 15.3 psia, as indicated by LH2 tank ullage measurement D0177 (figure 8-2). The ullage pressure was increased to 33.6 psia at ESC -583 sec, at which time the ground fill ullage pressure switch terminated pressurization. Ullage heating caused the usual pressure rise to tank relieving pressure. The pressure increased beyond the vent and relief valve setting and the backup vent valve was actuated. The valve cycled three times before the vent and relief valve opened and controlled the ullage pressure at 36.2 psia from ESC -390 sec until Engine Start Command. During prepressurization, 17.4 lbm of helium were added to the ullage volume. Significant LH2 tank prepressurization data are summarized in table 8-1.

#### 8.1.1.2 Pressurization

The LH2 tank ullage pressure decreased from 36.0 psia at Engine Start Command to 28.7 psia at engine cutoff. The injector tap-off pressure (D0013) and the GH2 pressurization module inlet pressure (D0104) were 865 psia and 845 psia, respectively, after their start transients. These values are within the ranges stated in the J-2 engine manual performance data for the LH2 tank pressurization of 810 to 900 psia. The injector temperature (C0200) was approximately 185 deg R, and module inlet temperature (C0231) stabilized at 192 deg R.

The LH2 tank inlet temperature was approximately 185 deg R. These values are consistent with results of previous acceptance firings. The collapse factor based on this temperature increased from 0.90 at ESC +10 sec to 1.15 at engine cutoff. This is a reflection of the effect of the nylon bag inlet diffuser on ullage conditions. A similar effect was noted during the S-IVB-501 acceptance firing. The nylon bag diffuser resulted in a lack of warm pressurant impingement on the saturated liquid surface. The boiloff during burn was negligible. The GH2 added to the ullage during burn was 75.69 lbm.

The ullage temperature trends were similar to S-IVB-501 and are presented in figure 8-3. The 90 to 101 percent level probe data asymptoted to approximately 190 deg R and 207 deg R respectively. Ullage conditions during 1st burn are summarized in figure 8-3.

### 8.1.2 Second Burn

#### 8.1.2.1 Repressurization

LH2 tank repressurization was initiated at ESC -322 sec at an ullage pressure of 15.5 psia. The tank ullage pressure continued to rise to 28.0 psia at ESC -124 sec. At that time it was necessary to use auxiliary pressurization due to the slow pressure rise in the tank.

At approximately ESC -112 sec, repressurization was continued until the repressurization pressure switch closed the repressurization valve at ESC -43 sec. During repressurization, 40.5 lbm of helium were added to the LH2 ullage which raised the pressure to 32.9 psia. At Engine Start Command, the ullage pressure was 33.1 psia. Repressurization system operation and LH2 tank ullage conditions prior to engine start are summarized in figure 8-4.

The helium flowrate during repressurization was computed from the temperature and pressure in the repressurization spheres. The fluctuating sphere temperature is responsible for the oscillatory flowrate which is presented in figure 8-4. Ambient helium was supplied from the seven repressurization spheres at a rate varying from 0.55 to 0.1 lbm/sec. Sphere temperatures and pressure rapidly decreased until repressurization was complete, at which

time the sphere temperatures increased, approaching ambient conditions at engine start. The pressure increased from 1,030 psia to 1,090 psia.

#### 8.1.2.2 Pressurization

The GH2 pressurization system operation (figure 8-5) reflects the same effects noted during 1st burn. The LH2 tank ullage pressure decreased from 33.5 psia at engine start to 31.0 psia at ESC +143 sec. At 31.0 psia, the pressurization module began control mode operation, continuing until engine cutoff when the ullage pressure was 32.8 psia.

Until EMR cutback (ESC -90 sec), 2nd burn operation was nearly identical to 1st burn. The injector tapoff port and module inlet pressures stabilized at 865 psia and 845 psia, respectively. At approximately ESC +90 sec, these pressures began to reflect the EMR cutback by approaching new lower levels: injector tapoff port pressure of 750 psia and pressurization module inlet pressure of 730 psia.

The tank inlet temperature was approximately 195 deg R until ESC +90 sec and 165 deg R until engine cutoff.

The injector temperature was 280 deg R until ESC +90 sec, and 175 deg R from that time until engine cutoff. The GH2 pressurization module inlet temperature similarly was 195 deg R until it decreased to 175 deg R as an effect of the cutback. These changes in levels of operation during EMR variation are consistent with previous acceptance firing data. The collapse factor based on this temperature varied from 0.98 at ESC +10 sec to 0.85 at engine cutoff. Pressure and temperature data from the GH2 pressurization system and the pressurant flowrate during 2nd burn appear in figure 8-5. The GH2 added to the ullage during burn was 161.8 lbm; this agrees with the prediction. Boiloff during 2nd burn was negligible as during 1st burn.

## 8.2 LH2 Tank Vent and Relief Operation

### 8.2.1 LH2 Tank Relief Valve Operation

The vent and relief valve did not open during 1st burn prepressurization when the vent and relief setting was reached. The pressure continued to

increase to 37.8 psia where the backup relief valve was actuated. It cycled three times before the vent and relief valve opened and controlled the ullage pressure to 36.2 psia. The valve was replaced after the firing.

### 8.2.2 Vent Operations During Simulated Orbital Coast

Predictions of ambient heating of the LH2 tank indicated that the continuous vent system (CVS) would not allow sufficient flow under atmospheric back pressure conditions to maintain the ullage pressure below the nominal orbital pressure of 20.5 psia; therefore, the nonpropulsive vent (NPV) was used to assist the CVS in ullage pressure control.

Continuous venting was initiated 90 sec after 1st burn cutoff (ECC). Ullage pressure decayed rapidly from 29.5 to 20.5 psia in approximately 100 sec (figure 8-6). Ullage temperatures also dropped due to gaseous expansion and the venting of warm pressurant gas.

When the ullage pressurant had dropped to 20.5 psia, the continuous vent module began regulating, holding the ullage pressure steady for approximately 550 sec. The upper ullage temperatures increased at first (due to ground heating), but as boiloff gas began to rise all ullage temperatures decreased.

Approximately 700 sec after engine cutoff, the ullage pressure began to rise very slowly (0.064 psi/min). This indicated the point at which CVS regulation became insufficient to control the ullage pressure. Approximately 2,400 sec later (ECC +3,100 sec) the NPV was opened. The ullage pressure, which had been 23.0 psia at NPV opening, dropped rapidly at first, but tapered off to 16.3 psia approximately 1,000 sec later. Ullage temperatures dropped for 150 sec and then leveled off at lower steady values. Ullage pressure and temperatures remained essentially constant until repressurization commenced (2nd ESC -322 sec).

Pressure and temperature instrumentation immediately upstream of the continuous and nonpropulsive vent exits will supply flow data during S-IVB/V stage flights. During the acceptance firing, the instrumentation was installed, but the value of the data obtained is questionable in view

of the limitations of a static firing environment in the simulation of orbital conditions. The continuous and nonpropulsive vent exit nozzles were replaced by a manifold system to conduct the vented GH2 away from the stage. Venting flows at the manifold (to atmospheric back pressure) were unchoked at the LH2 tank ullage pressures maintained during simulated orbital coast, whereas choking at the vent exits will be ensured under orbital coast. Both the CVS and the NPV exit temperature profiles displayed differences in level that are explainable in terms of unequal flow past the instrumentation locations for each system. The increased manifold pressure during periods of nonpropulsive venting was reflected in continuous as well as nonpropulsive vent exit pressure data.

### 8.2.3 LH2 Tank Ullage History During Simulated Orbital Coast

Following 1st burn engine cutoff, the initial flow through the continuous vent system resulted in a rapid decrease in ullage pressure. The ullage temperature data from the 101, 90, and 70 percent level probes began to indicate a reduction in gas temperature. The 101 and 90 percent level probes then indicated an increase in gas temperature as the upward motion of the gas past the probes subsided after the initial surge. This increase persisted until approximately ECC +500 sec when all of the ullage temperature measurements began to decrease to a considerably lower level as the warm ullage gas was expelled and replaced by boiloff GH2 at nearly saturation temperature. The temperatures varied in the 40 to 85 deg R range until LH2 tank vent blowdown occurred at ECC +3,101 sec. Throughout the simulated orbital coast, data were distributed below approximately 225 deg R (the 101 percent probe indication) prior to ECC +3,101 sec (figure 8-6).

### 8.2.4 Continuous Vent System Performance

The continuous vent system performed as expected. The LH2 tank ullage pressure decay rate after CVS initiation was approximately 5.4 psi/min which agrees closely with the 5 psi/min rate attained during the S-IVB-203 stage acceptance firing. Ullage temperature profiles also agree, in general. These facts indicate that the CVS flowrates for the S-IVB-502 stage were consistent with the S-IVB-203 stage CVS flowrates.

### 8.2.5 LH2 Liquid Condition During Simulated Coast

During the simulated coast period, the LH2 temperature increased steadily from 38.1 deg R at engine cutoff to 39.5 deg R at ECC +3,101 sec when the LH2 tank vent blowdown began (figure 8-7). The liquid was saturated throughout the period between engine cutoff and tank blowdown. Total LH2 boiloff during the simulated coast period, presuming no entrainment loss, was 3,151 lbm.

## 8.3 LH2 Pump Chilldown

### 8.3.1 First Burn

The LH2 pump chilldown system performed adequately. At engine start, the pump inlet pressure of 38.2 psia and temperature of 39.6 deg R were within the start requirements. The available NPSH was 14.3 psi which was above the minimum requirement of 8.5 psi.

System temperatures and pressures and the LH2 chilldown flowrate (figures 8-8 and 8-9) were used to determine fluid and hardware temperature conditions, pressure drops, and heat inputs. The LH2 tank was loaded with the prevalve and gas generator bleed valve open, which allowed a partial hardware chilldown before the chilldown pump was started. Recirculation chilldown was started 92 sec before tank prepressurization and was terminated shortly before engine start. At ESC -3.1 sec, the prevalve was opened with the pump still running to remove any bubbles which might have collected under the prevalve during chilldown. The chilldown shutoff valve was closed just prior to engine start.

The chilldown flowrate (figure 8-8) went through a normal start transient, reached 89 gpm at the end of the transient, then slowly varied between 90 and 92 gpm until the initiation of prepressurization. Subsequently, the flowrates increased to and stabilized at 135 gpm until the termination of chilldown at SLO +510 sec.

The heat input rates to the chilldown system during this firing are compared to those of the S-IVB-501 firing in the following table:

| TEST | UNPRESSURIZED (Btu/hr) | | PRESSURIZED (Btu/hr) | |
|---|---|---|---|---|
| | S-IVB-501 | S-IVB-502 | S-IVB-501 | S-IVB-502 |
| *Sect 1 | 18,000 | 19,000 | 13,000 | 13,500 |
| **Sect 2 | 30,000 | 25,000 | 27,000 | 13,500 |
| ***Sect 3 | | | 13,500 | 24,500 |
| TOTAL | 48,000 | 44,000 | 53,500 | 56,000 |

* Tank to pump inlet
** Pump inlet to bleed valve
*** Bleed valve to tank

Because of the large effects of minor temperature inaccuracies, only a very general comparison of the heat inputs could be made. The total heat input to the chilldown system was greater than that during the S-IVB-501 stage acceptance firing. As in the S-IVB-501 acceptance firing, an environmental helium purge of 65 scfm was used during the S-IVB-502 stage acceptance firing to prevent the formation of liquid nitrogen.

During unpressurized chilldown, the LH2 pump inlet was slightly subcooled; immediately following prepressurization, the temperature decreased to 38.8 deg R as the flowrate increased. The temperature then slowly increased as the LH2 bulk warmed and, by engine start, was 39.3 deg R. All chilldown system temperatures reflected the LH2 bulk warming.

The bleed valve and return line temperatures increased sharply at the initiation of prepressurization because all of the heat input went into heating the pressurized fluid, and no vaporization occurred. The LH2 entered the system sufficiently subcooled to absorb all the heat input to the system without reaching the saturation temperature. A 1-deg margin existed in the return line at engine start. After prepressurization was terminated at SLO -74 sec, the pump inlet followed the ullage pressure until the prevalve was opened and allowed essentially all of the flow to return to the LH2 tank through the prevalve with no flow through the chilldown system. The pump inlet pressure then decreased (because of loss of chilldown pump head) to 38.2 psia where it remained until engine start.

The LH2 prevalve sequencing was as follows:

| | |
|---|---|
| Open Command Received | ESC -3.11 sec |
| Valve Left Closed Position | ESC -2.38 sec |
| Valve Reached Open Position | ESC -0.59 sec |

The NPSH at the pump inlet followed the ullage pressure during prepressurization and reached a maximum of 25.4 psi when the ullage pressure attained the vent relief setting. Although the ullage pressure then remained constant until engine start, the NPSH decreased to 21.8 psi just before the prevalve was opened because of the increasing LH2 bulk temperatures. The NPSH then decreased to 14.6 psi because of the loss of chilldown pump head and was at this pressure at engine start.

The flow coefficient was calculated from flowrate and chilldown system pressure drop data and the results varied from 18 to 19.5 $sec^2/in.^2ft^3$ (figure 8-9), which was within the range calculated for previous S-IVB stages. The flow coefficient was used to compute average fluid quality during the unpressurized phase of the chilldown.

In the region of two-phase flow (sections 2 and 3), the average fluid quality was 0.04 lbm gas/lbm two-phase mixture prior to prepressurization. This quality decreased to zero during prepressurization when the fluid in the system became subcooled.

The LH2 chilldown system pressure drop was relatively steady at 8.8 and 7.2 to 7.9 psi, respectively, during the unpressurized and pressurized portions of the LH2 chilldown operation.

### 8.3.2 Second Burn

The LH2 chilldown (figure 8-10) was similar to that for 1st burn in that it started with a wet feed duct (prevalve open). The recirculation chilldown system performed satisfactorily. At engine start, the pump inlet pressure and temperature of 35.1 psia and 39.8 deg R were within the engine start requirements. The pump inlet NPSH at engine start was 10.5 psi. This satisfied the minimum acceptable limit of 8.5 psi but was

less than the 1st burn NPSH of 14.4 psi. The lower NPSH was a result of the lower ullage pressure during 2nd burn.

The LH2 chilldown pump was started at ESC -715 sec with the tank unpressurized. The tank was repressurized at ESC -322 sec. Pressurization was gradual to simulate the use of a helium heater. At ESC -125 sec, the auxiliary pressurization system was used to increase the LH2 tank pressure by approximately 3 psi. At ESC -40 sec, repressurization was completed.

The LH2 quality went through a normal start transient and reached a steady-state value of 0.07 (figure 8-11), where it remained until the initiation of repressurization. At that time, it slowly decreased and, in 20 sec, reached zero, where it remained.

The heat inputs for the 2nd burn of the S-IVB-502 stage firing are compared to those for the 1st burns of S-IVB-501 and -502 stage firings in the following table:

| TEST | UNPRESSURIZED (Btu/hr) | | | PRESSURIZED (Btu/hr) | | |
|---|---|---|---|---|---|---|
| | S-IVB-501 | S-IVB-502 1st BURN | S-IVB-502 2nd BURN | S-IVB-501 | S-IVB-502 1st BURN | S-IVB-502 2nd BURN |
| *Sect 1 | 18,000 | 19,000 | 21,000 | 13,000 | 13,500 | 19,000 |
| **Sect 2 | 30,000 | 25,000 | 35,000 | 27,000 | 18,000 | 21,000 |
| ***Sect 3 | | | | 13,500 | 24,500 | 15,000 |
| TOTAL | 48,000 | 44,000 | 56,000 | 53,500 | 56,000 | 55,000 |

* Tank to pump inlet
** Pump inlet to bleed valve
*** Bleed valve to tank

Again, because of the large effects of minor temperature inaccuracies, only a very general comparison of the heat inputs could be made; however, the heat inputs during pressurized chilldown were surprisingly close.

The LH2 pump NPSH was zero during the unpressurized portion of chilldown, but increased during repressurization and at ESC -116 sec was 16 psi. It then gradually increased and was at 18.2 psi just before the prevalve was opened (figure 8-10).

Steady-state pressurized chilldown conditions were not reached after repressurization, but the LH2 conditions at engine start were very nearly the same for 1st and 2nd burns. As explained in paragraph 7.3.2, the recirculation system had been purged with ambient helium during simulated orbital coast, and had had only a short period of contact with the propellant prior to initiation of chilldown.

Repressurization caused the vapor in the system to collapse, thus allowing a surge in the flowrate by reducing the system flow resistance. After the surge the flowrate decreased rapidly to 96 gpm. During the remainder of chilldown, the flowrate gradually increased as steady-state conditions were being approached.

Just before the prevalve was opened, the flowrate had increased to 133 gpm, which was slightly less than the 135 gpm obtained during 1st burn. Both these values are lower than the 146 gpm obtained during the S-IVB-501 stage acceptance firing 1st burn. This indicated a greater resistance to flow during the S-IVB-502 acceptance firings.

## 8.4 Engine LH2 Supply

The LH2 engine supply system (figure 8-12) satisfactorily provided the engine with propellant throughout 1st and 2nd burns, with the exception of the 2nd burn engine cutoff when the pump inlet NPSH decreased sharply below the required 5.6 psi.

### 8.4.1 First Burn

The LH2 pump inlet static pressure followed the ullage pressure throughout the firing. It was 37.3 psia at engine start and steadily decreased to 27.0 psia at engine cutoff (figure 8-13).

The available NPSH at the LH2 pump inlet at engine start was 13.5 psia. It then increased sharply to 17.7 psia at ESC +2 sec as cold LH2 from the tank replaced the warmer LH2 in the suction ducts. The pump inlet temperature dropped from 39.6 deg R at engine start to 37.9 deg R at ESC +2 sec and then slowly increased to 38.0 at engine cutoff; therefore, the NPSH varied directly as a function of the ullage pressure. By engine cutoff the NPSH had decreased to 9.5 psi.

The average frictional pressure drop in the LH2 suction duct was calculated to be 1.0 psi at an average flowrate of 79.5 lbm/sec. These values were similar to those incurred during the S-IVB/V-501 acceptance firing.

The LH2 pump inlet pressure and temperature plotted in the engine operating region (figure 8-14) indicate that the pump inlet conditions were met satisfactorily throughout the 1st burn. In figure 8-15, the pump inlet temperature is plotted as a function of the mass remaining within the LH2 tank. This trend is similar to that of the S-IVB/V-501 acceptance firing.

### 8.4.2 Second Burn

The LH2 supply system functioned satisfactorily throughout the 2nd burn. At engine start the pump inlet pressure and temperature were 33.0 psia and 40.0 deg R, and the NPSH was 16.0 psi (figure 8-16). The pump inlet pressure and the NPSH followed the ullage pressure as the pump inlet temperature dropped to 37.8 deg R at ESC +2 sec and then slowly increased to 39.0 deg R prior to engine cutoff. The firing was terminated by the strip chart observer when the LH2 pump inlet temperature increased and caused the NPSH to decrease below the minimum requirement of 5.6 psi.

The average frictional pressure drop for the high EMR portion of the firing was 1.8 psi at an LH2 flowrate of 78.5 lbm/sec. After the EMR cutback, the pressure drop was 1.7 psi at an average LH2 flowrate of 76.3 lbm/sec. The apparent difference between the 1st and 2nd burn pressure drop is within data accuracy. The plot of pump inlet pressure and temperature in the engine operating region (figure 8-17), indicated that, except at cutoff, the inlet conditions were satisfactory. Figure 8-15 shows pump inlet temperature as a function of the mass remaining in the LH2 tank. This trend was similar to that of the S-IVB/V-501 acceptance firing.

TABLE 8-1
SUMMARY OF LH2 TANK PREPRESSURIZATION DATA

| ITEM | UNIT |
|---|---|
| Prepressurization initiation (sec from ESC) | -624 |
| Prepressurization completion (sec from ESC) | -583 |
| Prepressurization elapsed time (sec) | 41 |
| GH2 at start of prepressurization (lbm) | 73 |
| GH2 at start of prepressurization (moles) | 36.5 |
| Helium added during prepressurization (lbm) | 17.4 |
| Helium added during prepressurization (moles) | 4.4 |
| Gas misture in ullage at the end of prepressurization (total moles) | 40.9 |
| GH2 evaporated during prepressurization (moles) | 0 |
| GH2 evaporated during prepressurization (lbm) | 0 |
| Mass ratio of GH2 to helium at termination of prepressurization | 4.2 |
| GH2 mass in ullage at termination of prepressurization (percent) | 81 |

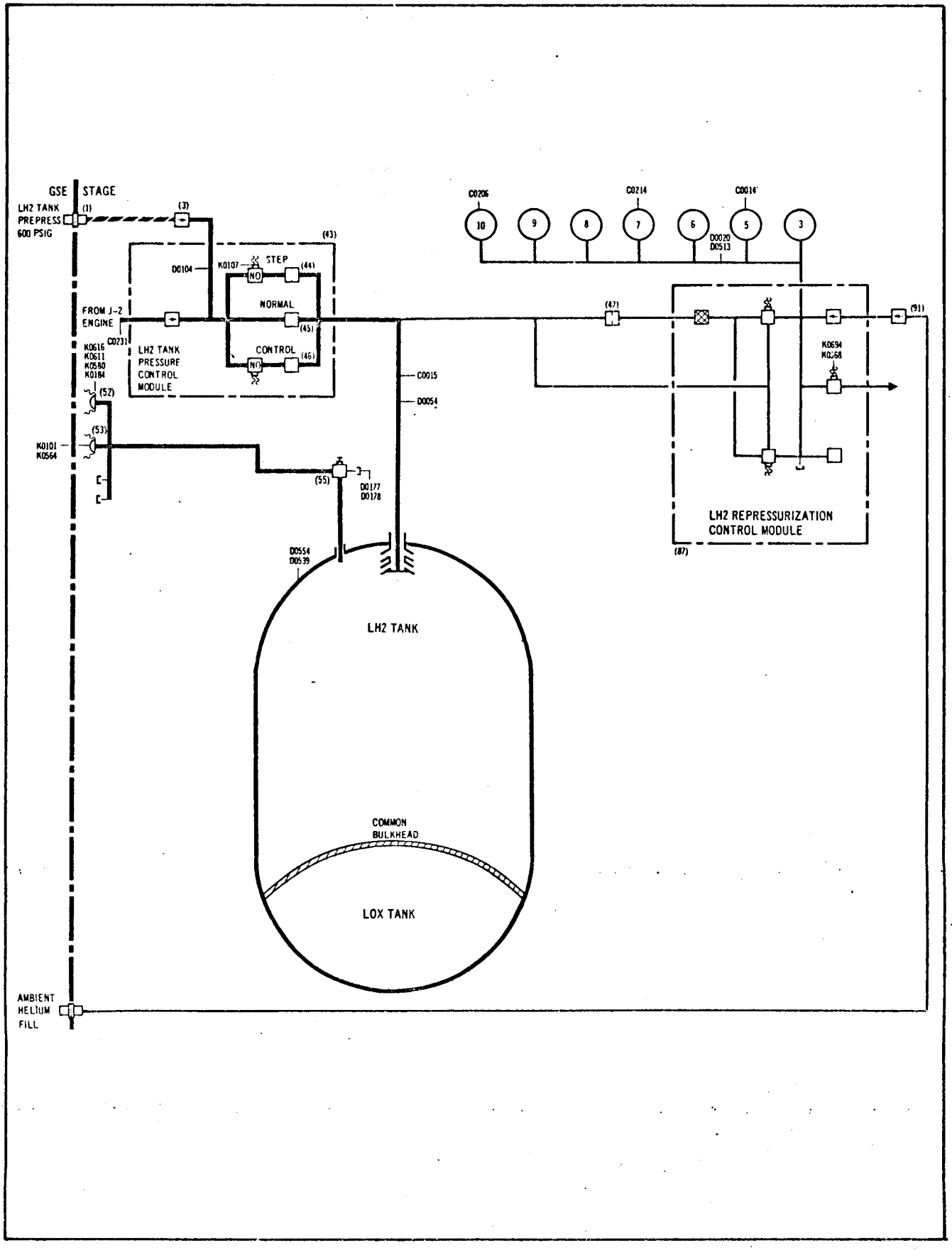


Figure 8-1. LH2 Tank Pressurization System

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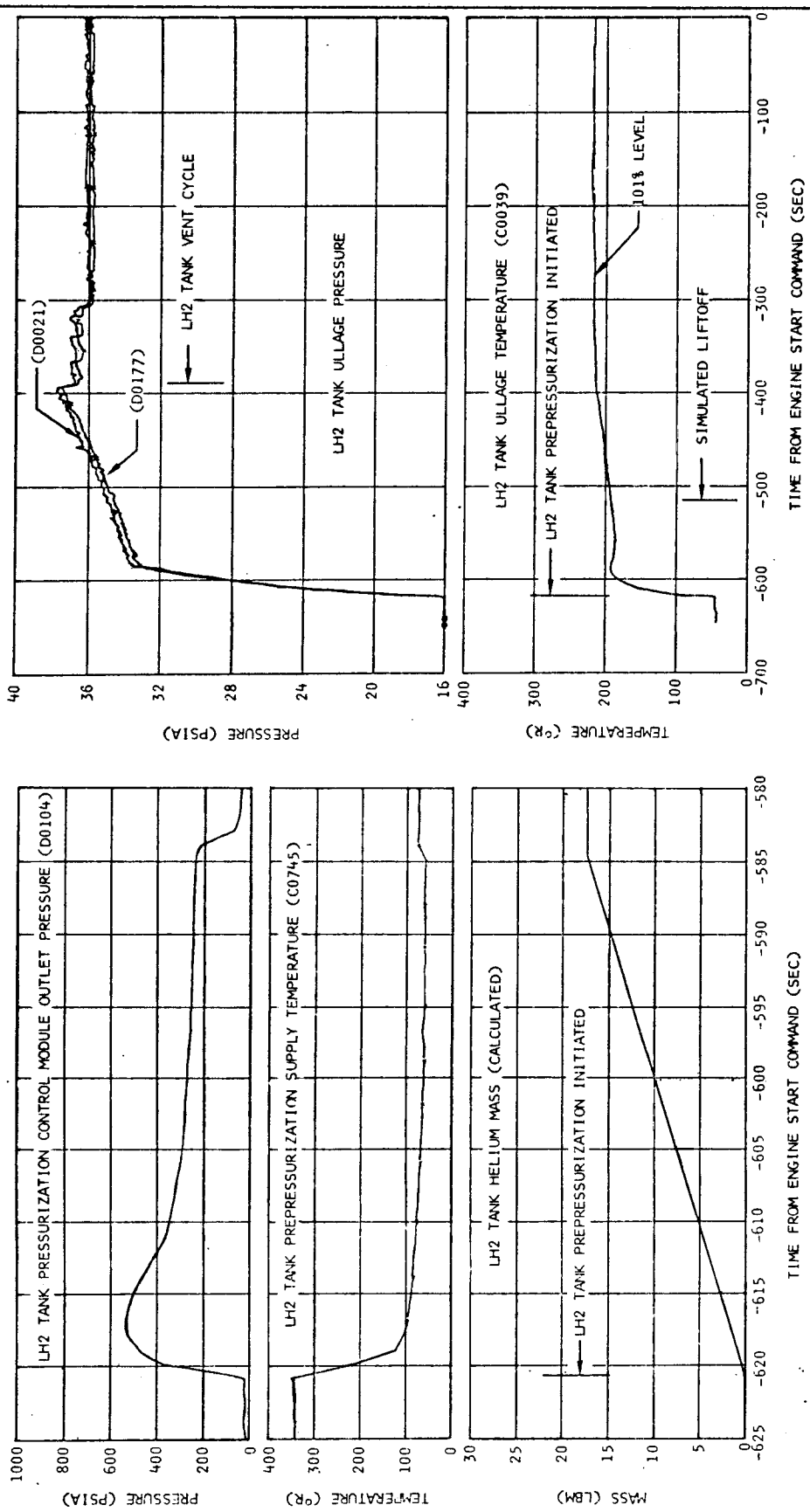


Figure 8-2. LH2 Tank Prepressurization System Performance - 1st Burn

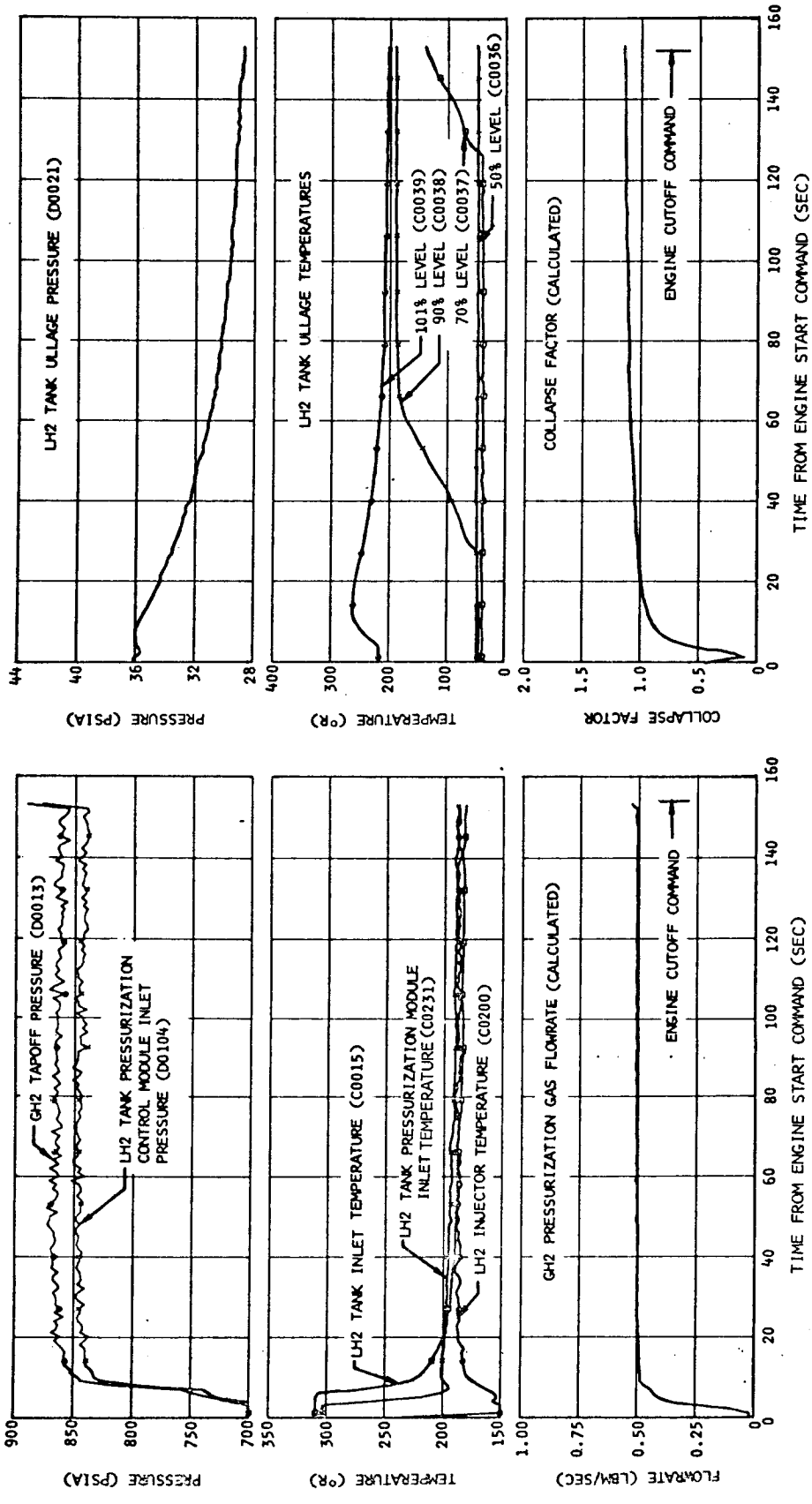


Figure 8-3. LH2 Tank Pressurization System Performance - 1st Burn

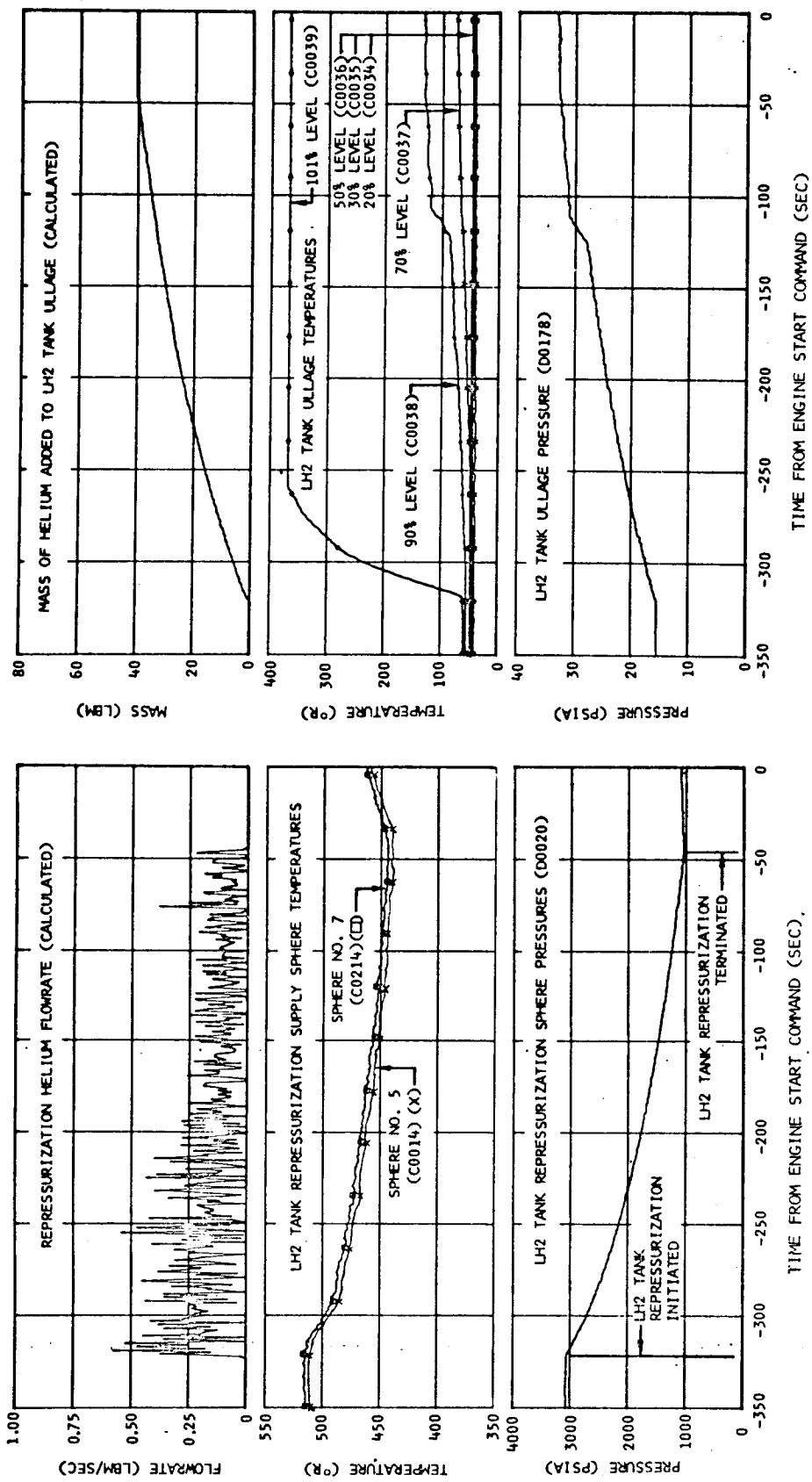


Figure 8-4. LH2 Tank Repressurization System Performance - 2nd Burn

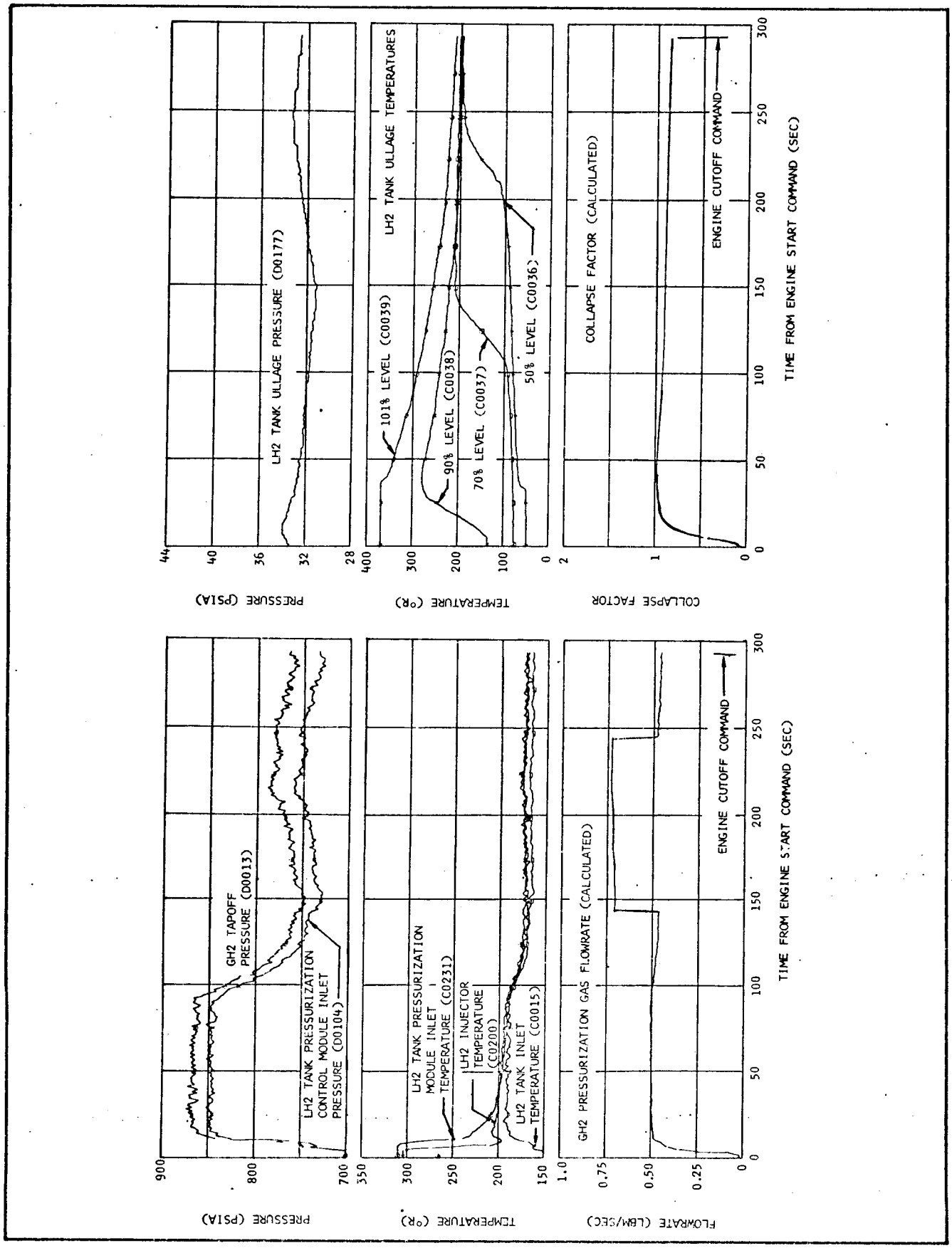


Figure 8-5. LH2 Tank Pressurization System Performance - 2nd Burn

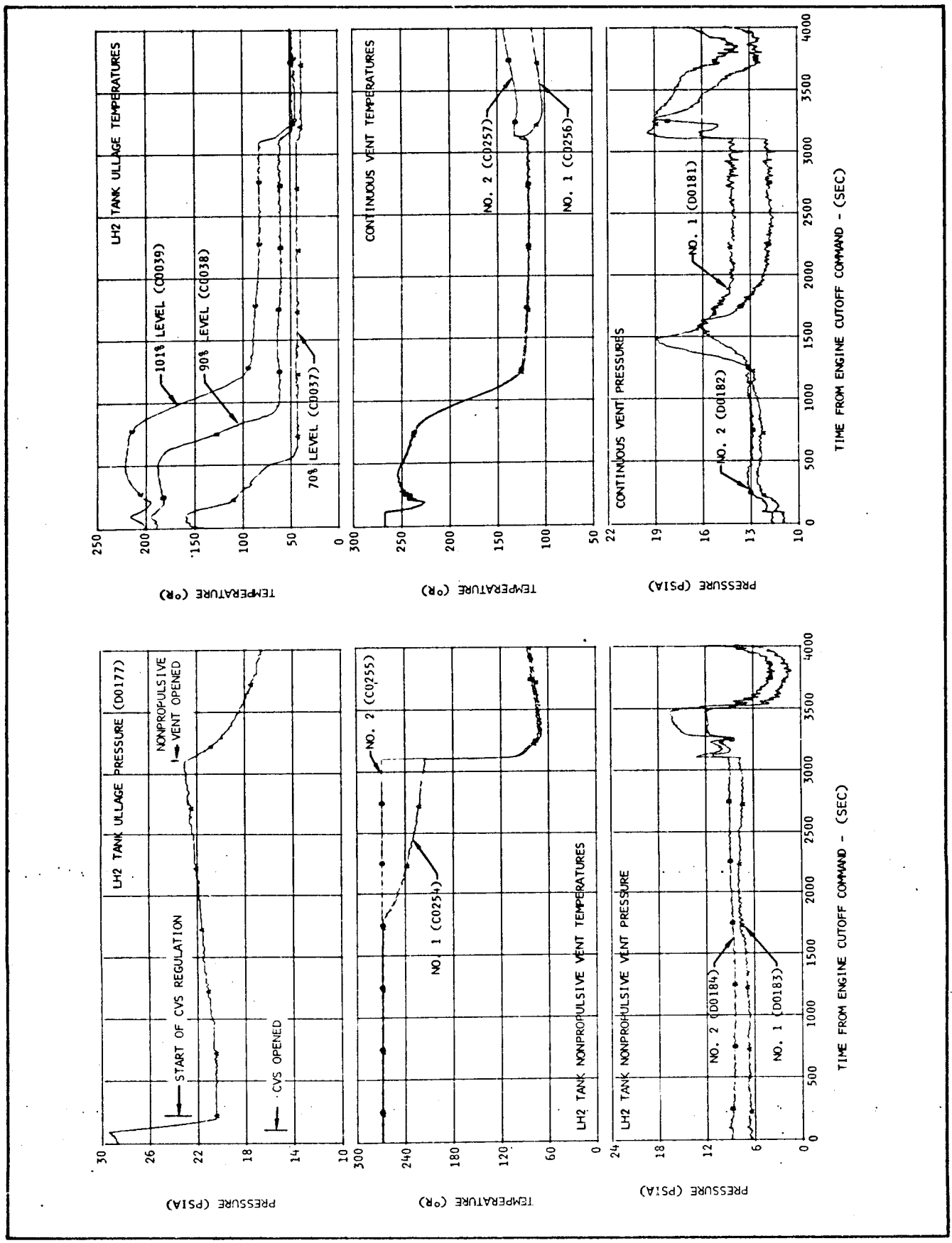


Figure 8-6. LH2 Tank Venting System Operation - Simulated Orbital Coast

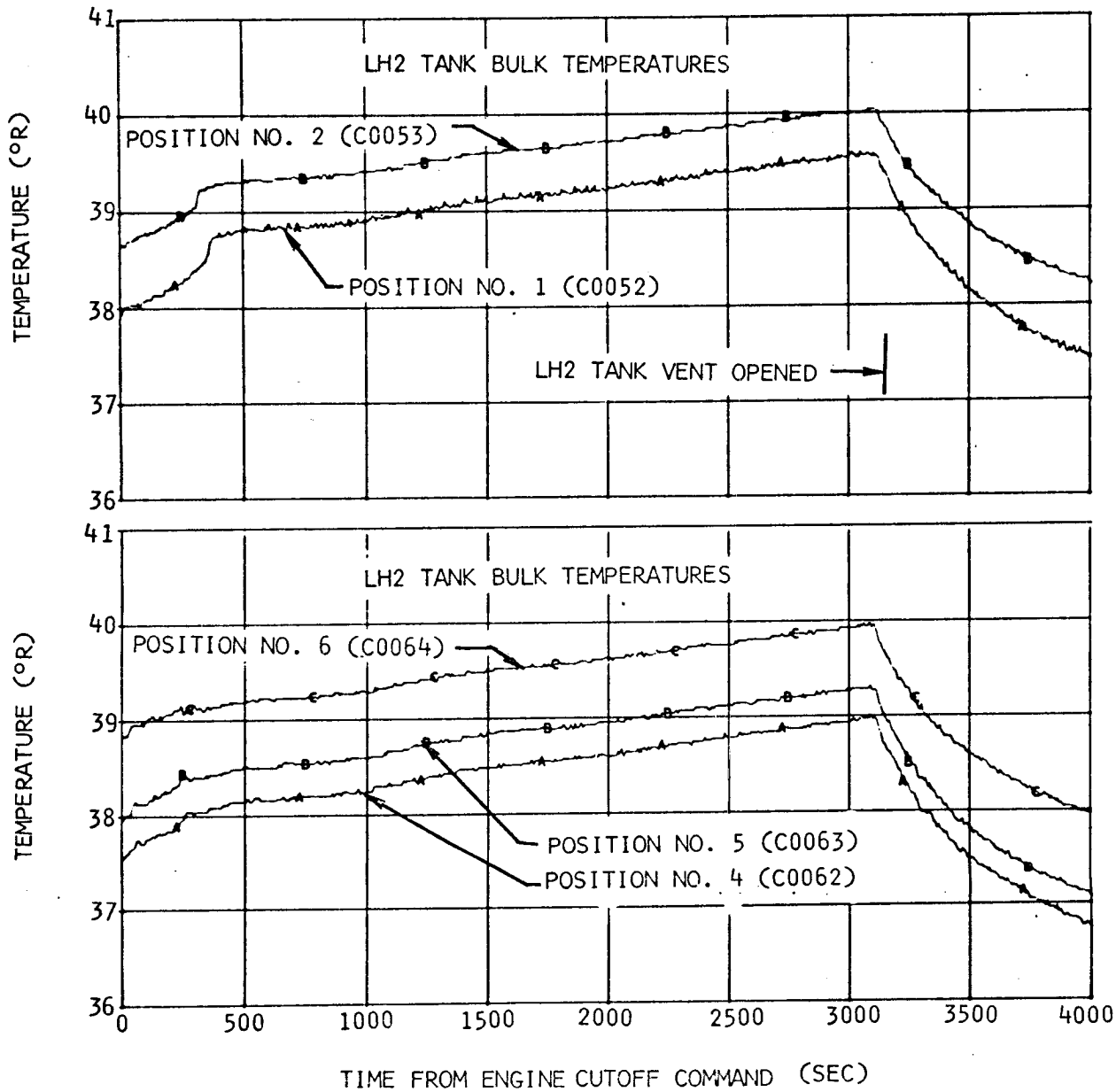


Figure 8-7. LH2 Tank Bulk Temperature History - Simulated Orbital Coast

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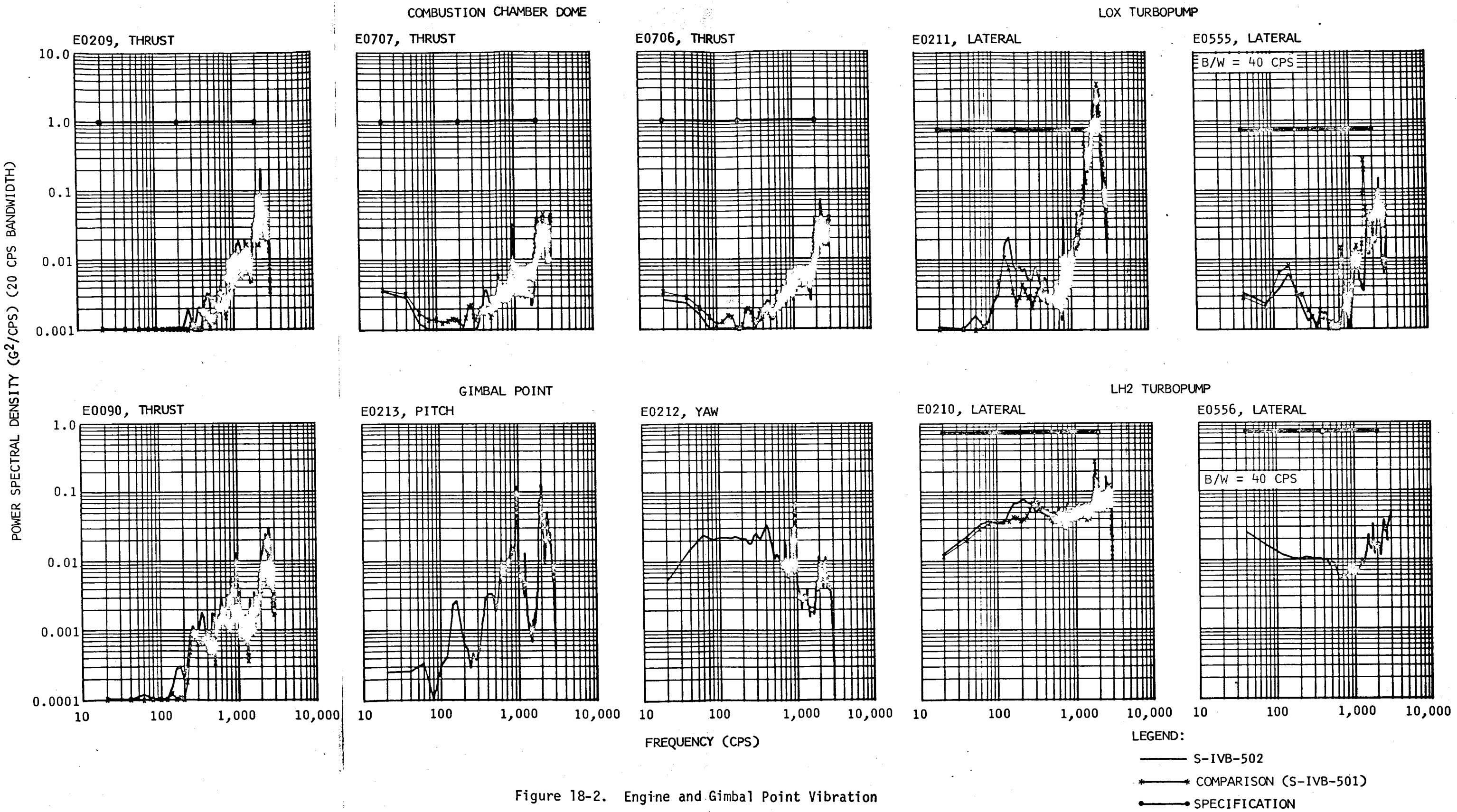


Figure 18-2. Engine and Gimbal Point Vibration

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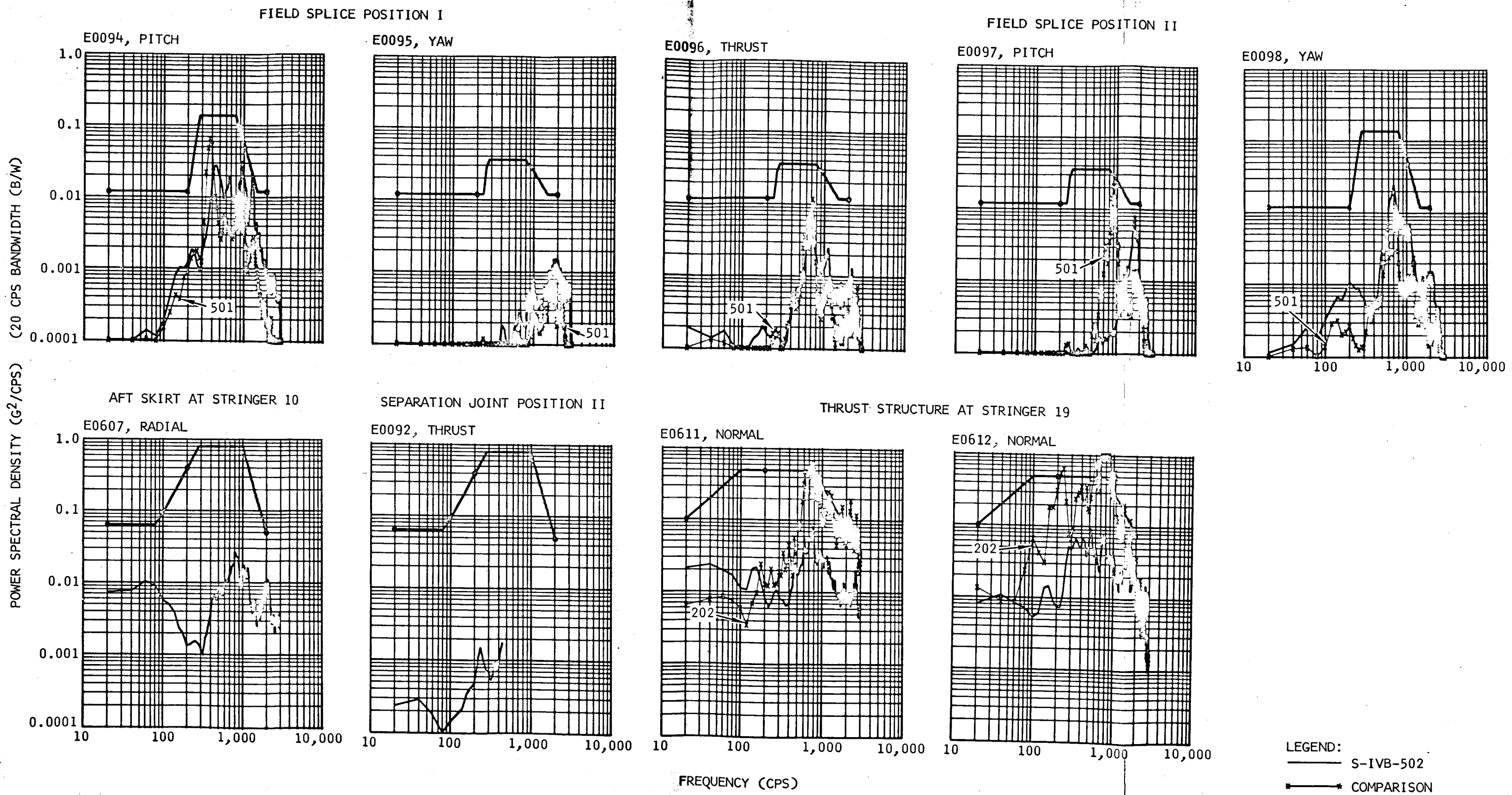


Figure 18-3. Basic Structure Vibration

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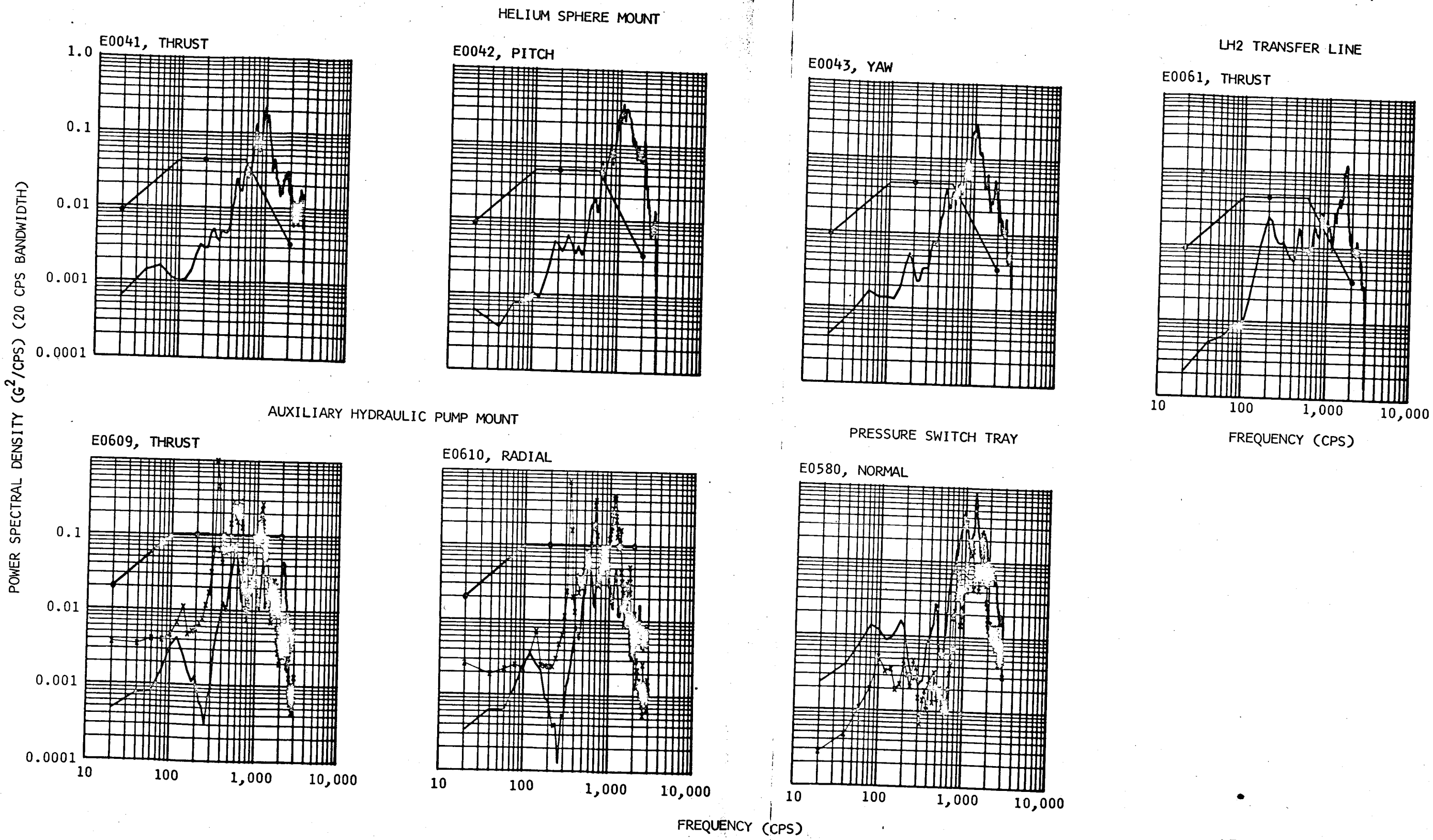


Figure 18-4. Thrust Structure Component Vibration

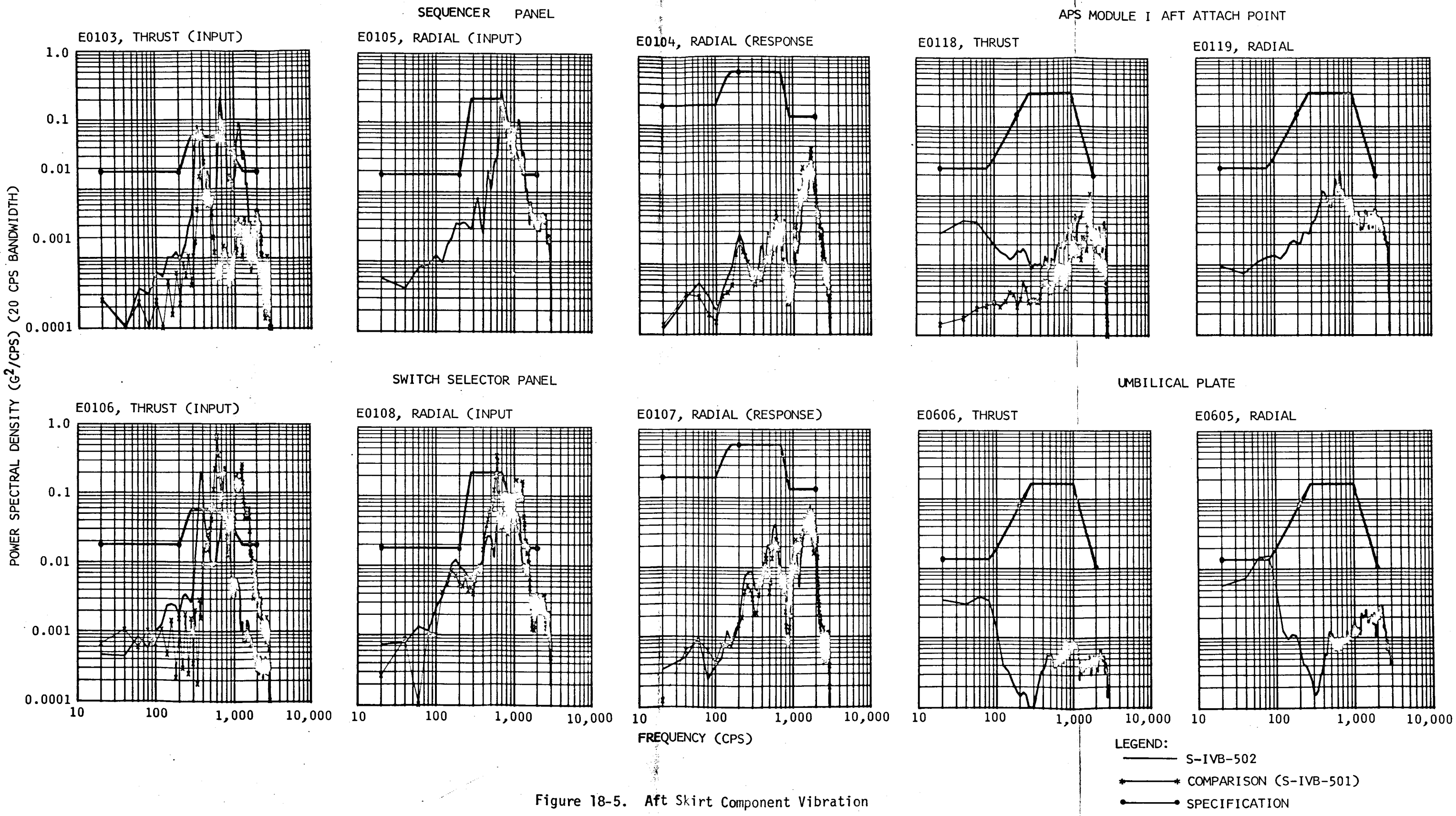


Figure 18-5. Aft Skirt Component Vibration

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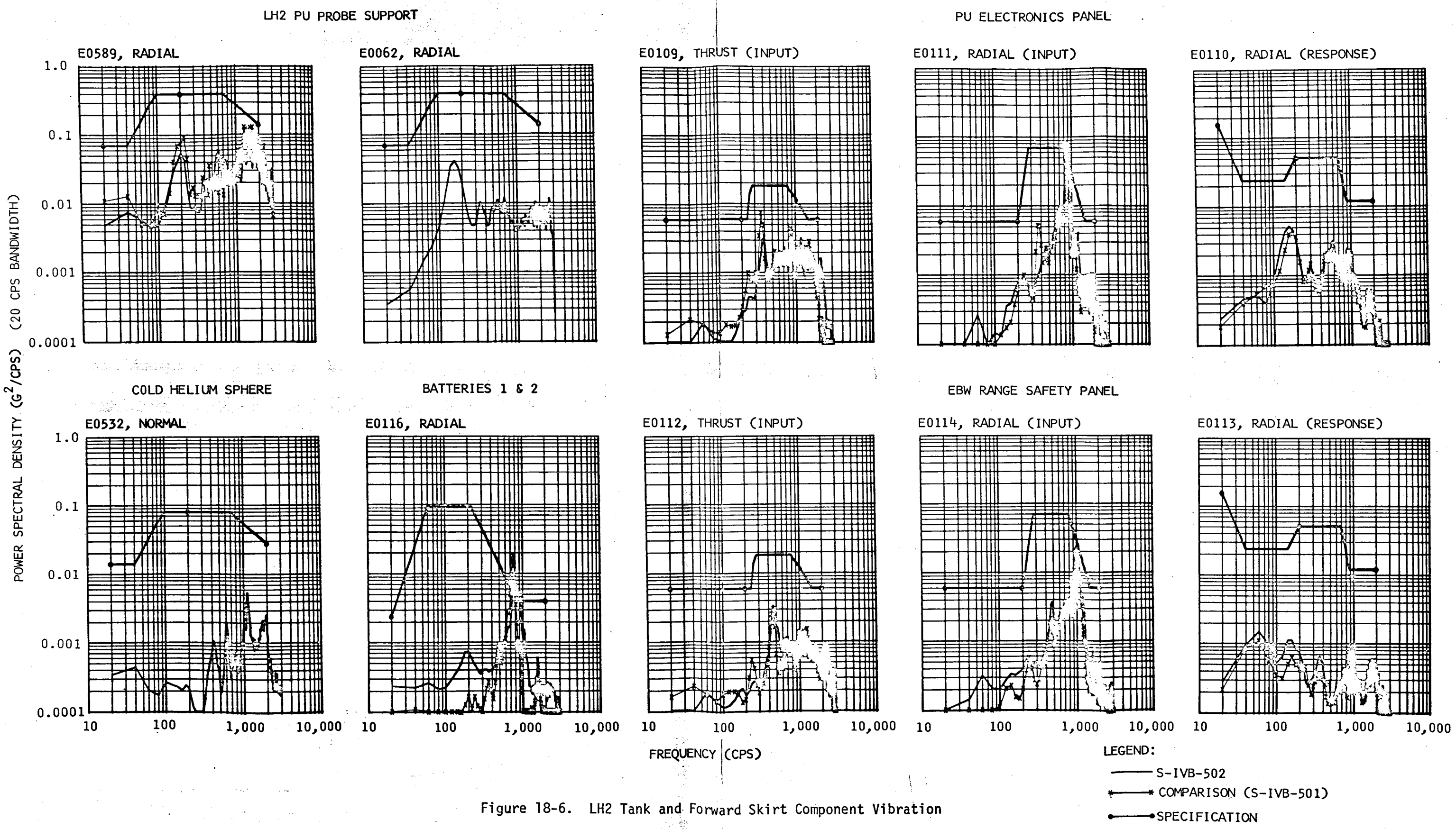


Figure 18-6. LH2 Tank and Forward Skirt Component Vibration

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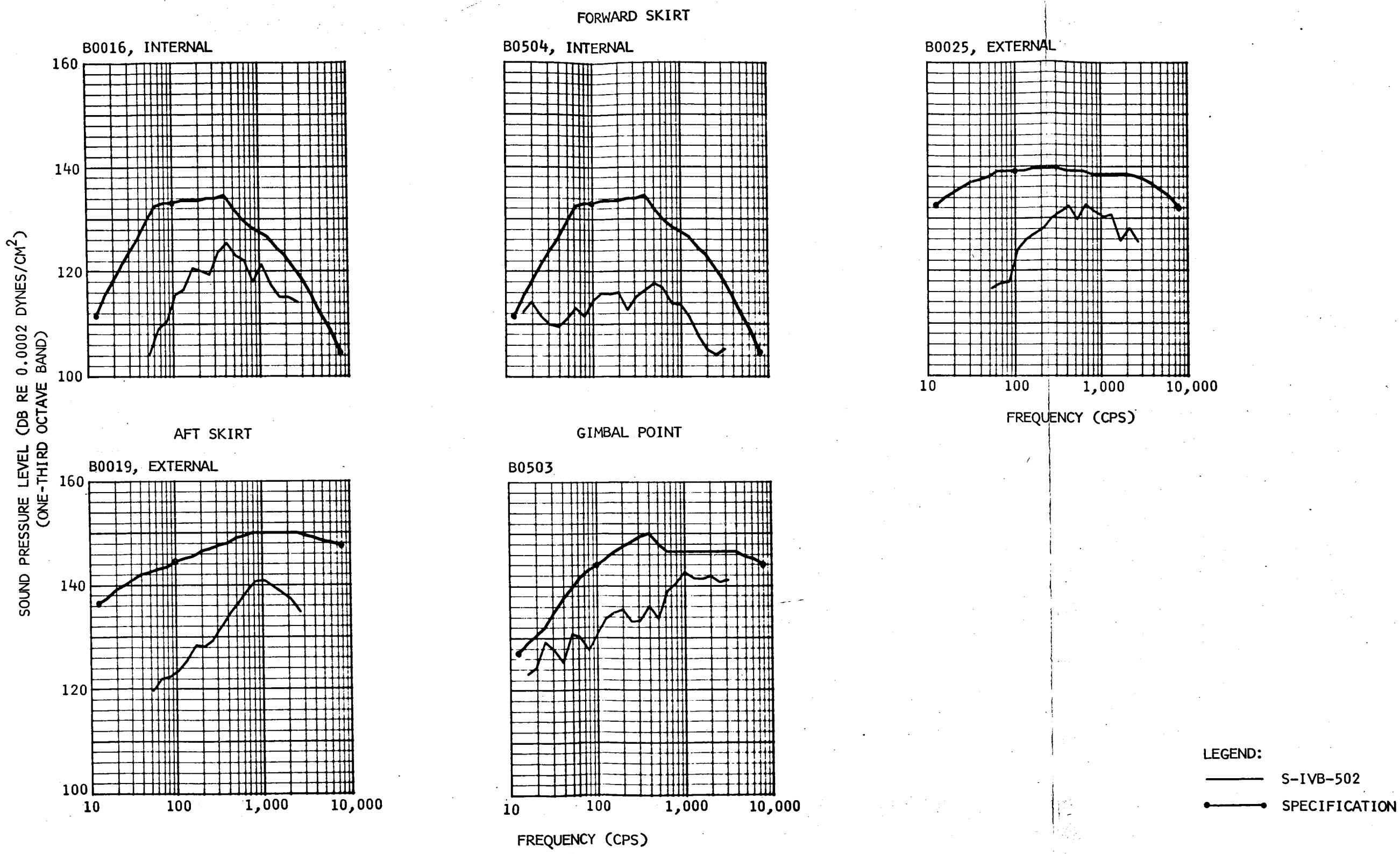


Figure 18-7. Sound Pressure Levels

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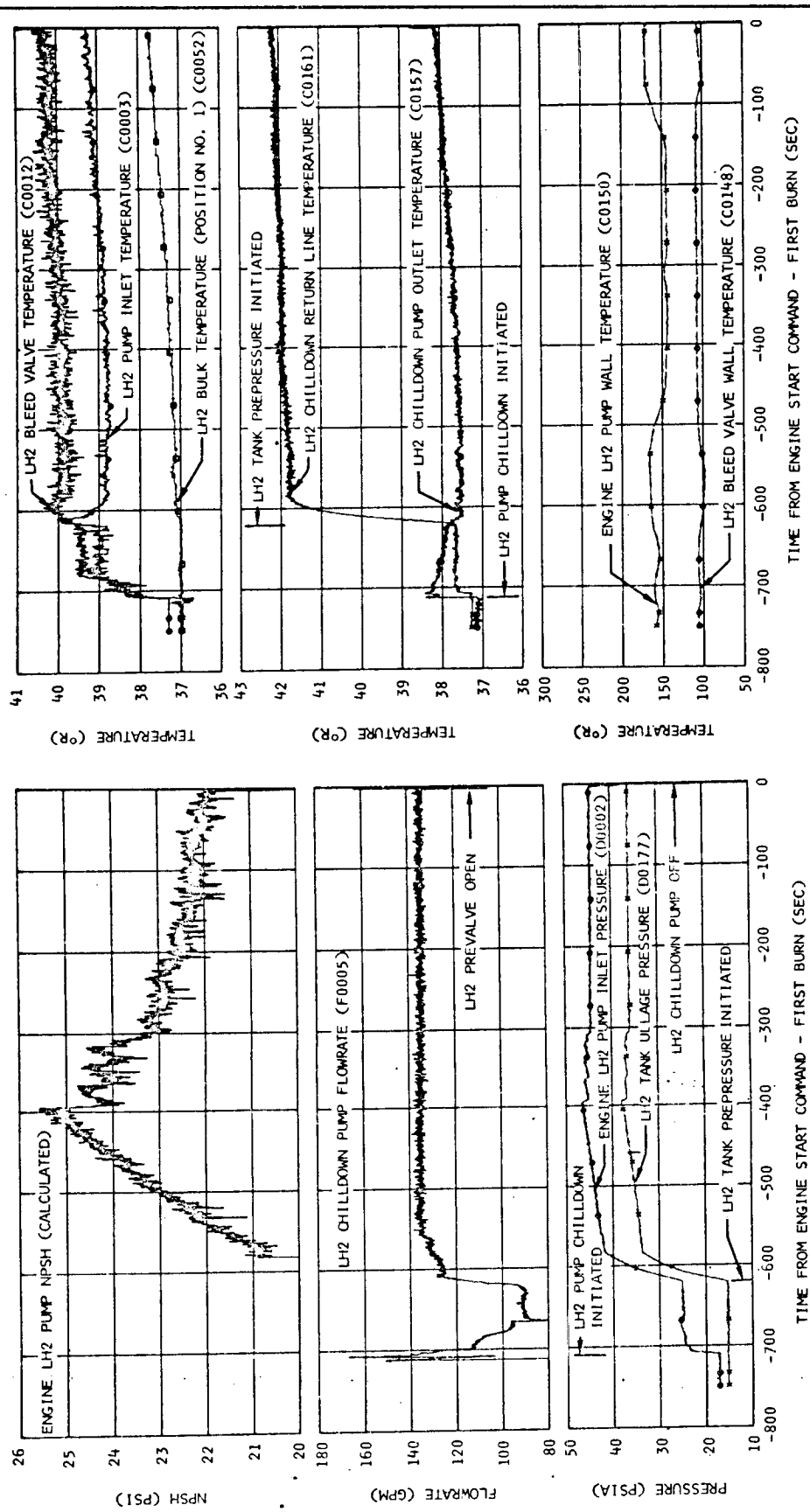


Figure 8-8. LH2 Pump Chilldown - 1st Burn

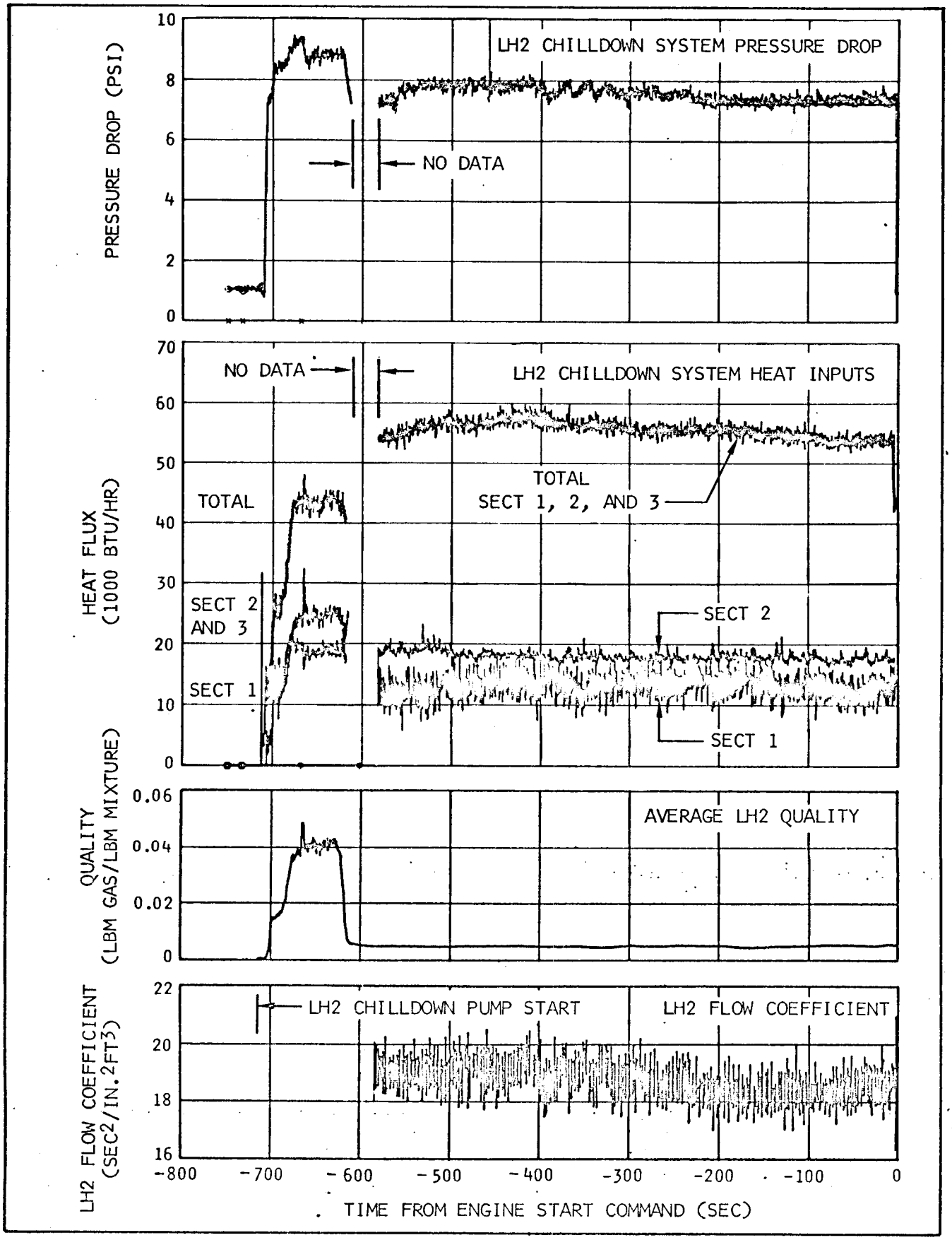


Figure 8-9. LH2 Pump Chilldown Characteristics - 1st Burn

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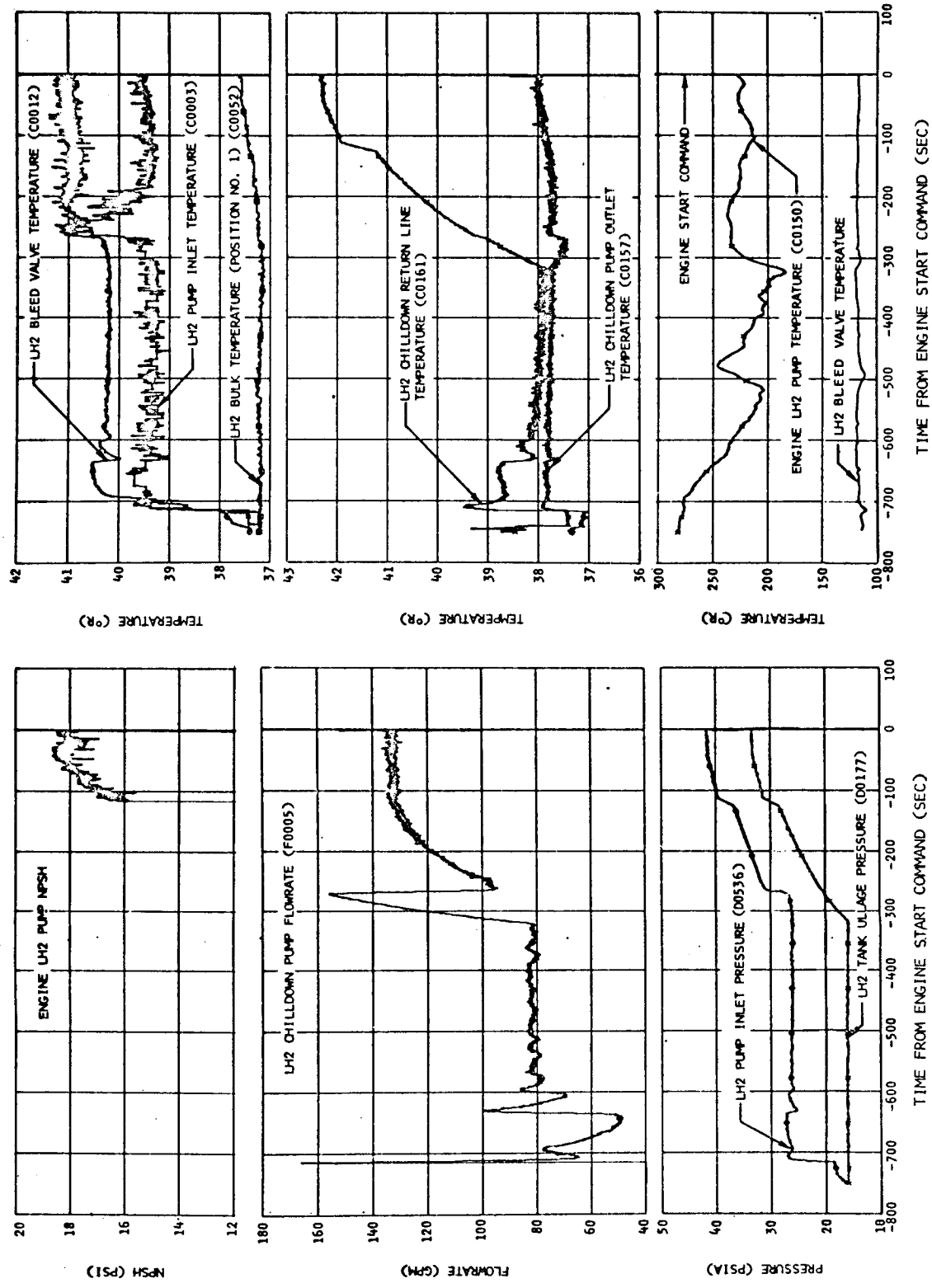


Figure 8-10. LH2 Pump Chilldown - 2nd Burn

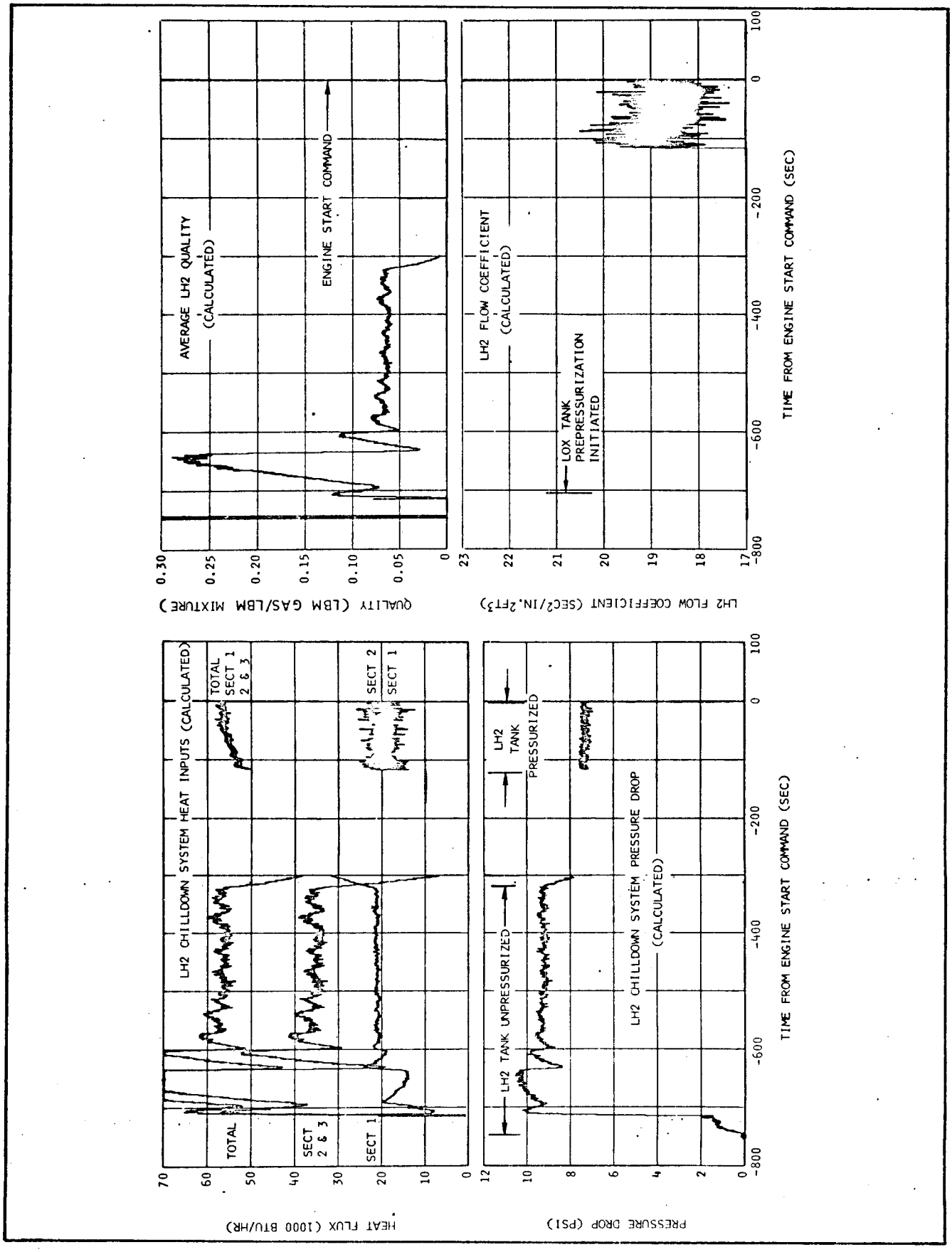


Figure 8-11. LH2 Pump Chilldown Characteristics - 2nd Burn

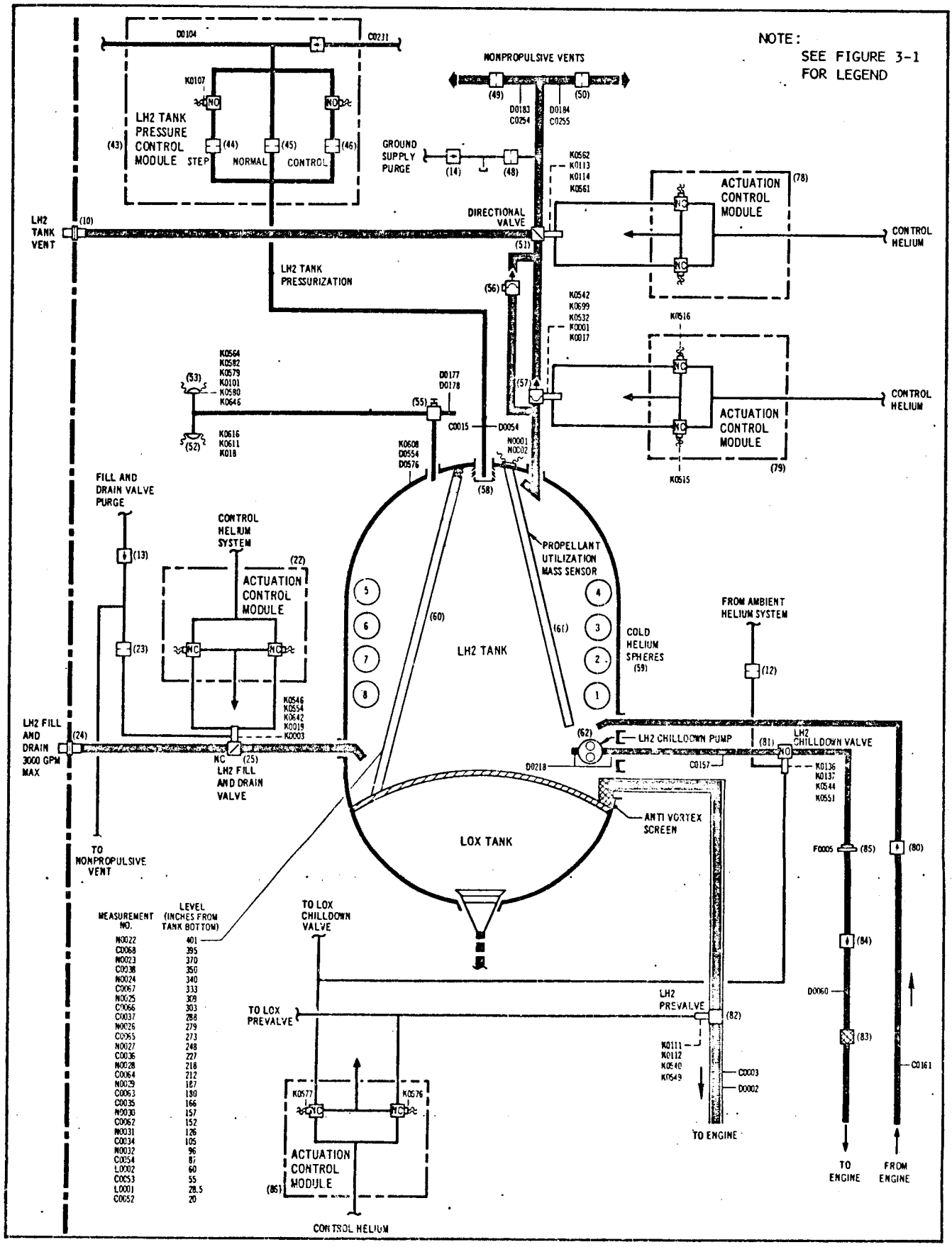


Figure 8-12. LH2 Supply System

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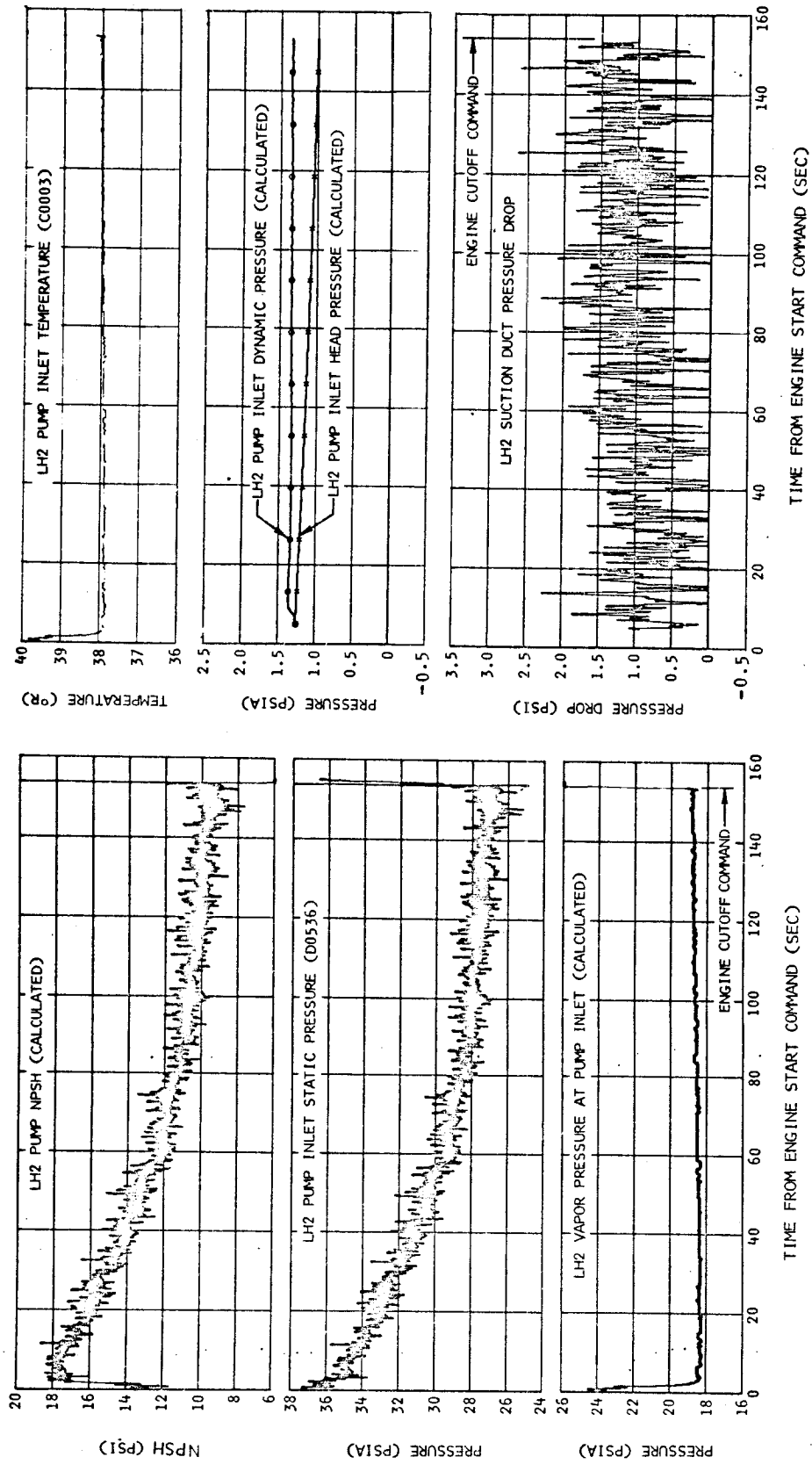


Figure 8-13. LH2 Pump Inlet Conditions - 1st Burn

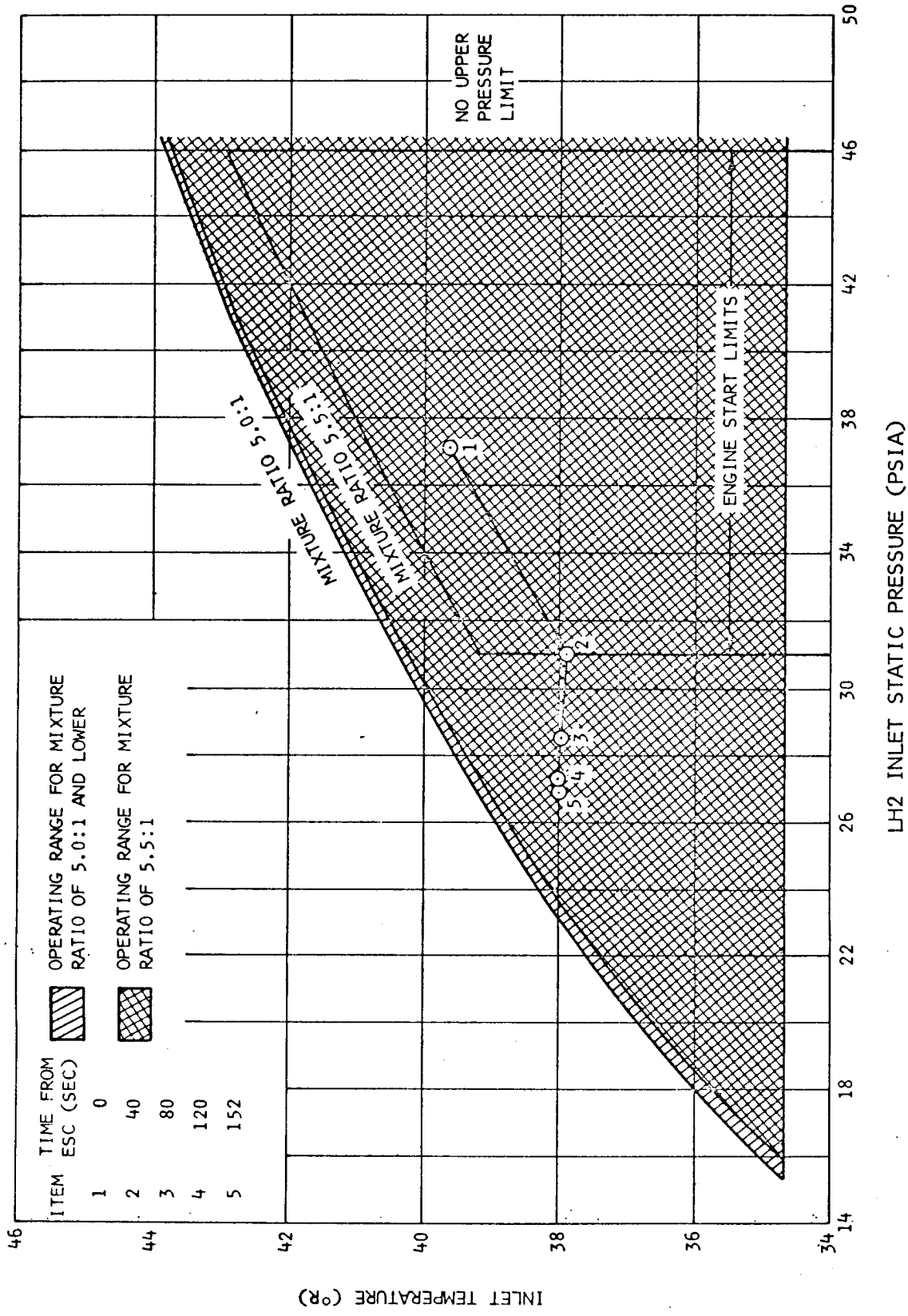


Figure 8-14. LH2 Pump Inlet Conditions During Firing - 1st Burn

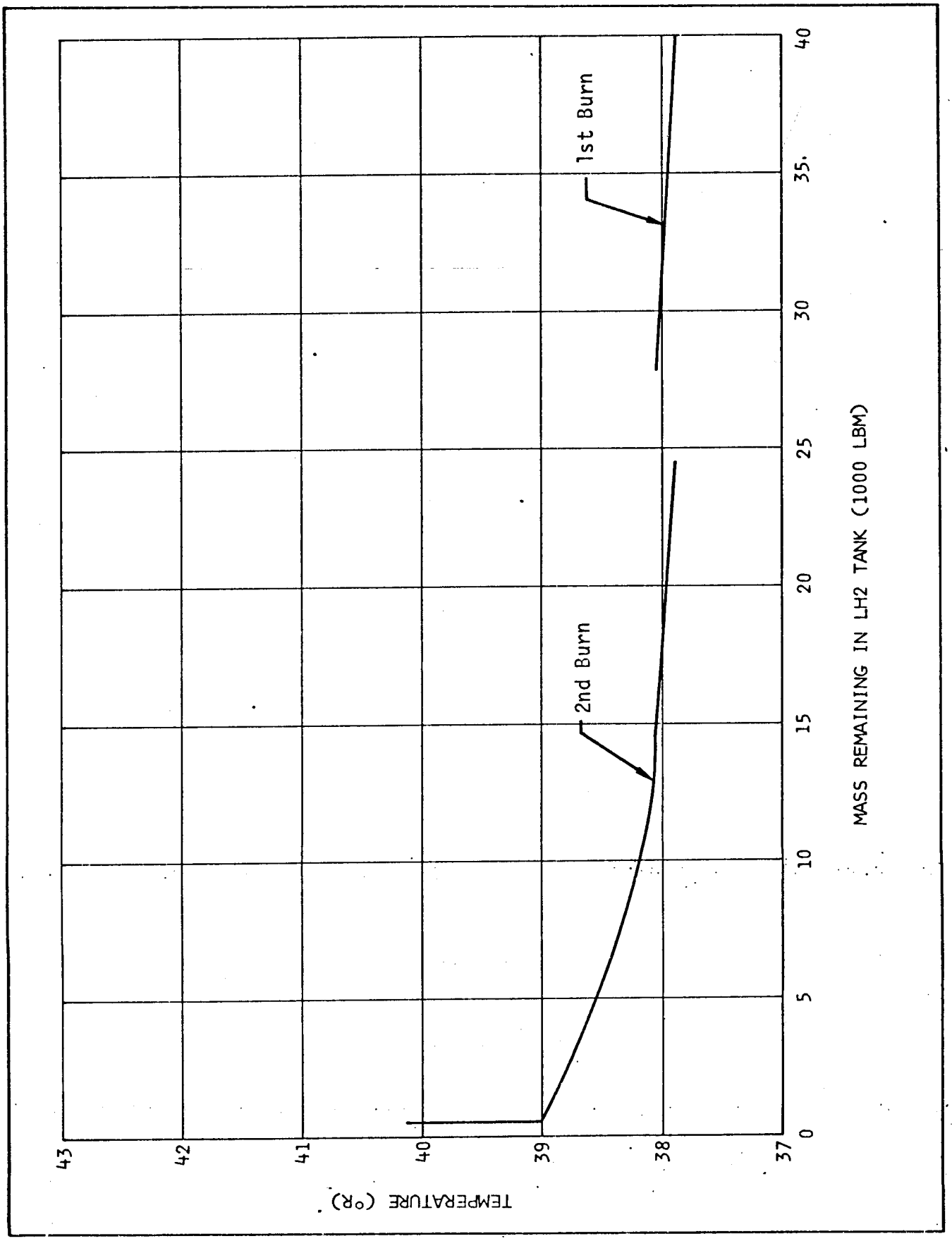


Figure 8-15. Effect of LH2 Tank Mass Level on LH2 Pump Inlet Temperature

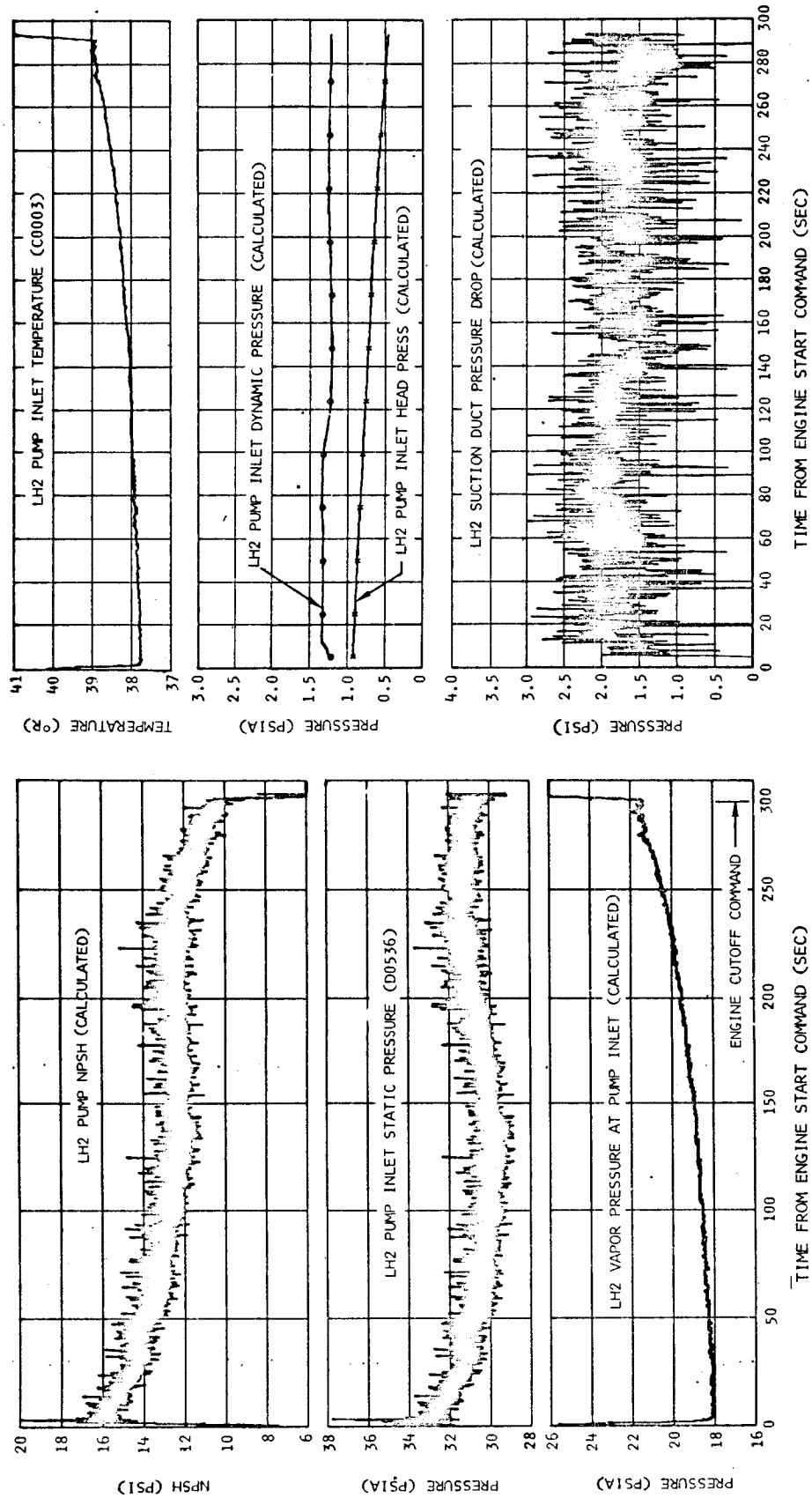


Figure 8-16. LH2 Pump Inlet Conditions - 2nd Burn

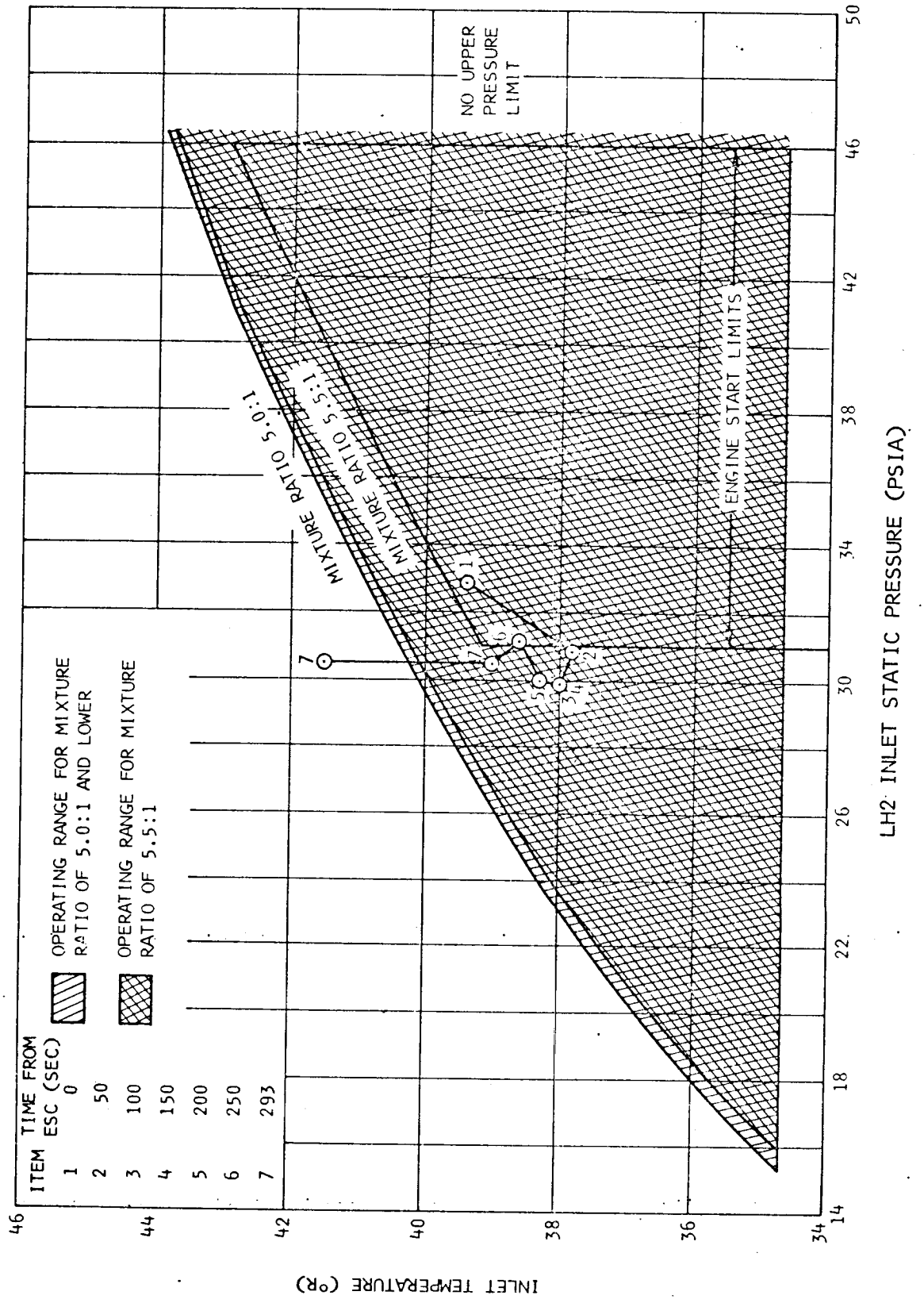


Figure 8-17. LH2 Pump Inlet Conditions During Firing - 2nd Burn

# 9. PNEUMATIC CONTROL AND PURGE SYSTEM

The pneumatic control and purge system (figure 9-1) performed satisfactorily throughout the acceptance firing. The helium supply to the system was adequate for both pneumatic valve control and purging; the regulated pressure was maintained within acceptable limits and all components functioned normally.

## 9.1 Ambient Helium Supply

The ground support equipment (GSE) helium supply was isolated at approximately 10 sec prior to simulated liftoff (SLO).

Pressures at significant times (figures 9-2, 9-3, and 9-4) were as follows:

| TIME | PRESSURE (psia) |
|---|---|
| Simulated Liftoff | 3,205 |
| 1st Burn Engine Cutoff Command | 3,110 |
| 2nd Burn Engine Start Command | 2,640 |
| 2nd Burn Engine Cutoff Command | 2,640 |

Usage during the simulated orbital coast was primarily for the 10-min engine pump purge immediately after engine cutoff.

Of the 9.75 lbm loaded at simulated liftoff, a total of 1.68 lbm was used during the acceptance firing. The following is a comparison of the helium consumption during the various phases of the S-IVB-502 acceptance firing with that of the S-IVB-501 acceptance firing:

| TIME | S-IVB-501 USAGE (lbm) | S-IVB-502 USAGE (lbm) |
|---|---|---|
| Simulated Boost | 0.13 | 0.22 |
| 1st Burn | 0.06 | 0.03 |
| Simulated Coast (ECC to ESC) | 1.00 | 1.42 |
| 2nd Burn | 0.02 | 0.01 |
| Total | 1.21 | 1.68 |

Of this indicated usage, the largest volume was used by the engine pump purge; 0.13 lbm was used during the repressurization and prepressurization operation. The mass consumed and the rate of consumption during engine pump purges were as follows:

| PERIOD | MASS (lbm) | | FLOWRATE (lbm/min) | |
|---|---|---|---|---|
| | S-IVB-501 | S-IVB-502 | S-IVB-501 | S-IVB-502 |
| SLO +332 to SLO +454 sec | 0.12 | 0.17 | 0.06 | 0.085 |
| 1st ECC to 1st ECC +605 sec | 0.75 | 0.84 | 0.074 | 0.084 |
| 2nd ESC -178 to 2nd ESC -57 sec | 0.12 | 0.17 | 0.06 | 0.085 |

The prevalves were held closed from 1st burn engine cutoff to nearly 3,000 sec into simulated coast. A possible slight leakage from these activation modules, usage by the continuous vent regulator, and opening of the LH2 tank vent valves accounted for 0.26 lbm from 1st ECC +600 sec to approximately 4,000 sec into simulated coast. Inspection of the S-IVB-501 data indicates that little or no control helium was used from 2nd ESC -900 sec to the initiation of the engine purge at 2nd ESC -198 sec; 0.13 lbm were used by the S-IVB-502 stage over the same period. The available data indicate that a slightly higher degree of leakage existed in the S-IVB-502 control helium systems than in the S-IVB-501 stage; however, the leakage was very minor and the reserve was far in excess of requirements.

## 9.2 Pneumatic Control

All engine and stage pneumatic control valves responded properly throughout the acceptance firing. The pneumatic control helium regulator operated satisfactorily and generally maintained an output pressure of 515 to 545 psia. The regulator lockup pressure appeared to be 555 psia; however, the system pressure dropped to as low as 425 psia during the start and cutoff transients. These dips have occurred on all past firings and, since the system pressure recovers quickly, are considered satisfactory. The continual cycling of the regulator during the simulated coast was due to the cycling of the LH2 tank vent valve while it controlled the tank ullage pressure.

## 9.3 Ambient Helium Purges

Throughout the countdown, ten purge functions were satisfactorily accomplished. The purge function characteristics, gas sources, and purging periods are listed in table 9-1.

The LOX chilldown motor container pressure was maintained at approximately 41 $\pm$1.6 psia throughout the acceptance firing, satisfying the requirements of 37 to 40 psia.

TABLE 9-1
S-IVB-502 STAGE PURGE FUNCTIONS

| PURGE FUNCTION | PURGE HELIUM SOURCE | | | ORIFICE TYPE/SIZE | NOMINAL FLOWRATE |
|---|---|---|---|---|---|
| | GROUND PHASE | BOOST PHASE | S-IVB FLIGHT PHASE | | |
| LOX Tank Vent Valve | Facility* | ** | -- | 0.024 in. | 65 scfm at 3,000 psig |
| Engine Fuel Turbine Seal Cavity | Stage† | Stage | Stage | †† | |
| Engine LH2 Pump Seal Cavity | Stage | Stage | Stage | †† | Total 6.0 scfm at 85 psia |
| Engine LOX Pump Seal | Stage | Stage | Stage | †† | |
| GG GH2 Injector | Stage | Stage | Stage | †† | |
| LOX Chilldown Pump | Stage | Stage | Stage | Sintered | 35 scim at 475 psid |
| LOX Fill and Drain Valve Housing | Facility | ** | -- | Sintered | 15 scim at 3,200 psig |
| LH2 Fill and Drain Valve | Facility | ** | -- | Sintered | 15 scim at 3,200 psig |
| LH2 Nonpropulsive Vent | Facility | ** | -- | Sintered | 1,728 scim at 3,200 psig |
| Continuous Vent System | Facility | | -- | Sintered | 300 scim |

* Facility = GSE console A (DSV-4B-319)
** Purged from facility until GSE isolation at SLO +91 sec
† Stage = S-IVB regulated pneumatic control supply
†† Common orifice in engine pump purge control module

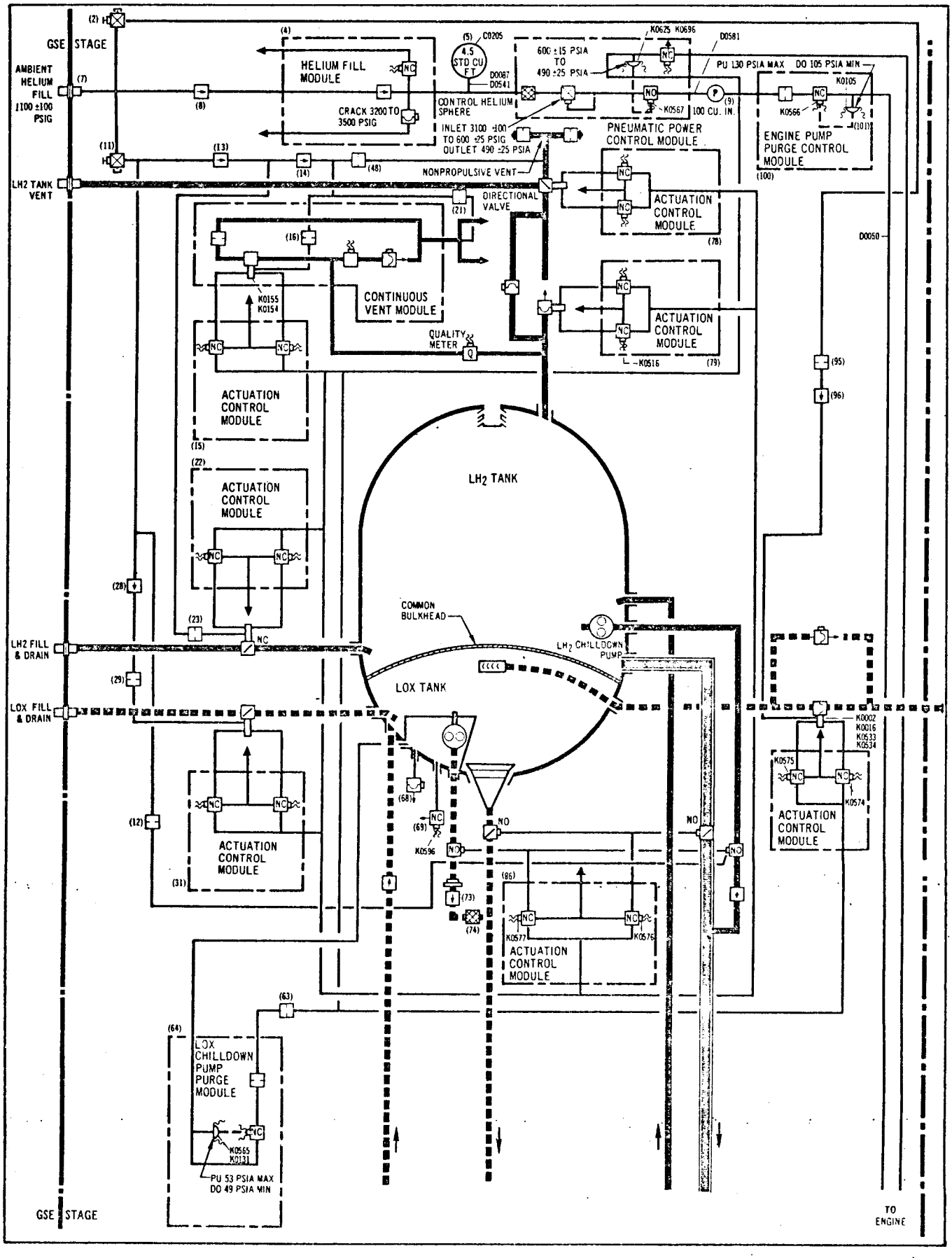


Figure 9-1. Pneumatic Control and Purge System

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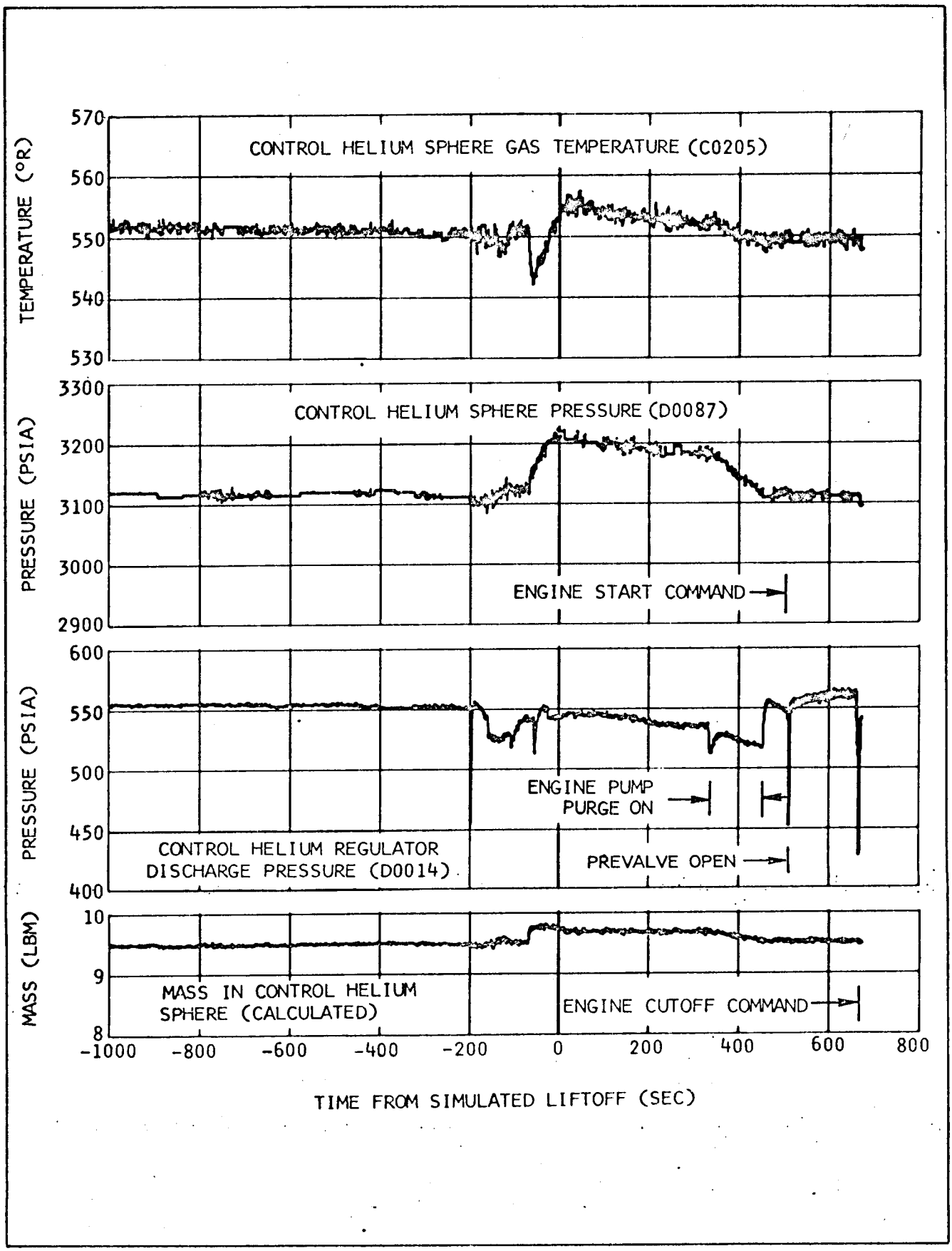


Figure 9-2. Pneumatic Control and Purge System Performance - 1st Burn

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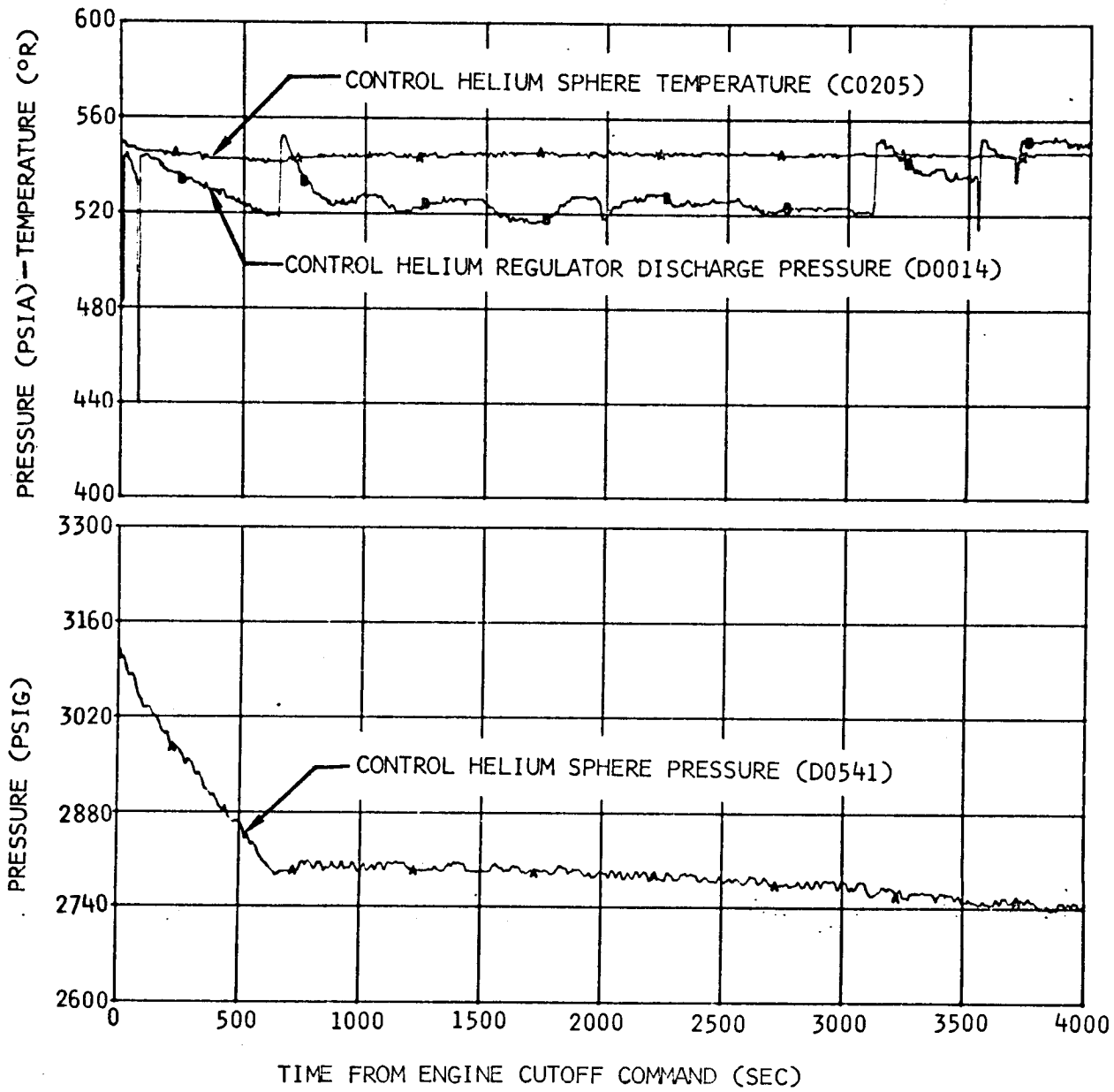


Figure 9-3. Pneumatic Control System Conditions - Simulated Orbital Coast

28 September 1966

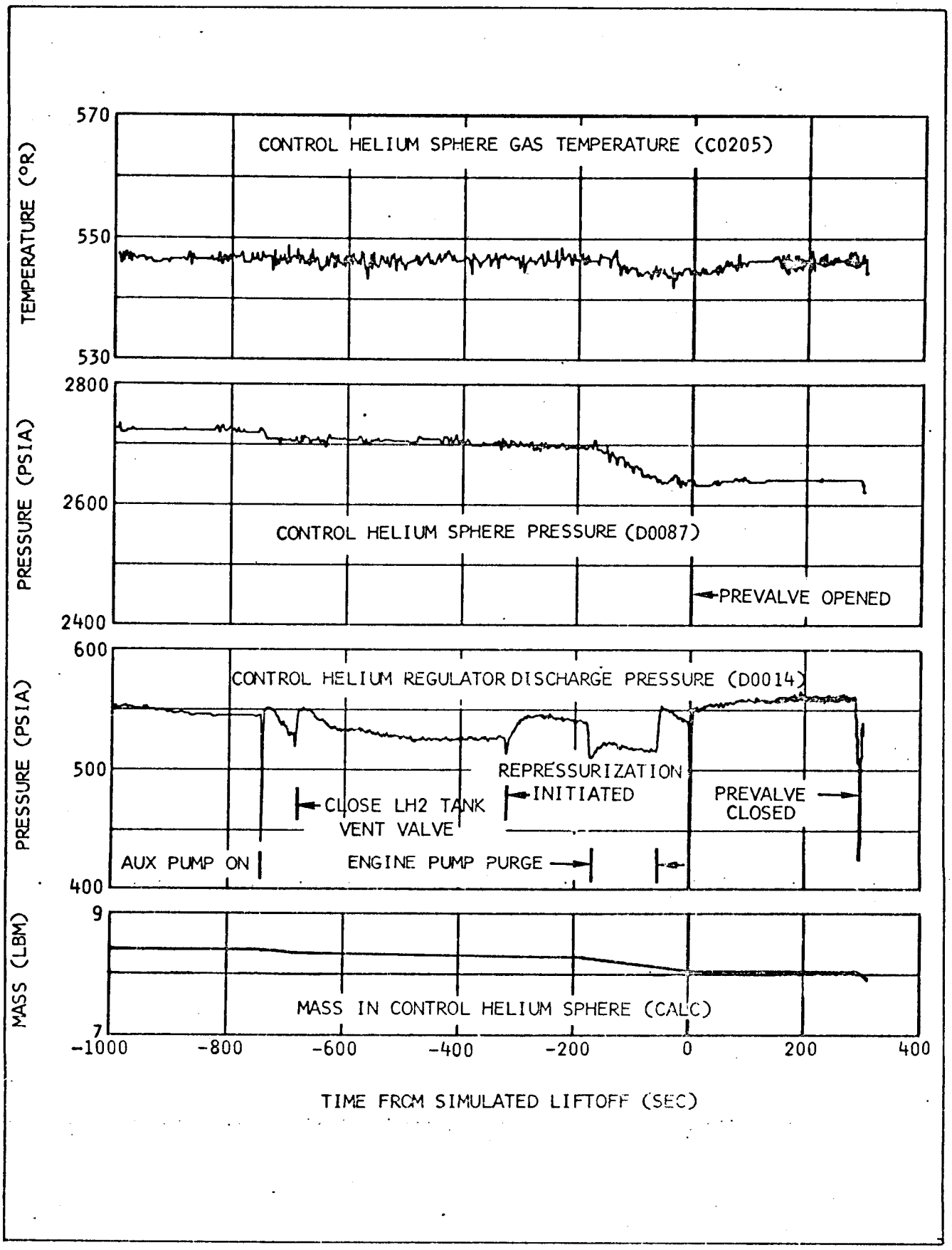


Figure 9-4. Pneumatic Control and Purge System Performance - 2nd Burn

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# 10. AUXILIARY PROPULSION SYSTEM

The S-IVB-502 APS modules were confidence fired during countdowns 624360 and 624368. These tests were conducted at the Complex Gamma Test Facility of the Sacramento Test Center on 19 July and 27 July 1966. The tests were authorized by Test Request 2077 and 2078 which delineate the procedures used during the tests. The operating techniques established during Phases I and II of Complex Gamma testing were employed during the confidence firing tests.

Each APS module contains four engines. Three of the engines are TRW 150-lbf-thrust engines used for attitude control of the stage. The fourth engine is a rocketdyne 72 lbf thrust engine used for ullage control of the stage. Figure 10-1 shows the orientation of the engines; figure 10-2 is a schematic of the APS modules.

## 10.1 APS Module No. 1

### 10.1.1 APS Oxidizer System Loading and Operation

The operation of the oxidizer system was satisfactory during the confidence firing of module No. 1. The pertinent oxidizer system data for this module are presented in table 10-1.

Recirculation and loading of the oxidizer system were carried out simultaneously; however, after the bladder was full, recirculation was continued until the returning liquid was free of gas bubbles. Loading of the nitrogen tetraoxide (NTO) required approximately 12.3 min. Recirculation was continued for an additional 5 min 20 sec. The oxidizer temperature was 530 deg R, thus the quantity of oxidizer in the bladder at the full loaded condition was 213.6 lbm. To provide an ullage to allow for thermal expansion, 7.2 lbm of oxidizer were off-loaded; therefore, the quantity of oxidizer in the bladder prior to the firings was 206.4 lbm.

The oxidizer consumption during the test was calculated by two methods. The first was the pressure differential ($\Delta P$) method which was used to calculate the consumption for the individual pulses. By summing these values, the overall consumption during the test was determined to be 7.00 lbm.

The second method utilized the change in helium sphere conditions to determine the change in ullage volume and, therefore, the volume of propellant displaced from the bladder. With a known propellant temperature and an assumed EMR value, the propellant consumption could be approximated. The oxidizer consumption calculated by this method was 9.1 lbm. The difference of 2.1 lbm is within the accuracies of the instrumentation and method used.

The oxidizer consumption for the various pulse widths fired during the test are shown in figure 10-3. This figure shows that the oxidizer consumption was within the two sigma variation as determined during TRW engine testing.

The oxidizer supply pressure transients were similar to those obtained during previous testing. For a single engine firing, the transients ranged from 140 to 240 psia. For multiple engines firing, the minimum pressures were 100 psia and 300 psia, respectively. In both cases, the shutdown transients required approximately 0.25 sec to dampen out.

The pressure differential across the oxidizer bladder was kept below 11 psid throughout the test; however, a $\Delta P$ of 17 psid was recorded during oxidizer tank ullage venting following firing because the ullage pressure tap sensed the static pressure of the venting helium. The bladder did not experience this $\Delta P$.

### 10.1.2 APS Fuel System Loading and Operation

The operation of the fuel system of module No. 1 was satisfactory during the confidence firing. The pertinent fuel system data are presented in table 10-1. As with the oxidizer system, recirculation and loading were carried out simultaneously with recirculation continuing until the return line was free of gas bubbles. Loading of the fuel bladder required approximately 9.3 min. Recirculation was continued for an additional 4.3 min. The fuel temperature was 536 deg R; therefore, the amount of fuel in the bladder was 129.0 lbm. To allow for thermal expansion, 4.4 lbm of fuel were off-loaded; thus, the amount of fuel in the bladder prior to the firings was 124.6 lbm. The fuel consumption during the test was calculated by the same methods as the oxidizer consumption. The $\Delta P$ method indicated a fuel

consumption of 4.6 lbm. Using the helium sphere conditions, the fuel consumption was determined to be 6.1 lbm. Again, the difference in the values is within the accuracies of the instrumentation and methods used.

The fuel consumptions for the various pulse widths fired during the test are shown in figure 10-4. From this figure, it can be seen that the fuel consumption was within the TRW two sigma variations.

The fuel supply pressure transients were similar to those of previous tests. For a single engine firing, the minimum supply pressure transient was 150 psia and the maximum point was 260 psia. For multiple engine firings, the pressure dropped to a minimum of 160 psia and increased to a maximum of 220 psia. In both cases, the steady-state supply pressure was 191 to 195 psia.

The pressure differential across the fuel bladder was kept below 10 psid, except for a short period after the pressure spike indicating a full fuel bladder. At this time, the $\Delta P$ reached 10.8 psid.

### 10.1.3 APS Helium System Loading and Operation

The helium pressurization system of module 1 operated satisfactorily throughout the confidence firing. The helium sphere was pressurized to 3,115 psia. Since the objectives of the test required that the sphere be pressurized to only 3,100 $\pm$100 psia, a fully loaded condition was not achieved. The pertinent data for the helium system of module 1 are shown in table 10-1.

Just prior to firing, the helium sphere conditions were 2,993 psia and 566 deg R, indicating a contained helium mass of 0.967 lbm. Upon completion of the firings, the sphere contained 0.940 lbm at 2,870 psia and 560 deg R; thus, the amount of helium required to expel propellants during the test was 0.027 lbm.

The ullage pressure was maintained at 191 to 196 psia during the test. With the regulator reference pressure less than 0.3 psia during regulator operation, this satisfies the test objective of maintaining the propellant tank pressures at 193 $\pm$5 psia plus the regulator reference pressure. The regulator outlet pressure ranged from 196 to 198 fulfilling the 196 $\pm$3 psia requirement.

### 10.1.4 APS Engine Performance

The data obtained during the confidence firing indicated that the engine performance of module 1 successfully met the test objectives stated in TR 2077. The data agree with that obtained during previous testing and with the TRW test data.

The injector valve opening times for all eight valves of each of the TRW engines were 20 ms or less, fulfilling the requirement of 21 ms maximum. The injector valves of the ullage engines required 15 ms to open, fulfilling the requirement of 21 ms maximum. The steady-state chamber pressures were 97.3, 97.6, 97.4, and 102.5 psia for engines 1, 2, 3, and 4, respectively. These values satisfy the requirement of 100 +5 psia.

The steady-state thrusts of the TRW engines were 141.1, 140.0, and 141.2 lbf for engines 1, 2, and 3, respectively. This fulfills the requirement of 145 ±10 lbf stated in TR 2077. The steady-state thrust of engine 4 was 73.8 lbf, thus satisfying the requirement of 72 ±3.6 lbf.

The pertinent engine performance parameters for engines 1, 2, and 3 are shown in figures 10-3 through 10-7. The TRW two sigma variations are also shown for comparison.

The engine performance of the TRW engines agreed favorably with the TRW two sigma bands. The performance of the ullage engine compared well with that obtained during Rocketdyne testing.

## 10.2 APS Module No. 2

### 10.2.1 APS Oxidizer System Loading and Operation

The operation of the oxidizer system was satisfactory during the confidence firing of module 2. The pertinent oxidizer system data for this module are presented in table 10-2.

Recirculation and loading of the oxidizer system were carried out simultaneously; however, recirculation was continued after the bladder was full until the returning liquid was free of gas bubbles. Loading of the NTO required approximately 11.7 min. Recirculation was continued for an additional 3 min. The oxidizer temperature was 522 deg R, thus the quantity of oxidizer in the bladder at the fully loaded condition was 215 lbm. To

provide an ullage to allow for thermal expansion, 10.4 lbm of oxidizer was off-loaded. The quantity of oxidizer in the bladder prior to the firings was therefore 204.6 lbm.

The oxidizer consumption during the test was calculated by the two methods described in paragraph 10.1.1. The ΔP method indicated an overall consumption of 7.3 lbm, and the helium sphere conditions indicated 9.2 lbm. The difference of 1.9 lbm is within the accuracies of the instrumentation and methods used.

The oxidizer consumptions for the various pulse widths fired during the test are shown in figure 10-3. This figure also shows that the oxidizer consumption was within the two sigma variation as determined during TRW testing.

The oxidizer supply pressure transients were similar to those obtained during previous testing. For a single engine firing, the transients ranged from 130 to 280 psia. For multiple engines firing, the minimum and maximum pressures were 100 psia and 300 psia, respectively. In both cases, the shutdown transients required approximately 0.25 sec to dampen out.

The pressure differential across the oxidizer bladder was maintained at less than 10 psid throughout most of the test. The ΔP reached a maximum of 11 psid during post-test purging.

### 10.2.2 APS Fuel System Loading and Operation

The operation of the fuel system of module 2 was satisfactory during the confidence firing. The pertinent fuel system data are presented in table 10-2.

As with the oxidizer system, recirculation and loading were carried out simultaneously, with recirculation continuing until the return line was free of gas bubbles. Loading of the fuel bladder required approximately 8.3 min. Recirculation was continued for an additional 2 min. The fuel temperature was 526 deg R; therefore, the amount of fuel in the bladder was 129.7 lbm. To allow for thermal expansion, 3.7 lbm of fuel were off-loaded; thus, the amount of fuel in the bladder prior to the firings was 126.0 lbm. The fuel consumption during the test was calculated by the same methods as the oxidizer consumption. The ΔP method indicated a fuel

consumption of 4.8 lbm, and the helium sphere conditions indicated 6.1 lbm. Again, the difference in the values is within the accuracies of the instrumentation and methods used.

The fuel consumptions for the various pulse widths fired during the test are shown in figure 10-4 which also shows that the fuel consumption was within the TRW two sigma variations.

The fuel supply pressure transients were similar to those of previous tests. For a single engine firing, the minimum supply pressure transient was 180 psia and the maximum point was 220 psia. For multiple engine firings, the pressure dropped to a minimum of 170 psia and increased to a maximum of 230 psia. In both cases, the steady-state supply pressure was 195 to 200 psia.

The pressure differential across the fuel bladder was maintained below 11.5 psid throughout the test.

### 10.2.3 APS Helium System Loading and Operation

The helium pressurization system of module 2 operated satisfactorily throughout the confidence firing test. The helium sphere was prepressurized to approximately 250 psia and then fully pressurized to 3,132 psia. Since the objectives of the test required only that the sphere be pressurized to 3,100 ±100 psia, a fully loaded condition was not achieved. The pertinent data for the helium system of module 2 are shown in table 10-2.

Just prior to firing, the helium sphere conditions were 2,950 psia and 551 deg R, indicating a contained helium mass of 0.978 lbm. Upon completion of the firings, the sphere contained 0.951 lbm at 2,835 psia and 546 deg R; thus, the amount of helium required to expel propellants during the test was 0.027 lbm.

The ullage and tank pressure was maintained at 189 to 197 psia during the test. The regulator reference pressure was less than 0.4 psia during regulator operation. This satisfies the test objective of maintaining the propellant tank pressures at 193 ±5 psia plus the regulator reference pressure.

The helium regulator outlet pressure was maintained at 194 psia, which satisfies the requirement of 196 ±3 psia plus the regulator reference pressure.

### 10.2.4 APS Engine Performance

The data obtained during the confidence firing indicated that the engine performance of module 2 successfully met the test objectives stated in TR 2078. The data agreed with that obtained during previous testing and with the TRW test data.

The injector valve opening times for all eight valves of each of the TRW engines were 20 ms or less, fulfilling the requirement of 23 ms maximum. The injector valves of the ullage engine required 17 ms to open, fulfilling the 21 ms maximum requirement.

The steady-state chamber pressures were 96.0, 97.4, 100.6, and 102.7 for engines 1, 2, 3, and 4, respectively. These chamber pressures meet the requirement of 100 $\pm$5 psia.

The steady-state thrusts of engines 1, 2, 3, and 4 were 139.2, 141.2, 145.9, and 73.9, respectively. These values fulfill the requirements of 145 $\pm$10 lbf for the TRW engines, and 72 $\pm$3.6 lbf for the Rocketdyne ullage engine.

The pertinent engine performance parameters for engines 1, 2, and 3 are shown in figures 10-3 through 10-7. The TRW two sigma variations are also shown for comparative purposes.

TABLE 10-1
APS MODULE 1

| | OXIDIZER | FUEL | HELIUM |
|---|---|---|---|
| PROPELLANT RECIRCULATION | | | |
| Mobile Servicer Storage Tank Pressure (psia) | 39.5-50 | 37-48 | |
| Mobile Servicer Collection tank pressure (psia) | 34-36 | 34.5-36 | |
| PROPELLANT LOADING | | | |
| APS Ullage Pressure (psia) | 34-35.3 | 34.5-35 | |
| APS Tank Outlet Pressure (psia) | 35.3-45 | 35-45.3 | |
| Loading Time (min) | 17 | 13 | |
| Tank Outlet Temperature at Full Load (°R) | 530 | 536 | |
| Quantity Loaded (cu in.) | 4,092 | 4,092 | |
| Quantity Loaded (lbm) | 213.6 | 129.0 | |
| Quantity Off-Loaded (gal) | 0.6 | 0.6 | |
| Quantity Off-Loaded (lbm) | 7.2 | 4.4 | |
| Quantity in Tank Before Firing (lbm) | 206.4 | 124.6 | |
| HELIUM LOADING | | | |
| Loading Time (min) | | | 9.5 |
| Sphere Pressure at Loaded Condition (psia) | | | 2,993 |
| Sphere Temperature at Loaded Condition (°R) | | | 566 |
| Helium Mass at Loaded Condition (lbm) | | | 0.967 |
| APS Ullage Pressure (psia) | 191 | 193 | |
| APS Tank Outlet Pressure (psia) | 195 | 191 | |
| DURING FIRING (AFTER CLEARING BURSTS) | | | |
| APS Ullage Pressure (psia) | 192 | 193 | |
| APS Tank Outlet Pressure (psia) | 196 | 192 | |
| Helium Regulator Reference Pressure (psia) | | | 0.3 |
| HELIUM USAGE DURING TEST | | | |
| Sphere Pressure at End of Test (psia) | | | 2,870 |
| Sphere Temperature at End of Test (°R) | | | 560 |
| Helium Mass Remaining (lbm) | | | 0.940 |
| Helium Mass Used (lbm) | | | 0.027 |
| PROPELLANT USAGE DURING TEST* | | | |
| Tank Outlet Temperature at End of Test (°R) | 533 | 537 | |
| Quantity of Propellant Used (lbm) | 9.1 | 6.1 | |
| Quantity Remaining in Tanks (lbm) | 197.3 | 118.5 | |

* Calculated from helium usage with mixture ratio assumed to be 1.5.

TABLE 10-2
APS MODULE 2

| | OXIDIZER | FUEL | HELIUM |
|---|---|---|---|
| PROPELLANT RECIRCULATION | | | |
| Mobile Servicer Storage Tank Pressure (psia) | 38.549 | 37-48 | |
| Mobile Servicer Collection Tank Pressure (psia) | 34-36 | 34.5-36 | |
| PROPELLANT LOADING | | | |
| APS Ullage Pressure (psia) | 34.5-36.5 | 34.3-34.5 | |
| APS Tank Outlet Pressure (psia) | 35.3-45.5 | 35-46 | |
| Loading Time (min) | 14.8 | 10.9 | |
| Tank Outlet Temperature at Full Load (°R) | 522 | 526 | |
| Quantity Loaded (cu in.) | 4,092 | 4,092 | |
| Quantity Loaded (lbm) | 215.0 | 129.7 | |
| Quantity Off-Loaded (gal) | 0.86 | 0.50 | |
| Quantity Off-Loaded (lbm) | 10.4 | 3.7 | |
| Quantity in Tank Before Firing (lbm) | 204.6 | 126.0 | |
| HELIUM LOADING | | | |
| Loading Time (min) | | | 7.3 |
| Sphere Pressure at Loaded Condition (psia) | | | 2,950 |
| Sphere Temperature at Loaded Condition (°R) | | | 551 |
| Helium Mass at Loaded Condition (lbm) | | | 0.978 |
| APS Ullage Pressure (psia) | 195 | 193 | |
| APS Tank Outlet Pressure (psia) | 195 | 189 | |
| DURING FIRING (AFTER CLEARING BURSTS) | | | |
| APS Ullage Pressure (psia) | 196 | 193 | |
| APS Tank Outlet Pressure (psia) | 197 | 189 | |
| Helium Regulator Reference Pressure (psia) | | | 0.4 |
| HELIUM USAGE DURING TEST | | | |
| Sphere Pressure at End of Test (psia) | | | 2,835 |
| Sphere Temperature at End of Test (°R) | | | 546 |
| Helium Mass Remaining (lbm) | | | 0.951 |
| Helium Mass Used (lbm) | | | 0.027 |
| PROPELLANT USAGE DURING TEST* | | | |
| Tank Outlet Temperature at End of Test (°R) | 524 | 530 | |
| Quantity of Propellant Used (lbm) | 9.2 | 6.1 | |
| Quantity Remaining in Tanks (lbm) | 195.4 | 119.9 | |

* Calculated from helium usage with mixture ratio assumed to be 1.50.

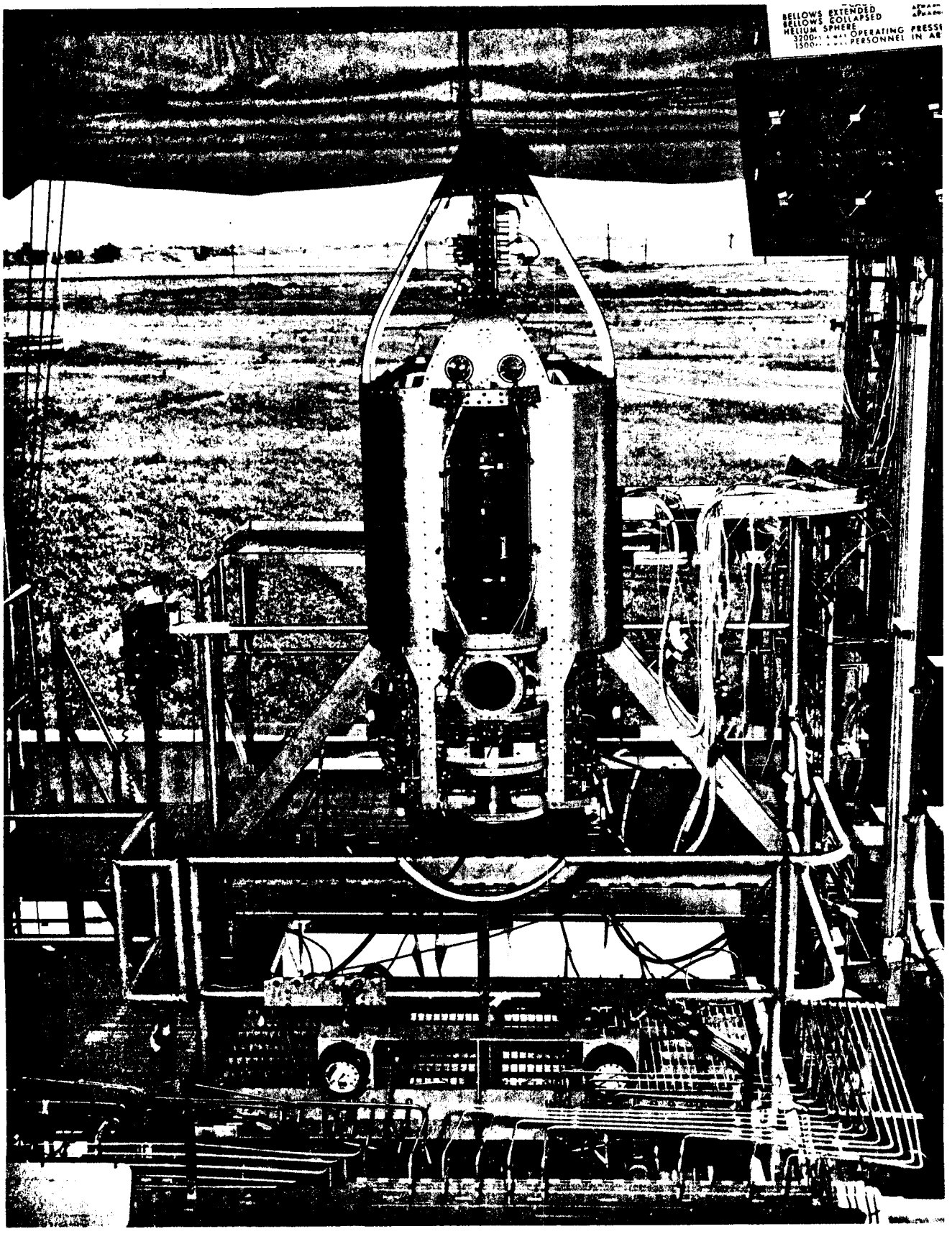



Figure 10-1. S-IVB/V APS Module on Test Stand

28 September 1966

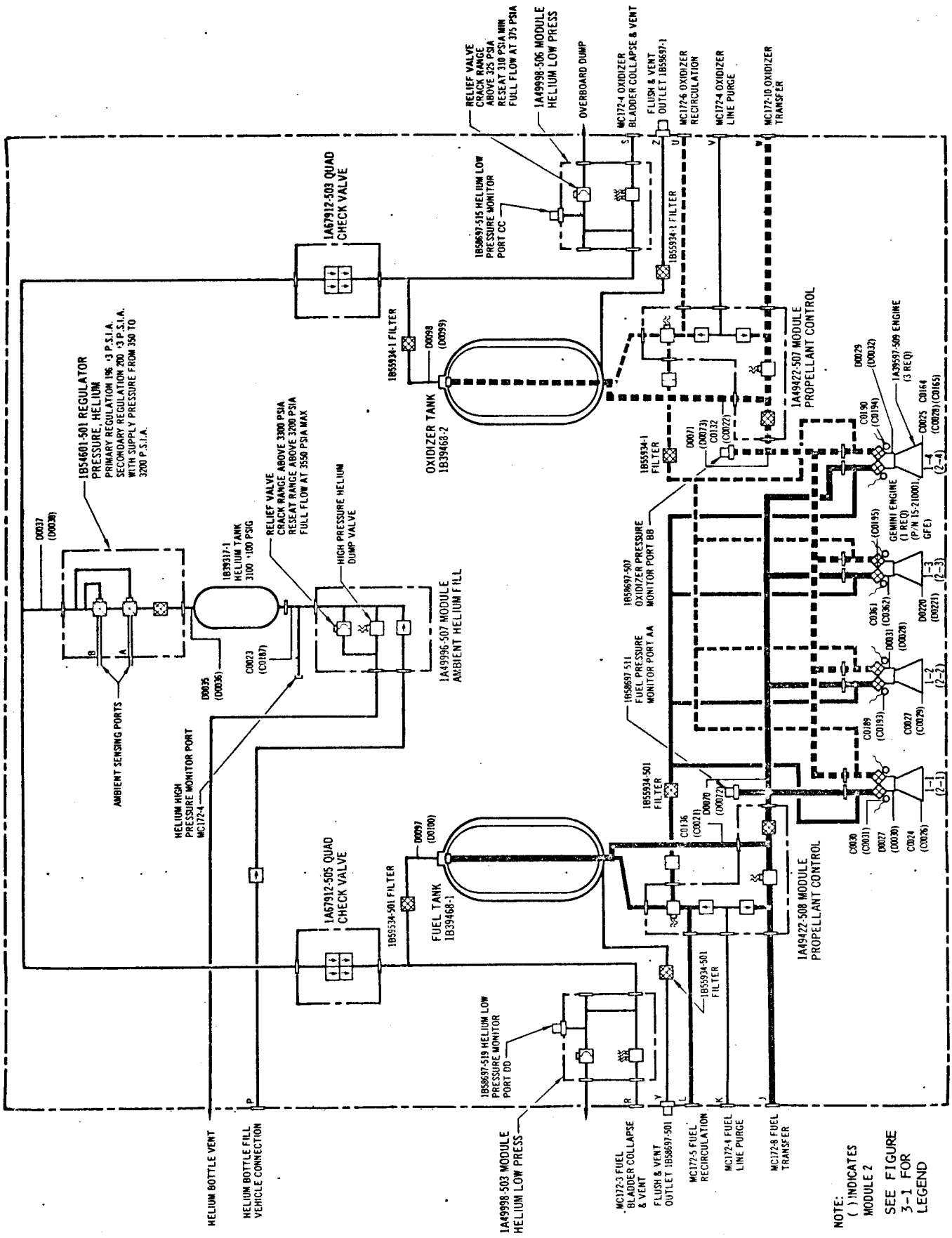
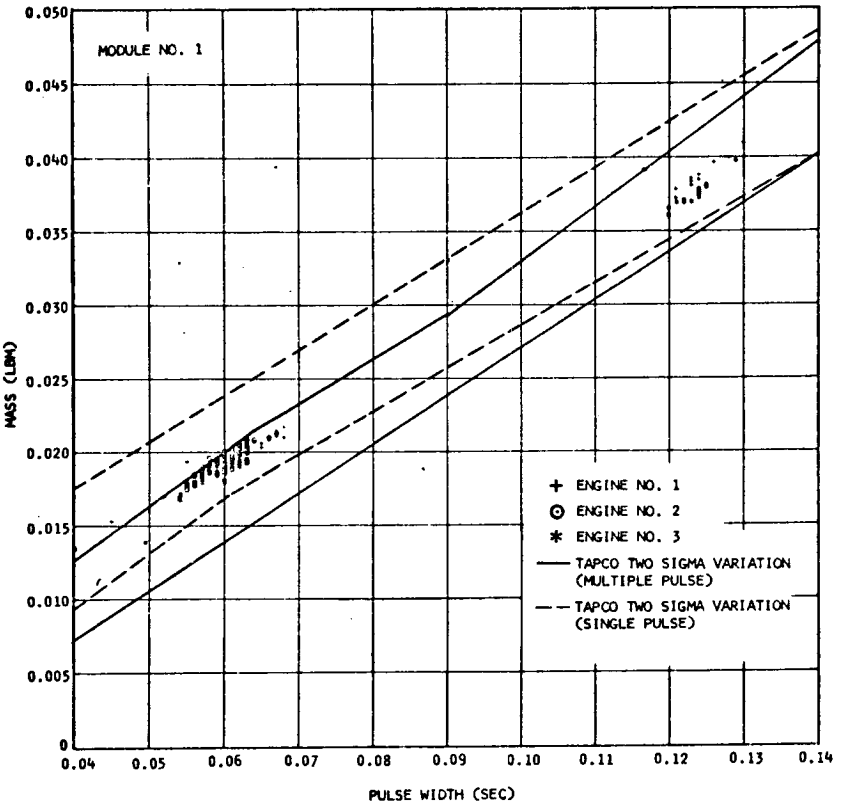



Figure 10-2. Auxiliary Propulsion System and Instrumentation

28 September 1966



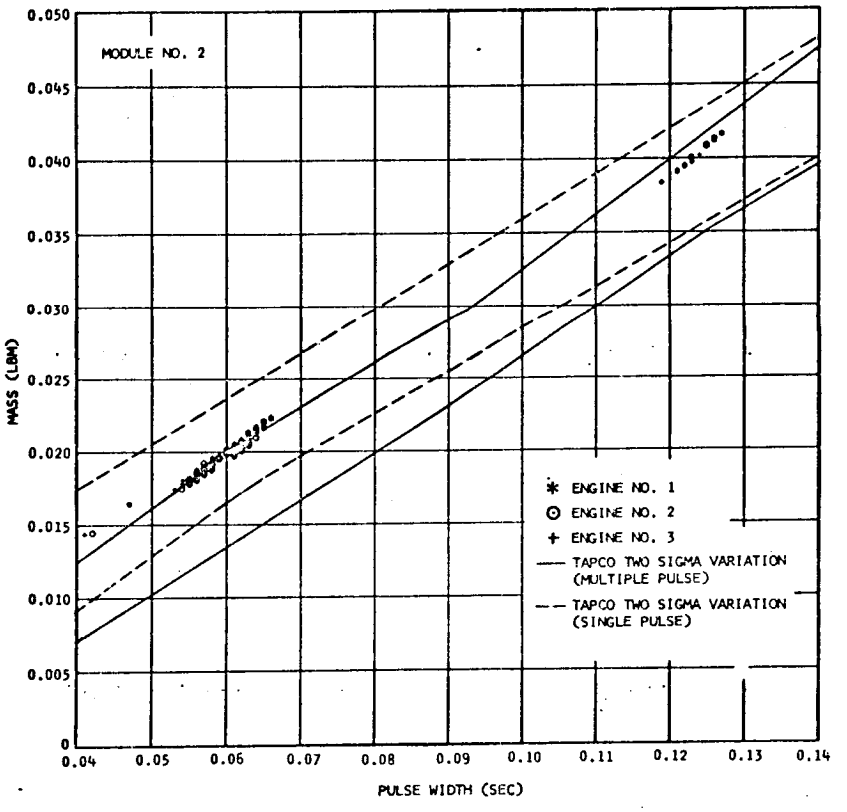
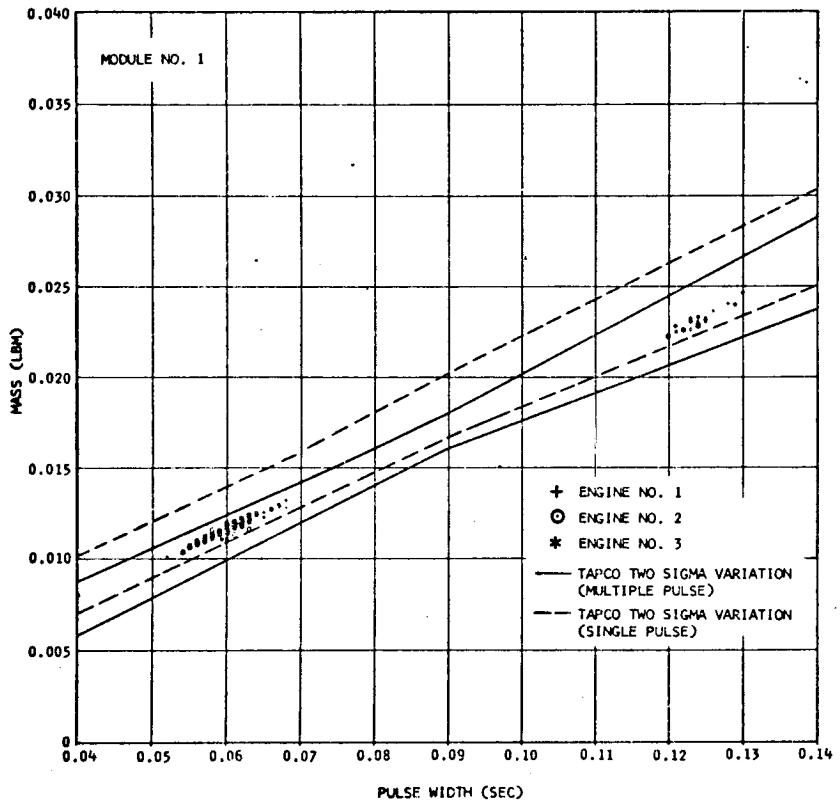




Figure 10-3. APS Oxidizer Consumption

28 September 1966



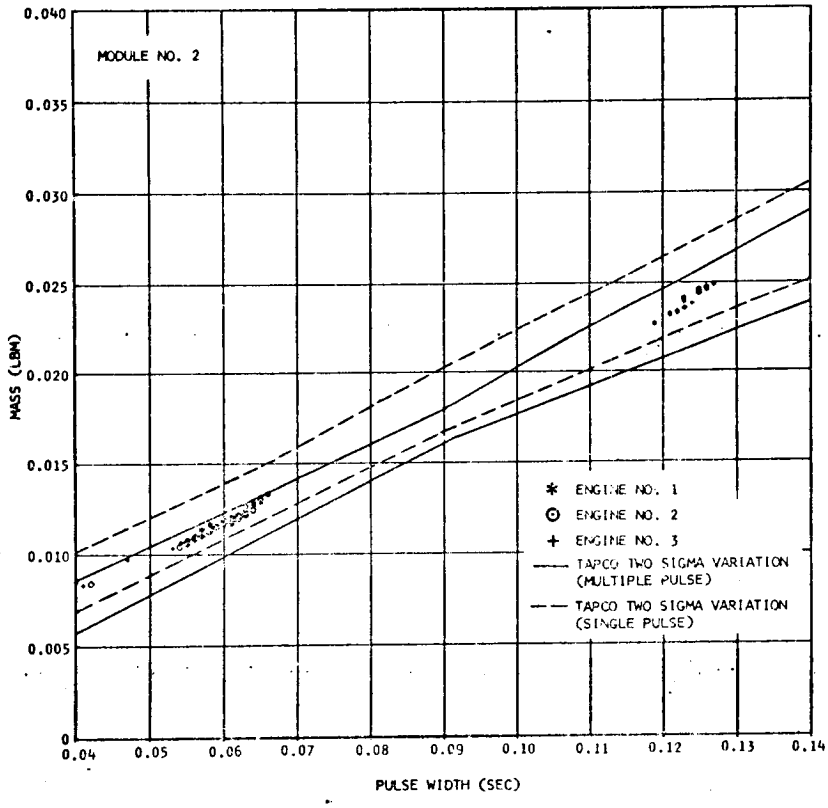
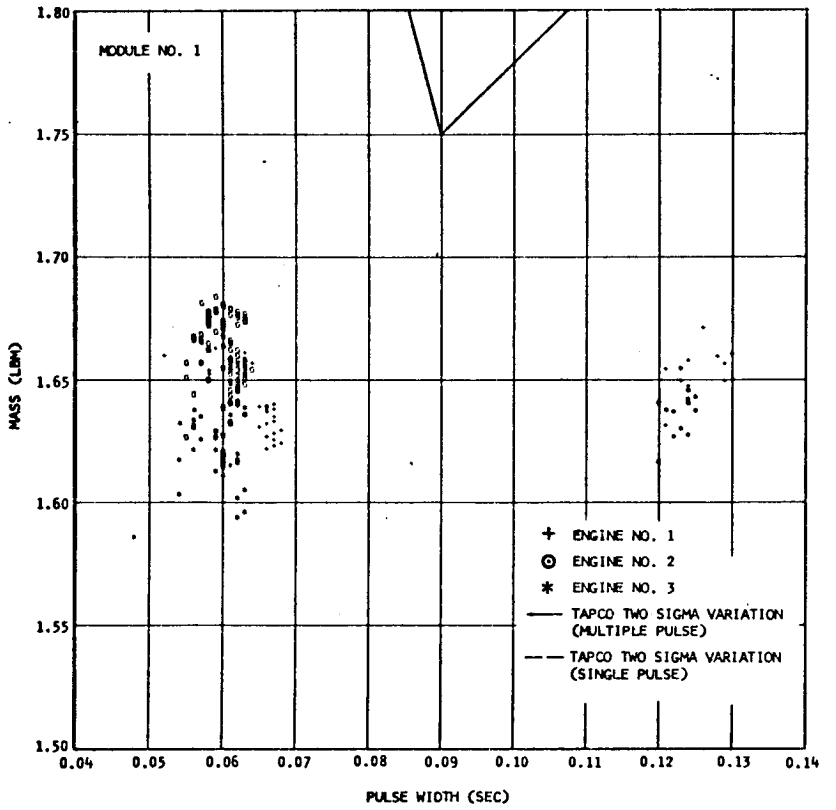




Figure 10-4. APS Fuel Consumption

28 September 1966



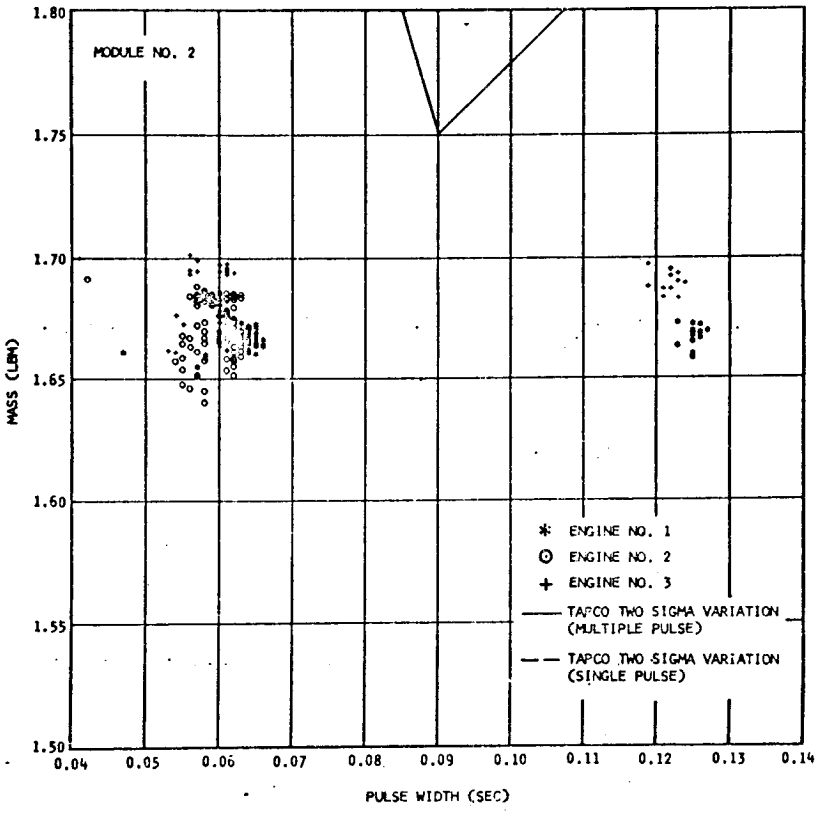




Figure 10-5. APS Engine Mixture Ratio

28 September 1966

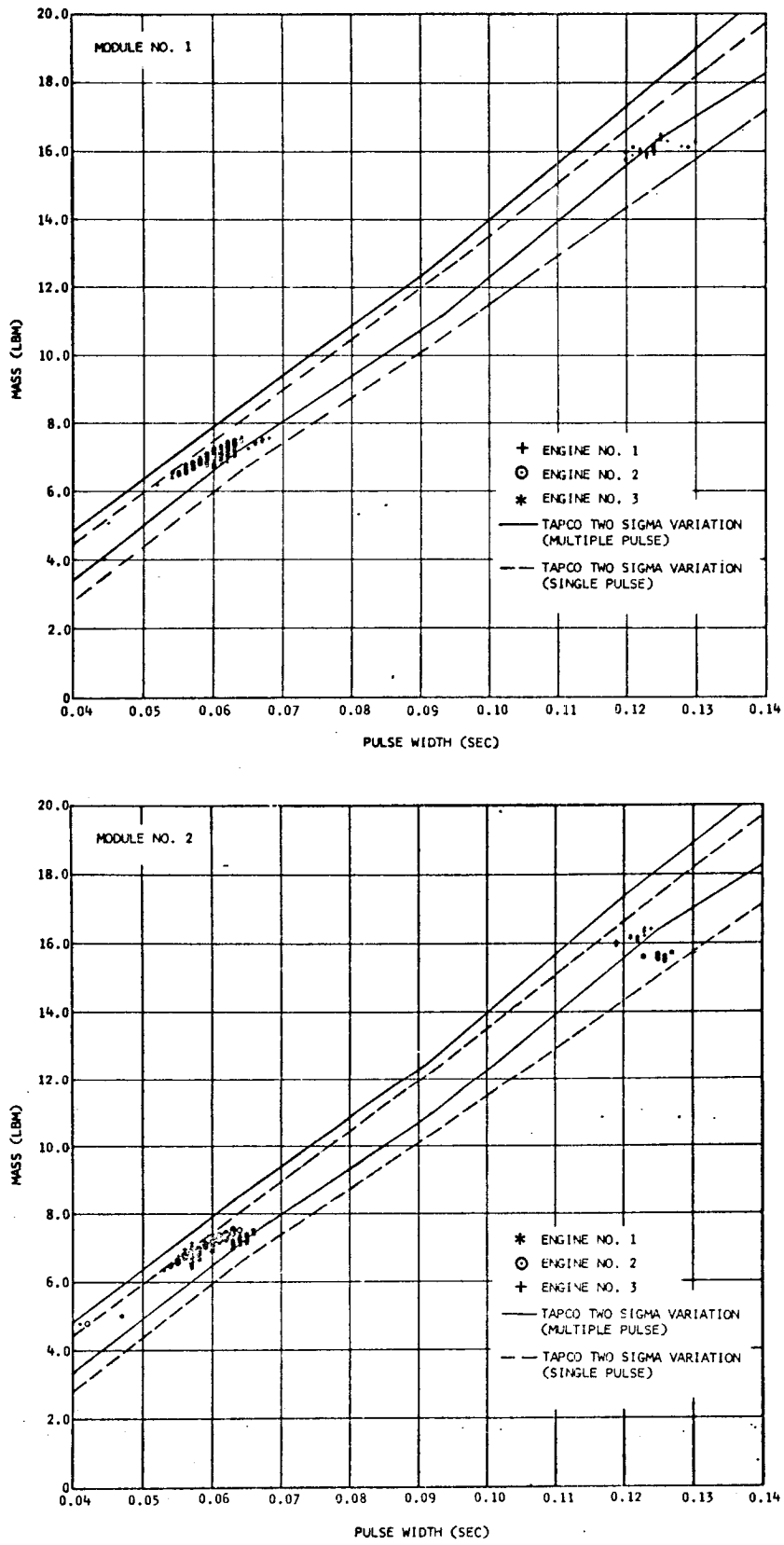
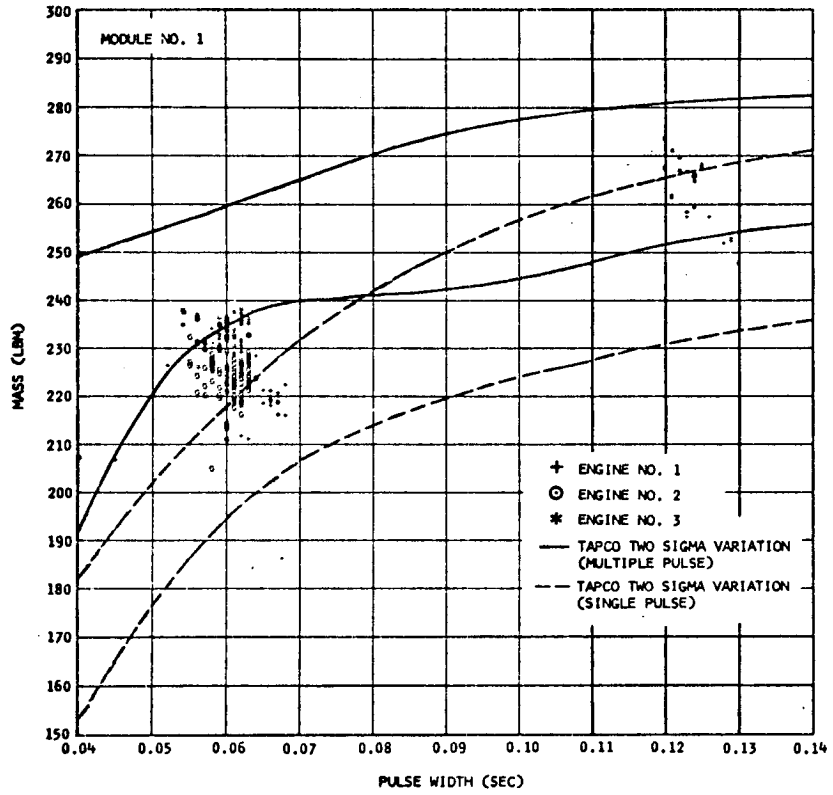



Figure 10-6. APS Total Impulse

28 September 1966



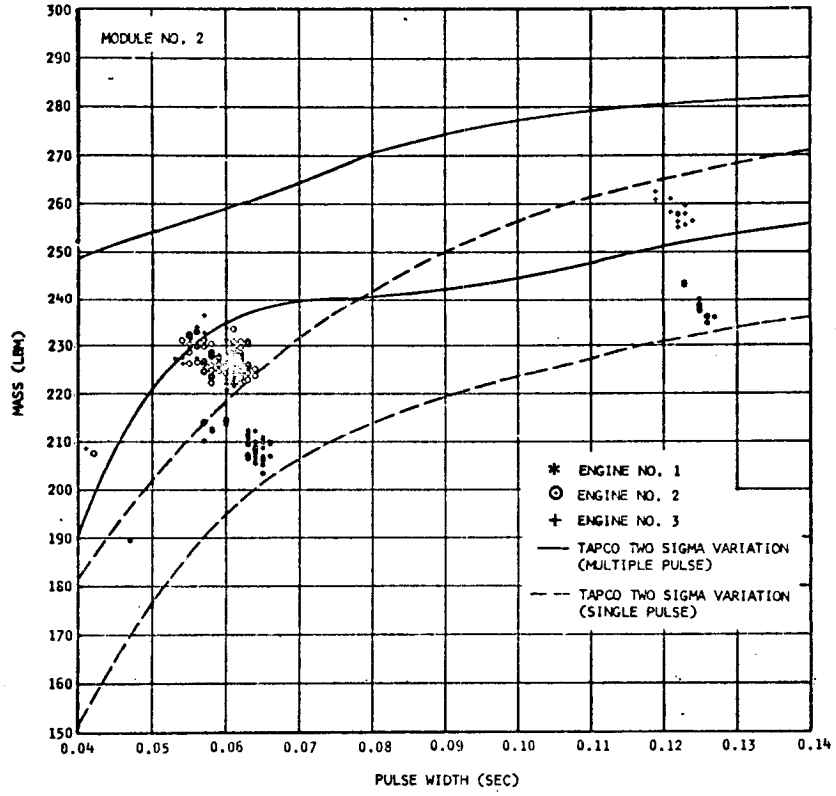




Figure 10-7. APS Specific Impulse

28 September 1966

# 11. PROPELLANT UTILIZATION SYSTEM

The PU (propellant utilization) system accomplished all the design objectives as listed in the DAC Report No. SM-47378, Saturn S-IVB-502 Stage Acceptance Firing Test Plan.

The PU system was operated in the closed-loop mode during 1st and 2nd burns with no problems. Calibration was based on an EMR of 5.0:1, but at MSFC request, the propellants loaded for the test programmed an EMR history to support the objectives noted below:

a. Operation of the J-2 engine during 1st burn at a performance level that would enable refilling of the start tank to the pressure and temperature limits required for engine restart, thus removing the one-orbit minimum constraint for restart. Present operational procedure dictates that a minimum interval of 90 min is required prior to restart to allow time for pressure buildup in the start tank considering orbital heat transfer.

b. Operation of the J-2 engine during the initial portion of 2nd burn with a minimum chamber pressure of 730 psia during the restraining link release (approximately ESC +13 sec).

## 11.1 PU System Calibration

The nominal pre-acceptance mass sensor calibration was determined from a combination of empirical and theoretical analysis.

The lower propellant mass calibration point was determined from calculated tank volume and predicted propellant density. The corresponding capacitance at the lower extremity was determined from the vendor's sensor calibration data and fast drain empty capacitance data from previous acceptance firings.

The propellant mass and its capacitance at the upper extremity was determined from the vendor's calibration data and the S-IVB-501 stage level and PU sensor mass analysis.

The LOX and LH2 PU mass sensor calibrations are shown in the following table:

| PU MASS SENSOR | PICOFARADS | POUNDS MASS | REMARKS |
|---|---|---|---|
| LOX | 282.36 | 1,270 | Bottom of Inner Element |
| | 414.54 | 195,942 | Top of Inner Element |
| LH2 | 974.34 | 206 | Bottom of Inner Element |
| | 1,190.75 | 44,901 | Top of Inner Element |

## 11.2 Level Sensor vs PU Mass

The point level sensor and PU sensor masses at each level sensor activation time are presented in table 11-1. The deviation between these two system masses are graphically presented in figures 11-1 and 11-2. Both the PU system and level sensors were referenced to the unique S-IVB-502 stage propellant tank volume computed from actual tank measurements. The indicated PU sensor masses were adjusted for predicted sensor-to-tank mismatch non-linearities. The sensor-to-tank nonlinearities were computed from the unique S-IVB-502 stage tank volume and the vendor's calibration data. These non-linearities are shown in figures 11-3 and 11-4 for the LH2 and LOX tank, respectively. The maximum deviation for the LOX system masses shown in figure 11-1 is 0.42 percent of the full load. This deviation is a considerable improvement over the 2.0 percent maximum deviation determined for the S-IVB-501 stage system. Also, the precision of the LOX data again verified the effectiveness of the LOX level sensor slosh guard. The deviation diminished to approximately zero at the lower end of the LOX tank which demonstrates that both systems have excellent height reference correlation. These critical locations were measured prior to the acceptance firing.

The LH2 systems analysis is shown in figure 11-2. The maximum deviation was 0.44 percent of the full load. The deviations were random in both positive and negative directions and were well within the predicted accuracy of the two systems.

The deviations diminished in magnitude as the in-tank mass approached the lower sensors, which again is attributed to the good level sensor and PU sensor height correlation.

## 11.3 PU Calibration Analysis

An excellent LH2 PU sensor calibration was verified on the S-IVB-502 stage by the series of level and temperature sensors. The data indicated no appreciable error in the mass - capacitance relationship. The relationship at the empty condition was exceptionally good.

The empirically determined S-IVB-502 stage LOX PU sensor calibration was examined for the validity of the method used. The LOX sensor calibration was modified 31.5 lbm per pf lower from the S-IVB-501 stage acceptance firing calibration. The indications based on the S-IVB-502 stage level sensors are the LOX PU sensor calibration is indicating approximately 6 lbm per pf lower than level sensor masses. The equivalent LOX mass error is approximately 0.4 percent. The 2nd burn high EMR cutback time also verified the accuracies of the LOX and LH2 PU sensor calibrations. The difference between the PU sensor mass and flow integral mass at Engine Start Command for the LOX and LH2 are -0.11 percent and 0.30 percent, respectively.

## 11.4 Propellant Utilization

### 11.4.1 Propellant Loading

The following is a tabulation of the desired, indicated, and actual full propellant loading at ESC for the S-IVB-502 stage acceptance firing:

| | LOX (lbm) | LH2 (lbm) |
|---|---|---|
| Desired Full Load (Predicted) | 193,273 | 40,660 |
| Indicated Full Load (PU Reading) | 193,113 | 40,574 |
| Actual Full Load (Flow Integral) | 193,325 | 40,452 |
| Difference (Indicated Less Desired) | -160 | -86 |
| Difference (Actual Less Desired) | 52 | -208 |
| Difference (Indicated Less Actual) | -212<br>-(0.11%) | 122<br>(0.30%) |

Propellant loading for 1st burn was accomplished automatically and smoothly by the loading computer. Following 1st burn cutoff, the propellant mass remaining in the stage tanks was determined from PU system data. An analysis was then made to determine the amount of LOX required to insure compliance with objective b (paragraph 11.0). The analysis indicated that the propellants were in the proper ratio for a 3-orbit simulated boiloff in both propellant tanks.

The LH2 boiloff was approximately 3,150 lbm or 100 lbm less than predicted. LOX boiloff was approximately 570 lbm (300 lbm is for orbital boiloff and 270 lbm for prepressurization effect) or 10 lbm less than predicted. No propellant was added during the orbital coast period between 1st burn cutoff and 2nd burn start.

### 11.4.2 Propellant Mass History

Propellant mass history during the stage acceptance firing is presented in table 11-2. Results of the flow integral method of mass determination shall be used to recalibrate the PU system capacitance mass sensors to achieve the desired ±1.3 percent PU system loading accuracy for flight.

Flow integral mass values shown in table 11-2 were based on the analysis of propellant flowrates using engine influence equations (computer program AA89), engine flowmeter data (computer program G105-3) and thrust chamber temperature data (computer program F823-1). Residual mass values at engine cutoff were based on point level sensor data.

The flow integral method consists of determining the mass flowrate of LOX and LH2 and integrating as a function of time to obtain total consumed mass during firing. The initial full-loaded mass on board is determined by adding total propellant residuals, boiloff, and pressurant to the total consumed mass as shown in the following table.

| ADDITIONS TO ENGINE PROPELLANT CONSUMPTION | 1st BURN | | COAST | | 2nd BURN | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | LOX | LH2 | LOX | LH2 | LOX | LH2 | LOX | LH2 |
| Propellant Residual | -- | -- | -- | -- | 2,276 | 604 | 2,276 | 604 |
| Net Mass Lost Through Boiloff or Condensation in Tanks | 86 | 0 | 570 | 3,150 | 28 | 0 | 684 | 3,150 |
| Pressurant Added to Ullage | -- | 76 | -- | 0 | -- | 209 | -- | 285 |
| Total | 86 | 76 | 570 | 3,150 | 2,304 | 813 | 2,960 | 4,039 |

The propellant mass history results of the three programs were combined into a single set of values by averaging. These values define the best estimate of actual mass history and are presented in table 11-4.

### 11.4.3 Thrust Variations

The effect of stage PU system performance on engine thrust is summarized in the following table. A more detailed discussion of thrust is included in a separate evaluation of engine performance (section 6).

| PARAMETER | ACTUAL | PREDICTED |
|---|---|---|
| Transient Thrust Overshoot (%) | 0 | 0 |
| Thrust Oscillation after PU Cutback (lbf) | ±5,000 | ±2,330 |

Thrust overshoot for this test is defined as zero since a minimum value or slope inflection point did not occur during the PU cutback (PUC) transient. The PU cutback transient interval is defined as occurring from PUC to PUC +50 sec per a NASA, Rocketdyne and DAC agreement.

## 11.5 Propellant Residuals

Propellant residuals were computed at the end of the 1st and 2nd burn by means of point level sensors and the PU mass sensor. Two LH2 level sensors (N0025 and N0026) and two LOX level sensors (L0012 and L0011) were used to determine the 1st burn propellant residuals. Two LH2 level sensors (N0032

and L0002) and two LOX level sensors (L0006 and L0005) were used to determine propellant residuals for the 2nd burn.

Propellant residuals by means of point level sensors were computed by subtracting the propellant consumption between the time interval of point level sensor activation to engine cutoff from the computed point level sensor mass. The propellant consumption was derived from the engine flow analysis (PA49 analysis program).

The PU mass sensor residuals were computed at Engine Cutoff Command. The mass sensor accuracies were based upon obtaining an accurate empty probe capacitance value immediately after the 2nd burn engine cutoff.

A summary of point level sensor residuals, PU mass sensor residuals, and "best estimate" residuals is presented in tables 11-4 and 11-5.

## 11.6 System Operation

### 11.6.1 PU System Nonlinearities

Figures 11-5 and 11-6 indicate the normalized nonlinearity of the LH2 and LOX mass sensor as compared to the flow-integral reference. If a smooth curve were drawn through these graphs, it would represent the mass sensor-to-tank mismatch. The LOX mass sensor has a maximum error of approximately +0.75 percent occurring near the 55 percent level of the tank. The LH2 mass sensor has a maximum error of approximately +0.40 percent, near the 29 percent level of the tank. Superimposed on these hypothetically smooth mismatch nonlinearity curves are the manufacturing-produced discontinuities in the linearity.

### 11.6.2 System Response

The S-IVB-502 acceptance firing PU valve history prediction, giving a PU valve cutback time of 2nd ESC +76 sec was based on the following:

a. S-IVB-201 acceptance firing tank-to-sensor mismatch nonlinearities

b. S-IVB-502 sensor nonlinearities (LOX - E0009 and LH2 - E0009)

c. S-IVB-502 predicted pump inlet conditions

d. S-IVB-502 acceptance calibration

e. Predicted 3-orbit coast simulation.

The actual, predicted, and simulated PU valve position histories for 1st and 2nd burns are shown in figure 11-7. Actual cutback time was 2nd ESC +70 sec.

During 1st burn, the PU system was biased to remove the propellant allotted for boiloff during the simulated 3-orbit coast. The PU system was activated at 1st ESC +6.8 sec. The PU valve reached the positive stop at 1st ESC +9.6 sec. Figure 11-7 indicates that the actual PU valve position was 1 deg higher than predicted before PU activate and 0.5 deg higher than predicted while on the positive stop.

During the simulated 3-orbit coast, the electrical propellant bias was removed from the PU system. During 2nd burn, the PU system was activated at ESC +6.8 sec. The PU valve reached the positive stop at ESC +13.0 sec. Figure 11-7 shows the actual PU valve position to be 1 deg higher than predicted before PU activate and 0.5 deg higher than predicted while on the positive stop.

The differences between the predicted and actual valve positions were caused by the following:

| DESCRIPTION | CUTBACK TIME DISPERSION (sec) | VALVE POSITION SHIFT (deg) |
|---|---|---|
| Loading Errors | +6.7 | 0 |
| 3-Orbit Boiloff Errors | -24.3 | 0 |
| Calibration Mismatch between Flow Integral and Desired | +3.2 | +0.5 |
| Difference Between S-IVB-201 Acceptance Mismatch Data used for Prediction and Actual S-IVB-502 Mismatch | +8.4 | -0.7 |
| Total | -6.0 | -0.2 |

Considering the above factors, predicted cutback time would be decreased by 6 sec and the mean level of the PU valve position after the cutback transient would be decreased by 0.2 deg. This gives a close comparison between the actual valve response and the reconstructed prediction.

Loading errors are the difference between desired-indicated and actual-indicated loads. The loading errors were -160 lbm LOX and -86 lbm LH2. The combined effect of these errors was to increase cutback by 6.7 sec.

The 3-orbit boiloff errors are the difference between the predicted and the actual propellant boiloffs between 1st and 2nd burns. The boiloff errors were +345 lbm LOX and -125 lbm LH2. The combined effect of these errors was to decrease cutback time by 24.3 sec.

Calibration mismatch is the difference between the desired calibration and the actual flow integral calibration and is calculated from the actual and indicated mass end points. The calibration mismatch is -0.03 percent for LOX and +0.17 percent for LH2. The effect of the calibration mismatch is to increase cutback time by 3.2 sec and to shift the mean value of valve position by +0.5 deg.

The effect of the differences between the S-IVB-201 mismatch and the S-IVB-502 mismatch increased cutback time by 8.4 sec and shifted the mean level of valve position after the cutback transient by -0.7 deg. The valve shift was not constant and was caused by changes in the LH2 mismatch.

The desired reference mixture ratio (RMR) for the S-IVB-502 acceptance firing was 5.00:1, but was actually 5.02:1 due to the calibration mismatch. The actual average EMR during the valve transient was also 5.02:1.

The valve response after 2nd ESC +130 sec contained two major variations. Both variations deviated approximately 2.5 deg from the mean valve slope and were caused by sensor nonlinearities and tank-to-sensor mismatch.

### 11.6.3 PU Efficiency

By extrapolating propellant mass history rates at cutoff, LOX propellant depletion would have occurred at 2nd ESC +298.22 sec, with 46 lbm of usable LH2 remaining. This is equivalent to a closed-loop PU efficiency of 99.980 percent. The stage propellant consumption rates at Engine Cutoff Command of $W_{LOX}$ = 391.80 lbm/sec and $W_{LH2}$ = 80.345 lbm/sec represent the summation of total flow through the engine, boiloff rates, and GH2 pressurant flowrate, and were used to determine the above values.

PU efficiency in percent is determined by expressing the usable residual propellant ($R_u$) at depletion cutoff extrapolated or actual as a percentage of the total propellant load ($P_t$) as shown below:

$$\eta_{pu} = (1.0 - R_u/P_t)\ 100$$

TABLE 11-1
LH2 AND LOX LEVEL SENSOR

| LEVEL SENSOR | ACTIVATION TIME (sec) | LEVEL SENSOR MASS (lbm) | PU MASS (lbm) |
|---|---|---|---|
| LH2 MASS 1ST BURN | | | |
| N0025 | 589.46 | 33,975 | 34,104 |
| N0026 | 635.67 | 30,084 | 30,207 |
| 2ND BURN | | | |
| N0028 | 30.34 | 22,271 | 22,237 |
| N0029 | 78.36 | 18,199 | 18,216 |
| N0030 | 126.12 | 14,185 | 14,010 |
| N0031 | 177.20 | 10,099 | 10,116 |
| N0032 | 225.06 | 6,208 | 6.243 |
| L0002 | 274.00 | 2,273 | 2,280 |
| LOX MASS 1ST BURN | | | |
| L0013 | 516.40 | 193,099 | 192,403 |
| L0012 | 557.50 | 174,492 | 173,763 |
| L0011 | 617.50 | 146,949 | 146,152 |
| 2ND BURN | | | |
| L0010 | 29.79 | 112,701 | 111,988 |
| L0009 | 111.86 | 75,215 | 74,822 |
| L0008 | 193.54 | 43,081 | 42,904 |
| L0006 | 252.35 | 19,177 | 19,104 |
| L0005 | 275.23 | 9,878 | 9,817 |
| L0004 | 295.10 | 2,221 | 2,034 |

TABLE 11-2
PROPELLANT MASS HISTORY

| EVENT | FLOW INTEGRAL MASS (lbm) | | | *PU SYSTEM INDICATED MASS (lbm) | | |
|---|---|---|---|---|---|---|
| | LOX | LH2 | TOTAL | LOX | LH2 | TOTAL |
| Simulated Booster Liftoff | 193,325 | 40,452 | 233,777 | - | - | - |
| Engine Start Command (1st Burn) | 193,325 | 40,452 | 233,777 | 193,113 | 40,574 | 223,687 |
| PU Activate Command (1st Burn) | 191,810 | 40,092 | 231,902 | 191,630 | 40,226 | 231,856 |
| Engine Cutoff Command (1st Burn) | 124,316 | 27,634 | 151,950 | 124,191 | 27,631 | 151,822 |
| Engine Start Command (2nd Burn) | 123,634 | 24,464 | 148,098 | 123,648 | 24,488 | 148,136 |
| PU Activate Command (2nd Burn) | 122,142 | 24,104 | 146,246 | 122,108 | 24,120 | 146,228 |
| Engine Cutoff Command (2nd Burn) | 2,276 | 604 | 2,880 | 2,124 | 658 | 2,782 |

* The total mass in the tank as determined by the PU system.

TABLE 11-3
ENGINE PERFORMANCE PROGRAM

| EVENT | FLOWMETER (G105-3) | | | INFLUENCE COEFFICIENT (AA89) | | | INJECTOR DELTA T (F823-1) | | | FLOW INTEGRAL RESULTS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOX | LH2 | TOTAL PROPELLANT | LOX | LH2 | TOTAL PROPELLANT | LOX | LH2 | TOTAL PROPELLANT | LOX | LH2 | TOTAL PROPELLANT |
| Simulated Booster Liftoff | 192,929 | 40,618 | 233,547 | 193,715 | 40,238 | 233,953 | 192,996 | 40,501 | 233,497 | 193,325 | 40,452 | 233,777 |
| Engine Start Command (1st Burn) | 192,929 | 40,618 | 233,547 | 193,715 | 40,238 | 233,953 | 192,996 | 40,501 | 233,497 | 193,325 | 40,452 | 233,777 |
| PU Activate Command (1st Burn) | 191,586 | 40,259 | 231,845 | 191,852 | 39,837 | 231,689 | 191,655 | 40,180 | 231,835 | 191,810 | 40,092 | 231,902 |
| Engine Cutoff Command (1st Burn) | 124,161 | 27,774 | 151,935 | 124,068 | 27,530 | 151,598 | 124,371 | 27,599 | 151,970 | 124,316 | 27,634 | 151,950 |
| Engine Start Command (2nd Burn) | 123,471 | 24,594 | 148,065 | 123,378 | 24,365 | 147,743 | 123,718 | 24,433 | 148,151 | 123,634 | 24,464 | 148,098 |
| PU Activate Command (2nd Burn) | 122,038 | 24,225 | 146,263 | 121,793 | 23,982 | 145,775 | 122,259 | 24,105 | 146,364 | 122,142 | 24,104 | 146,246 |
| PU Valve Cutback (2nd Burn) | 91,966 | 18,321 | 110,287 | 91,748 | 18,482 | 110,230 | 92,229 | 18,543 | 110,772 | 92,093 | 18,449 | 110,542 |
| Engine Cutoff Command* (2nd Burn) | 2,276 | 604 | 2,880 | 2,276 | 604 | 2,880 | 2,276 | 604 | 2,880 | 2,276 | 604 | 2,880 |

*Measured at the time that the start signal arrives at engine logic.

NOTE: All values in pounds mass (lbm).

TABLE 11-4
SUMMARY OF LH2 AND LOX RESIDUAL COMPUTATIONS - 1st BURN

| LOX AND LH2 RESIDUALS | LH2 LEVEL SENSOR | | LOX LEVEL SENSOR | |
|---|---|---|---|---|
| | N0025 | N0026 | L0012 | L0011 |
| Propellant Mass Below Level Sensor at Sensor Activation | | | | |
| Time of Level Sensor Activation (sec) ($T_o$ = 1411:13) | 589.46 | 635.67 | 557.50 | 617.50 |
| Drainable Volume in Tank Below Sensor ($ft^3$) | 7,786.7 | 6,891.7 | 2,456.61 | 2,069.19 |
| Volume Trapped in Tank ($ft^3$) | 16.3 | 16.3 | 0.65 | 0.65 |
| Volume Outside the Tank to the Engine Valve ($ft^3$) | 11.0 | 11.0 | 4.54 | 4.54 |
| Total Volume Below the Level Sensor to the Engine ($ft^3$) | 7,814 | 6,919 | 2,461.80 | 2,074.38 |
| Propellant Density ($lbm/ft^3$) | 4,348 | 4.348 | 70.88 | 70.84 |
| Total Propellant Mass Below Level Sensor (lbm) | 33,975 | 30,084 | 174,492 | 146,949 |
| Propellant Consumption Between Level Sensor Activation and Engine Cutoff Obtained by Means of PA49 (lbm) | 6,380 | 2,463 | 49,373 | 21,737 |
| Total Residual at Engine Cutoff (lbm) | 27,595 | 27,621 | 125,119 | 125,212 |
| Mean Statistical Average Residual (lbm) | 27,610 ±234 lbm | | 125,174 ±1,201 lbm | |
| PU Mass Sensor Residual | 27,631 ±295 lbm | | 124,191 ±1,360 lbm | |
| Best Estimate Residual* | 27,618 ±183 lbm | | 124,741 ±900 lbm | |

*Statistical average of PU and level sensor residuals.

TABLE 11-5
SUMMARY OF LH2 AND LOX RESIDUAL COMPUTATIONS - 2nd BURN

| LOX AND LH2 RESIDUALS | LH2 LEVEL SENSOR | | LOX LEVEL SENSOR | | |
|---|---|---|---|---|---|
| | N0032 | L0002 | L0006 | L0005 | L0004* |
| Propellant Mass Below Level Sensor at Sensor Activation | | | | | |
| Time of Level Sensor Activation (sec) ($T_o$ = 1553:04) | 225.06 | 274.00 | 252.35 | 275.23 | 295.10 |
| Drainable Volume in Tank Below Sensor ($ft^3$) | 1,405.7 | 497.7 | 266.05 | 135.26 | 26.49 |
| Volume Trapped in Tank ($ft^3$) | 16.3 | 16.3 | 0.65 | 0.65 | 0.65 |
| Volume Outside the Tank to the Engine Valve ($ft^3$) | 11.0 | 11.0 | 4.54 | 4.54 | 4.54 |
| Total Volume Below the Level Sensor to the Engine Valve ($ft^3$) | 1,433 | 525 | 271.24 | 140.45 | 31.68 |
| Propellant Density ($lbm/ft^3$ | 4.332 | 4.329 | 70.60 | 70.33 | 70.11 |
| Total Propellant Mass Below Level Sensor (lbm) | 6,208 | 2,273 | 19,177 | 9,878 | 2,221 |
| Propellant Consumption Between Level Sensor Avtivation and Engine Cutoff Obtained by Means of PA49 (lbm) | 5,620 | 1,666 | 16,740 | 7,678 | N/A |
| Total Residual at Engine Cutoff (lbm) | 588 | 607 | 2,437 | 2,200 | |
| Mean Statistical Average Residual (lbm) | 604 ±41 lbm | | 2,276 ±209 lbm | | |
| PU Mass Sensor Residual | 658 ±68 lbm | | 2,124 ±320 lbm | | |
| Best Estimate Residual** | 619 ±35 lbm | | 2,230 ±172 lbm | | |

*Activated after engine cutoff.
**Statistical average of PU and level sensor residuals.

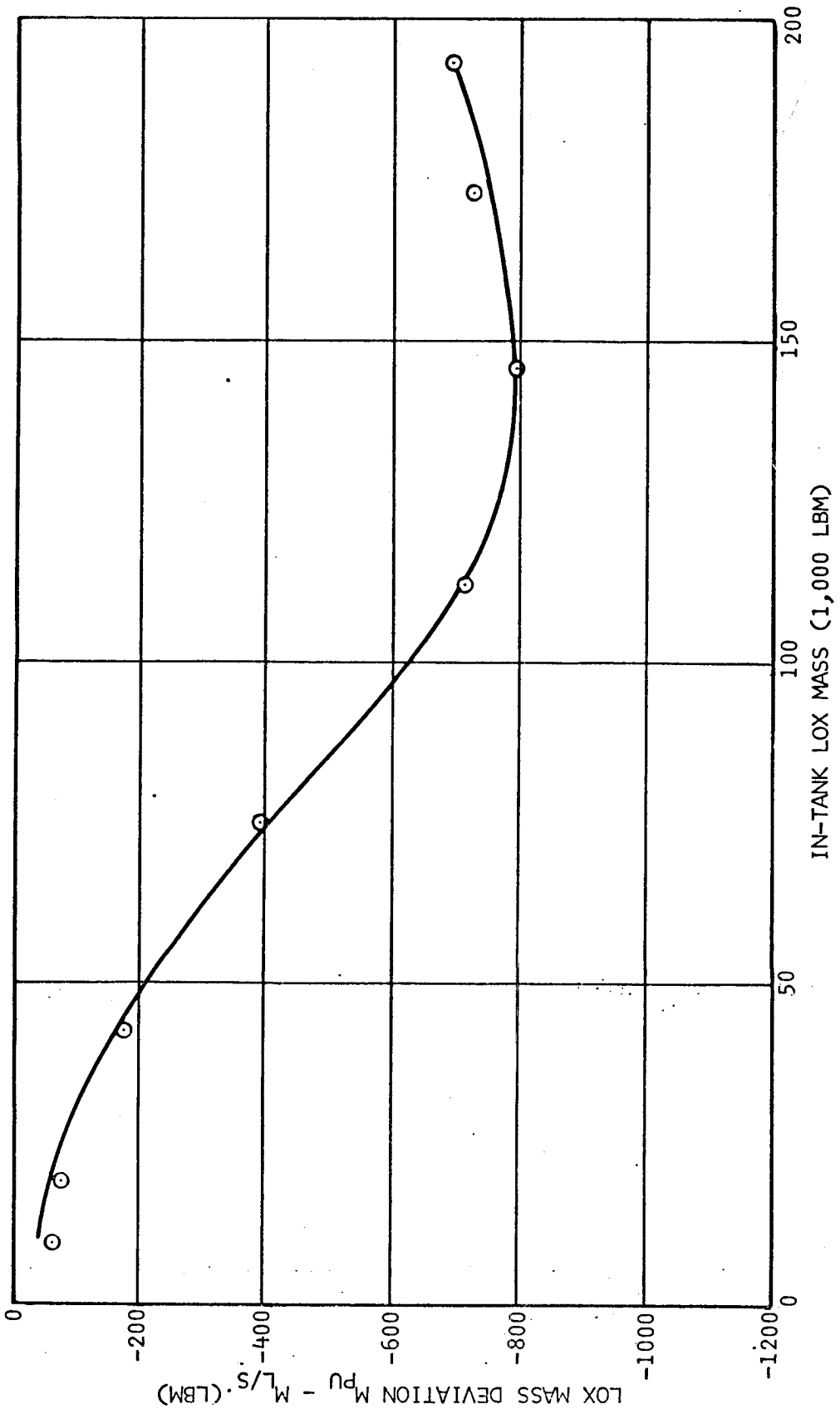



Figure 11-1. LOX Tank Indicated PU Mass and Level Sensor Comparison

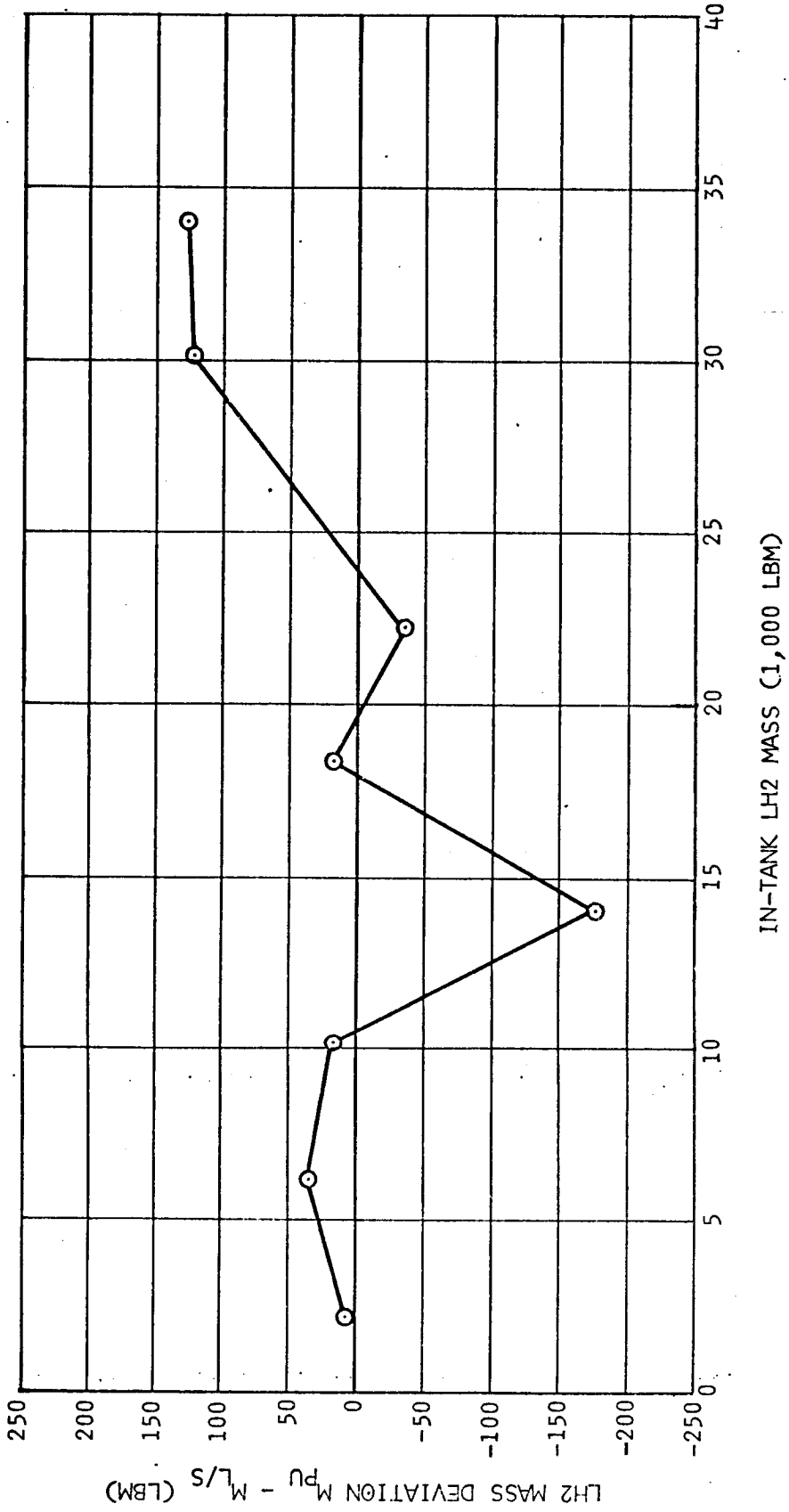



Figure 11-2. LH2 Tank Indicated PU Mass and Level Sensor Comparison

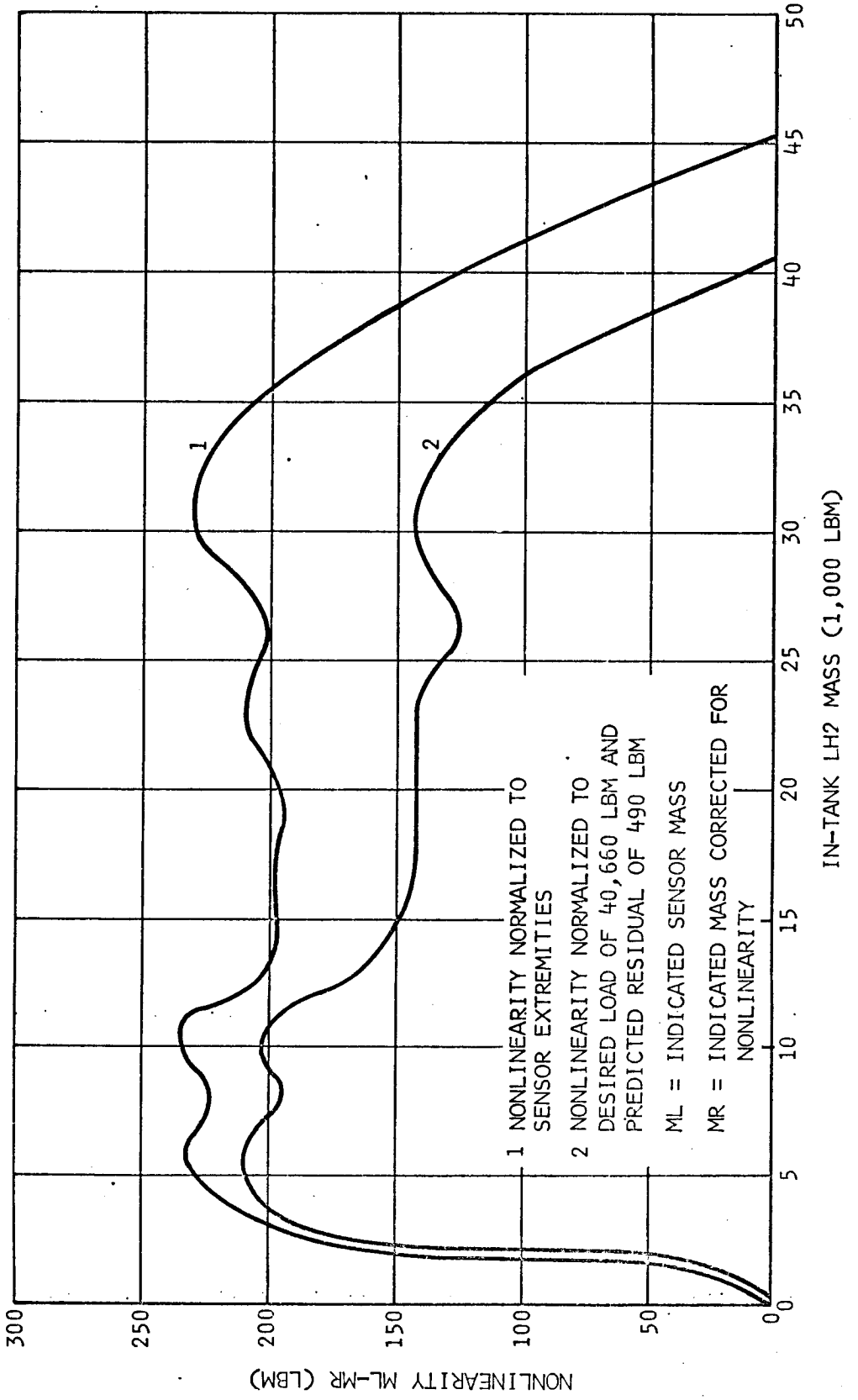



Figure 11-3 Predicted LH2 Mass Sensor Nonlinearity

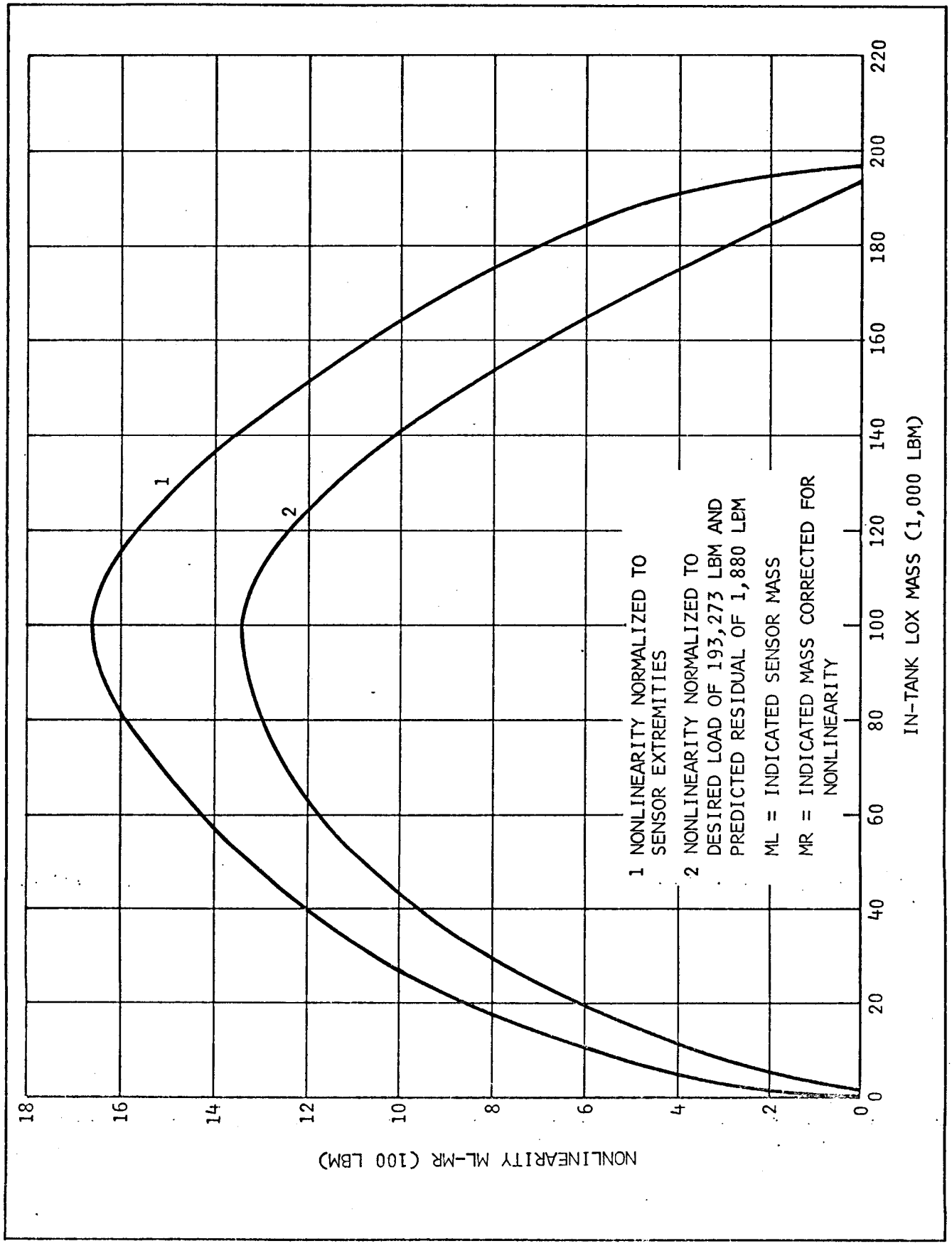



Figure 11-4. Predicted LOX Mass Sensor Nonlinearity

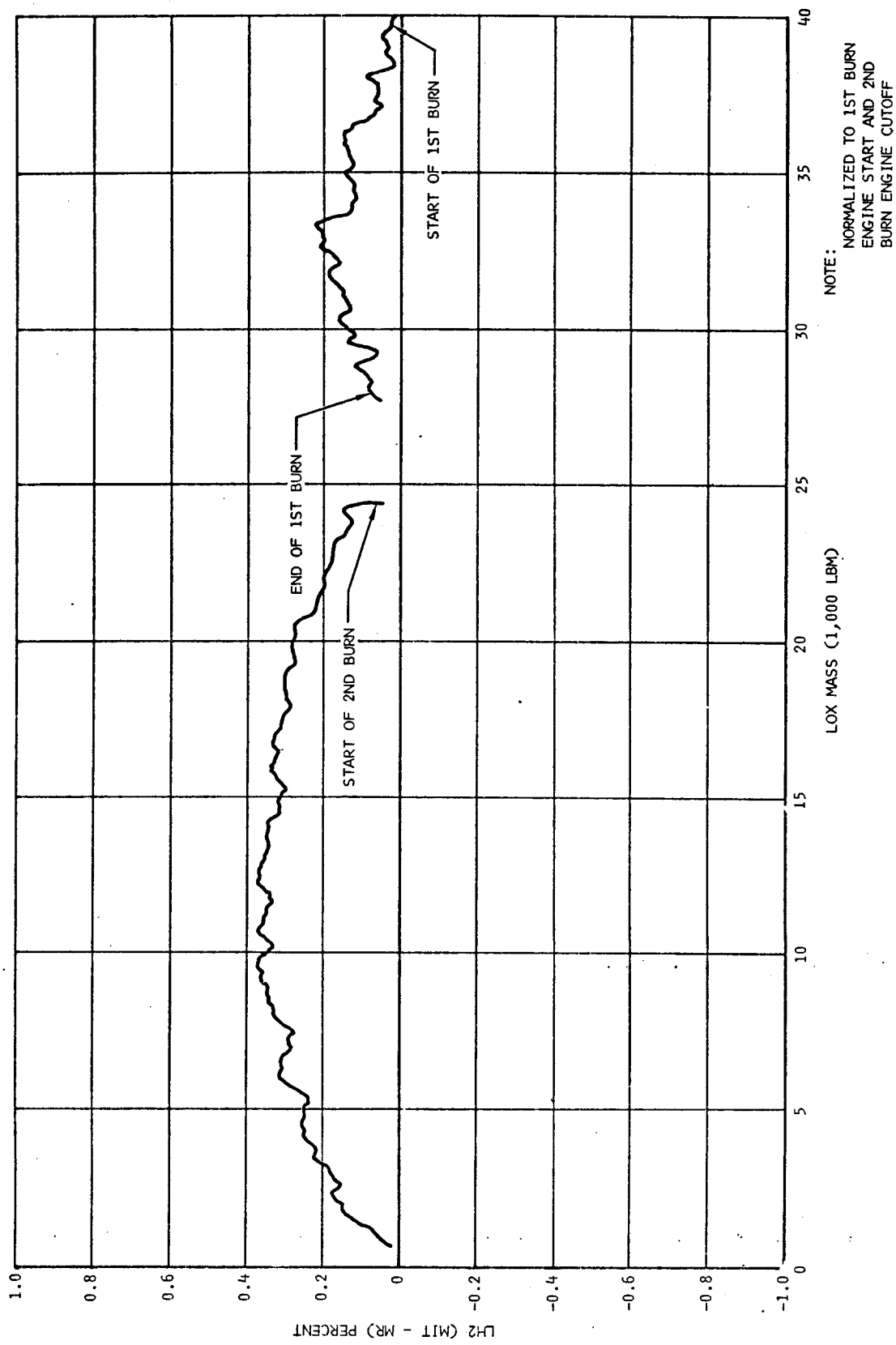



Figure 11-5. Total LH2 Nonlinearity

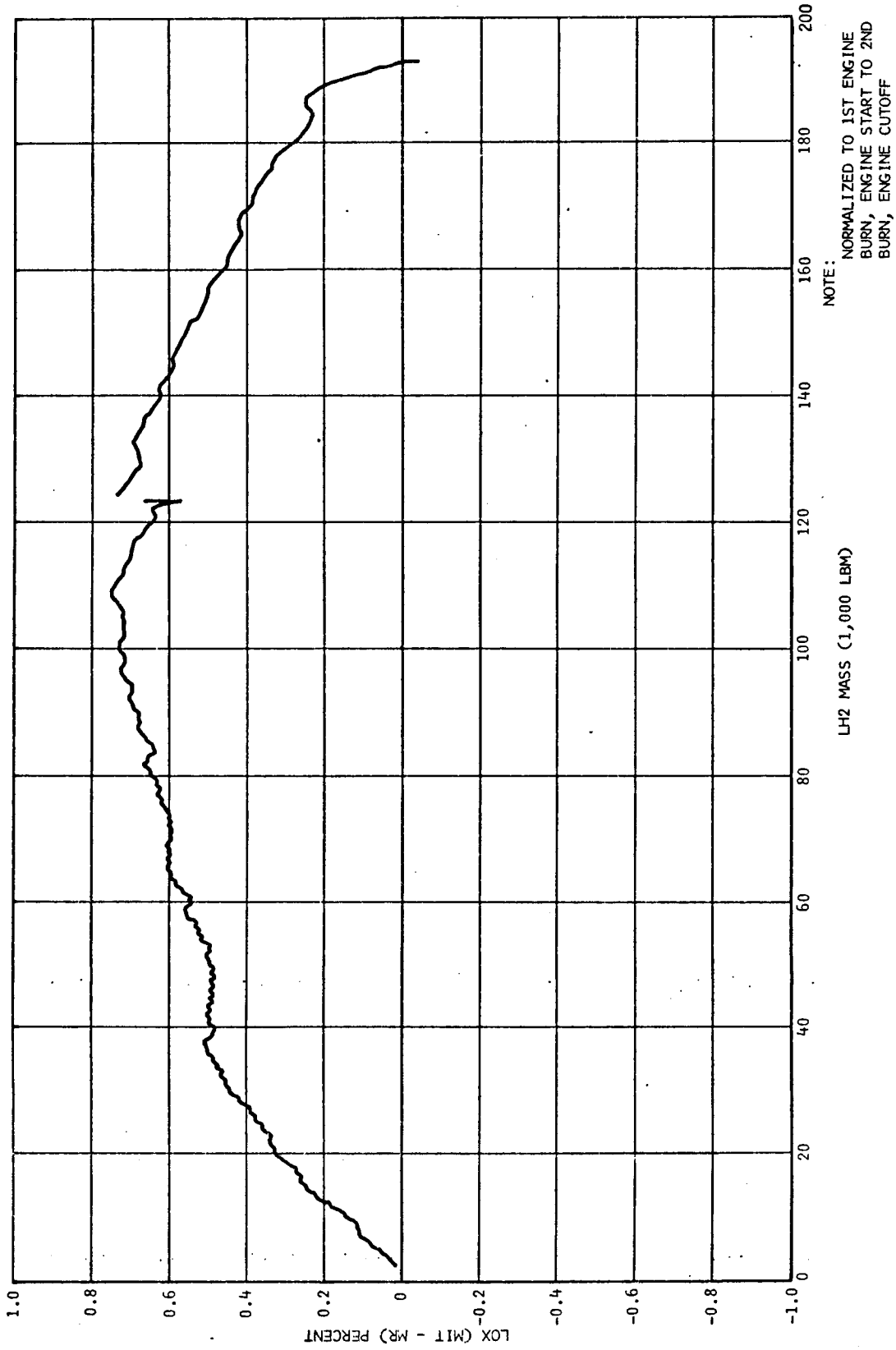



Figure 11-6. Total LOX Nonlinearity

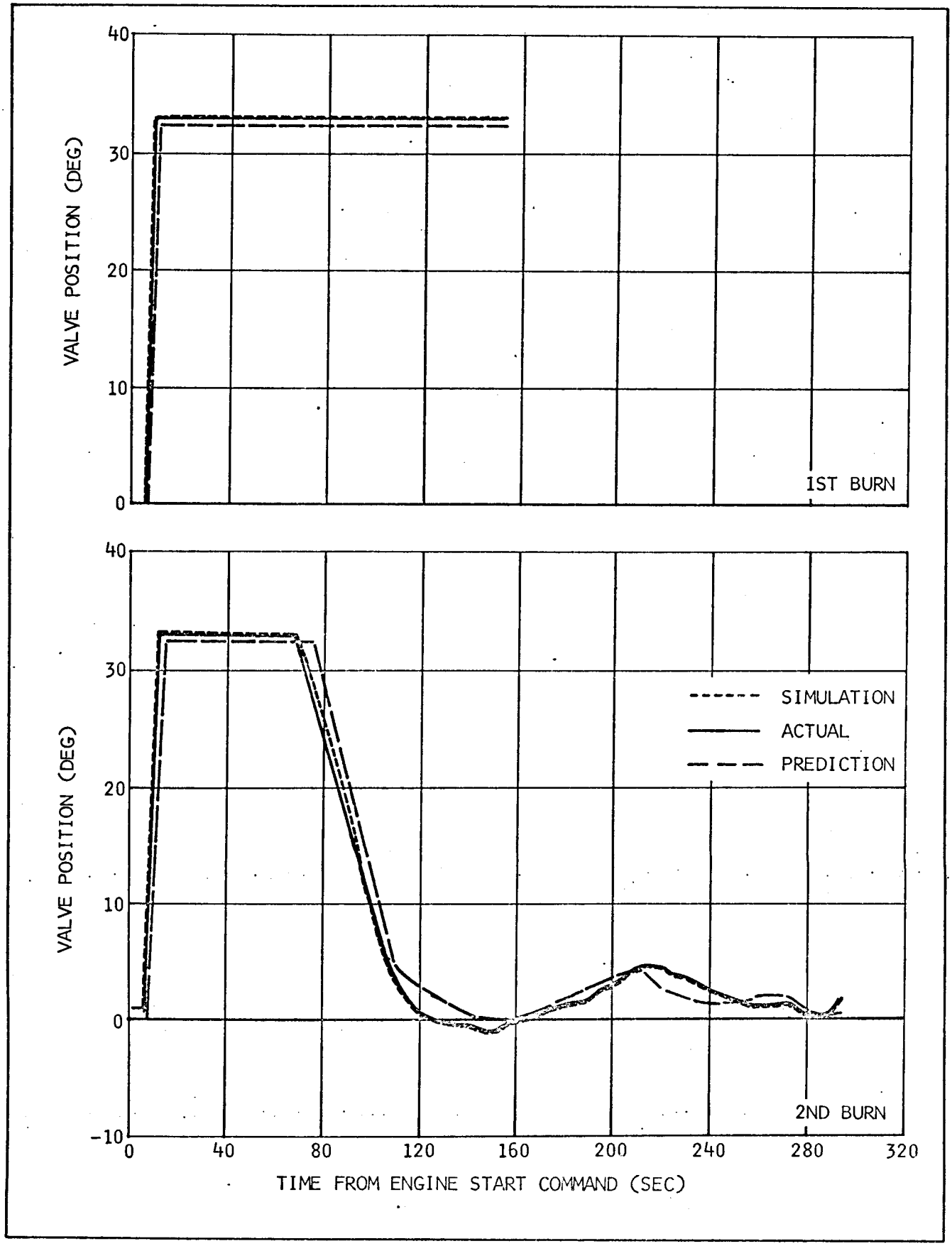



Figure 11-7. PU Valve Position History

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# 12. DATA ACQUISITION SYSTEM

The data acquisition system is designed to collect and transmit information describing the stage environment and performance of the stage systems. The measurements which comprise this required information are specified in the Instrumentation Program and Components List (IPCL) Drawing No. 1B43567.

The stage data acquisition system performed satisfactorily throughout the acceptance firing. A measurement summary is presented in the following table.

| | |
|---|---|
| Measurement efficiency | 95% |
| Total number of measurements assigned | 594 |
| Total number of measurements deleted | 119 |
| Total number of active measurements | 475 |
| Measurement failures | 24 |
| Total successful measurements | 451 |

## 12.1 Instrumentation System Performance

The instrumentation system performed satisfactorily throughout the acceptance firing. Valid data were received from 94.95 percent of the 475 active measurements. A summary of the instrumentation system performance is presented in table 12-1.

Measurement failures and abnormalities that occurred during the acceptance firing are listed, with their qualification comments, in tables 12-2 and 12-3. Measurement failures that occurred prior to $T_o$-163 sec are listed in table 12-4. The status of the telemetry measurements is tabulated in table 12-5; deleted non-operational telemetry measurements are listed in table 12-6.

A detailed discussion of the major measurement failures, grouped according to measurement types, is presented in the following paragraphs.

### 12.1.1 Temperature Measurements

Four temperature measurements were classified as failures for CD 614067. Three of these failed prior to simulated liftoff and one during the coast phase. This number of failures is relatively low and yielded a 97.8 percent measurement efficiency. No major temperature problems occurred during the acceptance firing.

### 12.1.2 Pressure Measurements

Measurements D0002 and D0105 were invalid due to turbulent flow at the sensing ports. The transducers for these two measurements and measurements D0003 and D0054 are to relocated and an orifice installed in the pressure sensing lines to isolate these transducers from the turbulent flow and pressure spikes. Also, a similar phenomenon could explain the invalid data of measurements D0055 and D0062.

RFI susceptibility of the transducer amplifier caused measurements D0016, D0182, and D0183 to be classified as failures. An Engineering Change Proposal (ECP 7518 Revision 1) has been approved to correct this RFI problem. The ECP consists of the transducer power/signal connector to have a built-in RFI filter. This is to be effective on S-IVB-507 and subs.

Plugged lines to the sensing ports on measurements D0200 and D0202 accounted for their failure. The circuitry for measurements D0179 and D0180 appears to have opened momentarily causing data dropout. The transducer used on measurement D0205 was rejected as being faulty.

### 12.1.3 Strain Measurements

The strain measurements were on scale at all times and the changes in strain were of the proper magnitude; however, the apparent direction of the strain change was incorrect. Investigation of this problem has shown that the strain gages were incorrectly wired. Work is presently underway to develop a method of checking the strain gage installations for correct polarity. As the data obtained remained on scale at all times, it provided valid strain data for the static firing. The stage wiring will be modified to eliminate this problem prior to flight.

## 12.2 Telemetry System Performance

The telemetry system performed very well during the acceptance firing. System noise was well within acceptable limits. All reference channels were stable and remained well within the required limits.

The PAM data correlated very closely with the PCM and hardwire data with two exceptions. Measurements D0002 and D0016 did not correlate correctly with their hardwire measurements; D0536 and D0452. Measurements D0002 and D0016, use pressure transducer 1B40242 which is RF sensitive. This RF sensitivity is suspected as being the cause of both of these discrepancies and is being studied further. Table 12-7 shows the comparison of the telemetry system PCM, PAM, FM, and the hardwire DDAS, strip chart, and FM. The PCM data used for correlation was stripped out using a two percent editband; therefore, exact values for the PCM data were not always available at the comparison time noted in the table. When this situation occurred, the PCM values were obtained by extrapolation. All measurements responded correctly to RACS commands.

### 12.2.1 Pulse Amplitude Modulation (PAM) Subsystem

The performance of the PAM subsystem was excellent. The general noise level was well within acceptable limits. All reference channels were stable and remained within the required limits.

### 12.2.2 Pulse Code Modulation (PCM) Subsystem

The performance of the PCM subsystem was excellent. The frame rate was nominal. All data were accurately reduced.

### 12.2.3 Frequency Modulation to Frequency Modulation (FM/FM) Subsystem

The performance of the FM/FM subsystem was excellent. All voltage controlled oscillators (VCO) were within their prescribed limits (table 12-8). All data were reduced and readily interpreted.

### 12.2.4 Single Sideband Subsystem

The single sideband subsystem performed normally. The proper operation of all channels was confirmed by the proper reception of in-flight calibration signals.

### 12.2.5 Calibrator Assembly

The calibrator assembly provided good calibration steps and signals during the acceptance firing.

It was noted during the acceptance firing that the duration of the first telemetry calibrator calibration step was greater than 200 ms. The duration and tolerance per specification of each calibration step, except the first, is presently 140 $\pm$5 ms, and the duration of the first step is loosely specified as approximately 200 ms.

A study of the telemetry calibrator schematics indicates that the design of the clock circuit within the calibrator is such that the first calibration step is and should be greater than 140 ms.

In reply to a DAC request, NASA has established new tolerances for the telemetry calibrator as follows: the tolerances on the first voltage step is 140 +105, -5 ms and consequently; a tolerance of 700 +125, -25 ms on the first staircase sequence; and a tolerance of 1,400 +150, -5 ms on the first SSB sequence.

These newly established tolerances will be reflected in a change of the telemetry calibrator specification, No. 50M60026.

### 12.2.6 Radio Frequency (RF) Subsystem

The RF subsystem performed very well throughout the acceptance firing. A summary of the RF system performance is presented in table 12-8.

### 12.2.7 Tape Recorder Operation

The tape recorder operated satisfactorily during the acceptance firing. Both analog (PAM) and digital (PCM) data were recorded and reduced satisfactorily. The comparison between the real time (RT) and the playback (P/B) data (digital and analog) is summarized in tables 12-9 and 12-10. Both compare well within established limits.

The normal sequence of operation for the tape recorder playback shutdown should be: "Ready to Record" indication "ON", Playback "OFF" command, with the "Ready to Record" indication remaining "ON".

When examining the tape recorder sequence data in table 12-11, it is noted that a "Ready to Record ON" was indicated at $T_o$ +821.19 sec. A "Playback OFF" command was given 110 ms later, and the "Ready to Record" indication went OFF at $T_o$ +821.9 or 300 ms after the "Playback OFF" command was given.

Then at $T_o$ +1,300.04 sec, a "Slow Record ON" command was given, and 110 ms later, the "Ready to Record" indication came "ON" and went "OFF" in 1.7 sec ($T_o$ +1,301.32 sec). This abnormal sequence is explained by the design and operation of the "Ready to Record" sensor on the tape which is segmented instead of one continuous metalized strip. This strip is sensed by "fingers" which make an electrical contact to pull in a relay which shuts off the tape recorder drive motor. Evidently this segmented strip was sensed at $T_o$ +821.19 sec. Then a "Playback OFF" command was given before the tape recorder could come to a stop caused by the "Ready to Record" circuit. It appears the tape recorder mechanism had enough inertial energy to continue moving and finally stopped at a point where the "fingers" were sensing a gap between the metalized segments.

Normally the sequence is such that the "Ready to Record" circuit shuts off the tape recorder playback instead of "Playback OFF" command. This sequence will result in "Ready to Record ON" indication after tape recorder playback.

### 12.2.8 Electromagnetic Compatibility

The data acquisition system was electromagnetically compatible with the other stage systems; however, the radio frequencies of the data acquisition system's transmitters interferred with the operation of the pressure transducer 1B40242. As noted in paragraph 12.1.2, an Engineering Change Proposal has been submitted to correct this problem.

## 12.3 Hardwire Data Acquisition System Performance

The GIS (ground instrumentation system) provides for data recording of all measurements as specified in the S-IVB Stage Basic Static Firing Program. This system provides a backup and data comparison for certain telemetry system parameters in addition to recording measurements from the ground support and facility equipment. The GIS also provides strip charts for redline and cutoff parameter monitoring. The following table presents the type of recording equipment and the number of channels required for the acceptance firing.

| RECORDING EQUIPMENT | NO. OF CHANNELS |
|---|---|
| Beckman 210 Digital Data System | 155 |
| Constant Bandwidth FM | 44 |
| Wideband FM | 21 |
| Strip Charts | 37 |
| Total | 269 |

With the exception of one measurement, the instrumentation performance during the acceptance firing was very good.

Analysis of the data on measurements E0580 and E0555 indicated that the gain settings on the AC amplifiers were wrong. Resultant investigation revealed this to be true and the data which had been qualified as trend only could now be used correctly by utilizing the proper gain factors.

TABLE 12-1
INSTRUMENTATION SYSTEM MEASUREMENT SUMMARY

| PARAMETER | ASSIGNED PER IP&CL | DELETED | | | | ACTIVE | UNSUCCESSFUL | ACCEPTABLE |
|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | TOTAL | | | |
| Accelerations | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Acoustics | 12 | 0 | 0 | 3 | 3 | 9 | 1 | 8 |
| Temperature | 218 | 43 | 1 | 0 | 44 | 174 | 4 | 170 |
| Pressures | 107 | 43 | 1 | 1 | 44 | 63 | 12 | 51 |
| Vibrations | 41 | 0 | 3 | 2 | 5 | 36 | 2 | 34 |
| Flows | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 4 |
| Positions | 8 | 5 | 0 | 0 | 5 | 3 | 0 | 3 |
| Events | 76 | 14 | 0 | 0 | 14 | 62 | 0 | 62 |
| Levels | 12 | 1 | 0 | 0 | 1 | 11 | 0 | 11 |
| Voltages | 41 | 0 | 0 | 0 | 0 | 41 | 3 | 38 |
| Miscellaneous | 40 | 0 | 1 | 1 | 2 | 38 | 2 | 36 |
| Strains | 32 | 0 | 0 | 0 | 0 | 32 | 0 | 32 |
| Speeds | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| TOTAL | 594 | 106 | 7 | 7 | 119 | 475 | 24 | 451 |

(1) Deleted due to acceptance firing configuration.

(2) Deleted due to shortages.

(3) Deletions caused by transducers not replaced due to schedules.

TABLE 12-2 (Sheet 1 of 3)
TELEMETRY MEASUREMENT FAILURES DURING ACCEPTANCE FIRING

| MEASUREMENT NO. | PARAMETER | REMARKS |
|---|---|---|
| C0147-401 | Temp GG Oxid Inlet Line Wall | Acceptable data were obtained during 1st burn. Following engine cutoff the data increased to above full scale in a normal manner; however, it failed to come "on scale" during 2nd burn. Dry ice was applied to the temperature patch after the acceptance firing. The temperature patch open circuited when the temperature was reduced to 28 deg F. The dry ice was then removed and as the temperature increased the circuit closed. The transducer has been rejected and will be replaced. |
| D0002-403 | Press - Fuel Pump Inlet | During engine mainstage operation in both firings this measurement decreased rapidly to zero pressure, which is not a valid test condition. This phenomenon is thought to be caused by pressure turbulance at the pressure sensing port. An Engineering Change Proposal (ECP No. 7538) has been initiated to relocate this transducer on future stages to isolate it from this turbulence. This transducer will not be rejected or replaced on the S-IVB-502 stage. |
| D0055-424 | Press - Oxidizer Tank Inlet | This measurement provided valid data except when the measurement output occasionally decreased to zero volts in a step function manner. The duration of the invalid data shifts varied from approximately one sec to 20 sec. The measurement was patched to a strip chart after the acceptance firing and no shifts in data were observed for 2 1/2 hr. The measurement system was thoroughly checked and no anomalies were found. |

TABLE 12-2 (Sheet 2 of 3)
TELEMETRY MEASUREMENT FAILURES DURING ACCEPTANCE FIRING

| MEASUREMENT NO. | PARAMETER | REMARKS |
|---|---|---|
| D0062-424 | Press - LH2 Circ Ret Line Tank Inlet | The data from this measurement was acceptable except from $T_o$-147 to $T_o$-100 sec when a slight vacuum was indicated at the tank inlet. The measurement was thoroughly checked after the acceptance firing and no anomalies were found. |
| D0105-403 | Press - LOX Tank Press Mod He Gas | A turbulent pressure condition at the sensing port of the transducer invalidated its data. An Engineering Change Proposal (ECP No. 7538) has been initiated to relocate this transducer on future stages to isolate it from this turbulence. This transducer will not be rejected or replaced on the S-IVB-502 stage. |
| VXD0179-424<br>VXD0180-424 | Press - Oxid Tank Ullage EDS 1<br>Press - Oxid Tank Ullage EDS 2 | These measurements provided valid data except for occasional data dropouts after each engine cutoff. These measurements were patched to strip charts after the acceptance firing and monitored for a 15 hr period. During this test no data dropouts were observed. Evaluation of acceptance firing data indicated that these dropouts were caused by the measuring circuit opening. The transducers were rejected and are to be replaced. |
| E0212-403 | Vib - Gimbal Point Yaw | The data from this measurement was invalid during the 2nd burn. The transducer and amplifier have been rejected and are to be replaced. |
| XM0021-404 | Current, Aft Battery No. 1 | This measurement indicated transients when the auxiliary pump was energized. These transients are due to crosstalk within the battery simulator modules. Hardwire current data verify that the transients observed on the telemetry are not data. This crosstalk phenomonen will not occur when primary batteries are installed. |

TABLE 12-2 (Sheet 3 of 3)
TELEMETRY MEASUREMENT FAILURES DURING ACCEPTANCE FIRING

| MEASUREMENT NO. | PARAMETER | REMARKS |
|---|---|---|
| XM0041-404 | Voltage, Phase A-C LH2 Chilldown Inverter | A voltage dropout having a duration of approximately 1/2 sec noted at $T_o$ +207 sec. This dropout is not considered data since a voltage decrease in phase A-C would have resulted in a voltage decrease in phase $A_1$-$C_1$ which did not occur. During checkout of this problem inadequate insulation of the test leads caused destruction of the voltage sensing circuitry and the inverter phase circuitry for phase A-C. The chilldown inverter has been rejected and sent to A3 for rework. |

TABLE 12-3
MEASUREMENT ABNORMALITIES DURING ACCEPTANCE FIRING

| MEASUREMENT NO. | PARAMETER | REMARKS |
|---|---|---|
| C0070-408 | Temp. Fuel Tank Wall Internal -2 | These measurements provided data which indicated that the measurements are crosswired on the stage. It has been concluded that the schematic in the measurement request drawings for these parameters is incorrect. The drawings will be corrected to reflect the proper measurements. |
| C0071-408 | Temp. Fuel Tank Wall Internal -3 | |
| C0152-403 | Temp. LOX Main Supply Line Flange Wall | The data obtained from this measurement were off scale high throughout the firing. The responsible design group has determined that during ground testing, the temperature of the flange wall will not be within the range of the measurement. The temperature of the flange wall is expected to be within the measurement range only when the stage is in orbit. This prediction was verified during the S-IVB-203 stage flight. |

TABLE 12-4 (Sheet 1 of 2)
MEASUREMENT FAILURES PRIOR TO $T_o$-163 SEC

| MEASUREMENT NO. | PARAMETER | REMARKS |
|---|---|---|
| B0018-411 | Acoustic - Fwd (4800-9600. CPS) Int. | No remote automatic checkout (RAC) signal or data were obtained from this measurement during the acceptance firing. The transducer and amplifier have been rejected. |
| C0054-408 | Temp Fuel Tank Position 3 | This measurement was "off scale high" throughout Test Request 614067. This indicated an open circuit condition during the acceptance firing. The measurement checked out correctly after the acceptance firing. The transducer resistance was 5,200 ohms which is a nominal value for ambient temperature. The transducer has been rejected and is to be replaced. |
| C0127-403 | Temp - Fuel Duct - 2 | The data were "off scale high" throughout the acceptance firing. The A3 Aero-Thermodynamic design section has concluded the measurement range is incorrect and is processing an Engineering Change Proposal (ECP) to change this range. Also, the measurement did not come "on scale" throughout the S-IVB-203 stage flight. |
| C0155-404 | Temp LH2 Prevalve Bypass Line Wall | No valid data were received from this measurement. It was "off scale high" during the firing. Although the measurement did not indicate an open circuit condition prior to, during, or after the application of dry ice, the transducer has been rejected and is to be replaced. |
| D0016-425 | Press Cold Helium Sphere | These measurements are RF susceptible and provided trend only data during the acceptance firing. ECP 7518, Revision 1 has been initiated to correct this problem. (Refer to paragraph 12.1.2). |
| D0182-409 | Press Fuel Tank Continuous Vent 2 | |
| D0183-409 | Press LH2 Tank Non-Prop Vent 1 | |

TABLE 12-4 (Sheet 2 of 2)
MEASUREMENT FAILURES PRIOR TO $T_o$-163 SEC

| MEASUREMENT NO. | PARAMETER | REMARKS |
|---|---|---|
| D0200-427<br>D0202-427<br>D0205-428 | Press External Aft Skt #4<br>Press External Aft Skt #6<br>Press External Aft Skt #9 | The ambient atmospheric pressures for these measurements were 6,7,and 10 percent low respectively, so these data were classified as trend only. Post-firing checks showed that the transducer outputs were directly proportional to the ambient temperature. The transducers were rejected and sent to the calibration lab for further testing which did not verify these parts were temperature sensitive. It was later determined that the tubing to the transducer for measurement D0200 was plugged, trapping air in the line. A similar cause is suspected for measurement D0202. Investigation of measurement D0205 revealed a faulty cal module which is to be replaced. |
| E0117-411 | Vib - Forward Skirt Battery 1, 2 - Tan | This measurement provided no data (no output) during the acceptance firing. The transducer has been rejected and sent to the calibration lab for recalibration. |
| M0046-404 | Voltage, Phase A1-B1 Chill-down Inverter | This measurement provided trend data which were approximately 7 percent high. During checkout of this measurement the LH2 chilldown inverter failed which precluded further checkout of this measurement. The chilldown inverter was rejected and sent to A3. |
| N0008-411 | Misc - T/M 2 Antenna Refl RF Pwr Mecs. | The data were classified as trend only as this measurement was suspected of being RFI susceptible. This measurement is to be investigated further during the VCL checkout at STF. |
| N0024-408 | Misc - Fuel Liq Gas Diff Pos 4 | No remote automatic checkout (RAC) signal or data were obtained prior to 1st burn engine start. The data after engine start were valid and the measurement checked good after the acceptance firing. It is presently concluded that the sensor circuit opened when cryogenics were loaded and that the initial vibration at engine start cleared the open circuit condition. The sensor has been rejected and is to be replaced. |

TABLE 12-5 (Sheet 1 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| A0005-411 | Accel. Axial (Low Range) | Deleted transducer is not available (shortage). |
| B0022-404 | Acoustic Aft (50-3000CPS) Int. | Deleted measurement failed. Replacement was not accomplished due to schedules. |
| B0023-404 | Acoustic Aft (2400-4800CPS) Int. | Same as B0022-404. |
| B0024-404 | Acoustic Aft (4800-9600CPS) Int. | Same as B0022-404. |
| C007-401 | Temp Engine Control Helium | Open - the measurement is disconnect from T/M per DAC requirement for H/W and redline monitoring. |
| C0021-415 | Temp Attitude Control Fuel Module No. 2 | Simulated - APS modules not installed for acceptance firing. |
| C0022-415 | Temp Attitude Control Oxid Module No. 2 | Simulated - Same as C0021-415. |
| C0023-414 | Temp APS He Press Tank No. 1 | Simulated - Same as C0021-415. |
| C0030-414 | Temp APS Control Engine Injector Wall 1-1 | Simulated - Same as C0021-415. |
| C0031-415 | Temp APS Control Engine Injector Wall 2-1 | Simulated - Same as C0021-415. |
| C0050-401 | Temp Hydraulic Pump Inlet Oil | Open - Disconnected from T/M per SC1195A for H/W redline cutoff monitoring. |
| C0119-419 | Temp Aft Interstage -2 | Open - Aft interstage not installed for acceptance firing. |
| C0120-419 | Temp Aft Interstage -3 | Same as C0119-419. |
| C0121-419 | Temp Aft Interstage -4 | Same as C0119-419. |
| C0123-419 | Temp Aft Interstage -5 | Same as C0119-419. |
| C0132-414 | Temp APS Control Oxid No. 1 | Simulated - APS modules not installed for the acceptance firing. |
| C0136-414 | Temp APS Control Fuel No. 1 | Same as C0132-414. |
| C0187-415 | Temp APS Helium Pressurizing Tank Module 2 | Same as C0132-414. |

TABLE 12-5 (Sheet 2 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| C0189-414 | Temp APS Engine Injector Wall 1-2 | Same as C0132-414. |
| C0190-414 | Temp APS Engine Injector Wall 1-3 | Same as C0132-414. |
| C0193-415 | Temp APS Engine Injector Wall 2-2 | Same as C0132-414. |
| C0194-415 | Temp APS Engine Injector Wall 2-3 | Same as C0132-414. |
| C0200-401 | Temp Fuel Injection | Open - Disconnect from T/M per SC 1195A for H/W recording |
| C0202-401 | Temp LOX Pump Bearing Coolant | Open - Disconnect from T/M per SC 1195A for H/W redling cutoff monitoring. |
| C0227-405 | Temp Electrical Tunnel -2 | Open - Electrical tunnel not installed for acceptance firing. |
| C0242-405 | Temp Electrical Tunnel -4 | Same as C0227-405. |
| C0271-402 | Temp Gas Interstage Area -3 | Open - Aft interstage not installed for acceptance firing. |
| C0272-402 | Temp Gas Interstage Area -4 | Same as C0271-402. |
| C0273-402 | Temp Gas Interstage Area -5 | Same as C0271-402. |
| C0275-403 | Temp Gas Interstage Area -7 | Deleted transducer is not available (shortage). |
| C0286-415 | Temp APS Fairing 2-4 | Simulated - APS modules not installed. |
| C0287-415 | Temp APS Fairing 2-5 | Same as C0286-415. |
| C0288-415 | Temp APS Fairing 2-6 | Same as C0286-415. |
| C0289-415 | Temp APS Fairing 2-7 | Same as C0286-415. |
| C0294-415 | Temp APS Fuel Line -4 | Same as C0286-415. |
| C0295-415 | Temp APS Fuel Line -5 | Same as C0286-415. |
| C0296-415 | Temp APS Fuel Line -6 | Same as C0286-415. |
| C0297-415 | Temp APS Oxidizer Line -4 | Same as C0286-415. |
| C0298-415 | Temp APS Oxidizer Line -5 | Same as C0286-415. |
| C0299-415 | Temp APS Oxidizer Line -6 | Same as C0286-415. |
| C0300-415 | Temp APS Fuel Tank -2 | Simulated - APS modules not installed for acceptance firing. |

TABLE 12-5 (Sheet 3 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| C0301-415 | Temp APS Oxidizer Tank -2 | Same as C0300-415. |
| C0302-415 | Temp APS Fuel Control Module -2 | Same as C0300-415. |
| C0303-415 | Temp APS Oxidizer Control Module -2 | Same as C0300-415. |
| C0305-415 | Temp Aft Interstage -7 | Open - Aft interstage not installed for acceptance firing. |
| C0306-415 | Temp Aft Interstage -8 | Same as C0305-415. |
| C0361-414 | Temp Ullage Control Engine Injector Wall 1-4 | Simulated - APS modules not installed for acceptance firing. |
| C0362-415 | Temp Ullage Control Engine Injector Wall 2-4 | Same as C0361-414. |
| D0027-414 | Press Attitude Control Chamber 1-1 | Same as C0361-414 |
| D0028-414 | Press Attitude Control Chamber 1-2 | Same as C0361-414. |
| D0029-414 | Press Attitude Control Chamber 1-3 | Same as C0361-414. |
| D0030-415 | Press Attitude Control Chamber 2-1 | Same as C0361-414. |
| D0031-415 | Press Attitude Control Chamber 2-2 | Same as C0361-414. |
| D0032-415 | Press Attitude Control Chamber 2-3 | Same as C0361-414. |
| D0035-414 | Press APS Control He Press Tank No. 1 | Same as C0361-414. |
| D0036-415 | Press Attitude Control Helium | Same as C0361-414. |
| D0037-414 | Press Helium Regulator Outlet Module 1 | Same as C0361-414. |
| D0038-415 | Press Helium Regulator Outlet Module 2 | Same as C0361-414. |
| D0041-403 | Press Hydraulic System | Open - Disconnect from T/M per 1195A for H/W redline - cutoff monitoring. |
| D0042-403 | Press Reservoir Oil | Same as D0041-403. |
| D0044-403 | Press Engine Actuator Pitch Diff | Open - Disconnected per 1195A for H/W recording |

TABLE 12-5 (Sheet 4 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| D0045-403 | Press Engine Actuator Yaw Diff | Same as D0044-403 |
| D0052-404 | Press Int. at Mike-Aft Static | Deleted transducer is not available (shortage). |
| D0054-410 | Press Fuel Tank Inlet | Deleted measurement failed. Replacement was not accomplished due to schedules. |
| D0070-414 | Press Oxid Supply Manifold Module 1. | Simulated - APS modules not installed for acceptance firing. |
| D0071-414 | Press Oxid Supply Manifold Module 1 | Same as D0070-414. |
| D0072-415 | Press Fuel Supply Manifold Module -2 | Same as D0070-414. |
| D0073-415 | Press Oxid Supply Manifold Module -2 | Same as D0070-414. |
| D0097-414 | Press Fuel Tank Ullage Volume Module 1 | Same as D0070-414. |
| D0098-414 | Press Oxidizer Tank Ullage Volume Module 1 | Same as D0070-414. |
| D0099-415 | Press Oxidizer Tank Ullage Module 2 | Same as D0070-414. |
| D0100-415 | Press Fuel Tank Ullage Volume Module 2 | Same as D0070-414. |
| D0153-423 | Press Chamber Retro Rocket Position IV-1 | Installed on S-IVB, monitored via S-II T/M. |
| D0154-421 | Press Chamber Retro Rocket Position II-III | Same as D0153-423. |
| D0155-420 | Press Chamber Retro Rocket Position I-II | Same as D0153-423. |
| D0156-422 | Press Chamber Retro Rocket Position III-IV | Same as D0153-423. |
| D0187-419 | Press Aft Interstage -9 | Open - Aft interstage not installed for acceptance firing. |
| D0188-419 | Press Aft Interstage -10 | Same as D0187-419. |
| D0189-419 | Press Aft Interstage -11 | Same as D0187-419. |
| D0190-419 | Press Aft Interstage -12 | Same as D0187-419. |
| D0191-419 | Press Aft Interstage -13 | Same as D0187-419.. |

TABLE 12-5 (Sheet 5 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| D0192-419 | Press Aft Interstage -14 | Same as D0187-419. |
| D0194-419 | Press Aft Interstage -16 | Same as D0187-419. |
| D0195-419 | Press Aft Interstage -17 | Same as D0187-419. |
| D0196-419 | Press Aft Interstage -18 | Same as D0187-419. |
| D0197-419 | Press Aft Interstage -19 | Same as D0187-419 |
| D0198-419 | Press Aft Interstage -20 | Same as D0187-419. |
| D0199-419 | Press Aft Interstage -21 | Same as D0187-419. |
| D0210-402 | Press Interstage Interval -6 | Same as D0187-419. |
| D0216-428 | Press Chamber Solid Ullage Rocket II-III | Open - Ullage rockets not installed for acceptance firing. |
| D0217-429 | Press Chamber Solid Ullage Rocket IV-I | Same as D0216-428. |
| D0220-414 | Press Ullage Control Chamber 1-4 | Simulated - APS modules not installed for acceptance firing. |
| D0221-415 | Press Ullage Control Chamber 2-4 | Same as D0220-414. |
| E0091-411 | Vib. Field Splice Position 1 (LF) Thrust | Deleted transducer is not available (shortage) |
| E0093-411 | Vib. Field Splice Position - Thrust | Same as E0091-411 |
| E0102-404 | Vib. Natural Bending - Aft Yaw | Same as E0091-411 |
| E0115-411 | Vib. Fwd Skirt Battery 1-2 Thrust | Deleted measurement failed. Replacement was not accomplished due to schedules. |
| E0120-427 | Vib. APS Fwd Attach Point - RAD | Same as E0115-411. |
| G0003-401 | Position, Main LOX Valve | Simulated - Disconnected per SC 1195A for H/W recording. |
| G0004-401 | Position, Main Fuel Valve | Same as G0003-401. |
| G0005-401 | Position, Gas Generator Valve | Same as G0003-401. |
| G0008-401 | Position, LOX Turbine Bypass Valve | Same as G0003-401. |
| G0009-401 | Position, GH2 Start Tank Valve | Same as G0003-401. |

TABLE 12-5 (Sheet 6 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| K0006-401 (K535) | Event Ignition Phase Control Solenoid Energized | Open - Recorded via N/W per SC 1195A. Disconnected due to GSE loading. |
| K0010-401 | Event Thrust Chamber Spark System ON | Same as K0006-401 |
| K0020-401 (K534) | Event, ASI LOX Valve Open | Open - Switched from T/M to computer for stage control by Flight Measurement Enable Command. |
| K0095-401 | Event, Thrust Chamber LH2 Injection Temp. OK | Open - Recorded via H/W per SC 1195A. Disconnected due to GSE loading. |
| K0116-401 (K631) | Event, Gas Generator Valve Closed | Open - Switched from T/M to computer for stage control by Flight Measurement Enable Command. |
| K0119-401 (K632) | Event, Main Fuel Valve Closed | Same as K0116-401. |
| K0121-401 | Event, Main LOX Valve Closed | Same as K0116-401. |
| K0123-401 (K695) | Event, Start Tank Discharge Valve Closed | Same as K0116-401. |
| K0126-401 (K558) | Event, LOX Bleed Valve Closed | Same as K0116-401. |
| K0127-401 (K557) | Event, LH2 Bleed Valve Closed | Same as K0116-401. |
| K0128-404 (M539) | Event, Switch Selector | Same as K0116-401. |
| K0152-404 | Event, Rate Cyro Wheel Speed OK | Open - Rate cyro not installed. |
| K0155-411 | Event, LH2 Cont. Vent Orifice Bypass Closed | Open - not connected during the acceptance firing. |
| K0175-404 | Event, LOX Transluner Vent Low Pressure Switch De-Energized | Deleted - LOX transluner vent pressure switch function has been deleted. |
| L0007-403 | Level Reservoir Oil | Simulated - Disconnected from T/M per SC 1195A for H/W recording and redline - cutoff monitoring. |

TABLE 12-5 (Sheet 7 of 7)
TELEMETRY MEASUREMENT STATUS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| N0017-411 | Power FM/FM Transmitter 3 Output | Deleted measurement failed. Replacement was not accomplished due to schedules. |
| N0054-410 | Misc. Quality GH2 Cont. Vent | Open transducer is not available (shortage). |

NOTE: A transducer is defined as a shortage item if it is not installed on the stage.

TABLE 12-6
DELETED NON-OPERATIONAL TELEMETRY MEASUREMENTS

| MEASUREMENT NO. | PARAMETER | REASON |
|---|---|---|
| B0022-404 | Acoustic Aft (50-3000 CPS) INT. | The transducer and amplifier for for these measurements failed prior to the acceptance firings. They will be replaced during the post firing operations. |
| B0023-404 | Acoustic Aft (2400-4800) INT. | |
| B0024-404 | Acoustic Aft (4800-9600 CPS) INT | |
| D0054-410 | Press. Fuel Tank Inlet | The flight allocated strain gage transducer for this measurement is RF susceptible. A waffer blanking flange was installed between the stage port and the transducer port to prevent transducer damage which could be caused by high overpressure transient spikes. The data thus obtained from the measurement were to be used for engineering evaluation of the effects that vibration and RF have on the measurement; however, the transducer amplifier was damaged prior to the acceptance firing and will be reinstated to the flight configuration during post firing operations. |
| E0115-411 | Vib Fwd Skirt Battery 1-2 thrust | The amplifiers for these measurements failed prior to the acceptance firing and will be replaced during post firing operations. |
| E0120-427 | Vib APS #1 Fwd attach point - radial | |
| N0017-411 | Power, FM/FM Transmitter No. 3 Output | This measurement failed during the simulated static firing and schedules precluded replacement. During post firing checks the measurement provided valid data when the flight transmitter group power was OFF. When turned ON, the measurement indicated a data shift. It is presently concluded that the measurement is RF susceptible. |

TABLE 12-7 (Sheet 1 of 3)
TELEMETRY TO HARDWIRE DATA COMPARISON AT $T_2$ +250 SEC

| PARAMETER | MEASUREMENT NUMBER | | VALUES | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | TELEMETRY | | | HARDWIRE | | |
| | T/M | H/W | PAM | PCM | FM | S/C | DDAS | FM |
| TEMPERATURE (°R) | | | | | | | | |
| LH2 Pump Inlet | C0003 | C0658 | 38.48 | 38.4 | -- | 38.6 | 38.5 | 38.6 |
| LOX Pump Inlet | C0004 | C0659 | 166.5 | 166.4 | -- | 166.1 | 166.0 | 166.3 |
| GH2 Start Bottle | C0006 | C0649 | 228 | 221 | -- | 234 | 228 | -- |
| Engine Control Assembly | C0011 | C0657 | 544.8 | 544 | -- | -- | 542 | -- |
| GO LH2 Bleed Valve | C0012 | C0650 | 55.1 | 55 | -- | 55.5 | 55 | |
| GO LOX Bleed Valve | C0013 | C0651 | 171.8 | 172.1 | -- | 172.3 | 172.3 | -- |
| LOX Tank He Inlet | C0016 | C0662 | 493 | 486 | -- | -- | 479 | -- |
| LOX Pump Discharge | C0133 | C0648 | 170.8 | 171.7 | -- | -- | 171.3 | 171.3 |
| LH2 Pump Discharge | C0134 | C0644 | 51.8 | 51.8 | -- | -- | 51.6 | 51.5 |
| Thrust Chamber Jacket | C0199 | C0645 | 130 | 131 | -- | 134.1 | 140 | -- |
| Cold He Sphere No. 4 | C0210 | C0661 | 46.5 | 45 | -- | 49.5 | 48.7 | -- |
| PRESSURE (PSIA) | | | | | | | | |
| Thrust Chamber | D0001 | D0524 | -- | -- | 725 | 730 | 729 | |
| LH2 Pump Inlet | *D0002 | D0536 | 0 | 0 | -- | 31.7 | 30.7 | 30.7 |
| LOX Pump Inlet | D0003 | D0537 | 38.7 | 38.5 | -- | 40.5 | 40.5 | 39.7 |
| Main LH2 Injection | D0004 | D0518 | 781 | 791 | -- | -- | 791 | 790 |
| LH2 Pump Discharge | D0008 | D0516 | 1,108 | 1,108 | -- | -- | 1,135 | 1,130 |
| LOX Pump Discharge | D0009 | D0522 | 906 | 906 | -- | -- | 909 | 915 |
| GG Chamber | D0010 | D0530 | -- | 620 | 625 | -- | 638 | 625 |
| GG LH2 Injection | D0011 | D0527 | 698 | 712 | -- | -- | 713 | 715 |
| GG LOX Injection | D0012 | D0529 | 722 | 714 | -- | -- | 730 | 720 |
| Control He Reg Discharge | D0014 | D0581 | 565 | 562 | -- | 568 | 568 | -- |
| LH2 Pump Bal Piston Cavity | D0015 | D0515 | 467 | 471 | -- | -- | 486 | -- |
| GH2 Start Bottle | D0017 | D0525 | 1,264 | 1,248 | -- | 1,275 | 1,263 | 1,275 |
| Cold He Sphere | **D0016 | D0542 | 939 | 934 | -- | 1,080 | 1,094 | -- |
| Engine Reg. Outlet | D0018 | D0535 | 401 | 405 | -- | 401 | 405 | -- |
| Control Helium Supply | D0019 | D0566 | 2,010 | 2,032 | -- | 2,034 | 2,047 | -- |
| He LH2 Tank Repress Sphere | D0020 | D0513 | 1,112 | 1,123 | -- | 1,158 | 1,095 | -- |
| LOX Pump Bearing Coolant | D0053 | D0556 | 159.5 | 160 | -- | -- | *** | -- |
| LOX Pump Primary Seal Cavity | D0085 | D0521 | 16.9 | 17.1 | -- | -- | 17.3 | -- |

* D0002 - Invalid during mainstage operations (See table 12-2).
** D0016 - Trend only data (See table 12-3).
*** D0556 - Invalid data.

TABLE 12-7 (Sheet 2 of 3)
TELEMETRY TO HARDWIRE DATA COMPARISON AT $T_2$ +250 SEC

| PARAMETER | MEASUREMENT NUMBER | | VALUES | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | TELEMETRY | | | HARDWIRE | | |
| | T/M | H/W | PAM | PCM | FM | S/C | DDAS | FM |
| LOX Turbine Outlet | D0086 | D0533 | 29 | 30 | -- | -- | 29.7 | -- |
| Amb. He Sphere | D0087 | D0541 | 2,621 | 2,652 | -- | 2,657 | 2,684 | -- |
| He LOX Tank Repress Sphere | D0088 | D0512 | 1,304 | 1,290 | -- | 1,295 | 1,249 | -- |
| LH2 Tank Ullage - EDS-1 | D0177 | D0539 | 33.3 | 33.3 | -- | 33.4 | 34.2 | -- |
| LH2 Tank Ullage - EDS-2 | D0178 | D0539 | 32.2 | 32.9 | -- | 33.4 | 34.2 | |
| LOX Tank Ullage - EDS-1 | D0179 | D0540 | 38.0 | 38.4 | -- | 40.2 | 39.9 | -- |
| LOX Tank Ullage - EDS-2 | D0180 | D0540 | 37.8 | 38.6 | -- | 40.2 | 39.9 | -- |
| Common Bulkhead Internal | D0208 | D0545 | .5 | 0 | -- | .3 | 0 | -- |
| FLOWRATE (GPM) | | | | | | | | |
| LOX **** | F0001 | F0506 | -- | -- | 269 | -- | -- | 269.2 |
| LH2 **** | F0002 | F0507 | -- | -- | 274 | -- | -- | 274.1 |
| POSITION (DEG) | | | | | | | | |
| Pitch Actuator | G0001 | G0504 | 2.43 | 2.43 | -- | 2.4 | -- | 2.48 |
| Yaw Actuator | G0002 | G0505 | 2.43 | 2.49 | -- | 2.5 | -- | 2.48 |
| PU Valve | G0010 | G0503 | 2.45 | 2.50 | -- | 2.48 | 2.43 | 2.50 |
| VOLTAGE (VDC) | | | | | | | | |
| Engine Control Bus | M0006 | M0514 | 28.9 | 29.4 | -- | 28.8 | 28.8 | -- |
| Engine Ignition Bus | M0007 | M0515 | 29.1 | 29.3 | -- | 29.0 | 28.8 | -- |
| Aft Battery No. 1 | M0014 | M0541 | 28.8 | 28.8 | -- | -- | 29.4 | -- |
| Aft Battery No. 2 | M0015 | M0540 | 57.6 | 58.0 | -- | 57.6 | 57.0 | -- |
| Forward Battery No. 1 | M0016 | M0543 | 28.8 | 28.5 | -- | -- | 28.3 | -- |
| Forward Battery No. 2 | M0018 | M0542 | 28.8 | 29.2 | -- | -- | 29.4 | -- |
| CURRENT (AMP) | | | | | | | | |
| Forward Battery No. 1 | M0019 | M0536 | 42.0 | 42 | -- | -- | 42 | -- |
| Forward Battery No. 2 | M0020 | M0537 | 4.2 | 4.2 | -- | -- | 4.0 | -- |
| Aft Battery No. 1 | M0021 | M0534 | 12.0 | 12.0 | -- | -- | 12 | -- |
| Aft Battery No. 2 | M0022 | M0535 | 30 | 31 | -- | 32 | -- | 30 |

**** These values were averaged between 1st ESC +60 to +63 Sec.

TABLE 12-7 (Sheet 3 of 3)
TELEMETRY TO HARDWIRE DATA COMPARISON AT $T_2$ +250 SEC

| PARAMETER | MEASUREMENT NUMBER | | VALUES | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | TELEMETRY | | | HARDWIRE | | |
| | T/M | H/W | PAM | PCM | FM | S/C | DDAS | FM |
| SPEED (RPM) | | | | | | | | |
| LOX Pump **** | T0001 | T0502 | -- | -- | 1,747 | -- | -- | 1,747 |
| LH2 Pump **** | T0002 | T0503 | -- | -- | 5,416 | -- | -- | 5,416 |

**** These values were averaged between 1st ESC +60 to +63 sec.

TABLE 12-8
TELEMETRY RF SYSTEM DATA

| SYSTEM | FM/FM 1 | FM/FM 2 | FM/FM 3 | PCM/FM | SSB |
|---|---|---|---|---|---|
| RF Power Amplifier Output (w) (Minimum acceptable is 12 w) | 24.6 | 20.4 | ** | 26.2 | 23.2 |
| Deviation (percent of bandwidth) | 24 | 17 | 17 | 21KC | 37 |
| Ground Station Signal Strength (uv) | 12K | 10K | 10K | 10K | 10K |
| 0.730 KC VCO Amplitude (db) | | -2 | | | |
| 1.7 KC VCO Amplitude (db) | 0 (REF) | 0 (REF) | 0 (REF) | | |
| 2.3 KC VCO Amplitude (db) | +1 | 0 | 0 | | |
| 3.0 KC VCO Amplitude (db) | +3 | +2 | +1 | | |
| 3.9 KC VCO Amplitude (db) | +2 | +2 | +1 | | |
| 5.4 KC VCO Amplitude (db) | +5 | +5 | +5 | | |
| 7.35 KC VCO Amplitude (db) | +8 | +7 | +5 | | |
| 14.5 KC VCO Amplitude (db) | +9 | +10 | +8 | | |
| 22.0 KC VCO Amplitude (db) | +14 | +12 | +10 | | |
| 30.0 KC VCO Amplitude (db) | +14 | +12 | +10 | | |
| 70.0 KC VCO Amplitude (db) | * | * | * | | |

| SYSTEM | ANTENNA 1 | ANTENNA 2 | ANTENNA 3 | ANTENNA 4 |
|---|---|---|---|---|
| Forward Power (w) | 16.8 | 15.2 | 19.6 | 20.0 |
| Reflected Power (w) | 2.0 | 1.9 | 2.0 | 1.5 |
| VSWR (maximum acceptable is 4.0:1) | 1.5 | 2.1 | 1.94 | 1.75 |
| RF Insertion Loss (db) (maximum acceptable is 7.5 db) | 4.75*** | 5.2*** | 5.5 | 5.4 |

*Channel modulated
**Measurement deleted sec table 12-6
***Values obtained assuming an FM/FM transmitter No. 3 output power of 26 w as measured during T/M "closed loop" operation after the acceptance firing.

TABLE 12-9
TAPE RECORDER DATA COMPARISON - ANALOG

| MEASUREMENT NO. | PARAMETER | UNITS | FAST RECORD To + 518 SEC | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | DATA LEVELS | | | | NOISE LEVELS (RMS) | |
| | | | PAM RT | PAM P/B | PAM RT* | PAM P/B* | PAM RT* | PAM P/B* |
| C0017 | Temp. PU System Internal | °R | 523 | 523 | 46 | 46 | .354 | 2.12 |
| C0076 | Temp. LH2 Tank External -2 | °R | 435 | 440 | 64 | 65 | .354 | 2.12 |
| D0224 | Press. LH2 Pump Interstage Outlet | PSIA | 135 | 137 | 68 | 69 | .708 | 3.18 |
| N0017 | FM/FM Transmitter Power | MVDC | OSH | OSH | OSH | OSH | - | - |
| C0010 | Temp. Engine Area Ambient | °R | 494 | 494 | 35 | 35 | .354 | 2.12 |
| C0197 | Temp. Primary Instru. Package | °R | 525 | 530 | 74 | 75 | 1.06 | 3.54 |
| D0202 | Press. Aft Skirt -E6 | PSIA | 13.4 | 13.4 | 88 | 88 | 1.06 | 2.83 |
| D0015 | Press. Fuel Pump Bal Piston Caivty | PSIA | 477 | 487 | 46 | 47 | .708 | 3.54 |
| C0012 | Temp. GG LH2 Bleed Valve | °R | 52.9 | 52.3 | 20 | 19 | .708 | 2.12 |
| C0013 | Temp. GG LOX Bleed Valve | °R | 169.9 | 169.9 | 21 | 21 | .708 | 2.12 |
| D0003 | Press. LOX Pump Inlet | PSIA | 40.8 | 40.2 | 67 | 66 | 1.06 | 2.83 |
| D0017 | Press. GH2 Start Bottle | PSIA | 756 | 756 | 50 | 50 | .708 | 2.12 |
| D0001 | Press. Thrust Chamber | PSIA | 680 | 680 | 68 | 68 | .708 | 2.12 |
| N0011 | Power T/M 1 Antenna Forward CF1-06 | MVDC | 83 | 82 | 76 | 75 | 1.42 | 2.12 |
| D0010 | Press. Gas Generator | PSIA | 680 | 690 | 68 | 69 | 1.42 | 2.83 |
| K0021 | Event. Engine Start ON | % | 15 | 14 | 15 | 14 | .708 | 1.77 |
| K0128 | Event. Switch Selector | % | 0 | 0 | 0 | 0 | .708 | 3.53 |

* % of full scale
OSH = Off Scale High

TABLE 12-10
TAPE RECORDER DATA COMPARISON - DIGITAL

| MEASUREMENT NO. | PARAMETER | UNITS | SLOW RECORD $T_o$ +2,296 SEC | |
|---|---|---|---|---|
| | | | PCM RT | PCM P/B |
| C0017 | Temp. PU System Internal | deg R | 527 | 529. |
| C0076 | Temp. LH2 Tank External -2 | deg R | 444 | 438 |
| D0224 | Press. LH2 Pump Interstage Internal | psia | 21 | 19 |
| N0017 | Misc. FM/FM Transmitter Power | percent | 102 | 102 |
| C0010 | Temp. Engine Area Ambient | deg R | 500 | 497 |
| C0197 | Temp. Primary Instru. Package | deg R | 537 | 526 |
| D0202 | Press. Aft Skirt - E6 | psia | 13.3 | 13.2 |
| D0015 | Press. Fuel Pump Bal Piston Cavity | psia | 19 | 16 |
| D0001 | Press. Thrust Chamber | psia | 15 | 31 |
| D0010 | Press. Gas Generator | psia | 16 | 17 |
| M0060 | Volt. PU Valve Control | vdc | 7.9 | 7.7 |
| M0061 | Volt. PU Valve Pos. Feedback | vdc | -0.3 | -0.6 |

TABLE 12-11
TAPE RECORDER SEQUENCE DATA

| EVENT | SOURCE | TIME (sec) |
|---|---|---|
| SEQUENCE DATA | | |
| Fast Record ON | DER | $T_o$ + 502.30 |
| Ready to Record Indication OFF | PCM/FM | $T_o$ + 502.79 |
| Fast Record OFF | DER | $T_o$ + 548.99 |
| Tape Recorder Playback ON | SW/SEL | $T_o$ + 774.3 |
| Loss of Real Time T/M Data | PAM | $T_o$ + 774.4 |
| Ready to Record Indication ON | PCM/FM | $T_o$ + 821.19 |
| Tape Recorder Playback OFF | SW/SEL | $T_o$ + 821.3 |
| Ready to Record Indication OFF | PCM/FM | $T_o$ + 821.60 |
| Pickup of Real Time T/M Data | PAM | $T_o$ + 821.9 |
| Ready to Record Indication ON | PCM | $T_o$ +1,300.15 |
| Slow Record ON | DER | $T_o$ +1,300.04 |
| Ready to Record Indication OFF | PCM/FM | $T_o$ +1,301.32 |
| Slow Record Command OFF & ON (Timing) | DER | $T_o$ +1,307.16/.25 |
| Slow Record Command OFF & ON (Timing) | DER | $T_o$ +2,345.35/.45 |
| Slow Record OFF | DER | $T_o$ +2,405.40 |
| Tape Recorder Playback ON | DER | $T_o$ +2,436.17 |
| Loss of PCM Real Time Data | PCM | $T_o$ +2,436.3 |
| Ready to Record Indication ON | PCM/FM | $T_o$ +2,574.79 |
| Tape Recorder Playback OFF | DER | $T_o$ +2,574.89 |
| Pickup of Real Time PCM Data | PCM | $T_o$ +2,575.1 |
| SPEED STABILIZATION DATA | | |
| Fast Record (maximum acceptable is 4 sec) | | 1.17 |

# 13. ELECTRICAL POWER AND CONTROL SYSTEMS

## 13.1 Stage Control System

The performance of control system items that function as a result of a switch selector command was satisfactory as shown in the sequence of events (section 5). The results of the evaluation of other control system components is described in the following paragraphs.

### 13.1.1 J-2 Engine Control System

All event measurements verified that the engine responded properly to the start and cutoff commands. All events occurred in the proper sequence within the specified times.

Engine second burn was terminated by an observer cutoff. Observer cutoff was initiated 165 ms prior to the switch selector cutoff and actuated the prevalve delay timer. The timer output occurred 431 ms later which is within the required limits (425 $\pm$25 ms). The main LOX and LH2 valves had closed prior to the timer output.

### 13.1.2 Range Safety System

During engine 1st burn, the range safety system was employed for verification of performance integrity.

Evaluation of data indicated that the parameters for all functions of this system performed within prescribed requirements. Listed in table 13-1 are the parameters monitored and their results.

### 13.1.3 Control Pressure Switches

Each pressure switch and its associated measurements were evaluated and a description of their performance is presented in the following paragraphs.

K0105 Engine Pump Purge Control Regulator Backup Pressure Switch - De-energized

(K0566) Engine Pump Purge Control Module Solenoid Valve Energized

D0050 Engine Pump Purge Regulator Pressure

The above measurements verified that this pressure switch maintained the engine pump purge regulator pressure between 105-130 psia. The switch is

enabled only when the engine pump purge command is given. The control valve responded during this period to the pressure switch movements.

K0184 LH2 Prepress Flight Switch - Energized
D0177, D0178 Fuel Tank Ullage EDS 1 and 2 Pressure.

During the period that the 1st burn command was on, this pressure switch was energized indicating that the ullage pressure never dropped below 28 psia. The pressure limits of the switch are 28-31 psia. At engine start, the pressure was approximately 36 psia and leveled off at 28.5 psia.

K0101 LH2 Prepress Control Switch - De-energized
D0177, K0178 Fuel Tank Ullage EDS 1 and 2 Pressure

During the period of time that the LH2 repress control valve command was on, this pressure switch controlled the control valve. The pressure switch limits are 31-34 psia. The above measurements verified that the pressure switch functioned properly.

K0108 LOX Prepress Flight Switch - De-energized
K0102 LOX Prepress Flight Switch - Energized
D0179, D0180 LOX Tank Ullage EDS Pressure

The above measurements verified that the pressure switch was operating. The required pressure limits of the switch are 38-41 psia; however, the actual pressure limits were between 38-40 psia.

K0107 LH2 Tank Step Pressure Switch - Energized
D0177, D0178 Fuel Tank Ullage EDS 1 and 2 Pressure

The above measurements verified that the pressure switch performed as required. The pressure limits of the switch are 31-34 psia.

K0131 LOX Chilldown Pump Purge Pressure Switch - De-energized
D0103 He Pressure to LOX Pump Motor Control
D0565 LOX Chilldown Pump Purge Control Valve - Energized

The above measurements verified that the pressure switch and its control circuitry functioned properly. The pressure limits of the switch are 38-41 psia.

K0156 LOX Tank Regulator Back-up Pressure Switch - Energized
K0571 Cold Helium Shutoff Valves - Energized
D0225 LOX Tank Purge Control Inlet Pressure

The above measurements verified that the pressure switch performed as expected. The pressure limits of the switch are 350-465 psia.

### 13.1.4 Vent Valves

The LOX and LH2 vent valves are commanded open and close by GSE, by-passing the switch selector. The vent valves responded to these commands. The following measurements were analyzed:

K0001 (K0532) Fuel Tank Vent Valve Closed
K0017 (K0542) Fuel Tank Vent Valve Open
K0002 (K0533) Oxid Tank Vent Valve Closed
K0016 (K0543) Oxid Tank Vent Valve Open

### 13.1.5 Fill and Drain Valves (Fuel and LOX)

These valves responded to GSE commands and performed satisfactorily. The following measurements were analyzed:

K0003 (K0554) Fuel Fill and Drain Valve Closed
K0019 (K0546) Fuel Fill and Drain Valve Open
K0004 (K0553) LOX Fill and Drain Valve Closed
K0018 (K0547) LOX Fill and Drain Valve Open

### 13.1.6 APS Electrical Control System

The APS Simulator No. 188C was activated for verification of the APS No. 1 and No. 2 engine control functions.

Engine feed valve data verified that the electrical control system performed within prescribed limitations. The monitored results are listed in the following table:

| MEASUREMENT NO. | FUNCTION | SPECIFIED MINIMUM VALUE (vdc) | ACTUAL VALUE (vdc) |
|---|---|---|---|
| K0132 | APS Eng 1-1/1-3 Feed Valves Open | 3.2 | 4.25 |
| K0133 | APS Eng 1-2 Feed Valves Open | 3.2 | 4.35 |
| K0134 | APS Eng 2-1/2-3 Feed Valves Open | 3.2 | 4.25 |
| K0135 | APS Eng 2-2 Feed Valves Open | 3.2 | 4.25 |

The specified minimum value of 3.2 vdc indicates that all of the feed valves were open.

## 13.2 Electrical Power System

The electrical power system consisted of battery simulators, the LH2 and LOX chilldown inverters, the inverter-converter, and the forward and aft 5-V excitation modules.

### 13.2.1 Battery Simulators

The battery simulators operated satisfactorily during the acceptance firing. The heater circuits and the telemetry voltage, temperature, and current outputs indicated the proper levels. The GSE ground power supplies provided power through the simulators to the buses. The load profiles and simulator temperatures are presented in figures 13-1 through 13-4.

### 13.2.2 Chilldown Inverters

The chilldown inverters performed satisfactorily. The output voltages were within the limits of 49 to 60 V. The LH2 inverter had one output (A-1 to B-1 phase) which indicated high (58.5 V), which was approximately 4.5 V higher than all the other outputs on both the LH2 and the LOX inverters. The cause of this problem has been established as a misadjustment of the A-1 to B-1 phase of the LH2 inverter T/M module.

### 13.2.3 5-V Excitation Modules

The 5-V excitation modules operated within limits. The forward 5-V module

output voltage was 5.0 V; the acceptable limit is 5 ±0.05 V. The output frequency was 2,060 cps; the acceptable tolerance is 2,000 ±200 cps. The aft 5-V module output voltage was 4.98 V, and the output frequency was 2,060 cps.

### 13.2.4 Static Inverter-Converter

The performance of the static inverter-converter was reviewed and found to be within limits. The output voltage remained at 114.5 V; the acceptable limits are 115 ±5 V. The 5-V output remained constant at 5.2 V; the acceptable limit is 5 ±0.5 V. The 21-V output was constant at 21.8 V; the acceptable limit is 21 ±1 V. The output frequence was 402 cps; the acceptable limit is 400 ±6 cps.

## 13.3 Electromagnetic Compatibility

Refer to paragraph 12.2.8.

TABLE 13-1
RANGE SAFETY SYSTEM SEQUENCE DATA

| MEASUREMENT NO. | FUNCTION | TIME FROM $T_o$ (sec) |
|---|---|---|
| | Range Safety Arm & Cutoff Command On | 534.8 |
| N0058-411 | Range Safety #1 Decoder Output Ind | 534.9 |
| K0098-411 | Range Safety #1 Arm & Cutoff Ind On | 535.2 |
| N0059-411 | Range Safety #2 Decoder Output Ind | 534.9 |
| K0099-411 | Range Safety #2 Arm & Cutoff Ind On | 535.2 |
| M0030-411 | Range Safety EBW #1 Charged (4.3 vdc) | 536.0 |
| M0031-411 | Range Safety EBW #2 Charged (4.3 vdc) | 536.0 |
| | Range Safety Destruct Command On | 539.8 |
| N0058-411 | Range Safety #1 Decoder Output Ind | 539.9 |
| K0098-411 | Range Safety #1 Destruct Ind On | 540.2 |
| N0059-411 | Range Safety #2 Decoder Output Ind | 539.9 |
| K0099-411 | Range Safety #2 Destruct Ind On | 540.2 |
| M0030-411 | Range Safety EBW #1 Fired (1.5 vdc) | 540.3 |
| K0141-411 | Range Safety EBW #1 Pulse Sensor Ind | 540.5 |
| M0031-411 | Range Safety EBW #2 Fired (1.5 vdc) | 540.3 |
| K0141-411 | Range Safety EBW #2 Pulse Sensor Ind | 540.5 |
| | Range Safety Safe Command On | 545.0 |
| N0058-411 | Range Safety #1 Decoder Output Ind | 545.0 |
| K0098-411 | Range Safety #1 Destruct Ind Dropout | 545.3 |
| N0059-411 | Range Safety #2 Decoder Output Ind | 545.0 |
| K0099-411 | Range Safety #2 Destruct Ind Dropout | 545.3 |
| N0057-411 | Range Safety #1 Signal Strength Dropout | 545.0 |
| N0056-411 | Range Safety #2 Signal Strength Dropout | 545.0 |

SIGNAL STRENGTH DATA

| MEASUREMENT NO. | FUNCTION | NOMINAL VALUE | MAXIMUM VALUE | MINIMUM VALUE |
|---|---|---|---|---|
| N0057-411 | Range Safety #1 Low Level Signal Strength | 3.60 vdc | 3.70 vdc | 3.60 vdc |
| N0056-411 | Range Safety #2 High Level | 1.50 vdc | 2.50 vdc | 1.00 vdc |
| N0065-411 | Low Level Signal Strength | 4.00 vdc | 4.00 vdc | 3.80 vdc |

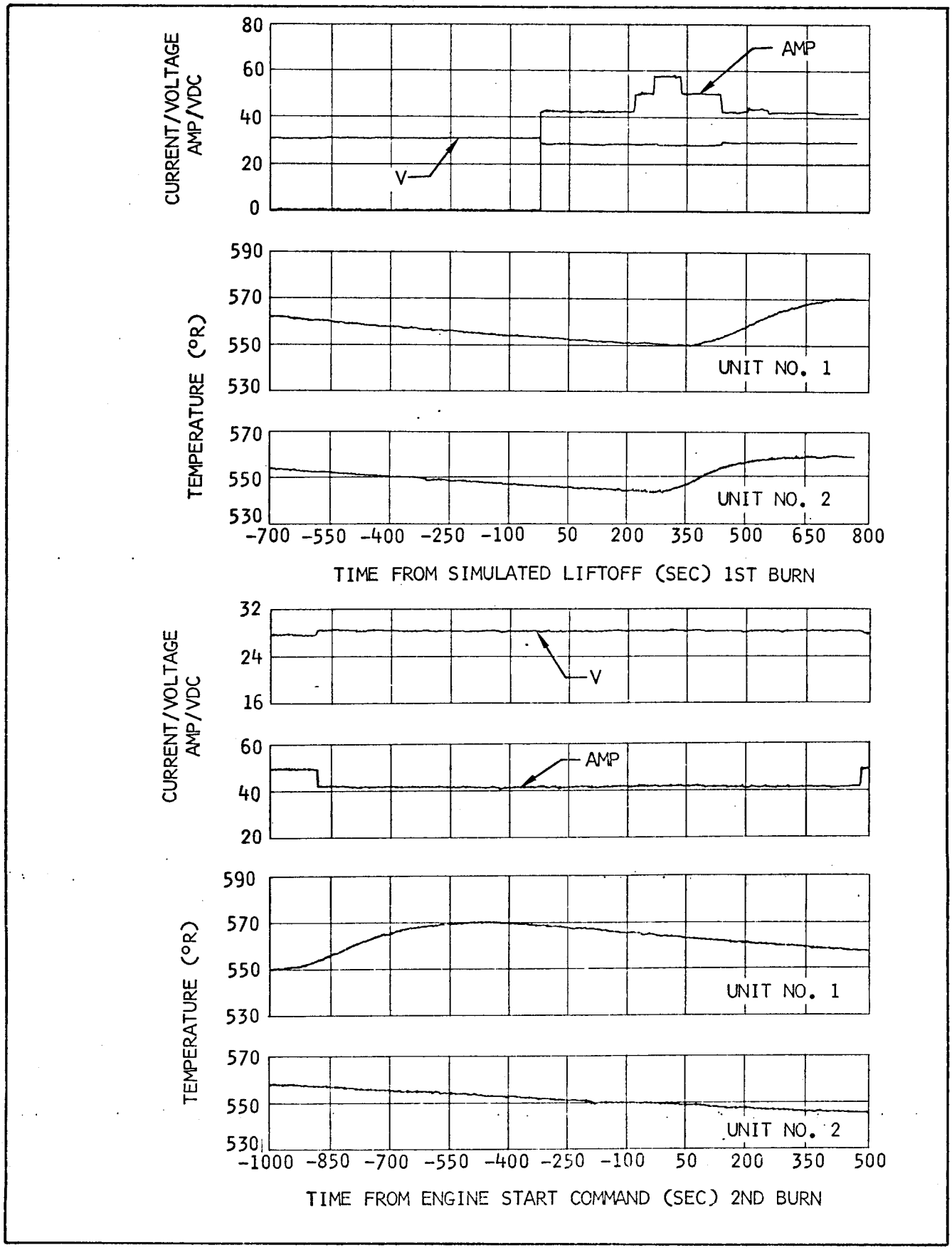


Figure 13-1. Forward Battery No. 1 History

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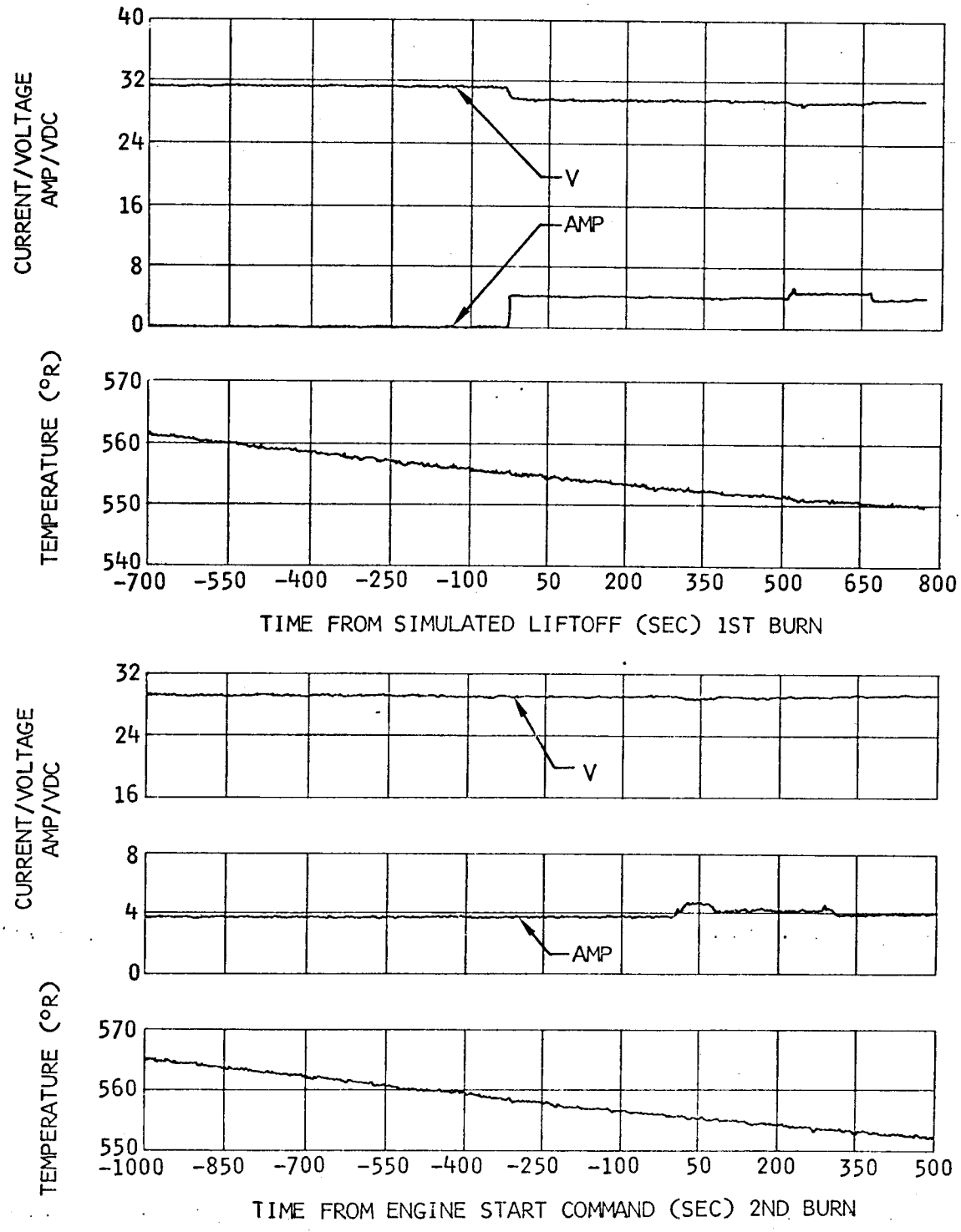


Figure 13-2. Forward Battery No. 2 History

28 September 1966

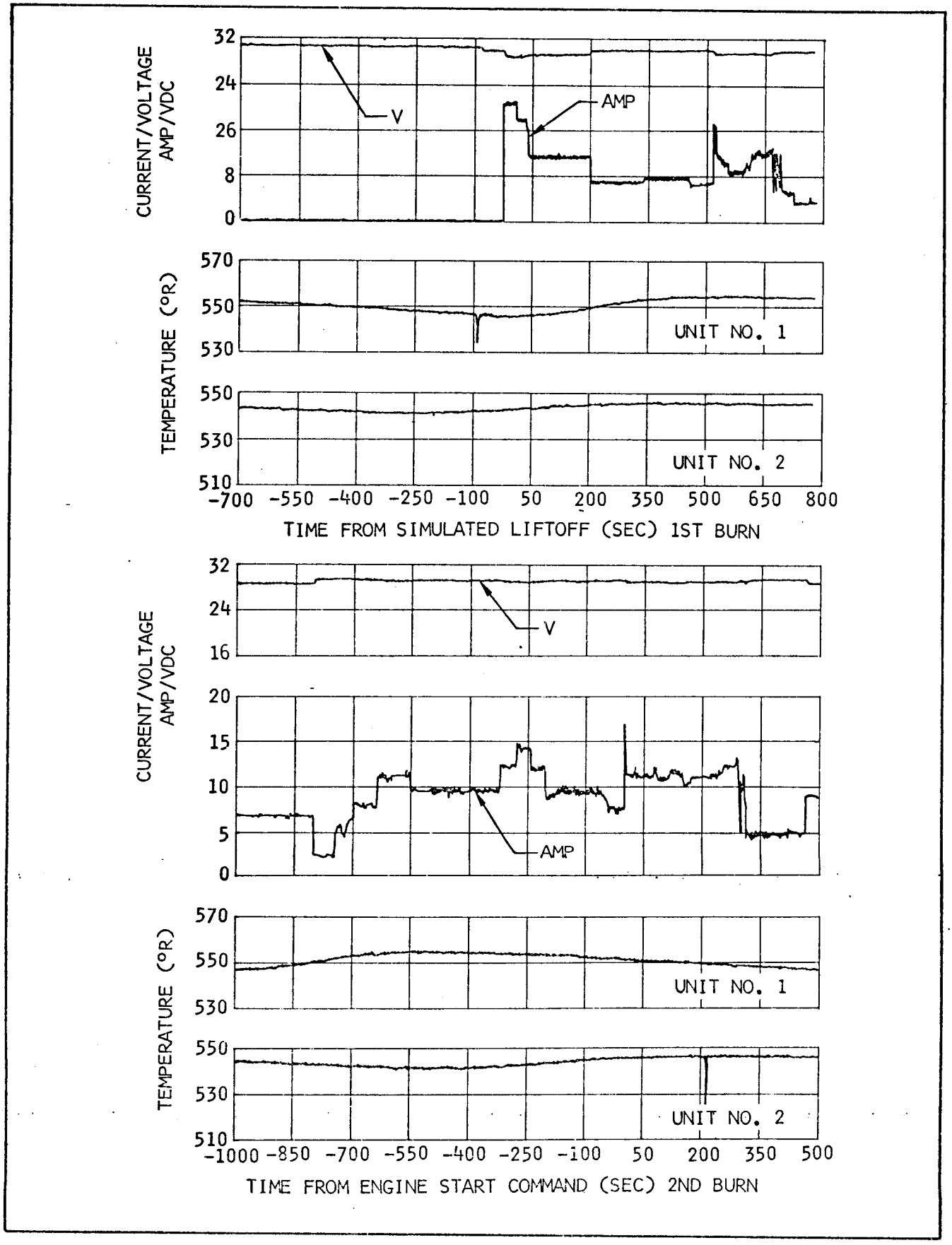


Figure 13-3. Aft Battery No. 1 History

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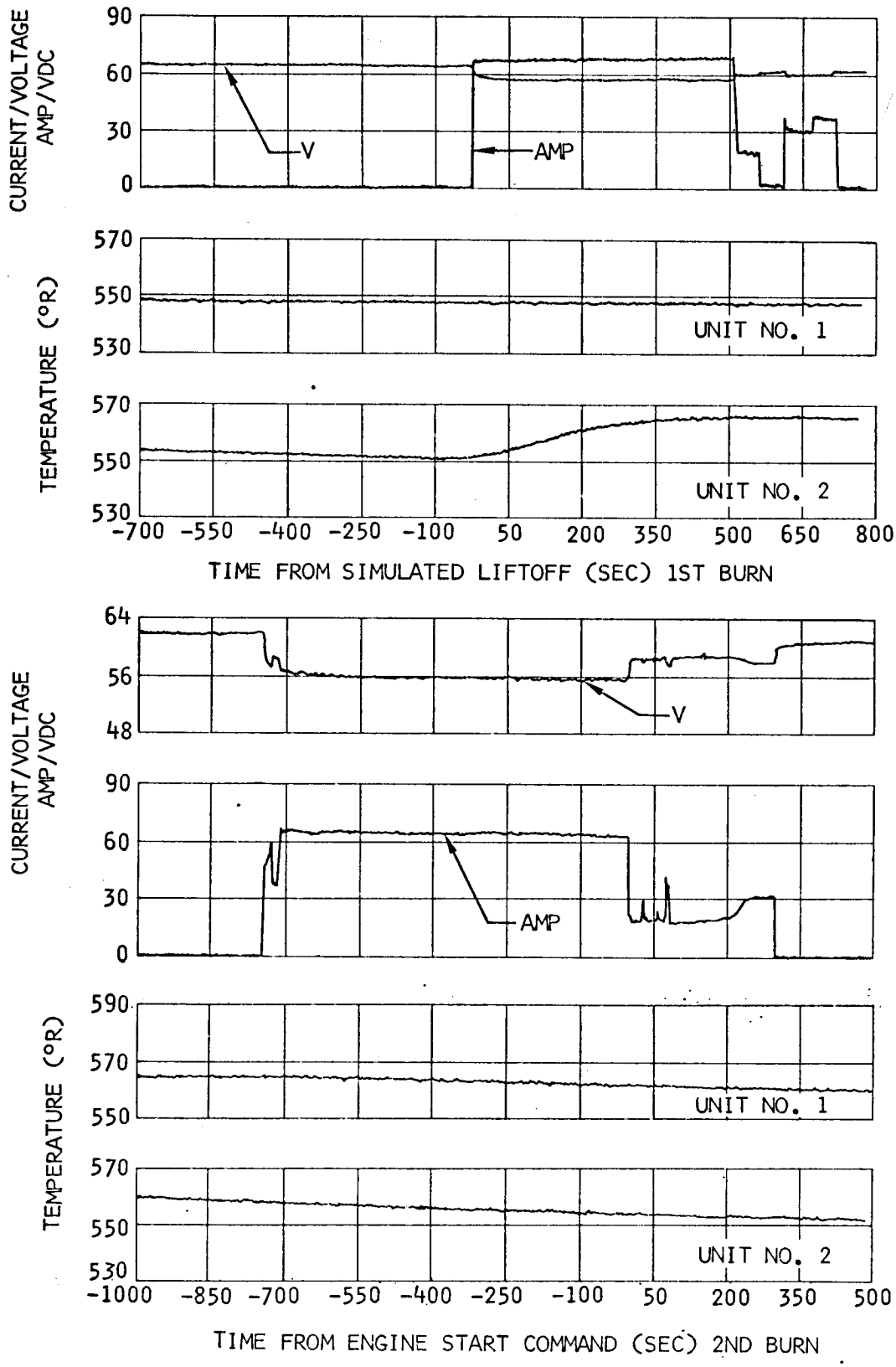


Figure 13-4. Aft Battery No. 2 History

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# 14. HYDRAULIC SYSTEM

## 14.1 Hydraulic System Operation

The hydraulic system test program was successfully completed during CD 634199. The countdown consisted of a 153-sec 1st burn, a simulated orbital coast period during which the auxiliary pump was off for 77 min, 19 sec, and a 2nd burn of 295 sec. The engine restrainer links were dropped and a gimbal program run during the 2nd burn. Test plan objectives were satisfied and all system variables operated within design limits. Significant event times are shown in the following table (times are approximate but of adequate accuracy for hydraulic system evaluation):

| EVENT | TIME (sec) | |
|---|---|---|
| | $T_o$ | $T_2$ |
| Auxiliary Pump ON | -606 | |
| Engine Start/Engine-Driven Pump START | 512 | |
| Engine Cutoff/Engine-Driven Pump STOP | 665 | |
| Auxiliary Pump OFF | 721 | |
| Auxiliary Pump ON | 5,360 | -752 |
| Engine Start/Engine-Driven Pump START | 6,112 | 0 |
| Engine Support Links DROPPED | | 26 |
| Gimbal Program START | | 28 |
| Gimbal Program STOP | | 83 |
| Engine Cutoff/Engine-Driven Pump STOP | | 295 |
| Auxiliary Pump OFF | | 300 |

$T_o$ = Time from simulated liftoff (14:11:13.000 range time)

$T_2$ = Time from restart engine ignition (15:53:05.212 range time)

## 14.2 System Pressure at Salient Times

The GN2 precharge of the accumulator was 2,233 psia at 52 deg F, corresponding to a corrected value of 2,315 psia at 70 deg F. The auxiliary pump compensator regulated to 3,620 psia (system leakage flow) and the engine-driven pump was slightly higher, at 3,640 psia. Overshoot during the engine 1st burn was 3,690 psia, and 3,720 psia during engine 2nd burn. GN2 pressure data duplicated all trends in the system pressure data, and though lower, were within the allowable data acquisition accuracy. The accumulator piston did not bottom in the oil-filled direction.

Reservoir pressure was 77 psia prior to the 1st burn auxiliary pump "ON" and 78 psia prior to 2nd burn auxiliary pump "ON."

Significant pressures at salient times are shown in the following table:

| TIME (sec) | SYSTEM PRESSURE (psia) | RESERVOIR PRESSURE (psia) |
|---|---|---|
| $T_o$ -606 | 3,620 | 164 to 175 |
| $T_o$ +512 | 3,640 | 176 |
| $T_o$ +721 | 3,620 | 176 |
| $T_2$ -752 | 3,615 | 172 |
| $T_2$ +0 | 3,630 | 176 |
| $T_2$ +28 to 83 | 3,670 to 3,580 | 176 to 174 |
| $T_2$ +300 | 3,630 | 176 |

## 14.3 Reservoir Level at Salient Times

Reservoir level (prior to 2nd burn) was 93.5 percent at an approximate average system temperature of 75 deg F, equivalent to 92.5 percent at 68 deg F. Minimum level during the 1st burn system operation was 31.5 percent and during the 2nd burn system operation was 38 percent. Following auxiliary pump "OFF," the level was 99.5 percent after 1st burn operation and 100 percent

after 2nd burn operation; fluid thermal expansion was insufficient to vent overboard. Significant reservoir levels at salient times are shown in the following table:

| TIME (sec) | RESERVOIR LEVEL (%) |
|---|---|
| $T_o$ -606 | 90.5 to 31.7 |
| $T_o$ +512 | 35 to 34.3 |
| $T_o$ +721 | 35.7 to 99.5 |
| $T_2$ -752 | 93.5 to 37 |
| $T_2$ +300 | 42.5 to 100 |

## 14.4 Hydraulic Fluid Temperature

The following table is a history of hydraulic fluid temperatures:

| TIME (sec) | ENGINE-DRIVEN PUMP INLET (°F) | RESERVOIR (°F) | PITCH ACTUATOR (°F) | YAW ACTUATOR (°F) |
|---|---|---|---|---|
| $T_o$ -606 | 81 to 47 | 39 | 63 | 71 |
| $T_o$ +0 | 97 | 76 | - | - |
| $T_o$ +512 | 114 | 95 | 72 | 78 |
| $T_o$ +721 | 122 | 99 | 70 | 80 |
| $T_2$ -752 | 106 to 75 | 78 | 68 | 78 |
| $T_2$ +0 | 112 | 101 | 72 | 84 |
| $T_2$ +28 to 83 | 116 min<br>124 max | 101 to 105 | 124 max | 101 max |
| $T_2$ +300 | 130 to 157 | 110 | 86 | 90 |

Accumulator GN2 temperature was a constant 60 deg F during the 1st burn system operation, and a constant 71 deg F during the 2nd burn system operation.

## 14.5 Engine Sideloads

Peak loads in the support links during both engine starts were corrected for prestart bias and are shown in the following table:

| EVENT | PITCH LINK (lbf) | YAW LINK (lbf) |
|---|---|---|
| 1st Start Transients | +9,000<br>-10,000 | +14,000<br>-23,000 |
| 2nd Start Transients | +9,000<br>-14,000 | +15,000<br>-22,000 |

## 14.6 Hydraulic Fluid Flowrates

The following fluid flowrates were averaged from reservoir fill and empty rates during system operation:

| ITEM | FLOW (gpm) | ALLOWABLE (gpm) |
|---|---|---|
| System Internal Leakage | 0.73 | 0.40 to 0.80 |
| Auxiliary Pump Flowrate | 1.85 | 1.50 min |

# 15. FLIGHT CONTROL SYSTEM

The following dynamic response characteristics of the J-2 engine gimbaling system were obtained during the acceptance firing of the S-IVB-502 stage. In each category, the system met the response requirements defined by the test objectives.

## 15.1 Thrust Vector Control System Response

The gain and phase lag response of the pitch and yaw actuators to a 0.5 deg sinusoidal command is shown in figures 15-1 and 15-2. The acceptance firing limits are also shown, as noted the gain and phase response data fall within the limits.

The actuator differential pressure frequency response to a 0.5 deg sinusoidal command is shown in figure 15-3. The frequency response predicted using a mathematical model of the system is also shown. Close agreement is seen between the predicted response and the test response.

The frequency response of the control system at 1.0 cps for both the 0.5 and 0.25 deg command is presented in the following table:

| Sinusoidal Command (deg) | Command Frequency (cps) | Phase Lag (deg) | Gain (db) |
|---|---|---|---|
| 0.25 - pitch | 0.97 | -25 | +0.4 |
| 0.50 - pitch | 0.98 | -25 | +0.83 |
| 0.25 - yaw | 1.00 | -25 | -0.4 |
| 0.50 - yaw | 0.962 | -30 | -0.45 |

## 15.2 Actuator Slew Rate

The actuator slew rate was obtained from the actuator piston position response to a 2 deg step command. A typical actuator transient response is shown in figure 15-4. A tabulation of the slew rates for both the pitch and yaw step commands is shown in the following table:

| Actuator Command | Pitch Plane | | Yaw Plane | |
|---|---|---|---|---|
| | Actuator (in/sec) | Engine (deg/sec) | Actuator (in/sec) | Engine (deg/sec) |
| Extend 0 to 2.0 deg | 2.75 | 13.3 | 2.4 | 11.6 |
| Retract 2.0 to 0 deg | 2.36 | 11.4 | 2.39 | 11.56 |
| Retract 0 to 2.0 deg | 2.3 | 11.1 | 2.3 | 11.1 |
| Extend 2.0 to 0 deg | 2.3 | 11.1 | 2.24 | 10.8 |

The minimum actuator piston rate was 2.24 in./sec, corresponding to an engine slew rate of 10.8 deg/sec (using the conversion factor of 4.83 deg of engine deflection per in. of actuator piston deflection). Thus, in all cases, the gimbal rates exceeded the minimum acceptable rate of 8.0 deg/sec of engine rate or 1.66 in/sec of actuator piston rate.

## 15.3 Cross-Axis Coupling

Cross-axis coupling is obtained from actuator piston differential pressure data. The cross-axis coupling from the yaw to pitch plane and from the pitch to yaw plane did not exceed 15 percent.

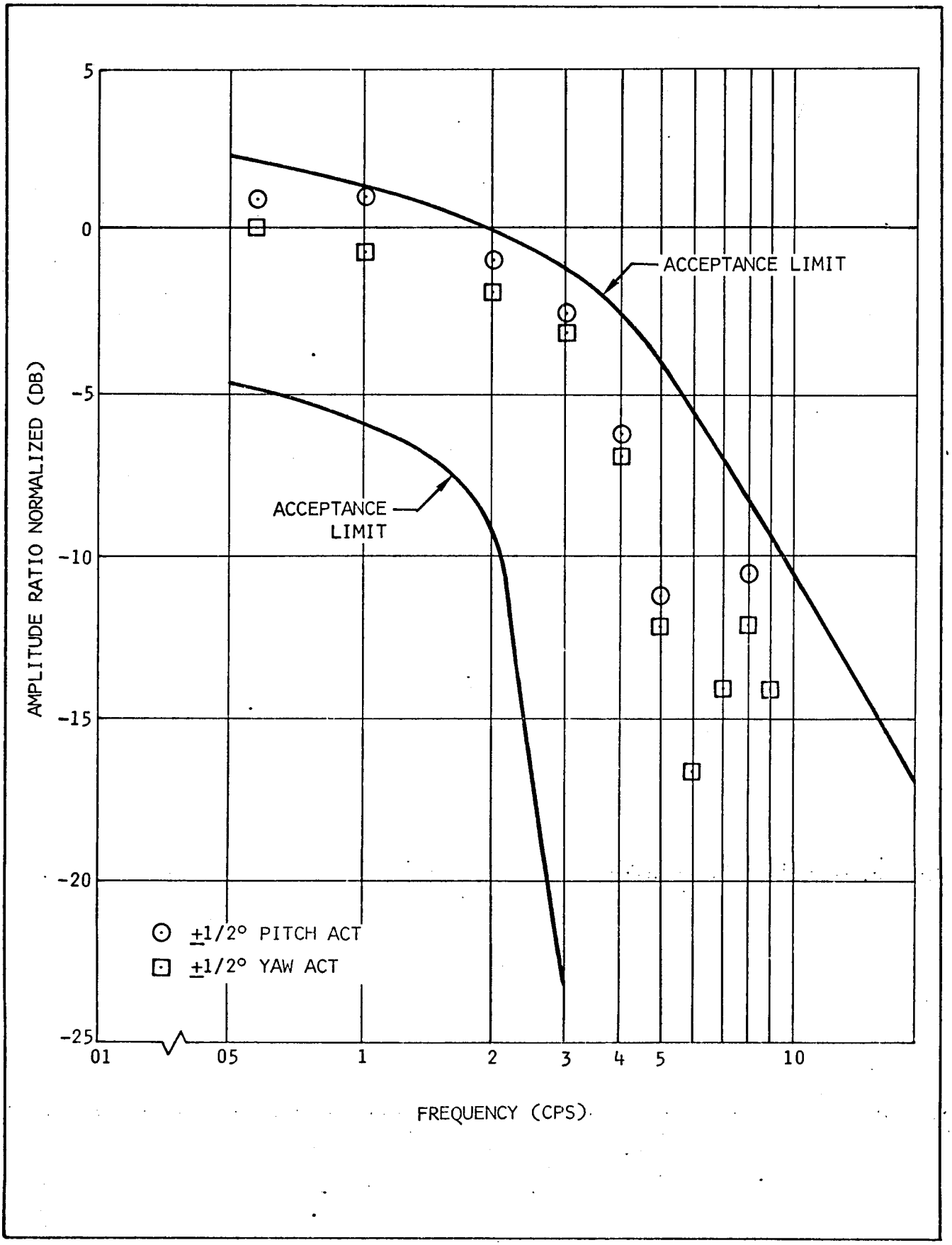


Figure 15-1. Actuator Frequency Response (Gain)

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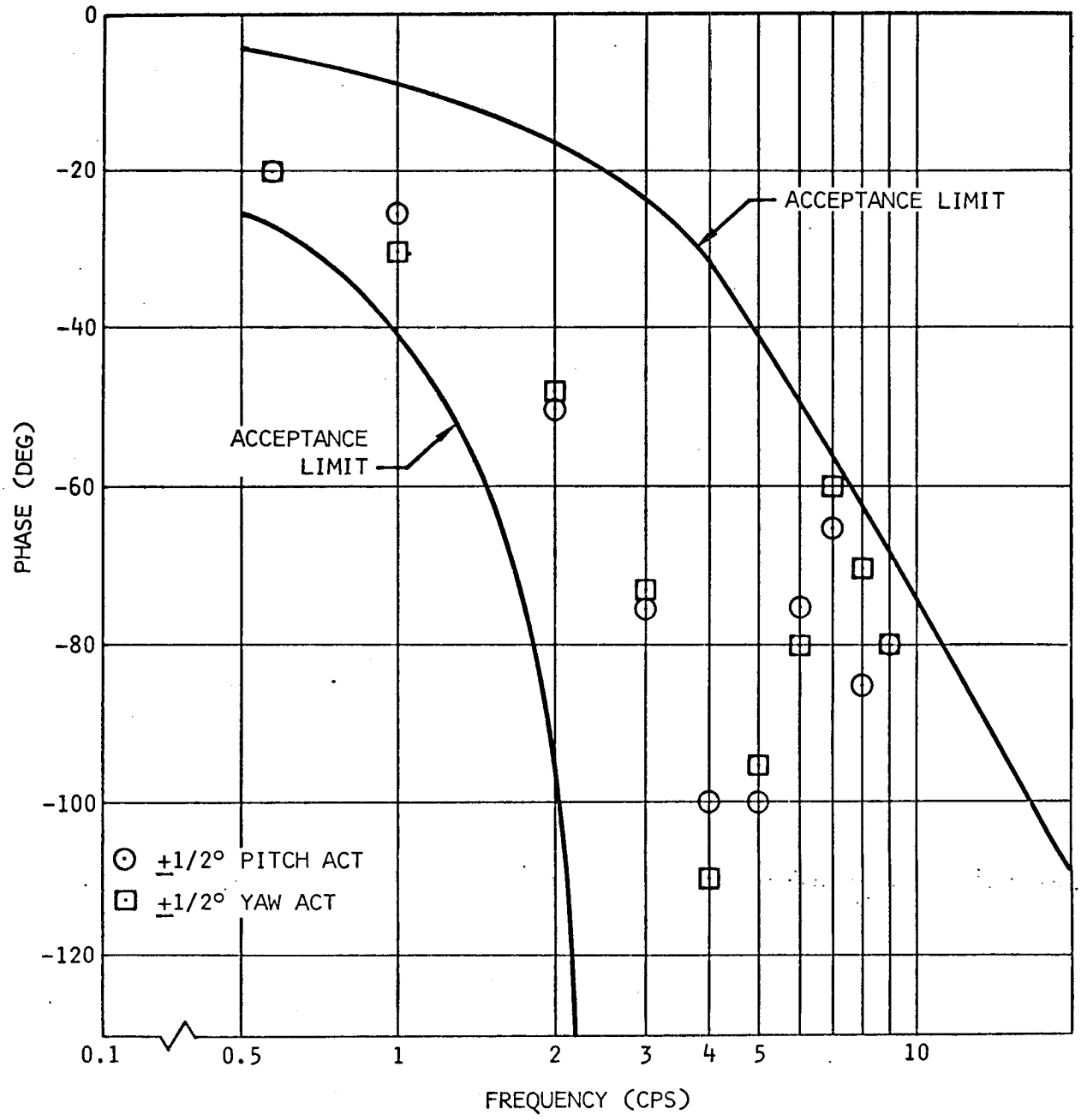


Figure 15-2. Actuator Frequency Response (Phase Lag)

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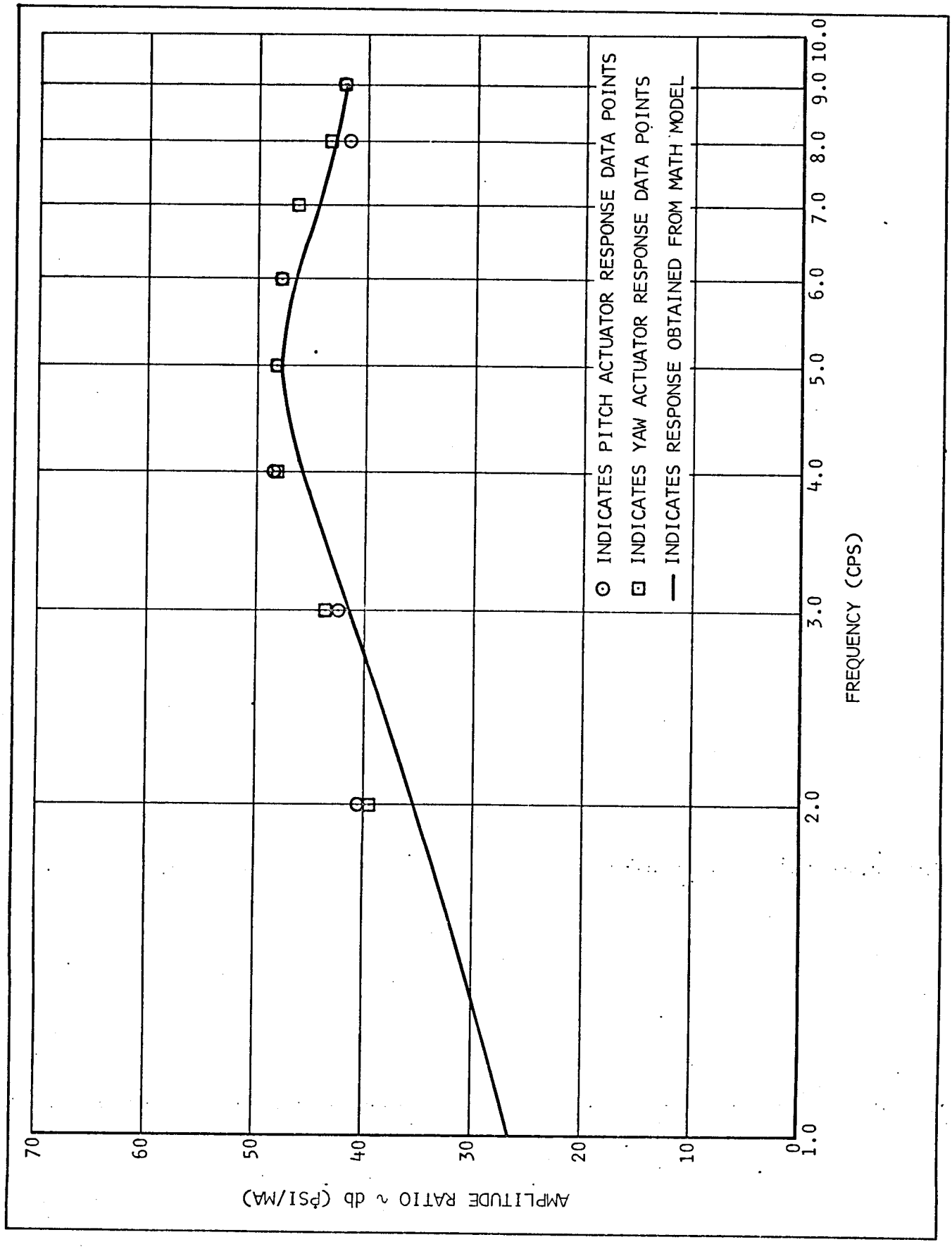


Figure 15-3. Actuator Differential Pressure Frequency Response

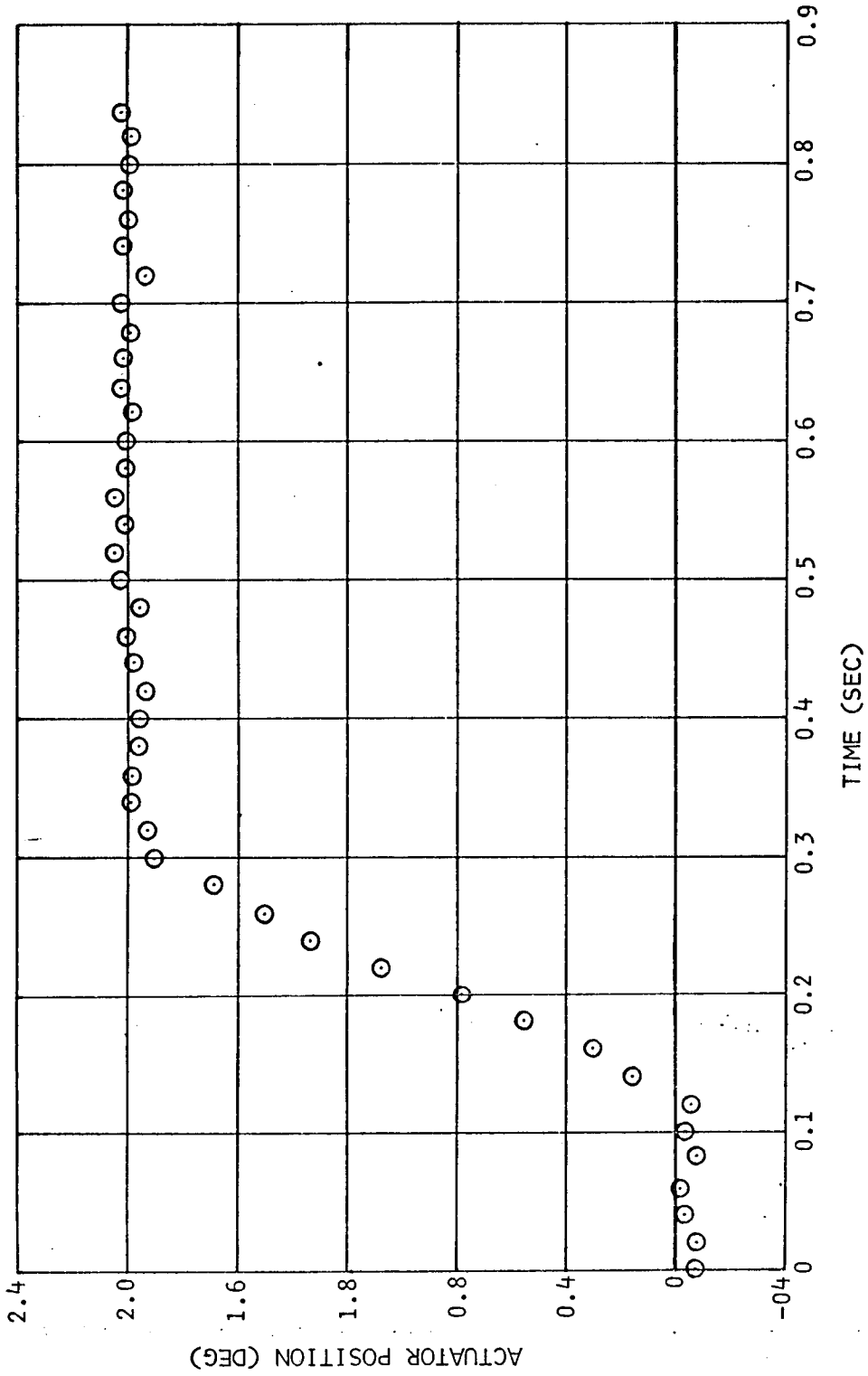


Figure 15-4. Yaw Actuator Response

# 16. STRUCTURAL SYSTEMS

Structural integrity of the S-IVB-502 stage was maintained for the vibration, temperature, and thrust load conditions of the acceptance firing. Minor structural deformations and debonding occurred, but these discrepancies have been corrected or disposed of as discussed in the following paragraphs.

## 16.1 Common Bulkhead

A post-acceptance firing visual inspection of the common bulkhead disclosed no abnormalities on the forward face. A dye check of the forward face weld seams revealed no cracks, porosity, or other defects. The gas samples taken from the interior of the common bulkhead indicated approximately six percent of the gas contents was helium, whereas the normal content of helium is usually less than one percent; however, this relatively high percentage of helium was approximately constant from the time prior to propellant loading until completion of postfire securing. This stabilized condition indicates the helium was introduced into the bulkhead prior to the first sampling and not as a result of leakage from the tanks during this period. These results, combined with satisfactory common bulkhead pressure decay checks and total gas sample surveys, indicate the dome portion of the bulkhead is sound. The results of the pressure checks and gas surveys are presented in DAC Report SM-37539, S-IVB-502 Stage Acceptance Firing 15 Day Report, dated August 1966.

## 16.2 LH2 Tank Liner

A visual inspection of the LH2 tank interior during postfiring checkout revealed no voids under the fiberglas cloth liner, such as were found in the S-IVB-205 and S-IVB-501 stages. A forty-inch long hairline crack, and two approximately one-inch long cracks were found in the liner. The cracks were repaired by bonding strips of glass cloth over the damaged areas, and then coating with resin.

## 16.3 Exterior Structure

A visual exterior inspection of the stage thrust structure, LOX Tank aft dome, aft skirt, LH2 tank cylindrical section, LH2 tank forward dome, and forward skirt revealed no structural damage after the 1st burn, simulated orbital coast, and 2nd burn, with the exception of partial debonding of supports. Ten Nylafil posts and one tunnel strap were found partially

debonded in the main tunnel, and one Nylafil post, each, was found partially debonded in the auxiliary tunnel and on the aft dome. The main tunnel strap had only one finger debonded with the remaining portion of the strap holding well. These supports were removed and rebonded after cleaning and priming the metal surfaces.

## 16.4 Thermal Protective Coating

A visual inspection revealed cracking and peeling of the Korotherm ablative coating on the forward skirt skin along each side of the main and auxiliary tunnels. This sprayed-on coating is used to control aerodynamic heating of the skin, external stringers, and underlying intercostals. All Korotherm was removed from the areas surrounding the tunnels. The adhesive surface was prepared using an epoxy base primer which has proven to be superior to the previously used wash primer. New Korotherm was applied and a silicone external coat was then added over the Korotherm to protect against moisture absorption.

## 16.5 Aft Purge Duct Seal

After acceptance firing, partial debonding of the glass cloth purge duct seal from the LOX tank dome was detected. The cloth was rebonded to the dome after proper metal surface preparation. A new seal design, which should eliminate this recurring problem, is scheduled to be phased in with the S-IVB-503 and S-IVB-207 stages.

## 16.6 Strain Gage Instrumentation

Strain gage readings recorded during the acceptance firing indicate incorrect polarity for aft skirt gage installations. Since no load change occurred in the forward skirt, the responses of the forward skirt strain gages could not be evaluated. A detailed checkout of all strain gage systems is planned, and polarities will be corrected as required.

# 17. THERMOCONDITIONING AND PURGE SYSTEM

## 17.1 Aft Skirt Thermoconditioning and Purge Systems

The aft skirt air purge was initiated prior to LOX loading, switched to GN2 prior to LH2 loading and maintained throughout the 1st burn, orbital coast, 2nd burn, and until completion of final tank purges. The system performed satisfactorily throughout the acceptance firing; however, a postfiring inspection revealed that the purge system main manifold membrane had become debonded from the LOX dome. The membrane will be rebonded. A new main manifold design which eliminates the LOX dome attachment has been incorporated on S-IVB-503 and subs and S-IVB-207 and subs.

### 17.1.1 Aft Skirt GN2 Flowrate

The GN2 flowrate was maintained between 3,400 and 3,550 scfm.

### 17.1.2 Aft Skirt GN2 Temperatures

The aft skirt umbilical inlet temperature (C0700) remained constant at 102 deg F throughout the acceptance firing. GN2 temperature at the auxiliary propulsion system (APS) module thermoconditioning system outlet sensors (C0663) was essentially constant at 90 deg F. Design temperature at the outlet sensors is 87 $\pm$5 deg F.

### 17.1.3 Aft Skirt Umbilical Inlet Pressure

The umbilical inlet pressure (D0767) was approximately 12.0 in. $H_2O$.

### 17.1.4 Non-Flight Hardware

a. APS Modules:

The flight modules were replaced with two APS simulators (P/N 1B70970). These replacements functionally represent the flight module thermoconditioning system.

b. Aft Interstage:

The Model DSV-4B-540 dummy interstage was used to support the stage on the test stand. Use of the dummy interstage lowers the aft

skirt purge system internal pressure very slightly, but does not materially affect the overall system purge capabilities.

## 17.2 Forward Skirt Environmental Control and Thermoconditioning System

The forward skirt GN2 purge was initiated prior to LOX loading and maintained throughout the acceptance firing until completion of final tank purges. The Model DSV-4B-359 thermoconditioning system servicer circulated thermally conditioned fluid through the 16 cold plates.

### 17.2.1 Forward Skirt GN2 Flowrate

The GN2 flowrate was maintained at design conditions of 500-600 scfm.

### 17.2.2 Forward Skirt GN2 Temperature

The forward skirt GN2 internal temperature (C0768) remained between 70 and 78 deg F.

### 17.2.3 Forward Skirt Internal Pressure

The forward skirt internal pressure (D0868) was essentially constant at 0.85 in. $H_2O$. The forward skirt relief valve setting is 2.0 in. $H_2O$.

### 17.2.4 Forward Skirt Thermoconditioning System Temperature

The thermoconditioning system fluid inlet temperatures (C0753) cycled in a normal manner between 50 and 55 deg F.

### 17.2.5 Non-Flight Hardware

Model DSV-4B-359 Thermoconditioning System Servicer:

The servicer supplies thermally conditioned fluid to the forward skirt cold plates during all field station operations requiring power to the forward skirt electronic equipment. When staged, the cold plates will receive fluid from the NASA Instrumentation Unit thermoconditioning system.

# 18. ACOUSTIC AND VIBRATION ENVIRONMENT

There were a total of 52 vibration, 14 acoustical, and 2 static pressure measurements planned for the acceptance firing. Four vibration and three acoustical measurements were deleted prior to the firing due to problems in the measurement system. Of the remaining 61 active measurements, two vibration measurements and one acoustical measurement provided no usable data due to instrumentation malfunctions.

In general, the stage dynamic environment was very similar to the S-IVB-501 stage acceptance firing.

## 18.1 Data Acquisition

Thirty-seven vibration, 12 acoustical, and 2 static pressure measurements were acquired via the stage telemetry system which included SSB/FM, FM/FM, and PAM/FM links. The ground instrumentation system (hardwire) was used to obtain an additional 15 vibration and 2 acoustical measurements. A list of the measurements is presented in table 18-1 and the transducer locations are shown in figure 18-1. Included in the table are composite levels measured during start transient and mainstage of 1st and 2nd burns. For comparison purposes, the mainstage levels from past acceptance firings for similarly located measurements are also presented.

The composite signal on magnetic tape was initially stripped out on oscillograms from which the data were qualified and sample time intervals were selected for spectrum analysis. The spectrum analyses are in the form of power spectral density (PSD) for the vibration data and one-third octave band for the acoustic data. Due to the inherent characteristics of the SSB/FM system, it should be noted that the data levels are attenuated below 150 cps and no valid data are obtained below 50 cps. The spectrum plots from the SSB/FM measurements were not corrected for the attenuation because no amplitude correction data are now available.

## 18.2 Vibration Measurements

The vibration measurements were grouped into engine, basic structure, and component measurements. In most cases, the measurements were categorized

into a specific zone of the S-IVB stage and the data were compared to the appropriate random test levels specified in Design Memo 110A, dated 3 August 1964. Also included in the figures are PSDs from past acceptance firings for comparison purposes. Since the vibration environments were similar during 1st and 2nd burns, only PSDs from the 2nd burn mainstage are shown. Because of the short duration of the start transients (approximately 2 sec), these data were ommitted.

### 18.2.1 Engine Measurements

Three measurements were made on the combustion chamber dome. Measurements E0706 and E0707, obtained via hardwire (H/W), were installed to monitor for rough combustion during acceptance firing; measurement E0209, obtained via the stage telemetry (T/M) system, provided data during both acceptance firing and flight.

Vibration measurements on the engine propellant pumps consisted of one T/M and one H/W measurement on each pump. These measurements were made to provide a means of assessing the turbopump operation in the event of a suspected turbopump malfunction. Data from the hardwire measurement on the LH2 turbopump (E0556) were not usable during the first 19 sec of each burn due to dc shifts; however, the remaining portions were usable and of much better quality than obtained on the three preceeding acceptance firings (S-IVB stages -204, -205, and -501).

Three measurements were located on the engine gimbal block and oriented in the thrust, pitch and yaw directions. The measurements in the thrust (E0090) and pitch (E0213) directions produced good data; however, no data were obtained from the yaw direction measurement (E0212) due to an instrumentation malfunction.

Plots of the data from the engine measurements are shown in figure 18-2 with corresponding data from S-IVB-501 stage acceptance firing and specification test levels where available. The high vibration level indicated by the SSB measurement (E0211) on the LOX turbopump may be due to accelerometer mounting block amplification. This is indicated by the fact that measurement E0555, also on the LOX pump, but attached without a mounting block, indicated considerably lower levels.

### 18.2.2 Basic Structure Measurements

Basic structure measurements included seven on the forward skirt, two on the thrust structure, and two on the aft skirt.

The measurements on the forward skirt were located on the field splice; four at position I and three at position II. Both locations were monitored in the thrust, pitch and yaw directions, and in addition, the thrust measurement system at position I had a dual output capability. The dual output system, which was to provide both a low and a high frequency range output, was found inoperative prior to the firing and the two measurements were therefore deleted. PSDs of the data obtained from the valid measurements are compared with specification test levels and S-IVB-501 stage acceptance firing levels in figure 18-3. The comparisons show that the measured levels were less than specification test levels at all frequencies, and in general, the spectra from both acceptance firings were the same.

Data obtained from measurements on the thrust structure, stringer 19 (E0611 and E0612), are also shown in figure 18-3. These data are contrasted with data from S-IVB-202 stage acceptance firing where the accelerometers were not mounted on the stringer but were erroneously located on the thrust structure skin adjacent to the stringer. It can be seen that changing the accelerometer location from the skin to a stringer, lowers the measured levels below the specification test level which was not intended to encompass skin vibration levels.

One aft skirt structure measurement was obtained in the thrust direction near position II at station 2748 (E0092). This station number corresponds to the S-IVB aft interstage/aft skirt explosive separation cutting plane. A second aft skirt structure measurement was made on stringer 10 at station 2766 (E0607, radial). This is in the vicinity of the aft skirt battery. Results of these measurements, presented in figure 18-3, indicate that the acceptance firing levels are considerably less than test specifications.

### 18.2.3 Thrust Structure Components

Accelerometers were located on the thrust structure near the attach points of the ambient helium sphere, the LH2 feedline, and the auxiliary hydraulic pump. In addition, one accelerometer was mounted on the oxidizer ullage pressure tray to measure vibration input to the oxidizer ullage pressure transducer. The data measured at these locations are presented in figure 18-4 and compared to test specifications, where available. These data indicate that the specification test levels were exceeded at the higher frequencies on both the ambient helium sphere and the LH2 feedline; however, it is believed that the higher frequencies are not critical since the significant dynamic response of these components occurs at low frequencies. Also, there were no vibration related problems reported.

Plots of the measured vibration levels near the auxiliary hydraulic pump on both the S-IVB-202 stage and the S-IVB-502 stage acceptance firings are compared to the pump vibration specification. The accelerometers were located on the thrust structure skin on the S-IVB-202 stage, and on a stiffener on the S-IVB-502 stage. The levels measured on the stiffener are considerably lower than the test specification levels. The S-IVB-202 levels, which were erroneously located on the skin, are not indicative of the pump input and are not directly applicable for comparison with the specification.

### 18.2.4 Aft Skirt Components

Accelerometers were located to measure the vibration environment of the sequence and switch selector panels, APS module attach point, and umbilical plate. Vibration levels at these components are shown in figure 18-5, with available S-IVB-501 stage acceptance firing and specification test levels for comparison.

Two accelerometers (input) were located on the intercostal to which the vibration isolated sequencer panel is mounted and one (response) was located on the panel. The vibration input to the panel exceeded specification at 700 and 1,200 cps, but measured response on the panel was well below the specification at all frequencies.

Input and response vibration was also obtained on the switch selector panel. The input levels exceeded specification, but response levels were lower than specification. These results indicate that the panel vibration isolators are effectively attenuating the high levels.

PSDs of the thrust direction data from both the sequencer and switch selector panels (E0103 and E0106) did not compare well with those obtained from S-IVB-501 stage acceptance firing. The same measurements will be repeated on the S-IVB-503 stage acceptance firing at which time inconsistency may be resolved.

The accelerometers at the APS module were located at the forward and aft attach points on the aft skirt structure. One measurement (E0120) was deleted prior to the firing due to a measurement system failure. The two remaining active measurements showed the vibration levels were considerably lower than specifications.

Measurements were made in the thrust and radial directions on the aft umbilical plate near the LH2 duct. PSDs of the data, shown in figure 18-5, are composed primarily of low frequency energy. The measured levels were well below specification test levels.

### 18.2.5 LH2 Tank and Forward Skirt Components

Three radial direction measurements were located on the LH2 tank cylinder. Measurement E0532 was located at the base of a cold He sphere and E0589 and E0062 were near the PU probe support structure approximately 6-in. apart. The 6-in. difference in location may account for the fact that the PSDs, shown in figure 18-6, indicate higher levels for E0589 (H/W) above 350 cps. The vibration levels measured at these locations were less than specification test levels.

Thrust and radial input vibration and radial response vibration were measured on the PU electronics panel and the EBW range safety panel. The data from these six measurements are compared with the S-IVB-501 stage acceptance firing levels and specification test levels in figure 18-6. The plots show very good agreement between the acceptance firing levels and also show that these levels are adequately covered by the test specifications. It can be seen (by comparing input with response) that the panel vibration isolators are effectively isolating the panel.

## 18.3 Acoustic Measurements

Acoustic measurements were made on the forward dome, thrust structure, and internal and external to the forward and aft skirt structure. The forward dome and thrust structure measurements were acquired via hardwire link which provided data from 20 cps to beyond 3,000 cps. The internal and external measurements on the forward and aft skirts were acquired via SSB/FM and PAM/FM telemetry links. The SSB/FM link provided composite data between 50 cps, and 3,000 cps. The PAM/FM link provided the rms data level of two-octave bands (2,400/4,800 and 4,800/9,600 cps). These rms values are shown in table 18-1.

Three aft skirt internal acoustic measurements (B0022, B0023, and B0024) were deleted prior to the firing due to a malfunction in the measurement system. One PAM measurement channel (B0018) was inactive during the firing. The data levels from the active measurements were within the range established on prior S-IVB stage acceptance firings.

The internal measurements in the forward area produced different spectra. The B0016 microphone was installed behind a cold plate panel and used SSB/FM. The location may have been reverberant at some frequencies and the low frequencies may have been attenuated by the SSB/FM link. The dome microphone (B0504) was almost unobstructed and its data were acquired via hardwire with a flat frequency response.

The spectra of the aft area measurements also differed. Measurement B0019, was acquired via SSB/FM and B0503 was acquired via hardwire link. This may account for the lower levels on the SSB/FM measurement below 150 cps.

Each of the five measurements indicated sound pressure spectra below the design specification 110A; therefore, the acoustic environment of the S-IVB-502 stage during acceptance firing is considered to have been within safe limits.

# TABLE 18-1
## SUMMARY OF ACOUSTIC AND VIBRATION MEASUREMENTS

| MEASUREMENT NO. | PARAMETER | DIRECTION | FREQUENCY RANGE (cps) | 1st BURN START TRANSIENT | 1st BURN MAINSTAGE | 2nd BURN START TRANSIENT | 2nd BURN MAINSTAGE | COMPARISON* VALUES |
|---|---|---|---|---|---|---|---|---|
| | VIBRATION (TM) | | | (Grms) | (Grms) | (Grms) | (Grms) | (Grms) |
| E0041-403 | Thrust Structure at Helium Bottle | Thrust | 50-3000 | NM | 7.4 | 14.0 | 9.8 | NC |
| E0042-403 | Thrust Structure at Helium Bottle | Pitch | 50-3000 | NM | 10.6 | NM | 14.7 | NC |
| E0043-403 | Thrust Structure at Helium Bottle | Yaw | 50-3000 | NM | 8.3 | NM | 11.6 | NC |
| E0061-403 | LH2 Transfer Line at Thrust Structure | Thrust | 50-3000 | NM | 5.5 | NM | 7.7 | NC |
| E0062-409 | LH2 Tank Skin and P.U. Probe Support | Radial | 50-3000 | 4.0 | 2.8 | NM | 4.5 | NC |
| E0090-403 | Gimbal Point | Thrust | 50-3000 | 3.4 | 3.6 | 4.3 | 4.4 | 3.0 |
| E0091-404 | Field Splice at Position I (Low Frequency) | Thrust | 5-440 | D | D | D | D | NC |
| E0092-404 | Aft Skirt at Position II, Station 2748 | Thrust | 5-440 | 0.7 | 0.7 | NM | 0.7 | NC |
| E0093-411 | Field Splice at Position I | Thrust | 50-3000 | D | D | D | D | NC |
| E0094-411 | Field Splice at Position I | Pitch | 50-3000 | NM | 3.3 | NM | 4.1 | 3.0 |
| E0095-411 | Field Splice at Position I | Yaw | 50-3000 | NM | 1.1 | NM | 1.3 | 0.8 |
| E0096-411 | Field Splice at Position II | Thrust | 50-3000 | NM | 1.3 | 2.2 | 1.6 | 1.4 |
| E0097-411 | Field Splice at Position II | Pitch | 50-3000 | NM | 1.3 | 2.2 | 1.7 | 1.9 |
| E0098-411 | Field Splice at Position II | Yaw | 50-3000 | 2.6 | 2.2 | NM | 2.8 | 1.6 |
| E0103-404 | Aft Skirt Sequencer Panel | Thrust | 50-3000 | NM | 5.3 | NM | 7.0 | 2.8 |
| E0104-404 | Aft Skirt Sequencer Assembly | Radial | 50-3000 | NM | 3.1 | NM | 4.1 | 4.5 |
| E0105-404 | Aft Skirt Sequencer Panel | Radial | 50-3000 | NM | 6.6 | NM | 8.3 | NC |
| E0106-404 | Aft Skirt Switch Selector Panel | Thrust | 50-3000 | 5.5 | 4.8 | NM | 6.3 | 11.4 |
| E0107-404 | Aft Skirt Switch Selector Assembly | Radial | 50-3000 | 6.2 | 5.1 | NM | 6.8 | 6.5 |
| E0108-404 | Aft Skirt Switch Selector Panel | Radial | 50-3000 | NM | 6.0 | 9.7 | 7.3 | 10.1 |
| E0109-411 | Forward Skirt P.U. Electronics Panel | Thrust | 50-3000 | NM | 1.4 | NM | 1.8 | 1.8 |
| E0110-411 | Forward Skirt P.U. Electronics Assembly | Radial | 50-3000 | 1.6 | 1.3 | NM | 1.6 | 1.4 |
| E0111-411 | Forward Skirt P.U. Electronics Panel | Radial | 50-3000 | 3.4 | 2.8 | NM | 3.4 | 2.4 |
| E0112-411 | Forward Skirt EBW Range Safety Panel | Thrust | 50-3000 | NM | 1.0 | 1.2 | 1.3 | 1.3 |
| E0113-411 | Forward Skirt EBW Range Safety Assembly | Radial | 50-3000 | NM | 0.9 | 1.4 | 1.0 | 0.9 |
| E0114-411 | Forward Skirt EBW Range Safety Panel | Radial | 50-3000 | NM | 1.6 | NM | 2.5 | 2.0 |
| E0115-411 | Forward Skirt Batteries #1 and #2 | Thrust | 50-3000 | D | D | D | D | NC |
| E0116-411 | Forward Skirt Batteries #1 and #2 | Radial | 50-3000 | 1.4 | 1.1 | NM | 1.6 | 1.5 |
| E0117-411 | Forward Skirt Batteries #1 and #2 | Tangential | 50-3000 | I | I | I | I | NC |
| E0118-427 | APS Module I, Aft Attach Point | Thrust | 50-3000 | NM | 2.2 | 3.6 | 3.0 | 2.2 |
| E0119-427 | APS Module I, Aft Attach Point | Radial | 50-3000 | NM | 2.8 | NM | 3.9 | NC |
| E0120-427 | APS Module I, Forward Attach Point | Radial | 50-3000 | D | D | D | D | NC |
| E0209-401 | Combustion Chamber Dome | Thrust | 50-3000 | NM | 7.0 | NM | 8.9 | 6.9 |
| E0210-401 | LH2 Turbo Pump | Lateral | 50-3000 | 12.6 | 12.1 | NM | 14.4 | 13.7 |
| E0211-401 | LOX Turbo Pump | Lateral | 50-3000 | 37.4 | 15.5 | NM | 34.2 | 31.9 |
| E0212-403 | Gimbal Point | Yaw | 50-3000 | NM | 5.2 | I | I | NC |
| E0213-403 | Gimbal Point | Pitch | 50-3000 | NM | 6.0 | 5.1 | 6.0 | NC |
| | VIBRATION (HW) | | | | | | | |
| E0532-405 | Cold Helium Sphere, Attach Point | Radial | 20-3000 | 1.8 | 1.4 | 2.0 | 1.7 | NC |
| E0555-401 | LOX Turbo Pump | Radial | 20-3000 | 2.6 | 1.6 | 2.6 | 6.5 | 10.1 |
| E0556-401 | LH2 Turbo Pump | Radial | 20-3000 | I | 8.7 | I | 7.2 | NC |
| E0580-424 | LOX Tank Ullage Pressure Transducer Tray | Normal | 20-3000 | 17.2 | 16.3 | 21.6 | 19.1 | 10.3† |
| E0589-405 | LH2 Tank P.U. Probe | Radial | 20-3000 | 11.6 | 8.3 | 11.1 | 10.1 | 10.9† |
| E0590-405 | LOX Tank P.U. Probe | Thrust | 20-3000 | I | I | I | I | NC |
| E0605-427 | Aft Skirt Umbilical Plate | Radial | 20-3000 | 2.9 | 2.2 | 3.2 | 2.2 | NC |
| E0606-427 | Aft Skirt Umbilical Plate | Thrust | 20-3000 | 1.6 | 1.2 | 1.8 | 1.3 | NC |
| E0607-404 | Aft Skirt Structure, Stringer 10, Station 2766 | Radial | 20-3000 | 5.3 | 4.4 | 6.0 | 4.6 | NC |
| E0609-403 | Auxiliary Hydraulic Pump Input | Thrust | 20-3000 | 9.0 | 7.5 | 10.2 | 7.4 | 12.7† |
| E0610-403 | Auxiliary Hydraulic Pump Input | Radial | 20-3000 | 8.7 | 7.1 | 9.7 | 6.9 | 13.0† |
| E0611-403 | Thrust Structure, Stringer 19, Station 2709 | Normal | 20-3000 | 8.7 | 7.0 | 10.2 | 7.1 | 18.3† |
| E0612-403 | Thrust Structure, Stringer 19, Station 2702 | Normal | 20-3000 | 11.1 | 8.2 | 13.0 | 8.6 | 26.3† |
| E0706-B03 | Vibration Safety Cutoff #2 | Thrust | 20-3000 | 6.1 | 6.2 | 6.3 | 6.1 | 6.0 |
| E0707-B03 | Vibration Safety Cutoff #1 | Thrust | 20-3000 | 5.6 | 5.3 | 5.9 | 5.0 | 6.1 |
| | ACOUSTIC (TM) | (Location) | | (dB) | (dB) | (dB) | (dB) | (dB) |
| B0016-411 | Forward Skirt at Position II, Station 3216 | Internal | 50-3000 | 134 | 132 | 136 | 132 | NC |
| B0017-411 | Forward Skirt at Position II, Station 3216 | Internal | 2400-4800 | 130 | 126 | 130 | 126 | NC |
| B0018-411 | Forward Skirt at Position II, Station 3216 | Internal | 4800-9600 | I | I | I | I | NC |
| B0019-427 | Aft Skirt at Position II, Station 2880 | External | 50-3000 | 149 | 146 | 151 | 148 | 148 |
| B0020-427 | Aft Skirt at Position II, Station 2880 | External | 2400-4800 | 140 | 137 | 140 | 137 | 138 |
| B0021-427 | Aft Skirt at Position II, Station 2880 | External | 4800-9600 | 135 | 134 | 136 | 133 | 136 |
| B0022-404 | Aft Skirt at Position II, Station 2880 | Internal | 50-3000 | D | D | D | D | NC |
| B0023-404 | Aft Skirt at Position II, Station 2880 | Internal | 2400-4800 | D | D | D | D | NC |
| B0024-404 | Aft Skirt at Position II, Station 2880 | Internal | 4800-9600 | D | D | D | D | NC |
| B0025-426 | Forward Skirt at Position I, Station 3220 | External | 50-3000 | 142 | 140 | 146 | 141 | NC |
| B0026-426 | Forward Skirt at Position I, Station 3220 | External | 2400-4800 | 130 | 129 | 130 | 128 | NC |
| B0027-426 | Forward Skirt at Position I, Station 3220 | External | 4800-9600 | 129 | 125 | 125 | 125 | NC |
| | ACOUSTIC (HW) | | | | | | | |
| B503-403 | Gimbal Point | N/A | 10-3,000 | 154 | 150 | 154 | 150 | NC |
| B504-411 | Forward Skirt | Internal | 10-3,000 | 133 | 128 | 133 | 127 | NC |
| | STATIC PRESSURE (TM) | | | (psia) | (psia) | (psia) | (psia) | (psia) |
| D0051-411 | Forward Skirt at Microphone | Internal | 0-2.4 | 14.2 | 14.2 | 14.2 | 14.2 | 14.3 |
| D0052-404 | Aft Skirt at Microphone | Internal | 0-2.4 | 14.2 | 14.2 | 14.2 | 14.2 | 14.4 |

NM = Measurement not monitored during time period due to time sharing.
I = Invalid data.
D = Measurement deleted prior to firing due to instrumentation problems.
dB = Sound pressure level re. 0.0002 dynes/cm$^2$

*Comparison Values
No Symbol = S-IVB-501 2nd Burn Mainstage
† = S-IVB-202 Mainstage
NC = No Comparison

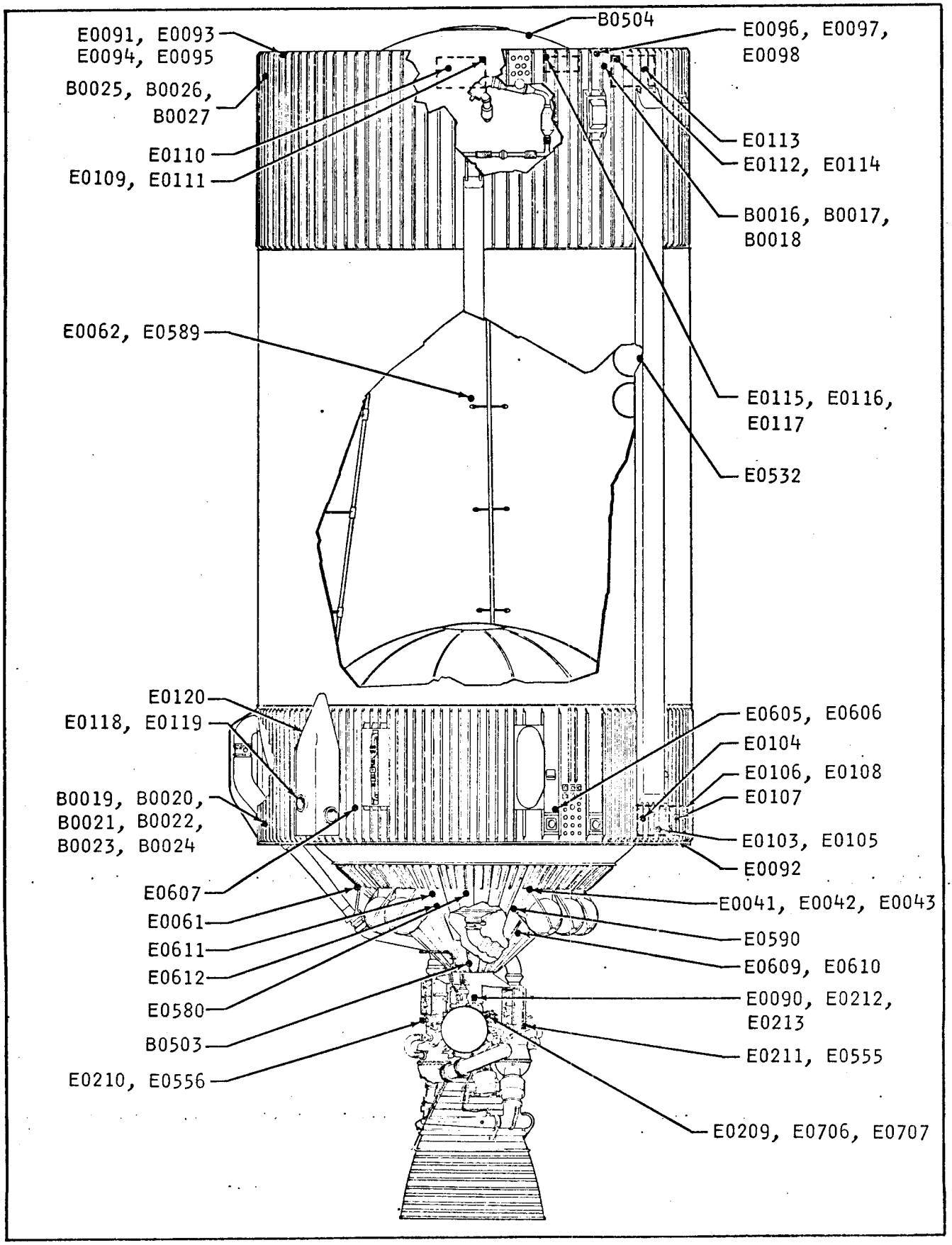


Figure 18-1. Acoustic And Vibration Measurement Locations

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# 19. STAGE THERMODYNAMICS

## 19.1 LH2 Tank Internal Insulation Performance

An analysis was performed to determine the effective thermal conductivity of the stage internal insulation during the loading. The procedure was as follows:

1. PU probe data measured during an extended vented hold period were used to determine a steady state boiloff rate. The boiloff rate was converted to an equivalent heating rate, and this value was taken to be the total heat input rate.
2. The rate at which heat entered through heat shorts (i.e., paths other than the insulation) was subtracted from the total heat input rate to determine the amount input through the insulation.
3. Skin temperatures recorded during the boiloff period were used to determine the thermal gradient across the insulation.
4. The steady state heat conduction equation was then used with the preceding data to calculate the effective insulation thermal conductivity.

A summary of the test data and equivalent heat input rate is presented in the following table, along with the calculated thermal conductivity value:

| | | |
|---|---|---|
| Mass Boiloff Rate | 40.9 | lb/min |
| Average LH2 Load | 39,900 | lb |
| Equivalent Total Heating Rate | 472,900 | Btu/hr |
| Cylindrical Section Heating Rate | 319,900 | Btu/hr |
| Average LH2 Tank Skin Temperature | 441 | deg R |
| Calculated Thermal Conductivity | 0.045 | Btu/hr-ft/deg R |

It is anticipated that these conductivity values will result in an acceptable heat input level during the flight.

# 20. RELIABILITY AND HUMAN ENGINEERING

## 20.1 Reliability Engineering

All functional failures of flight critical items (FCI) and ground support equipment/special attention items (GSE/SAI) were investigated by Reliability Engineering. Significant malfunctions of flight critical items documented are noted in table 20-1.

## 20.2 Human Engineering

The following Human Engineering evaluation was made in support of the S-IVB-502 stage acceptance firing at the Sacramento Test Center.

The stage monitor panel tank ullage pressure gage overlays were employed as recommended in HER A45-058. These overlays employ larger scale numerals (in psia) to prevent possible misinterpretation by TCC personnel. As a result of their successful trial use, these overlays will be employed during all subsequent stage acceptance firings.

TABLE 20-1 (Sheet 1 of 3)
FLIGHT CRITICAL ITEMS MALFUNCTIONS

| P/N AND S/N | PART | TROUBLE | CAUSE | ACTION TAKEN |
|---|---|---|---|---|
| 1B32647-503 S/N 040 | Switch, starter, hydraulic power unit | Switch was x-ray inspected because similar units have demonstrated a tendency to fail to operate. | Misalignment of the switch rollers due to improper assembly by the vendor. | Switch replaced with a similar unit, S/N 046. inspected switch returned to vendor for repair or replacement. Defect has been corrected on subsequent units. |
| 1A57350-503 S/N 0212 | Module, helium fill | Relief valve cracking pressure was determined to be 2,700 psi instead of the required 3,200 psi. | Improper setting of the relief valve. | Valve replaced with a -505 configuration valve S/N 0208. Defective valve returned to vendor for rework. The -505 configuration corrects the condition by fully defining the test requirements and procedures for setting relief valve crack and reseat pressures. |
| 103826 S/N J-2042 | J-2 Engine | During propulsion leak check, the start tank discharge check valve gate seal leakage was 370 scim. The maximum allowable leakage is 50 scim. | Small metal particle imbedded in the check valve gate seat. | Particle removed from contaminated seat, unit subsequently leak checked and found acceptable. This is a GFE item. |
| 103826 S/N J-2042 | J-2 Engine | Electrical control assembly P/N 502670, S/N 4076598 failed during propulsion auto checkout. No. 1 ASI spark rate was approximately 18 cps instead of the minimum 40 cps. | To be determined by the vendor. | Unit replaced with a like unit S/N 4077329 and routed to R/NAA Government stores for failure analysis. This is a GFE item. |

TABLE 20-1 (Sheet 2 of 3)
FLIGHT CRITICAL ITEMS MALFUNCTIONS

| P/N AND S/N | PART | TROUBLE | CAUSE | ACTION TAKEN |
|---|---|---|---|---|
| 103826 S/N J-2042 (continued) | | The No. 1 spark did not drop out when de-energized. | | |
| 1B29319-519 S/N 00016 | Accumulator, reservoir assembly | During hydraulic system checkout, a slight hydraulic fluid leakage was noted around the reservoir transducer port. | Deep scratches were observed on the reservoir cap. | Scratches on the sealing surfaces were machined and alodined. Accumulator re-assembled, retested with no resultant leakage and accepted. |
| 1A48257-507-002 S/N 0036 | Valve, vent and relief, fuel tank | During relief valve checks of CD 614067, TR-1042, the LH2 tank pressure was relieved 5 times. Relief occurred at 38 psia on the first four cycles and at 37 psia on the fifth cycle indicating that the LH2 tank relief valve (P/N 1A49591) relieved on the first four cycles, and the LH2 vent and relief valve relieved on the fifth cycle. The LH2 tank vent and relief valve functioned normally at ambient temperature. | To be determined. | Valve will be replaced. module will be returned to vendor for failure analysis. |

TABLE 20-1 (Sheet 3 of 3)
FLIGHT CRITICAL ITEMS MALFUNCTIONS

| P/N AND S/N | PART | TROUBLE | CAUSE | ACTION TAKEN |
|---|---|---|---|---|
| 1A74039-507 S/N 00034 | Inverter electronic assembly, chilldown | Using a Simpson meter, tests were performed to measure output voltage of each phase with the results to be compared with T/M data. In the process of taking these readings, a partial short was caused when the leads of the Simpson meter were moved from one set of phase voltage output pins to another. Also, a loose lead shorted 56 vdc to the inverter case and burned a 1/8 in. diameter hole through the top of the inverter. | Test leads from Simpson meter not properly insulated. | Inverter removed and returned to A-MRCC for further evaluation. |

# 1. ACCEPTANCE FIRING ADJUSTED DATA (AA89)

This appendix contains the digital printout of the AA89 computer program, one of the methods employed in the propulsion system performance reconstruction of the S-IVB stage acceptance firing. The performance analysis and associated plots are presented in section 6. Table AP 1-1 contains the definitions of the digital data abbreviations, and table AP 1-2 contains the computer program digital printout.

## 1.1 Acceptance Firing Data

The following procedures and assumptions were used to generate the printout:

a. The computation interval was 0.1 sec.

b. The measured turbopump inlet temperatures, pressures, and individual engine PU valve angles were supplied by magnetic tape. Obvious instrumentation errors, noise, and discontinuities were corrected.

c. Individual Rocketdyne engine acceptance tag performance values were included.

d. Propellant load values were included. The initial propellant load values or the residuals are not the final values; their use does not influence the determination of propellant consumption.

e. Thrust and the flowrates were attenuated to reflect engine start transients and stabilization. Programs such as G105-3 (flowmeter analysis) were used to aid in determining these attenuations.

TABLE AP 1-1 (Sheet 1 of 2)
DIGITAL DATA ABBREVIATIONS

| SYMBOL | DEFINITION | SYMBOL | DEFINITION |
|---|---|---|---|
| ASUBM | Stage axial acceleration, (g's) | PCC | Thrust chamber pressure (psia) (Injector static pressure) |
| CSUBFEV | Vacuum thrust coefficient | PFPI | LH2 pump inlet pressure, total (psia) |
| DEL | PU valve position (deg) | OPOI | LOX pump inlet pressure, total (psia) |
| DRAG | Atmospheric Resistance to the motion of the vehicle | RHOSUBF | LH2 bulk density (lbm/ft$^3$); calculated from pump inlet temperature + a bias |
| EMR | Total engine propellant mixture ratio. The ratio of the tape engine LOX mass flowrate to the total engine LH2 mass flowrate | RHOSUBO | LOX bulk density (lbm/ft$^3$); calculated from pump inlet temperature + a bias |
| ENGINE ISP | Engine specific impulse (sec) engine thrust divided by engine mass flowrate | TFPI | LH2 pump inlet temperature (deg R) |
| EPS | Fuel Pump speed (RPM) | TIME | Time from S-IVB stage engine start (sec) |
| FSUBE | Stage thrust (lbf) | TOPI | LOX pump inlet temperature (deg R) |
| FSUBAUX | Auxiliary thrust (lbf) | TTFHE | GHE in LH2 tank ullage (lbm) |
| FUEL OVB | Fuel overboard (lbm) thru engine and vented | TTFLH2 | GH2 in LH2 tank ullage (lbm) |
| GGMR | Gas generator mixture ratio | TTMF | Total mass in LH2 tank ullage (lbm) |
| HSUBF | Height of LH2 above pump inlet (in); computed from height versus volume polynominal | TTMO | Total mass in LOX tank ullage (lbm) |
| HSUBO | Height of LOX above pump inlet (in); computed from height versus volume polynominal | TTOHE | GHe in LOX tank ullage (lbm) |
| IMPSUBT | Stage total impulse (lbf/sec) | TTOLOX | GOX in LOX tank ullage (lbm) |
| LPS | LOX pump speed (RPM) | TTPSUBF | Fuel tank top pressure (psia) |
| OXID OVB | LOX overboard (lbm) thru engine and vented | TTPSUBO | Oxidizer tank top pressure (psia) |
| | | VSUBF | Fuel volume in tank (ft$^3$) |
| | | VSUBO | Oxidizer volume in tank (ft$^3$) |
| | | WDOTFBO | Rate of LH2 boiloff (lbm/sec) |
| | | WDOTFGG | Gas generator fuel flowrate (lbm/sec) |
| | | WDOTFPR | LH2 tank pressurant flowrate (lbm/sec) |

TABLE AP 1-1 (Sheet 2 of 2)
DIGITAL DATA ABBREVIATIONS

| SYMBOL | DEFINITION | SYMBOL | DEFINITION |
|---|---|---|---|
| WDOTFVO | Rate of GH2 vented overboard (lbm/sec) | WOBOT | Accumulated LOX boiloff (lbm) |
| WDOTHE | LOX tank pressurant (GHe) flowrate (lbm/sec) | WO IN TANK | Weight of LOX in tank (lbm) |
| WDOTOBO | Rate of LOX boiloff (lbm/sec) | WO PU | PU indicated LOX weight (lbm) |
| WDOTOGG | Gas generator LOX flowrate (lbm/sec) | WO PU USABLE | PU indicated usable LOX weight (lbm) |
| WDOTOVO | Rate of GOX vented overboard (lbm/sec) | WO USABLE | Usable LOX in tank (lbm) |
| WDOTSUBF | Engine fuel flowrate (lbm/sec) | WOVOT | Total GOX vented overboard (lbm) |
| WDOTSUBO | Engine Oxidizer flowrate (lbm/sec) | WSUBFT | Total fuel on board (lbm) |
| WDOTSUBT | Total propellant consumption, includes auxiliary flows (lbm/sec) | WSUBHE | Weight of helium in cold helium bottles (lbm) |
| WFBOT | Accumulated LH2 boiloff (lbm) | WSUBO ERROR | Equivalent LOX weight error, defined as fuel weight (PU indicated) times reference mixture ratio of PU system, subtracted from oxidizer weight (PU indicated) (lbm) |
| WF IN TANK | Weight of LH2 in tank (lbm) | | |
| WFPRT | Accumulated LH2 tank pressurant (lbm) | | |
| WF PU | PU indicated fuel weight (lbm) | WSUBOT | Total LOX on board (lbm) |
| WF USABLE | Usable fuel in tank (lbm) | WSUBV | Total weight of S-IVB + payload (lbm) |
| WFPU USABLE | PU indicated usable fuel weight (lbm) | | |
| WFVOT | Total GH2 vented overboard (lbm) | | |

# TABLE AP 1-2 (Sheet 1 of 7)
## COMPUTER PROGRAM AA89 (1ST BURN)

| | | | | | |
|---|---|---|---|---|---|
| 1 | TIME | WDOTSUBO | WDOTSUBF | WDOTSUBT | OEL |
| 2 | FSUBE | TTPSUBO | TTPSUBF | HSUBO | HSUBF |
| 3 | EMR | POPI | PFPI | VSUBO | VSUBF |
| 4 | ENGINE ISP | TOPI | TFPI | WO PU | WF PU |
| 5 | CSUBFEV | RHOSUBO | RHOSUBF | WOPU USABLE | WFPU USABLE |
| 6 | PCC | WOUTOBO | WOUTFBO | WO USABLE | WF USABLE |
| 7 | LPS | WDOTHE | WDOTFPR | WO IN TANK | WF IN TANK |
| 8 | FPS | TTOHE | TTFHE | WSUBOT | WSUBFT |
| 9 | FSUBAUX | TTULOX | TTFLH2 | OXID OVB | FUEL OVB |
| 10 | WSUBO ERROR | WOBOT | WFBOT | WOUTOVO | WOUTFVO |
| 11 | WSUBHE | TTHO | TTHF | WOVOT | WFVOT |
| 12 | GOMR | WOOTUGO | WDOTFGO | DRAG | WSUBV |
| 13 | ASUBX | | WFPRT | | IMPSUBT |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 | 0.036 |
| 2 | 0.00 | 37.364 | 38.845 | 226.264 | 511.651 |
| 3 | 0.000 | 46.604 | 40.110 | 2730.625 | 9516.095 |
| 4 | 0.000 | 165.463 | 39.616 | 0.000 | 0.000 |
| 5 | 1.727 | 70.568 | 4.273 | 189926.000 | 35483.000 |
| 6 | 0.000 | 0.561 | 0.000 | 190046.000 | 35635.000 |
| 7 | 0.000 | 0.000 | 0.000 | 192696.000 | 40658.000 |
| 8 | 0.000 | 3.400 | 13.100 | 193063.000 | 40706.000 |
| 9 | 0.000 | 25.000 | 57.600 | 0.000 | 0.000 |
| 10 | 12511.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 11 | 3.330 | 28.400 | 70.700 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.000 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.200 | 0.000 | 0.000 | 0.000 | 0.036 |
| 2 | 0.00 | 37.301 | 38.882 | 227.174 | 519.965 |
| 3 | 0.000 | 46.579 | 40.177 | 2730.422 | 9448.533 |
| 4 | 0.000 | 165.434 | 39.577 | 189925.887 | 35482.997 |
| 5 | 1.727 | 70.574 | 4.303 | 189925.887 | 35482.997 |
| 6 | 0.000 | 0.561 | 0.000 | 190045.887 | 35634.997 |
| 7 | 0.000 | 0.053 | 0.018 | 192695.887 | 40657.997 |
| 8 | 0.000 | 3.408 | 13.100 | 193062.887 | 40705.997 |
| 9 | 0.000 | 25.112 | 57.603 | 0.000 | 0.000 |
| 10 | 12510.902 | 0.112 | 0.000 | 0.000 | 0.000 |
| 11 | 3.322 | 28.520 | 70.703 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.003 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.400 | 0.000 | 0.000 | 0.000 | 0.036 |
| 2 | 0.00 | 37.235 | 38.610 | 227.173 | 519.791 |
| 3 | 0.000 | 46.513 | 39.905 | 2730.416 | 9444.375 |
| 4 | 0.000 | 165.434 | 39.531 | 189925.777 | 35482.993 |
| 5 | 1.727 | 70.574 | 4.305 | 189925.777 | 35482.993 |
| 6 | 0.000 | 0.561 | 0.000 | 190045.775 | 35634.993 |
| 7 | 0.000 | 0.053 | 0.019 | 192695.775 | 40657.993 |
| 8 | 0.000 | 3.419 | 13.100 | 193062.775 | 40705.993 |
| 9 | 0.000 | 25.224 | 57.606 | 0.000 | 0.000 |
| 10 | 12510.813 | 0.224 | 0.000 | 0.000 | 0.000 |
| 11 | 3.311 | 28.643 | 70.706 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.006 | | 0.000 |

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|---|---|---|---|---|---|
| 1 | 0.600 | 0.000 | 1.958 | 1.958 | 0.036 |
| 2 | 0.00 | 37.451 | 38.814 | 227.226 | 520.327 |
| 3 | 0.000 | 46.730 | 40.107 | 2730.847 | 9457.087 |
| 4 | 0.000 | 165.495 | 39.662 | 189925.664 | 35482.842 |
| 5 | 1.728 | 70.563 | 4.299 | 189925.664 | 35482.842 |
| 6 | 0.000 | 0.561 | 0.000 | 190045.662 | 35634.842 |
| 7 | 0.000 | 0.053 | 0.019 | 192695.662 | 40657.840 |
| 8 | 638.445 | 3.429 | 13.100 | 193062.652 | 40705.840 |
| 9 | 0.000 | 25.337 | 57.610 | 0.000 | 0.149 |
| 10 | 12511.453 | 0.337 | 0.000 | 0.000 | 0.000 |
| 11 | 3.301 | 28.766 | 70.710 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.086 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.010 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.800 | 0.000 | 3.002 | 3.002 | 0.036 |
| 2 | 0.00 | 37.484 | 38.832 | 227.232 | 521.016 |
| 3 | 0.000 | 46.762 | 40.143 | 2730.893 | 9473.427 |
| 4 | 0.000 | 165.502 | 39.826 | 189925.553 | 35482.340 |
| 5 | 1.728 | 70.561 | 4.292 | 189925.553 | 35482.340 |
| 6 | 0.000 | 0.561 | 0.000 | 190045.551 | 35634.339 |
| 7 | 0.000 | 0.053 | 0.019 | 192695.551 | 40657.333 |
| 8 | 980.142 | 3.440 | 13.100 | 193062.551 | 40705.333 |
| 9 | 0.000 | 25.449 | 57.614 | 0.000 | 0.653 |
| 10 | 12513.854 | 0.449 | 0.000 | 0.000 | 0.000 |
| 11 | 3.290 | 28.888 | 70.714 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.132 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.014 | | 0.000 |

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|---|---|---|---|---|---|
| 1 | 1.000 | 0.000 | 20.879 | 20.879 | 0.037 |
| 2 | 0.00 | 38.291 | 37.154 | 227.242 | 519.671 |
| 3 | 0.000 | 47.570 | 38.345 | 2730.978 | 9441.539 |
| 4 | 0.000 | 165.514 | 39.484 | 189925.439 | 35480.552 |
| 5 | 1.728 | 70.559 | 4.306 | 189925.439 | 35480.552 |
| 6 | 0.000 | 0.561 | 0.000 | 190045.438 | 35632.552 |
| 7 | 0.000 | 0.068 | 0.031 | 192695.438 | 40655.527 |
| 8 | 6806.455 | 3.451 | 13.100 | 193062.438 | 40703.527 |
| 9 | 0.000 | 25.561 | 57.618 | 0.000 | 2.455 |
| 10 | 12522.680 | 0.561 | 0.000 | 0.000 | 0.000 |
| 11 | 3.279 | 29.012 | 70.718 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.921 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.018 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.200 | 47.208 | 42.249 | 89.458 | 0.110 |
| 2 | 6015.45 | 37.433 | 38.615 | 227.251 | 518.464 |
| 3 | 1.117 | 46.665 | 39.497 | 2731.036 | 9411.883 |
| 4 | 67.244 | 165.524 | 39.216 | 189924.541 | 35473.896 |
| 5 | 1.727 | 70.557 | 4.319 | 189924.541 | 35473.896 |
| 6 | 20.391 | 0.561 | 0.000 | 190044.539 | 35625.895 |
| 7 | 890.355 | 0.097 | 0.054 | 192694.539 | 40648.801 |
| 8 | 13734.486 | 3.468 | 13.100 | 193061.539 | 40695.801 |
| 9 | 0.000 | 25.673 | 57.627 | 0.787 | 9.172 |
| 10 | 12555.054 | 0.673 | 0.000 | 0.000 | 0.000 |
| 11 | 3.262 | 29.141 | 70.727 | 0.000 | 0.000 |
| 12 | 0.194 | 0.362 | 1.863 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.027 | | 293.193 |

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|---|---|---|---|---|---|
| 1 | 1.400 | 94.870 | 46.788 | 141.658 | 0.141 |
| 2 | 10439.57 | 41.955 | 38.095 | 227.180 | 518.730 |
| 3 | 2.028 | 51.051 | 38.883 | 2730.461 | 9418.945 |
| 4 | 73.696 | 165.481 | 39.299 | 189905.352 | 35465.335 |
| 5 | 1.728 | 70.565 | 4.315 | 189905.352 | 35465.335 |
| 6 | 35.371 | 0.561 | 0.000 | 190025.350 | 35617.335 |
| 7 | 1783.709 | 0.126 | 0.077 | 192675.342 | 40640.152 |
| 8 | 15232.521 | 3.490 | 13.100 | 193042.342 | 40688.152 |
| 9 | 0.000 | 25.785 | 57.640 | 19.871 | 17.808 |
| 10 | 12579.678 | 0.785 | 0.000 | 0.000 | 0.000 |
| 11 | 3.240 | 29.275 | 70.740 | 0.000 | 0.000 |
| 12 | 0.392 | 0.726 | 2.685 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.040 | | 1765.441 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.600 | 13.870 | 55.184 | 69.054 | 0.142 |
| 2 | 36188.82 | 39.424 | 38.527 | 227.233 | 518.351 |
| 3 | 0.251 | 48.695 | 39.120 | 2730.901 | 9409.082 |
| 4 | 524.066 | 165.572 | 39.226 | 189891.236 | 35454.990 |
| 5 | 1.728 | 70.549 | 4.318 | 189891.236 | 35454.990 |
| 6 | 122.644 | 0.561 | 0.000 | 190011.236 | 35636.989 |
| 7 | 261.252 | 0.155 | 0.100 | 192661.223 | 40629.700 |
| 8 | 17955.943 | 3.518 | 13.100 | 193028.223 | 40677.700 |
| 9 | 0.000 | 25.897 | 57.657 | 33.879 | 28.243 |
| 10 | 12616.289 | 0.897 | 0.000 | 0.000 | 0.000 |
| 11 | 3.212 | 29.415 | 70.757 | 0.000 | 0.000 |
| 12 | 0.044 | 0.106 | 2.435 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.057 | | 6286.276 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.800 | 86.041 | 56.096 | 142.137 | 0.142 |
| 2 | 69551.16 | 39.292 | 38.908 | 227.291 | 515.306 |
| 3 | 1.534 | 48.420 | 39.481 | 2731.376 | 9333.660 |
| 4 | 489.324 | 165.657 | 38.465 | 189882.592 | 35443.989 |
| 5 | 1.727 | 70.533 | 4.352 | 189882.592 | 35443.989 |
| 6 | 235.755 | 0.561 | 0.000 | 190002.590 | 35595.989 |
| 7 | 1621.737 | 0.185 | 0.123 | 192652.574 | 40618.565 |
| 8 | 18136.929 | 3.552 | 13.100 | 193019.574 | 40666.565 |
| 9 | 0.000 | 26.010 | 57.680 | 42.416 | 39.354 |
| 10 | 12662.746 | 1.010 | 0.000 | 0.000 | 0.000 |
| 11 | 3.178 | 29.562 | 70.780 | 0.000 | 0.000 |
| 12 | 0.267 | 0.659 | 2.471 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.080 | | 16707.730 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.000 | 175.641 | 57.513 | 233.155 | 0.142 |
| 2 | 106251.81 | 39.085 | 38.650 | 227.155 | 514.552 |
| 3 | 3.054 | 47.752 | 39.187 | 2730.253 | 9314.980 |
| 4 | 455.714 | 165.551 | 38.286 | 189856.318 | 35432.696 |
| 5 | 1.727 | 70.553 | 4.359 | 189856.318 | 35432.696 |
| 6 | 360.174 | 0.561 | 0.000 | 189976.316 | 35584.696 |
| 7 | 3311.168 | 0.214 | 0.146 | 192626.289 | 40637.176 |
| 8 | 18575.736 | 3.592 | 13.100 | 192993.289 | 40655.176 |
| 9 | 0.000 | 26.122 | 57.707 | 68.588 | 50.717 |
| 10 | 12692.838 | 1.122 | 0.000 | 0.000 | 0.000 |
| 11 | 3.138 | 29.714 | 70.807 | 0.000 | 0.000 |
| 12 | 0.531 | 1.346 | 2.533 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.107 | | 34221.937 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.200 | 234.947 | 60.465 | 295.412 | 0.142 |
| 2 | 142507.62 | 39.867 | 39.307 | 226.969 | 513.996 |
| 3 | 3.886 | 48.058 | 39.764 | 2728.712 | 9299.737 |
| 4 | 482.402 | 165.414 | 38.158 | 189815.166 | 35421.010 |
| 5 | 1.727 | 70.577 | 4.365 | 189815.166 | 35421.010 |
| 6 | 483.062 | 0.561 | 0.000 | 189935.164 | 35573.010 |
| 7 | 4427.117 | 0.216 | 0.169 | 192585.121 | 40595.369 |
| 8 | 19505.624 | 3.635 | 13.100 | 192952.121 | 40643.359 |
| 9 | 0.000 | 26.234 | 57.738 | 109.665 | 62.493 |
| 10 | 12710.115 | 1.234 | 0.000 | 0.000 | 0.000 |
| 11 | 3.045 | 29.869 | 70.838 | 0.000 | 0.000 |
| 12 | 0.676 | 1.800 | 2.663 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.138 | | 53176.457 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.400 | 294.039 | 65.067 | 359.107 | 0.142 |
| 2 | 172607.17 | 39.740 | 37.954 | 226.817 | 513.566 |
| 3 | 4.519 | 47.321 | 38.280 | 2727.459 | 9289.690 |
| 4 | 480.657 | 165.343 | 38.055 | 189762.162 | 35408.600 |
| 5 | 1.727 | 70.590 | 4.369 | 189762.162 | 35408.600 |
| 6 | 585.087 | 0.591 | 0.000 | 189882.160 | 35560.599 |
| 7 | 5541.550 | 0.218 | 0.192 | 192532.096 | 40582.835 |
| 8 | 20998.939 | 3.678 | 13.100 | 192899.096 | 40630.835 |
| 9 | 0.000 | 26.346 | 57.774 | 162.557 | 74.995 |
| 10 | 12719.164 | 1.346 | 0.000 | 0.000 | 0.000 |
| 11 | 3.052 | 30.025 | 70.874 | 0.000 | 0.000 |
| 12 | 0.786 | 2.253 | 2.867 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.174 | | 90867.821 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.630 | 349.771 | 71.824 | 421.595 | 0.142 |
| 2 | 196410.06 | 39.306 | 38.423 | 226.663 | 513.284 |
| 3 | 4.870 | 46.189 | 39.538 | 2726.137 | 9282.414 |
| 4 | 465.274 | 165.285 | 38.013 | 189697.527 | 35395.052 |
| 5 | 1.727 | 70.601 | 4.371 | 189697.527 | 35395.052 |
| 6 | 565.834 | 0.561 | 0.000 | 189817.525 | 35547.051 |
| 7 | 6595.891 | 0.221 | 0.215 | 192467.436 | 40569.142 |
| 8 | 23172.539 | 3.722 | 13.100 | 192834.436 | 40617.142 |
| 9 | 0.000 | 26.458 | 57.815 | 227.105 | 88.693 |
| 10 | 12722.270 | 1.458 | 0.000 | 0.000 | 0.000 |
| 11 | 3.008 | 30.181 | 70.915 | 0.000 | 0.000 |
| 12 | 0.847 | 2.680 | 3.165 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.215 | | 127865.076 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.800 | 392.665 | 78.641 | 471.306 | 0.142 |
| 2 | 214681.55 | 41.230 | 38.070 | 226.556 | 512.945 |
| 3 | 4.993 | 47.494 | 37.953 | 2725.037 | 9273.702 |
| 4 | 455.503 | 165.279 | 37.946 | 189622.818 | 35380.078 |
| 5 | 1.728 | 70.602 | 4.373 | 189622.818 | 35380.078 |
| 6 | 727.669 | 0.561 | 0.000 | 189742.816 | 35532.078 |
| 7 | 7397.860 | 0.223 | 0.238 | 192392.697 | 40554.013 |
| 8 | 25375.615 | 3.767 | 13.100 | 192759.697 | 40602.013 |
| 9 | 0.000 | 26.571 | 57.860 | 301.730 | 103.726 |
| 10 | 12722.432 | 1.571 | 0.000 | 0.000 | 0.000 |
| 11 | 2.963 | 30.337 | 70.960 | 0.000 | 0.000 |
| 12 | 0.868 | 3.008 | 3.466 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.260 | | 169191.363 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 3.000 | 420.148 | 83.562 | 503.709 | 0.142 |
| 2 | 222605.97 | 41.236 | 39.183 | 226.434 | 512.704 |
| 3 | 5.028 | 47.064 | 38.885 | 2723.794 | 9267.470 |
| 4 | 441.933 | 165.267 | 37.932 | 189540.900 | 35353.922 |
| 5 | 1.727 | 70.604 | 4.374 | 189540.900 | 35353.922 |
| 6 | 754.578 | 0.561 | 0.000 | 189660.898 | 35515.921 |
| 7 | 7518.149 | 0.225 | 0.257 | 192310.748 | 40537.690 |
| 8 | 26543.412 | 3.811 | 13.100 | 192677.748 | 40585.690 |
| 9 | 0.000 | 26.683 | 57.910 | 383.568 | 120.000 |
| 10 | 12721.291 | 1.683 | 0.000 | 0.000 | 0.000 |
| 11 | 2.919 | 30.494 | 71.010 | 0.000 | 0.000 |
| 12 | 0.874 | 3.219 | 3.642 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.310 | | 213053.652 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 5.000 | 452.501 | 84.356 | 536.867 | 0.068 |
| 2 | 224858.69 | 39.839 | 37.761 | 224.852 | 511.245 |
| 3 | 5.364 | 45.070 | 37.428 | 2707.718 | 9229.791 |
| 4 | 418.835 | 164.767 | 37.919 | 188651.717 | 35195.917 |
| 5 | 1.728 | 70.695 | 4.374 | 188651.717 | 35195.917 |
| 6 | 762.145 | 0.561 | 0.000 | 188771.715 | 35347.917 |
| 7 | 8525.510 | 0.228 | 0.400 | 191421.213 | 40367.947 |
| 8 | 27275.834 | 4.263 | 13.100 | 191788.213 | 40415.947 |
| 9. | 0.000 | 27.804 | 58.567 | 1271.982 | 289.085 |
| 10 | 12672.135 | 2.804 | 0.000 | 0.000 | 0.000 |
| 11 | 2.457 | 32.068 | 71.667 | 0.000 | 0.000 |
| 12 | 0.930 | 3.466 | 3.726 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.967 | | 660254.773 |

28 September 1966

# TABLE AP 1-2 (Sheet 2 of 7)
## COMPUTER PROGRAM AA89 (1ST BURN)

| | | | | | |
|---|---|---|---|---|---|
| 1 | 10.000 | 460.530 | 83.554 | 544.084 | 32.402 |
| 2 | 230883.42 | 35.869 | 37.327 | 221.702 | 507.480 |
| 3 | 5.512 | 40.830 | 37.016 | 2675.397 | 9130.681 |
| 4 | 424.353 | 164.768 | 37.876 | 186367.283 | 34778.066 |
| 5 | 1.727 | 70.695 | 4.375 | 186367.288 | 34778.066 |
| 6 | 782.817 | 0.561 | 0.000 | 186487.281 | 34930.066 |
| 7 | 8699.784 | 0.248 | 0.487 | 189135.877 | 39945.775 |
| 8 | 27035.725 | 5.448 | 13.100 | 189502.877 | 39993.775 |
| 9 | 0.000 | 30.609 | 60.829 | 3554.514 | 708.996 |
| 10 | 12476.951 | 5.609 | 0.000 | 0.000 | 0.000 |
| 11 | 1.282 | 36.057 | 73.929 | 0.000 | 0.000 |
| 12 | 0.956 | 3.529 | 3.693 | 0.000 | 0.000 |
| 13 | 0.000 | | 3.229 | | 1799658.547 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 20.000 | 459.788 | 83.430 | 543.218 | 32.349 |
| 2 | 230515.02 | 33.976 | 36.255 | 216.340 | 500.574 |
| 3 | 5.511 | 38.732 | 35.931 | 2609.909 | 8942.794 |
| 4 | 424.351 | 164.719 | 37.893 | 181763.432 | 33946.846 |
| 5 | 1.727 | 70.704 | 4.373 | 181763.432 | 33946.846 |
| 6 | 781.665 | 0.561 | 0.000 | 181883.430 | 34098.845 |
| 7 | 8695.734 | 0.293 | 0.496 | 184530.207 | 39105.957 |
| 8 | 27020.795 | 8.173 | 13.100 | 184897.207 | 39153.957 |
| 9 | 0.000 | 36.218 | 65.751 | 8154.574 | 1543.892 |
| 10 | 12029.203 | 11.218 | 0.000 | 0.000 | 0.000 |
| 11 | -1.443 | 44.391 | 78.851 | 0.000 | 0.000 |
| 12 | 0.955 | 3.523 | 3.689 | 0.000 | 0.000 |
| 13 | 0.000 | | 8.151 | | 4106016.438 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 30.000 | 459.638 | 83.400 | 543.038 | 32.408 |
| 2 | 230436.79 | 33.874 | 35.911 | 211.674 | 493.815 |
| 3 | 5.511 | 38.441 | 35.571 | 2545.104 | 8751.445 |
| 4 | 424.348 | 164.766 | 37.879 | 177162.477 | 33116.367 |
| 5 | 1.727 | 70.696 | 4.373 | 177162.477 | 33116.367 |
| 6 | 781.417 | 0.561 | 0.000 | 177282.475 | 33268.367 |
| 7 | 8695.313 | 0.331 | 0.499 | 179927.436 | 38256.889 |
| 8 | 27015.670 | 11.292 | 13.100 | 180294.436 | 38314.889 |
| 9 | 0.000 | 41.827 | 70.725 | 12751.736 | 2377.986 |
| 10 | 11580.645 | 16.827 | 0.000 | 0.000 | 0.000 |
| 11 | -4.562 | 53.119 | 83.825 | 0.000 | 0.000 |
| 12 | 0.955 | 3.522 | 3.688 | 0.000 | 0.000 |
| 13 | 0.000 | | 13.125 | | 6410635.625 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 40.000 | 459.965 | 83.353 | 543.318 | 32.530 |
| 2 | 230520.34 | 34.882 | 35.019 | 207.491 | 487.561 |
| 3 | 5.518 | 39.272 | 34.664 | 2479.976 | 8552.725 |
| 4 | 424.283 | 164.766 | 37.887 | 172560.777 | 32286.658 |
| 5 | 1.727 | 70.696 | 4.371 | 172560.777 | 32286.658 |
| 6 | 781.607 | 0.561 | 0.000 | 172680.775 | 32438.658 |
| 7 | 8695.940 | 0.344 | 0.501 | 175323.920 | 37428.599 |
| 8 | 27020.315 | 14.677 | 13.100 | 175690.920 | 37476.599 |
| 9 | 0.000 | 47.436 | 75.724 | 17349.643 | 3211.277 |
| 10 | 11127.486 | 22.436 | 0.000 | 0.000 | 0.000 |
| 11 | -7.947 | 62.113 | 88.824 | 0.000 | 0.000 |
| 12 | 0.956 | 3.524 | 3.688 | 0.000 | 0.000 |
| 13 | 0.000 | | 18.124 | | 8715008.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 50.000 | 460.205 | 83.224 | 543.429 | 32.498 |
| 2 | 230508.97 | 35.708 | 33.022 | 203.633 | 481.394 |
| 3 | 5.530 | 39.935 | 32.656 | 2415.003 | 8376.248 |
| 4 | 424.175 | 164.797 | 37.906 | 167956.291 | 31457.311 |
| 5 | 1.727 | 70.690 | 4.368 | 167956.291 | 31457.311 |
| 6 | 781.454 | 0.561 | 0.000 | 168076.289 | 31609.310 |
| 7 | 8695.637 | 0.355 | 0.503 | 170717.615 | 36590.673 |
| 8 | 27021.783 | 18.173 | 13.100 | 171084.615 | 36638.673 |
| 9 | 0.000 | 53.045 | 80.743 | 21950.338 | 4044.134 |
| 10 | 10669.738 | 28.045 | 0.000 | 0.000 | 0.000 |
| 11 | -11.443 | 71.218 | 93.843 | 0.000 | 0.000 |
| 12 | 0.956 | 3.524 | 3.686 | 0.000 | 0.000 |
| 13 | 0.000 | | 23.143 | | 11020054.625 |

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|---|---|---|---|---|---|
| 1 | 60.000 | 460.532 | 83.174 | 543.706 | 32.414 |
| 2 | 230590.45 | 36.752 | 32.243 | 199.990 | 475.185 |
| 3 | 5.537 | 40.823 | 31.862 | 2349.838 | 8189.190 |
| 4 | 424.109 | 164.812 | 37.937 | 163349.111 | 30628.423 |
| 5 | 1.727 | 70.688 | 4.366 | 163349.111 | 30628.423 |
| 6 | 781.636 | 0.561 | 0.000 | 163469.109 | 30780.423 |
| 7 | 8696.285 | 0.362 | 0.505 | 166108.615 | 35753.212 |
| 8 | 27028.855 | 21.764 | 13.100 | 166475.615 | 35801.212 |
| 9 | 0.000 | 58.654 | 85.783 | 26553.730 | 4876.605 |
| 10 | 10206.998 | 33.654 | 0.000 | 0.000 | 0.000 |
| 11 | -15.034 | 80.418 | 98.883 | 0.000 | 0.000 |
| 12 | 0.957 | 3.526 | 3.685 | 0.000 | 0.000 |
| 13 | 0.000 | | 28.183 | | 13325714.250 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 70.000 | 460.775 | 83.199 | 543.973 | 32.415 |
| 2 | 230698.55 | 37.628 | 32.483 | 196.521 | 468.861 |
| 3 | 5.538 | 41.553 | 32.085 | 2284.832 | 7998.328 |
| 4 | 424.099 | 164.847 | 37.937 | 158738.881 | 29799.978 |
| 5 | 1.728 | 70.682 | 4.365 | 158738.881 | 29799.978 |
| 6 | 781.963 | 0.561 | 0.000 | 158858.879 | 29951.978 |
| 7 | 8697.576 | 0.368 | 0.507 | 161496.564 | 34916.198 |
| 8 | 27033.760 | 25.414 | 13.100 | 161863.564 | 34964.198 |
| 9 | 0.000 | 64.263 | 90.843 | 31160.172 | 5708.558 |
| 10 | 9738.992 | 39.263 | 0.000 | 0.000 | 0.000 |
| 11 | -18.634 | 89.677 | 103.943 | 0.000 | 0.000 |
| 12 | 0.957 | 3.528 | 3.686 | 0.000 | 0.000 |
| 13 | 0.000 | | 33.243 | | 15632135.125 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 80.000 | 461.111 | 83.193 | 544.304 | 32.471 |
| 2 | 230817.81 | 38.671 | 32.198 | 193.275 | 462.569 |
| 3 | 5.543 | 42.457 | 31.784 | 2219.603 | 7808.413 |
| 4 | 424.060 | 164.859 | 37.942 | 154125.623 | 28971.568 |
| 5 | 1.728 | 70.680 | 4.364 | 154125.623 | 28971.568 |
| 6 | 782.293 | 0.561 | 0.000 | 154245.621 | 29123.567 |
| 7 | 8698.743 | 0.373 | 0.508 | 156881.484 | 34079.220 |
| 8 | 27039.702 | 29.119 | 13.100 | 157248.484 | 34127.220 |
| 9 | 0.000 | 69.872 | 95.921 | 35769.643 | 6540.458 |
| 10 | 9267.785 | 44.872 | 0.000 | 0.000 | 0.000 |
| 11 | -22.389 | 98.990 | 109.021 | 0.000 | 0.000 |
| 12 | 0.957 | 3.530 | 3.687 | 0.000 | 0.000 |
| 13 | 0.000 | | 38.322 | | 17939624.000 |

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|---|---|---|---|---|---|
| 1 | 90.000 | 461.181 | 83.166 | 544.349 | 32.349 |
| 2 | 230824.61 | 39.100 | 31.820 | 190.131 | 456.285 |
| 3 | 5.545 | 42.756 | 31.391 | 2154.343 | 7618.750 |
| 4 | 424.038 | 164.875 | 37.949 | 149509.363 | 28143.489 |
| 5 | 1.728 | 70.677 | 4.363 | 149509.363 | 28143.489 |
| 6 | 782.291 | 0.561 | 0.000 | 149629.361 | 28295.489 |
| 7 | 8698.120 | 0.270 | 0.508 | 152263.402 | 33242.576 |
| 8 | 27040.727 | 32.718 | 13.100 | 152630.402 | 33290.576 |
| 9 | 0.000 | 75.481 | 101.002 | 40382.115 | 7372.021 |
| 10 | 8791.920 | 50.481 | 0.000 | 0.000 | 0.000 |
| 11 | -25.988 | 108.199 | 114.102 | 0.000 | 0.000 |
| 12 | 0.958 | 3.530 | 3.687 | 0.000 | 0.000 |
| 13 | 0.000 | | 43.403 | | 20247946.250 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 100.000 | 460.784 | 83.092 | 543.877 | 32.403 |
| 2 | 230619.85 | 38.187 | 31.212 | 187.091 | 450.078 |
| 3 | 5.545 | 41.725 | 30.769 | 2089.220 | 7431.401 |
| 4 | 424.030 | 164.906 | 37.984 | 144897.252 | 27315.813 |
| 5 | 1.728 | 70.672 | 4.361 | 144897.252 | 27315.813 |
| 6 | 781.642 | 0.561 | 0.000 | 145017.252 | 27467.813 |
| 7 | 8696.850 | 0.378 | 0.508 | 147649.471 | 32406.340 |
| 8 | 27035.094 | 35.598 | 13.100 | 148016.471 | 32454.340 |
| 9 | 0.000 | 81.090 | 106.085 | 44990.438 | 8203.175 |
| 10 | 8318.188 | 56.090 | 0.000 | 0.000 | 0.000 |
| 11 | -28.868 | 116.688 | 119.185 | 0.000 | 0.000 |
| 12 | 0.957 | 3.527 | 3.684 | 0.000 | 0.000 |
| 13 | 0.000 | | 48.485 | | 22554437.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 110.000 | 460.959 | 83.073 | 544.033 | 32.408 |
| 2 | 230669.34 | 38.767 | 30.943 | 184.187 | 443.824 |
| 3 | 5.549 | 42.183 | 30.485 | 2023.916 | 7242.640 |
| 4 | 423.999 | 164.906 | 38.007 | 140284.500 | 26488.295 |
| 5 | 1.728 | 70.672 | 4.359 | 140284.500 | 26488.295 |
| 6 | 781.763 | 0.561 | 0.000 | 140404.498 | 26640.295 |
| 7 | 8697.219 | 0.395 | 0.508 | 143034.896 | 31570.263 |
| 8 | 27039.835 | 39.486 | 13.100 | 143401.896 | 31618.263 |
| 9 | 0.000 | 86.699 | 111.168 | 49599.404 | 9034.168 |
| 10 | 7843.025 | 61.699 | 0.000 | 0.000 | 0.000 |
| 11 | -32.756 | 126.185 | 124.268 | 0.000 | 0.000 |
| 12 | 0.958 | 3.528 | 3.684 | 0.000 | 0.000 |
| 13 | 0.000 | | 53.569 | | 24861046.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 120.000 | 460.643 | 83.037 | 543.680 | 32.408 |
| 2 | 230525.32 | 38.258 | 30.717 | 181.360 | 437.531 |
| 3 | 5.547 | 41.563 | 30.244 | 1958.831 | 7052.698 |
| 4 | 424.009 | 164.953 | 38.016 | 135670.605 | 25660.928 |
| 5 | 1.728 | 70.664 | 4.358 | 135670.605 | 25660.928 |
| 6 | 781.326 | 0.561 | 0.000 | 135790.604 | 25812.928 |
| 7 | 8695.343 | 0.268 | 0.509 | 138419.180 | 30734.338 |
| 8 | 27034.072 | 42.651 | 13.100 | 138786.180 | 30782.338 |
| 9 | 0.000 | 92.308 | 116.253 | 54209.512 | 9865.008 |
| 10 | 7365.966 | 67.308 | 0.000 | 0.000 | 0.000 |
| 11 | -35.921 | 134.958 | 129.353 | 0.000 | 0.000 |
| 12 | 0.957 | 3.526 | 3.683 | 0.000 | 0.000 |
| 13 | 0.000 | | 58.653 | | 27167960.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 130.000 | 460.575 | 83.053 | 543.628 | 32.408 |
| 2 | 230512.15 | 38.163 | 31.122 | 178.831 | 431.255 |
| 3 | 5.546 | 41.366 | 30.633 | 1893.645 | 6853.357 |
| 4 | 424.026 | 164.969 | 38.030 | 131061.230 | 24833.993 |
| 5 | 1.728 | 70.662 | 4.356 | 131061.230 | 24833.993 |
| 6 | 781.302 | 0.561 | 0.000 | 131181.229 | 24985.993 |
| 7 | 8696.048 | 0.394 | 0.509 | 133807.984 | 29898.851 |
| 8 | 27034.975 | 45.957 | 13.100 | 134174.984 | 29946.851 |
| 9 | 0.000 | 97.917 | 121.339 | 58815.098 | 10695.410 |
| 10 | 6891.264 | 72.917 | 0.000 | 0.000 | 0.000 |
| 11 | -39.227 | 143.874 | 134.439 | 0.000 | 0.000 |
| 12 | 0.957 | 3.525 | 3.683 | 0.000 | 0.000 |
| 13 | 0.000 | | 63.739 | | 29472873.750 |

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|---|---|---|---|---|---|
| 1 | 140.000 | 460.879 | 83.073 | 543.952 | 32.480 |
| 2 | 230639.35 | 39.093 | 31.072 | 176.300 | 424.925 |
| 3 | 5.548 | 42.186 | 30.565 | 1828.425 | 6672.314 |
| 4 | 424.007 | 164.984 | 38.008 | 126449.812 | 24007.072 |
| 5 | 1.728 | 70.659 | 4.356 | 126449.812 | 24007.072 |
| 6 | 781.678 | 0.561 | 0.000 | 126569.810 | 24159.072 |
| 7 | 8697.435 | 0.403 | 0.509 | 129194.744 | 29063.377 |
| 8 | 27038.374 | 49.955 | 13.100 | 129561.744 | 29111.377 |
| 9 | 0.000 | 103.525 | 126.426 | 63422.729 | 11525.797 |
| 10 | 6414.450 | 78.526 | 0.000 | 0.000 | 0.000 |
| 11 | -43.225 | 153.480 | 139.526 | 0.000 | 0.000 |
| 12 | 0.957 | 3.527 | 3.684 | 0.000 | 0.000 |
| 13 | 0.000 | | 68.826 | | 31778530.000 |

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|---|---|---|---|---|---|
| 1 | 150.000 | 460.583 | 83.015 | 543.598 | 32.480 |
| 2 | 230486.72 | 38.583 | 30.648 | 173.771 | 418.722 |
| 3 | 5.548 | 41.578 | 30.128 | 1763.251 | 6485.073 |
| 4 | 424.002 | 165.013 | 38.039 | 121837.855 | 23180.412 |
| 5 | 1.728 | 70.654 | 4.353 | 121837.855 | 23180.412 |
| 6 | 781.197 | 0.561 | 0.000 | 121957.854 | 23332.412 |
| 7 | 8695.262 | 0.278 | 0.509 | 124580.958 | 28228.166 |
| 8 | 27034.736 | 53.024 | 13.100 | 124947.958 | 28276.166 |
| 9 | 0.000 | 109.134 | 131.514 | 68030.897 | 12355.919 |
| 10 | 5935.797 | 84.135 | 0.000 | 0.000 | 0.000 |
| 11 | -46.294 | 162.158 | 144.614 | 0.000 | 0.000 |
| 12 | 0.957 | 3.525 | 3.682 | 0.000 | 0.000 |
| 13 | 0.000 | | 73.915 | | 34084184.500 |

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|---|---|---|---|---|---|
| 1 | 151.000 | 460.602 | 82.984 | 543.586 | 32.480 |
| 2 | 230469.66 | 38.644 | 30.232 | 173.518 | 418.131 |
| 3 | 5.550 | 41.628 | 29.741 | 1756.736 | 6467.235 |
| 4 | 423.980 | 165.016 | 38.050 | 121376.914 | 23097.757 |
| 5 | 1.728 | 70.654 | 4.352 | 121376.914 | 23097.757 |
| 6 | 781.121 | 0.561 | 0.000 | 121496.913 | 23249.757 |
| 7 | 8695.010 | 0.277 | 0.509 | 124119.844 | 28144.656 |
| 8 | 27035.168 | 53.302 | 13.100 | 124486.844 | 28192.656 |
| 9 | 0.000 | 109.695 | 132.023 | 68491.460 | 12438.920 |
| 10 | 5888.132 | 84.696 | 0.000 | 0.000 | 0.000 |
| 11 | -46.572 | 162.997 | 145.123 | 0.000 | 0.000 |
| 12 | 0.957 | 3.525 | 3.682 | 0.000 | 0.000 |
| 13 | 0.000 | | 74.423 | | 34314648.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 152.000 | 460.454 | 83.005 | 543.458 | 32.416 |
| 2 | 230430.98 | 38.292 | 30.549 | 173.267 | 417.452 |
| 3 | 5.547 | 41.629 | 30.025 | 1750.256 | 6446.751 |
| 4 | 424.009 | 165.026 | 38.032 | 120916.016 | 23015.105 |
| 5 | 1.728 | 70.652 | 4.353 | 120916.016 | 23015.105 |
| 6 | 781.031 | 0.561 | 0.000 | 121036.015 | 23167.105 |
| 7 | 8694.816 | 0.277 | 0.509 | 123658.764 | 28051.150 |
| 8 | 27031.375 | 53.579 | 13.100 | 124025.764 | 28109.150 |
| 9 | 0.000 | 110.256 | 132.532 | 68951.979 | 12521.918 |
| 10 | 5840.491 | 85.256 | 0.000 | 0.000 | 0.000 |
| 11 | -46.849 | 163.835 | 145.632 | 0.000 | 0.000 |
| 12 | 0.957 | 3.524 | 3.682 | 0.000 | 0.000 |
| 13 | 0.000 | | 74.932 | | 34545094.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.000 | 460.358 | 83.004 | 543.361 | 32.414 |
| 2 | 230394.99 | 38.086 | 30.688 | 173.015 | 416.843 |
| 3 | 5.546 | 41.054 | 30.160 | 1743.772 | 6428.352 |
| 4 | 424.018 | 165.036 | 38.043 | 120455.143 | 22932.458 |
| 5 | 1.728 | 70.650 | 4.352 | 120455.143 | 22932.458 |
| 6 | 780.929 | 0.561 | 0.000 | 120575.141 | 23084.458 |
| 7 | 8694.517 | 0.276 | 0.509 | 123197.708 | 27977.648 |
| 8 | 27030.929 | 53.855 | 13.100 | 123564.708 | 28025.648 |
| 9 | 0.000 | 110.817 | 133.041 | 69412.475 | 12604.911 |
| 10 | 5792.854 | 85.817 | 0.000 | 0.000 | 0.000 |
| 11 | -47.125 | 164.672 | 146.141 | 0.000 | 0.000 |
| 12 | 0.957 | 3.524 | 3.682 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.441 | | 34775525.500 |

28 September 1966

# TABLE AP 1-2 (Sheet 3 of 7)
## COMPUTER PROGRAM AA89 (1ST BURN)

| | | | | | |
|---|---|---|---|---|---|
| | 153.322 | 460.294 | 83.045 | 543.338 | 32.414 |
| 2 | 230402.96 | 37.959 | 31.268 | 172.936 | 416.588 |
| 3 | 5.54[illegible] | 40.924 | 30.741 | 1741.720 | 6420.672 |
| 4 | 424.0[illegible] | 165.047 | 38.027 | 120306.766 | 22935.849 |
| 5 | 1.727 | 70.648 | 4.353 | 120306.766 | 22935.849 |
| 6 | 780.949 | 0.561 | 0.000 | 120426.764 | 23057.848 |
| 7 | 8694.812 | 0.276 | 0.509 | 123049.272 | 27950.763 |
| 8 | 27029.596 | 53.944 | 13.100 | 123416.272 | 27998.763 |
| 9 | 0.000 | 110.998 | 133.205 | 69560.729 | 12631.632 |
| 10 | 5777.522 | 85.998 | 0.000 | 0.000 | 0.000 |
| 11 | -47.214 | 164.942 | 146.305 | 0.000 | 0.000 |
| 12 | 0.957 | 3.524 | 3.682 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.605 | | 34949712.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.422 | 460.294 | 83.045 | 543.338 | 32.414 |
| 2 | 231549.68 | 40.150 | 32.419 | 172.910 | 416.428 |
| 3 | 5.543 | 43.114 | 31.892 | 1741.066 | 6415.880 |
| 4 | 426.161 | 165.046 | 38.000 | 120260.696 | 22897.578 |
| 5 | 1.727 | 70.648 | 4.355 | 120260.696 | 22897.578 |
| 6 | 785.461 | 0.561 | 0.000 | 120380.695 | 23049.578 |
| 7 | 8722.618 | 0.276 | 0.509 | 123003.186 | 27942.407 |
| 8 | 26891.341 | 53.972 | 13.100 | 123370.186 | 27990.407 |
| 9 | 0.000 | 111.054 | 133.256 | 69606.760 | 12639.936 |
| 10 | 5772.805 | 86.054 | 0.000 | 0.000 | 0.000 |
| 11 | -47.242 | 165.026 | 146.355 | 0.000 | 0.000 |
| 12 | 0.958 | 3.528 | 3.684 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.656 | | 34872751.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.522 | 396.664 | 71.559 | 468.223 | 32.414 |
| 2 | 199650.51 | 50.335 | 32.031 | 172.885 | 417.124 |
| 3 | 5.543 | 54.350 | 31.904 | 1740.418 | 6436.697 |
| 4 | 426.400 | 165.041 | 38.352 | 120216.713 | 22889.681 |
| 5 | 1.727 | 70.649 | 4.340 | 120216.713 | 22889.681 |
| 6 | 677.252 | 0.561 | 0.000 | 120336.712 | 23041.681 |
| 7 | 7516.826 | 0.276 | 0.509 | 122959.185 | 27934.428 |
| 8 | 23172.226 | 53.999 | 13.100 | 123326.185 | 27982.428 |
| 9 | 0.000 | 111.110 | 133.306 | 69650.705 | 12647.865 |
| 10 | 5768.308 | 86.110 | 0.000 | 0.000 | 0.000 |
| 11 | -47.269 | 165.109 | 146.406 | 0.000 | 0.000 |
| 12 | 0.958 | 3.040 | 3.174 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.707 | | 34894857.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.622 | 243.177 | 43.893 | 287.069 | 32.414 |
| 2 | 122132.74 | 50.663 | 38.536 | 172.870 | 418.984 |
| 3 | 5.540 | 56.774 | 39.132 | 1740.017 | 6492.337 |
| 4 | 425.447 | 165.053 | 39.318 | 120184.490 | 22883.891 |
| 5 | 1.727 | 70.647 | 4.302 | 120184.490 | 22883.891 |
| 6 | 414.297 | 0.561 | 0.000 | 120304.489 | 23035.891 |
| 7 | 4608.226 | 0.276 | 0.509 | 122926.949 | 27928.578 |
| 8 | 14213.215 | 54.027 | 13.100 | 123293.949 | 27976.578 |
| 9 | 0.000 | 111.166 | 133.357 | 69682.884 | 12653.664 |
| 10 | 5765.036 | 86.166 | 0.000 | 0.000 | 0.000 |
| 11 | -47.297 | 165.193 | 146.457 | 0.000 | 0.000 |
| 12 | 0.957 | 1.864 | 1.947 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.758 | | 34911051.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.722 | 92.509 | 16.775 | 109.284 | 32.414 |
| 2 | 46497.87 | 50.625 | 53.719 | 172.879 | 421.190 |
| 3 | 5.515 | 57.518 | 54.689 | 1740.257 | 6558.313 |
| 4 | 425.479 | 165.159 | 40.509 | 120168.139 | 22880.919 |
| 5 | 1.727 | 70.628 | 4.258 | 120168.139 | 22880.919 |
| 6 | 157.730 | 0.561 | 0.000 | 120288.137 | 23032.918 |
| 7 | 1753.050 | 0.276 | 0.509 | 122910.591 | 27925.575 |
| 8 | 5432.005 | 54.055 | 13.100 | 123277.591 | 27973.575 |
| 9 | 0.000 | 111.222 | 133.408 | 69699.187 | 12656.516 |
| 10 | 5763.546 | 86.222 | 0.000 | 0.000 | 0.000 |
| 11 | -47.325 | 165.277 | 146.508 | 0.000 | 0.000 |
| 12 | 0.953 | 0.709 | 0.746 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.809 | | 34919217.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.822 | 39.726 | 6.836 | 46.562 | 32.414 |
| 2 | 19072.28 | 50.455 | 35.676 | 172.916 | 423.889 |
| 3 | 5.812 | 57.484 | 36.695 | 1741.201 | 6639.060 |
| 4 | 409.611 | 165.338 | 41.283 | 120162.386 | 22879.863 |
| 5 | 1.727 | 70.596 | 4.206 | 120162.386 | 22879.863 |
| 6 | 64.697 | 0.561 | 0.000 | 120282.385 | 23031.863 |
| 7 | 752.817 | 0.276 | 0.509 | 122904.836 | 27924.509 |
| 8 | 2213.516 | 54.082 | 13.100 | 123271.836 | 27972.509 |
| 9 | 0.000 | 111.278 | 133.459 | 69704.885 | 12657.632 |
| 10 | 5763.071 | 86.278 | 0.000 | 0.000 | 0.000 |
| 11 | -47.352 | 165.360 | 146.559 | 0.000 | 0.000 |
| 12 | 1.004 | 0.304 | 0.303 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.860 | | 34922067.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 153.922 | 29.321 | 5.170 | 34.492 | 32.414 |
| 2 | 13862.36 | 48.327 | 28.240 | 172.960 | 425.094 |
| 3 | 5.671 | 55.368 | 29.262 | 1742.331 | 6675.114 |
| 4 | 401.907 | 165.651 | 41.611 | 120158.952 | 22879.224 |
| 5 | 1.727 | 70.539 | 4.183 | 120158.952 | 22879.224 |
| 6 | 47.024 | 0.561 | 0.000 | 120278.951 | 23031.223 |
| 7 | 555.643 | 0.276 | 0.509 | 122901.401 | 27923.853 |
| 8 | 1674.192 | 54.110 | 13.100 | 123269.401 | 27971.853 |
| 9 | 0.000 | 111.334 | 133.510 | 69708.264 | 12658.227 |
| 10 | 5762.834 | 86.335 | 0.000 | 0.000 | 0.000 |
| 11 | -47.380 | 165.444 | 146.610 | 0.000 | 0.000 |
| 12 | 0.980 | 0.225 | 0.229 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.910 | | 34923676.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.022 | 25.237 | 4.433 | 29.670 | 32.414 |
| 2 | 11819.30 | 48.473 | 33.281 | 172.993 | 425.237 |
| 3 | 5.693 | 55.517 | 34.304 | 1743.190 | 6679.373 |
| 4 | 398.354 | 165.850 | 41.746 | 120156.200 | 22878.704 |
| 5 | 1.727 | 70.502 | 4.181 | 120156.200 | 22878.704 |
| 6 | 40.093 | 0.561 | 0.000 | 120276.199 | 23030.703 |
| 7 | 478.244 | 0.276 | 0.509 | 122898.648 | 27923.337 |
| 8 | 1435.605 | 54.137 | 13.100 | 123265.648 | 27971.337 |
| 9 | 0.000 | 111.390 | 133.56[illegible] | 69710.961 | 12658.701 |
| 10 | 5762.683 | 86.391 | 0.000 | 0.000 | 0.000 |
| 11 | -47.407 | 165.528 | 146.661 | 0.000 | 0.000 |
| 12 | 0.983 | 0.193 | 0.197 | 0.000 | 0.000 |
| 13 | 0.000 | | 75.961 | | 34924943.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.122 | 23.096 | 4.047 | 27.143 | 32.414 |
| 2 | 10748.96 | 47.043 | 31.618 | 173.016 | 425.388 |
| 3 | 5.707 | 54.087 | 32.641 | 1743.769 | 6683.875 |
| 4 | 396.011 | 165.98[illegible] | 41.774 | 120153.729 | 22878.234 |
| 5 | 1.727 | 70.477 | 4.178 | 120153.729 | 22878.234 |
| 6 | 36.463 | 0.561 | 0.000 | 120273.729 | 23030.233 |
| 7 | 437.673 | 0.276 | 0.509 | 122896.177 | 27922.863 |
| 8 | 1310.491 | 54.165 | 13.100 | 123263.177 | 27970.863 |
| 9 | 0.000 | 111.446 | 133.612 | 69713.376 | 12659.125 |
| 10 | 5762.562 | 86.447 | 0.000 | 0.000 | 0.000 |
| 11 | -47.435 | 165.611 | 146.712 | 0.000 | 0.000 |
| 12 | 0.986 | 0.177 | 0.180 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.012 | | 34926070.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.222 | 20.268 | 3.537 | 23.804 | 32.414 |
| 2 | 9333.06 | 47.291 | 32.375 | 173.034 | 426.102 |
| 3 | 5.731 | 54.337 | 33.398 | 1744.230 | 6705.245 |
| 4 | 392.074 | 166.095 | 42.043 | 120151.494 | 22877.806 |
| 5 | 1.727 | 70.457 | 4.164 | 120151.494 | 22877.806 |
| 6 | 31.660 | 0.561 | 0.000 | 120271.493 | 23029.806 |
| 7 | 384.076 | 0.276 | 0.509 | 122893.940 | 27922.430 |
| 8 | 1145.212 | 54.193 | 13.100 | 123260.940 | 27970.430 |
| 9 | 0.000 | 111.503 | 133.663 | 69715.557 | 12659.506 |
| 10 | 5762.465 | 86.503 | 0.000 | 0.000 | 0.000 |
| 11 | -47.463 | 165.695 | 146.763 | 0.000 | 0.000 |
| 12 | 0.990 | 0.155 | 0.157 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.063 | | 34927080.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.322 | 16.049 | 2.776 | 18.824 | 32.414 |
| 2 | 7219.99 | 47.022 | 33.233 | 173.047 | 429.06[illegible] |
| 3 | 5.782 | 54.070 | 34.250 | 1744.585 | 6793.163 |
| 4 | 383.543 | 166.179 | 43.055 | 120149.611 | 22877.441 |
| 5 | 1.727 | 70.442 | 4.110 | 120149.611 | 22877.441 |
| 6 | 24.492 | 0.561 | 0.000 | 120269.610 | 23029.441 |
| 7 | 304.130 | 0.276 | 0.509 | 122892.057 | 27922.062 |
| 8 | 898.758 | 54.220 | 13.100 | 123259.057 | 27970.062 |
| 9 | 0.000 | 111.559 | 133.714 | 69717.384 | 12659.824 |
| 10 | 5762.407 | 86.559 | 0.000 | 0.000 | 0.000 |
| 11 | -47.490 | 165.779 | 146.813 | 0.000 | 0.000 |
| 12 | 0.999 | 0.123 | 0.123 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.114 | | 34927912.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.422 | 11.333 | 1.925 | 13.258 | 32.414 |
| 2 | 4858.29 | 46.287 | 34.146 | 173.058 | 434.645 |
| 3 | 5.888 | 53.337 | 35.153 | 1744.863 | 6960.843 |
| 4 | 366.450 | 166.245 | 44.754 | 120148.188 | 22877.158 |
| 5 | 1.727 | 70.430 | 4.011 | 120148.188 | 22877.158 |
| 6 | 16.480 | 0.561 | 0.000 | 120268.187 | 23029.158 |
| 7 | 214.759 | 0.276 | 0.509 | 122890.633 | 27921.776 |
| 8 | 623.293 | 54.248 | 13.100 | 123257.633 | 27969.776 |
| 9 | 0.000 | 111.615 | 133.764 | 69718.752 | 12660.055 |
| 10 | 5762.397 | 86.615 | 0.000 | 0.000 | 0.000 |
| 11 | -47.518 | 165.852 | 146.864 | 0.000 | 0.000 |
| 12 | 1.017 | 0.087 | 0.085 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.165 | | 34928514.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.522 | 7.625 | 1.256 | 8.881 | 32.414 |
| 2 | 3002.80 | 45.073 | 35.759 | 173.069 | 440.254 |
| 3 | 6.071 | 52.123 | 36.757 | 1745.132 | 7128.678 |
| 4 | 338.131 | 166.308 | 46.222 | 120147.196 | 22876.953 |
| 5 | 1.727 | 70.419 | 3.917 | 120147.196 | 22876.953 |
| 6 | 10.186 | 0.561 | 0.000 | 120267.195 | 23028.952 |
| 7 | 144.490 | 0.276 | 0.509 | 122889.641 | 27921.568 |
| 8 | 406.667 | 54.275 | 13.100 | 123256.641 | 27969.568 |
| 9 | 0.000 | 111.671 | 133.815 | 69719.688 | 12660.216 |
| 10 | 5762.434 | 86.671 | 0.000 | 0.000 | 0.000 |
| 11 | -47.545 | 165.946 | 146.915 | 0.000 | 0.000 |
| 12 | 1.049 | 0.058 | 0.056 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.216 | | 34928900.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.622 | 5.267 | 0.830 | 6.097 | 32.414 |
| 2 | 1824.36 | 44.308 | 36.798 | 173.079 | 443.313 |
| 3 | 6.344 | 51.359 | 37.790 | 1745.394 | 7220.219 |
| 4 | 299.223 | 166.367 | 46.937 | 120146.500 | 22876.830 |
| 5 | 1.727 | 70.408 | 3.867 | 120146.500 | 22876.800 |
| 6 | 6.189 | 0.561 | 0.000 | 120266.499 | 23028.800 |
| 7 | 99.807 | 0.276 | 0.509 | 122888.944 | 27921.414 |
| 8 | 268.827 | 54.303 | 13.100 | 123255.944 | 27969.414 |
| 9 | 0.000 | 111.727 | 133.866 | 69720.328 | 12660.319 |
| 10 | 5762.501 | 86.727 | 0.000 | 0.000 | 0.000 |
| 11 | -47.573 | 166.030 | 146.966 | 0.000 | 0.000 |
| 12 | 1.096 | 0.040 | 0.037 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.267 | | 34929138.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.722 | 0.000 | 0.000 | 0.000 | 32.414 |
| 2 | 0.00 | 44.166 | 37.422 | 173.087 | 444.134 |
| 3 | 0.000 | 51.218 | 38.413 | 1745.592 | 7244.776 |
| 4 | 0.000 | 166.412 | 47.126 | 120146.093 | 22876.699 |
| 5 | 1.727 | 70.399 | 3.854 | 120146.093 | 22876.699 |
| 6 | 0.000 | 0.561 | 0.000 | 120266.092 | 23028.699 |
| 7 | 0.000 | 0.276 | 0.509 | 122888.537 | 27921.312 |
| 8 | 0.000 | 54.330 | 13.100 | 123255.537 | 27969.312 |
| 9 | 0.000 | 111.783 | 133.917 | 69720.679 | 12660.370 |
| 10 | 5762.599 | 86.783 | 0.000 | 0.000 | 0.000 |
| 11 | -47.600 | 166.113 | 147.017 | 0.000 | 0.000 |
| 12 | 0.030 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.318 | | 34929233.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 154.822 | 0.000 | 0.000 | 0.000 | 32.414 |
| 2 | 0.30 | 43.458 | 37.887 | 173.092 | 444.435 |
| 3 | 0.030 | 50.519 | 38.877 | 1746.961 | 7273.609 |
| 4 | 0.000 | 166.442 | 47.201 | 120146.037 | 22876.648 |
| 5 | 1.727 | 70.394 | 3.845 | 120146.037 | 22876.648 |
| 6 | 0.030 | 0.561 | 0.000 | 120266.036 | 23028.648 |
| 7 | 0.030 | 0.275 | 0.509 | 122888.481 | 27921.261 |
| 8 | 0.000 | 54.358 | 13.100 | 123255.481 | 27969.261 |
| 9 | 0.030 | 111.839 | 133.968 | 69720.679 | 12660.370 |
| 10 | 5762.795 | 86.839 | 0.000 | 0.000 | 0.000 |
| 11 | -47.628 | 166.197 | 147.068 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 76.369 | | 34929233.000 |

28 September 1966

## TABLE AP 1-2 (Sheet 4 of 7)
## COMPUTER PROGRAM AA89 (2ND BURN)

| | | | | | |
|---|---|---|---|---|---|
| 1 | TIME | WDOTSUBO | WDOTSUBF | WDOTSUBT | DEL |
| 2 | FSUBE | TTPSUBO | TTPSUBF | HSUBO | HSUBF |
| 3 | EMP | POPI | PFPI | VSUBO | VSUBF |
| 4 | ENGINE ISP | TOPI | TFPI | WO PU | WF PU |
| 5 | CSUBFEV | RHOSUBO | RHOSUBF | WOPU USABLE | WFPU USABLE |
| 6 | PCC | WDOTOBO | WDOTFBO | WO USABLE | WF USABLE |
| 7 | LPS | WDOTHF | WDOTFPR | WO IN TANK | WF IN TANK |
| 8 | FPS | TTOHE | TTFHE | WSUBOT | WSUBFT |
| 9 | FSUDAUX | TTOLOX | TTFLH2 | DKID OVB | FUEL OVB |
| 10 | WSUBO ERROR | WOBOT | WFBOT | WDOTOVO | WDOTFVO |
| 11 | WSUBHE | TTMO | TTMF | WOVOT | WFVOT |
| 12 | GGMR | WDOTOGG | WDOTFGG | DRAG | WSUBV |
| 13 | ASUBM | | WFPRT | | IMPSUBT |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 | 0.238 |
| 2 | 0.00 | 35.119 | 36.502 | 173.491 | 388.899 |
| 3 | 0.000 | 42.211 | 37.454 | 1761.086 | 5834.345 |
| 4 | 0.000 | 165.497 | 40.173 | 0.000 | 0.000 |
| 5 | 1.697 | 70.635 | 4.229 | 124270.000 | 24177.000 |
| 6 | 0.000 | 0.095 | 0.000 | 124390.000 | 24329.000 |
| 7 | 0.000 | 0.000 | 0.000 | 124394.000 | 24672.000 |
| 8 | 0.000 | 42.000 | 49.000 | 124761.000 | 24720.000 |
| 9 | 0.000 | 308.000 | 297.000 | 0.000 | 0.000 |
| 10 | 3385.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 11 | 282.000 | 350.000 | 346.000 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.000 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.200 | 0.000 | 0.000 | 0.000 | 0.238 |
| 2 | 0.00 | 35.114 | 36.679 | 173.653 | 395.084 |
| 3 | 0.000 | 42.211 | 37.653 | 1761.333 | 5792.795 |
| 4 | 0.000 | 165.552 | 40.135 | 124269.980 | 24176.998 |
| 5 | 1.697 | 70.625 | 4.259 | 124269.980 | 24176.999 |
| 6 | 0.000 | 0.095 | 0.000 | 124389.980 | 24328.997 |
| 7 | 0.000 | 0.014 | 0.018 | 124393.980 | 24671.997 |
| 8 | 0.000 | 42.001 | 49.000 | 124760.980 | 24719.997 |
| 9 | 0.000 | 308.019 | 297.000 | 0.000 | 0.000 |
| 10 | 3384.993 | 0.019 | 0.000 | 0.000 | 0.000 |
| 11 | 281.999 | 350.021 | 346.000 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.000 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.400 | 0.000 | 0.000 | 0.000 | 0.238 |
| 2 | 0.00 | 35.114 | 36.480 | 173.649 | 395.083 |
| 3 | 0.000 | 42.211 | 37.454 | 1761.300 | 5792.785 |
| 4 | 0.000 | 165.545 | 40.132 | 124269.961 | 24176.994 |
| 5 | 1.697 | 70.626 | 4.259 | 124269.961 | 24176.994 |
| 6 | 0.000 | 0.095 | 0.000 | 124389.961 | 24328.994 |
| 7 | 0.000 | 0.029 | 0.018 | 124393.961 | 24671.994 |
| 8 | 0.000 | 42.006 | 49.000 | 124760.961 | 24719.994 |
| 9 | 0.000 | 308.038 | 297.006 | 0.000 | 0.000 |
| 10 | 3384.992 | 0.038 | 0.000 | 0.000 | 0.000 |
| 11 | 281.994 | 350.044 | 346.006 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.006 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.600 | 0.000 | 1.868 | 1.868 | 0.239 |
| 2 | 0.00 | 35.112 | 36.712 | 173.655 | 395.107 |
| 3 | 0.000 | 42.209 | 37.684 | 1761.452 | 5793.554 |
| 4 | 0.000 | 165.578 | 40.147 | 124269.942 | 24176.850 |
| 5 | 1.697 | 70.620 | 4.259 | 124269.942 | 24176.850 |
| 6 | 0.000 | 0.095 | 0.000 | 124389.942 | 24328.850 |
| 7 | 0.000 | 0.043 | 0.018 | 124393.942 | 24671.849 |
| 8 | 609.790 | 42.013 | 49.000 | 124760.942 | 24719.849 |
| 9 | 0.000 | 308.057 | 297.010 | 0.000 | 0.141 |
| 10 | 3385.691 | 0.057 | 0.000 | 0.000 | 0.000 |
| 11 | 281.997 | 350.070 | 346.010 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.042 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.010 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.800 | 0.000 | 2.867 | 2.867 | 0.204 |
| 2 | 0.00 | 34.799 | 36.009 | 173.667 | 394.645 |
| 3 | 0.000 | 41.895 | 36.981 | 1761.774 | 5779.640 |
| 4 | 0.000 | 165.650 | 39.922 | 124269.923 | 24176.371 |
| 5 | 1.697 | 70.607 | 4.269 | 124269.923 | 24176.371 |
| 6 | 0.000 | 0.095 | 0.000 | 124389.923 | 24328.371 |
| 7 | 0.000 | 0.055 | 0.018 | 124393.923 | 24671.365 |
| 8 | 934.694 | 42.023 | 49.000 | 124760.923 | 24719.365 |
| 9 | 0.000 | 308.076 | 297.013 | 0.000 | 0.622 |
| 10 | 3388.069 | 0.076 | 0.000 | 0.000 | 0.000 |
| 11 | 281.977 | 350.099 | 346.013 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.125 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.013 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.000 | 19.962 | 19.962 | 0.207 |
| 2 | 0.00 | 38.382 | 35.395 | 173.664 | 394.142 |
| 3 | 0.000 | 45.478 | 36.275 | 1761.685 | 5764.535 |
| 4 | 0.000 | 165.630 | 39.678 | 124269.904 | 24174.662 |
| 5 | 1.697 | 70.611 | 4.280 | 124269.904 | 24174.662 |
| 6 | 0.000 | 0.095 | 0.000 | 124389.904 | 24326.662 |
| 7 | 0.000 | 0.058 | 0.018 | 124393.904 | 24669.640 |
| 8 | 6498.510 | 42.034 | 49.000 | 124760.904 | 24717.640 |
| 9 | 0.000 | 308.095 | 297.017 | 0.000 | 2.343 |
| 10 | 3396.593 | 0.095 | 0.000 | 0.000 | 0.000 |
| 11 | 281.966 | 350.129 | 346.017 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.872 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.017 | | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.200 | 40.148 | 40.319 | 80.467 | 0.231 |
| 2 | 5281.01 | 31.471 | 35.819 | 173.675 | 393.484 |
| 3 | 0.996 | 38.532 | 36.419 | 1761.946 | 5744.824 |
| 4 | 65.629 | 165.690 | 39.337 | 124269.215 | 24168.302 |
| 5 | 1.696 | 70.600 | 4.293 | 124269.215 | 24168.302 |
| 6 | 18.234 | 0.095 | 0.000 | 124389.215 | 24326.301 |
| 7 | 841.113 | 0.060 | 0.018 | 124393.215 | 24663.220 |
| 8 | 13088.391 | 42.046 | 49.000 | 124760.215 | 24711.220 |
| 9 | 0.000 | 308.114 | 297.020 | 0.670 | 8.759 |
| 10 | 3427.708 | 0.114 | 0.000 | 0.000 | 0.000 |
| 11 | 281.954 | 350.160 | 346.020 | 0.000 | 0.000 |
| 12 | 0.180 | 0.317 | 1.759 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.020 | | 257.717 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.400 | 80.859 | 44.719 | 125.578 | 0.354 |
| 2 | 9182.80 | 37.758 | 36.196 | 173.689 | 393.526 |
| 3 | 1.808 | 44.720 | 36.710 | 1762.317 | 5746.058 |
| 4 | 73.124 | 165.822 | 39.443 | 124252.912 | 24160.122 |
| 5 | 1.697 | 70.576 | 4.291 | 124252.912 | 24160.122 |
| 6 | 31.683 | 0.095 | 0.000 | 124372.912 | 24312.122 |
| 7 | 1686.093 | 0.063 | 0.018 | 124376.912 | 24654.965 |
| 8 | 14523.160 | 42.058 | 49.000 | 124743.912 | 24702.965 |
| 9 | 0.000 | 308.133 | 297.024 | 16.954 | 17.011 |
| 10 | 3452.302 | 0.133 | 0.000 | 0.000 | 0.000 |
| 11 | 281.942 | 350.192 | 346.024 | 0.000 | 0.000 |
| 12 | 0.326 | 0.637 | 1.952 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.024 | | 1553.711 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.600 | 11.856 | 52.843 | 64.738 | 0.239 |
| 2 | 31923.64 | 38.175 | 36.417 | 173.653 | 392.659 |
| 3 | 0.224 | 45.266 | 35.751 | 1761.659 | 5720.052 |
| 4 | 493.118 | 165.713 | 39.054 | 124240.928 | 24150.221 |
| 5 | 1.697 | 70.596 | 4.309 | 124240.928 | 24150.221 |
| 6 | 110.145 | 0.095 | 0.000 | 124360.928 | 24302.220 |
| 7 | 247.112 | 0.066 | 0.018 | 124364.928 | 24644.971 |
| 8 | 17115.392 | 42.071 | 49.000 | 124731.928 | 24692.971 |
| 9 | 0.000 | 308.153 | 297.027 | 28.919 | 27.001 |
| 10 | 3489.824 | 0.153 | 0.000 | 0.000 | 0.000 |
| 11 | 281.929 | 350.224 | 346.027 | 0.000 | 0.000 |
| 12 | 0.040 | 0.093 | 2.306 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.027 | | 5539.967 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.800 | 73.515 | 53.693 | 127.208 | 0.238 |
| 2 | 61320.59 | 37.006 | 35.540 | 173.630 | 391.339 |
| 3 | 1.369 | 43.992 | 35.857 | 1760.806 | 5680.463 |
| 4 | 482.049 | 165.549 | 38.408 | 124233.618 | 24139.670 |
| 5 | 1.697 | 70.625 | 4.337 | 124233.618 | 24139.670 |
| 6 | 211.612 | 0.095 | 0.000 | 124353.618 | 24291.670 |
| 7 | 1533.349 | 0.069 | 0.018 | 124357.618 | 24634.323 |
| 8 | 17289.917 | 42.085 | 49.000 | 124724.618 | 24682.323 |
| 9 | 0.000 | 308.172 | 297.031 | 36.210 | 37.646 |
| 10 | 3535.268 | 0.172 | 0.000 | 0.000 | 0.000 |
| 11 | 281.915 | 350.256 | 346.031 | 0.000 | 0.000 |
| 12 | 0.248 | 0.579 | 2.339 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.031 | | 14727.859 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.000 | 150.052 | 55.139 | 205.190 | 0.238 |
| 2 | 93716.57 | 36.451 | 36.217 | 173.591 | 390.693 |
| 3 | 2.721 | 43.104 | 36.500 | 1759.814 | 5661.095 |
| 4 | 456.731 | 165.399 | 38.122 | 124211.233 | 24128.882 |
| 5 | 1.697 | 70.653 | 4.350 | 124211.233 | 24128.882 |
| 6 | 323.453 | 0.095 | 0.000 | 124331.233 | 24280.882 |
| 7 | 3131.077 | 0.072 | 0.018 | 124335.233 | 24623.434 |
| 8 | 17702.226 | 42.099 | 49.000 | 124702.233 | 24671.434 |
| 9 | 0.000 | 308.191 | 297.035 | 58.575 | 48.531 |
| 10 | 3566.822 | 0.191 | 0.000 | 0.000 | 0.000 |
| 11 | 281.901 | 350.289 | 346.035 | 0.000 | 0.000 |
| 12 | 0.493 | 1.183 | 2.399 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.035 | | 30176.264 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.200 | 200.649 | 57.934 | 258.583 | 0.238 |
| 2 | 125643.79 | 36.588 | 36.133 | 173.567 | 390.340 |
| 3 | 3.463 | 42.896 | 36.344 | 1758.669 | 5650.501 |
| 4 | 485.893 | 165.255 | 37.977 | 124176.154 | 24117.683 |
| 5 | 1.697 | 70.679 | 4.356 | 124176.154 | 24117.683 |
| 6 | 433.640 | 0.095 | 0.000 | 124296.154 | 24269.683 |
| 7 | 4185.820 | 0.075 | 0.041 | 124300.154 | 24612.131 |
| 8 | 18583.525 | 42.113 | 49.000 | 124667.154 | 24660.131 |
| 9 | 0.000 | 308.210 | 297.040 | 93.636 | 59.828 |
| 10 | 3587.738 | 0.210 | 0.000 | 0.000 | 0.000 |
| 11 | 281.886 | 350.323 | 346.040 | 0.000 | 0.000 |
| 12 | 0.628 | 1.582 | 2.521 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.041 | | 52185.665 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.400 | 250.945 | 62.472 | 313.457 | 0.238 |
| 2 | 152217.98 | 35.737 | 37.998 | 173.496 | 390.154 |
| 3 | 4.018 | 41.605 | 38.085 | 1757.355 | 5644.921 |
| 4 | 485.610 | 165.104 | 37.953 | 124130.957 | 24105.799 |
| 5 | 1.696 | 70.706 | 4.358 | 124130.957 | 24105.799 |
| 6 | 525.446 | 0.095 | 0.000 | 124250.957 | 24257.799 |
| 7 | 5239.728 | 0.078 | 0.064 | 124254.957 | 24600.137 |
| 8 | 20014.754 | 42.129 | 49.000 | 124621.957 | 24648.137 |
| 9 | 0.000 | 308.229 | 297.051 | 138.813 | 71.812 |
| 10 | 3601.961 | 0.229 | 0.000 | 0.000 | 0.000 |
| 11 | 281.871 | 350.357 | 346.051 | 0.000 | 0.000 |
| 12 | 0.729 | 1.980 | 2.716 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.051 | | 80125.715 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.600 | 298.639 | 68.833 | 367.472 | 0.238 |
| 2 | 173149.74 | 35.543 | 36.112 | 173.461 | 390.047 |
| 3 | 4.339 | 40.903 | 36.009 | 1756.458 | 5641.695 |
| 4 | 471.192 | 165.078 | 37.917 | 124075.839 | 24092.829 |
| 5 | 1.696 | 70.710 | 4.358 | 124075.839 | 24092.829 |
| 6 | 597.683 | 0.095 | 0.000 | 124195.839 | 24244.829 |
| 7 | 6236.130 | 0.110 | 0.087 | 124199.839 | 24587.037 |
| 8 | 22084.394 | 42.146 | 49.000 | 124566.839 | 24635.037 |
| 9 | 0.000 | 308.248 | 297.066 | 193.913 | 84.897 |
| 10 | 3611.737 | 0.248 | 0.000 | 0.000 | 0.000 |
| 11 | 281.854 | 350.394 | 346.066 | 0.000 | 0.000 |
| 12 | 0.786 | 2.355 | 2.996 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.066 | | 112740.438 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2.800 | 334.583 | 75.345 | 409.928 | 0.238 |
| 2 | 188962.94 | 34.925 | 36.102 | 173.421 | 389.826 |
| 3 | 4.441 | 39.845 | 35.786 | 1755.429 | 5635.056 |
| 4 | 460.966 | 165.049 | 37.854 | 124012.127 | 24078.486 |
| 5 | 1.696 | 70.716 | 4.361 | 124012.127 | 24078.486 |
| 6 | 652.330 | 0.095 | 0.000 | 124132.127 | 24230.486 |
| 7 | 6991.775 | 0.173 | 0.111 | 124136.127 | 24572.569 |
| 8 | 24170.020 | 42.174 | 49.000 | 124503.127 | 24620.569 |
| 9 | 0.000 | 308.267 | 297.086 | 257.695 | 99.345 |
| 10 | 3619.498 | 0.267 | 0.000 | 0.000 | 0.000 |
| 11 | 281.826 | 350.441 | 346.086 | 0.000 | 0.000 |
| 12 | 0.805 | 2.639 | 3.280 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.086 | | 149157.586 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 3.000 | 358.756 | 80.284 | 439.040 | 0.238 |
| 2 | 196402.45 | 37.001 | 39.952 | 173.375 | 389.549 |
| 3 | 4.469 | 41.596 | 39.461 | 1754.247 | 5626.753 |
| 4 | 447.345 | 165.005 | 37.825 | 123942.257 | 24062.994 |
| 5 | 1.696 | 70.723 | 4.364 | 123942.257 | 24062.994 |
| 6 | 677.967 | 0.095 | 0.000 | 124062.257 | 24214.994 |
| 7 | 7488.216 | 0.235 | 0.134 | 124066.257 | 24556.933 |
| 8 | 25688.730 | 42.215 | 49.000 | 124433.257 | 24604.933 |
| 9 | 0.000 | 308.286 | 297.110 | 327.457 | 114.956 |
| 10 | 3627.286 | 0.286 | 0.000 | 0.000 | 0.000 |
| 11 | 281.785 | 350.501 | 346.110 | 0.000 | 0.000 |
| 12 | 0.811 | 2.830 | 3.493 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.110 | | 187835.990 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 5.000 | 386.151 | 80.846 | 466.998 | 0.107 |
| 2 | 198135.88 | 35.162 | 36.753 | 172.878 | 388.291 |
| 3 | 4.776 | 39.352 | 36.239 | 1741.459 | 5588.905 |
| 4 | 424.276 | 164.535 | 37.765 | 123183.718 | 23901.950 |
| 5 | 1.697 | 70.807 | 4.365 | 123183.718 | 23901.950 |
| 6 | 683.860 | 0.095 | 0.000 | 123303.718 | 24053.949 |
| 7 | 8059.531 | 0.234 | 0.365 | 123307.718 | 24394.390 |
| 8 | 25985.329 | 42.688 | 49.000 | 123674.718 | 24442.390 |
| 9 | 0.000 | 308.477 | 297.609 | 1085.805 | 277.001 |
| 10 | 3673.970 | 0.477 | 0.000 | 0.000 | 0.000 |
| 11 | 281.311 | 351.165 | 346.609 | 0.000 | 0.000 |
| 12 | 0.863 | 3.044 | 3.528 | 0.000 | 0.000 |
| 13 | 0.000 | | 0.609 | | 581982.555 |

# TABLE AP 1-2 (Sheet 5 of 7)
## COMPUTER PROGRAM AA89 (2ND BURN)

| | | | | | |
|---|---|---|---|---|---|
| 1 | 10.000 | 458.939 | 83.453 | 542.392 | 16.888 |
| 2 | 230222.21 | 35.125 | 36.418 | 171.752 | 385.224 |
| 3 | 5.499 | 38.082 | 35.799 | 1712.457 | 5496.400 |
| 4 | 424.458 | 164.500 | 37.781 | 121137.388 | 23496.509 |
| 5 | 1.726 | 70.811 | 4.366 | 121137.388 | 23496.509 |
| 6 | 780.864 | 0.095 | 0.000 | 121257.388 | 23648.508 |
| 7 | 8689.179 | 0.257 | 0.479 | 121261.388 | 23985.176 |
| 8 | 26995.386 | 43.879 | 49.000 | 121628.388 | 24033.176 |
| 9 | 0.000 | 308.953 | 299.728 | 3131.658 | 684.095 |
| 10 | 3654.846 | 0.953 | 0.000 | 0.000 | 0.000 |
| 11 | 280.121 | 352.832 | 348.728 | 0.000 | 0.000 |
| 12 | 0.954 | 3.519 | 3.687 | 0.000 | 0.000 |
| 13 | 0.000 | | 2.728 | | 1625469.188 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 20.000 | 459.465 | 83.402 | 542.868 | 32.408 |
| 2 | 230375.10 | 34.560 | 35.822 | 169.245 | 378.921 |
| 3 | 5.509 | 37.404 | 35.188 | 1647.916 | 5306.230 |
| 4 | 424.367 | 164.562 | 37.812 | 116541.042 | 22665.309 |
| 5 | 1.727 | 70.796 | 4.362 | 116541.042 | 22665.309 |
| 6 | 781.245 | 0.095 | 0.000 | 116661.042 | 22817.309 |
| 7 | 8693.579 | 0.317 | 0.494 | 116665.042 | 23146.232 |
| 8 | 27005.956 | 46.779 | 49.000 | 117032.042 | 23194.232 |
| 9 | 0.000 | 309.907 | 304.614 | 7727.051 | 1518.154 |
| 10 | 3214.541 | 1.907 | 0.000 | 0.000 | 0.000 |
| 11 | 277.220 | 356.686 | 353.614 | 0.000 | 0.000 |
| 12 | 0.955 | 3.521 | 3.688 | 0.000 | 0.000 |
| 13 | 0.000 | | 7.614 | | 3929494.125 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 30.000 | 459.340 | 83.299 | 542.639 | 32.485 |
| 2 | 230249.22 | 34.402 | 34.305 | 166.735 | 372.557 |
| 3 | 5.514 | 37.144 | 33.659 | 1583.281 | 5114.181 |
| 4 | 424.314 | 164.609 | 37.793 | 111944.577 | 21834.549 |
| 5 | 1.727 | 70.782 | 4.362 | 111944.577 | 21834.549 |
| 6 | 780.794 | 0.095 | 0.000 | 112064.577 | 21986.549 |
| 7 | 8692.515 | 0.348 | 0.498 | 112068.577 | 22307.749 |
| 8 | 26997.968 | 50.133 | 49.000 | 112435.577 | 22355.749 |
| 9 | 0.000 | 310.860 | 309.587 | 12322.562 | 2351.663 |
| 10 | 2771.833 | 2.860 | 0.000 | 0.000 | 0.000 |
| 11 | 273.866 | 360.993 | 358.587 | 0.000 | 0.000 |
| 12 | 0.955 | 3.520 | 3.686 | 0.000 | 0.000 |
| 13 | 0.000 | | 12.588 | | 6233131.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 40.000 | 459.722 | 83.295 | 543.017 | 32.546 |
| 2 | 230386.57 | 35.587 | 34.022 | 164.221 | 366.213 |
| 3 | 5.519 | 38.218 | 33.360 | 1518.568 | 4922.747 |
| 4 | 424.271 | 164.640 | 37.804 | 107348.738 | 21004.095 |
| 5 | 1.727 | 70.772 | 4.361 | 107348.738 | 21004.095 |
| 6 | 781.176 | 0.095 | 0.000 | 107468.738 | 21156.095 |
| 7 | 8693.959 | 0.363 | 0.498 | 107472.738 | 21469.567 |
| 8 | 27005.345 | 53.692 | 49.000 | 107839.738 | 21517.567 |
| 9 | 0.000 | 311.813 | 314.556 | 16917.447 | 3184.876 |
| 10 | 2328.263 | 3.814 | 0.000 | 0.000 | 0.000 |
| 11 | 270.307 | 365.505 | 363.556 | 0.000 | 0.000 |
| 12 | 0.955 | 3.522 | 3.686 | 0.000 | 0.000 |
| 13 | 0.000 | | 17.557 | | 8536312.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 50.000 | 459.497 | 83.315 | 542.812 | 32.349 |
| 2 | 230319.35 | 35.369 | 34.904 | 161.714 | 359.904 |
| 3 | 5.515 | 37.900 | 34.225 | 1454.012 | 4732.341 |
| 4 | 424.308 | 164.719 | 37.855 | 102752.612 | 20173.727 |
| 5 | 1.727 | 70.754 | 4.360 | 102752.612 | 20173.727 |
| 6 | 781.006 | 0.095 | 0.000 | 102872.612 | 20325.727 |
| 7 | 8693.792 | 0.373 | 0.500 | 102876.612 | 20631.471 |
| 8 | 27007.794 | 57.372 | 49.000 | 103243.612 | 20679.471 |
| 9 | 0.000 | 312.766 | 319.542 | 21912.620 | 4017.985 |
| 10 | 1883.979 | 4.767 | 0.000 | 0.000 | 0.000 |
| 11 | 266.627 | 370.138 | 368.542 | 0.000 | 0.000 |
| 12 | 0.955 | 3.521 | 3.686 | 0.000 | 0.000 |
| 13 | 0.000 | | 22.543 | | 10839516.250 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 60.000 | 459.627 | 83.291 | 542.918 | 32.479 |
| 2 | 230348.62 | 35.982 | 34.672 | 159.202 | 353.582 |
| 3 | 5.518 | 38.406 | 33.978 | 1389.356 | 4541.558 |
| 4 | 424.279 | 164.781 | 37.883 | 99155.874 | 19343.719 |
| 5 | 1.727 | 70.738 | 4.358 | 99155.874 | 19343.719 |
| 6 | 781.066 | 0.095 | 0.000 | 98275.874 | 19495.719 |
| 7 | 8694.345 | 0.379 | 0.502 | 98279.874 | 19793.739 |
| 8 | 27011.993 | 61.137 | 49.000 | 98646.874 | 19841.739 |
| 9 | 0.000 | 313.720 | 324.550 | 26108.404 | 4850.710 |
| 10 | 1437.277 | 5.721 | 0.000 | 0.000 | 0.000 |
| 11 | 262.861 | 374.857 | 373.550 | 0.000 | 0.000 |
| 12 | 0.955 | 3.521 | 3.686 | 0.000 | 0.000 |
| 13 | 0.000 | | 27.551 | | 13142646.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 70.000 | 459.662 | 83.217 | 542.879 | 32.076 |
| 2 | 230303.98 | 36.380 | 33.766 | 156.690 | 347.279 |
| 3 | 5.524 | 38.699 | 33.058 | 1324.665 | 4351.331 |
| 4 | 424.227 | 164.844 | 37.914 | 93558.725 | 18513.964 |
| 5 | 1.727 | 70.722 | 4.356 | 93558.725 | 18513.964 |
| 6 | 780.871 | 0.095 | 0.000 | 93678.725 | 18665.964 |
| 7 | 8694.001 | 0.385 | 0.504 | 93682.725 | 18956.261 |
| 8 | 27013.207 | 64.960 | 49.000 | 94049.725 | 19004.261 |
| 9 | 0.000 | 314.673 | 329.579 | 30704.601 | 5683.158 |
| 10 | 988.905 | 6.674 | 0.000 | 0.000 | 0.000 |
| 11 | 259.039 | 379.633 | 379.579 | 0.000 | 0.000 |
| 12 | 0.956 | 3.521 | 3.685 | 0.000 | 0.000 |
| 13 | 0.000 | | 32.581 | | 15445712.750 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 80.000 | 459.646 | 83.209 | 542.856 | 25.608 |
| 2 | 230292.79 | 37.519 | 33.648 | 154.178 | 340.896 |
| 3 | 5.524 | 39.734 | 32.925 | 1259.997 | 4158.707 |
| 4 | 424.225 | 164.906 | 37.902 | 89962.057 | 17684.355 |
| 5 | 1.727 | 70.703 | 4.357 | 89962.057 | 17684.355 |
| 6 | 780.832 | 0.095 | 0.000 | 89082.057 | 17836.355 |
| 7 | 8693.181 | 0.387 | 0.506 | 89086.057 | 18118.933 |
| 8 | 27011.280 | 68.818 | 49.000 | 89453.057 | 18166.933 |
| 9 | 0.000 | 315.626 | 334.631 | 35300.315 | 6515.435 |
| 10 | 540.279 | 7.628 | 0.000 | 0.000 | 0.000 |
| 11 | 255.180 | 384.444 | 383.631 | 0.000 | 0.000 |
| 12 | 0.956 | 3.521 | 3.685 | 0.000 | 0.000 |
| 13 | 0.000 | | 37.632 | | 17748470.250 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 90.000 | 459.129 | 83.166 | 542.295 | 17.041 |
| 2 | 230069.90 | 37.673 | 33.672 | 151.667 | 334.591 |
| 3 | 5.521 | 39.793 | 32.934 | 1195.344 | 3968.408 |
| 4 | 424.252 | 164.969 | 37.949 | 84368.484 | 16855.125 |
| 5 | 1.727 | 70.685 | 4.355 | 84368.484 | 16855.125 |
| 6 | 780.165 | 0.095 | 0.000 | 84488.484 | 17007.125 |
| 7 | 8689.807 | 0.388 | 0.503 | 84492.484 | 17281.985 |
| 8 | 27005.944 | 72.693 | 49.000 | 84859.484 | 17329.985 |
| 9 | 0.000 | 316.580 | 339.699 | 39892.934 | 7347.314 |
| 10 | 92.858 | 8.581 | 0.000 | 0.000 | 0.000 |
| 11 | 251.305 | 389.273 | 388.699 | 0.000 | 0.000 |
| 12 | 0.955 | 3.517 | 3.683 | 0.000 | 0.000 |
| 13 | 0.000 | | 42.700 | | 20049783.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 100.000 | 427.370 | 81.485 | 508.855 | 9.121 |
| 2 | 217137.65 | 38.150 | 32.776 | 149.227 | 328.292 |
| 3 | 5.245 | 40.711 | 32.084 | 1132.526 | 3778.318 |
| 4 | 426.718 | 165.031 | 37.949 | 79907.249 | 16032.844 |
| 5 | 1.713 | 70.666 | 4.354 | 79907.249 | 16032.844 |
| 6 | 742.243 | 0.095 | 0.000 | 80027.249 | 16184.844 |
| 7 | 8463.473 | 0.399 | 0.479 | 80031.249 | 16452.052 |
| 8 | 26411.500 | 76.584 | 49.000 | 80398.249 | 16500.052 |
| 9 | 0.000 | 317.533 | 344.617 | 44353.216 | 8172.336 |
| 10 | -256.971 | 9.935 | 0.000 | 0.000 | 0.000 |
| 11 | 247.414 | 394.118 | 393.610 | 0.000 | 0.000 |
| 12 | 0.924 | 3.315 | 3.590 | 0.000 | 0.000 |
| 13 | 0.000 | | 47.612 | | 22297325.750 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 110.000 | 403.291 | 80.315 | 483.606 | 2.971 |
| 2 | 207411.36 | 38.779 | 33.824 | 146.965 | 322.126 |
| 3 | 5.021 | 41.632 | 33.160 | 1074.278 | 3592.277 |
| 4 | 428.885 | 165.094 | 37.984 | 75771.776 | 15227.438 |
| 5 | 1.761 | 70.648 | 4.354 | 75771.776 | 15227.438 |
| 6 | 713.810 | 0.095 | 0.000 | 75891.776 | 15379.438 |
| 7 | 8252.771 | 0.394 | 0.455 | 75895.776 | 15639.150 |
| 8 | 25968.200 | 80.504 | 49.000 | 76262.776 | 15687.150 |
| 9 | 0.000 | 318.486 | 349.281 | 48487.735 | 8980.566 |
| 10 | -365.414 | 10.488 | 0.000 | 0.000 | 0.000 |
| 11 | 243.494 | 398.990 | 398.281 | 0.000 | 0.000 |
| 12 | 0.898 | 3.162 | 3.521 | 0.000 | 0.000 |
| 13 | 0.000 | | 52.283 | | 26412557.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 120.000 | 395.007 | 79.930 | 474.937 | 0.238 |
| 2 | 204079.98 | 39.565 | 34.130 | 144.692 | 315.987 |
| 3 | 4.942 | 42.451 | 33.465 | 1018.143 | 3407.094 |
| 4 | 429.699 | 165.157 | 37.980 | 71787.660 | 14429.994 |
| 5 | 1.697 | 70.630 | 4.354 | 71787.660 | 14429.994 |
| 6 | 704.088 | 0.095 | 0.000 | 71907.660 | 14581.993 |
| 7 | 8233.437 | 0.292 | 0.431 | 71911.660 | 14834.284 |
| 8 | 25814.367 | 84.308 | 49.000 | 72278.660 | 14882.284 |
| 9 | 0.000 | 319.439 | 353.712 | 52470.897 | 9781.062 |
| 10 | -362.307 | 11.442 | 0.000 | 0.000 | 0.000 |
| 11 | 239.690 | 403.748 | 402.712 | 0.000 | 0.000 |
| 12 | 0.889 | 3.110 | 3.498 | 0.000 | 0.000 |
| 13 | 0.000 | | 56.714 | | 26486318.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 130.000 | 393.183 | 79.815 | 472.998 | -1.047 |
| 2 | 203322.47 | 38.624 | 33.650 | 142.429 | 309.914 |
| 3 | 4.926 | 41.444 | 32.973 | 962.548 | 3223.973 |
| 4 | 429.859 | 165.216 | 38.012 | 67844.519 | 13634.753 |
| 5 | 1.696 | 70.613 | 4.352 | 67844.519 | 13634.753 |
| 6 | 701.851 | 0.095 | 0.000 | 67964.519 | 13786.753 |
| 7 | 8222.020 | 0.276 | 0.407 | 67968.519 | 14031.643 |
| 8 | 25782.611 | 87.107 | 49.000 | 68335.519 | 14079.643 |
| 9 | 0.000 | 320.393 | 357.902 | 56413.086 | 10579.453 |
| 10 | -329.246 | 12.395 | 0.000 | 0.000 | 0.000 |
| 11 | 236.891 | 407.500 | 406.902 | 0.000 | 0.000 |
| 12 | 0.887 | 3.098 | 3.492 | 0.000 | 0.000 |
| 13 | 0.000 | | 60.904 | | 28503538.750 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 140.000 | 391.598 | 79.646 | 471.244 | -1.310 |
| 2 | 202611.11 | 38.385 | 32.532 | 140.105 | 303.855 |
| 3 | 4.917 | 41.132 | 31.846 | 907.192 | 3041.276 |
| 4 | 429.949 | 165.280 | 38.043 | 63919.438 | 12840.661 |
| 5 | 1.696 | 70.595 | 4.350 | 63919.438 | 12840.661 |
| 6 | 699.693 | 0.095 | 0.000 | 64039.438 | 12992.661 |
| 7 | 8210.818 | 0.274 | 0.407 | 64043.439 | 13230.161 |
| 8 | 25753.188 | 89.858 | 49.000 | 64410.438 | 13278.161 |
| 9 | 0.000 | 321.346 | 361.971 | 60337.214 | 11376.865 |
| 10 | -283.869 | 13.348 | 0.000 | 0.000 | 0.000 |
| 11 | 234.139 | 411.295 | 410.971 | 0.000 | 0.000 |
| 12 | 0.886 | 3.088 | 3.485 | 0.000 | 0.000 |
| 13 | 0.000 | | 64.973 | | 30533340.750 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 150.000 | 388.664 | 78.764 | 467.428 | -1.868 |
| 2 | 200843.01 | 38.461 | 33.438 | 137.752 | 297.819 |
| 3 | 4.935 | 41.156 | 32.768 | 852.168 | 2857.885 |
| 4 | 429.677 | 165.344 | 38.074 | 60021.653 | 12048.193 |
| 5 | 1.695 | 70.580 | 4.349 | 60021.653 | 12048.193 |
| 6 | 693.904 | 0.095 | 0.000 | 60141.653 | 12200.192 |
| 7 | 8182.989 | 0.273 | 1.143 | 60145.653 | 12630.317 |
| 8 | 25683.754 | 92.591 | 49.000 | 60512.653 | 12678.317 |
| 9 | 0.000 | 322.299 | 370.860 | 64234.044 | 12167.820 |
| 10 | -219.309 | 14.302 | 0.000 | 0.000 | 0.000 |
| 11 | 231.406 | 414.891 | 419.860 | 0.000 | 0.000 |
| 12 | 0.882 | 3.063 | 3.474 | 0.000 | 0.000 |
| 13 | 0.000 | | 73.863 | | 32548678.750 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 160.000 | 392.943 | 78.961 | 471.905 | -1.015 |
| 2 | 202562.49 | 38.051 | 33.757 | 135.346 | 291.825 |
| 3 | 4.976 | 40.581 | 33.064 | 797.023 | 2675.708 |
| 4 | 429.244 | 165.422 | 38.144 | 56116.748 | 11255.625 |
| 5 | 1.697 | 70.564 | 4.347 | 56116.748 | 11255.625 |
| 6 | 698.920 | 0.095 | 0.000 | 56236.748 | 11407.625 |
| 7 | 8215.123 | 0.407 | 1.157 | 56240.748 | 11630.374 |
| 8 | 25770.387 | 96.129 | 49.000 | 56607.748 | 11678.374 |
| 9 | 0.000 | 323.253 | 382.399 | 68137.996 | 12956.224 |
| 10 | -161.377 | 15.255 | 0.000 | 0.000 | 0.000 |
| 11 | 227.868 | 419.382 | 431.399 | 0.000 | 0.000 |
| 12 | 0.886 | 3.090 | 3.486 | 0.000 | 0.000 |
| 13 | 0.000 | | 85.402 | | 34563401.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 170.000 | 393.414 | 79.025 | 472.439 | -1.000 |
| 2 | 202784.19 | 39.451 | 34.477 | 132.857 | 285.763 |
| 3 | 4.978 | 41.871 | 33.767 | 741.481 | 2491.203 |
| 4 | 429.229 | 165.516 | 38.149 | 52183.430 | 10461.758 |
| 5 | 1.697 | 70.545 | 4.347 | 52183.430 | 10461.758 |
| 6 | 699.603 | 0.095 | 0.000 | 52303.430 | 10613.758 |
| 7 | 8218.209 | 0.412 | 1.160 | 52307.430 | 10829.119 |
| 8 | 25780.909 | 100.227 | 49.000 | 52674.430 | 10877.119 |
| 9 | 0.000 | 324.206 | 393.980 | 72070.361 | 13745.899 |
| 10 | -125.359 | 16.209 | 0.000 | 0.000 | 0.000 |
| 11 | 222.770 | 424.433 | 442.980 | 0.000 | 0.000 |
| 12 | 0.887 | 3.093 | 3.488 | 0.000 | 0.000 |
| 13 | 0.000 | | 96.982 | | 36590112.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 180.000 | 393.972 | 78.982 | 472.955 | -0.031 |
| 2 | 202955.78 | 39.084 | 33.825 | 130.283 | 279.758 |
| 3 | 4.988 | 41.388 | 33.101 | 685.436 | 2308.389 |
| 4 | 429.123 | 165.609 | 38.207 | 48244.962 | 9667.641 |
| 5 | 1.698 | 70.525 | 4.344 | 48244.962 | 9667.641 |
| 6 | 700.047 | 0.095 | 0.000 | 48364.962 | 9819.641 |
| 7 | 8222.204 | 0.284 | 1.163 | 48368.962 | 10027.612 |
| 8 | 25794.982 | 103.586 | 49.000 | 48735.962 | 10075.612 |
| 9 | 0.000 | 325.159 | 405.591 | 76007.875 | 14535.793 |
| 10 | -93.245 | 17.167 | 0.000 | 0.000 | 0.000 |
| 11 | 220.411 | 428.745 | 454.591 | 0.000 | 0.000 |
| 12 | 0.887 | 3.096 | 3.488 | 0.000 | 0.000 |
| 13 | 0.000 | | 108.595 | | 38618879.500 |

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TABLE AP 1-2 (Sheet 6 of 7)
COMPUTER PROGRAM AA89 (2ND BURN)

| | | | | | |
|---|---|---|---|---|---|
| 1 | 190.000 | 394.191 | 78.968 | 473.159 | 0.335 |
| 2 | 203024.85 | 39.077 | 33.766 | 127.632 | 273.724 |
| 3 | 4.992 | 41.270 | 33.027 | 630.041 | 2124.690 |
| 4 | 429.084 | 165.669 | 38.246 | 44303.964 | 8873.342 |
| 5 | 1.698 | 70.516 | 4.342 | 44303.964 | 8873.342 |
| 6 | 700.228 | 0.095 | 0.000 | 44423.964 | 9025.342 |
| 7 | 8224.162 | 0.279 | 1.166 | 44427.964 | 9225.920 |
| 8 | 25802.362 | 106.398 | 49.000 | 44794.964 | 9273.920 |
| 9 | 0.000 | 326.113 | 417.235 | 79947.920 | 15325.842 |
| 10 | -62.744 | 18.116 | 0.000 | 0.000 | 0.000 |
| 11 | 217.599 | 432.511 | 466.235 | 0.000 | 0.000 |
| 12 | 0.888 | 3.097 | 3.489 | 0.000 | 0.000 |
| 13 | 0.000 | | 120.238 | | 42648688.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 200.000 | 398.564 | 79.226 | 477.790 | 1.917 |
| 2 | 204825.95 | 38.895 | 34.554 | 124.851 | 267.667 |
| 3 | 5.031 | 40.906 | 33.790 | 574.010 | 1940.299 |
| 4 | 428.695 | 165.778 | 38.281 | 40342.830 | 8078.148 |
| 5 | 1.700 | 70.499 | 4.341 | 40342.830 | 8078.148 |
| 6 | 705.531 | 0.095 | 0.000 | 40462.830 | 8230.148 |
| 7 | 8256.995 | 0.278 | 1.169 | 40466.830 | 8423.326 |
| 8 | 25888.759 | 109.178 | 49.000 | 40833.830 | 8471.326 |
| 9 | 0.000 | 327.066 | 428.910 | 83908.101 | 16116.761 |
| 10 | -47.910 | 19.069 | 0.000 | 0.000 | 0.000 |
| 11 | 214.818 | 436.245 | 477.910 | 0.000 | 0.000 |
| 12 | 0.892 | 3.125 | 3.502 | 0.000 | 0.000 |
| 13 | 0.000 | | 131.913 | | 42686547.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 210.000 | 403.587 | 79.447 | 483.033 | 3.375 |
| 2 | 206836.21 | 38.615 | 34.514 | 121.974 | 261.604 |
| 3 | 5.080 | 40.429 | 33.727 | 517.353 | 1755.697 |
| 4 | 428.203 | 165.988 | 38.324 | 36339.599 | 7280.824 |
| 5 | 1.703 | 70.481 | 4.339 | 36339.599 | 7280.824 |
| 6 | 711.388 | 0.095 | 0.000 | 36459.599 | 7432.824 |
| 7 | 8293.830 | 0.278 | 1.185 | 36463.599 | 7618.582 |
| 8 | 25985.762 | 111.958 | 49.000 | 36830.599 | 7666.582 |
| 9 | 0.000 | 328.019 | 440.668 | 87910.378 | 16909.746 |
| 10 | -64.523 | 20.023 | 0.000 | 0.000 | 0.000 |
| 11 | 212.038 | 439.978 | 489.668 | 0.000 | 0.000 |
| 12 | 0.898 | 3.157 | 3.516 | 0.000 | 0.000 |
| 13 | 0.000 | | 143.671 | | 44741425.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 220.000 | 403.630 | 79.446 | 483.076 | 3.475 |
| 2 | 206851.48 | 38.326 | 35.104 | 118.857 | 255.540 |
| 3 | 5.081 | 40.011 | 34.301 | 460.079 | 1571.029 |
| 4 | 428.196 | 166.044 | 38.415 | 32290.867 | 6481.380 |
| 5 | 1.703 | 70.455 | 4.336 | 32290.867 | 6481.380 |
| 6 | 711.431 | 0.095 | 0.000 | 32410.867 | 6633.380 |
| 7 | 8296.018 | 0.278 | 1.185 | 32414.867 | 6811.698 |
| 8 | 25996.094 | 114.738 | 49.000 | 32781.867 | 6859.698 |
| 9 | 0.000 | 328.972 | 452.518 | 91958.156 | 17704.781 |
| 10 | -116.033 | 20.976 | 0.000 | 0.000 | 0.000 |
| 11 | 209.258 | 443.711 | 501.518 | 0.000 | 0.000 |
| 12 | 0.898 | 3.157 | 3.516 | 0.000 | 0.000 |
| 13 | 0.000 | | 155.521 | | 46814551.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 230.000 | 400.302 | 79.231 | 479.534 | 2.674 |
| 2 | 205466.35 | 38.119 | 34.408 | 115.647 | 249.475 |
| 3 | 5.052 | 39.724 | 33.597 | 403.109 | 1385.436 |
| 4 | 428.471 | 166.172 | 38.426 | 28270.481 | 5683.442 |
| 5 | 1.701 | 70.439 | 4.335 | 28270.481 | 5683.442 |
| 6 | 707.336 | 0.095 | 0.000 | 28390.481 | 5835.442 |
| 7 | 8273.533 | 0.278 | 1.176 | 28394.481 | 6006.334 |
| 8 | 25933.282 | 117.518 | 49.000 | 28761.481 | 6054.334 |
| 9 | 0.000 | 329.926 | 464.294 | 95977.589 | 18498.368 |
| 10 | -146.729 | 21.930 | 0.000 | 0.000 | 0.000 |
| 11 | 206.478 | 447.445 | 513.294 | 0.000 | 0.000 |
| 12 | 0.894 | 3.135 | 3.505 | 0.000 | 0.000 |
| 13 | 0.000 | | 167.298 | | 48876178.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 240.000 | 398.123 | 79.141 | 477.264 | 2.169 |
| 2 | 204597.17 | 37.529 | 35.316 | 112.259 | 243.434 |
| 3 | 5.031 | 39.028 | 34.493 | 346.486 | 1200.604 |
| 4 | 428.688 | 166.311 | 38.504 | 24276.448 | 4887.046 |
| 5 | 1.700 | 70.423 | 4.333 | 24276.448 | 4887.046 |
| 6 | 704.806 | 0.095 | 0.000 | 24396.448 | 5039.046 |
| 7 | 8261.024 | 0.404 | 1.177 | 24400.448 | 5202.527 |
| 8 | 25901.661 | 120.687 | 49.000 | 24767.448 | 5250.527 |
| 9 | 0.000 | 330.879 | 476.054 | 99970.669 | 19290.415 |
| 10 | -158.783 | 22.883 | 0.000 | 0.000 | 0.000 |
| 11 | 203.309 | 451.567 | 525.054 | 0.000 | 0.000 |
| 12 | 0.892 | 3.122 | 3.499 | 0.000 | 0.000 |
| 13 | 0.000 | | 179.058 | | 50926958.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 250.000 | 396.117 | 79.742 | 475.859 | 1.459 |
| 2 | 204338.34 | 39.507 | 35.574 | 108.586 | 237.183 |
| 3 | 4.967 | 40.885 | 34.714 | 290.151 | 1016.220 |
| 4 | 429.409 | 166.505 | 38.613 | 20301.548 | 4091.819 |
| 5 | 1.698 | 70.396 | 4.330 | 20301.548 | 4091.819 |
| 6 | 704.635 | 0.095 | 0.000 | 20421.548 | 4243.819 |
| 7 | 8253.575 | 0.412 | 0.475 | 20425.548 | 4399.899 |
| 8 | 25893.155 | 124.767 | 49.000 | 20792.548 | 4447.899 |
| 9 | 0.000 | 331.832 | 483.969 | 103944.615 | 20085.128 |
| 10 | -157.548 | 23.837 | 0.000 | 0.000 | 0.000 |
| 11 | 199.229 | 456.601 | 532.968 | 0.000 | 0.000 |
| 12 | 0.891 | 3.115 | 3.497 | 0.000 | 0.000 |
| 13 | 0.000 | | 186.973 | | 52972847.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 260.000 | 393.413 | 79.498 | 472.910 | 0.725 |
| 2 | 203158.79 | 39.660 | 34.300 | 104.642 | 230.273 |
| 3 | 4.949 | 40.917 | 33.431 | 234.155 | 831.565 |
| 4 | 429.593 | 166.734 | 38.664 | 16352.033 | 3298.103 |
| 5 | 1.697 | 70.364 | 4.328 | 16352.033 | 3298.103 |
| 6 | 701.092 | 0.095 | 0.000 | 16472.033 | 3450.103 |
| 7 | 8234.778 | 0.288 | 0.472 | 16476.033 | 3598.796 |
| 8 | 25844.034 | 128.271 | 49.000 | 16843.033 | 3646.796 |
| 9 | 0.000 | 332.786 | 488.703 | 107893.177 | 20881.497 |
| 10 | -138.481 | 24.790 | 0.000 | 0.000 | 0.000 |
| 11 | 195.725 | 461.058 | 537.703 | 0.000 | 0.000 |
| 12 | 0.888 | 3.097 | 3.487 | 0.000 | 0.000 |
| 13 | 0.000 | | 191.707 | | 55010767.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 270.000 | 393.067 | 79.504 | 472.572 | 0.780 |
| 2 | 203036.92 | 39.540 | 35.392 | 100.287 | 222.370 |
| 3 | 4.944 | 40.622 | 34.502 | 178.429 | 647.117 |
| 4 | 429.643 | 167.107 | 38.770 | 12420.651 | 2505.789 |
| 5 | 1.697 | 70.306 | 4.326 | 12420.651 | 2505.789 |
| 6 | 700.755 | 0.095 | 0.000 | 12540.651 | 2657.789 |
| 7 | 8236.428 | 0.285 | 0.468 | 12544.651 | 2799.109 |
| 8 | 25849.233 | 131.132 | 49.000 | 12911.651 | 2847.109 |
| 9 | 0.000 | 333.739 | 493.402 | 111823.694 | 21676.485 |
| 10 | -108.295 | 25.743 | 0.000 | 0.000 | 0.000 |
| 11 | 192.863 | 464.872 | 542.491 | 0.000 | 0.000 |
| 12 | 0.888 | 3.094 | 3.486 | 0.000 | 0.000 |
| 13 | 0.000 | | 196.406 | | 57040976.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 280.000 | 390.872 | 79.360 | 470.232 | -0.570 |
| 2 | 202120.51 | 39.637 | 35.472 | 95.242 | 213.119 |
| 3 | 4.925 | 40.543 | 34.565 | 122.817 | 462.664 |
| 4 | 429.832 | 167.579 | 38.847 | 8501.399 | 1714.691 |
| 5 | 1.696 | 70.230 | 4.324 | 8501.399 | 1714.691 |
| 6 | 698.043 | 0.095 | 0.000 | 8621.399 | 1866.691 |
| 7 | 8225.119 | 0.282 | 0.465 | 8625.399 | 2000.649 |
| 8 | 25814.636 | 133.964 | 49.000 | 8992.399 | 2048.649 |
| 9 | 0.000 | 334.692 | 498.066 | 115741.903 | 22470.282 |
| 10 | -72.056 | 26.697 | 0.000 | 0.000 | 0.000 |
| 11 | 190.031 | 468.658 | 547.065 | 0.000 | 0.000 |
| 12 | 0.885 | 3.080 | 3.479 | 0.000 | 0.000 |
| 13 | 0.000 | | 201.070 | | 59065817.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 290.000 | 389.938 | 79.222 | 469.160 | 0.100 |
| 2 | 201670.75 | 38.593 | 34.772 | 88.946 | 201.629 |
| 3 | 4.922 | 39.248 | 33.841 | 67.399 | 278.427 |
| 4 | 429.855 | 168.586 | 38.925 | 4597.536 | 924.927 |
| 5 | 1.695 | 70.054 | 4.323 | 4597.536 | 924.927 |
| 6 | 696.646 | 0.095 | 0.000 | 4717.536 | 1076.927 |
| 7 | 8228.852 | 0.281 | 0.461 | 4721.536 | 1203.535 |
| 8 | 25800.580 | 136.778 | 49.000 | 5088.536 | 1251.535 |
| 9 | 0.000 | 335.645 | 502.694 | 119644.813 | 23262.768 |
| 10 | -27.099 | 27.650 | 0.000 | 0.000 | 0.000 |
| 11 | 187.217 | 472.425 | 551.692 | 0.000 | 0.000 |
| 12 | 0.884 | 3.073 | 3.475 | 0.000 | 0.000 |
| 13 | 0.000 | | 205.698 | | 61084006.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 291.000 | 390.200 | 79.225 | 469.426 | 0.273 |
| 2 | 201769.84 | 39.387 | 34.646 | 88.224 | 200.326 |
| 3 | 4.925 | 40.006 | 33.711 | 61.858 | 259.974 |
| 4 | 429.823 | 168.767 | 38.923 | 4207.372 | 845.982 |
| 5 | 1.695 | 70.021 | 4.323 | 4207.372 | 845.982 |
| 6 | 696.928 | 0.095 | 0.000 | 4327.372 | 997.982 |
| 7 | 8231.461 | 0.280 | 0.461 | 4331.372 | 1123.855 |
| 8 | 25804.593 | 137.058 | 49.000 | 4698.372 | 1171.855 |
| 9 | 0.000 | 335.741 | 503.154 | 120034.882 | 23341.987 |
| 10 | -22.536 | 27.746 | 0.000 | 0.000 | 0.000 |
| 11 | 186.937 | 472.801 | 552.153 | 0.000 | 0.000 |
| 12 | 0.885 | 3.074 | 3.476 | 0.000 | 0.000 |
| 13 | 0.000 | | 206.159 | | 61285719.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 292.000 | 390.039 | 78.877 | 468.915 | 0.376 |
| 2 | 201440.38 | 39.782 | 33.953 | 87.504 | 199.147 |
| 3 | 4.945 | 40.372 | 33.024 | 56.324 | 243.384 |
| 4 | 429.583 | 169.019 | 39.630 | 3817.289 | 767.172 |
| 5 | 1.696 | 69.975 | 4.291 | 3817.289 | 767.172 |
| 6 | 695.677 | 0.095 | 0.000 | 3937.289 | 919.172 |
| 7 | 8227.769 | 0.280 | 0.460 | 3941.289 | 1044.312 |
| 8 | 25865.869 | 137.339 | 49.000 | 4308.289 | 1092.312 |
| 9 | 0.000 | 335.836 | 503.615 | 120424.870 | 23421.069 |
| 10 | -18.572 | 27.941 | 0.000 | 0.000 | 0.000 |
| 11 | 186.656 | 473.176 | 552.614 | 0.000 | 0.000 |
| 12 | 0.886 | 3.071 | 3.468 | 0.000 | 0.000 |
| 13 | 0.000 | | 206.619 | | 61487298.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 293.000 | 389.513 | 78.475 | 467.987 | 0.510 |
| 2 | 200935.14 | 39.417 | 35.795 | 86.783 | 197.958 |
| 3 | 4.964 | 39.984 | 34.871 | 50.786 | 227.828 |
| 4 | 429.360 | 169.252 | 40.819 | 3427.614 | 688.738 |
| 5 | 1.696 | 69.932 | 4.236 | 3427.614 | 688.738 |
| 6 | 693.883 | 0.095 | 0.000 | 3547.614 | 840.738 |
| 7 | 8221.181 | 0.280 | 0.460 | 3551.614 | 965.148 |
| 8 | 25971.616 | 137.619 | 49.000 | 3918.614 | 1013.148 |
| 9 | 0.000 | 335.931 | 504.075 | 120814.448 | 23499.773 |
| 10 | -16.075 | 27.936 | 0.000 | 0.000 | 0.000 |
| 11 | 186.376 | 473.552 | 553.074 | 0.000 | 0.000 |
| 12 | 0.887 | 3.066 | 3.458 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.079 | | 61688433.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 293.666 | 389.115 | 78.134 | 467.249 | 0.460 |
| 2 | 200525.63 | 39.255 | 33.396 | 86.160 | 197.077 |
| 3 | 4.980 | 39.801 | 32.480 | 47.106 | 216.531 |
| 4 | 429.162 | 169.474 | 41.210 | 3168.309 | 636.840 |
| 5 | 1.696 | 69.891 | 4.215 | 3168.309 | 636.840 |
| 6 | 692.413 | 0.095 | 0.000 | 3288.309 | 788.840 |
| 7 | 8216.853 | 0.280 | 0.460 | 3292.309 | 912.766 |
| 8 | 25994.879 | 137.895 | 49.000 | 3659.309 | 960.766 |
| 9 | 0.000 | 335.995 | 504.381 | 121073.690 | 23551.848 |
| 10 | -15.889 | 28.000 | 0.000 | 0.000 | 0.000 |
| 11 | 186.190 | 473.802 | 553.380 | 0.000 | 0.000 |
| 12 | 0.887 | 3.061 | 3.450 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.385 | | 61822045.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 293.766 | 389.115 | 78.134 | 467.249 | 0.594 |
| 2 | 201523.64 | 41.203 | 33.079 | 86.061 | 196.968 |
| 3 | 4.980 | 41.745 | 32.161 | 46.552 | 215.068 |
| 4 | 431.298 | 169.496 | 41.363 | 3129.388 | 629.053 |
| 5 | 1.696 | 69.888 | 4.208 | 3129.388 | 629.053 |
| 6 | 683.606 | 0.095 | 0.000 | 3249.388 | 781.053 |
| 7 | 7373.773 | 0.280 | 0.460 | 3253.388 | 904.907 |
| 8 | 25301.198 | 137.833 | 49.000 | 3620.388 | 952.907 |
| 9 | 0.000 | 336.004 | 504.427 | 121112.603 | 23559.662 |
| 10 | -15.875 | 28.009 | 0.000 | 0.000 | 0.000 |
| 11 | 186.162 | 473.840 | 553.426 | 0.000 | 0.000 |
| 12 | 0.860 | 2.982 | 3.466 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.431 | | 61842097.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 293.866 | 335.325 | 67.328 | 402.653 | 0.648 |
| 2 | 173760.97 | 45.921 | 35.347 | 85.966 | 196.894 |
| 3 | 4.980 | 47.211 | 34.785 | 46.023 | 213.990 |
| 4 | 431.541 | 169.521 | 41.681 | 3092.234 | 621.519 |
| 5 | 1.696 | 69.383 | 4.194 | 3092.234 | 621.618 |
| 6 | 589.430 | 0.095 | 0.000 | 3212.234 | 773.618 |
| 7 | 6354.442 | 0.280 | 0.460 | 3216.234 | 897.403 |
| 8 | 21802.002 | 137.861 | 49.000 | 3583.234 | 945.403 |
| 9 | 0.000 | 336.014 | 504.473 | 121149.747 | 23567.120 |
| 10 | -15.855 | 28.019 | 0.000 | 0.000 | 0.000 |
| 11 | 186.134 | 473.877 | 553.472 | 0.000 | 0.000 |
| 12 | 0.860 | 2.570 | 2.987 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.477 | | 61861333.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 293.966 | 205.572 | 41.297 | 246.870 | 0.642 |
| 2 | 106295.27 | 49.034 | 43.297 | 85.897 | 196.951 |
| 3 | 4.978 | 51.679 | 43.375 | 45.635 | 214.293 |
| 4 | 430.573 | 169.532 | 42.433 | 3065.018 | 616.166 |
| 5 | 1.696 | 69.881 | 4.162 | 3065.018 | 616.166 |
| 6 | 360.574 | 0.095 | 0.000 | 3185.018 | 768.166 |
| 7 | 3895.621 | 0.280 | 0.460 | 3189.018 | 891.900 |
| 8 | 13372.757 | 137.869 | 49.000 | 3556.018 | 939.900 |
| 9 | 0.000 | 336.024 | 504.519 | 121176.953 | 23572.576 |
| 10 | -15.812 | 28.028 | 0.000 | 0.000 | 0.000 |
| 11 | 185.106 | 473.915 | 553.518 | 0.000 | 0.000 |
| 12 | 0.860 | 1.575 | 1.832 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.523 | | 61875425.000 |

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TABLE AP 1-2 (Sheet 7 of 7)
COMPUTER PROGRAM AA89 (2ND BURN)

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.066 | 78.203 | 15.783 | 93.986 | 0.654 |
| 2 | 40468.29 | 49.075 | 40.637 | 85.862 | 197.276 |
| 3 | 4.955 | 52.423 | 41.043 | 45.438 | 217.435 |
| 4 | 430.576 | 169.532 | 43.733 | 3051.228 | 613.369 |
| 5 | 1.696 | 69.881 | 4.089 | 3051.228 | 613.369 |
| 6 | 137.276 | 0.095 | 0.000 | 3171.228 | 765.369 |
| 7 | 1481.963 | 0.280 | 0.460 | 3175.228 | 889.377 |
| 8 | 5110.799 | 137.917 | 49.000 | 3542.228 | 937.077 |
| 9 | 0.000 | 336.033 | 504.565 | 121190.734 | 23575.353 |
| 10 | -15.617 | 28.038 | 0.000 | 0.000 | 0.000 |
| 11 | 186.078 | 473.952 | 553.564 | 0.000 | 0.000 |
| 12 | 0.856 | 0.599 | 0.700 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.569 | | 61882532.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.166 | 33.583 | 6.431 | 40.015 | 0.719 |
| 2 | 16599.09 | 49.069 | 33.571 | 85.849 | 197.743 |
| 3 | 5.222 | 52.516 | 36.017 | 45.369 | 222.083 |
| 4 | 414.826 | 169.531 | 45.151 | 3046.407 | 612.377 |
| 5 | 1.696 | 69.881 | 3.999 | 3046.407 | 612.377 |
| 6 | 56.307 | 0.095 | 0.000 | 3166.407 | 764.377 |
| 7 | 636.404 | 0.280 | 0.460 | 3170.407 | 888.376 |
| 8 | 2082.626 | 137.945 | 49.000 | 3537.407 | 936.076 |
| 9 | 0.000 | 336.043 | 504.611 | 121195.546 | 23576.309 |
| 10 | -15.476 | 28.048 | 0.000 | 0.000 | 0.000 |
| 11 | 186.050 | 473.990 | 553.610 | 0.000 | 0.000 |
| 12 | 0.902 | 0.257 | 0.285 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.615 | | 61885008.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.266 | 24.787 | 4.864 | 29.652 | 0.745 |
| 2 | 12064.77 | 46.271 | 35.855 | 85.842 | 198.102 |
| 3 | 5.096 | 49.728 | 36.299 | 45.328 | 225.670 |
| 4 | 406.884 | 169.531 | 46.168 | 3043.542 | 611.776 |
| 5 | 1.696 | 69.881 | 3.933 | 3043.542 | 611.776 |
| 6 | 40.926 | 0.095 | 0.000 | 3163.542 | 763.776 |
| 7 | 469.719 | 0.280 | 0.460 | 3167.542 | 887.469 |
| 8 | 1575.194 | 137.973 | 49.000 | 3534.542 | 935.469 |
| 9 | 0.000 | 336.052 | 504.657 | 121198.401 | 23576.870 |
| 10 | -15.337 | 28.057 | 0.000 | 0.000 | 0.000 |
| 11 | 186.022 | 474.027 | 553.656 | 0.000 | 0.000 |
| 12 | 0.880 | 0.190 | 0.216 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.661 | | 61886408.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.366 | 21.334 | 4.171 | 25.506 | 0.744 |
| 2 | 10286.64 | 45.075 | 38.209 | 85.836 | 198.317 |
| 3 | 5.115 | 48.535 | 38.650 | 45.295 | 227.797 |
| 4 | 403.309 | 169.531 | 46.768 | 3041.253 | 611.288 |
| 5 | 1.696 | 69.881 | 3.894 | 3041.253 | 611.288 |
| 6 | 34.894 | 0.095 | 0.000 | 3161.253 | 763.288 |
| 7 | 404.289 | 0.280 | 0.459 | 3145.253 | 886.977 |
| 8 | 1350.714 | 138.001 | 49.000 | 3532.253 | 934.977 |
| 9 | 0.000 | 336.062 | 504.703 | 121200.680 | 23577.316 |
| 10 | -15.187 | 28.067 | 0.000 | 0.000 | 0.000 |
| 11 | 185.994 | 474.065 | 553.702 | 0.000 | 0.000 |
| 12 | 0.884 | 0.163 | 0.135 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.707 | | 61887511.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.466 | 19.525 | 3.808 | 23.332 | 0.744 |
| 2 | 9355.10 | 45.424 | 41.202 | 85.831 | 198.426 |
| 3 | 5.128 | 48.886 | 41.643 | 45.266 | 228.868 |
| 4 | 400.952 | 169.531 | 47.102 | 3039.202 | 610.847 |
| 5 | 1.696 | 69.881 | 3.874 | 3039.202 | 610.847 |
| 6 | 31.734 | 0.095 | 0.000 | 3159.202 | 762.847 |
| 7 | 369.992 | 0.280 | 0.459 | 3163.202 | 886.532 |
| 8 | 1232.999 | 138.029 | 49.000 | 3530.202 | 934.532 |
| 9 | 0.000 | 336.071 | 504.749 | 121202.721 | 23577.715 |
| 10 | -15.035 | 28.076 | 0.000 | 0.000 | 0.000 |
| 11 | 185.966 | 474.102 | 553.748 | 0.000 | 0.000 |
| 12 | 0.886 | 0.150 | 0.169 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.753 | | 61888491.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.566 | 17.134 | 3.327 | 20.461 | 0.744 |
| 2 | 8122.80 | 46.175 | 44.188 | 85.826 | 198.469 |
| 3 | 5.149 | 49.638 | 44.629 | 45.239 | 229.066 |
| 4 | 396.989 | 169.531 | 47.226 | 3037.350 | 610.447 |
| 5 | 1.696 | 69.881 | 3.868 | 3037.350 | 610.447 |
| 6 | 27.554 | 0.095 | 0.000 | 3157.350 | 762.447 |
| 7 | 324.683 | 0.280 | 0.459 | 3161.350 | 886.128 |
| 8 | 1077.493 | 138.057 | 49.000 | 3528.350 | 934.128 |
| 9 | 0.000 | 336.081 | 504.795 | 121204.563 | 23578.073 |
| 10 | -14.883 | 28.086 | 0.000 | 0.000 | 0.000 |
| 11 | 185.938 | 474.140 | 553.794 | 0.000 | 0.000 |
| 12 | 0.890 | 0.131 | 0.148 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.799 | | 61889370.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.666 | 13.567 | 2.611 | 16.179 | 0.745 |
| 2 | 6283.74 | 45.711 | 46.037 | 85.822 | 198.427 |
| 3 | 5.195 | 49.176 | 46.479 | 45.217 | 228.819 |
| 4 | 388.399 | 169.531 | 47.224 | 3035.797 | 610.105 |
| 5 | 1.696 | 69.881 | 3.871 | 3035.797 | 610.105 |
| 6 | 21.316 | 0.095 | 0.000 | 3155.797 | 762.105 |
| 7 | 257.100 | 0.280 | 0.459 | 3159.797 | 885.783 |
| 8 | 845.613 | 138.085 | 49.000 | 3526.797 | 933.783 |
| 9 | 0.000 | 336.090 | 504.841 | 121206.107 | 23578.372 |
| 10 | -14.729 | 28.095 | 0.000 | 0.000 | 0.000 |
| 11 | 185.910 | 474.177 | 553.840 | 0.000 | 0.000 |
| 12 | 0.898 | 0.104 | 0.116 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.845 | | 61890094.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.766 | 9.580 | 1.811 | 11.391 | 0.739 |
| 2 | 4228.29 | 45.916 | 47.454 | 85.819 | 198.407 |
| 3 | 5.290 | 49.383 | 47.898 | 45.200 | 228.598 |
| 4 | 371.183 | 169.531 | 47.214 | 3034.632 | 609.841 |
| 5 | 1.696 | 69.881 | 3.874 | 3034.632 | 609.841 |
| 6 | 14.343 | 0.095 | 0.000 | 3154.632 | 761.841 |
| 7 | 181.549 | 0.280 | 0.459 | 3158.632 | 885.516 |
| 8 | 586.436 | 138.113 | 49.000 | 3525.632 | 933.516 |
| 9 | 0.000 | 336.100 | 504.887 | 121207.263 | 23578.593 |
| 10 | -14.572 | 28.105 | 0.000 | 0.000 | 0.000 |
| 11 | 185.882 | 474.215 | 553.886 | 0.000 | 0.000 |
| 12 | 0.914 | 0.073 | 0.080 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.891 | | 61890618.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.866 | 6.446 | 1.182 | 7.627 | 0.766 |
| 2 | 2613.41 | 45.625 | 49.063 | 85.817 | 198.392 |
| 3 | 5.455 | 49.094 | 49.507 | 45.189 | 228.426 |
| 4 | 342.641 | 169.531 | 47.215 | 3033.833 | 609.649 |
| 5 | 1.696 | 69.881 | 3.876 | 3033.833 | 609.649 |
| 6 | 8.865 | 0.095 | 0.000 | 3153.833 | 761.649 |
| 7 | 122.146 | 0.280 | 0.459 | 3157.833 | 885.323 |
| 8 | 382.620 | 138.141 | 49.000 | 3524.833 | 933.323 |
| 9 | 0.000 | 336.109 | 504.933 | 121208.053 | 23578.740 |
| 10 | -14.414 | 28.114 | 0.000 | 0.000 | 0.000 |
| 11 | 185.854 | 474.252 | 553.931 | 0.000 | 0.000 |
| 12 | 0.942 | 0.049 | 0.052 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.937 | | 61890953.500 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 294.966 | 4.452 | 0.781 | 5.233 | 0.891 |
| 2 | 1587.79 | 44.639 | 50.190 | 85.816 | 198.381 |
| 3 | 5.700 | 48.109 | 50.634 | 45.181 | 228.301 |
| 4 | 303.392 | 169.531 | 47.215 | 3033.282 | 609.508 |
| 5 | 1.696 | 69.881 | 3.877 | 3033.282 | 609.508 |
| 6 | 5.386 | 0.095 | 0.000 | 3153.282 | 761.507 |
| 7 | 84.373 | 0.280 | 0.459 | 3157.282 | 885.180 |
| 8 | 252.930 | 138.169 | 49.000 | 3524.282 | 933.180 |
| 9 | 0.000 | 336.119 | 504.979 | 121208.593 | 23578.837 |
| 10 | -14.255 | 28.124 | 0.000 | 0.000 | 0.000 |
| 11 | 185.826 | 474.290 | 553.977 | 0.000 | 0.000 |
| 12 | 0.985 | 0.034 | 0.035 | 0.000 | 0.000 |
| 13 | 0.000 | | 207.983 | | 61891161.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 295.066 | 0.000 | 0.000 | 0.000 | 0.856 |
| 2 | 0.00 | 44.599 | 51.200 | 85.815 | 198.372 |
| 3 | 0.000 | 48.070 | 51.646 | 45.176 | 228.198 |
| 4 | 0.000 | 169.531 | 47.215 | 3032.977 | 609.414 |
| 5 | 1.696 | 69.881 | 3.879 | 3032.977 | 609.414 |
| 6 | 0.000 | 0.095 | 0.000 | 3152.977 | 761.414 |
| 7 | 0.000 | 0.280 | 0.459 | 3156.977 | 885.086 |
| 8 | 0.000 | 138.197 | 49.000 | 3523.977 | 933.086 |
| 9 | 0.000 | 336.128 | 505.025 | 121208.889 | 23578.885 |
| 10 | -14.095 | 28.133 | 0.000 | 0.000 | 0.000 |
| 11 | 185.798 | 474.327 | 554.023 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 208.029 | | 61891246.000 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | 295.166 | 0.000 | 0.000 | 0.000 | 0.813 |
| 2 | 0.00 | 44.678 | 52.158 | 85.815 | 198.367 |
| 3 | 0.000 | 48.148 | 52.603 | 45.579 | 281.849 |
| 4 | 0.000 | 169.531 | 47.215 | 3032.968 | 609.369 |
| 5 | 1.696 | 69.881 | 3.878 | 3032.968 | 609.369 |
| 6 | 0.000 | 0.095 | 0.000 | 3152.968 | 761.369 |
| 7 | 0.000 | 0.280 | 0.459 | 3156.968 | 885.040 |
| 8 | 0.000 | 138.225 | 49.000 | 3523.968 | 933.040 |
| 9 | 0.000 | 336.138 | 505.070 | 121208.889 | 23578.885 |
| 10 | -13.877 | 28.143 | 0.000 | 0.000 | 0.000 |
| 11 | 185.770 | 474.365 | 554.069 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | | 208.075 | | 61891246.000 |

28 September 1966

# 1. ACCEPTANCE FIRING DATA (G105-3)

This appendix contains engine performance determination and reconstruction of the S-IVB stage acceptance firing, using computer program G105-3 (table AP 2-1). This program operates directly on measured engine functional parameters from the beginning of the start transients, through steady state, to the end of cutoff transients, and is used for functional evaluation of the systems such as determination of the profiles of thrust and flowrates. For a discussion of the performance values, see section 8 and associated plots.

## 1.1 Acceptance Firing Data

The following procedures and assumptions were used to generate the printout:

a. The computation interval was 0.1 sec.

b. Measurements of pump discharge pressures and temperatures, flowmeters, and thrust chamber pressure were obtained from tape.

c. The propellant load and residual values indicated on the printout are not final values; their use does not influence the computation of propellant consumption.

d. Obvious instrumentation errors and noise were eliminated.

## 1.2 Digital Data Abbreviations

Abbreviations appearing on the printout are defined as follows:

| | |
|---|---|
| TIME | Time from engine start signal (sec) |
| THRUST | Engine total thrust (lbf) |
| EMR | Engine total mixture ratio (O/F) |
| ISP | Engine total specific impulse (sec) |
| WDOTO | Engine total LOX flowrate (lbm/sec) |
| WDOTF | Engine total LH2 flowrate (lbm/sec) |
| WDOTT | Engine total propellant flowrate (lbm/sec) |
| WO | LOX mass on board (lbm) |
| WF | LH2 mass on board (lbm) |
| WT | Total propellant on board (lbm) |

# TABLE AP 2-1 (Sheet 1 of 9)
## COMPUTER PROGRAM G105-3 (1ST BURN)

| | | | | |
|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.0000 | 0.0000 | 193063.0000 | 40706.0000 | 233759.0000 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.1000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.1836 | 0.1836 | 193062.9434 | 43705.9907 | 233768.9336 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.0561 | 0.3125 | 0.0156 | 0.0280 | 0.0014 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.2000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.4787 | 3.4787 | 193062.8867 | 43705.8071 | 233768.6934 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.1122 | 0.6250 | 0.0625 | 0.0560 | 0.0056 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.3000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5.5882 | 5.5882 | 193062.8301 | 43705.3535 | 233768.1836 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.1683 | 0.9375 | 0.1406 | 0.0840 | 0.0126 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.4000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6.2501 | 6.2501 | 193062.7734 | 40704.7612 | 233767.5332 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.2244 | 1.2500 | 0.2500 | 0.1120 | 0.0224 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.5000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7.9724 | 7.9724 | 193062.7168 | 40704.0498 | 233766.7656 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.2805 | 1.5625 | 0.3906 | 0.1400 | 0.0350 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.6000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8.5848 | 8.5848 | 193062.6602 | 43703.2217 | 233755.8809 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.3365 | 1.8750 | 0.5625 | 0.1680 | 0.0504 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.7000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8.1993 | 8.1993 | 193062.6035 | 43702.3823 | 233764.9844 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.3926 | 2.1875 | 0.7656 | 0.1960 | 0.0686 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.8000 | 77.1553 | 0.0000 | 9.3234 | 0.0000 |
| 8.2755 | 8.2755 | 193062.5469 | 43701.5581 | 233754.1035 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5609 |
| 0.4487 | 2.5000 | 1.0000 | 0.2240 | 0.0896 |
| 0.0000 | 0.9734 | 1.5299 | | |
| 0.9000 | 0.0000 | 0.0890 | 0.0000 | 0.7365 |
| 8.2786 | 9.0151 | 193062.4531 | 43700.7295 | 233753.1816 |
| 0.0088 | 0.0004 | 0.0000 | 0.0000 | 0.5609 |
| 0.5048 | 2.6250 | 1.2562 | 0.2520 | 0.1134 |
| 0.0857 | 0.9742 | 1.5376 | | |
| 1.0000 | 0.0000 | 0.5005 | 0.0000 | 10.4596 |
| 20.8999 | 31.3595 | 193061.8359 | 40699.2690 | 233751.1035 |
| 0.0177 | 0.0018 | 0.0000 | 0.0000 | 0.5609 |
| 0.5609 | 2.7500 | 1.5250 | 0.2800 | 0.1400 |
| 0.5609 | 0.9785 | 1.5809 | | |
| 1.1000 | 0.0000 | 0.2081 | 0.0000 | 7.4340 |
| 35.7185 | 43.1526 | 193060.8828 | 40696.4355 | 233757.3184 |
| 0.0265 | 0.0040 | 0.0000 | 0.0000 | 0.5609 |
| 0.6170 | 2.8750 | 1.8062 | 0.3080 | 0.1694 |
| 0.2170 | 0.9754 | 1.5496 | | |
| 1.2000 | 3581.6112 | 0.4679 | 56.5426 | 20.1901 |
| 43.1534 | 63.3435 | 193059.4434 | 43692.4883 | 233751.9316 |
| 0.0353 | 0.0071 | 0.0000 | 0.0000 | 0.5609 |
| 0.6731 | 3.0000 | 2.1000 | 0.3360 | 0.2016 |
| 0.4945 | 0.9779 | 1.5778 | | |
| 1.3000 | 6218.5062 | 1.1712 | 62.6958 | 53.5030 |
| 45.6823 | 99.1853 | 193055.7012 | 40688.0420 | 233743.7422 |
| 0.0441 | 0.0110 | 0.0000 | 0.0000 | 0.5609 |
| 0.7292 | 3.0900 | 2.4045 | 0.3640 | 0.2366 |
| 1.2476 | 0.9848 | 1.6448 | | |
| 1.4000 | 6717.8974 | 1.4500 | 59.6050 | 66.7049 |
| 46.0020 | 112.7069 | 193049.6328 | 40683.4526 | 233733.0840 |
| 0.0530 | 0.0159 | 0.0000 | 0.0000 | 0.5609 |
| 0.7853 | 3.1800 | 2.7180 | 0.3920 | 0.2744 |
| 1.5486 | 0.9875 | 1.6696 | | |
| 1.5000 | 7340.1994 | 1.4355 | 66.9571 | 64.6147 |
| 45.0108 | 109.6255 | 193043.0098 | 43678.8960 | 233721.9043 |
| 0.0618 | 0.0216 | 0.0000 | 0.0000 | 0.5609 |
| 0.8414 | 3.2700 | 3.0405 | 0.4200 | 0.3150 |
| 1.5379 | 0.9874 | 1.6690 | | |
| 1.6000 | 23112.5293 | 1.3329 | 217.4517 | 50.7270 |
| 45.5611 | 106.2881 | 193036.6855 | 43674.3604 | 233711.0449 |
| 0.0706 | 0.0283 | 0.0000 | 0.0000 | 0.5609 |
| 0.8975 | 3.2860 | 3.3683 | 0.4600 | 0.3590 |
| 1.4256 | 0.9864 | 1.6664 | | |
| 1.7000 | 31093.9297 | 1.1165 | 316.9765 | 51.7480 |
| 46.3474 | 98.0954 | 193031.0039 | 43669.7568 | 233700.7598 |
| 0.0795 | 0.0358 | 0.0000 | 0.0000 | 0.5609 |
| 0.9535 | 3.3020 | 3.6977 | 0.5000 | 0.4070 |
| 1.1906 | 0.9843 | 1.6517 | | |
| 1.8000 | 36296.0967 | 1.1051 | 367.7829 | 51.8089 |
| 46.8830 | 98.6889 | 193025.7676 | 43665.0864 | 233690.8535 |
| 0.0883 | 0.0441 | 0.0000 | 0.0000 | 0.5609 |
| 1.0096 | 3.3180 | 4.0287 | 0.6250 | 0.4632 |
| 1.1750 | 0.9841 | 1.6527 | | |
| 1.9000 | 41327.4097 | 1.2678 | 386.9083 | 59.7142 |
| 47.1003 | 106.8145 | 193020.1348 | 43660.3779 | 233680.5117 |
| 0.0971 | 0.0534 | 0.0000 | 0.0000 | 0.5609 |
| 1.0657 | 3.3340 | 4.3613 | 0.7500 | 0.5320 |
| 1.3473 | 0.9857 | 1.6674 | | |
| 2.0000 | 44991.8628 | 1.4447 | 390.6652 | 58.0584 |
| 47.1089 | 115.1673 | 193013.6895 | 43655.6567 | 233659.3457 |
| 0.1060 | 0.0636 | 0.0000 | 0.0000 | 0.5609 |
| 1.1218 | 3.3500 | 4.6955 | 0.8750 | 0.6132 |
| 1.5353 | 0.9874 | 1.6820 | | |

| | | | | |
|---|---|---|---|---|
| 2.1000 | 50367.7314 | 1.6106 | 402.1168 | 77.2771 |
| 47.9794 | 125.2565 | 193006.3652 | 43650.8906 | 233657.2559 |
| 0.1148 | 0.0746 | 0.0000 | 0.0000 | 0.5609 |
| 1.1779 | 3.3650 | 5.0312 | 1.0000 | 0.7070 |
| 1.7097 | 0.9890 | 1.6955 | | |
| 2.2000 | 57466.8887 | 1.7879 | 419.7280 | 97.8041 |
| 49.1105 | 136.9146 | 192998.0527 | 40646.0234 | 233644.0762 |
| 0.1236 | 0.0865 | 0.0000 | 0.0000 | 0.5609 |
| 1.2340 | 3.3800 | 5.3685 | 1.1000 | 0.8120 |
| 1.8960 | 0.9907 | 1.7094 | | |
| 2.3000 | 65291.7168 | 1.9955 | 437.7929 | 99.3515 |
| 49.7869 | 149.1384 | 192988.6367 | 43641.0649 | 233629.7012 |
| 0.1324 | 0.0993 | 0.0000 | 0.0000 | 0.5609 |
| 1.2901 | 3.3950 | 5.7072 | 1.2000 | 0.9270 |
| 2.1157 | 0.9927 | 1.7246 | | |
| 2.4000 | 74656.7148 | 2.2567 | 454.8921 | 113.7259 |
| 50.3937 | 164.1196 | 192977.9258 | 40636.0415 | 233613.9668 |
| 0.1413 | 0.1130 | 0.0000 | 0.0000 | 0.5609 |
| 1.3462 | 3.4100 | 6.0475 | 1.3000 | 1.0520 |
| 2.3929 | 0.9952 | 1.7423 | | |
| 2.5000 | 84798.1895 | 2.5544 | 462.1066 | 131.8766 |
| 51.6270 | 183.5035 | 192965.5879 | 40630.9258 | 233596.5137 |
| 0.1501 | 0.1276 | 0.0000 | 0.0000 | 0.5609 |
| 1.4023 | 3.4250 | 6.3892 | 1.4000 | 1.1870 |
| 2.7069 | 0.9981 | 1.7606 | | |
| 2.6000 | 94071.1514 | 2.8520 | 455.5256 | 152.8994 |
| 53.6118 | 206.5112 | 192951.2910 | 43625.6479 | 233576.9375 |
| 0.1589 | 0.1430 | 0.0000 | 0.0000 | 0.5609 |
| 1.4584 | 3.4400 | 6.7325 | 1.5000 | 1.3320 |
| 3.0176 | 1.0009 | 1.7770 | | |
| 2.7000 | 103276.4463 | 3.1093 | 446.9173 | 174.8510 |
| 56.2353 | 231.0863 | 192934.8457 | 40620.1387 | 233554.9844 |
| 0.1678 | 0.1594 | 0.0000 | 0.0000 | 0.5609 |
| 1.5145 | 3.4550 | 7.0772 | 1.6000 | 1.4870 |
| 3.2825 | 1.0033 | 1.7899 | | |
| 2.8000 | 115239.4237 | 3.3571 | 452.8294 | 196.0804 |
| 58.4072 | 254.4875 | 192916.2422 | 43614.3887 | 233530.6309 |
| 0.1766 | 0.1766 | 0.0000 | 0.0000 | 0.5609 |
| 1.5705 | 3.4700 | 7.4235 | 1.7000 | 1.6520 |
| 3.5382 | 1.0056 | 1.8016 | | |
| 2.9000 | 130060.2715 | 3.6346 | 468.0595 | 217.9149 |
| 59.9563 | 277.8712 | 192895.4844 | 43608.4517 | 233503.9355 |
| 0.1854 | 0.1947 | 0.0000 | 0.0000 | 0.5609 |
| 1.6266 | 3.4850 | 7.7712 | 1.8000 | 1.8270 |
| 3.8270 | 1.0082 | 1.8139 | | |
| 3.0000 | 143965.9180 | 3.9066 | 476.2271 | 240.6936 |
| 61.6115 | 302.3052 | 192872.4961 | 43602.3540 | 233474.8496 |
| 0.1943 | 0.2137 | 0.0000 | 0.0000 | 0.5609 |
| 1.6827 | 3.5000 | 8.1205 | 1.9000 | 2.0120 |
| 4.1092 | 1.0108 | 1.8250 | | |
| 3.1000 | 154866.0703 | 4.1767 | 475.7761 | 262.6237 |
| 62.8783 | 325.5020 | 192847.2734 | 43596.1094 | 233443.3828 |
| 0.2031 | 0.2335 | 0.0000 | 0.0000 | 0.5609 |
| 1.7388 | 3.5030 | 8.4706 | 2.0000 | 2.2070 |
| 4.3894 | 1.0134 | 1.8352 | | |
| 3.2000 | 162628.7051 | 4.3795 | 466.8068 | 283.6239 |
| 64.7613 | 348.3855 | 192819.9043 | 40589.7061 | 233409.6094 |
| 0.2119 | 0.2543 | 0.0000 | 0.0000 | 0.5609 |
| 1.7949 | 3.5060 | 8.8211 | 2.0556 | 2.4098 |
| 4.5966 | 1.0152 | 1.8424 | | |
| 3.3000 | 167841.1074 | 4.5016 | 454.3436 | 302.2677 |
| 67.1468 | 369.4145 | 192790.5527 | 40583.0884 | 233373.6406 |
| 0.2207 | 0.2759 | 0.0000 | 0.0000 | 0.5609 |
| 1.8510 | 3.5090 | 9.1718 | 2.1111 | 2.6181 |
| 4.7166 | 1.0163 | 1.8464 | | |
| 3.4000 | 172220.1895 | 4.5667 | 445.7103 | 316.9826 |
| 69.4122 | 386.3949 | 192759.5332 | 40576.2373 | 233335.7695 |
| 0.2296 | 0.2986 | 0.0000 | 0.0000 | 0.5609 |
| 1.9071 | 3.5120 | 9.5229 | 2.1667 | 2.8320 |
| 4.7772 | 1.0169 | 1.8484 | | |
| 3.5000 | 175849.9512 | 4.6012 | 440.7683 | 327.7344 |
| 71.2279 | 398.9624 | 192727.2402 | 40569.1816 | 233296.4219 |
| 0.2384 | 0.3218 | 0.0000 | 0.0000 | 0.5609 |
| 1.9632 | 3.5150 | 9.8742 | 2.2222 | 3.0514 |
| 4.8072 | 1.0172 | 1.8495 | | |
| 3.6000 | 178934.1387 | 4.5956 | 439.1876 | 334.6101 |
| 72.8106 | 407.4207 | 192694.0645 | 40561.9551 | 233256.0195 |
| 0.2472 | 0.3461 | 0.0000 | 0.0000 | 0.5609 |
| 2.0193 | 3.5180 | 10.2259 | 2.2778 | 3.2764 |
| 4.7961 | 1.0171 | 1.8492 | | |
| 3.7000 | 180818.8516 | 4.5725 | 436.7039 | 339.7503 |
| 74.3034 | 414.0536 | 192660.2891 | 40554.5737 | 233214.8613 |
| 0.2561 | 0.3713 | 0.0000 | 0.0000 | 0.5609 |
| 2.0754 | 3.5210 | 10.5778 | 2.3333 | 3.5070 |
| 4.7670 | 1.0168 | 1.8483 | | |
| 3.8000 | 183329.1035 | 4.5506 | 437.1493 | 343.8188 |
| 75.5554 | 419.3741 | 192626.0527 | 40547.0542 | 233173.1055 |
| 0.2649 | 0.3973 | 0.0000 | 0.0000 | 0.5609 |
| 2.1315 | 3.5240 | 10.9301 | 2.3889 | 3.7431 |
| 4.7400 | 1.0166 | 1.8474 | | |
| 3.9000 | 185802.6172 | 4.5444 | 438.4603 | 347.3314 |
| 76.4301 | 423.7615 | 192591.4375 | 40539.6272 | 233130.8633 |
| 0.2737 | 0.4243 | 0.0000 | 0.0000 | 0.5609 |
| 2.1875 | 3.5270 | 11.2826 | 2.4444 | 3.9848 |
| 4.7308 | 1.0165 | 1.8472 | | |
| 4.0000 | 185297.2715 | 4.5385 | 434.2181 | 349.6890 |
| 77.0487 | 426.7378 | 192556.5293 | 40531.7251 | 233088.2539 |
| 0.2826 | 0.4521 | 0.0000 | 0.0000 | 0.5609 |
| 2.2436 | 3.5300 | 11.6355 | 2.5000 | 4.2320 |
| 4.7225 | 1.0164 | 1.8469 | | |
| 4.1000 | 185403.0156 | 4.5216 | 432.2028 | 351.2821 |
| 77.6902 | 428.9723 | 192521.4238 | 40523.9593 | 233045.3828 |
| 0.2914 | 0.4808 | 0.0000 | 0.0000 | 0.5609 |
| 2.2997 | 3.5340 | 11.9887 | 2.5300 | 4.4835 |
| 4.7029 | 1.0162 | 1.8463 | | |

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TABLE AP 2-1 (Sheet 2 of 9)
COMPUTER PROGRAM G105-3 (1ST BURN)

| | | | | |
|---|---|---|---|---|
| 4.2000 | 186443.3359 | 4.5132 | 432.2349 | 353.1082 |
| 78.2390 | 431.3473 | 192486.1465 | 40516.1323 | 233002.2773 |
| 0.3002 | 0.5104 | 0.0000 | 0.0000 | 0.5609 |
| 2.3558 | 3.5380 | 12.3423 | 2.5600 | 4.7380 |
| 4.6927 | 1.0161 | 1.8460 | | |
| 4.3000 | 188179.4883 | 4.5148 | 433.8918 | 355.0589 |
| 78.6626 | 433.7014 | 192450.6797 | 40508.2573 | 232958.9355 |
| 0.3090 | 0.5408 | 0.0000 | 0.0000 | 0.5609 |
| 2.4119 | 3.5420 | 12.6963 | 2.5900 | 4.9955 |
| 4.6933 | 1.0161 | 1.8460 | | |
| 4.4000 | 188890.2832 | 4.5170 | 433.6951 | 356.5922 |
| 78.9448 | 435.5371 | 192415.0391 | 40500.3462 | 232915.3848 |
| 0.3179 | 0.5722 | 0.0000 | 0.0000 | 0.5609 |
| 2.4680 | 3.5460 | 13.0507 | 2.6200 | 5.2560 |
| 4.6947 | 1.0161 | 1.8461 | | |
| 4.5000 | 189418.7637 | 4.5114 | 433.7022 | 357.5044 |
| 79.2440 | 436.7484 | 192379.2773 | 40492.4038 | 232871.6797 |
| 0.3267 | 0.6044 | 0.0000 | 0.0000 | 0.5609 |
| 2.5241 | 3.5500 | 13.4055 | 2.6500 | 5.5195 |
| 4.6880 | 1.0161 | 1.8459 | | |
| 4.6000 | 189433.7559 | 4.5097 | 432.6819 | 358.3511 |
| 79.4620 | 437.8130 | 192343.4277 | 40484.4351 | 232827.8613 |
| 0.3355 | 0.6375 | 0.0000 | 0.0000 | 0.5609 |
| 2.5802 | 3.5480 | 13.7604 | 2.6800 | 5.7860 |
| 4.6852 | 1.0161 | 1.8458 | | |
| 4.7000 | 190141.2227 | 4.5163 | 432.7722 | 359.7099 |
| 79.6464 | 439.3563 | 192307.4668 | 40476.4453 | 232783.9121 |
| 0.3444 | 0.6715 | 0.0000 | 0.0000 | 0.5609 |
| 2.6363 | 3.5460 | 14.1151 | 2.7100 | 6.0555 |
| 4.6912 | 1.0161 | 1.8460 | | |
| 4.8000 | 190896.2480 | 4.5298 | 432.5379 | 361.5281 |
| 79.8118 | 441.3399 | 192271.3477 | 40468.4370 | 232739.7832 |
| 0.3532 | 0.7064 | 0.0000 | 0.0000 | 0.5609 |
| 2.6924 | 3.5440 | 14.4696 | 2.7400 | 6.3280 |
| 4.7043 | 1.0162 | 1.8464 | | |
| 4.9000 | 191517.0684 | 4.5396 | 432.6689 | 362.7369 |
| 79.9043 | 442.6412 | 192235.0762 | 40460.4150 | 232695.4902 |
| 0.3620 | 0.7421 | 0.0000 | 0.0000 | 0.5609 |
| 2.7485 | 3.5420 | 14.8239 | 2.7700 | 6.6035 |
| 4.7139 | 1.0163 | 1.8467 | | |
| 5.0000 | 191660.9277 | 4.5400 | 432.6150 | 363.0594 |
| 79.9895 | 443.0288 | 192198.7285 | 40452.3838 | 232651.1113 |
| 0.3709 | 0.7789 | 0.0000 | 0.0000 | 0.5609 |
| 2.8045 | 3.5400 | 15.1780 | 2.8000 | 6.9820 |
| 4.7136 | 1.0163 | 1.8467 | | |
| 5.1000 | 191817.3320 | 4.5333 | 432.7597 | 363.1371 |
| 80.1051 | 443.2421 | 192162.3613 | 40444.3423 | 232606.7031 |
| 0.3797 | 0.8163 | 0.0000 | 0.0000 | 0.5609 |
| 2.8606 | 3.5380 | 15.5319 | 2.8133 | 7.1627 |
| 4.7060 | 1.0162 | 1.8465 | | |
| 5.2000 | 192365.5781 | 4.5332 | 433.1701 | 363.8287 |
| 80.2592 | 444.0879 | 192125.9551 | 40436.2852 | 232562.2402 |
| 0.3885 | 0.8547 | 0.0000 | 0.0000 | 0.5609 |
| 2.9167 | 3.5360 | 15.8856 | 2.8267 | 7.4447 |
| 4.7053 | 1.0162 | 1.8465 | | |
| 5.3000 | 192643.4707 | 4.5461 | 432.4121 | 365.1808 |
| 80.3282 | 445.5090 | 192089.4473 | 40428.2358 | 232517.6621 |
| 0.3973 | 0.8940 | 0.0000 | 0.0000 | 0.5609 |
| 2.9728 | 3.5340 | 16.2391 | 2.8403 | 7.7280 |
| 4.7183 | 1.0164 | 1.8469 | | |
| 5.4000 | 192610.8145 | 4.5612 | 431.2914 | 366.2863 |
| 80.3046 | 446.5909 | 192052.8164 | 40420.1436 | 232472.9590 |
| 0.4062 | 0.9342 | 0.0000 | 0.0000 | 0.5609 |
| 3.0289 | 3.5320 | 16.5924 | 2.8533 | 8.0127 |
| 4.7339 | 1.0165 | 1.8474 | | |
| 5.5000 | 192831.2676 | 4.5686 | 431.2985 | 366.8059 |
| 80.2888 | 447.0947 | 192016.1035 | 40412.0723 | 232428.1758 |
| 0.4150 | 0.9752 | 0.0000 | 0.0000 | 0.5609 |
| 3.0850 | 3.5300 | 16.9455 | 2.8667 | 8.2987 |
| 4.7413 | 1.0166 | 1.8476 | | |
| 5.6000 | 193468.4805 | 4.5705 | 432.2788 | 367.2119 |
| 80.3439 | 447.5549 | 191979.3657 | 40403.9985 | 232383.3438 |
| 0.4166 | 1.0168 | 0.0000 | 0.0000 | 0.5609 |
| 3.1411 | 3.5280 | 17.2984 | 2.8800 | 8.5860 |
| 4.7429 | 1.0166 | 1.8477 | | |
| 5.7000 | 194203.7480 | 4.5724 | 433.1144 | 367.9223 |
| 80.4667 | 448.3890 | 191942.5313 | 40395.9155 | 232338.4453 |
| 0.4182 | 1.0586 | 0.0000 | 0.0000 | 0.5609 |
| 3.1972 | 3.5260 | 17.6511 | 2.8933 | 8.8747 |
| 4.7443 | 1.0166 | 1.8478 | | |
| 5.8000 | 194302.8594 | 4.5770 | 432.5697 | 368.6407 |
| 80.5420 | 449.1827 | 191905.6645 | 40387.8228 | 232293.4668 |
| 0.4198 | 1.1005 | 0.0000 | 0.0000 | 0.5609 |
| 3.2533 | 3.5240 | 18.0036 | 2.9067 | 9.1647 |
| 4.7487 | 1.0166 | 1.8479 | | |
| 5.9000 | 194371.8516 | 4.5839 | 431.9550 | 369.3965 |
| 80.5852 | 449.9817 | 191868.6355 | 40379.7236 | 232248.4082 |
| 0.4214 | 1.1425 | 0.0000 | 0.0000 | 0.5609 |
| 3.3094 | 3.5220 | 18.3559 | 2.9200 | 9.4560 |
| 4.7555 | 1.0167 | 1.8481 | | |
| 6.0000 | 194774.3398 | 4.5907 | 432.0741 | 370.1575 |
| 80.6317 | 450.7892 | 191831.6504 | 40371.6201 | 232203.2695 |
| 0.4230 | 1.1847 | 0.0000 | 0.0000 | 0.5609 |
| 3.3655 | 3.5200 | 18.7080 | 2.9333 | 9.7487 |
| 4.7622 | 1.0168 | 1.8484 | | |
| 6.1000 | 195438.4766 | 4.5922 | 433.1070 | 370.5546 |
| 80.6930 | 451.2475 | 191794.5566 | 40363.5112 | 232158.0664 |
| 0.4241 | 1.2271 | 0.0000 | 0.0000 | 0.5609 |
| 3.4216 | 3.5180 | 19.0599 | 2.9467 | 10.0427 |
| 4.7633 | 1.0168 | 1.8484 | | |
| 6.2000 | 195433.2930 | 4.5937 | 432.7083 | 370.9090 |
| 80.7424 | 451.6514 | 191757.4258 | 40355.3970 | 232112.8223 |
| 0.4252 | 1.2696 | 0.0000 | 0.0000 | 0.5609 |
| 3.4776 | 3.5160 | 19.4116 | 2.9600 | 10.3380 |
| 4.7645 | 1.0168 | 1.8484 | | |
| 6.3000 | 195175.2695 | 4.5970 | 431.5345 | 371.4736 |
| 80.8083 | 452.2820 | 191720.2500 | 40347.2764 | 232067.5254 |
| 0.4263 | 1.3121 | 0.0000 | 0.0000 | 0.5609 |
| 3.5337 | 3.5140 | 19.7631 | 2.9733 | 10.6347 |
| 4.7675 | 1.0168 | 1.8485 | | |
| 6.4000 | 194973.9238 | 4.6024 | 430.5122 | 372.0501 |
| 80.8381 | 452.8883 | 191683.0156 | 40339.1509 | 232022.1660 |
| 0.4274 | 1.3549 | 0.0000 | 0.0000 | 0.5609 |
| 3.5898 | 3.5120 | 20.1144 | 2.9867 | 10.9327 |
| 4.7728 | 1.0169 | 1.8487 | | |
| 6.5000 | 195143.7324 | 4.6084 | 430.4466 | 372.5168 |
| 80.8349 | 453.3518 | 191645.7305 | 40331.0239 | 231976.7539 |
| 0.4285 | 1.3976 | 0.0000 | 0.0000 | 0.5609 |
| 3.6459 | 3.5100 | 20.4655 | 3.0000 | 11.2320 |
| 4.7788 | 1.0169 | 1.8489 | | |
| 6.6000 | 195631.6504 | 4.6185 | 430.6919 | 373.3820 |
| 80.8444 | 454.2264 | 191608.3770 | 40322.8970 | 231931.2734 |
| 0.4296 | 1.4405 | 0.0000 | 0.0000 | 0.5609 |
| 3.7020 | 3.5153 | 20.8168 | 3.0253 | 11.5333 |
| 4.7894 | 1.0170 | 1.8492 | | |
| 6.7000 | 196385.6777 | 4.6286 | 431.4765 | 374.2839 |
| 80.8641 | 455.1480 | 191570.9355 | 40314.7681 | 231885.7031 |
| 0.4307 | 1.4835 | 0.0000 | 0.0000 | 0.5609 |
| 3.7581 | 3.5207 | 21.1686 | 3.0507 | 11.8371 |
| 4.7998 | 1.0171 | 1.8496 | | |
| 6.8000 | 197034.8457 | 4.6406 | 431.7947 | 375.4173 |
| 80.8987 | 456.3160 | 191533.3926 | 40306.6362 | 231840.0273 |
| 0.4318 | 1.5267 | 0.0000 | 0.0000 | 0.5609 |
| 3.8142 | 3.5260 | 21.5209 | 3.0760 | 12.1434 |
| 4.8123 | 1.0172 | 1.8500 | | |
| 6.9000 | 197555.0840 | 4.6536 | 431.5253 | 376.8310 |
| 80.9755 | 457.8065 | 191495.7227 | 40298.4993 | 231794.2207 |
| 0.4329 | 1.5699 | 0.0000 | 0.0000 | 0.5609 |
| 3.8703 | 3.5313 | 21.8738 | 3.1013 | 12.4523 |
| 4.8258 | 1.0173 | 1.8504 | | |
| 7.0000 | 198514.3223 | 4.6701 | 431.9185 | 378.5514 |
| 81.0593 | 459.6106 | 191457.8965 | 40290.3535 | 231748.2500 |
| 0.4340 | 1.6132 | 0.0000 | 0.0000 | 0.5609 |
| 3.9264 | 3.5367 | 22.2272 | 3.1267 | 12.7637 |
| 4.8428 | 1.0175 | 1.8510 | | |
| 7.1000 | 199092.9961 | 4.6882 | 431.5125 | 380.2719 |
| 81.1122 | 461.3841 | 191419.8984 | 40282.2007 | 231702.0977 |
| 0.4360 | 1.6567 | 0.0000 | 0.0000 | 0.5609 |
| 3.9825 | 3.5420 | 22.5811 | 3.1520 | 13.0776 |
| 4.8617 | 1.0177 | 1.8516 | | |
| 7.2000 | 199843.3594 | 4.7144 | 430.8937 | 382.6274 |
| 81.1606 | 463.7880 | 191381.6953 | 40274.0430 | 231655.7383 |
| 0.4380 | 1.7004 | 0.0000 | 0.0000 | 0.5609 |
| 4.0386 | 3.5473 | 22.9356 | 3.1773 | 13.3941 |
| 4.8890 | 1.0179 | 1.8524 | | |
| 7.3000 | 201066.5840 | 4.7418 | 430.6799 | 385.5502 |
| 81.3084 | 466.8586 | 191343.2285 | 40265.8755 | 231609.1035 |
| 0.4400 | 1.7443 | 0.0000 | 0.0000 | 0.5609 |
| 4.0946 | 3.5527 | 23.2906 | 3.2027 | 13.7131 |
| 4.9173 | 1.0182 | 1.8533 | | |
| 7.4000 | 202848.8066 | 4.7726 | 431.3030 | 388.8417 |
| 81.4746 | 470.3162 | 191304.6512 | 40257.6919 | 231562.1426 |
| 0.4450 | 1.7886 | 0.0000 | 0.0000 | 0.5609 |
| 4.1507 | 3.5580 | 23.6461 | 3.2280 | 14.0346 |
| 4.9491 | 1.0185 | 1.8543 | | |
| 7.5000 | 203955.8223 | 4.8013 | 430.4575 | 392.1387 |
| 81.6730 | 473.8117 | 191265.3438 | 40249.4893 | 231514.8320 |
| 0.4500 | 1.8333 | 0.0000 | 0.0000 | 0.5609 |
| 4.2068 | 3.5633 | 24.0022 | 3.2533 | 14.3587 |
| 4.9787 | 1.0187 | 1.8552 | | |
| 7.6000 | 205355.5352 | 4.8310 | 430.0698 | 395.6042 |
| 81.8893 | 477.4935 | 191225.8984 | 40241.2656 | 231467.1641 |
| 0.4530 | 1.8785 | 0.0000 | 0.0000 | 0.5609 |
| 4.2629 | 3.5687 | 24.3588 | 3.2787 | 14.6853 |
| 5.0092 | 1.0190 | 1.8562 | | |
| 7.7000 | 207285.9297 | 4.8656 | 430.3648 | 399.5366 |
| 82.1151 | 481.6517 | 191186.0840 | 40233.0193 | 231419.1016 |
| 0.4560 | 1.9239 | 0.0000 | 0.0000 | 0.5609 |
| 4.3190 | 3.5740 | 24.7159 | 3.3040 | 15.0144 |
| 5.0449 | 1.0193 | 1.8573 | | |
| 7.8000 | 209278.4727 | 4.9086 | 430.4074 | 403.9413 |
| 82.2921 | 486.2334 | 191145.8516 | 40224.7524 | 231370.6035 |
| 0.4590 | 1.9697 | 0.0000 | 0.0000 | 0.5609 |
| 4.3751 | 3.5793 | 25.0736 | 3.3293 | 15.3461 |
| 5.0895 | 1.0197 | 1.8587 | | |
| 7.9000 | 211234.1094 | 4.9529 | 430.3819 | 408.3575 |
| 82.4488 | 490.8062 | 191105.1797 | 40216.4688 | 231321.6484 |
| 0.4620 | 2.0157 | 0.0000 | 0.0000 | 0.5609 |
| 4.4312 | 3.5847 | 25.4318 | 3.3547 | 15.6803 |
| 5.1355 | 1.0202 | 1.8600 | | |
| 8.0000 | 213769.1953 | 4.9939 | 431.6501 | 412.6140 |
| 82.6233 | 495.2373 | 191064.0742 | 40208.1685 | 231272.2422 |
| 0.4650 | 2.0621 | 0.0000 | 0.0000 | 0.5609 |
| 4.4873 | 3.5900 | 25.7905 | 3.3800 | 16.0170 |
| 5.1780 | 1.0205 | 1.8613 | | |
| 8.1000 | 215075.6875 | 5.0374 | 432.1035 | 417.2295 |
| 82.8259 | 500.0554 | 191022.5254 | 40199.8491 | 231222.3730 |
| 0.4680 | 2.1087 | 0.0000 | 0.0000 | 0.5609 |
| 4.5434 | 3.5905 | 26.1495 | 3.3840 | 16.3552 |
| 5.2230 | 1.0209 | 1.8627 | | |
| 8.2000 | 217735.4824 | 5.0831 | 430.7823 | 422.3532 |
| 83.0889 | 505.4421 | 190980.4883 | 40191.5059 | 231171.9941 |
| 0.4710 | 2.1557 | 0.0000 | 0.0000 | 0.5609 |
| 4.5995 | 3.5910 | 26.5086 | 3.3880 | 16.6938 |
| 5.2701 | 1.0214 | 1.8640 | | |
| 8.3000 | 219124.8789 | 5.1283 | 429.2124 | 427.2207 |
| 83.3072 | 510.5279 | 190937.9512 | 40183.1387 | 231121.0898 |
| 0.4740 | 2.2029 | 0.0000 | 0.0000 | 0.5609 |
| 4.6556 | 3.5915 | 26.8677 | 3.3920 | 17.0328 |
| 5.3168 | 1.0218 | 1.8654 | | |

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TABLE AP 2-1 (Sheet 3 of 9)
COMPUTER PROGRAM G105-3 (1ST BURN)

| | | | | |
|---|---|---|---|---|
| 8.4000 | 221069.9980 | 5.1690 | 429.4807 | 431.2981 |
| 83.4398 | 514.7379 | 190894.9669 | 43174.7534 | 231059.7158 |
| 0.4750 | 2.2504 | 0.0000 | 0.0000 | 0.5609 |
| 4.7116 | 3.5920 | 27.2269 | 3.3960 | 17.3722 |
| 5.3590 | 1.0222 | 1.8666 | | |
| 8.5000 | 222467.6719 | 5.1985 | 429.6101 | 434.2945 |
| 83.5417 | 517.8362 | 190851.6289 | 43166.3564 | 231317.9844 |
| 0.4760 | 2.2979 | 0.0000 | 0.0000 | 0.5609 |
| 4.7677 | 3.5925 | 27.5861 | 3.4000 | 17.7120 |
| 5.3896 | 1.0225 | 1.8674 | | |
| 8.6000 | 223454.7910 | 5.2137 | 429.6291 | 436.4069 |
| 83.7040 | 520.1110 | 190808.0371 | 43157.9463 | 233955.9824 |
| 0.4770 | 2.3456 | 0.0000 | 0.0000 | 0.5609 |
| 4.8238 | 3.5930 | 27.9454 | 3.4040 | 18.0522 |
| 5.4050 | 1.0226 | 1.8679 | | |
| 8.7000 | 223952.6445 | 5.2221 | 429.1683 | 437.9621 |
| 83.8673 | 521.8294 | 190764.2617 | 43149.5195 | 233913.7813 |
| 0.4780 | 2.3933 | 0.0000 | 0.0000 | 0.5609 |
| 4.8799 | 3.5935 | 28.3047 | 3.4080 | 18.3928 |
| 5.4134 | 1.0227 | 1.8681 | | |
| 8.8000 | 224408.4434 | 5.2296 | 428.8222 | 439.3097 |
| 84.0037 | 523.3134 | 190720.3398 | 43141.0781 | 233851.4180 |
| 0.4790 | 2.4412 | 0.0000 | 0.0000 | 0.5609 |
| 4.9360 | 3.5940 | 28.6641 | 3.4120 | 18.7338 |
| 5.4210 | 1.0228 | 1.8683 | | |
| 8.9000 | 224463.1406 | 5.2360 | 427.9113 | 440.4378 |
| 84.1176 | 524.5553 | 190676.2949 | 43132.5235 | 233808.9180 |
| 0.4800 | 2.4891 | 0.0000 | 0.0000 | 0.5609 |
| 4.9921 | 3.5945 | 29.0235 | 3.4160 | 19.0752 |
| 5.4273 | 1.0228 | 1.8685 | | |
| 9.0000 | 224137.4805 | 5.2382 | 426.6228 | 441.1576 |
| 84.2187 | 525.3762 | 190632.1582 | 43124.1582 | 233756.3164 |
| 0.4810 | 2.5372 | 0.0000 | 0.0000 | 0.5609 |
| 5.0482 | 3.5950 | 29.3830 | 3.4200 | 19.4170 |
| 5.4294 | 1.0228 | 1.8686 | | |
| 9.1000 | 224310.3398 | 5.2408 | 426.2626 | 441.9053 |
| 84.3204 | 526.2257 | 190587.9473 | 43115.6826 | 233703.6289 |
| 0.4820 | 2.5853 | 0.0000 | 0.0000 | 0.5609 |
| 5.1043 | 3.5955 | 29.7425 | 3.4240 | 19.7592 |
| 5.4318 | 1.0228 | 1.8686 | | |
| 9.2000 | 224361.3262 | 5.2451 | 425.6830 | 442.6664 |
| 84.3955 | 527.0619 | 190543.6602 | 43107.1982 | 230650.8574 |
| 0.4830 | 2.6336 | 0.0000 | 0.0000 | 0.5609 |
| 5.1604 | 3.5960 | 30.1021 | 3.4280 | 20.1018 |
| 5.4362 | 1.0229 | 1.8687 | | |
| 9.3000 | 224050.2207 | 5.2477 | 424.5689 | 443.2479 |
| 84.4644 | 527.7122 | 190499.3066 | 40098.7061 | 230598.0117 |
| 0.4840 | 2.6819 | 0.0000 | 0.0000 | 0.5609 |
| 5.2165 | 3.5965 | 30.4617 | 3.4320 | 20.4448 |
| 5.4387 | 1.0229 | 1.8688 | | |
| 9.4000 | 223895.4395 | 5.2478 | 423.9665 | 443.5716 |
| 84.5254 | 528.0970 | 190454.9082 | 43090.2075 | 232545.1152 |
| 0.4850 | 2.7304 | 0.0000 | 0.0000 | 0.5609 |
| 5.2726 | 3.5970 | 30.8214 | 3.4360 | 20.7882 |
| 5.4386 | 1.0229 | 1.8688 | | |
| 9.5000 | 224445.2070 | 5.2471 | 424.9536 | 443.6184 |
| 84.5457 | 528.1640 | 190410.4902 | 43081.7051 | 230492.1953 |
| 0.4852 | 2.7789 | 0.0000 | 0.0000 | 0.5609 |
| 5.3286 | 3.5975 | 31.1811 | 3.4400 | 21.1320 |
| 5.4378 | 1.0229 | 1.8688 | | |
| 9.6000 | 225221.3965 | 5.2472 | 426.4522 | 443.5896 |
| 84.5385 | 528.1281 | 190366.0723 | 43073.2017 | 230439.2734 |
| 0.4853 | 2.8274 | 0.0000 | 0.0000 | 0.5609 |
| 5.3847 | 3.5980 | 31.5409 | 3.4440 | 21.4762 |
| 5.4379 | 1.0229 | 1.8689 | | |
| 9.7000 | 225184.9785 | 5.2479 | 426.0510 | 443.9456 |
| 84.5943 | 528.5399 | 190321.6387 | 40064.6958 | 230386.3340 |
| 0.4855 | 2.8760 | 0.0000 | 0.0000 | 0.5609 |
| 5.4408 | 3.5985 | 31.9007 | 3.4480 | 21.8209 |
| 5.4385 | 1.0229 | 1.8688 | | |
| 9.8000 | 225568.7402 | 5.2520 | 426.1656 | 444.6373 |
| 84.6611 | 529.2984 | 190277.1523 | 43056.1841 | 230333.3359 |
| 0.4856 | 2.9245 | 0.0000 | 0.0000 | 0.5609 |
| 5.4969 | 3.5990 | 32.2606 | 3.4520 | 22.1658 |
| 5.4426 | 1.0229 | 1.8689 | | |
| 9.9000 | 225798.6230 | 5.2576 | 426.3368 | 444.9881 |
| 84.6369 | 529.6250 | 190232.6133 | 40047.6699 | 230280.2832 |
| 0.4858 | 2.9731 | 0.0000 | 0.0000 | 0.5609 |
| 5.5530 | 3.5995 | 32.6205 | 3.4560 | 22.5112 |
| 5.4485 | 1.0230 | 1.8691 | | |
| 10.0000 | 225905.9473 | 5.2580 | 426.6180 | 444.9114 |
| 84.6160 | 529.5275 | 190188.0605 | 43039.1582 | 233227.2188 |
| 0.4859 | 3.0217 | 0.0000 | 0.0000 | 0.5609 |
| 5.6091 | 3.6000 | 32.9805 | 3.4600 | 22.8570 |
| 5.4489 | 1.0230 | 1.8691 | | |
| 15.0000 | 227532.7656 | 5.3326 | 423.8563 | 452.0451 |
| 84.7708 | 536.8159 | 187939.3457 | 39613.0308 | 227552.3750 |
| 0.4930 | 5.4700 | 0.0000 | 0.0000 | 0.5609 |
| 8.4136 | 3.6000 | 50.9805 | 3.5600 | 49.4320 |
| 5.5252 | 1.0237 | 1.8712 | | |
| 20.0000 | 228854.9609 | 5.3993 | 423.5278 | 455.9148 |
| 84.4392 | 540.3540 | 185665.1094 | 39187.4902 | 224852.5996 |
| 0.4960 | 7.9445 | 0.0000 | 0.0000 | 0.5609 |
| 11.2182 | 3.6000 | 68.9805 | 3.5900 | 58.3070 |
| 5.5954 | 1.0243 | 1.8731 | | |
| 25.0000 | 229716.7402 | 5.4406 | 423.7445 | 457.9607 |
| 84.1705 | 542.1113 | 183378.7402 | 38763.5454 | 222142.2852 |
| 0.4972 | 10.4276 | 0.0000 | 0.0000 | 0.5609 |
| 14.0227 | 3.5909 | 86.9577 | 3.5962 | 76.2726 |
| 5.6385 | 1.0247 | 1.8742 | | |
| 30.0000 | 230242.9434 | 5.4465 | 424.4238 | 458.3325 |
| 84.1511 | 542.4836 | 181084.4512 | 38340.1480 | 219424.6387 |
| 0.4985 | 12.9170 | 0.0000 | 0.0000 | 0.5609 |
| 16.8273 | 3.5814 | 104.8895 | 3.5933 | 94.2603 |
| 5.6441 | 1.0248 | 1.8744 | | |
| 35.0000 | 229541.6621 | 5.4516 | 422.8461 | 458.7072 |
| 84.1419 | 542.8491 | 178786.3867 | 37917.0894 | 216703.4745 |
| 0.4997 | 15.4126 | 0.0000 | 0.0000 | 0.5609 |
| 19.6318 | 3.5640 | 122.7584 | 3.5600 | 112.1519 |
| 5.6485 | 1.0248 | 1.8745 | | |
| 40.0000 | 230156.6738 | 5.4667 | 423.1645 | 459.7866 |
| 84.1076 | 543.8941 | 176485.8496 | 37494.2856 | 213387.1349 |
| 0.5010 | 17.9145 | 0.0000 | 0.0000 | 0.5609 |
| 22.4364 | 3.5900 | 140.6203 | 3.6000 | 129.9869 |
| 5.6657 | 1.0250 | 1.8749 | | |
| 45.0000 | 230765.0742 | 5.4639 | 424.5747 | 459.4344 |
| 84.0861 | 543.5205 | 174185.2539 | 37071.2173 | 211256.4707 |
| 0.5020 | 20.4220 | 0.0000 | 0.0000 | 0.5609 |
| 25.2409 | 3.5945 | 158.5817 | 3.6133 | 148.0285 |
| 5.6630 | 1.0250 | 1.8749 | | |
| 50.0000 | 229858.7344 | 5.4673 | 422.6346 | 459.7750 |
| 84.0962 | 543.8711 | 171883.6816 | 35648.0723 | 208531.7539 |
| 0.5030 | 22.9345 | 0.0000 | 0.0000 | 0.5609 |
| 28.0455 | 3.5991 | 176.5657 | 3.6200 | 166.1119 |
| 5.6667 | 1.0250 | 1.8749 | | |
| 55.0000 | 229628.0332 | 5.4610 | 422.2015 | 459.7033 |
| 84.1794 | 543.8826 | 169581.5195 | 35224.7375 | 205836.2559 |
| 0.5040 | 25.4520 | 0.0000 | 0.0000 | 0.5609 |
| 30.8500 | 3.5867 | 194.5385 | 3.6000 | 184.1617 |
| 5.6594 | 1.0249 | 1.8748 | | |
| 60.0000 | 231334.4395 | 5.4664 | 425.0194 | 460.1198 |
| 84.1717 | 544.2915 | 167278.8320 | 35801.0679 | 203079.8984 |
| 0.5050 | 27.9745 | 0.0000 | 0.0000 | 0.5609 |
| 33.6545 | 3.5900 | 212.4601 | 3.6200 | 202.1917 |
| 5.6651 | 1.0250 | 1.8749 | | |
| 65.0000 | 230556.2266 | 5.4678 | 422.8383 | 460.9548 |
| 84.3038 | 545.2586 | 164974.3320 | 35377.0869 | 200351.4180 |
| 0.5055 | 30.5007 | 0.0000 | 0.0000 | 0.5609 |
| 36.4591 | 3.6025 | 230.4476 | 3.6200 | 220.2917 |
| 5.6670 | 1.0250 | 1.8750 | | |
| 70.0000 | 230972.1055 | 5.4616 | 423.9571 | 460.4876 |
| 84.3131 | 544.8007 | 162667.6855 | 34952.8047 | 197620.4902 |
| 0.5060 | 33.0294 | 0.0000 | 0.0000 | 0.5609 |
| 39.2636 | 3.6087 | 248.4757 | 3.6200 | 238.3916 |
| 5.6610 | 1.0249 | 1.8748 | | |
| 75.0000 | 231223.9238 | 5.4630 | 423.7403 | 461.2438 |
| 84.4298 | 545.6737 | 160359.7715 | 34528.2432 | 194888.0137 |
| 0.5065 | 35.5607 | 0.0000 | 0.0000 | 0.5609 |
| 42.0682 | 3.5900 | 266.4850 | 3.6200 | 256.4916 |
| 5.6609 | 1.0249 | 1.8748 | | |
| 80.0000 | 231541.2461 | 5.4615 | 424.6595 | 460.8565 |
| 84.3833 | 545.2397 | 158051.9004 | 34103.4551 | 192155.3555 |
| 0.5070 | 38.0944 | 0.0000 | 0.0000 | 0.5609 |
| 44.8727 | 3.6009 | 284.4708 | 3.6200 | 274.5916 |
| 5.6601 | 1.0249 | 1.8748 | | |
| 85.0000 | 230675.8750 | 5.4574 | 422.6296 | 461.2855 |
| 84.5255 | 545.8110 | 155743.6270 | 33678.4497 | 189422.0762 |
| 0.5072 | 40.6300 | 0.0000 | 0.0000 | 0.5609 |
| 47.6772 | 3.6032 | 302.4809 | 3.6200 | 292.6916 |
| 5.6556 | 1.0249 | 1.8747 | | |
| 90.0000 | 231839.2637 | 5.4403 | 424.9414 | 460.8665 |
| 84.7129 | 545.5794 | 153434.8359 | 33252.9175 | 185687.7520 |
| 0.5075 | 43.1669 | 0.0000 | 0.0000 | 0.5609 |
| 50.4818 | 3.6055 | 320.5024 | 3.6200 | 310.7915 |
| 5.6375 | 1.0247 | 1.8742 | | |
| 95.0000 | 230522.0391 | 5.4299 | 424.0573 | 459.0662 |
| 84.5444 | 543.6106 | 151134.5352 | 32827.5952 | 183952.1289 |
| 0.5077 | 45.7050 | 0.0000 | 0.0000 | 0.5609 |
| 53.2863 | 3.6077 | 338.5353 | 3.6086 | 328.8686 |
| 5.6273 | 1.0246 | 1.8739 | | |
| 100.0000 | 230522.7676 | 5.4471 | 422.6801 | 460.7902 |
| 84.5933 | 545.3835 | 148837.2266 | 32402.5601 | 181239.7852 |
| 0.5080 | 48.2444 | 0.0000 | 0.0000 | 0.5609 |
| 56.0909 | 3.6100 | 356.5795 | 3.6057 | 346.9871 |
| 5.6454 | 1.0248 | 1.8744 | | |
| 105.0000 | 230337.6836 | 5.4376 | 422.4618 | 460.5329 |
| 84.6943 | 545.2272 | 146530.8555 | 31976.9119 | 178507.7656 |
| 0.5077 | 50.7837 | 0.0000 | 0.0000 | 0.5609 |
| 58.8954 | 3.6191 | 374.6521 | 3.6200 | 364.9513 |
| 5.6357 | 1.0247 | 1.8741 | | |
| 110.0000 | 231775.4121 | 5.4346 | 424.8321 | 460.7831 |
| 84.7864 | 545.5695 | 144224.3105 | 31551.0896 | 175775.3984 |
| 0.5075 | 53.3218 | 0.0000 | 0.0000 | 0.5609 |
| 61.7000 | 3.6282 | 392.7702 | 3.6300 | 383.0762 |
| 5.6329 | 1.0247 | 1.8741 | | |
| 115.0000 | 230810.9355 | 5.4318 | 424.2246 | 459.4860 |
| 84.5912 | 544.0772 | 141917.9902 | 31125.1216 | 173043.1113 |
| 0.5072 | 55.8587 | 0.0000 | 0.0000 | 0.5609 |
| 64.5045 | 3.6211 | 410.9014 | 3.6400 | 401.2511 |
| 5.6298 | 1.0247 | 1.8740 | | |
| 120.0000 | 229752.7891 | 5.4231 | 423.1676 | 458.4072 |
| 84.5284 | 542.9357 | 139621.3887 | 33699.6665 | 170321.0547 |
| 0.5070 | 58.3943 | 0.0000 | 0.0000 | 0.5609 |
| 67.3090 | 3.6100 | 428.9791 | 3.6300 | 419.4260 |
| 5.6202 | 1.0246 | 1.8737 | | |
| 125.0000 | 229684.1973 | 5.4147 | 423.4201 | 457.9859 |
| 84.5640 | 542.4499 | 137326.8379 | 33274.3416 | 167601.1777 |
| 0.5070 | 60.9293 | 0.0000 | 0.0000 | 0.5609 |
| 70.1135 | 3.6000 | 447.0040 | 3.6217 | 437.5550 |
| 5.6107 | 1.0245 | 1.8735 | | |
| 130.0000 | 230062.9063 | 5.4328 | 422.6245 | 459.7435 |
| 84.6237 | 544.3672 | 135027.1523 | 29848.8477 | 164876.0000 |
| 0.5070 | 63.4643 | 0.0000 | 0.0000 | 0.5609 |
| 72.9180 | 3.6100 | 465.0289 | 3.6250 | 455.6658 |
| 5.6301 | 1.0247 | 1.8740 | | |
| 135.0000 | 231982.1660 | 5.4271 | 425.8428 | 460.0001 |
| 84.7600 | 544.7601 | 132723.5039 | 29422.7369 | 162146.2383 |
| 0.5070 | 65.9993 | 0.0000 | 0.0000 | 0.5609 |
| 75.7226 | 3.6267 | 483.1372 | 3.6317 | 473.8065 |
| 5.6249 | 1.0246 | 1.8735 | | |

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TABLE AP 2-1 (Sheet 4 of 9)
COMPUTER PROGRAM G105-3 (1ST BURN)

| | | | | |
|---|---|---|---|---|
| 140.0000 | 230950.4336 | 5.4335 | 423.5161 | 450.5543 |
| 84.7625 | 545.3168 | 130418.6133 | 28996.7012 | 159415.3145 |
| 0.5070 | 68.5342 | 0.0000 | 0.0000 | 0.5609 |
| 78.5271 | 3.6100 | 501.2287 | 3.5400 | 491.9856 |
| 5.6303 | 1.0247 | 1.8740 | | |
| 145.0000 | 230396.8457 | 5.4226 | 423.6470 | 459.1658 |
| 84.6757 | 543.8415 | 128114.9580 | 29570.6533 | 155685.6113 |
| 0.5070 | 71.0692 | 0.0000 | 0.0000 | 0.5609 |
| 81.3316 | 3.6100 | 519.2785 | 3.6317 | 510.1647 |
| 5.6193 | 1.0246 | 1.8737 | | |
| 150.0000 | 231809.3105 | 5.4220 | 426.8683 | 458.4856 |
| 84.5608 | 543.0464 | 125819.2676 | 29145.0559 | 153964.3223 |
| 0.5070 | 73.6041 | 0.0000 | 0.0000 | 0.5609 |
| 84.1361 | 3.6100 | 537.3281 | 3.6142 | 528.2837 |
| 5.6191 | 1.0246 | 1.8737 | | |
| 151.0000 | 231018.7090 | 5.4247 | 425.4469 | 458.4851 |
| 84.5176 | 543.0024 | 125360.3271 | 29059.9800 | 153470.1066 |
| 0.5070 | 74.1111 | 0.0000 | 0.0000 | 0.5609 |
| 84.6970 | 3.6100 | 540.9380 | 3.6103 | 531.4959 |
| 5.6222 | 1.0246 | 1.8738 | | |
| 152.0000 | 230444.8848 | 5.4137 | 424.7812 | 457.9180 |
| 84.5846 | 542.5026 | 124901.4961 | 27974.9034 | 152476.3984 |
| 0.5070 | 74.6181 | 0.0000 | 0.0000 | 0.5609 |
| 85.2579 | 3.6100 | 544.5479 | 3.6063 | 535.5042 |
| 5.6105 | 1.0245 | 1.8735 | | |
| 153.0000 | 230200.3770 | 5.4162 | 424.3502 | 457.9290 |
| 84.5483 | 542.4773 | 124442.9580 | 27889.8123 | 152332.7695 |
| 0.5070 | 75.1251 | 0.0000 | 0.0000 | 0.5609 |
| 85.8188 | 3.6100 | 548.1579 | 3.6024 | 539.1085 |
| 5.6132 | 1.0245 | 1.8736 | | |
| 153.1000 | 230242.1309 | 5.4208 | 424.2597 | 458.1702 |
| 84.5213 | 542.6915 | 124397.0957 | 27881.3079 | 152278.4023 |
| 0.5070 | 75.1758 | 0.0000 | 0.0000 | 0.5609 |
| 85.8749 | 3.6100 | 548.5188 | 3.6020 | 539.4687 |
| 5.6181 | 1.0245 | 1.8737 | | |
| 153.2000 | 229404.1152 | 5.4242 | 422.6804 | 458.2529 |
| 84.4837 | 542.7366 | 124351.2178 | 27872.8066 | 152224.0234 |
| 0.5070 | 75.2265 | 0.0000 | 0.0000 | 0.5609 |
| 85.9310 | 3.6100 | 548.8799 | 3.6016 | 539.8289 |
| 5.6217 | 1.0246 | 1.8738 | | |
| 153.3000 | 229490.5449 | 5.4243 | 423.7402 | 457.2819 |
| 84.3022 | 541.5832 | 124305.3838 | 27864.3164 | 152169.6992 |
| 0.5070 | 75.2772 | 0.0000 | 0.0000 | 0.5609 |
| 85.9871 | 3.6100 | 549.2408 | 3.6012 | 540.1890 |
| 5.6223 | 1.0246 | 1.8738 | | |
| 153.4000 | 236427.3301 | 5.3992 | 432.4485 | 461.2825 |
| 85.4354 | 546.7179 | 124259.4263 | 27855.8040 | 152115.2305 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 3.6100 | 549.6018 | 3.6004 | 540.5491 |
| 5.5934 | 1.0243 | 1.8731 | | |
| 153.5000 | 149626.6914 | 5.2512 | 295.6031 | 422.3863 |
| 80.4051 | 502.7914 | 124215.2432 | 27847.5117 | 152062.7539 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 3.6100 | 549.9624 | 3.6004 | 540.9092 |
| 5.4533 | 1.0230 | 1.8676 | | |
| 153.6000 | 41668.4312 | 3.1933 | 139.0023 | 228.2806 |
| 71.4874 | 299.7680 | 124182.7093 | 27839.9173 | 152022.6259 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 3.6100 | 550.3238 | 3.6000 | 541.2692 |
| 3.3101 | 1.0035 | 1.7883 | | |
| 153.7000 | 14471.2125 | 1.5310 | 115.7634 | 75.6157 |
| 49.3911 | 125.0069 | 124167.5137 | 27833.8733 | 152001.3867 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 1.8050 | 550.5945 | 1.8000 | 541.5392 |
| 1.5512 | 0.9875 | 1.6728 | | |

| | | | | |
|---|---|---|---|---|
| 153.8000 | 15007.9850 | 1.3016 | 272.4034 | 31.1569 |
| 23.9378 | 55.0947 | 124162.1748 | 27830.2065 | 151992.3809 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.3016 | 0.9853 | 1.6534 | | |
| 153.9000 | 12440.6757 | 1.2084 | 416.9022 | 16.3400 |
| 13.5224 | 29.8623 | 124159.7998 | 27828.3335 | 151984.1379 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.2084 | 0.9844 | 1.6447 | | |
| 154.0000 | 10243.7429 | 1.4316 | 400.4085 | 15.0622 |
| 10.5211 | 25.5832 | 124158.2295 | 27827.1311 | 151955.3594 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.4316 | 0.9864 | 1.6617 | | |
| 154.1000 | 7467.5548 | 1.9522 | 307.5228 | 16.0575 |
| 8.2254 | 24.2829 | 124156.6729 | 27826.1936 | 151982.8652 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.9522 | 0.9912 | 1.7009 | | |
| 154.2000 | 5005.5427 | 1.2990 | 327.7638 | 8.6290 |
| 6.6428 | 15.2718 | 124155.4385 | 27825.4500 | 151980.8867 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.2990 | 0.9852 | 1.6485 | | |
| 154.3000 | 4593.5966 | 2.2646 | 239.1987 | 13.3216 |
| 5.8825 | 19.2041 | 124154.3408 | 27824.8235 | 151979.1641 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 2.2646 | 0.9940 | 1.7226 | | |
| 154.4000 | 2869.0024 | 1.4448 | 224.1126 | 7.5655 |
| 5.2362 | 12.8016 | 124153.2959 | 27824.2673 | 151977.5625 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.4448 | 0.9865 | 1.6596 | | |
| 154.5000 | 331.2912 | 2.2236 | 24.3273 | 9.3936 |
| 4.2244 | 11.6181 | 124152.4473 | 27823.7942 | 151976.2402 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6849 | 0.0000 | 541.6292 |
| 2.2236 | 0.9937 | 1.7187 | | |
| 154.6000 | 0.0000 | 1.5253 | 0.0000 | 6.5719 |
| 4.3087 | 10.8807 | 124151.6484 | 27823.3674 | 151975.0156 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 1.5253 | 0.9873 | 1.6650 | | |
| 154.7000 | 0.0000 | 0.2202 | 0.0000 | 0.8483 |
| 3.8518 | 4.7001 | 124151.2773 | 27822.9592 | 151974.2363 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 0.2202 | 0.9754 | 1.5499 | | |
| 154.8000 | 0.0000 | 0.0293 | 0.0000 | 0.0874 |
| 2.9804 | 3.0678 | 124151.2305 | 27822.6174 | 151973.9477 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 0.0293 | 0.9737 | 1.5325 | | |
| 154.9000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.6043 | 2.6043 | 124151.2256 | 27822.3381 | 151973.5625 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.5292 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 155.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.5977 | 2.5977 | 124151.2256 | 27822.0779 | 151973.3027 |
| 0.0000 | 75.3026 | 0.0000 | 0.0000 | 0.0000 |
| 86.0151 | 0.0000 | 550.6848 | 0.0000 | 541.6292 |
| 0.0000 | 0.9734 | 1.5298 | | |

TABLE AP 2-1 (Sheet 5 of 9)
COMPUTER PROGRAM G105-3 (2ND BURN)

| | | | | |
|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.0000 | 0.0000 | 124761.0000 | 24720.0000 | 149481.0000 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.1000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.4204 | 0.4204 | 124760.9902 | 24719.9788 | 149480.9688 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0095 | 0.1250 | 0.0062 | 0.0600 | 0.0030 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.2000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3.4956 | 3.4956 | 124760.9805 | 24719.7827 | 149480.7617 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0191 | 0.2500 | 0.0250 | 0.1200 | 0.0120 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.3000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4.7285 | 4.7285 | 124760.9707 | 24719.3713 | 149480.3418 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0286 | 0.3750 | 0.0562 | 0.1800 | 0.0270 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.4000 | 198.7745 | 0.0000 | 36.6965 | 0.0000 |
| 5.4182 | 5.4182 | 124760.9609 | 24718.8638 | 149479.8242 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0381 | 0.5000 | 0.1000 | 0.2400 | 0.0480 |
| 0.0000 | 0.9734 | 1.5300 | | |
| 0.5000 | 176.2707 | 0.0000 | 25.5317 | 0.0000 |
| 6.9040 | 6.9040 | 124760.9512 | 24718.2476 | 149479.1973 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0477 | 0.6250 | 0.1562 | 0.3000 | 0.0750 |
| 0.0000 | 0.9734 | 1.5300 | | |
| 0.6000 | 139.5822 | 0.0000 | 20.3129 | 0.0000 |
| 6.8716 | 6.8716 | 124760.9414 | 24717.5586 | 149478.5000 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0572 | 0.7500 | 0.2250 | 0.3600 | 0.1080 |
| 0.0000 | 0.9734 | 1.5299 | | |
| 0.7000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6.7864 | 6.7864 | 124760.9316 | 24716.8755 | 149477.8066 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0667 | 0.8750 | 0.3062 | 0.4200 | 0.1470 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.8000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7.2379 | 7.2379 | 124760.9219 | 24716.1741 | 149477.0957 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0763 | 1.0000 | 0.4000 | 0.4800 | 0.1920 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 0.9000 | 0.0000 | 0.1086 | 0.0000 | 0.8472 |
| 7.8007 | 8.6479 | 124760.8691 | 24715.4221 | 149476.2910 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0858 | 1.1250 | 0.5062 | 0.5400 | 0.2430 |
| 0.0460 | 0.9738 | 1.5340 | | |
| 1.0000 | 0.0000 | 0.8008 | 0.0000 | 13.2422 |
| 16.5370 | 29.7792 | 124760.1543 | 24714.2051 | 149474.3594 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.0953 | 1.2500 | 0.6250 | 0.6000 | 0.3000 |
| 0.8270 | 0.9809 | 1.6049 | | |
| 1.1000 | 746.2705 | 0.3930 | 15.9814 | 13.1902 |
| 33.5644 | 46.7546 | 124758.8223 | 24711.7000 | 149470.5215 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1049 | 1.3750 | 0.7562 | 0.6600 | 0.3630 |
| 0.3893 | 0.9770 | 1.5660 | | |
| 1.2000 | 3082.9214 | 0.4069 | 53.2251 | 16.7526 |
| 41.1697 | 57.9223 | 124757.3145 | 24707.9631 | 149455.2773 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1144 | 1.5000 | 0.9000 | 0.7200 | 0.4320 |
| 0.4042 | 0.9771 | 1.5693 | | |
| 1.3000 | 5385.4171 | 1.4209 | 50.4121 | 52.7314 |
| 44.1265 | 106.8279 | 124753.3311 | 24703.6982 | 149457.0293 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1239 | 1.6250 | 1.0562 | 0.7800 | 0.5070 |
| 1.4569 | 0.9867 | 1.6617 | | |
| 1.4000 | 6689.6803 | 1.5948 | 57.3215 | 71.7279 |
| 44.9769 | 116.7046 | 124746.5996 | 24699.7429 | 149445.8418 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1335 | 1.7500 | 1.2250 | 0.8400 | 0.5880 |
| 1.6399 | 0.9883 | 1.6768 | | |
| 1.5000 | 13159.6830 | 1.5351 | 115.2555 | 59.1387 |
| 45.0396 | 114.1783 | 124739.5459 | 24694.7419 | 149434.2871 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1430 | 1.8750 | 1.4062 | 0.9000 | 0.6750 |
| 1.5809 | 0.9878 | 1.6746 | | |
| 1.6000 | 32321.8206 | 1.3693 | 294.3476 | 53.4622 |
| 46.3461 | 109.8083 | 124732.9053 | 24690.1726 | 149423.0762 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1525 | 2.0000 | 1.6000 | 0.9600 | 0.7680 |
| 1.4094 | 0.9862 | 1.6687 | | |
| 1.7000 | 32010.6978 | 1.1646 | 316.2901 | 54.4514 |
| 46.7554 | 101.2068 | 124726.9990 | 24685.5173 | 149412.5156 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1621 | 2.1250 | 1.8062 | 1.0200 | 0.8670 |
| 1.1972 | 0.9843 | 1.6526 | | |
| 1.8000 | 35537.4863 | 1.1156 | 351.5154 | 53.3106 |
| 47.7874 | 101.0980 | 124721.6006 | 24680.7900 | 149432.3906 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1716 | 2.2500 | 2.0250 | 1.0800 | 0.9720 |
| 1.1470 | 0.9839 | 1.6503 | | |
| 1.9000 | 44841.8672 | 1.2635 | 405.5012 | 61.7276 |
| 48.8562 | 110.5838 | 124715.8389 | 24675.9578 | 149391.7949 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1811 | 2.3750 | 2.2562 | 1.1400 | 1.0830 |
| 1.3035 | 0.9853 | 1.6654 | | |
| 2.0000 | 52817.9253 | 1.5118 | 421.0724 | 75.4981 |
| 49.9386 | 125.4367 | 124708.9678 | 24671.0174 | 149379.9844 |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0953 |
| 0.1907 | 2.5000 | 2.5000 | 1.2000 | 1.2000 |
| 1.5662 | 0.9877 | 1.6864 | | |
| 2.1000 | 61703.1250 | 1.7651 | 433.2236 | 90.9181 |
| 51.5094 | 142.4279 | 124700.6367 | 24665.9446 | 149356.5801 |
| 0.0133 | 0.0007 | 0.0000 | 0.0000 | 0.0953 |
| 0.2002 | 2.6000 | 2.7550 | 1.2600 | 1.3230 |
| 1.8331 | 0.9901 | 1.7062 | | |
| 2.2000 | 73688.0400 | 2.0366 | 458.7866 | 107.7212 |
| 52.8939 | 160.6151 | 124690.6943 | 24660.7222 | 149331.4160 |
| 0.0267 | 0.0027 | 0.0000 | 0.0000 | 0.0953 |
| 0.2097 | 2.7000 | 3.0200 | 1.3200 | 1.4520 |
| 2.1198 | 0.9927 | 1.7262 | | |
| 2.3000 | 86784.2402 | 2.3957 | 475.5123 | 128.7609 |
| 53.7460 | 182.5068 | 124678.8604 | 24655.3867 | 149334.2461 |
| 0.0400 | 0.0060 | 0.0000 | 0.0000 | 0.0953 |
| 0.2193 | 2.8000 | 3.2950 | 1.3800 | 1.5870 |
| 2.5003 | 0.9962 | 1.7496 | | |
| 2.4000 | 96744.2373 | 2.7326 | 461.2391 | 153.5546 |
| 56.1939 | 209.7486 | 124664.7344 | 24649.8848 | 149314.6191 |
| 0.0533 | 0.0107 | 0.0000 | 0.0000 | 0.0953 |
| 0.2288 | 2.9000 | 3.5800 | 1.4400 | 1.7280 |
| 2.8543 | 0.9994 | 1.7690 | | |
| 2.5000 | 109096.5010 | 3.0096 | 455.1711 | 179.9048 |
| 59.7776 | 239.6824 | 124648.0508 | 24644.0801 | 149292.1309 |
| 0.0667 | 0.0167 | 0.0000 | 0.0000 | 0.0953 |
| 0.2383 | 3.0000 | 3.8750 | 1.5000 | 1.8750 |
| 3.1422 | 1.0020 | 1.7836 | | |
| 2.6000 | 124722.5479 | 3.2790 | 467.8618 | 204.2801 |
| 62.2998 | 266.5799 | 124628.8311 | 24637.9685 | 149266.7988 |
| 0.0800 | 0.0240 | 0.0000 | 0.0000 | 0.0953 |
| 0.2479 | 3.1000 | 4.1800 | 1.7000 | 2.0350 |
| 3.4223 | 1.0046 | 1.7968 | | |
| 2.7000 | 141377.2305 | 3.5875 | 481.7756 | 229.4831 |
| 63.9673 | 293.4504 | 124607.1328 | 24631.6462 | 149238.7773 |
| 0.0933 | 0.0327 | 0.0000 | 0.0000 | 0.0953 |
| 0.2574 | 3.2000 | 4.4950 | 1.9000 | 2.2150 |
| 3.7452 | 1.0075 | 1.8108 | | |
| 2.8000 | 155485.1445 | 3.9066 | 483.2237 | 256.1882 |
| 65.5782 | 321.7664 | 124582.8389 | 24625.1569 | 149207.9961 |
| 0.1067 | 0.0427 | 0.0000 | 0.0000 | 0.0953 |
| 0.2670 | 3.3000 | 4.8200 | 2.1000 | 2.4150 |
| 4.0799 | 1.0105 | 1.8241 | | |
| 2.9000 | 164944.3086 | 4.1521 | 472.0234 | 281.6161 |
| 67.8248 | 349.4410 | 124555.9385 | 24618.4773 | 149174.4141 |
| 0.1200 | 0.0540 | 0.0000 | 0.0000 | 0.0953 |
| 0.2765 | 3.4000 | 5.1550 | 2.3000 | 2.6350 |
| 4.3335 | 1.0129 | 1.8335 | | |
| 3.0000 | 171445.3652 | 4.3480 | 459.4868 | 303.3541 |
| 69.7694 | 373.1236 | 124526.6797 | 24611.5847 | 149138.2637 |
| 0.1333 | 0.0667 | 0.0000 | 0.0000 | 0.0953 |
| 0.2860 | 3.5000 | 5.5000 | 2.5000 | 2.8750 |
| 4.5399 | 1.0147 | 1.8407 | | |
| 3.1000 | 177026.5938 | 4.4660 | 450.6621 | 320.9490 |
| 71.8655 | 392.8145 | 124495.4541 | 24604.4888 | 149099.9414 |
| 0.1467 | 0.0807 | 0.0000 | 0.0000 | 0.0953 |
| 0.2956 | 3.4991 | 5.8500 | 2.5500 | 3.1275 |
| 4.6572 | 1.0158 | 1.8447 | | |
| 3.2000 | 180428.5469 | 4.5194 | 443.4783 | 333.1358 |
| 73.7129 | 406.8487 | 124462.7393 | 24597.1943 | 149059.9336 |
| 0.1600 | 0.0960 | 0.0000 | 0.0000 | 0.0953 |
| 0.3051 | 3.4982 | 6.1998 | 2.6000 | 3.3850 |
| 4.7075 | 1.0163 | 1.8464 | | |
| 3.3000 | 184394.9375 | 4.5527 | 442.2161 | 341.8851 |
| 75.0942 | 416.9793 | 124428.9775 | 24589.7371 | 149018.7129 |
| 0.1733 | 0.1127 | 0.0000 | 0.0000 | 0.0953 |
| 0.3146 | 3.4973 | 6.5496 | 2.6500 | 3.5475 |
| 4.7381 | 1.0165 | 1.8474 | | |
| 3.4000 | 186888.0234 | 4.5673 | 440.2313 | 348.2699 |
| 76.2524 | 424.5223 | 124394.4600 | 24582.1516 | 148976.6113 |
| 0.1867 | 0.1307 | 0.0000 | 0.0000 | 0.0953 |
| 0.3242 | 3.4964 | 6.8993 | 2.7000 | 3.9150 |
| 4.7497 | 1.0166 | 1.8478 | | |
| 3.5000 | 187561.8789 | 4.5787 | 436.3666 | 352.7788 |
| 77.0476 | 429.8264 | 124359.3975 | 24574.4672 | 148933.8633 |
| 0.2000 | 0.1500 | 0.0000 | 0.0000 | 0.0953 |
| 0.3337 | 3.4955 | 7.2489 | 2.7500 | 4.1875 |
| 4.7589 | 1.0167 | 1.8481 | | |
| 3.6000 | 189559.2070 | 4.5901 | 437.4169 | 355.8377 |
| 77.5228 | 433.3605 | 124323.9561 | 24566.7175 | 148890.6719 |
| 0.2107 | 0.1705 | 0.0000 | 0.0000 | 0.0953 |
| 0.3432 | 3.4945 | 7.5984 | 2.8000 | 4.4650 |
| 4.7690 | 1.0168 | 1.8485 | | |
| 3.7000 | 190035.6895 | 4.5911 | 435.0499 | 358.6871 |
| 78.1264 | 436.8135 | 124288.2197 | 24558.9133 | 148847.1328 |
| 0.2213 | 0.1921 | 0.0000 | 0.0000 | 0.0953 |
| 0.3528 | 3.4936 | 7.9478 | 2.8500 | 4.7475 |
| 4.7678 | 1.0168 | 1.8485 | | |
| 3.8000 | 190450.0488 | 4.5846 | 433.6284 | 360.5563 |
| 78.6447 | 439.2010 | 124252.2471 | 24551.0520 | 148803.2988 |
| 0.2320 | 0.2148 | 0.0000 | 0.0000 | 0.0953 |
| 0.3623 | 3.4927 | 8.2971 | 2.9000 | 5.0350 |
| 4.7591 | 1.0167 | 1.8482 | | |
| 3.9000 | 190829.9160 | 4.5843 | 433.5368 | 361.3479 |
| 78.8222 | 440.1701 | 124216.1416 | 24543.1545 | 148759.2949 |
| 0.2427 | 0.2385 | 0.0000 | 0.0000 | 0.0953 |
| 0.3718 | 3.4918 | 8.6463 | 2.9500 | 5.3275 |
| 4.7577 | 1.0167 | 1.8481 | | |
| 4.0000 | 191719.8359 | 4.5965 | 434.2296 | 362.6251 |
| 78.8921 | 441.5172 | 124179.9326 | 24535.2439 | 148715.1758 |
| 0.2533 | 0.2633 | 0.0000 | 0.0000 | 0.0953 |
| 0.3814 | 3.4909 | 8.9955 | 3.0000 | 5.6250 |
| 4.7695 | 1.0168 | 1.8485 | | |
| 4.1000 | 192607.7559 | 4.5810 | 435.1768 | 363.2920 |
| 79.3045 | 442.5965 | 124143.6270 | 24527.3381 | 148670.9336 |
| 0.2640 | 0.2892 | 0.0000 | 0.0000 | 0.0953 |
| 0.3909 | 3.4900 | 9.3445 | 3.0020 | 5.9751 |
| 4.7523 | 1.0167 | 1.8480 | | |

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Table AP 2-1

TABLE AP 2-1 (Sheet 6 of 9)
COMPUTER PROGRAM G105-3 (2ND BURN)

| | | | | |
|---|---|---|---|---|
| 4.2000 | 193750.8047 | 4.6026 | 437.1788 | 364.0804 |
| 79.1040 | 443.1843 | 124107.2480 | 24519.3604 | 148626.6074 |
| 0.2747 | 0.3161 | 0.0000 | 0.0000 | 0.0953 |
| 0.4004 | 3.4891 | 9.6935 | 3.0040 | 6.2254 |
| 4.7752 | 1.0169 | 1.8487 | | |
| 4.3000 | 194731.3613 | 4.6184 | 438.4941 | 365.0495 |
| 79.0417 | 444.0912 | 124070.7813 | 24511.4248 | 148552.2051 |
| 0.2853 | 0.3441 | 0.0000 | 0.0000 | 0.0953 |
| 0.4100 | 3.4882 | 10.0423 | 3.0060 | 6.5259 |
| 4.7919 | 1.0170 | 1.8493 | | |
| 4.4000 | 194442.8242 | 4.6098 | 436.8509 | 355.7571 |
| 79.3440 | 445.1011 | 124034.2305 | 24503.4761 | 148537.7051 |
| 0.2960 | 0.3732 | 0.0000 | 0.0000 | 0.0953 |
| 0.4195 | 3.4873 | 10.3911 | 3.0080 | 6.8266 |
| 4.7820 | 1.0169 | 1.8490 | | |
| 4.5000 | 193786.7227 | 4.5913 | 434.1767 | 366.5049 |
| 79.8265 | 446.3314 | 123997.6074 | 24495.4871 | 148493.0938 |
| 0.3067 | 0.4033 | 0.0000 | 0.0000 | 0.0953 |
| 0.4290 | 3.4864 | 10.7398 | 3.0100 | 7.1275 |
| 4.7615 | 1.0168 | 1.8483 | | |
| 4.6000 | 193878.5273 | 4.5999 | 433.7363 | 367.1736 |
| 79.8227 | 446.9963 | 123960.9131 | 24487.4731 | 148448.3848 |
| 0.3173 | 0.4345 | 0.0000 | 0.0000 | 0.0953 |
| 0.4386 | 3.4855 | 11.0884 | 3.0120 | 7.4286 |
| 4.7704 | 1.0168 | 1.8486 | | |
| 4.7000 | 194603.9590 | 4.6025 | 434.7632 | 367.7147 |
| 79.8944 | 447.6090 | 123924.1582 | 24479.4546 | 148403.6113 |
| 0.3280 | 0.4668 | 0.0000 | 0.0000 | 0.0953 |
| 0.4481 | 3.4845 | 11.4369 | 3.0140 | 7.7299 |
| 4.7730 | 1.0169 | 1.8487 | | |
| 4.8000 | 194889.8242 | 4.6040 | 434.6266 | 368.3918 |
| 80.0157 | 448.4075 | 123887.3429 | 24471.4255 | 148358.7676 |
| 0.3387 | 0.5001 | 0.0000 | 0.0000 | 0.0953 |
| 0.4576 | 3.4836 | 11.7853 | 3.0160 | 8.0314 |
| 4.7742 | 1.0169 | 1.8487 | | |
| 4.9000 | 194877.9219 | 4.6117 | 433.7903 | 369.1890 |
| 80.0555 | 449.2445 | 123850.4531 | 24463.3875 | 148313.8398 |
| 0.3493 | 0.5345 | 0.0000 | 0.0000 | 0.0953 |
| 0.4672 | 3.4827 | 12.1336 | 3.0180 | 8.3331 |
| 4.7820 | 1.0169 | 1.8490 | | |
| 5.0000 | 195249.7402 | 4.6177 | 434.1614 | 369.6627 |
| 80.0542 | 449.7169 | 123813.5000 | 24455.3462 | 148258.8457 |
| 0.3600 | 0.5700 | 0.0000 | 0.0000 | 0.0953 |
| 0.4767 | 3.4818 | 12.4818 | 3.0200 | 8.6350 |
| 4.7882 | 1.0170 | 1.8492 | | |
| 5.1000 | 195379.3105 | 4.6203 | 434.2243 | 369.8917 |
| 80.0585 | 449.9501 | 123776.5117 | 24447.3043 | 148223.8145 |
| 0.3640 | 0.6062 | 0.0000 | 0.0000 | 0.0953 |
| 0.4862 | 3.4809 | 12.8300 | 3.0220 | 8.9371 |
| 4.7908 | 1.0170 | 1.8493 | | |
| 5.2000 | 195357.1953 | 4.6258 | 433.4233 | 370.6267 |
| 80.1040 | 450.7307 | 123739.4756 | 24439.2590 | 148178.7344 |
| 0.3680 | 0.6428 | 0.0000 | 0.0000 | 0.0953 |
| 0.4958 | 3.4800 | 13.1780 | 3.0240 | 9.2394 |
| 4.7975 | 1.0171 | 1.8495 | | |
| 5.3000 | 195039.5684 | 4.6379 | 431.7841 | 371.5861 |
| 80.1202 | 451.7062 | 123702.3545 | 24431.2107 | 148133.5645 |
| 0.3720 | 0.6798 | 0.0000 | 0.0000 | 0.0953 |
| 0.5053 | 3.4791 | 13.5260 | 3.0260 | 9.5419 |
| 4.8089 | 1.0172 | 1.8498 | | |
| 5.4000 | 195318.9785 | 4.6443 | 431.7182 | 372.2661 |
| 80.1563 | 452.4224 | 123665.1514 | 24423.1592 | 148088.3105 |
| 0.3760 | 0.7172 | 0.0000 | 0.0000 | 0.0953 |
| 0.5148 | 3.4782 | 13.8738 | 3.0280 | 9.8446 |
| 4.8154 | 1.0172 | 1.8500 | | |
| 5.5000 | 195904.7520 | 4.6450 | 432.6281 | 372.6079 |
| 80.2169 | 452.8248 | 123627.8975 | 24415.1325 | 148043.[illegible]000 |
| 0.3800 | 0.7550 | 0.0000 | 0.0000 | 0.0953 |
| 0.5244 | 3.4773 | 14.2216 | 3.0300 | 10.1475 |
| 4.8160 | 1.0172 | 1.8501 | | |
| 5.6000 | 196549.6426 | 4.6470 | 433.6819 | 372.9548 |
| 80.2568 | 453.2116 | 123590.6094 | 24407.0403 | 147997.6484 |
| 0.3840 | 0.7932 | 0.0000 | 0.0000 | 0.0953 |
| 0.5339 | 3.4764 | 14.5693 | 3.0320 | 10.4506 |
| 4.8179 | 1.0173 | 1.8501 | | |
| 5.7000 | 196412.5859 | 4.6508 | 432.9809 | 373.3516 |
| 80.2771 | 453.6287 | 123553.2842 | 24398.9746 | 147952.2578 |
| 0.3880 | 0.8318 | 0.0000 | 0.0000 | 0.0953 |
| 0.5434 | 3.4755 | 14.9169 | 3.0340 | 10.7539 |
| 4.8217 | 1.0173 | 1.8503 | | |
| 5.8000 | 196412.4785 | 4.6581 | 432.5309 | 373.8441 |
| 80.2564 | 454.1004 | 123515.9141 | 24390.9087 | 147906.4223 |
| 0.3920 | 0.8708 | 0.0000 | 0.0000 | 0.0953 |
| 0.5530 | 3.4745 | 15.2644 | 3.0360 | 11.0574 |
| 4.8294 | 1.0174 | 1.8505 | | |
| 5.9000 | 196945.9375 | 4.6649 | 433.1160 | 374.4479 |
| 80.2707 | 454.7186 | 123478.4593 | 24382.8429 | 147861.3320 |
| 0.3960 | 0.9102 | 0.0000 | 0.0000 | 0.0953 |
| 0.5625 | 3.4736 | 15.6118 | 3.0380 | 11.3611 |
| 4.8362 | 1.0174 | 1.8507 | | |
| 6.0000 | 197414.5840 | 4.6702 | 433.5752 | 375.0172 |
| 80.2997 | 455.3169 | 123441.0059 | 24374.7742 | 147815.7793 |
| 0.4000 | 0.9500 | 0.0000 | 0.0000 | 0.0953 |
| 0.5720 | 3.4727 | 15.9591 | 3.0400 | 11.6650 |
| 4.8418 | 1.0175 | 1.8509 | | |
| 6.1000 | 197386.3203 | 4.6723 | 432.8537 | 375.6183 |
| 80.3933 | 456.0116 | 123403.4639 | 24366.6992 | 147770.1621 |
| 0.4016 | 0.9901 | 0.0000 | 0.0000 | 0.0953 |
| 0.5816 | 3.4718 | 16.3063 | 3.0430 | 11.9691 |
| 4.8436 | 1.0175 | 1.8510 | | |
| 6.2000 | 197550.7363 | 4.6789 | 432.5767 | 376.2661 |
| 80.4177 | 456.6838 | 123365.8594 | 24358.6182 | 147724.4766 |
| 0.4033 | 1.0303 | 0.0000 | 0.0000 | 0.0953 |
| 0.5911 | 3.4709 | 16.6535 | 3.0460 | 12.2736 |
| 4.8504 | 1.0176 | 1.8512 | | |
| 6.3000 | 198096.9629 | 4.6863 | 432.9685 | 377.0696 |
| 80.4624 | 457.5320 | 123328.1826 | 24350.5334 | 147678.7148 |
| 0.4049 | 1.0707 | 0.0000 | 0.0000 | 0.0953 |
| 0.6006 | 3.4700 | 17.0005 | 3.0490 | 12.5783 |
| 4.8579 | 1.0176 | 1.8514 | | |
| 6.4000 | 197601.3223 | 4.6917 | 431.3739 | 377.5925 |
| 80.4818 | 458.0743 | 123290.4395 | 24342.4453 | 147632.8848 |
| 0.4066 | 1.1113 | 0.0000 | 0.0000 | 0.0953 |
| 0.6102 | 3.4691 | 17.3475 | 3.0520 | 12.8834 |
| 4.8634 | 1.0177 | 1.8516 | | |
| 6.5000 | 196562.1543 | 4.6953 | 428.8125 | 377.9025 |
| 80.4847 | 458.3872 | 123252.6543 | 24334.3562 | 147587.0098 |
| 0.4082 | 1.1520 | 0.0000 | 0.0000 | 0.0953 |
| 0.6197 | 3.4682 | 17.6943 | 3.0550 | 13.1887 |
| 4.8671 | 1.0177 | 1.8517 | | |
| 6.6000 | 196304.7383 | 4.6993 | 428.2747 | 377.9371 |
| 80.4246 | 458.3617 | 123214.8525 | 24326.2695 | 147541.1211 |
| 0.4098 | 1.1930 | 0.0000 | 0.0000 | 0.0953 |
| 0.6292 | 3.4673 | 18.0411 | 3.0580 | 13.4944 |
| 4.8713 | 1.0177 | 1.8518 | | |
| 6.7000 | 197619.0664 | 4.7017 | 430.9041 | 378.1799 |
| 80.4350 | 458.6150 | 123177.0361 | 24318.1951 | 147495.2207 |
| 0.4115 | 1.2340 | 0.0000 | 0.0000 | 0.0953 |
| 0.6388 | 3.4664 | 18.3878 | 3.0610 | 13.8003 |
| 4.8737 | 1.0178 | 1.8519 | | |
| 6.8000 | 198669.5898 | 4.7074 | 432.4751 | 378.8901 |
| 80.4880 | 459.3781 | 123139.1729 | 24310.0974 | 147449.2695 |
| 0.4131 | 1.2752 | 0.0000 | 0.0000 | 0.0953 |
| 0.6483 | 3.4655 | 18.7344 | 3.0640 | 14.1066 |
| 4.8794 | 1.0178 | 1.8521 | | |
| 6.9000 | 199117.2266 | 4.7145 | 432.3763 | 379.9302 |
| 80.5881 | 460.5184 | 123101.2217 | 24302.0020 | 147403.2227 |
| 0.4148 | 1.3166 | 0.0000 | 0.0000 | 0.0953 |
| 0.6578 | 3.4645 | 19.0809 | 3.0670 | 14.4131 |
| 4.8865 | 1.0179 | 1.8523 | | |
| 7.0000 | 199317.2109 | 4.7260 | 431.6537 | 381.1109 |
| 80.6417 | 461.7525 | 123063.1592 | 24293.8987 | 147357.0566 |
| 0.4164 | 1.3582 | 0.0000 | 0.0000 | 0.0953 |
| 0.6674 | 3.4636 | 19.4273 | 3.0700 | 14.7200 |
| 4.8983 | 1.0180 | 1.8527 | | |
| 7.1000 | 199697.9961 | 4.7392 | 431.3607 | 382.2853 |
| 80.6637 | 462.9489 | 123024.9795 | 24285.7915 | 147310.7695 |
| 0.4180 | 1.3999 | 0.0000 | 0.0000 | 0.0953 |
| 0.6769 | 3.4627 | 19.7736 | 3.0730 | 15.0271 |
| 4.9120 | 1.0181 | 1.8531 | | |
| 7.2000 | 199947.6855 | 4.7537 | 430.8039 | 383.4605 |
| 80.6665 | 464.1269 | 122986.6816 | 24277.6829 | 147264.3633 |
| 0.4197 | 1.4418 | 0.0000 | 0.0000 | 0.0953 |
| 0.6864 | 3.4618 | 20.1198 | 3.0760 | 15.3346 |
| 4.9270 | 1.0183 | 1.8536 | | |
| 7.3000 | 200264.7246 | 4.7661 | 430.3071 | 384.6865 |
| 80.7130 | 465.3995 | 122948.2637 | 24269.5715 | 147217.8340 |
| 0.4213 | 1.4839 | 0.0000 | 0.0000 | 0.0953 |
| 0.6960 | 3.4609 | 20.4660 | 3.0790 | 15.6423 |
| 4.9398 | 1.0184 | 1.8540 | | |
| 7.4000 | 201189.3535 | 4.7802 | 430.9092 | 386.1207 |
| 80.7743 | 466.8950 | 122909.7129 | 24261.4548 | 147171.1660 |
| 0.4230 | 1.5261 | 0.0000 | 0.0000 | 0.0953 |
| 0.7055 | 3.4600 | 20.8120 | 3.0820 | 15.9504 |
| 4.9543 | 1.0185 | 1.8545 | | |
| 7.5000 | 202222.5742 | 4.7998 | 431.3963 | 387.9396 |
| 80.8233 | 468.7629 | 122871.0000 | 24253.3323 | 147124.3320 |
| 0.4246 | 1.5684 | 0.0000 | 0.0000 | 0.0953 |
| 0.7150 | 3.4591 | 21.1580 | 3.0850 | 16.2587 |
| 4.9746 | 1.0187 | 1.8551 | | |
| 7.6000 | 203362.6758 | 4.8192 | 432.0336 | 389.8595 |
| 80.8971 | 470.7566 | 122832.0996 | 24245.2034 | 147077.3027 |
| 0.4262 | 1.6110 | 0.0000 | 0.0000 | 0.0953 |
| 0.7246 | 3.4582 | 21.5038 | 3.0880 | 16.5674 |
| 4.9945 | 1.0189 | 1.8557 | | |
| 7.7000 | 204633.1738 | 4.8364 | 432.8261 | 391.7771 |
| 81.0067 | 472.7838 | 122793.0078 | 24237.0654 | 147030.0723 |
| 0.4279 | 1.6537 | 0.0000 | 0.0000 | 0.0953 |
| 0.7341 | 3.4574 | 21.8496 | 3.0910 | 16.8763 |
| 5.0121 | 1.0190 | 1.8563 | | |
| 7.8000 | 205948.5762 | 4.8492 | 433.8411 | 393.5513 |
| 81.1585 | 474.7097 | 122753.7314 | 24228.9141 | 146982.6445 |
| 0.4295 | 1.6966 | 0.0000 | 0.0000 | 0.0953 |
| 0.7437 | 3.4564 | 22.1953 | [illegible].0940 | 17.1856 |
| 5.0251 | 1.0191 | 1.8567 | | |
| 7.9000 | 206251.8750 | 4.8630 | 432.5536 | 395.4960 |
| 81.3278 | 476.8239 | 122714.2686 | 24220.7463 | 146935.0137 |
| 0.4312 | 1.7396 | 0.0000 | 0.0000 | 0.0953 |
| 0.7532 | 3.4555 | 22.5409 | 3.0970 | 17.4951 |
| 5.0390 | 1.0193 | 1.8571 | | |
| 8.0000 | 206485.5078 | 4.8819 | 430.9997 | 397.6339 |
| 81.4512 | 479.0951 | 122674.6016 | 24212.5640 | 146887.1641 |
| 0.4328 | 1.7828 | 0.0000 | 0.0000 | 0.0953 |
| 0.7627 | 3.4545 | 22.8964 | 3.1000 | 17.8050 |
| 5.0583 | 1.0195 | 1.8577 | | |
| 8.1000 | 207151.9023 | 4.9026 | 430.3624 | 399.7953 |
| 81.5476 | 481.3329 | 122634.7197 | 24204.3704 | 146839.0898 |
| 0.4344 | 1.8262 | 0.0000 | 0.0000 | 0.0953 |
| 0.7723 | 3.4536 | 23.2318 | 3.1200 | 18.1160 |
| 5.0795 | 1.0196 | 1.8583 | | |
| 8.2000 | 208412.7578 | 4.9230 | 430.9762 | 401.9381 |
| 81.6449 | 483.5930 | 122594.6230 | 24196.1670 | 146790.7891 |
| 0.4361 | 1.8697 | 0.0000 | 0.0000 | 0.0953 |
| 0.7818 | 3.4527 | 23.5771 | 3.1400 | 18.4290 |
| 5.1002 | 1.0199 | 1.8590 | | |
| 8.3000 | 209236.[illegible]688 | 4.9445 | 430.6661 | 404.1717 |
| 81.7418 | 485.9135 | 122554.3076 | 24187.9539 | 146742.2598 |
| 0.4377 | 1.9134 | 0.0000 | 0.0000 | 0.0953 |
| 0.7913 | 3.4518 | 23.9223 | 3.1600 | 18.7440 |
| 5.1221 | 1.0200 | 1.8596 | | |

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TABLE AP 2-1 (Sheet 7 of 9)
COMPUTER PROGRAM G105-3 (2ND BURN)

| | | | | |
|---|---|---|---|---|
| 8.4000 | 210249.1660 | 4.9960 | 430.6055 | 406.4229 |
| 81.8411 | 488.2640 | 122513.7676 | 24179.7307 | 145693.4980 |
| 0.4394 | 1.9572 | 0.0000 | 0.0000 | 0.0953 |
| 0.8009 | 3.4509 | 24.2674 | 3.1800 | 19.0610 |
| 5.1440 | 1.0202 | 1.8603 | | |
| 8.5000 | 211442.3906 | 4.9926 | 430.8640 | 408.8488 |
| 81.8917 | 490.7404 | 122472.9941 | 24171.4998 | 145644.4922 |
| 0.4410 | 2.0012 | 0.0000 | 0.0000 | 0.0953 |
| 0.8104 | 3.4500 | 24.6125 | 3.2000 | 19.3800 |
| 5.1713 | 1.0205 | 1.8611 | | |
| 8.6000 | 212467.4434 | 5.0192 | 430.7471 | 411.3064 |
| 81.9470 | 493.2534 | 122431.9766 | 24163.2634 | 145595.2383 |
| 0.4426 | 2.0456 | 0.0000 | 0.0000 | 0.0953 |
| 0.8199 | 3.4600 | 24.9580 | 3.2200 | 19.7010 |
| 5.1994 | 1.0207 | 1.8619 | | |
| 8.7000 | 213087.6523 | 5.0395 | 429.9329 | 413.5659 |
| 82.0642 | 495.6301 | 122390.7227 | 24155.0183 | 145545.7402 |
| 0.4443 | 2.0898 | 0.0000 | 0.0000 | 0.0953 |
| 0.8295 | 3.4700 | 25.3045 | 3.2400 | 20.0240 |
| 5.2208 | 1.0209 | 1.8625 | | |
| 8.8000 | 214084.0879 | 5.0591 | 429.7403 | 415.9517 |
| 82.2191 | 498.1708 | 122349.2363 | 24146.7593 | 146495.9941 |
| 0.4459 | 2.1343 | 0.0000 | 0.0000 | 0.0953 |
| 0.8390 | 3.4800 | 25.6520 | 3.2600 | 20.3490 |
| 5.2413 | 1.0211 | 1.8631 | | |
| 8.9000 | 215303.3496 | 5.0774 | 430.1938 | 418.1284 |
| 82.3516 | 500.4799 | 122307.5225 | 24138.4858 | 146446.0078 |
| 0.4476 | 2.1790 | 0.0000 | 0.0000 | 0.0953 |
| 0.8485 | 3.4900 | 26.0005 | 3.2800 | 20.6760 |
| 5.2605 | 1.0213 | 1.8637 | | |
| 9.0000 | 216509.3945 | 5.0984 | 430.3774 | 420.5762 |
| 82.4925 | 503.0687 | 122265.5771 | 24130.1985 | 146395.7754 |
| 0.4492 | 2.2238 | 0.0000 | 0.0000 | 0.0953 |
| 0.8581 | 3.5000 | 26.3500 | 3.3000 | 21.0050 |
| 5.2825 | 1.0215 | 1.8644 | | |
| 9.1000 | 217797.0977 | 5.1242 | 430.3753 | 423.4297 |
| 82.6334 | 506.0631 | 122223.3662 | 24121.8973 | 146345.2617 |
| 0.4508 | 2.2688 | 0.0000 | 0.0000 | 0.0953 |
| 0.8676 | 3.5150 | 26.7007 | 3.3200 | 21.3360 |
| 5.3099 | 1.0217 | 1.8652 | | |
| 9.2000 | 219052.2676 | 5.1597 | 429.9245 | 426.7964 |
| 82.7169 | 509.5133 | 122180.8447 | 24113.5942 | 146294.4277 |
| 0.4525 | 2.3140 | 0.0000 | 0.0000 | 0.0953 |
| 0.8771 | 3.5300 | 27.0530 | 3.3400 | 21.6690 |
| 5.3476 | 1.0221 | 1.8662 | | |
| 9.3000 | 219955.6055 | 5.1878 | 429.2570 | 429.6007 |
| 82.8093 | 512.4100 | 122138.0146 | 24105.2625 | 146243.2754 |
| 0.4541 | 2.3593 | 0.0000 | 0.0000 | 0.0953 |
| 0.8867 | 3.5450 | 27.4067 | 3.3600 | 22.0040 |
| 5.3775 | 1.0224 | 1.8671 | | |
| 9.4000 | 220753.5195 | 5.2042 | 428.8704 | 431.7676 |
| 82.9649 | 514.7325 | 122094.9355 | 24096.9280 | 146191.8633 |
| 0.4558 | 2.4048 | 0.0000 | 0.0000 | 0.0953 |
| 0.8962 | 3.5600 | 27.7620 | 3.3800 | 22.3410 |
| 5.3950 | 1.0225 | 1.8676 | | |
| 9.5000 | 221488.2598 | 5.2233 | 428.4150 | 433.9206 |
| 83.0741 | 516.9947 | 122051.6406 | 24088.5801 | 146140.2207 |
| 0.4574 | 2.4504 | 0.0000 | 0.0000 | 0.0953 |
| 0.9057 | 3.5750 | 28.1187 | 3.4000 | 22.6800 |
| 5.4154 | 1.0227 | 1.8681 | | |
| 9.6000 | 222160.6367 | 5.2392 | 427.9235 | 435.9502 |
| 83.2095 | 519.1597 | 122008.1367 | 24080.2200 | 146088.3555 |
| 0.4590 | 2.4963 | 0.0000 | 0.0000 | 0.0953 |
| 0.9153 | 3.5900 | 28.4770 | 3.4200 | 23.0210 |
| 5.4325 | 1.0229 | 1.8686 | | |
| 9.7000 | 222916.6230 | 5.2565 | 427.4521 | 438.1470 |
| 83.3538 | 521.5009 | 121964.4219 | 24071.8455 | 146036.2656 |
| 0.4607 | 2.5423 | 0.0000 | 0.0000 | 0.0953 |
| 0.9248 | 3.6050 | 28.8367 | 3.4400 | 23.3640 |
| 5.4510 | 1.0230 | 1.8691 | | |
| 9.8000 | 223744.7129 | 5.2685 | 427.2044 | 440.1899 |
| 83.5518 | 523.7416 | 121920.4951 | 24063.4536 | 145983.9473 |
| 0.4623 | 2.5884 | 0.0000 | 0.0000 | 0.0953 |
| 0.9343 | 3.6200 | 29.1980 | 3.4600 | 23.7090 |
| 5.4638 | 1.0231 | 1.8695 | | |
| 9.9000 | 224311.2344 | 5.2877 | 426.6101 | 442.1759 |
| 83.6233 | 525.7992 | 121876.3662 | 24055.0483 | 145931.4141 |
| 0.4640 | 2.6347 | 0.0000 | 0.0000 | 0.0953 |
| 0.9439 | 3.6350 | 29.5607 | 3.4800 | 24.0560 |
| 5.4845 | 1.0233 | 1.8701 | | |
| 10.0000 | 225563.1680 | 5.3067 | 427.5425 | 443.9266 |
| 83.6542 | 527.5807 | 121832.0508 | 24046.6377 | 145878.6875 |
| 0.4656 | 2.6812 | 0.0000 | 0.0000 | 0.0953 |
| 0.9534 | 3.6500 | 29.9250 | 3.5000 | 24.4050 |
| 5.5050 | 1.0235 | 1.8706 | | |
| 15.0000 | 229887.2051 | 5.4392 | 424.1296 | 457.8454 |
| 84.1757 | 542.0211 | 119563.2870 | 23623.6067 | 143186.8125 |
| 0.4870 | 5.0965 | 0.0000 | 0.0000 | 0.0953 |
| 1.4301 | 3.6450 | 48.1625 | 3.5700 | 42.0650 |
| 5.6410 | 1.0248 | 1.8743 | | |
| 20.0000 | 230846.5723 | 5.4824 | 423.4276 | 461.0836 |
| 84.1018 | 545.1855 | 117265.8301 | 23200.7454 | 140466.5742 |
| 0.4903 | 7.5398 | 0.0000 | 0.0000 | 0.0953 |
| 1.9068 | 3.6400 | 66.3750 | 3.6281 | 60.1231 |
| 5.6854 | 1.0252 | 1.8754 | | |
| 25.0000 | 231937.4395 | 5.5076 | 424.7692 | 462.1247 |
| 83.9069 | 546.0317 | 114958.5400 | 22778.3285 | 137736.8672 |
| 0.4937 | 9.9998 | 0.0000 | 0.0000 | 0.0953 |
| 2.3835 | 3.6333 | 84.5583 | 3.6234 | 78.2520 |
| 5.7117 | 1.0254 | 1.8761 | | |
| 30.0000 | 232181.1895 | 5.5079 | 425.5343 | 461.7826 |
| 83.8401 | 545.6277 | 112649.2637 | 22354.5300 | 135335.7637 |
| 0.4970 | 12.4765 | 0.0000 | 0.0000 | 0.0953 |
| 2.8602 | 3.6767 | 102.7033 | 3.6187 | 95.3574 |
| 5.7118 | 1.0254 | 1.8761 | | |
| 35.0000 | 231269.5078 | 5.5202 | 423.4215 | 462.4226 |
| 83.7696 | 546.1921 | 110339.4553 | 21935.2046 | 132274.6096 |
| 0.4985 | 14.9652 | 0.0000 | 0.0000 | 0.0953 |
| 3.3369 | 3.6200 | 120.8249 | 3.6141 | 114.4394 |
| 5.7244 | 1.0255 | 1.8764 | | |
| 40.0000 | 231906.7441 | 5.5156 | 424.7539 | 462.1835 |
| 83.7956 | 545.9790 | 108032.2051 | 21514.1428 | 129546.3477 |
| 0.5000 | 17.4615 | 0.0000 | 0.0000 | 0.0953 |
| 3.8136 | 3.6133 | 138.9082 | 3.6094 | 132.4980 |
| 5.7191 | 1.0255 | 1.8763 | | |
| 45.0000 | 231123.8398 | 5.4996 | 424.2714 | 460.9380 |
| 83.8167 | 544.7547 | 105723.9043 | 21092.9429 | 126816.8467 |
| 0.5010 | 19.9640 | 0.0000 | 0.0000 | 0.0953 |
| 4.2903 | 3.6067 | 156.9582 | 3.6047 | 150.5331 |
| 5.7017 | 1.0253 | 1.8759 | | |
| 50.0000 | 230644.9609 | 5.5219 | 422.5379 | 462.2002 |
| 83.7034 | 545.9036 | 103413.2158 | 23671.6594 | 124084.8750 |
| 0.5020 | 22.4715 | 0.0000 | 0.0000 | 0.0953 |
| 4.7670 | 3.6000 | 174.9748 | 3.6000 | 168.5448 |
| 5.7251 | 1.0255 | 1.8765 | | |
| 55.0000 | 230120.5391 | 5.5093 | 421.6369 | 461.9326 |
| 83.8464 | 545.7790 | 101102.8584 | 23250.1672 | 121353.0256 |
| 0.5029 | 24.9837 | 0.0000 | 0.0000 | 0.0953 |
| 5.2437 | 3.6000 | 192.9747 | 3.6025 | 186.5510 |
| 5.7115 | 1.0254 | 1.8761 | | |
| 60.0000 | 230787.3945 | 5.5080 | 422.8673 | 461.9063 |
| 83.3616 | 545.7679 | 98794.2256 | 19828.4053 | 118622.6309 |
| 0.5038 | 27.5003 | 0.0000 | 0.0000 | 0.0953 |
| 5.7204 | 3.6000 | 210.9746 | 3.6050 | 204.5697 |
| 5.7101 | 1.0254 | 1.8761 | | |
| 65.0000 | 231112.0742 | 5.5033 | 424.0932 | 461.1594 |
| 83.7965 | 544.9558 | 96487.2236 | 19406.4731 | 115893.6963 |
| 0.5046 | 30.0213 | 0.0000 | 0.0000 | 0.0953 |
| 6.1971 | 3.6000 | 228.9746 | 3.6075 | 222.6009 |
| 5.7054 | 1.0253 | 1.8760 | | |
| 70.0000 | 231096.8242 | 5.5024 | 423.4495 | 461.8181 |
| 83.9301 | 545.7482 | 94178.9385 | 19984.1155 | 113163.0537 |
| 0.5055 | 32.5467 | 0.0000 | 0.0000 | 0.0953 |
| 6.6738 | 3.6000 | 246.9745 | 3.6100 | 240.6446 |
| 5.7041 | 1.0253 | 1.8759 | | |
| 75.0000 | 231347.9707 | 5.4906 | 423.8746 | 461.7042 |
| 84.0893 | 545.7935 | 91871.4424 | 18561.5100 | 110432.9521 |
| 0.5064 | 35.0766 | 0.0000 | 0.0000 | 0.0953 |
| 7.1505 | 3.6000 | 264.9744 | 3.6100 | 258.6945 |
| 5.6914 | 1.0252 | 1.8756 | | |
| 80.0000 | 228995.5586 | 5.4669 | 422.2312 | 458.4809 |
| 83.8656 | 542.3464 | 89572.0527 | 19139.0146 | 107711.0674 |
| 0.5073 | 37.6108 | 0.0000 | 0.0000 | 0.0953 |
| 7.6272 | 3.6000 | 282.9742 | 3.6100 | 276.7443 |
| 5.6671 | 1.0250 | 1.8749 | | |
| 85.0000 | 231500.7754 | 5.4853 | 424.5762 | 461.1769 |
| 84.0746 | 545.2514 | 87271.7256 | 17716.3181 | 104988.0430 |
| 0.5075 | 40.1492 | 0.0000 | 0.0000 | 0.0953 |
| 8.1339 | 3.6000 | 300.9741 | 3.6100 | 294.7941 |
| 5.6859 | 1.0252 | 1.8755 | | |
| 90.0000 | 230313.4102 | 5.4710 | 423.6574 | 459.8379 |
| 84.0501 | 543.8880 | 84966.6416 | 17293.1316 | 102259.7725 |
| 0.5080 | 42.6804 | 0.0000 | 0.0000 | 0.0953 |
| 8.5806 | 3.6000 | 318.9739 | 3.6100 | 312.8439 |
| 5.6709 | 1.0250 | 1.8751 | | |
| 95.0000 | 226845.5391 | 5.3682 | 424.9967 | 449.9427 |
| 83.8157 | 533.7584 | 82689.0137 | 15870.5127 | 99559.5264 |
| 0.5000 | 45.1929 | 0.0000 | 0.0000 | 0.0953 |
| 9.0573 | 3.5500 | 336.8988 | 3.5550 | 330.8113 |
| 5.5614 | 1.0240 | 1.8721 | | |
| 100.0000 | 220072.9082 | 5.2061 | 425.7819 | 433.5836 |
| 83.2841 | 516.8677 | 80480.6338 | 15450.6421 | 95931.0752 |
| 0.4950 | 47.6804 | 0.0000 | 0.0000 | 0.0953 |
| 9.5339 | 3.5300 | 354.5987 | 3.4500 | 348.3437 |
| 5.3932 | 1.0225 | 1.8675 | | |
| 105.0000 | 214231.5840 | 5.0757 | 426.5427 | 419.5849 |
| 82.4662 | 502.2512 | 78347.8486 | 15033.4260 | 94381.2744 |
| 0.4900 | 50.1429 | 0.0000 | 0.0000 | 0.0953 |
| 10.0106 | 3.5150 | 372.2111 | 3.3550 | 365.3561 |
| 5.2587 | 1.0213 | 1.8636 | | |
| 110.0000 | 210081.3828 | 4.9943 | 427.8410 | 409.1118 |
| 81.9150 | 491.0268 | 76276.6865 | 15619.8026 | 91496.4883 |
| 0.4850 | 52.5803 | 0.0000 | 0.0000 | 0.0953 |
| 10.4873 | 3.5000 | 389.7485 | 3.2600 | 381.8935 |
| 5.1757 | 1.0205 | 1.8612 | | |
| 115.0000 | 207010.2754 | 4.9413 | 428.0710 | 402.1937 |
| 81.3949 | 483.5886 | 74247.1553 | 15209.2627 | 89456.4180 |
| 0.4815 | 54.9966 | 0.0000 | 0.0000 | 0.0953 |
| 10.9665 | 3.4500 | 407.1234 | 3.2100 | 398.0684 |
| 5.1198 | 1.0200 | 1.8595 | | |
| 120.0000 | 203608.6973 | 4.9061 | 427.6316 | 395.9023 |
| 80.6965 | 476.5988 | 72252.2383 | 14801.7595 | 87053.9971 |
| 0.4750 | 57.3953 | 0.0000 | 0.0000 | 0.0953 |
| 11.4407 | 3.4000 | 424.2483 | 3.1600 | 413.9933 |
| 5.0810 | 1.0197 | 1.8583 | | |
| 125.0000 | 203639.3535 | 4.8709 | 430.6900 | 392.2843 |
| 80.5369 | 472.8211 | 70281.8135 | 14396.1010 | 84677.9141 |
| 0.4740 | 59.7753 | 0.0000 | 0.0000 | 0.0953 |
| 11.9174 | 3.4000 | 441.2481 | 3.1450 | 429.7557 |
| 5.0448 | 1.0193 | 1.8572 | | |
| 130.0000 | 201095.6367 | 4.8659 | 427.4403 | [illegible] |
| 80.2045 | 470.4649 | 68326.3447 | 13992.0585 | [illegible] |
| 0.4703 | 62.1353 | 0.0000 | 0.0000 | .0953 |
| 12.3941 | 3.4000 | 458.2480 | 3.1300 | 5.4431 |
| 5.0405 | 1.0193 | 1.8571 | | |
| 135.0000 | 202161.6992 | 4.8552 | 430.5863 | 389.3183 |
| 80.1851 | 469.5034 | 66379.5654 | 13589.0289 | 79968.5938 |
| 0.4690 | 64.4828 | 0.0000 | 0.0000 | 0.0953 |
| 12.8704 | 3.4000 | 475.2478 | 3.1100 | 461.0430 |
| 5.0297 | 1.0192 | 1.8569 | | |

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Table AP 2-1

TABLE AP 2-1 (Sheet 8 of 9)
COMPUTER PROGRAM G105-3 (2ND BURN)

| | | | | |
|---|---|---|---|---|
| 140.0000 | 200876.4082 | 4.8486 | 429.3499 | 387.8666 |
| 79.9952 | 467.8618 | 64436.2445 | 13186.1025 | 77622.3506 |
| 0.4680 | 66.8253 | 0.0000 | 0.0000 | 0.0953 |
| 13.3475 | 3.4000 | 492.2476 | 3.0900 | 476.5429 |
| 5.0235 | 1.0191 | 1.8566 | | |
| 145.0000 | 199872.3691 | 4.8821 | 429.3176 | 384.4103 |
| 79.1479 | 465.5583 | 62498.7798 | 12783.9740 | 75282.7529 |
| 1.1500 | 70.1802 | 0.0000 | 0.0000 | 0.0953 |
| 13.8242 | 3.4000 | 509.2474 | 3.0850 | 491.9803 |
| 5.0605 | 1.0195 | 1.8576 | | |
| 150.0000 | 198763.6133 | 4.8773 | 428.6264 | 384.8211 |
| 78.9012 | 463.7223 | 60571.0376 | 12382.8308 | 72953.8682 |
| 1.1500 | 75.9302 | 0.0000 | 0.0000 | 0.0953 |
| 14.3009 | 3.4000 | 526.2472 | 3.0800 | 507.3927 |
| 5.0561 | 1.0194 | 1.8575 | | |
| 155.0000 | 200977.7402 | 4.8919 | 430.5753 | 387.5444 |
| 79.2212 | 466.7656 | 58644.0361 | 11981.9331 | 70625.9688 |
| 1.1510 | 81.6827 | 0.0000 | 0.0000 | 0.0953 |
| 14.7776 | 3.4000 | 543.2470 | 3.0853 | 522.5050 |
| 5.0706 | 1.0196 | 1.8580 | | |
| 160.0000 | 201852.2617 | 4.9083 | 429.5385 | 390.3906 |
| 79.5376 | 469.9282 | 56696.0693 | 11579.1290 | 68275.1982 |
| 1.1520 | 87.4402 | 0.0000 | 0.0000 | 0.0953 |
| 15.2543 | 3.4000 | 560.2468 | 3.0900 | 538.2423 |
| 5.0865 | 1.0197 | 1.8585 | | |
| 165.0000 | 201647.2393 | 4.9240 | 427.8442 | 391.7508 |
| 79.5592 | 471.3100 | 54739.8516 | 11175.4914 | 65915.3428 |
| 1.1535 | 93.2039 | 0.0000 | 0.0000 | 0.0953 |
| 15.7310 | 3.4000 | 577.2467 | 3.1000 | 553.7172 |
| 5.1031 | 1.0199 | 1.8589 | | |
| 170.0000 | 200632.2617 | 4.9287 | 426.4949 | 391.0742 |
| 79.3471 | 470.4213 | 52780.2197 | 10771.8945 | 63552.1240 |
| 1.1550 | 98.9751 | 0.0000 | 0.0000 | 0.0953 |
| 16.2077 | 3.4000 | 594.2465 | 3.1100 | 569.2423 |
| 5.1083 | 1.0199 | 1.8591 | | |
| 175.0000 | 202169.5859 | 4.9185 | 429.1384 | 391.5087 |
| 79.5970 | 471.1058 | 50823.2334 | 10368.8967 | 61192.1299 |
| 1.1565 | 104.7533 | 0.0000 | 0.0000 | 0.0953 |
| 16.6844 | 3.4000 | 611.2463 | 3.1200 | 584.8168 |
| 5.0972 | 1.0194 | 1.8588 | | |
| 180.0000 | 202635.4468 | 4.9315 | 427.9815 | 393.4452 |
| 79.8226 | 473.4678 | 48860.3867 | 9964.8777 | 58825.2642 |
| 1.1580 | 110.5401 | 0.0000 | 0.0000 | 0.0953 |
| 17.1611 | 3.4000 | 628.2461 | 3.1300 | 600.4416 |
| 5.1099 | 1.0199 | 1.8592 | | |
| 185.0000 | 203576.8242 | 4.9347 | 430.0403 | 393.6237 |
| 79.7668 | 473.3905 | 46892.3604 | 9560.1743 | 55452.5342 |
| 1.1595 | 116.3338 | 0.0000 | 0.0000 | 0.0953 |
| 17.6377 | 3.4000 | 645.2459 | 3.1450 | 616.1289 |
| 5.1132 | 1.0200 | 1.8593 | | |
| 190.0000 | 203575.9102 | 4.9419 | 429.1648 | 394.5219 |
| 79.8314 | 474.3537 | 44921.7700 | 9155.3239 | 54077.0938 |
| 1.1610 | 122.1350 | 0.0000 | 0.0000 | 0.0953 |
| 18.1144 | 3.4167 | 662.2874 | 3.1600 | 631.8912 |
| 5.1215 | 1.0200 | 1.8595 | | |
| 195.0000 | 204784.4727 | 4.9551 | 428.9619 | 397.2293 |
| 80.1652 | 477.3954 | 42940.8022 | 8749.3148 | 51690.1167 |
| 1.1655 | 127.9513 | 0.0000 | 0.0000 | 0.0953 |
| 18.5911 | 3.4333 | 679.4122 | 3.1300 | 647.7410 |
| 5.1353 | 1.0202 | 1.8599 | | |
| 200.0000 | 205896.8750 | 4.9746 | 429.0407 | 399.5773 |
| 80.3233 | 479.9006 | 40948.1733 | 8342.2111 | 49290.3843 |
| 1.1700 | 133.7900 | 0.0000 | 0.0000 | 0.0953 |
| 19.0678 | 3.4500 | 696.6204 | 3.2000 | 663.6908 |
| 5.1562 | 1.0203 | 1.8606 | | |
| 205.0000 | 207024.9941 | 4.9933 | 429.1575 | 401.9085 |
| 80.4902 | 482.3987 | 38943.4785 | 7934.2955 | 46877.7739 |
| 1.1760 | 139.6549 | 0.0000 | 0.0000 | 0.0953 |
| 19.5445 | 3.4550 | 713.8827 | 3.2250 | 679.7531 |
| 5.1753 | 1.0205 | 1.8611 | | |
| 210.0000 | 208885.9219 | 5.0298 | 428.2400 | 404.8827 |
| 80.8949 | 487.7777 | 36923.4634 | 7524.9992 | 44444.3726 |
| 1.1810 | 145.5474 | 0.0000 | 0.0000 | 0.0953 |
| 20.0212 | 3.4600 | 731.1700 | 3.2500 | 695.9405 |
| 5.2125 | 1.0209 | 1.8622 | | |
| 215.0000 | 208880.0859 | 5.0415 | 427.1542 | 408.0627 |
| 80.9412 | 489.0039 | 34883.7271 | 7114.3491 | 41998.0757 |
| 1.1805 | 151.4511 | 0.0000 | 0.0000 | 0.0953 |
| 20.4974 | 3.4800 | 748.5198 | 3.2774 | 712.3597 |
| 5.2256 | 1.0210 | 1.8626 | | |
| 220.0000 | 209161.2227 | 5.0331 | 428.3725 | 407.3379 |
| 80.9316 | 488.2695 | 32840.8926 | 6703.6828 | 39544.5732 |
| 1.1800 | 157.3523 | 0.0000 | 0.0000 | 0.0953 |
| 20.9746 | 3.5000 | 765.9696 | 3.2955 | 729.7128 |
| 5.2181 | 1.0209 | 1.8624 | | |
| 225.0000 | 208187.4297 | 5.0164 | 428.2035 | 405.3781 |
| 80.8099 | 486.1880 | 30808.2742 | 6293.6974 | 37101.9712 |
| 1.1775 | 163.2460 | 0.0000 | 0.0000 | 0.0953 |
| 21.4513 | 3.4800 | 783.4194 | 3.2727 | 745.1331 |
| 5.1999 | 1.0207 | 1.8619 | | |
| 230.0000 | 207112.0020 | 5.0025 | 427.9600 | 403.3265 |
| 80.6253 | 483.3518 | 28783.9539 | 5884.5134 | 34668.4668 |
| 1.1750 | 169.1272 | 0.0000 | 0.0000 | 0.0953 |
| 21.9280 | 3.4600 | 800.7692 | 3.2500 | 761.4397 |
| 5.1847 | 1.0206 | 1.8614 | | |
| 235.0000 | 206395.7578 | 5.0050 | 427.4017 | 402.4904 |
| 80.4177 | 482.9081 | 26770.9682 | 5476.2657 | 32247.1338 |
| 1.1745 | 175.0009 | 0.0000 | 0.0000 | 0.0953 |
| 22.4047 | 3.4550 | 818.0565 | 3.2400 | 777.6645 |
| 5.1876 | 1.0206 | 1.8615 | | |
| 240.0000 | 207603.1797 | 5.0054 | 428.9575 | 403.3819 |
| 80.5895 | 483.9714 | 24751.3574 | 5067.7486 | 29819.1060 |
| 1.1740 | 180.8721 | 0.0000 | 0.0000 | 0.0953 |
| 22.8814 | 3.4500 | 835.3188 | 3.2300 | 793.8393 |
| 5.1874 | 1.0206 | 1.8615 | | |
| 245.0000 | 206874.8184 | 4.9642 | 427.9427 | 402.3638 |
| 81.0532 | 483.4171 | 22734.8918 | 4659.6039 | 27394.4956 |
| 0.4750 | 186.3950 | 0.0000 | 0.0000 | 0.0953 |
| 23.3581 | 3.4450 | 852.5561 | 3.2150 | 839.9516 |
| 5.1431 | 1.0202 | 1.8602 | | |
| 250.0000 | 206741.8691 | 4.9478 | 430.0307 | 399.9311 |
| 80.8296 | 480.7607 | 20730.7839 | 4252.7020 | 24983.4858 |
| 0.4736 | 188.7664 | 0.0000 | 0.0000 | 0.0953 |
| 23.8348 | 3.4400 | 869.7684 | 3.2000 | 825.9889 |
| 5.1264 | 1.0201 | 1.8597 | | |
| 255.0000 | 205647.1602 | 4.9272 | 429.4343 | 398.0863 |
| 80.7929 | 478.8792 | 18734.1596 | 3846.3209 | 22580.4802 |
| 0.4721 | 191.1306 | 0.0000 | 0.0000 | 0.0953 |
| 24.3115 | 3.4354 | 886.9569 | 3.1850 | 841.9512 |
| 5.1049 | 1.0199 | 1.8591 | | |
| 260.0000 | 203877.0820 | 4.9174 | 427.5932 | 396.2259 |
| 80.5756 | 476.8015 | 16750.8357 | 3440.4022 | 20191.6377 |
| 0.4707 | 193.4875 | 0.0000 | 0.0000 | 0.0953 |
| 24.7882 | 3.4309 | 904.1222 | 3.1700 | 857.8386 |
| 5.0950 | 1.0198 | 1.8587 | | |
| 265.0000 | 203486.3555 | 4.9067 | 427.7472 | 395.1782 |
| 80.5382 | 475.7164 | 14776.1261 | 3036.2024 | 17812.3284 |
| 0.4693 | 195.8373 | 0.0000 | 0.0000 | 0.0953 |
| 25.2649 | 3.4262 | 921.2647 | 3.1850 | 873.7259 |
| 5.0834 | 1.0197 | 1.8584 | | |
| 270.0000 | 203731.5234 | 4.9081 | 429.1054 | 394.4202 |
| 80.3618 | 474.7820 | 12802.4048 | 2631.8697 | 15434.2734 |
| 0.4678 | 198.1800 | 0.0000 | 0.0000 | 0.0953 |
| 25.7415 | 3.4217 | 938.3842 | 3.2000 | 889.6882 |
| 5.0847 | 1.0197 | 1.8584 | | |
| 275.0000 | 201843.8438 | 4.8808 | 428.0749 | 391.3368 |
| 80.1784 | 471.5152 | 10833.6892 | 2227.8764 | 13061.7655 |
| 0.4664 | 200.5154 | 0.0000 | 0.0000 | 0.0953 |
| 26.2182 | 3.4171 | 955.4808 | 3.1600 | 905.5880 |
| 5.0569 | 1.0194 | 1.8576 | | |
| 280.0000 | 201033.3711 | 4.8659 | 428.6439 | 389.1227 |
| 79.9692 | 469.0919 | 8882.6423 | 1825.7381 | 10708.3804 |
| 0.4649 | 202.8436 | 0.0000 | 0.0000 | 0.0953 |
| 26.6949 | 3.4125 | 972.5545 | 3.1200 | 921.2878 |
| 5.0420 | 1.0191 | 1.8571 | | |
| 285.0000 | 201035.8418 | 4.8693 | 429.5096 | 388.4273 |
| 79.7714 | 468.1987 | 6938.9153 | 1424.3645 | 8363.2798 |
| 0.4635 | 205.1647 | 0.0000 | 0.0000 | 0.0953 |
| 27.1716 | 3.4079 | 989.6052 | 3.1310 | 936.9152 |
| 5.0456 | 1.0193 | 1.8572 |
| 290.0000 | 201986.6343 | 4.8764 | 429.2356 | 390.4942 |
| 80.0786 | 470.5728 | 4992.2331 | 1022.7094 | 5014.9425 |
| 0.4621 | 237.4785 | 0.0000 | 0.0000 | 0.0953 |
| 27.6483 | 3.4033 | 1006.6330 | 3.1421 | 952.5977 |
| 5.0518 | 1.0194 | 1.8574 |
| 291.0000 | 202434.7461 | 4.8808 | 431.4143 | 390.2707 |
| 79.9612 | 470.2319 | 4601.9068 | 942.2535 | 5544.1603 |
| 0.4618 | 237.9604 | 0.0000 | 0.0000 | 0.0953 |
| 27.7437 | 3.4024 | 1010.0358 | 3.1443 | 955.7408 |
| 5.0566 | 1.0194 | 1.8576 |
| 292.0000 | 201438.0723 | 4.9050 | 427.6895 | 391.1723 |
| 79.7439 | 470.9213 | 4210.8698 | 861.9107 | 5072.7805 |
| 0.4615 | 238.4021 | 0.0000 | 0.0000 | 0.0953 |
| 27.8390 | 3.4015 | 1013.4377 | 3.1465 | 958.8861 |
| 5.0824 | 1.0197 | 1.8583 |
| 293.0000 | 201320.6035 | 4.9348 | 428.4216 | 390.7329 |
| 79.1794 | 469.9123 | 3819.7370 | 781.9739 | 4601.7109 |
| 0.4612 | 208.8634 | 0.0000 | 0.0000 | 0.0953 |
| 27.9343 | 3.4006 | 1016.8385 | 3.1487 | 962.0337 |
| 5.1147 | 1.0200 | 1.8593 |
| 293.1000 | 201720.7617 | 4.9480 | 429.3960 | 390.7970 |
| 78.9809 | 469.7779 | 3780.6509 | 774.0198 | 4554.6707 |
| 0.4612 | 208.9095 | 0.0000 | 0.0000 | 0.0953 |
| 27.9439 | 3.4005 | 1017.1787 | 3.1489 | 962.3485 |
| 5.1289 | 1.0201 | 1.8597 |
| 293.2000 | 200614.0879 | 4.9666 | 426.5987 | 391.4484 |
| 78.8158 | 470.2642 | 3741.5291 | 766.0938 | 4507.6129 |
| 0.4611 | 208.9556 | 0.0000 | 0.0000 | 0.0953 |
| 27.9534 | 3.4004 | 1017.5187 | 3.1491 | 962.6634 |
| 5.1488 | 1.0203 | 1.8603 |
| 293.3000 | 200645.7168 | 4.9637 | 427.3233 | 390.8859 |
| 78.7494 | 469.6344 | 3702.4029 | 758.1594 | 4460.5623 |
| 0.4611 | 209.0017 | 0.0000 | 0.0000 | 0.0953 |
| 27.9629 | 3.4003 | 1017.9587 | 3.1493 | 962.9784 |
| 5.1459 | 1.0202 | 1.8602 |
| 293.4000 | 201695.2520 | 4.9849 | 429.7773 | 390.8874 |
| 78.4144 | 469.3018 | 3663.3047 | 750.2551 | 4413.5598 |
| 0.4611 | 209.0473 | 0.0000 | 0.0000 | 0.0953 |
| 27.9725 | 3.4002 | 1018.1988 | 3.1496 | 963.2933 |
| 5.1689 | 1.0205 | 1.8609 |
| 293.5000 | 200520.3613 | 5.0950 | 428.3778 | 391.3059 |
| 76.7864 | 468.0923 | 3624.1455 | 742.4490 | 4366.6364 |
| 0.4611 | 209.0940 | 0.0000 | 0.0000 | 0.0953 |
| 27.9820 | 3.4001 | 1014.5388 | 3.1498 | 963.6083 |
| 5.2892 | 1.0216 | 1.8643 |
| 293.6000 | 198677.9961 | 5.2432 | 427.5443 | 390.2639 |
| 74.4318 | 466.6957 | 3585.0976 | 734.8420 | 4319.9393 |
| 0.4610 | 209.1401 | 0.0000 | 0.0000 | 0.0953 |
| 27.9915 | 3.4000 | 1018.4788 | 3.1500 | 953.9233 |
| 5.4499 | 1.0230 | 1.8687 |
| 293.7000 | 201018.3770 | 5.4040 | 431.8194 | 392.8232 |
| 72.6917 | 465.5149 | 3545.9383 | 727.4397 | 4273.3779 |
| 0.4610 | 209.1862 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 2.5500 | 1019.1763 | 2.3625 | 954.1989 |
| 5.5667 | 1.0241 | 1.8718 |
| 293.8000 | 168102.2285 | 5.3089 | 371.4459 | 389.7871 |
| 71.7259 | 452.5130 | 3507.2577 | 720.1957 | 4227.4534 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 1.7030 | 1019.3893 | 1.5750 | 964.3957 |
| 5.4153 | 1.0227 | 1.8671 |

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TABLE AP 2-1 (Sheet 9 of 9)
COMPUTER PROGRAM G105-3 (2ND BURN)

| | | | | |
|---|---|---|---|---|
| 293.9000 | 38446.7246 | 3.8303 | 118.3786 | 258.1940 |
| 67.4088 | 325.6028 | 3475.3087 | 713.2390 | 4148.5476 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.8500 | 1019.5143 | 0.7475 | 964.5139 |
| 3.5674 | 1.0086 | 1.8130 | | |
| 294.0000 | 17996.0449 | 1.6475 | 139.2336 | 80.4307 |
| 48.8201 | 129.2508 | 3458.3774 | 707.4276 | 4155.8049 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 1.6475 | 0.9884 | 1.6814 | | |
| 294.1000 | 14125.8169 | 1.5754 | 240.7023 | 35.8992 |
| 22.7866 | 58.6858 | 3452.5609 | 703.8472 | 4156.4081 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 1.5754 | 0.9878 | 1.6746 | | |
| 294.2000 | 13883.4458 | 1.2272 | 440.8927 | 17.3505 |
| 14.1389 | 31.4894 | 3449.8984 | 702.0909 | 4151.8993 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 1.2272 | 0.9846 | 1.6469 | | |
| 294.3000 | 10335.2372 | 1.3864 | 410.7083 | 14.6196 |
| 10.5449 | 25.1644 | 3448.2999 | 700.7667 | 4149.0666 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 1.3864 | 0.9860 | 1.6581 | | |
| 294.4000 | 6463.3113 | 2.1831 | 259.4455 | 17.0857 |
| 7.8263 | 24.9120 | 3444.7146 | 699.8482 | 4146.5628 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 2.1831 | 0.9933 | 1.7173 | | |
| 294.5000 | 4094.2665 | 2.4378 | 180.4908 | 16.0856 |
| 6.5984 | 22.6841 | 3445.0561 | 699.1269 | 4144.1830 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5537 |
| 2.4378 | 0.9956 | 1.7343 | | |
| 294.6000 | 3110.2502 | 1.3141 | 240.9780 | 7.3294 |
| 5.5774 | 12.9068 | 3443.8853 | 698.5181 | 4142.4034 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 1.3141 | 0.9854 | 1.6489 | | |
| 294.7000 | 3171.7512 | 2.3719 | 182.2224 | 12.2439 |
| 5.1620 | 17.4059 | 3442.9066 | 697.9812 | 4140.8878 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 2.3719 | 0.9950 | 1.7297 | | |
| 294.8000 | 1899.6358 | 3.2660 | 93.9387 | 15.4818 |
| 4.7402 | 20.2221 | 3441.5203 | 697.4861 | 4139.0063 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 3.2660 | 1.0031 | 1.7835 | | |
| 294.9000 | 332.6609 | 1.3165 | 32.7183 | 5.7782 |
| 4.3892 | 10.1674 | 3440.4573 | 697.0296 | 4137.4869 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 1.3165 | 0.9854 | 1.6477 | | |

| | | | | |
|---|---|---|---|---|
| 295.0000 | 0.0000 | 2.5578 | 0.0000 | 9.8929 |
| 3.8677 | 13.7607 | 3439.6737 | 696.6167 | 4136.2905 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 2.5578 | 0.9967 | 1.7415 | | |
| 295.1000 | 0.0000 | 0.5746 | 0.0000 | 2.1539 |
| 3.7468 | 5.8998 | 3439.0714 | 696.2360 | 4135.3074 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.5746 | 0.9786 | 1.5822 | | |
| 295.2000 | 0.0000 | 0.1630 | 0.0000 | 0.6324 |
| 3.8802 | 4.5126 | 3438.9322 | 695.8546 | 4134.7868 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.1630 | 0.9749 | 1.5447 | | |
| 295.3000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.9918 | 2.9918 | 3438.9005 | 695.5110 | 4134.4115 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 295.4000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.2730 | 2.2730 | 3438.9005 | 695.2478 | 4134.1483 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 295.5000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.1481 | 2.1481 | 3438.9005 | 695.0267 | 4133.9272 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 295.6000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.9303 | 1.9303 | 3438.9005 | 694.8228 | 4133.7233 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 295.7000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.7218 | 1.7218 | 3438.9005 | 694.6402 | 4133.5407 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 295.8000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.7625 | 1.7625 | 3438.9005 | 694.4663 | 4133.3665 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |
| 295.9000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.0608 | 2.0608 | 3438.9005 | 694.2748 | 4133.1753 |
| 0.0000 | 209.2092 | 0.0000 | 0.0000 | 0.0000 |
| 27.9963 | 0.0000 | 1019.5588 | 0.0000 | 964.5532 |
| 0.0000 | 0.9734 | 1.5298 | | |

# 1. COMPUTER PROGRAM (F823)

This appendix contains engine performance determination and reconstruction of the S-IVB stage acceptance firing, using computer program F823 (table AP 3-1). This program operates directly on measured engine functional parameters from the beginning of the start transients to the end of the cutoff transients, and is used for functional evaluation, evaluation of the systems, and the determination of the performance profiles. A discussion and a graphical presentation of the performance values are given in section 8.

## 1.1 Acceptance Firing Data

The following procedures and assumptions were used to generate the printout:

a. The computation interval was 0.1 sec.

b. Measurements of thrust chamber pressure, gas generator pressure, LH2 pump discharge temperature, LH2 injection temperature, and LH2 turbine inlet temperature were obtained from magnetic tape.

c. Obvious instrumentation errors and noise were eliminated.

## 1.2 Digital Data Abbreviations

| | |
|---|---|
| LOX CONST | LOX consumption (lbm) |
| FUEL CONST | LH2 consumption (lbm) |
| THRUST 1 | Thrust chamber thrust (lbf) |
| THRUST 2 | Gas generator thrust (lbf) |
| TOT THRUST | J-2 engine thrust (lbf) |
| AVG THRUST | Average J-2 engine thrust from 80 percent thrust to the particular time thereafter (lbf) |
| MIX. RAT. 1 | Thrust chamber mixture ratio |
| MIX. RAT. 2 | Gas generator mixture ratio |
| OA M.R. | J-2 engine mixture ratio |
| AVG M.R. | Average J-2 engine mixture ratio from 90 percent thrust to the particular time thereafter |

| | |
|---|---|
| I SUB SP I | Thrust chamber specific impulse (sec) |
| I SUB SP 2 | Gas generator specific impulse (sec) |
| OA 2 SP | J-2 engine specific impulse (sec) |
| AVG ISP | Average J-2 engine specific impulse from 90 percent thrust to the particular time thereafter |
| W DOT O 1 | Thrust chamber LOX flowrate (lbm/sec) |
| W DOT O 2 | Gas generator LOX flowrate (lbm/sec) |
| TOT WDOT O | J-2 engine LOX flowrate (lbm /sec) |
| AVG WDOT O | Average J-2 engine LOX flowrate (defined similar to average thrust) (lbm/sec) |
| W DOT F 1 | Thrust chamber LH2 flowrate (lbm/sec) |
| W DOT F 2 | Gas generator LH2 flowrate (lbm/sec) |
| TOT WDOT F | J-2 engine LH2 flowrate (lbm/sec) |
| AVG WDOT F | Average J-2 engine LH2 flowrate (defined similar to average thrust) (lbm/sec) |
| W DOT T 1 | Thrust chamber total flowrate (lbm/sec) |
| W DOT T 2 | Gas generator total flowrate (lbm/sec) |
| TOT WDOT T | J-2 engine LH2 flowrate (lbm/sec) |
| AVG WDOT T | Average J-2 engine total flowrate (defined similar to average thrust) (lbm/sec) |

# TABLE AP 3-1 (Sheet 1 of 12)
## COMPUTER PROGRAM F823 (1ST BURN)

TIME

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | T/C THRUST | T/C ISP | T/C W DOT T | T/C W DOT O | T/C W DOT F | T/C MR |
| 2 | RHO LOX | RHO LH2 | G/G W DOT T | G/G W DOT O | G/G W DOT F | G/G MR |
| 3 | J-2 THRUST | J-2 ISP | J-2 W DOT T | J-2 W DOT O | J-2 W DOT F | J-2 MR |
| 4 | AVG. J2 F | AVG. J2 ISP | AVG. J2 DWT | AVG. J2 DWO | AVG. J2 DWF | AVG. J2 MR |
| 5 | LOX CONS. | LOX O/B | LOX IN TK | LH2 CONS. | LH2 O/B | LH2 IN TK |

TOTAL IMPULSE

TIME = 1.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 6.3111E 00 |
| 2 | 7.0649E 01 | 4.2948E 00 | 4.3440E 00 | 7.5368E-01 | 3.5903E 00 | 2.0992E-01 |
| 3 | 0. | 0. | 4.3440E 00 | 7.5368E-01 | 3.5903E 00 | 2.0992E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.4654E-01 | 9.0654E-01 | 1.9306E 05 | 1.6337E 00 | 1.6536E 00 | 4.0704E 04 |

TOTAL IMPULSE = 9.5636E 00

TIME = 1.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 5.5843E 00 |
| 2 | 7.0650E 01 | 4.3025E 00 | 2.9569E 00 | 5.1303E-01 | 2.4439E 00 | 2.0992E-01 |
| 3 | 0. | 0. | 2.9569E 00 | 5.1303E-01 | 2.4439E 00 | 2.0992E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.9784E-01 | 1.0138E 00 | 1.9306E 05 | 1.8781E 00 | 1.9022E 00 | 4.0704E 04 |

TOTAL IMPULSE = 9.5636E 00

TIME = 1.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 4.1432E 03 | 2.1697E 03 | 1.9096E 00 | 1.5431E 00 | 3.6654E-01 | 4.2098E 03 |
| 2 | 7.0646E 01 | 4.3070E 00 | 2.3390E 00 | 4.0581E-01 | 1.9331E 00 | 2.0992E-01 |
| 3 | 4.1432E 03 | 9.7519E 02 | 4.2485E 00 | 1.9489E 00 | 2.2997E 00 | 8.4765E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 5.9272E-01 | 1.2647E 00 | 1.9306E 05 | 2.1081E 00 | 2.1376E 00 | 4.0704E 04 |

TOTAL IMPULSE = 4.2389E 02

TIME = 1.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 6.6481E 03 | 2.0904E 03 | 3.1804E 00 | 2.3464E 00 | 8.3394E-01 | 2.8136E 03 |
| 2 | 7.0655E 01 | 4.3084E 00 | 2.4400E 00 | 4.2334E-01 | 2.0167E 00 | 2.0992E-01 |
| 3 | 6.6481E 03 | 1.1828E 03 | 5.6204E 00 | 2.7698E 00 | 2.8507E 00 | 9.7162E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 8.6970E-01 | 1.5977E 00 | 1.9306E 05 | 2.3932E 00 | 2.4291E 00 | 4.0704E 04 |

TOTAL IMPULSE = 1.0887E 03

TIME = 1.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 6.8614E 03 | 2.0271E 03 | 3.3848E 00 | 2.2625E 00 | 1.1223E 00 | 2.0159E 00 |
| 2 | 7.0660E 01 | 4.3031E 00 | 2.5559E 00 | 4.4355E-01 | 2.1123E 00 | 2.0998E-01 |
| 3 | 6.8614E 03 | 1.1550E 03 | 5.9407E 00 | 2.7060E 00 | 3.2346E 00 | 8.3658E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.1403E 00 | 1.9243E 00 | 1.9306E 05 | 2.7166E 00 | 2.7603E 00 | 4.0703E 04 |

TOTAL IMPULSE = 1.7748E 03

TIME = 1.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 7.4813E 03 | 2.0221E 03 | 3.6997E 00 | 2.4486E 00 | 1.2511E 00 | 1.9771E 00 |
| 2 | 7.0653E 01 | 4.2985E 00 | 2.6278E 00 | 4.2057E-01 | 2.0072E 00 | 2.0953E-01 |
| 3 | 7.4813E 03 | 1.2209E 03 | 6.1274E 00 | 2.8691E 00 | 3.2583E 00 | 8.8055E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.4272E 00 | 2.2672E 00 | 1.9306E 05 | 3.0425E 00 | 3.0950E 00 | 4.0703E 04 |

TOTAL IMPULSE = 2.5229E 03

TIME = 1.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3755E 04 | 2.0360E 03 | 1.1667E 01 | 7.8617E 00 | 3.8056E 00 | 2.0659E 00 |
| 2 | 7.0641E 01 | 4.3064E 00 | 2.5597E 00 | 4.4332E-01 | 2.1163E 00 | 2.0948E-01 |
| 3 | 2.3755E 04 | 1.6697E 03 | 1.4227E 01 | 8.3050E 00 | 5.9219E 00 | 1.4024E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.2577E 00 | 3.1537E 00 | 1.9306E 05 | 3.6347E 00 | 3.6971E 00 | 4.0702E 04 |

TOTAL IMPULSE = 4.8984E 03

TIME = 1.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.2361E 04 | 1.1420E 03 | 2.8336E 01 | 1.9290E 01 | 9.0463E 00 | 2.1324E 00 |
| 2 | 7.0628E 01 | 4.3243E 00 | 2.6497E 00 | 4.6751E-01 | 2.1822E 00 | 2.1424E-01 |
| 3 | 3.2361E 04 | 1.0444E 03 | 3.0986E 01 | 1.9757E 01 | 1.1229E 01 | 1.7595E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 4.2335E 00 | 5.1855E 00 | 1.9306E 05 | 4.7575E 00 | 4.8311E 00 | 4.0701E 04 |

TOTAL IMPULSE = 8.1346E 03

TIME = 1.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.7902E 04 | 8.6880E 02 | 4.3626E 01 | 3.0080E 01 | 1.3349E 01 | 2.2206E 00 |
| 2 | 7.0626E 01 | 4.3390E 00 | 2.6867E 00 | 4.9793E-01 | 2.1887E 00 | 2.2753E-01 |
| 3 | 3.7902E 04 | 9.1840E 02 | 4.6313E 01 | 3.0574E 01 | 1.5735E 01 | 1.9434E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 7.2913E 00 | 8.2993E 00 | 1.9305E 05 | 5.3310E 00 | 6.4169E 00 | 4.0700E 04 |

TOTAL IMPULSE = 1.1925E 04

TIME = 1.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 4.2999E 04 | 7.4915E 02 | 5.7397E 01 | 4.0257E 01 | 1.7140E 01 | 2.3487E 00 |
| 2 | 7.0633E 01 | 4.3445E 00 | 2.8762E 00 | 5.6549E-01 | 2.3107E 00 | 2.4472E-01 |
| 3 | 4.2999E 04 | 7.1340E 02 | 6.0273E 01 | 4.0822E 01 | 1.9451E 01 | 2.0987E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.1374E 01 | 1.2438E 01 | 1.9305E 05 | 8.2761E 00 | 8.3754E 00 | 4.0698E 04 |

TOTAL IMPULSE = 1.6225E 04

TIME = 2.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 4.6711E 04 | 6.9750E 02 | 6.6968E 01 | 4.7990E 01 | 1.8978E 01 | 2.5288E 00 |
| 2 | 7.0643E 01 | 4.3463E 00 | 3.0420E 00 | 6.2733E-01 | 2.4147E 00 | 2.5980E-01 |
| 3 | 4.6711E 04 | 6.6720E 02 | 7.0910E 01 | 4.8618E 01 | 2.1392E 01 | 2.2727E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.6235E 01 | 1.7355E 01 | 1.9305E 05 | 1.0415E 01 | 1.0529E 01 | 4.0695E 04 |

TOTAL IMPULSE = 2.0896E 04

TIME = 2.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 5.2267E 04 | 6.4219E 02 | 8.1388E 01 | 5.9868E 01 | 2.1719E 01 | 2.7473E 00 |
| 2 | 7.0655E 01 | 4.3484E 00 | 3.2013E 00 | 6.8682E-01 | 2.5145E 00 | 2.7315E-01 |
| 3 | 5.2267E 04 | 6.1789E 02 | 8.4589E 01 | 6.0355E 01 | 2.4234E 01 | 2.4905E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.2271E 01 | 2.3447E 01 | 1.9304E 05 | 1.2839E 01 | 1.2968E 01 | 4.0693E 04 |

TOTAL IMPULSE = 2.6122E 04

TIME = 2.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 5.9427E 04 | 5.9158F 02 | 1.0045E 02 | 7.4621E 01 | 2.5833E 01 | 2.8885E 00 |
| 2 | 7.0667E 01 | 4.3521E 00 | 3.2779E 00 | 7.3225E-01 | 2.5457E 00 | 2.8764E-01 |
| 3 | 5.9427E 04 | 5.7289E 02 | 1.0373E 02 | 7.5353E 01 | 2.8379E 01 | 2.6552E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.9806E 01 | 3.1038E 01 | 1.9303E 05 | 1.5677E 01 | 1.5823E 01 | 4.0690E 04 |

TOTAL IMPULSE = 3.2065E 04

TIME = 2.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 6.7011E 04 | 5.5324E 02 | 1.2112E 02 | 9.0246E 01 | 3.0879E 01 | 2.9226E 00 |
| 2 | 7.0674E 01 | 4.3546E 00 | 3.3116E 00 | 7.7060E-01 | 2.5410E 00 | 3.0327E-01 |
| 3 | 6.7011E 04 | 5.3852E 02 | 1.2444E 02 | 9.1016F 01 | 3.3420E 01 | 2.7234E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.8908E 01 | 4.0196E 01 | 1.9302E 05 | 1.9019E 01 | 1.9183E 01 | 4.0687E 04 |

TOTAL IMPULSE = 3.8766E 04

TIME = 2.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 7.6022E 04 | 5.2265E 02 | 1.4546E 02 | 1.0901F 02 | 3.6448E 01 | 2.9908E 00 |
| 2 | 7.0679E 01 | 4.3555E 00 | 3.7256E 00 | 9.0363E-01 | 2.8219E 00 | 3.2022E-01 |
| 3 | 7.6022E 04 | 5.0959E 02 | 1.4918E 02 | 1.0991E 02 | 3.9270E 01 | 2.7989E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 4.9899E 01 | 5.1243E 01 | 1.9301F 05 | 2.2946E 01 | 2.3130E 01 | 4.0683E 04 |

TOTAL IMPULSE = 4.6368E 04

TIME = 2.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 8.5961E 04 | 5.0160E 02 | 1.7137E 02 | 1.3051E 02 | 4.0866E 01 | 3.1936E 00 |
| 2 | 7.0684E 01 | 4.3563E 00 | 4.4865E 00 | 1.1371E 00 | 3.3494E 00 | 3.3950E-01 |
| 3 | 8.5961E 04 | 4.8880E 02 | 1.7586E 02 | 1.3164E 02 | 4.4215E 01 | 2.9774E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 6.3063E 01 | 6.4463E 01 | 1.9300E 05 | 2.7367E 01 | 2.7571E 01 | 4.0678E 04 |

TOTAL IMPULSE = 5.4965E 04

TIME = 2.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 9.5088E 04 | 4.8852E 02 | 1.9464E 02 | 1.5075E 02 | 4.3895E 01 | 3.4343E 00 |
| 2 | 7.0687E 01 | 4.3574E 00 | 4.2930E 00 | 1.1393E 00 | 3.1538E 00 | 3.6124E-01 |
| 3 | 9.5088E 04 | 4.7798E 02 | 1.9894E 02 | 1.5189E 02 | 4.7049E 01 | 3.2283E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 7.8252E 01 | 7.9708E 01 | 1.9298E 05 | 3.2072E 01 | 3.2298E 01 | 4.0574E 04 |

TOTAL IMPULSE = 6.4473E 04

TIME = 2.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.0392E 05 | 4.7701E 02 | 2.1785E 02 | 1.6985E 02 | 4.8004E 01 | 3.5381E 00 |
| 2 | 7.0690E 01 | 4.3592E 00 | 4.2866E 00 | 1.1914F 00 | 3.0952E 00 | 3.8491E-01 |
| 3 | 1.0392E 05 | 4.6781E 02 | 2.2214E 02 | 1.7104F 02 | 5.1100E 01 | 3.3471E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 9.5356E 01 | 9.6868E 01 | 1.9297E 05 | 3.7182E 01 | 3.7430E 01 | 4.0669E 04 |

TOTAL IMPULSE = 7.4865E 04

TIME = 2.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.1535E 05 | 4.6436E 02 | 2.4839E 02 | 1.9420F 02 | 5.4199E 01 | 3.5830E 00 |
| 2 | 7.0690E 01 | 4.3598E 00 | 4.5491E 00 | 1.3251E 00 | 3.2240E 00 | 4.1102E-01 |
| 3 | 1.1535E 05 | 4.5601E 02 | 2.5794E 02 | 1.9552E 02 | 5.7423E 01 | 3.4049E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.1491E 02 | 1.1648E 02 | 1.9295E 05 | 4.2924E 01 | 4.3197E 01 | 4.0663E 04 |

TOTAL IMPULSE = 8.6400E 04

TIME = 2.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.2964E 05 | 4.5311E 02 | 2.8612E 02 | 2.2511E 02 | 6.1013E 01 | 3.6895E 00 |
| 2 | 7.0691E 01 | 4.3599E 00 | 4.8007E 00 | 1.4644E 00 | 3.3364E 00 | 4.3890E-01 |
| 3 | 1.2964E 05 | 4.4563E 02 | 2.9092E 02 | 2.2657E 02 | 6.4349E 01 | 3.5210E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.3757E 02 | 1.3919E 02 | 1.9292E 05 | 4.9359E 01 | 4.9657E 01 | 4.0656E 04 |

TOTAL IMPULSE = 9.9364E 04

TIME = 3.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.4323E 05 | 4.4601E 02 | 3.2114E 02 | 2.5521E 02 | 6.5927E 01 | 3.8711E 00 |
| 2 | 7.0691E 01 | 4.3609E 00 | 5.1482E 00 | 1.6413E 00 | 3.5068E 00 | 4.6804E-01 |
| 3 | 1.4323E 05 | 4.3897E 02 | 3.2629E 02 | 2.5685E 02 | 6.9433E 01 | 3.6993E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.6325E 02 | 1.6493E 02 | 1.9290E 05 | 5.6303E 01 | 5.6626E 01 | 4.0649E 04 |

TOTAL IMPULSE = 1.1369E 05

TIME = 3.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.5367E 05 | 4.4164E 02 | 3.4794E 02 | 2.7842E 02 | 6.9518E 01 | 4.0051E 00 |
| 2 | 7.0690E 01 | 4.3616E 00 | 5.4130E 00 | 1.7981E 00 | 3.6149E 00 | 4.9742E-01 |
| 3 | 1.5367E 05 | 4.3488E 02 | 3.5335E 02 | 2.8022E 02 | 7.3133E 01 | 3.8317E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.9127E 02 | 1.9301E 02 | 1.9287E 05 | 6.3616F 01 | 6.3965E 01 | 4.0642E 04 |

TOTAL IMPULSE = 1.2905E 05

TIME = 3.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.6096E 05 | 4.3872E 02 | 3.6688E 02 | 2.9448E 02 | 7.2399E 01 | 4.0675E 00 |
| 2 | 7.0694E 01 | 4.3611E 00 | 5.5935E 00 | 1.9303E 00 | 3.6622E 00 | 5.2703E-01 |
| 3 | 1.6096E 05 | 4.3214E 02 | 3.7247E 02 | 2.9641E 02 | 7.6061E 01 | 3.8970E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.2091E 02 | 2.2271E 02 | 1.9284E 05 | 7.1222E 01 | 7.1599E 01 | 4.0634E 04 |

TOTAL IMPULSE = 1.4515E 05

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# TABLE AP 3-1 (Sheet 2 of 12)
## COMPUTER PROGRAM F823 (1ST BURN)

TIME = 3.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.6600E 05 | 4.3718E 02 | 3.7971E 02 | 3.0580E 02 | 7.3913E 01 | 4.1372E 00 |
| 2 | 7.0703E 01 | 4.3621E 00 | 5.9293E 00 | 2.1195E 00 | 3.8099E 00 | 5.5630E-01 |
| 3 | 1.6600E 05 | 4.3046E 02 | 3.8564E 02 | 3.0792E 02 | 7.7723E 01 | 3.9617E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.5171E 02 | 2.5355E 02 | 1.9281E 05 | 7.8994E 01 | 7.9399E 01 | 4.0627E 04 |

TOTAL IMPULSE = 1.6175E 05

TIME = 3.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7058E 05 | 4.3651E 02 | 3.9078E 02 | 3.1652E 02 | 7.4257E 01 | 4.2625E 00 |
| 2 | 7.0716E 01 | 4.3621E 00 | 5.6514E 00 | 2.0831E 00 | 3.5683E 00 | 5.8379E-01 |
| 3 | 1.7058E 05 | 4.3029E 02 | 3.9643E 02 | 3.1860E 02 | 7.7825E 01 | 4.0938E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.8357E 02 | 2.8547E 02 | 1.9278E 05 | 8.6777E 01 | 8.7210E 01 | 4.0619E 04 |

TOTAL IMPULSE = 1.7881E 05

TIME = 3.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7462E 05 | 4.3644E 02 | 4.0009E 02 | 3.2630E 02 | 7.3790E 01 | 4.4221E 00 |
| 2 | 7.0720E 01 | 4.3618E 00 | 5.5832E 00 | 2.1116E 00 | 3.4716E 00 | 6.0825E-01 |
| 3 | 1.7462E 05 | 4.3043E 02 | 4.0568E 02 | 3.2842E 02 | 7.7261E 01 | 4.2507E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.1641E 02 | 3.1837E 02 | 1.9274E 05 | 9.4503E 01 | 9.4965E 01 | 4.0611E 04 |

TOTAL IMPULSE = 1.9627E 05

TIME = 3.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7828E 05 | 4.3663E 02 | 4.0430E 02 | 3.3532E 02 | 7.2983E 01 | 4.5944E 00 |
| 2 | 7.0724E 01 | 4.3619E 00 | 5.9133E 00 | 2.2878E 00 | 3.6255E 00 | 6.3103E-01 |
| 3 | 1.7828E 05 | 4.3040E 02 | 4.1421E 02 | 3.3760E 02 | 7.6609E 01 | 4.4069E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.5017E 02 | 3.5218E 02 | 1.9271E 05 | 1.0216E 02 | 1.0766E 02 | 4.0603E 04 |

TOTAL IMPULSE = 2.1410E 05

TIME = 3.6396

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7924E 05 | 4.3680E 02 | 4.1036E 02 | 3.3776E 02 | 7.2597E 01 | 4.6526E 00 |
| 2 | 7.0727E 01 | 4.3619E 00 | 5.9095E 00 | 2.3054E 00 | 3.6041E 00 | 6.3967E-01 |
| 3 | 1.7924E 05 | 4.3059E 02 | 4.1627E 02 | 3.4007E 02 | 7.6201E 01 | 4.4628E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.6365E 02 | 3.6569E 02 | 1.9270E 05 | 1.0518E 02 | 1.0569E 02 | 4.0630E 04 |

TOTAL IMPULSE = 2.2120E 05

TIME = 3.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8071E 05 | 4.3703E 02 | 4.1350E 02 | 3.4147E 02 | 7.2024E 01 | 4.7411E 00 |
| 2 | 7.0732E 01 | 4.3619E 00 | 5.9037E 00 | 2.3319E 00 | 3.5719E 00 | 6.5283E-01 |
| 3 | 1.8071E 05 | 4.3088E 02 | 4.1940E 02 | 3.4340E 02 | 7.5596E 01 | 4.5479E 00 |
| 4 | 1.8071E 05 | 4.3088E 02 | 4.1940E 02 | 3.4340E 02 | 7.5596E 01 | 4.5479E 00 |
| 5 | 3.8440E 02 | 3.8647E 02 | 1.9268E 05 | 1.0975E 02 | 1.1027E 02 | 4.0596E 04 |

TOTAL IMPULSE = 2.3211E 05

TIME = 3.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8356E 05 | 4.3671E 02 | 4.2033E 02 | 3.4815E 02 | 7.2184E 01 | 4.8231E 00 |
| 2 | 7.0739E 01 | 4.3622E 00 | 5.9588E 00 | 2.3977E 00 | 3.5611E 00 | 6.7330E-01 |
| 3 | 1.8356E 05 | 4.3081E 02 | 4.2629E 02 | 3.5055E 02 | 7.5765E 01 | 4.6280E 00 |
| 4 | 1.8249E 05 | 4.3071E 02 | 4.2370E 02 | 3.4801E 02 | 7.5689E 01 | 4.5979E 00 |
| 5 | 4.1945E 02 | 4.2158E 02 | 1.9264E 05 | 1.1732E 02 | 1.1784E 02 | 4.0588E 04 |

TOTAL IMPULSE = 2.5047E 05

TIME = 3.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8611E 05 | 4.3594E 02 | 4.2693E 02 | 3.5378E 02 | 7.3149E 01 | 4.8364E 00 |
| 2 | 7.0744E 01 | 4.3633E 00 | 6.3671E 00 | 2.6028E 00 | 3.7043E 00 | 6.9143E-01 |
| 3 | 1.8611E 05 | 4.2953E 02 | 4.3329E 02 | 3.5638E 02 | 7.6913E 01 | 4.6336E 00 |
| 4 | 1.8388E 05 | 4.3025E 02 | 4.2738E 02 | 3.5122E 02 | 7.6159E 01 | 4.6117E 00 |
| 5 | 4.5509E 02 | 4.5728E 02 | 1.9261E 05 | 1.2501E 02 | 1.2553E 02 | 4.0580E 04 |

TOTAL IMPULSE = 2.6905E 05

TIME = 4.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8560E 05 | 4.3602E 02 | 4.2567E 02 | 3.5258E 02 | 7.3028E 01 | 4.8245E 00 |
| 2 | 7.0748E 01 | 4.3634E 00 | 6.1289E 00 | 2.5405E 00 | 3.5883E 00 | 7.0000E-01 |
| 3 | 1.8560E 05 | 4.2983E 02 | 4.3180E 02 | 3.5513E 02 | 7.6670E 01 | 4.6319E 00 |
| 4 | 1.8436E 05 | 4.3013E 02 | 4.2861E 02 | 3.5231E 02 | 7.6301E 01 | 4.6173E 00 |
| 5 | 4.9060E 02 | 4.9284E 02 | 1.9257E 05 | 1.3268E 02 | 1.3330E 02 | 4.0573E 04 |

TOTAL IMPULSE = 2.8764E 05

TIME = 4.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8568E 05 | 4.3576E 02 | 4.2411E 02 | 3.5262E 02 | 7.3431E 01 | 4.7983E 00 |
| 2 | 7.0753E 01 | 4.3617E 00 | 5.9747E 00 | 2.5995E 00 | 3.4701E 00 | 7.2318E-01 |
| 3 | 1.8568E 05 | 4.2973E 02 | 4.3209E 02 | 3.5513E 02 | 7.6923E 01 | 4.6143E 00 |
| 4 | 1.8465E 05 | 4.3004E 02 | 4.2936E 02 | 3.5292E 02 | 7.6443E 01 | 4.6117E 00 |
| 5 | 5.2612E 02 | 5.2841E 02 | 1.9253E 05 | 1.4039E 02 | 1.4103E 02 | 4.0565E 04 |

TOTAL IMPULSE = 3.0621E 05

TIME = 4.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8665E 05 | 4.3515E 02 | 4.2894E 02 | 3.5455E 02 | 7.4397E 01 | 4.7655E 00 |
| 2 | 7.0758E 01 | 4.3608E 00 | 6.0785E 00 | 2.5782E 00 | 3.5003E 00 | 7.3657E-01 |
| 3 | 1.8665E 05 | 4.2907E 02 | 4.3502E 02 | 3.5712E 02 | 7.7897E 01 | 4.5946E 00 |
| 4 | 1.8500E 05 | 4.2987E 02 | 4.3037E 02 | 3.5367E 02 | 7.6704E 01 | 4.6109E 00 |
| 5 | 5.6183E 02 | 5.6618E 02 | 1.9250E 05 | 1.4817E 02 | 1.4885E 02 | 4.0557E 04 |

TOTAL IMPULSE = 3.2487E 05

TIME = 4.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8832E 05 | 4.3439E 02 | 4.3351E 02 | 3.5803E 02 | 7.5487E 01 | 4.7429E 00 |
| 2 | 7.0759E 01 | 4.3613E 00 | 6.2591E 00 | 2.6782E 00 | 3.5809E 00 | 7.4790E-01 |
| 3 | 1.8832E 05 | 4.2821E 02 | 4.3977E 02 | 3.6071E 02 | 7.9048E 01 | 4.5620E 00 |
| 4 | 1.8551E 05 | 4.2961E 02 | 4.3180E 02 | 3.5474E 02 | 7.7062E 01 | 4.6033E 00 |
| 5 | 5.9790E 02 | 6.0031E 02 | 1.9246E 05 | 1.5607E 02 | 1.5680E 02 | 4.0549E 04 |

TOTAL IMPULSE = 3.4370E 05

TIME = 4.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8898E 05 | 4.3405E 02 | 4.3538E 02 | 3.5937E 02 | 7.6003E 01 | 4.7284E 00 |
| 2 | 7.0760E 01 | 4.3620E 00 | 6.3291E 00 | 2.7313E 00 | 3.5978E 00 | 7.5916E-01 |
| 3 | 1.8898E 05 | 4.2783E 02 | 4.4171E 02 | 3.6211E 02 | 7.9601E 01 | 4.5490E 00 |
| 4 | 1.8596E 05 | 4.2937E 02 | 4.3310E 02 | 3.5570E 02 | 7.7396E 01 | 4.5959E 00 |
| 5 | 6.3411E 02 | 6.3658E 02 | 1.9243E 05 | 1.6403E 02 | 1.6479E 02 | 4.0541E 04 |

TOTAL IMPULSE = 3.6260E 05

TIME = 4.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8947E 05 | 4.3375E 02 | 4.3693E 02 | 3.6036E 02 | 7.6465E 01 | 4.7128E 00 |
| 2 | 7.0764E 01 | 4.3619E 00 | 6.4293E 00 | 2.7983E 00 | 3.6310E 00 | 7.7067E-01 |
| 3 | 1.8947E 05 | 4.2746E 02 | 4.4326E 02 | 3.6316E 02 | 8.0096E 01 | 4.5341E 00 |
| 4 | 1.8637E 05 | 4.2915E 02 | 4.3428E 02 | 3.5657E 02 | 7.7710E 01 | 4.5885E 00 |
| 5 | 6.7043E 02 | 6.7295E 02 | 1.9239E 05 | 1.7204E 02 | 1.7284E 02 | 4.0533E 04 |

TOTAL IMPULSE = 3.8155E 05

TIME = 4.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8946E 05 | 4.3365E 02 | 4.3689E 02 | 3.6025E 02 | 7.6641E 01 | 4.7005E 00 |
| 2 | 7.0769E 01 | 4.3619E 00 | 6.4458E 00 | 2.8269E 00 | 3.6189E 00 | 7.8114E-01 |
| 3 | 1.8946E 05 | 4.2734E 02 | 4.4334E 02 | 3.6308E 02 | 8.0260E 01 | 4.5238E 00 |
| 4 | 1.8669E 05 | 4.2896E 02 | 4.3522E 02 | 3.5725E 02 | 7.7975E 01 | 4.5816E 00 |
| 5 | 7.0674E 02 | 7.0931E 02 | 1.9235E 05 | 1.8007E 02 | 1.8090E 02 | 4.0525E 04 |

TOTAL IMPULSE = 4.0049E 05

TIME = 4.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9013E 05 | 4.3339E 02 | 4.3871E 02 | 3.6169E 02 | 7.7014E 01 | 4.6964E 00 |
| 2 | 7.0771E 01 | 4.3617E 00 | 6.3356E 00 | 2.7963E 00 | 3.5393E 00 | 7.9005E-01 |
| 3 | 1.9013E 05 | 4.2722E 02 | 4.4504E 02 | 3.6449E 02 | 8.0553E 01 | 4.5248E 00 |
| 4 | 1.8702E 05 | 4.2879E 02 | 4.3615E 02 | 3.5793E 02 | 7.8218E 01 | 4.5761E 00 |
| 5 | 7.4318E 02 | 7.4582E 02 | 1.9232E 05 | 1.9812E 02 | 1.8899E 02 | 4.0517E 04 |

TOTAL IMPULSE = 4.1951E 05

TIME = 4.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9083E 05 | 4.3313E 02 | 4.4058E 02 | 3.6318E 02 | 7.7397E 01 | 4.6925E 00 |
| 2 | 7.0771E 01 | 4.3613E 00 | 6.3261E 00 | 2.8088E 00 | 3.5173E 00 | 7.9858E-01 |
| 3 | 1.9083E 05 | 4.2700E 02 | 4.4691E 02 | 3.6599E 02 | 8.0914E 01 | 4.5232E 00 |
| 4 | 1.8735E 05 | 4.2863E 02 | 4.3708E 02 | 3.5863E 02 | 7.8451E 01 | 4.5714E 00 |
| 5 | 7.7978E 02 | 7.8247E 02 | 1.9228E 05 | 1.9622E 02 | 1.9712E 02 | 4.0509E 04 |

TOTAL IMPULSE = 4.3859E 05

TIME = 4.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9138E 05 | 4.3286E 02 | 4.4213E 02 | 3.6431E 02 | 7.7820E 01 | 4.6815E 00 |
| 2 | 7.0773E 01 | 4.3609E 00 | 6.3213E 00 | 2.8201E 00 | 3.5012E 00 | 8.0545E-01 |
| 3 | 1.9138E 05 | 4.2676E 02 | 4.4845E 02 | 3.6713E 02 | 8.1321E 01 | 4.5146E 00 |
| 4 | 1.8767E 05 | 4.2844E 02 | 4.3798E 02 | 3.5930E 02 | 7.8678E 01 | 4.5667E 00 |
| 5 | 8.1650E 02 | 8.1924E 02 | 1.9224E 05 | 2.0435E 02 | 2.0529E 02 | 4.0501E 04 |

TOTAL IMPULSE = 4.5773E 05

TIME = 5.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9149E 05 | 4.3272E 02 | 4.4251E 02 | 3.6446E 02 | 7.8049E 01 | 4.6697E 00 |
| 2 | 7.0775E 01 | 4.3606E 00 | 6.3214E 00 | 2.8319E 00 | 3.4895E 00 | 8.1156E-01 |
| 3 | 1.9149E 05 | 4.2663E 02 | 4.4883E 02 | 3.6730E 02 | 8.1533E 01 | 4.5046E 00 |
| 4 | 1.8795E 05 | 4.2834E 02 | 4.3878E 02 | 3.5989E 02 | 7.8889E 01 | 4.5620E 00 |
| 5 | 8.5323E 02 | 8.5603E 02 | 1.9221E 05 | 2.1250E 02 | 2.1349E 02 | 4.0493E 04 |

TOTAL IMPULSE = 4.7688E 05

TIME = 5.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9166E 05 | 4.3265E 02 | 4.4299E 02 | 3.6483E 02 | 7.8166E 01 | 4.6673E 00 |
| 2 | 7.0775E 01 | 4.3608E 00 | 6.3584E 00 | 2.8604E 00 | 3.4980E 00 | 8.1773E-01 |
| 3 | 1.9166E 05 | 4.2653E 02 | 4.4935E 02 | 3.6769E 02 | 8.1664E 01 | 4.5024E 00 |
| 4 | 1.8820E 05 | 4.2821E 02 | 4.3950E 02 | 3.6042E 02 | 7.9079E 01 | 4.5578E 00 |
| 5 | 8.8999E 02 | 8.9285E 02 | 1.9217E 05 | 2.2067E 02 | 2.2170E 02 | 4.0484E 04 |

TOTAL IMPULSE = 4.9604E 05

TIME = 5.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9222E 05 | 4.3250E 02 | 4.4444E 02 | 3.6609E 02 | 7.8367E 01 | 4.6713E 00 |
| 2 | 7.0775E 01 | 4.3608E 00 | 6.4326E 00 | 2.9066E 00 | 3.5260E 00 | 8.2433E-01 |
| 3 | 1.9222E 05 | 4.2633E 02 | 4.5088E 02 | 3.6893E 02 | 8.1893E 01 | 4.5057E 00 |
| 4 | 1.8846E 05 | 4.2809E 02 | 4.4023E 02 | 3.6097E 02 | 7.9259E 01 | 4.5543E 00 |
| 5 | 9.2689E 02 | 9.2981E 02 | 1.9213E 05 | 2.2996E 02 | 2.2993E 02 | 4.0476E 04 |

TOTAL IMPULSE = 5.1526E 05

TIME = 5.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9248E 05 | 4.3248E 02 | 4.4506E 02 | 3.6667E 02 | 7.8387E 01 | 4.6777E 00 |
| 2 | 7.0776E 01 | 4.3609E 00 | 6.4321E 00 | 2.9177E 00 | 3.5143E 00 | 8.3024E-01 |
| 3 | 1.9248E 05 | 4.2632E 02 | 4.5149E 02 | 3.6959E 02 | 8.1901E 01 | 4.5126E 00 |
| 4 | 1.8870E 05 | 4.2798E 02 | 4.4091E 02 | 3.6149E 02 | 7.9414E 01 | 4.5517E 00 |
| 5 | 9.6385E 02 | 9.6682E 02 | 1.9210E 05 | 2.3705E 02 | 2.3816E 02 | 4.0468E 04 |

TOTAL IMPULSE = 5.3451E 05

TIME = 5.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9241E 05 | 4.3256E 02 | 4.4484E 02 | 3.6654E 02 | 7.8293E 01 | 4.6817E 00 |
| 2 | 7.0777E 01 | 4.3608E 00 | 6.3371E 00 | 2.8829E 00 | 3.4543E 00 | 8.3456E-01 |
| 3 | 1.9241E 05 | 4.2646E 02 | 4.5117E 02 | 3.6943E 02 | 8.1748E 01 | 4.5191E 00 |
| 4 | 1.8891E 05 | 4.2789E 02 | 4.4149E 02 | 3.6194E 02 | 7.9551E 01 | 4.5498E 00 |
| 5 | 1.0008E 03 | 1.0038E 03 | 1.9206E 05 | 2.4522E 02 | 2.4637E 02 | 4.0460E 04 |

TOTAL IMPULSE = 5.5375E 05

TIME = 5.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9261E 05 | 4.3250E 02 | 4.4535E 02 | 3.6701E 02 | 7.8341E 01 | 4.6948E 00 |
| 2 | 7.0776E 01 | 4.3608E 00 | 6.3092E 00 | 2.8772E 00 | 3.4320E 00 | 8.3936E-01 |
| 3 | 1.9261E 05 | 4.2645E 02 | 4.5165E 02 | 3.6989E 02 | 8.1773E 01 | 4.5233E 00 |
| 4 | 1.8912E 05 | 4.2781E 02 | 4.4204E 02 | 3.6237E 02 | 7.9670E 01 | 4.5484E 00 |
| 5 | 1.0378E 03 | 1.0409E 03 | 1.9202E 05 | 2.5340E 02 | 2.5459E 02 | 4.0451E 04 |

TOTAL IMPULSE = 5.7301E 05

# TABLE AP 3-1 (Sheet 3 of 12)
# COMPUTER PROGRAM F823 (1ST BURN)

TIME = 5.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9327E 05 | 4.3236E 02 | 4.4702E 02 | 3.6848E 02 | 7.8531E 01 | 4.6922E 00 |
| 2 | 7.0776E 01 | 4.3609E 00 | 6.3767E 00 | 2.9148E 00 | 3.4619E 00 | 8.4197E-01 |
| 3 | 1.9327E 05 | 4.2628E 02 | 4.5339E 02 | 3.7140E 02 | 8.1993E 01 | 4.5297E 00 |
| 4 | 1.8932E 05 | 4.2773E 02 | 4.4762E 02 | 3.6283E 02 | 7.9788E 01 | 4.5474E 00 |
| 5 | 1.0749E 03 | 1.0781E 03 | 1.9198E 05 | 2.6160E 02 | 2.6283E 02 | 4.0443E 04 |

TOTAL IMPULSE = 5.9234E 05

TIME = 5.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9401E 05 | 4.3216E 02 | 4.4894E 02 | 3.7013E 02 | 7.8815E 01 | 4.6961E 00 |
| 2 | 7.0776E 01 | 4.3607E 00 | 6.5404E 00 | 2.9980E 00 | 3.5424E 00 | 8.4631E-01 |
| 3 | 1.9401E 05 | 4.2595E 02 | 4.5548E 02 | 3.7312E 02 | 8.2357E 01 | 4.5305E 00 |
| 4 | 1.8955E 05 | 4.2764E 02 | 4.4324E 02 | 3.6333E 02 | 7.9913E 01 | 4.5465E 00 |
| 5 | 1.1122E 03 | 1.1134E 03 | 1.9195E 05 | 2.6983E 02 | 2.7111E 02 | 4.0435E 04 |

TOTAL IMPULSE = 6.1174E 05

TIME = 5.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9408E 05 | 4.3209E 02 | 4.4916E 02 | 3.7022E 02 | 7.8939E 01 | 4.6900E 00 |
| 2 | 7.0776E 01 | 4.3609E 00 | 6.5887E 00 | 3.0288E 00 | 3.5600E 00 | 8.5079E-01 |
| 3 | 1.9408E 05 | 4.2584E 02 | 4.5575E 02 | 3.7325E 02 | 8.2499E 01 | 4.5243E 00 |
| 4 | 1.8976E 05 | 4.2756E 02 | 4.4382E 02 | 3.6379E 02 | 8.0033E 01 | 4.5455E 00 |
| 5 | 1.1496E 03 | 1.1528E 03 | 1.9191E 05 | 2.7808E 02 | 2.7940E 02 | 4.0427E 04 |

TOTAL IMPULSE = 6.3115E 05

TIME = 5.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9411E 05 | 4.3204E 02 | 4.4928E 02 | 3.7027E 02 | 7.9018E 01 | 4.6859E 00 |
| 2 | 7.0775E 01 | 4.3608E 00 | 6.6604E 00 | 2.9763E 00 | 3.4841E 00 | 8.5425E-01 |
| 3 | 1.9411E 05 | 4.2592E 02 | 4.5574E 02 | 3.7324E 02 | 8.2502E 01 | 4.5240E 00 |
| 4 | 1.8995E 05 | 4.2748E 02 | 4.4435E 02 | 3.6421E 02 | 8.0142E 01 | 4.5445E 00 |
| 5 | 1.1869E 03 | 1.1902E 03 | 1.9187E 05 | 2.8633E 02 | 2.8770E 02 | 4.0418E 04 |

TOTAL IMPULSE = 6.5056E 05

TIME = 6.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9453E 05 | 4.3201E 02 | 4.5028E 02 | 3.7125E 02 | 7.9033E 01 | 4.6974E 00 |
| 2 | 7.0775E 01 | 4.3609E 00 | 6.3150E 00 | 2.9152E 00 | 3.3993E 00 | 8.5748E-01 |
| 3 | 1.9453E 05 | 4.2604E 02 | 4.5660E 02 | 3.7416E 32 | 8.2433E 01 | 4.5390E 00 |
| 4 | 1.9015E 05 | 4.2742E 02 | 4.4487E 02 | 3.6463E 02 | 8.0239E 01 | 4.5443E 00 |
| 5 | 1.2243E 03 | 1.2277E 03 | 1.9184E 05 | 2.9458E 02 | 2.9598E 02 | 4.0410E 04 |

TOTAL IMPULSE = 6.7001E 05

TIME = 6.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9525E 05 | 4.3195E 02 | 4.5202E 02 | 3.7295E 02 | 7.9069E 01 | 4.7168E 00 |
| 2 | 7.0776E 01 | 4.3612E 00 | 6.2738E 00 | 2.9010E 00 | 3.3728E 00 | 8.6014E-01 |
| 3 | 1.9525E 05 | 4.2604E 02 | 4.5830E 02 | 3.7585E 02 | 8.2442E 01 | 4.5590E 00 |
| 4 | 1.9035E 05 | 4.2736E 02 | 4.4541E 02 | 3.6508E 02 | 8.0329E 01 | 4.5449E 00 |
| 5 | 1.2619E 03 | 1.2653E 03 | 1.9180E 05 | 3.0282E 02 | 3.0427E 02 | 4.0402E 04 |

TOTAL IMPULSE = 6.8954E 05

TIME = 6.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9531E 05 | 4.3210E 02 | 4.5200E 02 | 3.7319E 02 | 7.8806E 01 | 4.7356E 00 |
| 2 | 7.0776E 01 | 4.3613E 00 | 6.2394E 00 | 2.8903E 00 | 3.3492E 00 | 8.6298E-01 |
| 3 | 1.9531E 05 | 4.2622E 02 | 4.5824E 02 | 3.7608E 02 | 8.2155E 01 | 4.5777E 00 |
| 4 | 1.9055E 05 | 4.2732E 02 | 4.4591E 02 | 3.6551E 02 | 8.0400E 01 | 4.5462E 00 |
| 5 | 1.2995E 03 | 1.3030E 03 | 1.9176E 05 | 3.1104E 02 | 3.1253E 02 | 4.0393E 04 |

TOTAL IMPULSE = 7.0907E 05

TIME = 6.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9508E 05 | 4.3226E 02 | 4.5129E 02 | 3.7276E 02 | 7.8536E 01 | 4.7463E 00 |
| 2 | 7.0775E 01 | 4.3611E 00 | 6.3027E 00 | 2.9229E 00 | 3.3798E 00 | 8.6481E-01 |
| 3 | 1.9508E 05 | 4.2631E 02 | 4.5759E 02 | 3.7568E 02 | 8.1916E 01 | 4.5862E 00 |
| 4 | 1.9072E 05 | 4.2728E 02 | 4.4635E 02 | 3.6590E 02 | 8.0457E 01 | 4.5477E 00 |
| 5 | 1.3371E 03 | 1.3406E 03 | 1.9172E 05 | 3.1923E 02 | 3.2076E 02 | 4.0385E 04 |

TOTAL IMPULSE = 7.2858E 05

TIME = 6.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9488E 05 | 4.3238E 02 | 4.5071E 02 | 3.7237E 02 | 7.8349E 01 | 4.7527E 00 |
| 2 | 7.0777E 01 | 4.3611E 00 | 6.4676E 00 | 3.0029E 00 | 3.4647E 00 | 8.6671E-01 |
| 3 | 1.9488E 05 | 4.2626E 02 | 4.5718E 02 | 3.7537E 02 | 8.1814E 01 | 4.5881E 00 |
| 4 | 1.9087E 05 | 4.2724E 02 | 4.4675E 02 | 3.6624E 02 | 8.0506E 01 | 4.5492E 00 |
| 5 | 1.3746E 03 | 1.3782E 03 | 1.9168E 05 | 3.2741E 02 | 3.2899E 02 | 4.0377E 04 |

TOTAL IMPULSE = 7.4807E 05

TIME = 6.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9507E 05 | 4.3243E 02 | 4.5111E 02 | 3.7287E 02 | 7.8237E 01 | 4.7659E 00 |
| 2 | 7.0779E 01 | 4.3608E 00 | 6.4824E 00 | 3.1051E 00 | 3.5737E 00 | 8.6798E-01 |
| 3 | 1.9507E 05 | 4.2612E 02 | 4.5779E 02 | 3.7538E 02 | 8.1814E 01 | 4.5955E 00 |
| 4 | 1.9101E 05 | 4.2720E 02 | 4.4713E 02 | 3.6658E 02 | 8.0552E 01 | 4.5509E 00 |
| 5 | 1.4122E 03 | 1.4158E 03 | 1.9165E 05 | 3.3559E 02 | 3.3721E 02 | 4.0369E 04 |

TOTAL IMPULSE = 7.6757E 05

TIME = 6.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9561E 05 | 4.3249E 02 | 4.5230E 02 | 3.7422E 02 | 7.8083E 01 | 4.7926E 00 |
| 2 | 7.0781E 01 | 4.3613E 00 | 6.7565E 00 | 3.1446E 00 | 3.6119E 00 | 8.7063E-01 |
| 3 | 1.9561E 05 | 4.2612E 02 | 4.5906E 02 | 3.7736E 02 | 8.1494E 01 | 4.6192E 00 |
| 4 | 1.9117E 05 | 4.2716E 02 | 4.4753E 02 | 3.6694E 02 | 8.0590E 01 | 4.5532E 00 |
| 5 | 1.4499E 03 | 1.4536E 03 | 1.9161E 05 | 3.4376E 02 | 3.4542E 02 | 4.0361E 04 |

TOTAL IMPULSE = 7.8713E 05

TIME = 6.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9643E 05 | 4.3249E 02 | 4.5419E 02 | 3.7619E 02 | 7.8003E 01 | 4.8227E 00 |
| 2 | 7.0781E 01 | 4.3625E 00 | 6.5939E 00 | 3.0763E 00 | 3.5177E 00 | 8.7452E-01 |
| 3 | 1.9643E 05 | 4.2630E 02 | 4.6078E 02 | 3.7926E 02 | 8.1521E 01 | 4.6524E 00 |
| 4 | 1.9136E 05 | 4.2713E 02 | 4.4797E 02 | 3.6735E 02 | 8.0621E 01 | 4.5565E 00 |
| 5 | 1.4879E 03 | 1.4916E 03 | 1.9157E 05 | 3.5191E 02 | 3.5362E 02 | 4.0352E 04 |

TOTAL IMPULSE = 8.0678E 05

TIME = 6.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9714E 05 | 4.3252E 02 | 4.5579E 02 | 3.7789E 02 | 7.7896E 01 | 4.8513E 00 |
| 2 | 7.0780E 01 | 4.3635E 00 | 6.3000E 00 | 2.9451E 00 | 3.3550E 00 | 8.7782E-01 |
| 3 | 1.9714E 05 | 4.2662E 02 | 4.6209E 02 | 3.8084E 02 | 8.1250E 01 | 4.6872E 00 |
| 4 | 1.9153E 05 | 4.2712E 02 | 4.4841E 01 | 3.6777E 02 | 8.0641E 01 | 4.5606E 00 |
| 5 | 1.5259E 03 | 1.5298E 03 | 1.9153E 05 | 3.6004E 02 | 3.6179E 02 | 4.0344E 04 |

TOTAL IMPULSE = 8.2649E 05

TIME = 6.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9769E 05 | 4.3255E 02 | 4.5704E 02 | 3.7924E 02 | 7.7796E 01 | 4.8748E 00 |
| 2 | 7.0780E 01 | 4.3635E 00 | 6.2147E 00 | 2.9071F 00 | 3.3076E 00 | 8.7890E-01 |
| 3 | 1.9769E 05 | 4.2675E 02 | 4.6325E 02 | 3.8215E 02 | 8.1104E 01 | 4.7118E 00 |
| 4 | 1.9171E 05 | 4.2711E 02 | 4.4887E 02 | 3.6821F 02 | 8.0655E 01 | 4.5653E 00 |
| 5 | 1.5642E 03 | 1.5680E 03 | 1.9149E 05 | 3.6815E 02 | 3.6994E 02 | 4.0336E 04 |

TOTAL IMPULSE = 8.4626E 05

TIME = 7.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9864E 05 | 4.3239E 02 | 4.5941E 02 | 3.8142E 02 | 7.7993E 01 | 4.8904E 00 |
| 2 | 7.0780E 01 | 4.3635E 00 | 6.4602E 00 | 3.0241E 00 | 3.4361E 00 | 8.8011E-01 |
| 3 | 1.9864E 05 | 4.2640E 02 | 4.6587E 02 | 3.8444E 02 | 8.1429E 01 | 4.7211E 00 |
| 4 | 1.9192E 05 | 4.2708E 02 | 4.4937E 02 | 3.6870E 02 | 8.0678E 01 | 4.5700E 00 |
| 5 | 1.6026E 03 | 1.6065E 03 | 1.9146E 05 | 3.7629E 02 | 3.7813E 02 | 4.0328E 04 |

TOTAL IMPULSE = 8.6613E 05

TIME = 7.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9919E 05 | 4.3231E 02 | 4.6076E 02 | 3.8266E 02 | 7.8102E 01 | 4.8995E 00 |
| 2 | 7.0780E 01 | 4.3636E 00 | 6.6188E 00 | 3.1018E 00 | 3.5169E 00 | 8.8198E-01 |
| 3 | 1.9919E 05 | 4.2618E 02 | 4.6738E 02 | 3.8576E 02 | 8.1619E 01 | 4.7264E 00 |
| 4 | 1.9213E 05 | 4.2706F 02 | 4.4990E 02 | 3.6919E 02 | 8.0705E 01 | 4.5746E 00 |
| 5 | 1.6412E 03 | 1.6452E 03 | 1.9142E 05 | 3.8445E 02 | 3.8634E 02 | 4.0320E 04 |

TOTAL IMPULSE = 8.8604E 05

TIME = 7.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9990E 05 | 4.3223E 02 | 4.6249E 02 | 3.8431E 02 | 7.8183E 01 | 4.9155E 00 |
| 2 | 7.0780E 01 | 4.3634E 00 | 6.6165E 00 | 3.1045E 00 | 3.5120E 00 | 8.8398E-01 |
| 3 | 1.9990E 05 | 4.2613E 02 | 4.6911E 02 | 3.8741E 02 | 8.1695E 01 | 4.7422E 00 |
| 4 | 1.9235E 05 | 4.2703E 02 | 4.5043E 02 | 3.6970E 02 | 8.0733E 01 | 4.5793E 00 |
| 5 | 1.6799E 03 | 1.6840E 03 | 1.9138E 05 | 3.9262E 02 | 3.9455E 02 | 4.0311E 04 |

TOTAL IMPULSE = 9.0603E 05

TIME = 7.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0114E 05 | 4.3213E 02 | 4.6346E 02 | 3.8720E 02 | 7.8261E 01 | 4.9475E 00 |
| 2 | 7.0780E 01 | 4.3634E 00 | 6.7095E 00 | 3.1510E 00 | 3.5586E 00 | 8.8551E-01 |
| 3 | 2.0114E 05 | 4.2599E 02 | 4.7217E 02 | 3.9035E 02 | 8.1819E 01 | 4.7708E 00 |
| 4 | 1.9259E 05 | 4.2700E 02 | 4.5103E 02 | 3.7027E 02 | 8.0763E 01 | 4.5846E 00 |
| 5 | 1.7190E 03 | 1.7230E 03 | 1.9134E 05 | 4.0080E 02 | 4.0278E 02 | 4.0303E 04 |

TOTAL IMPULSE = 9.2615E 05

TIME = 7.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0294E 05 | 4.3193E 02 | 4.6988E 02 | 3.9137E 02 | 7.8487E 01 | 4.9864E 00 |
| 2 | 7.0780E 01 | 4.3636E 00 | 6.8311E 00 | 3.2362E 00 | 3.6449E 00 | 8.8786E-01 |
| 3 | 2.0294E 05 | 4.2589E 02 | 4.7674E 02 | 3.9460E 02 | 8.2132E 01 | 4.8045E 00 |
| 4 | 1.9286E 05 | 4.2696E 02 | 4.5171E 02 | 3.7091F 02 | 8.0799E 01 | 4.5906E 00 |
| 5 | 1.7584E 03 | 1.7626E 03 | 1.9130F 05 | 4.0902E 02 | 4.1103E 02 | 4.0295E 04 |

TOTAL IMPULSE = 9.4644E 05

TIME = 7.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0405E 05 | 4.3185E 02 | 4.7250E 02 | 3.9395E 02 | 7.8551E 01 | 5.0152E 00 |
| 2 | 7.0779E 01 | 4.3636E 00 | 6.9742E 00 | 3.2856E 00 | 3.6886E 00 | 8.9376E-01 |
| 3 | 2.0405E 05 | 4.2556E 02 | 4.7947E 02 | 3.9723E 02 | 8.2240E 01 | 4.8302E 00 |
| 4 | 1.9315E 05 | 4.2693E 02 | 4.5243E 02 | 3.7160E 02 | 8.0836E 01 | 4.5969E 00 |
| 5 | 1.7981E 03 | 1.8023E 03 | 1.9126F 05 | 4.1724E 02 | 4.1930E 02 | 4.0287E 04 |

TOTAL IMPULSE = 9.6685E 05

TIME = 7.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0539F 05 | 4.3157E 02 | 4.7590E 02 | 3.9695E 02 | 7.8955E 01 | 5.0275E 00 |
| 2 | 7.0778E 01 | 4.3631E 00 | 6.8995E 00 | 3.2594E 00 | 3.6401E 00 | 8.9540E-01 |
| 3 | 2.0539E 05 | 4.2540E 02 | 4.8240F 02 | 4.0021F 02 | 8.2595E 01 | 4.8454E 00 |
| 4 | 1.9346E 05 | 4.2688E 02 | 4.5320E 02 | 3.7232E 02 | 8.0881E 01 | 4.6033E 00 |
| 5 | 1.8382E 03 | 1.8424F 03 | 1.9122E 05 | 4.2550E 02 | 4.2761E 02 | 4.0278E 04 |

TOTAL IMPULSE = 9.8739E 05

TIME = 7.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0719F 05 | 4.3107F 02 | 4.8065F 02 | 4.0089F 02 | 7.9758E 01 | 5.0263E 00 |
| 2 | 7.0779E 01 | 4.3627E 00 | 6.7754E 00 | 3.2104F 00 | 3.5654E 00 | 9.0044E-01 |
| 3 | 2.0719E 05 | 4.2508E 02 | 4.8742E 02 | 4.0410E 02 | 8.3324E 01 | 4.8498E 00 |
| 4 | 1.9380E 05 | 4.2684E 02 | 4.5404E 02 | 3.7310F 02 | 8.0941E 01 | 4.6095E 00 |
| 5 | 1.8786E 03 | 1.8829E 03 | 1.9114E 05 | 4.3383E 02 | 4.3599E 02 | 4.0270E 04 |

TOTAL IMPULSE = 1.0081E 06

TIME = 7.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0902E 05 | 4.3054E 02 | 4.9548E 02 | 4.0485E 02 | 8.0629E 01 | 5.0211E 00 |
| 2 | 7.0780E 01 | 4.3630E 00 | 6.6125E 00 | 3.1423E 00 | 3.4702E 00 | 9.0550E-01 |
| 3 | 2.0902E 05 | 4.2475E 02 | 4.9209E 02 | 4.0799E 02 | 8.4099E 01 | 4.8513E 00 |
| 4 | 1.9417E 05 | 4.2678E 02 | 4.5496E 02 | 3.7394E 02 | 8.1017E 01 | 4.6156E 00 |
| 5 | 1.9194E 03 | 1.9237E 03 | 1.9114F 05 | 4.4224E 02 | 4.4444E 02 | 4.0262E 04 |

TOTAL IMPULSE = 1.0290E 06

TIME = 7.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1082E 05 | 4.3008E 02 | 4.9019F 02 | 4.0841F 02 | 8.1383E 01 | 5.0233E 00 |
| 2 | 7.0780E 01 | 4.3634E 00 | 6.7350E 00 | 3.2072F 00 | 3.5278F 00 | 9.0913E-01 |
| 3 | 2.1082E 05 | 4.2425E 02 | 4.9693E 02 | 4.1202F 02 | 8.4911E 01 | 4.8523E 00 |
| 4 | 1.9456E 05 | 4.2672E 02 | 4.5594E 02 | 3.7483E 02 | 8.1109E 01 | 4.6214E 00 |
| 5 | 1.9606E 03 | 1.9650E 03 | 1.9110F 05 | 4.5073E 02 | 4.5298E 02 | 4.0253E 04 |

TOTAL IMPULSE = 1.0501E 06

28 September 1966

# TABLE AP 3-1 (Sheet 4 of 12)
## COMPUTER PROGRAM F823 (1ST BURN)

TIME = 8.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1327E 05 | 4.2959E 02 | 4.9445F 02 | 4.1427F 07 | 8.2182F 01 | 5.0409E 00 |
| 2 | 7.0779E 01 | 4.3635E 00 | 6.7984E 00 | 3.2445E 00 | 3.5540E 00 | 9.1291E-01 |
| 3 | 2.1327E 05 | 4.2379E 02 | 5.9325E 02 | 4.1752E 02 | 8.5736F 01 | 4.8698E 00 |
| 4 | 1.9499E 05 | 4.2664E 02 | 4.5703E 02 | 3.7581E 02 | 8.1214E 01 | 4.6274E 00 |
| 5 | 2.0023E 03 | 2.0069E 03 | 1.9106E 05 | 4.5931E 02 | 4.6160E 02 | 4.0244E 04 |

TOTAL IMPULSE = 1.0714E 06

TIME = 8.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1553E 05 | 4.2927E 02 | 5.0209E 02 | 4.1939E 02 | 8.2694E 01 | 5.0716E 00 |
| 2 | 7.0778E 01 | 4.3635E 00 | 6.7898E 00 | 3.2687E 00 | 3.5411E 00 | 9.1742E-01 |
| 3 | 2.1553E 05 | 4.2354E 02 | 5.0888E 02 | 4.2264E 02 | 8.6235E 01 | 4.9010E 00 |
| 4 | 1.9545E 05 | 4.2657E 02 | 4.5819E 02 | 3.7686E 02 | 8.1327F 01 | 4.6339E 00 |
| 5 | 2.0446E 03 | 2.0491E 03 | 1.9101E 05 | 4.6793E 02 | 4.7027E 02 | 4.0236E 04 |

TOTAL IMPULSE = 1.0930E 06

TIME = 8.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1715F 05 | 4.2914E 02 | 5.0601F 02 | 4.2316E 02 | 8.2858E 01 | 5.1070E 00 |
| 2 | 7.0777E 01 | 4.3631E 00 | 6.7930E 00 | 3.2597E 00 | 3.5333E 00 | 9.2256E-01 |
| 3 | 2.1715E 05 | 4.2346E 02 | 5.1281E 02 | 4.2642E 02 | 8.6391F 01 | 4.9359E 00 |
| 4 | 1.9592E 05 | 4.2649E 02 | 4.5939E 02 | 3.7795E 02 | 8.1438E 01 | 4.6409E 00 |
| 5 | 2.0872E 03 | 2.0918E 03 | 1.9097E 05 | 4.7657E 02 | 4.7895E 02 | 4.0227E 04 |

TOTAL IMPULSE = 1.1147E 06

TIME = 8.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1849E 05 | 4.2905E 02 | 5.0924E 02 | 4.2627E 02 | 8.2968E 01 | 5.1378E 00 |
| 2 | 7.0776E 01 | 4.3630E 00 | 7.0639E 00 | 3.3985E 00 | 3.6654E 00 | 9.2717E-01 |
| 3 | 2.1849E 05 | 4.2318E 02 | 5.1630E 02 | 4.2967E 02 | 8.6633E 01 | 4.9596E 00 |
| 4 | 1.9641E 05 | 4.2641E 02 | 4.6061E 02 | 3.7906E 02 | 8.1550E 01 | 4.6482E 00 |
| 5 | 2.1302E 03 | 2.1348E 03 | 1.9093E 05 | 4.8523E 02 | 4.8767E 02 | 4.0218E 04 |

TOTAL IMPULSE = 1.1365E 06

TIME = 8.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2038E 05 | 4.2880E 02 | 5.1395E 02 | 4.3057E 02 | 8.3372F 01 | 5.1645E 00 |
| 2 | 7.0777E 01 | 4.3628E 00 | 7.2828E 00 | 3.5103E 00 | 3.7725E 00 | 9.3048E-01 |
| 3 | 2.2038E 05 | 4.2281E 02 | 5.2123E 02 | 4.3408F 02 | 8.7145E 01 | 4.9812E 00 |
| 4 | 1.9691E 05 | 4.2633E 02 | 4.6188E 02 | 3.8021F 02 | 8.1667E 01 | 4.6557E 00 |
| 5 | 2.1736E 03 | 2.1783E 03 | 1.9048E 05 | 4.9395E 02 | 4.9643E 02 | 4.0210E 04 |

TOTAL IMPULSE = 1.1586E 06

TIME = 8.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2176E 05 | 4.2867E 02 | 5.1733E 02 | 4.3375E 02 | 8.3575E 01 | 5.1900E 00 |
| 2 | 7.0778E 01 | 4.3627E 00 | 7.2036E 00 | 3.4787E 00 | 3.7249E 00 | 9.3389E-01 |
| 3 | 2.2176E 05 | 4.2278E 02 | 5.2453E 02 | 4.3723E 02 | 8.7299E 01 | 5.0084E 00 |
| 4 | 1.9742E 05 | 4.2624E 02 | 4.6317E 02 | 3.8139E 02 | 8.1783E 01 | 4.6634E 00 |
| 5 | 2.2173E 03 | 2.2221E 03 | 1.9034E 05 | 5.0268E 02 | 5.0520E 02 | 4.0201E 04 |

TOTAL IMPULSE = 1.1807E 06

TIME = 8.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2277E 05 | 4.2859E 02 | 5.1977E 02 | 4.3608E 02 | 8.3683E 01 | 5.2111E 00 |
| 2 | 7.0778E 01 | 4.3626E 00 | 7.1014E 00 | 3.4365E 00 | 3.6651E 00 | 9.3762E-01 |
| 3 | 2.2277E 05 | 4.2282E 02 | 5.2647E 02 | 4.3952F 02 | 8.7348E 01 | 5.0318E 00 |
| 4 | 1.9793E 05 | 4.2616E 02 | 4.6445F 02 | 3.8256E 02 | 8.1895E 01 | 4.6713E 00 |
| 5 | 2.2613E 03 | 2.2661E 03 | 1.9080F 05 | 5.1141F 02 | 5.1399E 02 | 4.0192E 04 |

TOTAL IMPULSE = 1.2030E 06

TIME = 8.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2330F 05 | 4.2861E 02 | 5.2099E 02 | 4.3736E 02 | 8.3627E 01 | 5.2300E 00 |
| 2 | 7.0778E 01 | 4.3632E 00 | 7.1882E 00 | 3.4854E 00 | 3.7028F 00 | 9.4130E-01 |
| 3 | 2.2330E 05 | 4.2278E 02 | 5.2818F 02 | 4.4085F 02 | 8.7330E 01 | 5.0481E 00 |
| 4 | 1.9843E 05 | 4.2609E 02 | 4.6571E 02 | 3.8371E 02 | 8.2003F 01 | 4.6793E 00 |
| 5 | 2.3054E 03 | 2.3102E 03 | 1.9075E 05 | 5.2015E 02 | 5.2277E 02 | 4.0183E 04 |

TOTAL IMPULSE = 1.2254E 06

TIME = 8.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2379E 05 | 4.2863E 02 | 5.2211E 02 | 4.3854E 02 | 8.3570E 01 | 5.2476E 00 |
| 2 | 7.0778E 01 | 4.3636E 00 | 7.2955E 00 | 3.5436E 00 | 3.7518E 00 | 9.4450E-01 |
| 3 | 2.2379E 05 | 4.2272F 02 | 5.2941E 02 | 4.4209E 02 | 8.7322E 01 | 5.0627E 00 |
| 4 | 1.9893E 05 | 4.2601E 02 | 4.6695E 02 | 3.8484E 02 | 8.2106E 01 | 4.6872E 00 |
| 5 | 2.3496E 03 | 2.3545E 03 | 1.9071E 05 | 5.2888E 02 | 5.3155E 02 | 4.0174E 04 |

TOTAL IMPULSE = 1.2477E 06

TIME = 8.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2387E 05 | 4.2870E 02 | 5.2220F 02 | 4.3878E 02 | 8.3425E 01 | 5.2535E 00 |
| 2 | 7.0778E 01 | 4.3637E 00 | 7.0769E 00 | 3.4428E 00 | 3.6340E 00 | 9.4738E-01 |
| 3 | 2.2387E 05 | 4.2297E 02 | 5.2928F 02 | 4.4222E 02 | 8.7059E 01 | 5.0795E 00 |
| 4 | 1.9940E 05 | 4.2595E 02 | 4.6813F 02 | 3.8593E 02 | 8.2200E 01 | 4.6951E 00 |
| 5 | 2.3938E 03 | 2.3988E 03 | 1.9066E 05 | 5.3758E 02 | 5.4030F 02 | 4.0166E 04 |

TOTAL IMPULSE = 1.2701E 06

TIME = 9.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2354E 05 | 4.2877E 02 | 5.2134E 02 | 4.3805E 02 | 8.3282F 01 | 5.2599E 00 |
| 2 | 7.0778E 01 | 4.3636E 00 | 6.9518F 00 | 3.3879E 00 | 3.5639E 00 | 9.5060E-01 |
| 3 | 2.2354E 05 | 4.2313E 02 | 5.2829E 02 | 4.4144E 02 | 8.6946E 01 | 5.0830F 00 |
| 4 | 1.9985E 05 | 4.2589E 02 | 4.6925E 02 | 3.8697E 02 | 8.2286E 01 | 4.7027E 00 |
| 5 | 2.4379E 03 | 2.4430E 03 | 1.9062E 05 | 5.4627E 02 | 5.4904E 02 | 4.0157E 04 |

TOTAL IMPULSE = 1.2925E 06

TIME = 9.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2370E 05 | 4.2873E 02 | 5.2177E 02 | 4.3840E 02 | 8.3363E 01 | 5.2589E 00 |
| 2 | 7.0778E 01 | 4.3637E 00 | 7.0012E 00 | 3.4170E 00 | 3.5542E 00 | 9.5336E-01 |
| 3 | 2.2370E 05 | 4.2305E 02 | 5.2877F 02 | 4.4182E 02 | 8.6944E 01 | 5.0814E 00 |
| 4 | 2.0029F 05 | 4.2583E 02 | 4.7034E 02 | 3.8797E 02 | 8.2372E 01 | 4.7100E 00 |
| 5 | 2.4821E 03 | 2.4872E 03 | 1.9058F 05 | 5.5496E 02 | 5.5778E 02 | 4.0148E 04 |

TOTAL IMPULSE = 1.3148E 06

TIME = 9.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2375E 05 | 4.2876E 02 | 5.2186E 02 | 4.3855E 02 | 8.3306E 01 | 5.2644E 00 |
| 2 | 7.0778E 01 | 4.3636E 00 | 7.0741F 00 | 3.4575E 00 | 3.6167E 00 | 9.5590E-01 |
| 3 | 2.2375E 05 | 4.2302E 02 | 5.2893E 02 | 4.4201E 02 | 8.6923E 01 | 5.0351E 00 |
| 4 | 2.0071E 05 | 4.2577F 02 | 4.7140F 02 | 3.8894E 02 | 8.2454E 01 | 4.7171E 00 |
| 5 | 2.5263E 03 | 2.5315E 03 | 1.9053E 05 | 5.6366E 02 | 5.6652E 02 | 4.0139E 04 |

TOTAL IMPULSE = 1.3372E 06

TIME = 9.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2348E 05 | 4.2891F 02 | 5.2103E 02 | 4.3802E 02 | 8.3011E 01 | 5.2766E 00 |
| 2 | 7.0778E 01 | 4.3636E 00 | 7.0423E 00 | 3.4468E 00 | 3.5955E 00 | 9.5865E-01 |
| 3 | 2.2348E 05 | 4.2319E 02 | 5.2907E 02 | 4.4146E 02 | 8.6607E 01 | 5.0973E 00 |
| 4 | 2.0111E 05 | 4.2572E 02 | 4.7240F 02 | 3.8987E 02 | 8.2527E 01 | 4.7242E 00 |
| 5 | 2.5705E 03 | 2.5757E 03 | 1.9049E 05 | 5.7232E 02 | 5.7523E 02 | 4.0131E 04 |

TOTAL IMPULSE = 1.3596E 06

TIME = 9.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2336E 05 | 4.2902E 02 | 5.2063E 02 | 4.3783E 02 | 8.2793E 01 | 5.2883E 00 |
| 2 | 7.0777E 01 | 4.3638E 00 | 7.0318E 00 | 3.4470E 00 | 3.5848E 00 | 9.6156E-01 |
| 3 | 2.2336E 05 | 4.2331E 02 | 5.2766E 02 | 4.4128E 02 | 8.6378E 01 | 5.1087E 00 |
| 4 | 2.0150E 05 | 4.2568E 02 | 4.7336E 02 | 3.9076E 02 | 8.2594E 01 | 4.7312E 00 |
| 5 | 2.6146E 03 | 2.6199E 03 | 1.9044F 05 | 5.8095E 02 | 5.8392E 02 | 4.0122E 04 |

TOTAL IMPULSE = 1.3819E 06

TIME = 9.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2394E 05 | 4.2896E 02 | 5.2207E 02 | 4.3916E 02 | 8.2902E 01 | 5.2974E 00 |
| 2 | 7.0774E 01 | 4.3636E 00 | 7.0359E 00 | 3.4508E 00 | 3.5851E 00 | 9.6254E-01 |
| 3 | 2.2394E 05 | 4.2325E 02 | 5.2910F 02 | 4.4261E 02 | 8.6487E 01 | 5.1177E 00 |
| 4 | 2.0188E 05 | 4.2563E 02 | 4.7431E 02 | 3.9165E 02 | 8.2660E 01 | 4.7381E 00 |
| 5 | 2.6589E 03 | 2.6642E 03 | 1.9040E 05 | 5.8960E 02 | 5.9261E 02 | 4.0113E 04 |

TOTAL IMPULSE = 1.4043E 06

TIME = 9.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2473E 05 | 4.2879E 02 | 5.2409E 02 | 4.4089E 02 | 8.3192E 01 | 5.2997E 00 |
| 2 | 7.0771E 01 | 4.3636E 00 | 7.1071E 00 | 3.4861E 00 | 3.6209E 00 | 9.6278E-01 |
| 3 | 2.2473F 05 | 4.2306E 02 | 5.3119E 02 | 4.4438E 02 | 8.6812E 01 | 5.1188E 00 |
| 4 | 2.0226E 05 | 4.2558E 02 | 4.7526E 02 | 3.9253E 02 | 8.2730E 01 | 4.7448E 00 |
| 5 | 2.7033E 03 | 2.7087E 03 | 1.9035E 05 | 5.9828E 02 | 6.0134E 02 | 4.0105E 04 |

TOTAL IMPULSE = 1.4268E 06

TIME = 9.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2469E 05 | 4.2881E 02 | 5.2399E 02 | 4.4082E 02 | 8.3169E 01 | 5.3003E 00 |
| 2 | 7.0769E 01 | 4.3635E 00 | 7.0789E 00 | 3.4736E 00 | 3.6053E 00 | 9.6347E-01 |
| 3 | 2.2469E 05 | 4.2309E 02 | 5.3106E 02 | 4.4429E 02 | 8.6774E 01 | 5.1201E 00 |
| 4 | 2.0263E 05 | 4.2554E 02 | 4.7619E 02 | 3.9339E 02 | 8.2797E 01 | 4.7513E 00 |
| 5 | 2.7477E 03 | 2.7532E 03 | 1.9031E 05 | 6.0696E 02 | 6.1007E 02 | 4.0096E 04 |

TOTAL IMPULSE = 1.4492E 06

TIME = 9.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2509E 05 | 4.2878E 02 | 5.2495E 02 | 4.4175E 02 | 8.3203E 01 | 5.3092E 00 |
| 2 | 7.0769E 01 | 4.3628E 00 | 6.9614E 00 | 3.4185E 00 | 3.5430E 00 | 9.6486E-01 |
| 3 | 2.2509E 05 | 4.2317E 02 | 5.3191E 02 | 4.4516E 02 | 8.6746E 01 | 5.1318E 00 |
| 4 | 2.0300E 05 | 4.2549E 02 | 4.7709E 02 | 3.9423E 02 | 8.2861E 01 | 4.7577E 00 |
| 5 | 2.7922E 03 | 2.7977E 03 | 1.9027E 05 | 6.1564E 02 | 6.1879E 02 | 4.0087E 04 |

TOTAL IMPULSE = 1.4717E 06

TIME = 9.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2539E 05 | 4.2890E 02 | 5.2550E 02 | 4.4254E 02 | 8.2953E 01 | 5.3349E 00 |
| 2 | 7.0769E 01 | 4.3622E 00 | 6.9554E 00 | 3.4167E 00 | 3.5387E 00 | 9.6550E-01 |
| 3 | 2.2539E 05 | 4.2330E 02 | 5.3245E 02 | 4.4596E 02 | 8.6491E 01 | 5.1561E 00 |
| 4 | 2.0336E 05 | 4.2545E 02 | 4.7797E 02 | 3.9504E 02 | 8.2919E 01 | 4.7644E 00 |
| 5 | 2.8368E 03 | 2.8424E 03 | 1.9022E 05 | 6.2429E 02 | 6.2749E 02 | 4.0079E 04 |

TOTAL IMPULSE = 1.4943E 06

TIME = 10.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2558E 05 | 4.2905E 02 | 5.2577E 02 | 4.4313E 02 | 8.2640E 01 | 5.3622E 00 |
| 2 | 7.0768E 01 | 4.3622E 00 | 7.1966F 00 | 3.5388E 00 | 3.6578E 00 | 9.6744E-01 |
| 3 | 2.2558E 05 | 4.2326E 02 | 5.3297E 02 | 4.4667E 02 | 8.6297E 01 | 5.1760E 00 |
| 4 | 2.0371E 05 | 4.2542E 02 | 4.7886E 02 | 3.9587E 02 | 8.2972E 01 | 4.7711E 00 |
| 5 | 2.8815E 03 | 2.8871E 03 | 1.9018E 05 | 6.3292E 02 | 6.3617E 02 | 4.0070E 04 |

TOTAL IMPULSE = 1.5168E 06

TIME = 20.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2863E 05 | 4.2960E 02 | 5.3220F 02 | 4.5080E 02 | 8.1403E 01 | 5.5379E 00 |
| 2 | 7.0774E 01 | 4.3609E 00 | 7.2462E 00 | 3.6135E 00 | 3.6327E 00 | 9.9470E-01 |
| 3 | 2.2863E 05 | 4.2383F 02 | 5.3945F 02 | 4.5441E 02 | 8.5036E 01 | 5.3438E 00 |
| 4 | 2.1849E 05 | 4.2424F 02 | 5.1500E 02 | 4.3038E 02 | 8.4627E 01 | 5.0856E 00 |
| 5 | 7.4048E 03 | 7.4160E 03 | 1.8565E 05 | 1.4897E 03 | 1.4979E 03 | 3.9208E 04 |

TOTAL IMPULSE = 3.7957E 06

TIME = 30.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3001E 05 | 4.2961E 02 | 5.3545E 02 | 4.5404F 02 | 8.1324E 01 | 5.5836E 00 |
| 2 | 7.0766E 01 | 4.3612E 00 | 7.1663E 00 | 3.4900E 00 | 3.5763F 00 | 1.0038E 00 |
| 3 | 2.3001E 05 | 4.2393E 02 | 6.4257E 02 | 4.5767E 02 | 8.4900E 01 | 5.3907E 00 |
| 4 | 2.2266E 05 | 4.2416E 02 | 5.2494E 02 | 4.4030E 02 | 8.4641E 01 | 5.2020E 00 |
| 5 | 1.1970E 04 | 1.1987E 04 | 1.8108E 05 | 2.3363E 03 | 2.3495E 03 | 3.8357E 04 |

TOTAL IMPULSE = 6.0906E 06

TIME = 40.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2972E 05 | 4.2939E 02 | 5.3500F 02 | 4.5323E 02 | 8.1775E 01 | 5.5423E 00 |
| 2 | 7.0767E 01 | 4.3604F 00 | 7.0627E 00 | 3.5411E 00 | 3.5216E 00 | 1.0055E 00 |
| 3 | 2.2972E 05 | 4.2379E 02 | 5.4206E 02 | 4.5677E 02 | 8.5297E 01 | 5.3550E 00 |
| 4 | 2.2463E 05 | 4.2413E 02 | 5.2963E 02 | 4.4498E 02 | 8.4643E 01 | 5.2572E 00 |
| 5 | 1.6543F 04 | 1.6566E 04 | 1.7650F 05 | 3.1928E 03 | 3.2010E 03 | 3.7505E 04 |

TOTAL IMPULSE = 8.3889E 06

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# TABLE AP 3-1 (Sheet 5 of 12)
## COMPUTER PROGRAM F823 (1ST BURN)

TIME = 50.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2955E 05 | 4.2969E 02 | 5.3422E 02 | 4.5305E 02 | 8.1169E 01 | 5.5915E 00 |
| 2 | 7.0782E 01 | 4.3584E 00 | 7.0439E 00 | 3.5317E 00 | 3.5122E 00 | 1.0055E 00 |
| 3 | 2.2955E 05 | 4.2410E 02 | 5.4126E 02 | 4.5658E 02 | 8.4682E 01 | 5.3917E 00 |
| 4 | 2.2579E 05 | 4.2407F 02 | 5.3244E 02 | 4.4770E 02 | 8.4735E 01 | 5.2836E 00 |
| 5 | 2.1119E 04 | 2.1147E 04 | 1.7192E 05 | 4.0335E 03 | 4.0567E 03 | 3.6649E 04 |

TOTAL IMPULSE = 1.0689E 07

TIME = 60.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3098E 05 | 4.2928E 02 | 5.3806E 02 | 4.5611E 02 | 8.1948E 01 | 5.5659E 00 |
| 2 | 7.0761E 01 | 4.3567E 00 | 7.2098E 00 | 3.6149E 00 | 3.5949E 00 | 1.0056E 00 |
| 3 | 2.3098E 05 | 4.2360E 02 | 5.4527E 02 | 4.5973E 02 | 8.5543E 01 | 5.3742E 00 |
| 4 | 2.2655E 05 | 4.2404E 02 | 5.3427E 02 | 4.4949E 02 | 8.4773E 01 | 5.3023E 00 |
| 5 | 2.5697E 04 | 2.5731E 04 | 1.6733E 05 | 4.8830E 03 | 4.9112E 03 | 3.5795E 04 |

TOTAL IMPULSE = 1.2990E 07

TIME = 70.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3066E 05 | 4.2941F 02 | 5.3716E 02 | 4.5546E 02 | 8.1696E 01 | 5.5751E 00 |
| 2 | 7.0756E 01 | 4.3568F 00 | 7.1883F 00 | 3.6041E 00 | 3.5842E 00 | 1.0055E 00 |
| 3 | 2.3066E 05 | 4.2374E 02 | 5.4434F 02 | 4.5904F 02 | 8.5280E 01 | 5.3830E 00 |
| 4 | 2.2714E 05 | 4.24CCE 02 | 5.3570F 02 | 4.5088E 02 | 8.4815E 01 | 5.3161E 00 |
| 5 | 3.C284E 04 | 3.0324E 04 | 1.6274F 05 | 5.7335E 03 | 5.7668F 03 | 3.4939E 04 |

TOTAL IMPULSE = 1.5294E 07

TIME = 80.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3157E 05 | 4.2992F 02 | 5.3864E 02 | 4.5801E 02 | 8.0629E 01 | 5.6805E 00 |
| 2 | 7.C755E 01 | 4.3564E 00 | 7.0118F 00 | 3.5216E 00 | 3.4902E 00 | 1.0090E 00 |
| 3 | 2.3157E 05 | 4.2439E 02 | 5.4565E 02 | 4.6153F 02 | 8.4119E 01 | 5.4967E 00 |
| 4 | 2.2766E 05 | 4.2399E 02 | 5.3694E 02 | 4.5211E 02 | 8.4827E C1 | 5.3298E C0 |
| 5 | 3.4887E 04 | 3.4932E 04 | 1.5813E 05 | 6.5826E 03 | 6.6210E 03 | 3.4085E C4 |

TOTAL IMPULSE = 1.7605E 07

TIME = 90.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3157E 05 | 4.2914E 02 | 5.3960E 02 | 4.5740E 02 | 8.2205E 01 | 5.5641E 00 |
| 2 | 7.C753E C1 | 4.3559E 00 | 7.4080F C0 | 3.7225E 00 | 3.6855E 00 | 1.0100E 00 |
| 3 | 2.3157E 05 | 4.2333E 02 | 5.4701E 02 | 4.6112E 02 | 8.5890F 01 | 5.3687E 00 |
| 4 | 2.2804E C5 | 4.2396E 02 | 5.3788E 02 | 4.5301E 02 | 8.4867E 01 | 5.3379E 00 |
| 5 | 3.9486E 04 | 3.9536E 04 | 1.5353F 05 | 7.4343F 03 | 7.4777F 03 | 3.3228E 04 |

TOTAL IMPULSE = 1.9915E 07

TIME = 100.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3044E 05 | 4.2983E 02 | 5.3612F 02 | 4.5527E 02 | 8.0851E 01 | 5.6309E 00 |
| 2 | 7.0746E 01 | 4.3541E 00 | 7.2361E 00 | 3.6246E 00 | 3.6115E 00 | 1.0036E 00 |
| 3 | 2.3044F C5 | 4.2411E 02 | 5.4335E 02 | 4.5889E 02 | 8.4463F 01 | 5.4331E 00 |
| 4 | 2.2828E 05 | 4.2395E 02 | 5.3845E 02 | 4.5357E 02 | 8.4882E 01 | 5.3435E 00 |
| 5 | 4.4070E C4 | 4.4126E 04 | 1.4894E 05 | 8.2845E 03 | 8.3330E 03 | 3.2373E 04 |

TOTAL IMPULSE = 2.2218E 07

TIME = 110.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3167E C5 | 4.2944E 02 | 5.3948E 02 | 4.5790E 02 | 8.1579E 01 | 5.6129E 00 |
| 2 | 7.0747E C1 | 4.353CE 00 | 7.1039E 00 | 3.5675E 00 | 3.5364E 00 | 1.0048E 00 |
| 3 | 2.3167E 05 | 4.2386E 02 | 5.4658E 02 | 4.6146E 02 | 8.5116E 01 | 5.4216E 00 |
| 4 | 2.2852E C5 | 4.2393E C2 | 5.3905E 02 | 4.5413E 02 | 8.4920F 01 | 5.3477E 00 |
| 5 | 4.8665E C4 | 4.8727E 04 | 1.4434E 05 | 9.1373E C3 | 9.1909E 03 | 3.1515E 04 |

TOTAL IMPULSE = 2.4526E 07

TIME = 120.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2950E C5 | 4.2950E 02 | 5.3433E 02 | 4.5277F 02 | 8.1554E 01 | 5.5518E 00 |
| 2 | 7.0738E 01 | 4.3525E 00 | 7.0863E 00 | 3.5530E 00 | 3.5333E 00 | 1.0056E 00 |
| 3 | 2.2950F 05 | 4.2388E 02 | 5.4142F 02 | 4.5633F 02 | 8.5087E 01 | 5.3631E 00 |
| 4 | 2.2869E C5 | 4.2391E 02 | 5.3948E 02 | 4.5453F 02 | 8.4956E 01 | 5.3501E 00 |
| 5 | 5.3252E C4 | 5.3320E 04 | 1.3974E 05 | 9.9907E 03 | 1.0049E 04 | 3.0657E 04 |

TOTAL IMPULSE = 2.6832F 07

TIME = 130.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2982E 05 | 4.2954E 02 | 5.3505E 02 | 4.5358E 02 | 8.1472E 01 | 5.5673E 00 |
| 2 | 7.0735E C1 | 4.3521E 00 | 7.1283E 00 | 3.5748E 00 | 3.5535F 00 | 1.0060E 00 |
| 3 | 2.2982E C5 | 4.2389E 02 | 5.4218E 02 | 4.5715F 02 | 8.5025E 01 | 5.3767E 00 |
| 4 | 2.2882E C5 | 4.2390E 02 | 5.3980E 02 | 4.5483E 02 | 8.4974E 01 | 5.3525E 00 |
| 5 | 5.7836E C4 | 5.79C8E 04 | 1.3515E 05 | 1.0843E 04 | 1.0906E 04 | 2.9800E 04 |

TOTAL IMPULSE = 2.9135E 07

TIME = 140.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3072E 05 | 4.2936E 02 | 5.3735E 02 | 4.5556F 02 | 8.1798E 01 | 5.5693E 00 |
| 2 | 7.0733E C1 | 4.3530E 00 | 7.0674E 00 | 3.5474E 00 | 3.5200E 00 | 1.0078E 00 |
| 3 | 2.3072E 05 | 4.2378E 02 | 5.4442E 02 | 4.5910E 02 | 8.5318E 01 | 5.3811E 00 |
| 4 | 2.2897E 05 | 4.2389E 02 | 5.4017E 02 | 4.5519E 02 | 8.4976E 01 | 5.3567E 00 |
| 5 | 6.2434E C4 | 6.2512E 04 | 1.3055E 05 | 1.1693E 04 | 1.1761E 04 | 2.8945E 04 |

TOTAL IMPULSE = 3.1444E 07

TIME = 150.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3156E 05 | 4.2907E 02 | 5.3968E 02 | 4.5732E 02 | 8.2357E 01 | 5.5529E 00 |
| 2 | 7.0727E 01 | 4.3514E 00 | 6.9662E 00 | 3.4849F 00 | 3.4813E 00 | 1.0010E 00 |
| 3 | 2.3156E 05 | 4.2360E 02 | 5.4665E 02 | 4.6081E 02 | 8.5838E 01 | 5.3683E 00 |
| 4 | 2.2907E 05 | 4.2389E 02 | 5.4074E C2 | 4.5541E 02 | 8.4987E 01 | 5.3586E 00 |
| 5 | 6.7018E 04 | 6.71C2E 04 | 1.2596E 05 | 1.2544E 04 | 1.2618E 04 | 2.8088E 04 |

TOTAL IMPULSE = 3.3748F 07

TIME = 151.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3082E 05 | 4.2935E 02 | 5.3760E 02 | 4.5580F 02 | 8.1803E 01 | 5.5719E 00 |
| 2 | 7.0727E 01 | 4.3507E 00 | 7.2466E 00 | 3.6275E 00 | 3.6190E 00 | 1.0024E 00 |
| 3 | 2.3082E 05 | 4.2364E 02 | 5.4485E 02 | 4.5942E 02 | 8.5422E 01 | 5.3783E C0 |
| 4 | 2.2908E C5 | 4.2388E 02 | 5.4042E 02 | 4.5543E 02 | 8.4989E 01 | 5.3588E 00 |
| 5 | 6.7477E C4 | 6.7561E 04 | 1.2550E 05 | 1.2629E 04 | 1.2704E 04 | 2.8002E 04 |

TOTAL IMPULSE = 3.3978E 07

TIME = 152.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3023E 05 | 4.2937E 02 | 5.3621E 02 | 4.5441E 02 | 8.1800E 01 | 5.5551E 00 |
| 2 | 7.0725E 01 | 4.3517E 00 | 7.2677E 00 | 3.6413E 00 | 3.6265E 00 | 1.0041E 00 |
| 3 | 2.3C23E 05 | 4.2362E 02 | 5.4347E 02 | 4.5805E 02 | 8.5427E 01 | 5.3619E 00 |
| 4 | 2.29C4E 05 | 4.2388E 02 | 5.4044F 02 | 4.5545E 02 | 8.4991E 01 | 5.3588E 00 |
| 5 | 6.7934E 04 | 6.8C19E 04 | 1.2594F 05 | 1.2715E 04 | 1.2789E 04 | 2.7917E 04 |

TOTAL IMPULSE = 3.4208E 07

TIME = 153.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3015E 05 | 4.2975F 02 | 5.3555E 02 | 4.5453E 02 | 8.1018E 01 | 5.6102E 00 |
| 2 | 7.0723E 01 | 4.3513E 00 | 7.1918E 00 | 3.6032E 00 | 3.5887E 00 | 1.0040E 00 |
| 3 | 2.3015E 05 | 4.24C6E 02 | 5.4274E 02 | 4.5813E 02 | 8.4607E 01 | 5.4149E 00 |
| 4 | 2.2909E 05 | 4.2388E 02 | 5.4045E 02 | 4.5546E 02 | 8.4990E 01 | 5.3590E 00 |
| 5 | 6.8392E 04 | 6.8478E 04 | 1.2459E 05 | 1.2799E 04 | 1.2875E 04 | 2.7831E 04 |

TOTAL IMPULSE = 3.4438E 07

TIME = 153.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3018E 05 | 4.2974E 02 | 5.3562E 02 | 4.5458E 02 | 8.1041E 01 | 5.6092E 00 |
| 2 | 7.0721E C1 | 4.3510E 00 | 7.3511E 00 | 3.6835E 00 | 3.6675E 00 | 1.0044E 00 |
| 3 | 2.3018E 05 | 4.2392E 02 | 5.4297E 02 | 4.5826E 02 | 8.4709E 01 | 5.4098E 00 |
| 4 | 2.2909E 05 | 4.2388E 02 | 5.4045E 02 | 4.5547E 02 | 8.4989E 01 | 5.3591E 00 |
| 5 | 6.8438E 04 | 6.8523E 04 | 1.2454E 05 | 1.2808E 04 | 1.2883E 04 | 2.7823E 04 |

TOTAL IMPULSE = 3.4461E 07

TIME = 153.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2928E 05 | 4.2983E 02 | 5.3341E 02 | 4.5250F 02 | 8.0906E 01 | 5.5930E 00 |
| 2 | 7.0721E C1 | 4.3508E 00 | 7.4247E 00 | 3.7187E 00 | 3.7060E 00 | 1.0034E 00 |
| 3 | 2.2928E 05 | 4.2393E 02 | 5.4084E 02 | 4.5622E 02 | 8.4612E 01 | 5.3919E 00 |
| 4 | 2.2909E C5 | 4.2388E 02 | 5.4046E 02 | 4.5547E 02 | 8.4989E 01 | 5.3591E 00 |
| 5 | 6.8483E C4 | 6.8569E 04 | 1.2449E 05 | 1.2816E 04 | 1.2892E 04 | 2.7814E 04 |

TOTAL IMPULSE = 3.4484E 07

TIME = 153.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2952E C5 | 4.3010E 02 | 5.3363E 02 | 4.5329E 02 | 8.0344E 01 | 5.6418E 00 |
| 2 | 7.C721E C1 | 4.3512E 00 | 7.7726E 00 | 3.8951E 00 | 3.8775E 00 | 1.0045E 00 |
| 3 | 2.2952E 05 | 4.2393E 02 | 5.4140E 02 | 4.5718E 02 | 8.4221E 01 | 5.4283E 00 |
| 4 | 2.2909E 05 | 4.2388E 02 | 5.4046E 02 | 4.5547E 02 | 8.4989E 01 | 5.3591E 00 |
| 5 | 6.8529E C4 | 6.8615E 04 | 1.2445E 05 | 1.2825F 04 | 1.2900E 04 | 2.7806E 04 |

TOTAL IMPULSE = 3.4507E 07

TIME = 153.3220

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3101E 05 | 4.2968E 02 | 5.3765E 02 | 4.5651E 02 | 8.1138E 01 | 5.6263E 00 |
| 2 | 7.0721E C1 | 4.3523E 00 | 7.1158E 00 | 3.5636E 00 | 3.5522E 00 | 1.0032E 00 |
| 3 | 2.31C1E C5 | 4.24C6E 02 | 5.4476E 02 | 4.6007F 02 | 8.4691E 01 | 5.4324E 00 |
| 4 | 2.2909E C5 | 4.2388E 02 | 5.4046E 02 | 4.5547E 02 | 8.4989E 01 | 5.3592E 00 |
| 5 | 6.8539E 04 | 6.8625E 04 | 1.2444F 05 | 1.2826E 04 | 1.2902E 04 | 2.7804E 04 |

TOTAL IMPULSE = 3.4512E 07

TIME = 153.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3632E 05 | 4.2819E 02 | 5.5189E 02 | 4.6791E 02 | 8.3986E 01 | 5.5713E 00 |
| 2 | 7.0719E C1 | 4.3560E 00 | 4.7873E 00 | 2.3918F 00 | 2.3955E 00 | 9.9845E-01 |
| 3 | 2.3632E 05 | 4.2451E 02 | 5.5668E 02 | 4.7030E 02 | 8.6381F 01 | 5.4445E 00 |
| 4 | 2.2909E C5 | 4.2388E 02 | 5.4046E 02 | 4.5548E 02 | 8.4989E 01 | 5.3592E 00 |
| 5 | 6.8576E C4 | 6.8662E 04 | 1.2440E 05 | 1.2833E 04 | 1.2909E 04 | 2.7797E 04 |

TOTAL IMPULSE = 3.4530E 07

TIME = 153.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.4800E 05 | 4.5605E 02 | 3.2452E 02 | 2.7201E 02 | 5.2514E 01 | 5.1798E 00 |
| 2 | 7.0739E C1 | 4.3472E 00 | 2.1824F 00 | 1.0813E 00 | 1.1011E 00 | 9.8193E-01 |
| 3 | 1.48C0F 05 | 4.53C1E 02 | 3.2671E 02 | 2.7309E 02 | 5.3615E 01 | 5.0936E 00 |
| 4 | 2.29C4E C5 | 4.2390E 02 | 5.4032E 02 | 4.5535E 02 | 8.4968E 01 | 5.3591E 00 |
| 5 | 6.8603E 04 | 6.8689E 04 | 1.2437E 05 | 1.2839E 04 | 1.2914E 04 | 2.7792E 04 |

TOTAL IMPULSE = 3.4545E 07

TIME = 153.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 4.2617F C4 | 8.4967E 02 | 5.0157F 01 | 4.0669E 01 | 9.4884E 00 | 4.2862E 00 |
| 2 | 7.0744E 01 | 4.3112E 00 | 1.5623E 00 | 7.6784E-01 | 7.9443E-01 | 9.6653E-01 |
| 3 | 4.2617E 04 | 8.2400E 02 | 5.1720E 01 | 4.1437E 01 | 1.0283E 01 | 4.0297E 00 |
| 4 | 2.2892E C5 | 4.2392E 02 | 5.4000E 02 | 4.5508E 02 | 8.4919E 01 | 5.3590E 00 |
| 5 | 6.8607E 04 | 6.8693E 04 | 1.2437F 05 | 1.2840E 04 | 1.2915E 04 | 2.7791E 04 |

TOTAL IMPULSE = 3.4550E 07

TIME = 153.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.5551E C4 | 2.137CE 03 | 7.2773E 00 | 5.6738F 00 | 1.6036E 00 | 3.5382E 00 |
| 2 | 7.0732E 01 | 4.27C9E 00 | 1.4006E 00 | 6.8786F-01 | 7.1273E-01 | 9.6510E-01 |
| 3 | 1.5551E 04 | 1.7921F 03 | 8.6779E 00 | 6.3616F 00 | 2.3163E 00 | 2.7465E 00 |
| 4 | 2.2877E 05 | 4.2394E 02 | 5.3964F 02 | 4.5478E 02 | 8.4864E 01 | 5.3589E 00 |
| 5 | 6.8608F 04 | 6.8694E 04 | 1.2437F 05 | 1.2840E 04 | 1.2916F 04 | 2.7790E 04 |

TOTAL IMPULSE = 3.4551E 07

TIME = 153.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.6303E 04 | 2.1351F 03 | 7.6360F 00 | 5.9406E 00 | 1.6953E 00 | 3.5041E 00 |
| 2 | 7.0696E 01 | 4.2179E 00 | 1.3551E 00 | 6.6711E-01 | 6.8796E-01 | 9.6970E-01 |
| 3 | 1.6303E C4 | 1.8133E 03 | 8.9910F 00 | 6.6077F 00 | 2.3833E 00 | 2.7725E 00 |
| 4 | 2.2863E C5 | 4.2395E 02 | 5.3929F 02 | 4.5448E 02 | 8.4809E 01 | 5.3589E 00 |
| 5 | 6.8609F C4 | 6.8695E 04 | 1.2437E 05 | 1.2840E 04 | 1.2916E 04 | 2.7790E 04 |

TOTAL IMPULSE = 3.4553E 07

TIME = 153.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.3831E 04 | 2.1720E 03 | 6.3679E 00 | 5.1567E 00 | 1.2112E 00 | 4.2575E 00 |
| 2 | 7.0644E C1 | 4.1926F 00 | 1.3449E 00 | 6.6200F-01 | 6.8289E-01 | 9.6941E-01 |
| 3 | 1.3831E 04 | 1.7933E 03 | 7.712RE 00 | 5.8187F 00 | 1.8941E 00 | 3.0720E 00 |
| 4 | 2.2849E C5 | 4.2396E 02 | 5.3894F 02 | 4.5418E 02 | 8.4754E 01 | 5.3589E 00 |
| 5 | 6.8609E 04 | 6.8695F 04 | 1.2437E 05 | 1.2840E 04 | 1.2916F 04 | 2.7790E 04 |

TOTAL IMPULSE = 3.4554F 07

TABLE AP 3-1 (Sheet 6 of 12)
COMPUTER PROGRAM F823 (1ST BURN)

TIME = 154.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.1429E 04 | 2.2039E 03 | 5.1858E 00 | 4.3394E 00 | 8.4600E-01 | 5.1298E 00 |
| 2 | 7.0509E 01 | 4.1891E 00 | 1.3469E 00 | 6.6237E-01 | 6.8450E-01 | 9.6767E-01 |
| 3 | 1.1429E 04 | 1.7495E 03 | 6.5337E 00 | 5.0022E 00 | 1.5305E 00 | 3.2683E 00 |
| 4 | 2.2835E 05 | 4.2398E 02 | 5.3858E 02 | 4.5388E 02 | 8.4698E 01 | 5.3588E 00 |
| 5 | 6.8610E 04 | 6.8696E 04 | 1.2437E 05 | 1.2840E 04 | 1.2916E 04 | 2.7790E 04 |

TOTAL IMPULSE = 3.4555E 07

TIME = 154.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 8.2099E 03 | 2.2229E 03 | 3.6933E 00 | 3.1473E 00 | 5.4601E-01 | 5.7642E 00 |
| 2 | 7.0581E 01 | 4.1873E 00 | 1.3447E 00 | 6.6061E-01 | 6.8404E-01 | 9.6575E-01 |
| 3 | 8.2099E 03 | 1.6296E 03 | 5.0180E 00 | 3.8079E 00 | 1.2301E 00 | 3.0957E 00 |
| 4 | 2.2820E 05 | 4.2398E 02 | 5.3823E 02 | 4.5358E 02 | 8.4643E 01 | 5.3588E 00 |
| 5 | 6.8610E 04 | 6.8696E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4556E 07

TIME = 154.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 5.7121E 03 | 2.2363E 03 | 2.5563E 00 | 2.1998E 00 | 3.5450E-01 | 6.2054E 00 |
| 2 | 7.0561E 01 | 4.1822E 00 | 1.3403E 00 | 6.6786E-01 | 6.9247E-01 | 9.6446E-01 |
| 3 | 5.7121E 03 | 1.4592E 03 | 3.9146E 00 | 2.8677E 00 | 1.0470E 00 | 2.7390E 00 |
| 4 | 2.2805E 05 | 4.2399E 02 | 5.3787E 02 | 4.5328E 02 | 8.4587E 01 | 5.3588E 00 |
| 5 | 6.8610E 04 | 6.8697E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4557E 07

TIME = 154.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 5.0449E 03 | 2.2489E 03 | 2.2433E 00 | 1.9470E 00 | 2.9632E-01 | 6.5705E 00 |
| 2 | 7.0546E 01 | 4.1623E 00 | 1.3513E 00 | 6.6302E-01 | 6.8833E-01 | 9.6324E-01 |
| 3 | 5.0449E 03 | 1.4035E 03 | 3.5946E 00 | 2.6100E 00 | 9.8464E-01 | 2.6507E 00 |
| 4 | 2.2790E 05 | 4.2399E 02 | 5.3752E 02 | 4.5299E 02 | 8.4532E 01 | 5.3588E 00 |
| 5 | 6.8611E 04 | 6.8697E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4557E 07

TIME = 154.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.2883E 03 | 2.2612E 03 | 1.4543E 00 | 1.2695E 00 | 1.8474E-01 | 6.8719E 00 |
| 2 | 7.0533E 01 | 4.0502E 00 | 1.3572E 00 | 6.6535E-01 | 6.9190E-01 | 9.6163E-01 |
| 3 | 3.2883E 03 | 1.1696E 03 | 2.8115E 00 | 1.9349E 00 | 8.7664E-01 | 2.2071E 00 |
| 4 | 2.2775E 05 | 4.2399E 02 | 5.3716E 02 | 4.5269E 02 | 8.4476E 01 | 5.3587E 00 |
| 5 | 6.8611E 04 | 6.8697E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4557E 07

TIME = 154.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.6826E 02 | 2.2712E 03 | 1.6715E-01 | 1.4208E-01 | 2.0067E-02 | 7.0802E 00 |
| 2 | 7.0521E 01 | 3.9518E 00 | 1.3660E 00 | 6.6868E-01 | 6.9729E-01 | 9.5897E-01 |
| 3 | 3.6826E 02 | 2.4099E 02 | 1.5281E 00 | 8.1076E-01 | 7.1736E-01 | 1.1302E 00 |
| 4 | 2.2760E 05 | 4.2399E 02 | 5.3681E 02 | 4.5239E 02 | 8.4421E 01 | 5.3587E 00 |
| 5 | 6.8611E 04 | 6.8697E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4558E 07

TIME = 154.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 7.2305E 00 |
| 2 | 7.0508E 01 | 3.8955E 00 | 1.3588E 00 | 6.6416E-01 | 6.9465E-01 | 9.5611E-01 |
| 3 | 0. | 0. | 1.3588E 00 | 6.6416E-01 | 6.9465E-01 | 9.5611E-01 |
| 4 | 2.2745E 05 | 4.2399E 02 | 5.3645E 02 | 4.5209E 02 | 8.4365E 01 | 5.3587E 00 |
| 5 | 6.8611E 04 | 6.8698E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4558E 07

TIME = 154.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 7.3367E 00 |
| 2 | 7.0500E 01 | 3.8809E 00 | 1.3452E 00 | 6.5701E-01 | 6.8818E-01 | 9.5470E-01 |
| 3 | 0. | 0. | 1.3452E 00 | 6.5701E-01 | 6.8818E-01 | 9.5470E-01 |
| 4 | 2.2730E 05 | 4.2399E 02 | 5.3610E 02 | 4.5179E 02 | 8.4310E 01 | 5.3587E 00 |
| 5 | 6.8611E 04 | 6.8698E 04 | 1.2437E 05 | 1.2841E 04 | 1.2917E 04 | 2.7789E 04 |

TOTAL IMPULSE = 3.4558E 07

TIME = 154.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 7.4046E 00 |
| 2 | 7.0493E 01 | 3.8753E 00 | 1.3726E 00 | 6.7001E-01 | 7.0256E-01 | 9.5366E-01 |
| 3 | 0. | 0. | 1.3726E 00 | 6.7001E-01 | 7.0256E-01 | 9.5366E-01 |
| 4 | 2.2715E 05 | 4.2399E 02 | 5.3574E 02 | 4.5149E 02 | 8.4254E 01 | 5.3586E 00 |
| 5 | 6.8611E 04 | 6.8698E 04 | 1.2437E 05 | 1.2841E 04 | 1.2918E 04 | 2.7788E 04 |

TOTAL IMPULSE = 3.4558E 07

TIME = 154.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 7.4548E 00 |
| 2 | 7.0489E 01 | 3.8733E 00 | 1.3732E 00 | 6.7011E-01 | 7.0309E-01 | 9.5308E-01 |
| 3 | 0. | 0. | 1.3732E 00 | 6.7011E-01 | 7.0309E-01 | 9.5308E-01 |
| 4 | 2.2700E 05 | 4.2399E 02 | 5.3539E 02 | 4.5119E 02 | 8.4199E 01 | 5.3586E 00 |
| 5 | 6.8611E 04 | 6.8698E 04 | 1.2437E 05 | 1.2841E 04 | 1.2918E 04 | 2.7788E 04 |

TOTAL IMPULSE = 3.4558E 07

TIME = 155.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 7.4930E 00 |
| 2 | 7.0487E 01 | 3.8743E 00 | 1.3528E 00 | 6.5944E-01 | 6.9333E-01 | 9.5111E-01 |
| 3 | 0. | 0. | 1.3528E 00 | 6.5944E-01 | 6.9333E-01 | 9.5111E-01 |
| 4 | 2.2685E 05 | 4.2399E 02 | 5.3504E 02 | 4.5089E 02 | 8.4144E 01 | 5.3586E 00 |
| 5 | 6.8611E 04 | 6.8698E 04 | 1.2437E 05 | 1.2841E 04 | 1.2918E 04 | 2.7788E 04 |

TOTAL IMPULSE = 3.4558E 07

# TABLE AP 3-1 (Sheet 7 of 12)
## COMPUTER PROGRAM F823 (2ND BURN)

TIME

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | T/C THRUST | T/C ISP | T/C W DOT T | T/C W DOT O | T/C W DOT F | T/C MR |
| 2 | RHO LOX | RHO LH2 | G/G W DOT T | G/G W DOT O | G/G W DOT F | G/G MR |
| 3 | J-2 THRUST | J-2 ISP | J-2 W DOT T | J-2 W DOT O | J-2 W DOT F | J-2 MR |
| 4 | AVG. J2 F | AVG. J2 ISP | AVG. J2 DWT | AVG. J2 DWO | AVG. J2 DWF | AVG. J2 MR |
| 5 | LOX CONS. | LOX D/B | LOX IN TK | LH2 CONS. | LH2 D/B | LH2 IN TK |

TOTAL IMPULSE

TIME = 1.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 6.5037E 00 |
| 2 | 7.0626E 01 | 4.2850E 00 | 4.1687E 00 | 9.0850E-01 | 3.2602E 00 | 2.7867E-01 |
| 3 | 0. | 0. | 4.1687E 00 | 9.0850E-01 | 3.2602E 00 | 2.7867E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 4.9123E-01 | 5.8663E-01 | 1.2476E 05 | 1.6144E 00 | 1.6319E 00 | 2.4718E 04 |

TOTAL IMPULSE = 6.4746E 01

TIME = 1.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 8.9205E 02 | 2.2252E 03 | 4.0089E-01 | 3.4241E-01 | 5.8482E-02 | 5.8550E 00 |
| 2 | 7.0625E 01 | 4.2919E 00 | 3.0456E 00 | 6.2946E-01 | 2.4361E 00 | 2.5839E-01 |
| 3 | 8.9205E 02 | 2.5734E 02 | 3.4665E 00 | 9.7187E-01 | 2.4946E 00 | 3.8959E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 5.8841E-01 | 6.9335E-01 | 1.2476E 05 | 1.8638E 00 | 1.8831E 00 | 2.4718E 04 |

TOTAL IMPULSE = 1.5395E 02

TIME = 1.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.6072E 03 | 2.1827E 03 | 1.6526E 00 | 1.1538E 00 | 2.9885E-01 | 4.5300E 00 |
| 2 | 7.0606E 01 | 4.2978E 00 | 2.4824E 00 | 4.7391E-01 | 2.0085E 00 | 2.3596E-01 |
| 3 | 3.6072E 03 | 8.7235E 02 | 4.1350E 00 | 1.8277E 00 | 2.3073E 00 | 7.9212E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 7.7118E-01 | 8.8566E-01 | 1.2476E 05 | 2.0946E 00 | 2.1155E 00 | 2.4718E 04 |

TOTAL IMPULSE = 5.1467E 02

TIME = 1.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 5.7563E 03 | 2.1113E 03 | 2.7264E 00 | 2.0652E 00 | 6.6115E-01 | 3.1236E 00 |
| 2 | 7.0605E 01 | 4.2989E 00 | 2.5015E 00 | 4.4689E-01 | 2.0546E 00 | 2.1750E-01 |
| 3 | 5.7563E 03 | 1.1011E 03 | 5.2279E 00 | 2.5121E 00 | 2.7158E 00 | 9.2501E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.0224E 00 | 1.1444E 00 | 1.2476E 05 | 2.3661E 00 | 2.3889E 00 | 2.4718E 04 |

TOTAL IMPULSE = 1.0903E 03

TIME = 1.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 6.8644E 03 | 2.0454E 03 | 3.3561E 00 | 2.3172E 00 | 1.0389E 00 | 2.2306E 00 |
| 2 | 7.0592E 01 | 4.2956E 00 | 2.6641E 00 | 4.6668E-01 | 2.1974E 00 | 2.1238E-01 |
| 3 | 6.8644E 03 | 1.1402E 03 | 6.0202E 00 | 2.7839E 00 | 3.2362E 00 | 8.6023E-01 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.3008E 00 | 1.4343E 00 | 1.2476E 05 | 2.6898E 00 | 2.7143E 00 | 2.4717E 04 |

TOTAL IMPULSE = 1.7767E 03

TIME = 1.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.3429E 04 | 2.0315E 03 | 6.6106E 00 | 4.4394E 00 | 2.1713E 00 | 2.0446E 00 |
| 2 | 7.0598E 01 | 4.2986E 00 | 2.5170E 00 | 4.6442E-01 | 2.0525E 00 | 2.2626E-01 |
| 3 | 1.3429E 04 | 1.4713E 03 | 9.1277E 00 | 4.9038E 00 | 4.2239E 00 | 1.1610E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.7912E 00 | 1.9343E 00 | 1.2476E 05 | 3.1122E 00 | 3.1384E 00 | 2.4717E 04 |

TOTAL IMPULSE = 3.1197E 03

TIME = 1.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.3190E 04 | 1.0710E 03 | 3.0991E 01 | 2.0822E 01 | 1.0169E 01 | 2.0476E 00 |
| 2 | 7.0612E 01 | 4.3124E 00 | 2.6571E 00 | 5.3483E-01 | 2.1223E 00 | 2.5201E-01 |
| 3 | 3.3190E 04 | 9.8640E 02 | 3.3646E 01 | 2.1357E 01 | 1.2291E 01 | 1.7375E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 3.9268E 00 | 4.0795E 00 | 1.2476E 05 | 4.3413E 00 | 4.3693E 00 | 2.4716E 04 |

TOTAL IMPULSE = 6.4387E 03

TIME = 1.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.3306E 04 | 1.0747E 03 | 3.0991E 01 | 2.1109E 01 | 9.8825E 00 | 2.1359E 00 |
| 2 | 7.0624E 01 | 4.3291E 00 | 2.7440E 00 | 5.9798E-01 | 2.1400E 00 | 2.7855E-01 |
| 3 | 3.3306E 04 | 9.8727E 02 | 3.3735E 01 | 2.1707E 01 | 1.2029E 01 | 1.8046E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 6.0975E 00 | 6.2597E 00 | 1.2475E 05 | 5.5441E 00 | 5.5739E 00 | 2.4714E 04 |

TOTAL IMPULSE = 9.7693E 03

TIME = 1.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.7130E 04 | 8.9380E 02 | 4.1542E 01 | 2.8553E 01 | 1.2989E 01 | 2.1983E 00 |
| 2 | 7.0638E 01 | 4.3393E 00 | 2.8061E 00 | 6.5137E-01 | 2.1547E 00 | 3.0230E-01 |
| 3 | 3.7130E 04 | 8.3725E 02 | 4.4348E 01 | 2.9205E 01 | 1.5144E 01 | 1.9285E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 9.0180E 00 | 9.1837E 00 | 1.2475E 05 | 7.0585E 00 | 7.0900E 00 | 2.4713E 04 |

TOTAL IMPULSE = 1.3482E 04

TIME = 1.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 4.6889E 04 | 6.9132E 02 | 6.7425E 01 | 4.8156E 01 | 1.9668E 01 | 2.4484E 00 |
| 2 | 7.0651E 01 | 4.3464E 00 | 3.0085E 00 | 7.3479E-01 | 2.2697E 00 | 3.2550E-01 |
| 3 | 4.6889E 04 | 6.6196E 02 | 7.0833E 01 | 4.8495E 01 | 2.7938E 01 | 2.2288E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.3907E 01 | 1.4089E 01 | 1.2475E 05 | 9.2523E 00 | 9.2956E 00 | 2.4711E 04 |

TOTAL IMPULSE = 1.8171E 04

TIME = 2.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 5.5316E 04 | 6.1977E 02 | 8.9253E 01 | 6.6162E 01 | 2.3091E 01 | 2.3653E 00 |
| 2 | 7.0663E 01 | 4.3517E 00 | 3.1535E 00 | 8.1688E-01 | 2.3367E 00 | 3.4959E-01 |
| 3 | 5.5316E 04 | 5.9862E 02 | 9.2406E 01 | 6.6979E 01 | 2.5427E 01 | 2.6341E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.0605E 01 | 2.0796E 01 | 1.2474E 05 | 1.1795E 01 | 1.1830E 01 | 2.4708E 04 |

TOTAL IMPULSE = 2.3703E 04

TIME = 2.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 6.4701E 04 | 5.7328E 02 | 1.1286E 02 | 8.6663E 01 | 2.6199E 01 | 3.0379E 00 |
| 2 | 7.0674E 01 | 4.3565E 00 | 3.6613E 00 | 1.0015E 00 | 2.6598E 00 | 3.7651E-01 |
| 3 | 6.4701E 04 | 5.5526E 02 | 1.1652E 02 | 8.7665E 01 | 2.8858E 01 | 3.0377E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.9372E 01 | 2.9572E 01 | 1.2473E 05 | 1.4681E 01 | 1.4719E 01 | 2.4705E 04 |

TOTAL IMPULSE = 3.0173E 04

TIME = 2.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 7.6755E 04 | 5.3055E 02 | 1.4467E 02 | 1.1244E 02 | 3.2216E 01 | 3.4937E 00 |
| 2 | 7.0686E 01 | 4.3576E 00 | 3.8407E 00 | 1.1097E 00 | 2.7310E 00 | 4.0633E-01 |
| 3 | 7.6755E 04 | 5.1683E 02 | 1.4851E 02 | 1.1356E 02 | 3.4947E 01 | 3.2497E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 4.0728E 01 | 4.0938E 01 | 1.2472E 05 | 1.8176E 01 | 1.8218E 01 | 2.4702E 04 |

TOTAL IMPULSE = 3.7348E 04

TIME = 2.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 8.9456E 04 | 5.0150E 02 | 1.7338E 02 | 1.3964E 02 | 3.8734E 01 | 3.4051E 00 |
| 2 | 7.0701E 01 | 4.3584E 00 | 4.3868E 00 | 1.3373E 00 | 3.0494E 00 | 4.3855E-01 |
| 3 | 8.9456E 04 | 4.8946E 02 | 1.8276E 02 | 1.4098E 02 | 4.1784E 01 | 3.3740E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 5.4826E 01 | 5.5046E 01 | 1.2471E 05 | 2.2354E 01 | 2.2401E 01 | 2.4698E 04 |

TOTAL IMPULSE = 4.6794E 04

TIME = 2.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 9.9214E 04 | 4.8832E 02 | 2.0317E 02 | 1.6134E 02 | 4.1829E 01 | 3.8572E 00 |
| 2 | 7.0712E 01 | 4.3596E 00 | 4.4606E 00 | 1.4247E 00 | 3.0159E 00 | 4.7261E-01 |
| 3 | 9.9214E 04 | 4.7788E 02 | 2.0761E 02 | 1.6277E 02 | 4.4845E 01 | 3.6296E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 7.1103E 01 | 7.1332E 01 | 1.2469E 05 | 2.6838E 01 | 2.6892E 01 | 2.4693E 04 |

TOTAL IMPULSE = 5.6715E 04

TIME = 2.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.1153E 05 | 4.7539E 02 | 2.3475E 02 | 1.8861E 02 | 4.6133E 01 | 4.0884E 00 |
| 2 | 7.0716E 01 | 4.3589E 00 | 4.6041E 00 | 1.5521E 00 | 3.0520E 00 | 5.0856E-01 |
| 3 | 1.1153E 05 | 4.6395E 02 | 2.3935E 02 | 1.9016E 02 | 4.9185E 01 | 3.8663E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 9.0120E 01 | 9.0358E 01 | 1.2467E 05 | 3.1757E 01 | 3.1818E 01 | 2.4688E 04 |

TOTAL IMPULSE = 6.7868E 04

TIME = 2.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.2662E 05 | 4.6051E 02 | 2.7495E 02 | 2.2105E 02 | 5.3499E 01 | 4.1012E 00 |
| 2 | 7.0715E 01 | 4.3599E 00 | 5.2244E 00 | 1.8449E 00 | 3.3795E 00 | 5.4589E-01 |
| 3 | 1.2662E 05 | 4.5192E 02 | 2.8017E 02 | 2.2290E 02 | 5.7279E 01 | 3.4914E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.1241E 02 | 1.1266E 02 | 1.2465E 05 | 3.7485E 01 | 3.7555E 01 | 2.4682E 04 |

TOTAL IMPULSE = 8.0530E 04

TIME = 2.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.4224E 05 | 4.4945E 02 | 3.1718E 02 | 2.5414E 02 | 6.3038E 01 | 4.3315E 00 |
| 2 | 7.0718E 01 | 4.3609E 00 | 5.3994E 00 | 1.9881E 00 | 3.4113E 00 | 5.8279E-01 |
| 3 | 1.4224E 05 | 4.4094E 02 | 3.2257E 02 | 2.5613E 02 | 6.6449E 01 | 3.8544E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.3602E 02 | 1.3828E 02 | 1.2462E 05 | 4.4130E 01 | 4.4209E 01 | 2.4676E 04 |

TOTAL IMPULSE = 9.4753E 04

TIME = 2.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.5591E 05 | 4.4279E 02 | 3.5211E 02 | 2.8468E 02 | 6.7429E 01 | 4.2220E 00 |
| 2 | 7.0719E 01 | 4.3624E 00 | 5.6229E 00 | 2.1466E 00 | 3.4763E 00 | 6.1750E-01 |
| 3 | 1.5591E 05 | 4.3583E 02 | 3.5773E 02 | 2.8683E 02 | 7.0905E 01 | 4.0452E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.6670E 02 | 1.6697E 02 | 1.2459E 05 | 5.1220E 01 | 5.1311E 01 | 2.4669E 04 |

TOTAL IMPULSE = 1.1034E 05

TIME = 2.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.6550E 05 | 4.4119E 02 | 3.7512E 02 | 3.0718E 02 | 6.7941E 01 | 4.5213E 00 |
| 2 | 7.0725E 01 | 4.3635E 00 | 5.8324E 00 | 2.2968E 00 | 3.5355E 00 | 6.4952E-01 |
| 3 | 1.6550E 05 | 4.3443E 02 | 3.8095E 02 | 3.0948E 02 | 7.1476E 01 | 4.3298E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.9765E 02 | 1.9793E 02 | 1.2456E 05 | 5.8368E 01 | 5.8471E 01 | 2.4662E 04 |

TOTAL IMPULSE = 1.2689E 05

TIME = 3.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7211E 05 | 4.4059E 02 | 3.9064E 02 | 3.2290E 02 | 6.7738E 01 | 4.7669E 00 |
| 2 | 7.0729E 01 | 4.3657E 00 | 5.9587E 00 | 2.4110E 00 | 3.5576E 00 | 6.7771E-01 |
| 3 | 1.7211E 05 | 4.3396E 02 | 3.9661E 02 | 3.2531E 02 | 7.1295E 01 | 4.5628E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.3018E 02 | 2.3047E 02 | 1.2453E 05 | 6.5497E 01 | 6.5614E 01 | 2.4654E 04 |

TOTAL IMPULSE = 1.4411E 05

TIME = 3.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7739E 05 | 4.3863E 02 | 4.0441E 02 | 3.3446E 02 | 6.9950E 01 | 4.7826E 00 |
| 2 | 7.0733E 01 | 4.3627E 00 | 6.0399E 00 | 2.4930E 00 | 3.5668E 00 | 7.0289E-01 |
| 3 | 1.7739E 05 | 4.3218E 02 | 4.1045E 02 | 3.3695E 02 | 7.3496E 01 | 4.5846E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.6388E 02 | 2.6417E 02 | 1.2450E 05 | 7.2847E 01 | 7.2978E 01 | 2.4647E 04 |

TOTAL IMPULSE = 1.6184E 05

TIME = 3.1696

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.7948E 05 | 4.3738E 02 | 4.1036E 02 | 3.3872E 02 | 7.1637E 01 | 4.7283E 00 |
| 2 | 7.0738E 01 | 4.3631E 00 | 6.0944E 00 | 2.5468E 00 | 3.5675E 00 | 7.1791E-01 |
| 3 | 1.7948E 05 | 4.3098E 02 | 4.1645E 02 | 3.4127E 02 | 7.5185E 01 | 4.5391E 00 |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 2.8762E 02 | 2.8793E 02 | 1.2447E 05 | 7.8079E 01 | 7.8220E 01 | 2.4647E 04 |

TOTAL IMPULSE = 1.7633E 05

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# TABLE AP 3-1 (Sheet 8 of 12)
## COMPUTER PROGRAM F823 (2ND BURN)

TIME = 3.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8040E 05 | 4.3683E 02 | 4.1296E 02 | 3.4058E 02 | 7.2305E 01 | 4.7051E 00 |
| 2 | 7.0740E 01 | 4.3633E 00 | 6.1182E 00 | 2.5703E 00 | 3.5479E 00 | 7.2448E-01 |
| 3 | 1.8040E 05 | 4.3046E 02 | 4.1908E 02 | 3.4315E 02 | 7.5933E 01 | 4.5191E 00 |
| 4 | 1.8040E 05 | 4.3046E 02 | 4.1908E 02 | 3.4315E 02 | 7.5933E 01 | 4.5191E 00 |
| 5 | 2.9806E 02 | 2.9437E 02 | 1.2446E 05 | 8.0388E 01 | 8.0534E 01 | 2.4639E 04 |

TOTAL IMPULSE = 1.7982E 05

TIME = 3.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8416E 05 | 4.3519E 02 | 4.2316E 02 | 3.4855E 02 | 7.4605E 01 | 4.6719E 00 |
| 2 | 7.0756E 01 | 4.3662E 00 | 6.2859E 00 | 2.6824E 00 | 3.5035E 00 | 7.4439E-01 |
| 3 | 1.8416E 05 | 4.2882E 02 | 4.2944E 02 | 3.5123E 02 | 7.8209E 01 | 4.4909E 00 |
| 4 | 1.8328E 05 | 4.2920E 02 | 4.2702E 02 | 3.4935E 02 | 7.7678E 01 | 4.4973E 00 |
| 5 | 3.3319E 02 | 3.3150E 02 | 1.2443E 05 | 8.8209E 01 | 8.8372E 01 | 2.4632E 04 |

TOTAL IMPULSE = 1.9824E 05

TIME = 3.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8671E 05 | 4.3459E 02 | 4.2962E 02 | 3.5429E 02 | 7.5334E 01 | 4.7030E 00 |
| 2 | 7.0767E 01 | 4.3527E 00 | 6.3589E 00 | 2.7482E 00 | 3.6109E 00 | 7.4110E-01 |
| 3 | 1.8671E 05 | 4.2825E 02 | 4.3598E 02 | 3.5704E 02 | 7.8944E 01 | 4.5227E 00 |
| 4 | 1.8477E 05 | 4.2878E 02 | 4.3091E 02 | 3.5268E 02 | 7.8228E 01 | 4.5084E 00 |
| 5 | 3.6889E 02 | 3.6921E 02 | 1.2439E 05 | 9.6104E 01 | 9.6285E 01 | 2.4624E 04 |

TOTAL IMPULSE = 2.1691E 05

TIME = 3.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8748E 05 | 4.3467E 02 | 4.3132E 02 | 3.5621E 02 | 7.5111E 01 | 4.7425E 00 |
| 2 | 7.0774E 01 | 4.3640E 00 | 6.3645E 00 | 2.7785E 00 | 3.5861E 00 | 7.7479E-01 |
| 3 | 1.8748E 05 | 4.2835E 02 | 4.3759E 02 | 3.5899E 02 | 7.8597E 01 | 4.5617E 00 |
| 4 | 1.8559E 05 | 4.2855E 02 | 4.3266E 02 | 3.5459E 02 | 7.8370E 01 | 4.5246E 00 |
| 5 | 4.0479E 02 | 4.0512E 02 | 1.2436E 05 | 1.0397E 02 | 1.0417E 02 | 2.4616E 04 |

TOTAL IMPULSE = 2.3565E 05

TIME = 3.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.8969E 05 | 4.3457E 02 | 4.3649E 02 | 3.6145E 02 | 7.5044E 01 | 4.9165E 00 |
| 2 | 7.0782E 01 | 4.3661E 00 | 6.3280E 00 | 2.7813E 00 | 3.5468E 00 | 7.8414E-01 |
| 3 | 1.8969E 05 | 4.2836E 02 | 4.4282E 02 | 3.6423E 02 | 7.9591E 01 | 4.6345E 00 |
| 4 | 1.8654E 05 | 4.2859E 02 | 4.3525E 02 | 3.5683E 02 | 7.8421E 01 | 4.5502E 00 |
| 5 | 4.4121E 02 | 4.4155E 02 | 1.2432E 05 | 1.1183E 02 | 1.1205E 02 | 2.4608E 04 |

TOTAL IMPULSE = 2.5462E 05

TIME = 3.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9044E 05 | 4.3504E 02 | 4.3776E 02 | 3.6354E 02 | 7.4175E 01 | 4.9017E 00 |
| 2 | 7.0787E 01 | 4.3644E 00 | 5.7054E 00 | 2.5238E 00 | 3.1816E 00 | 7.9327E-01 |
| 3 | 1.9044E 05 | 4.2844E 02 | 4.4368E 02 | 3.6411E 02 | 7.7356E 01 | 4.7327E 00 |
| 4 | 1.8728E 05 | 4.2875E 02 | 4.3580E 02 | 3.5858E 02 | 7.8220E 01 | 4.5842E 00 |
| 5 | 4.7782E 02 | 4.7817E 02 | 1.2428E 05 | 1.1957E 02 | 1.1981E 02 | 2.4600E 04 |

TOTAL IMPULSE = 2.7167E 05

TIME = 3.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9099E 05 | 4.3512E 02 | 4.3942E 02 | 3.6495E 02 | 7.3974E 01 | 4.9335E 00 |
| 2 | 7.0792E 01 | 4.3649E 00 | 6.1017E 00 | 2.7134E 00 | 3.3846E 00 | 8.0079E-01 |
| 3 | 1.9099E 05 | 4.2916E 02 | 4.4503E 02 | 3.6766E 02 | 7.7362E 01 | 4.7525E 00 |
| 4 | 1.8786E 05 | 4.2881E 02 | 4.3911E 02 | 3.6002E 02 | 7.8034E 01 | 4.5107E 00 |
| 5 | 5.1459E 02 | 5.1495E 02 | 1.2425E 05 | 1.2730E 02 | 1.2757E 02 | 2.4592E 04 |

TOTAL IMPULSE = 2.9277E 05

TIME = 3.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9132E 05 | 4.3448E 02 | 4.3994E 02 | 3.6558E 02 | 7.4352E 01 | 4.9169E 00 |
| 2 | 7.0795E 01 | 4.3643E 00 | 6.4184E 00 | 3.0579E 00 | 3.7805E 00 | 8.0836E-01 |
| 3 | 1.9132E 05 | 4.2822E 02 | 4.4677E 02 | 3.6864E 02 | 7.8132E 01 | 4.7182E 00 |
| 4 | 1.8834E 05 | 4.2873E 02 | 4.3929E 02 | 3.6120E 02 | 7.8091E 01 | 4.6254E 00 |
| 5 | 5.5145E 02 | 5.5182E 02 | 1.2421E 05 | 1.3512E 02 | 1.3541E 02 | 2.4585E 04 |

TOTAL IMPULSE = 3.1190E 05

TIME = 4.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9215E 05 | 4.3456E 02 | 4.4218E 02 | 3.6736E 02 | 7.4912E 01 | 4.9105E 00 |
| 2 | 7.0797E 01 | 4.3655E 00 | 6.7215E 00 | 3.0188E 00 | 3.7027E 00 | 8.1529E-01 |
| 3 | 1.9215E 05 | 4.2805E 02 | 4.4490E 02 | 3.7038E 02 | 7.8515E 01 | 4.7174E 00 |
| 4 | 1.8880E 05 | 4.2865E 02 | 4.4045E 02 | 3.6231E 02 | 7.8142E 01 | 4.6365E 00 |
| 5 | 5.8949E 02 | 5.8847E 02 | 1.2417E 05 | 1.4297E 02 | 1.4328E 02 | 2.4577E 04 |

TOTAL IMPULSE = 3.3111E 05

TIME = 4.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9309E 05 | 4.3423E 02 | 4.4467E 02 | 3.6938E 02 | 7.5284E 01 | 4.9065E 00 |
| 2 | 7.0799E 01 | 4.3651E 00 | 6.3906E 00 | 2.8814E 00 | 3.5090E 00 | 8.2119E-01 |
| 3 | 1.9309E 05 | 4.2807E 02 | 4.5126E 02 | 3.7266E 02 | 7.8793E 01 | 4.7246E 00 |
| 4 | 1.8926E 05 | 4.2858E 02 | 4.4159E 02 | 3.6338E 02 | 7.8212E 01 | 4.6441E 00 |
| 5 | 6.2572E 02 | 6.2611E 02 | 1.2413E 05 | 1.5085E 02 | 1.5119E 02 | 2.4559E 04 |

TOTAL IMPULSE = 3.5042E 05

TIME = 4.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9414E 05 | 4.3386E 02 | 4.4767E 02 | 3.7166E 02 | 7.5517E 01 | 4.9220E 00 |
| 2 | 7.0801E 01 | 4.3646E 00 | 6.3791E 00 | 2.8838E 00 | 3.4754E 00 | 8.2573E-01 |
| 3 | 1.9414E 05 | 4.2776E 02 | 4.5346E 02 | 3.7456E 02 | 7.9114E 01 | 4.7223E 00 |
| 4 | 1.8973E 05 | 4.2850E 02 | 4.4278E 02 | 3.6444E 02 | 7.8319E 01 | 4.6536E 00 |
| 5 | 6.6317E 02 | 6.6357E 02 | 1.2410E 05 | 1.5878E 02 | 1.5915E 02 | 2.4561E 04 |

TOTAL IMPULSE = 3.7984E 05

TIME = 4.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9503E 05 | 4.3349E 02 | 4.4931E 02 | 3.7353E 02 | 7.5374E 01 | 4.8909E 00 |
| 2 | 7.0802E 01 | 4.3644E 00 | 6.3885E 00 | 2.8967E 00 | 3.4919E 00 | 8.3955E-01 |
| 3 | 1.9503E 05 | 4.2742E 02 | 4.5635E 02 | 3.7643E 02 | 7.9455E 01 | 4.7133E 00 |
| 4 | 1.9020E 05 | 4.2840E 02 | 4.4397E 02 | 3.6552E 02 | 7.8455E 01 | 4.6599E 00 |
| 5 | 7.0081E 02 | 7.0122E 02 | 1.2406E 05 | 1.6677E 02 | 1.6716E 02 | 2.4553E 04 |

TOTAL IMPULSE = 3.8936E 05

TIME = 4.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9474E 05 | 4.3348E 02 | 4.4923E 02 | 3.7282E 02 | 7.6411E 01 | 4.8792E 00 |
| 2 | 7.0801E 01 | 4.3649E 00 | 6.4490E 00 | 2.9335E 00 | 3.5155E 00 | 8.3447E-01 |
| 3 | 1.9474E 05 | 4.2735E 02 | 4.5568E 02 | 3.7576E 02 | 7.9927E 01 | 4.7013E 00 |
| 4 | 1.9057E 05 | 4.2832E 02 | 4.4493E 02 | 3.6635E 02 | 7.8575E 01 | 4.6624E 00 |
| 5 | 7.3839E 02 | 7.3881E 02 | 1.2402E 05 | 1.7476E 02 | 1.7519E 02 | 2.4545E 04 |

TOTAL IMPULSE = 4.0381E 05

TIME = 4.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9414E 05 | 4.3345E 02 | 4.4769E 02 | 3.7150E 02 | 7.6187E 01 | 4.8762E 00 |
| 2 | 7.0803E 01 | 4.3653E 00 | 6.3777E 00 | 2.9090E 00 | 3.4687E 00 | 8.3862E-01 |
| 3 | 1.9414E 05 | 4.2755E 02 | 4.5407E 02 | 3.7441E 02 | 7.9656E 01 | 4.7004E 00 |
| 4 | 1.9084E 05 | 4.2826E 02 | 4.4561E 02 | 3.6686E 02 | 7.8655E 01 | 4.6653E 00 |
| 5 | 7.7583E 02 | 7.7626E 02 | 1.2398E 05 | 1.8272E 02 | 1.8318E 02 | 2.4537E 04 |

TOTAL IMPULSE = 4.2823E 05

TIME = 4.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9422E 05 | 4.3367E 02 | 4.4785E 02 | 3.7172E 02 | 7.6135E 01 | 4.8823E 00 |
| 2 | 7.0804E 01 | 4.3656E 00 | 6.6289E 00 | 3.0301E 00 | 3.5988E 00 | 8.4196E-01 |
| 3 | 1.9422E 05 | 4.2735E 02 | 4.5448E 02 | 3.7475E 02 | 7.9734E 01 | 4.7000E 00 |
| 4 | 1.9107E 05 | 4.2819E 02 | 4.4623E 02 | 3.6750E 02 | 7.8732E 01 | 4.6678E 00 |
| 5 | 8.1331E 02 | 8.1374E 02 | 1.2395E 05 | 1.9070E 02 | 1.9118E 02 | 2.4529E 04 |

TOTAL IMPULSE = 4.4765E 05

TIME = 4.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9498E 05 | 4.3353E 02 | 4.4974E 02 | 3.7344E 02 | 7.6301E 01 | 4.8943E 00 |
| 2 | 7.0805E 01 | 4.3656E 00 | 6.5033E 00 | 2.9773E 00 | 3.5259E 00 | 8.4441E-01 |
| 3 | 1.9498E 05 | 4.2735E 02 | 4.5624E 02 | 3.7642E 02 | 7.9827E 01 | 4.7154E 00 |
| 4 | 1.9133E 05 | 4.2814E 02 | 4.4689E 02 | 3.6808E 02 | 7.8803E 01 | 4.6709E 00 |
| 5 | 8.5095E 02 | 8.5140E 02 | 1.2391E 05 | 1.9868E 02 | 1.9920E 02 | 2.4521E 04 |

TOTAL IMPULSE = 4.6715E 05

TIME = 4.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9529E 05 | 4.3351E 02 | 4.5048E 02 | 3.7416E 02 | 7.6323E 01 | 4.9023E 00 |
| 2 | 7.0804E 01 | 4.3661E 00 | 6.3129E 00 | 2.8965E 00 | 3.4164E 00 | 8.4781E-01 |
| 3 | 1.9529E 05 | 4.2751E 02 | 4.5679E 02 | 3.7706E 02 | 7.9739E 01 | 4.7286E 00 |
| 4 | 1.9157E 05 | 4.2810E 02 | 4.4750E 02 | 3.6863E 02 | 7.8861E 01 | 4.6745E 00 |
| 5 | 8.8865E 02 | 8.8911E 02 | 1.2387E 05 | 2.0665E 02 | 2.0721E 02 | 2.4513E 04 |

TOTAL IMPULSE = 4.8667E 05

TIME = 4.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9525E 05 | 4.3353E 02 | 4.5038E 02 | 3.7410E 02 | 7.6284E 01 | 4.9040E 00 |
| 2 | 7.0805E 01 | 4.3664E 00 | 6.2093E 00 | 2.8559E 00 | 3.3534E 00 | 8.5164E-01 |
| 3 | 1.9525E 05 | 4.2763E 02 | 4.5659E 02 | 3.7695E 02 | 7.9637E 01 | 4.7334E 00 |
| 4 | 1.9178E 05 | 4.2807E 02 | 4.4802E 02 | 3.6912E 02 | 7.8905E 01 | 4.6779E 00 |
| 5 | 9.2635E 02 | 9.2682E 02 | 1.2383E 05 | 2.1462E 02 | 2.1521E 02 | 2.4505E 04 |

TOTAL IMPULSE = 5.0620E 05

TIME = 5.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9561E 05 | 4.3342E 02 | 4.5130E 02 | 3.7487E 02 | 7.6436E 01 | 4.9044E 00 |
| 2 | 7.0806E 01 | 4.3664E 00 | 6.4415E 00 | 2.9694E 00 | 3.4721E 00 | 8.5524E-01 |
| 3 | 1.9561E 05 | 4.2732E 02 | 4.5775E 02 | 3.7784E 02 | 7.9938E 01 | 4.7284E 00 |
| 4 | 1.9199E 05 | 4.2803E 02 | 4.4855E 02 | 3.6959E 02 | 7.8960E 01 | 4.6807E 00 |
| 5 | 9.6413E 02 | 9.6461E 02 | 1.2380E 05 | 2.2261E 02 | 2.2321E 02 | 2.4497E 04 |

TOTAL IMPULSE = 5.2576E 05

TIME = 5.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9575E 05 | 4.3344E 02 | 4.5162E 02 | 3.7523E 02 | 7.6390E 01 | 4.9121E 00 |
| 2 | 7.0807E 01 | 4.3661E 00 | 6.5875E 00 | 3.0418E 00 | 3.5458E 00 | 8.5785E-01 |
| 3 | 1.9575E 05 | 4.2721E 02 | 4.5921E 02 | 3.7827E 02 | 7.9936E 01 | 4.7322E 00 |
| 4 | 1.9219E 05 | 4.2799E 02 | 4.4905E 02 | 3.7004E 02 | 7.9011E 01 | 4.6834E 00 |
| 5 | 1.0020E 03 | 1.0024E 03 | 1.2376E 05 | 2.3060E 02 | 2.3126E 02 | 2.4489E 04 |

TOTAL IMPULSE = 5.4534E 05

TIME = 5.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9572E 05 | 4.3349E 02 | 4.5150E 02 | 3.7519E 02 | 7.6318E 01 | 4.9161E 00 |
| 2 | 7.0808E 01 | 4.3653E 00 | 6.5558E 00 | 3.0319E 00 | 3.5243E 00 | 8.6016E-01 |
| 3 | 1.9572E 05 | 4.2728E 02 | 4.5808E 02 | 3.7822E 02 | 7.9842E 01 | 4.7371E 00 |
| 4 | 1.9236E 05 | 4.2795E 02 | 4.4950E 02 | 3.7044E 02 | 7.9052E 01 | 4.6861E 00 |
| 5 | 1.0398E 03 | 1.0403E 03 | 1.2372E 05 | 2.3859E 02 | 2.3929E 02 | 2.4481E 04 |

TOTAL IMPULSE = 5.6491E 05

TIME = 5.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9532E 05 | 4.3350E 02 | 4.5057E 02 | 3.7424E 02 | 7.6332E 01 | 4.9027E 00 |
| 2 | 7.0811E 01 | 4.3642E 00 | 6.3208E 00 | 2.9271E 00 | 3.3937E 00 | 8.6249E-01 |
| 3 | 1.9532E 05 | 4.2750E 02 | 4.5649E 02 | 3.7716E 02 | 7.9726E 01 | 4.7307E 00 |
| 4 | 1.9250E 05 | 4.2793E 02 | 4.4946E 02 | 3.7076E 02 | 7.9083E 01 | 4.6892E 00 |
| 5 | 1.0775E 03 | 1.0780E 03 | 1.2368E 05 | 2.4656E 02 | 2.4730E 02 | 2.4473E 04 |

TOTAL IMPULSE = 5.8444E 05

TIME = 5.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9547E 05 | 4.3339E 02 | 4.5125E 02 | 3.7438E 02 | 7.6867E 01 | 4.9705E 00 |
| 2 | 7.0813E 01 | 4.3642E 00 | 6.3068E 00 | 2.9245E 00 | 3.3823E 00 | 8.6457E-01 |
| 3 | 1.9547E 05 | 4.2721E 02 | 4.5755E 02 | 3.7730E 02 | 8.0249E 01 | 4.7017E 00 |
| 4 | 1.9263E 05 | 4.2788E 02 | 4.5019E 02 | 3.7105E 02 | 7.9136E 01 | 4.6888E 00 |
| 5 | 1.1152E 03 | 1.1157E 03 | 1.2365E 05 | 2.5458E 02 | 2.5538E 02 | 2.4465E 04 |

TOTAL IMPULSE = 6.0399E 05

TIME = 5.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9595E 05 | 4.3277E 02 | 4.5274E 02 | 3.7523E 02 | 7.7554E 01 | 4.8383E 00 |
| 2 | 7.0812E 01 | 4.3652E 00 | 6.3414E 00 | 2.9449E 00 | 3.3967E 00 | 8.6700E-01 |
| 3 | 1.9595E 05 | 4.2679E 02 | 4.5912E 02 | 3.7817E 02 | 8.0951E 01 | 4.6716E 00 |
| 4 | 1.9278E 05 | 4.2785E 02 | 4.5057E 02 | 3.7136E 02 | 7.9214E 01 | 4.6841E 00 |
| 5 | 1.1530E 03 | 1.1536E 03 | 1.2361E 05 | 2.6268E 02 | 2.6349E 02 | 2.4457E 04 |

TOTAL IMPULSE = 6.2158E 05

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# TABLE AP 3-1 (Sheet 9 of 12)
## COMPUTER PROGRAM F823 (2ND BURN)

TIME = 5.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9654E 05 | 4.3247E 02 | 4.5446E 02 | 3.7643E 02 | 7.8029E 01 | 4.9243E 00 |
| 2 | 7.0812E 01 | 4.3658E 00 | 6.2558E 00 | 2.9088E 00 | 3.3470E 00 | 8.6909E-01 |
| 3 | 1.9654E 05 | 4.2660E 02 | 4.6072E 02 | 3.7934E 02 | 8.1376E 01 | 4.6616E 00 |
| 4 | 1.9293E 05 | 4.2780E 02 | 4.5099E 02 | 3.7169E 02 | 7.9302E 01 | 4.6870E 00 |
| 5 | 1.1910E 03 | 1.1915E 03 | 1.2357E 05 | 2.7082E 02 | 2.7167E 02 | 2.4448E 04 |

TOTAL IMPULSE = 6.4324E 05

TIME = 5.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9645E 05 | 4.3264E 02 | 4.5427E 02 | 3.7433E 02 | 7.7735E 01 | 4.8612E 00 |
| 2 | 7.0812E 01 | 4.3656E 00 | 6.1997E 00 | 2.8844E 00 | 3.1152E 00 | 8.7205E-01 |
| 3 | 1.9645E 05 | 4.2682E 02 | 4.6027E 02 | 3.7922E 02 | 8.1050E 01 | 4.6788E 00 |
| 4 | 1.9307E 05 | 4.2776E 02 | 4.5136E 02 | 3.7198E 02 | 7.9372E 01 | 4.6866E 00 |
| 5 | 1.2284E 03 | 1.2294E 03 | 1.2353E 05 | 2.7892E 02 | 2.7981E 02 | 2.4440E 04 |

TOTAL IMPULSE = 6.6288E 05

TIME = 5.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9649E 05 | 4.3280E 02 | 4.5600E 02 | 3.7655E 02 | 7.7646E 01 | 4.8621E 00 |
| 2 | 7.0812E 01 | 4.3656E 00 | 6.2247E 00 | 2.8977E 00 | 3.3270E 00 | 8.7098E-01 |
| 3 | 1.9649E 05 | 4.2695E 02 | 4.6022E 02 | 3.7945E 02 | 8.0773E 01 | 4.6977E 00 |
| 4 | 1.9320E 05 | 4.2772E 02 | 4.5169E 02 | 3.7227E 02 | 7.9425E 01 | 4.6871E 00 |
| 5 | 1.2668E 03 | 1.2674E 03 | 1.2349E 05 | 2.8700E 02 | 2.8793E 02 | 2.4437E 04 |

TOTAL IMPULSE = 6.8253E 05

TIME = 5.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9704E 05 | 4.3274E 02 | 4.5534E 02 | 3.7783E 02 | 7.7512E 01 | 4.8745E 00 |
| 2 | 7.0813E 01 | 4.3657E 00 | 6.4519E 00 | 3.0084E 00 | 3.4435E 00 | 8.7366E-01 |
| 3 | 1.9704E 05 | 4.2669E 02 | 4.6179E 02 | 3.8064E 02 | 8.0955E 01 | 4.7043E 00 |
| 4 | 1.9334E 05 | 4.2769E 02 | 4.5206E 02 | 3.7258E 02 | 7.9481E 01 | 4.6877E 00 |
| 5 | 1.3049E 03 | 1.3055E 03 | 1.2346E 05 | 2.9509E 02 | 2.9606E 02 | 2.4424E 04 |

TOTAL IMPULSE = 7.0224E 05

TIME = 6.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9754E 05 | 4.3269E 02 | 4.5653E 02 | 3.7897E 02 | 7.7552E 01 | 4.8867E 00 |
| 2 | 7.0815E 01 | 4.3657E 00 | 6.5931E 00 | 3.0372E 00 | 3.4659E 00 | 8.7632E-01 |
| 3 | 1.9754E 05 | 4.2662E 02 | 4.6303E 02 | 3.8201E 02 | 8.1014E 01 | 4.7151E 00 |
| 4 | 1.9349E 05 | 4.2765E 02 | 4.5245E 02 | 3.7292E 02 | 7.9535E 01 | 4.6887E 00 |
| 5 | 1.3431E 03 | 1.3437E 03 | 1.2342E 05 | 3.0320E 02 | 3.0420E 02 | 2.4416E 04 |

TOTAL IMPULSE = 7.2199E 05

TIME = 6.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9759E 05 | 4.3289E 02 | 4.5644E 02 | 3.7924E 02 | 7.7191E 01 | 4.9131E 00 |
| 2 | 7.0815E 01 | 4.3660E 00 | 6.5886E 00 | 3.0788E 00 | 3.5094E 00 | 8.7719E-01 |
| 3 | 1.9759E 05 | 4.2673E 02 | 4.6302E 02 | 3.8232E 02 | 8.0701E 01 | 4.7375E 00 |
| 4 | 1.9363E 05 | 4.2762E 02 | 4.5281E 02 | 3.7324E 02 | 7.9575E 01 | 4.6904E 00 |
| 5 | 1.3814E 03 | 1.3819E 03 | 1.2338E 05 | 3.1127E 02 | 3.1231E 02 | 2.4408E 04 |

TOTAL IMPULSE = 7.4175E 05

TIME = 6.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9781E 05 | 4.3303E 02 | 4.5691E 02 | 3.7987E 02 | 7.6938E 01 | 4.9373E 00 |
| 2 | 7.0815E 01 | 4.3658E 00 | 6.6632E 00 | 3.0215E 00 | 3.4415E 00 | 8.7793E-01 |
| 3 | 1.9781E 05 | 4.2698E 02 | 4.6327E 02 | 3.8289E 02 | 8.0340E 01 | 4.7615E 00 |
| 4 | 1.9377E 05 | 4.2759E 02 | 4.5316E 02 | 3.7356E 02 | 7.9402E 01 | 4.6928E 00 |
| 5 | 1.4197E 03 | 1.4202E 03 | 1.2334E 05 | 3.1930E 02 | 3.2039E 02 | 2.4400E 04 |

TOTAL IMPULSE = 7.6153E 05

TIME = 6.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9837E 05 | 4.3296E 02 | 4.5418E 02 | 3.8118E 02 | 7.7001E 01 | 4.9503E 00 |
| 2 | 7.0815E 01 | 4.3653E 00 | 6.6194E 00 | 3.0972E 00 | 3.5222E 00 | 8.7932E-01 |
| 3 | 1.9837E 05 | 4.2680E 02 | 4.6480E 02 | 3.8427E 02 | 8.0524E 01 | 4.7722E 00 |
| 4 | 1.9391E 05 | 4.2757E 02 | 4.5353E 02 | 3.7390E 02 | 7.9531E 01 | 4.6954E 00 |
| 5 | 1.4581E 03 | 1.4587E 03 | 1.2330E 05 | 3.2736E 02 | 3.2846E 02 | 2.4392E 04 |

TOTAL IMPULSE = 7.8137E 05

TIME = 6.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9788E 05 | 4.3315E 02 | 4.5683E 02 | 3.8012E 02 | 7.6709E 01 | 4.9553E 00 |
| 2 | 7.0815E 01 | 4.3652E 00 | 6.6224E 00 | 3.1019E 00 | 3.5205E 00 | 8.8194E-01 |
| 3 | 1.9788E 05 | 4.2696E 02 | 4.6345E 02 | 3.8327E 02 | 8.0230E 01 | 4.7765E 00 |
| 4 | 1.9404E 05 | 4.2755E 02 | 4.5353E 02 | 3.7419E 02 | 7.9450E 01 | 4.6979E 00 |
| 5 | 1.4954E 03 | 1.4970E 03 | 1.2326E 05 | 3.3539E 02 | 3.3654E 02 | 2.4383E 04 |

TOTAL IMPULSE = 8.0115E 05

TIME = 6.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9682E 05 | 4.3347E 02 | 4.5406E 02 | 3.7783E 02 | 7.6238E 01 | 4.9559E 00 |
| 2 | 7.0815E 01 | 4.3664E 00 | 6.6710E 00 | 3.1289E 00 | 3.5430E 00 | 8.8249E-01 |
| 3 | 1.9682E 05 | 4.2720E 02 | 4.6073E 02 | 3.8095E 02 | 7.9781E 01 | 4.7759E 00 |
| 4 | 1.9412E 05 | 4.2754E 02 | 4.5404E 02 | 3.7439E 02 | 7.9553E 01 | 4.7032E 00 |
| 5 | 1.5345E 03 | 1.5351E 03 | 1.2323E 05 | 3.4336E 02 | 3.4456E 02 | 2.4375E 04 |

TOTAL IMPULSE = 8.2084E 05

TIME = 6.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9654E 05 | 4.3353E 02 | 4.5335E 02 | 3.7719E 02 | 7.6169E 01 | 4.9519E 00 |
| 2 | 7.0815E 01 | 4.3670E 00 | 6.6011E 00 | 3.0946E 00 | 3.5072E 00 | 8.8658E-01 |
| 3 | 1.9654E 05 | 4.2731E 02 | 4.5995E 02 | 3.8028E 02 | 7.9671E 01 | 4.7731E 00 |
| 4 | 1.9419E 05 | 4.2753E 02 | 4.5421E 02 | 3.7456E 02 | 7.9654E 01 | 4.7024E 00 |
| 5 | 1.5725E 03 | 1.5732E 03 | 1.2319E 05 | 3.5133E 02 | 3.5257E 02 | 2.4367E 04 |

TOTAL IMPULSE = 8.4049E 05

TIME = 6.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9782E 05 | 4.3304E 02 | 4.5674E 02 | 3.7994E 02 | 7.6463E 01 | 4.9443E 00 |
| 2 | 7.0815E 01 | 4.3668E 00 | 6.6705E 00 | 3.0383E 00 | 3.4322E 00 | 8.8518E-01 |
| 3 | 1.9782E 05 | 4.2703E 02 | 4.6325E 02 | 3.8298E 02 | 8.0276E 01 | 4.7704E 00 |
| 4 | 1.9429E 05 | 4.2752E 02 | 4.5447E 02 | 3.7480E 02 | 7.9672E 01 | 4.7043E 00 |
| 5 | 1.6108E 03 | 1.6115E 03 | 1.2315E 05 | 3.5935E 02 | 3.6064E 02 | 2.4359E 04 |

TOTAL IMPULSE = 8.6027E 05

TIME = 6.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9883E 05 | 4.3271E 02 | 4.5949E 02 | 3.8208E 02 | 7.7413E 01 | 4.9356E 00 |
| 2 | 7.0815E 01 | 4.3662E 00 | 6.4621E 00 | 3.0361E 00 | 3.4260E 00 | 8.8618E-01 |
| 3 | 1.9883E 05 | 4.2671E 02 | 4.6596E 02 | 3.8512E 02 | 8.0839E 01 | 4.7640E 00 |
| 4 | 1.9442E 05 | 4.2749E 02 | 4.5479E 02 | 3.7508E 02 | 7.9704E 01 | 4.7060E 00 |
| 5 | 1.6493E 03 | 1.6500E 03 | 1.2311E 05 | 3.6744E 02 | 3.6876E 02 | 2.4351E 04 |

TOTAL IMPULSE = 8.8015E 05

TIME = 6.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9924E 05 | 4.3257E 02 | 4.6061E 02 | 3.8298E 02 | 7.7626E 01 | 4.9336E 00 |
| 2 | 7.0815E 01 | 4.3657E 00 | 6.5449E 00 | 3.0772E 00 | 3.4677E 00 | 8.8741E-01 |
| 3 | 1.9924E 05 | 4.2651E 02 | 4.6715E 02 | 3.8606E 02 | 8.1094E 01 | 4.7606E 00 |
| 4 | 1.9455E 05 | 4.2747E 02 | 4.5512E 02 | 3.7538E 02 | 7.9741E 01 | 4.7075E 00 |
| 5 | 1.6879E 03 | 1.6886E 03 | 1.2307E 05 | 3.7555E 02 | 3.7691E 02 | 2.4343E 04 |

TOTAL IMPULSE = 9.0008E 05

TIME = 7.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9942E 05 | 4.3256E 02 | 4.6103E 02 | 3.8340E 02 | 7.7633E 01 | 4.9386E 00 |
| 2 | 7.0815E 01 | 4.3650E 00 | 6.5288E 00 | 3.0730E 00 | 3.4558E 00 | 8.8924E-01 |
| 3 | 1.9942E 05 | 4.2652E 02 | 4.6756E 02 | 3.8647E 02 | 8.1088E 01 | 4.7660E 00 |
| 4 | 1.9468E 05 | 4.2744E 02 | 4.5544E 02 | 3.7567E 02 | 7.9776E 01 | 4.7090E 00 |
| 5 | 1.7266E 03 | 1.7273E 03 | 1.2303E 05 | 3.8365E 02 | 3.8507E 02 | 2.4335E 04 |

TOTAL IMPULSE = 9.2002E 05

TIME = 7.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9979E 05 | 4.3254E 02 | 4.6191E 02 | 3.8428E 02 | 7.7632E 01 | 4.9500E 00 |
| 2 | 7.0815E 01 | 4.3648E 00 | 6.4533E 00 | 3.0399E 00 | 3.4134E 00 | 8.9055E-01 |
| 3 | 1.9979E 05 | 4.2650E 02 | 4.6836E 02 | 3.8732E 02 | 8.1045E 01 | 4.7790E 00 |
| 4 | 1.9481E 05 | 4.2742E 02 | 4.5577E 02 | 3.7596E 02 | 7.9808E 01 | 4.7108E 00 |
| 5 | 1.7653E 03 | 1.7660E 03 | 1.2300E 05 | 3.9176E 02 | 3.9321E 02 | 2.4327E 04 |

TOTAL IMPULSE = 9.4000E 05

TIME = 7.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0003E 05 | 4.3255E 02 | 4.6243E 02 | 3.8484E 02 | 7.7591E 01 | 4.9599E 00 |
| 2 | 7.0815E 01 | 4.3650E 00 | 6.5418E 00 | 3.0842E 00 | 3.4576E 00 | 8.9202E-01 |
| 3 | 2.0003E 05 | 4.2652E 02 | 4.6898E 02 | 3.8793E 02 | 8.1049E 01 | 4.7864E 00 |
| 4 | 1.9496E 05 | 4.2740E 02 | 4.5610E 02 | 3.7626E 02 | 7.9839E 01 | 4.7127E 00 |
| 5 | 1.8041E 03 | 1.8048E 03 | 1.2296E 05 | 3.9986E 02 | 4.0138E 02 | 2.4319E 04 |

TOTAL IMPULSE = 9.6000E 05

TIME = 7.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0032E 05 | 4.3250E 02 | 4.6315E 02 | 3.8556E 02 | 7.7652E 01 | 4.9645E 00 |
| 2 | 7.0815E 01 | 4.3654E 00 | 6.5528E 00 | 3.0916E 00 | 3.4612E 00 | 8.9324E-01 |
| 3 | 2.0032E 05 | 4.2647E 02 | 4.6971E 02 | 3.8859E 02 | 8.1113E 01 | 4.7908E 00 |
| 4 | 1.9507E 05 | 4.2737E 02 | 4.5643E 02 | 3.7656E 02 | 7.9870E 01 | 4.7146E 00 |
| 5 | 1.8430E 03 | 1.8437E 03 | 1.2292E 05 | 4.0798E 02 | 4.0951E 02 | 2.4310E 04 |

TOTAL IMPULSE = 9.8003E 05

TIME = 7.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0119E 05 | 4.3225E 02 | 4.6545E 02 | 3.8741E 02 | 7.8042E 01 | 4.9641E 00 |
| 2 | 7.0815E 01 | 4.3647E 00 | 6.4361E 00 | 3.0392E 00 | 3.3969E 00 | 8.9471E-01 |
| 3 | 2.0119E 05 | 4.2635E 02 | 4.7189E 02 | 3.9045E 02 | 8.1439E 01 | 4.7944E 00 |
| 4 | 1.9521E 05 | 4.2735E 02 | 4.5679E 02 | 3.7689E 02 | 7.9907E 01 | 4.7168E 00 |
| 5 | 1.8820E 03 | 1.8827E 03 | 1.2288E 05 | 4.1612E 02 | 4.1770E 02 | 2.4302E 04 |

TOTAL IMPULSE = 1.0002E 06

TIME = 7.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0215E 05 | 4.3195E 02 | 4.6799E 02 | 3.8950E 02 | 7.8493E 01 | 4.9622E 00 |
| 2 | 7.0815E 01 | 4.3641E 00 | 6.4735E 00 | 3.0590E 00 | 3.4145E 00 | 8.9589E-01 |
| 3 | 2.0215E 05 | 4.2636E 02 | 4.7446E 02 | 3.9256E 02 | 8.1907E 01 | 4.7927E 00 |
| 4 | 1.9537E 05 | 4.2732E 02 | 4.5720E 02 | 3.7725E 02 | 7.9953E 01 | 4.7184E 00 |
| 5 | 1.9213E 03 | 1.9220E 03 | 1.2284E 05 | 4.2431E 02 | 4.2593E 02 | 2.4294E 04 |

TOTAL IMPULSE = 1.0204E 06

TIME = 7.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0325E 05 | 4.3165E 02 | 4.7084E 02 | 3.9189E 02 | 7.8965E 01 | 4.9629E 00 |
| 2 | 7.0813E 01 | 4.3651E 00 | 6.7540E 00 | 3.1928E 00 | 3.5612E 00 | 8.9657E-01 |
| 3 | 2.0325E 05 | 4.2555E 02 | 4.7761E 02 | 3.9509E 02 | 8.2526E 01 | 4.7874E 00 |
| 4 | 1.9555E 05 | 4.2728E 02 | 4.5765E 02 | 3.7765E 02 | 8.0011E 01 | 4.7200E 00 |
| 5 | 1.9608E 03 | 1.9615E 03 | 1.2280E 05 | 4.3256E 02 | 4.3423E 02 | 2.4286E 04 |

TOTAL IMPULSE = 1.0407E 06

TIME = 7.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0449E 05 | 4.3143E 02 | 4.7398E 02 | 3.9471E 02 | 7.9276E 01 | 4.9789E 00 |
| 2 | 7.0810E 01 | 4.3630E 00 | 6.9702E 00 | 3.3002E 00 | 3.6700E 00 | 8.9921E-01 |
| 3 | 2.0449E 05 | 4.2519E 02 | 4.8095E 02 | 3.9801E 02 | 8.2945E 01 | 4.7984E 00 |
| 4 | 1.9575E 05 | 4.2723E 02 | 4.5818E 02 | 3.7810E 02 | 8.0076E 01 | 4.7218E 00 |
| 5 | 2.0006E 03 | 2.0013E 03 | 1.2276E 05 | 4.4086E 02 | 4.4257E 02 | 2.4277E 04 |

TOTAL IMPULSE = 1.0611E 06

TIME = 7.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0588E 05 | 4.3133E 02 | 4.7732E 02 | 3.9736E 02 | 7.9359E 01 | 5.0147E 00 |
| 2 | 7.0809E 01 | 4.3559E 00 | 6.9455E 00 | 3.2949E 00 | 3.6505E 00 | 9.0254E-01 |
| 3 | 2.0588E 05 | 4.2515E 02 | 4.8426E 02 | 4.0125E 02 | 8.3009E 01 | 4.8339E 00 |
| 4 | 1.9596E 05 | 4.2718E 02 | 4.5874E 02 | 3.7860E 02 | 8.0140E 01 | 4.7243E 00 |
| 5 | 2.0407E 03 | 2.0415E 03 | 1.2272E 05 | 4.4916E 02 | 4.5091E 02 | 2.4269E 04 |

TOTAL IMPULSE = 1.0817E 06

TIME = 7.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0624E 05 | 4.3147E 02 | 4.7799E 02 | 3.9890E 02 | 7.9088E 01 | 5.0418E 00 |
| 2 | 7.0811E 01 | 4.3551E 00 | 6.8902E 00 | 3.2756E 00 | 3.6146E 00 | 9.0623E-01 |
| 3 | 2.0624E 05 | 4.2533E 02 | 4.8438E 02 | 4.0218E 02 | 8.2702E 01 | 4.8510E 00 |
| 4 | 1.9618E 05 | 4.2714E 02 | 4.5929E 02 | 3.7915E 02 | 8.0194E 01 | 4.7273E 00 |
| 5 | 2.0809E 03 | 2.0817E 03 | 1.2268E 05 | 4.5743E 02 | 4.5922E 02 | 2.4261E 04 |

TOTAL IMPULSE = 1.1024E 06

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# TABLE AP 3-1 (Sheet 10 of 12)
## COMPUTER PROGRAM F823 (2ND BURN)

TIME = 8.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0644E 05 | 4.3148E 02 | 4.7843E 02 | 3.9939E 02 | 7.9043E 01 | 5.0528E 00 |
| 2 | 7.0813E 01 | 4.3657E 00 | 6.8544E 00 | 3.2612E 00 | 3.5932E 00 | 9.0758E-01 |
| 3 | 2.0644E 05 | 4.2539E 02 | 4.8529E 02 | 4.0265E 02 | 8.2636E 01 | 4.8726E 00 |
| 4 | 1.9639E 05 | 4.2710E 02 | 4.5983E 02 | 3.7959E 02 | 8.0244E 01 | 4.7304E 00 |
| 5 | 2.1212E 03 | 2.1220E 03 | 1.2264E 05 | 4.6569E 02 | 4.6753E 02 | 2.4252E 04 |

TOTAL IMPULSE = 1.1230E 06

TIME = 8.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0704E 05 | 4.3134E 02 | 4.8000E 02 | 4.0073E 02 | 7.9266E 01 | 5.0555E 00 |
| 2 | 7.0815E 01 | 4.3654E 00 | 6.8122E 00 | 3.2450E 00 | 3.5672E 00 | 9.0965E-01 |
| 3 | 2.0704E 05 | 4.2530E 02 | 4.8681E 02 | 4.0397E 02 | 3.2834E 01 | 4.8769E 00 |
| 4 | 1.9661E 05 | 4.2706E 02 | 4.6038E 02 | 3.8008E 02 | 8.0297E 01 | 4.7335E 00 |
| 5 | 2.1616E 03 | 2.1624E 03 | 1.2260E 05 | 4.7398E 02 | 4.7586E 02 | 2.4244E 04 |

TOTAL IMPULSE = 1.1437E 06

TIME = 8.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0831E 05 | 4.3119E 02 | 4.8312E 02 | 4.0366E 02 | 7.9462E 01 | 5.0799E 00 |
| 2 | 7.0814E 01 | 4.3658E 00 | 6.7028E 00 | 3.1975E 00 | 3.5054E 00 | 9.1216E-01 |
| 3 | 2.0831E 05 | 4.2529E 02 | 4.8982E 02 | 4.0685E 02 | 8.2967E 01 | 4.9038E 00 |
| 4 | 1.9684E 05 | 4.2702E 02 | 4.6096E 02 | 3.8061E 02 | 8.0350E 01 | 4.7370E 00 |
| 5 | 2.2023E 03 | 2.2031E 03 | 1.2256E 05 | 4.8227E 02 | 4.8420E 02 | 2.4236E 04 |

TOTAL IMPULSE = 1.1645E 06

TIME = 8.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0922E 05 | 4.3124E 02 | 4.8516E 02 | 4.0587E 02 | 7.9294E 01 | 5.1185E 00 |
| 2 | 7.0814E 01 | 4.3662E 00 | 6.6180E 00 | 3.1640E 00 | 3.4540E 00 | 9.1604E-01 |
| 3 | 2.0922E 05 | 4.2544E 02 | 4.9178E 02 | 4.0903E 02 | 8.2748E 01 | 4.9431E 00 |
| 4 | 1.9708E 05 | 4.2699E 02 | 4.6156E 02 | 3.8117E 02 | 8.0337E 01 | 4.7411E 00 |
| 5 | 2.2432E 03 | 2.2440E 03 | 1.2252E 05 | 4.9055E 02 | 4.9252E 02 | 2.4227E 04 |

TOTAL IMPULSE = 1.1855E 06

TIME = 8.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1029E 05 | 4.3132E 02 | 4.8754E 02 | 4.0846E 02 | 7.9083E 01 | 5.1649E 00 |
| 2 | 7.0814E 01 | 4.3662E 00 | 6.6757E 00 | 3.1957E 00 | 3.4800E 00 | 9.1831E-01 |
| 3 | 2.1029E 05 | 4.2549E 02 | 4.9422E 02 | 4.1166E 02 | 8.2563E 01 | 4.9860E 00 |
| 4 | 1.9734E 05 | 4.2696E 02 | 4.6219E 02 | 3.8175E 02 | 8.0438E 01 | 4.7459E 00 |
| 5 | 2.2843E 03 | 2.2851E 03 | 1.2248E 05 | 4.9880E 02 | 5.0082E 02 | 2.4219E 04 |

TOTAL IMPULSE = 1.2065E 06

TIME = 8.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1151E 05 | 4.3127E 02 | 4.9043E 02 | 4.1134E 02 | 7.9089E 01 | 5.2009E 00 |
| 2 | 7.0814E 01 | 4.3660E 00 | 6.9233E 00 | 3.3200E 00 | 3.6034E 00 | 9.2135E-01 |
| 3 | 2.1151E 05 | 4.2527E 02 | 4.9735E 02 | 4.1466E 02 | 8.2693E 01 | 5.0144E 00 |
| 4 | 1.9760E 05 | 4.2693E 02 | 4.6285E 02 | 3.8237E 02 | 8.0480F 01 | 4.7511E 00 |
| 5 | 2.3258E 03 | 2.3266E 03 | 1.2243E 05 | 5.0707E 02 | 5.0913E 02 | 2.4211E 04 |

TOTAL IMPULSE = 1.2276F 06

TIME = 8.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1252E 05 | 4.3119E 02 | 4.9286E 02 | 4.1369E 02 | 7.9178E 01 | 5.2248E 00 |
| 2 | 7.0814E 01 | 4.3659E 00 | 7.1847E 00 | 3.4491E 00 | 3.7355E 00 | 9.2332E-01 |
| 3 | 2.1252E 05 | 4.2499E 02 | 5.0005E 02 | 4.1714E 02 | 8.2913E 01 | 5.0310E 00 |
| 4 | 1.9788E 05 | 4.2689E 02 | 4.6353E 02 | 3.8301E 02 | 8.0525E 01 | 4.7564E 00 |
| 5 | 2.3675E 03 | 2.3683E 03 | 1.2239E 05 | 5.1536E 02 | 5.1747E 02 | 2.4203E 04 |

TOTAL IMPULSE = 1.2489E 06

TIME = 8.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1312E 05 | 4.3116E 02 | 4.9430E 02 | 4.1510E 02 | 7.9200E 01 | 5.2412E 00 |
| 2 | 7.0814E 01 | 4.3660E 00 | 6.8645E 00 | 3.3006E 00 | 3.5639E 00 | 9.2610F-01 |
| 3 | 2.1312E 05 | 4.2525E 02 | 5.0117E 02 | 4.1840E 02 | 8.2764E 01 | 5.0554E 00 |
| 4 | 1.9815E 05 | 4.2686E 02 | 4.6421E 02 | 3.8365E 02 | 8.0566E 01 | 4.7619E 00 |
| 5 | 2.4094E 03 | 2.4102E 03 | 1.2235E 05 | 5.2364E 02 | 5.2579E 02 | 2.4194F 04 |

TOTAL IMPULSE = 1.2702E 06

TIME = 8.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1414E 05 | 4.3109E 02 | 4.9673E 02 | 4.1747E 02 | 7.9259E 01 | 5.2672E 00 |
| 2 | 7.0814E 01 | 4.3660E 00 | 6.5049E 00 | 3.1312E 00 | 3.3737E 00 | 9.2819E-01 |
| 3 | 2.1414E 05 | 4.2552E 02 | 5.0323E 02 | 4.2060E 02 | 8.2632E 01 | 5.0930E 00 |
| 4 | 1.9844E 05 | 4.2683E 02 | 4.6491E 02 | 3.8430E 02 | 8.0602E 01 | 4.7679E 00 |
| 5 | 2.4514E 03 | 2.4523E 03 | 1.2231E 05 | 5.3190E 02 | 5.3410E 02 | 2.4166E 04 |

TOTAL IMPULSE = 1.2916E 06

TIME = 8.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1538E 05 | 4.3098E 02 | 4.9975E 02 | 4.2035E 02 | 7.9395E 01 | 5.2944E 00 |
| 2 | 7.0814E 01 | 4.3660E 00 | 6.6618E 00 | 3.2130E 00 | 3.4498E 00 | 9.3165E-01 |
| 3 | 2.1538E 05 | 4.2531E 02 | 5.0641E 02 | 4.2357E 02 | 8.2844E 01 | 5.1128E 00 |
| 4 | 1.9873E 05 | 4.2680E 02 | 4.6563E 02 | 3.8499E 02 | 8.0641E 01 | 4.7741E 00 |
| 5 | 2.4938E 03 | 2.4946E 03 | 1.2227E 05 | 5.4019E 02 | 5.4243E 02 | 2.4178E 04 |

TOTAL IMPULSE = 1.3132E 06

TIME = 9.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1654E 05 | 4.3075E 02 | 5.0271E 02 | 4.2295E 02 | 7.9758E 01 | 5.3029E 00 |
| 2 | 7.0813E 01 | 4.3660E 00 | 7.1616E 00 | 3.4595E 00 | 3.7021E 00 | 9.3446E-01 |
| 3 | 2.1654E 05 | 4.2470E 02 | 5.0987E 02 | 4.2641E 02 | 8.3460E 01 | 5.1091E 00 |
| 4 | 1.9904E 05 | 4.2676E 02 | 4.6639E 02 | 3.8570E 02 | 8.0690E 01 | 4.7800E 00 |
| 5 | 2.5364E 03 | 2.5373E 03 | 1.2222E 05 | 5.4853E 02 | 5.5082E 02 | 2.4169E 04 |

TOTAL IMPULSE = 1.3348E 06

TIME = 9.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1774E 05 | 4.3047E 02 | 5.0583E 02 | 4.2559E 02 | 8.0237E 01 | 5.3042E 00 |
| 2 | 7.0813E 01 | 4.3664E 00 | 7.0513E 00 | 3.4128E 00 | 3.6385E 00 | 9.3788E-01 |
| 3 | 2.1774E 05 | 4.2455E 02 | 5.1288E 02 | 4.2901E 02 | 8.3875E 01 | 5.1148E 00 |
| 4 | 1.9935E 05 | 4.2672E 02 | 4.6717E 02 | 3.8643E 02 | 8.0744E 01 | 4.7859E 00 |
| 5 | 2.5793E 03 | 2.5802E 03 | 1.2218E 05 | 5.5692E 02 | 5.5925E 02 | 2.4161E 04 |

TOTAL IMPULSE = 1.3565E 06

TIME = 9.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1892E 05 | 4.3029E 02 | 5.0878E 02 | 4.2826E 02 | 8.0523E 01 | 5.3185E 00 |
| 2 | 7.0813E 01 | 4.3658E 00 | 6.6978E 00 | 3.2472E 00 | 3.4506E 00 | 9.4107E-01 |
| 3 | 2.1892E 05 | 4.2470E 02 | 5.1548E 02 | 4.3151E 02 | 8.3974E 01 | 5.1386E 00 |
| 4 | 1.9968E 05 | 4.2668E 02 | 4.6797E 02 | 3.8718E 02 | 8.0797E 01 | 4.7920E 00 |
| 5 | 2.6225E 03 | 2.6233E 03 | 1.2214E 05 | 5.6532E 02 | 5.6770E 02 | 2.4157E 04 |

TOTAL IMPULSE = 1.3785E 06

TIME = 9.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1985E 05 | 4.3032E 02 | 5.1088E 02 | 4.3048E 02 | 8.0600E 01 | 5.3543E 00 |
| 2 | 7.0813E 01 | 4.3650E 00 | 6.7420E 00 | 3.2740E 00 | 3.4685E 00 | 9.4393E-01 |
| 3 | 2.1985E 05 | 4.2472E 02 | 5.1763E 02 | 4.3376E 02 | 8.3868E 01 | 5.1719E 00 |
| 4 | 2.0001E 05 | 4.2665E 02 | 4.6878E 02 | 3.8794E 02 | 8.0847E 01 | 4.7984F 00 |
| 5 | 2.6658E 03 | 2.6667E 03 | 1.2209E 05 | 5.7371E 02 | 5.7613E 02 | 2.4144E 04 |

TOTAL IMPULSE = 1.4005E 06

TIME = 9.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2069E 05 | 4.3035E 02 | 5.1281E 02 | 4.3250E 02 | 8.0314E 01 | 5.3851E 00 |
| 2 | 7.0811E 01 | 4.3643E 00 | 6.9384E 00 | 3.3733E 00 | 3.5651E 00 | 9.4618F-01 |
| 3 | 2.2069E 05 | 4.2460E 02 | 5.1975E 02 | 4.3587E 02 | 8.3879E 01 | 5.1964E 00 |
| 4 | 2.0034E 05 | 4.2661E 02 | 4.6960E 02 | 3.8871E 02 | 8.0896E 01 | 4.8050E 00 |
| 5 | 2.7094E 03 | 2.7103E 03 | 1.2205E 05 | 5.8209E 02 | 5.8456E 02 | 2.4135E 04 |

TOTAL IMPULSE = 1.4225E 06

TIME = 9.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2143E 05 | 4.3033E 02 | 5.1455E 02 | 4.3425E 02 | 8.0308E 01 | 5.4072E 00 |
| 2 | 7.0808E 01 | 4.3648E 00 | 7.0604E 00 | 3.4372E 00 | 3.6231E 00 | 9.4869E-01 |
| 3 | 2.2143E 05 | 4.2450E 02 | 5.2161E 02 | 4.3768E 02 | 8.3932E 01 | 5.2148E 00 |
| 4 | 2.0067E 05 | 4.2658E 02 | 4.7042E 02 | 3.8948E 02 | 8.0944E 01 | 4.8117E 00 |
| 5 | 2.7532E 03 | 2.7541E 03 | 1.2201E 05 | 5.9049E 02 | 5.9300E 02 | 2.4127E 04 |

TOTAL IMPULSE = 1.4447E 06

TIME = 9.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2209E 05 | 4.3027E 02 | 5.1616E 02 | 4.3578E 02 | 8.0378E 01 | 5.4216E 00 |
| 2 | 7.0808E 01 | 4.3643E 00 | 7.2304E 00 | 3.5239E 00 | 3.7065E 00 | 9.5073E-01 |
| 3 | 2.2209E 05 | 4.2433E 02 | 5.2339E 02 | 4.3931E 02 | 8.4045E 01 | 5.2246E 00 |
| 4 | 2.0100E 05 | 4.2654E 02 | 4.7125E 02 | 3.9026E 02 | 8.0993E 01 | 4.8184E 00 |
| 5 | 2.7971E 03 | 2.7980E 03 | 1.2196E 05 | 5.9890E 02 | 6.0146E 02 | 2.4119E 04 |

TOTAL IMPULSE = 1.4669E 06

TIME = 9.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2282E 05 | 4.3017E 02 | 5.1797E 02 | 4.3744E 02 | 8.0537E 01 | 5.4315E 00 |
| 2 | 7.0810E 01 | 4.3645E 00 | 7.3033E 00 | 3.5630E 00 | 3.7403E 00 | 9.5258F-01 |
| 3 | 2.2282E 05 | 4.2419E 02 | 5.2528E 02 | 4.4100E 02 | 8.4277E 01 | 5.2327E 00 |
| 4 | 2.0134E 05 | 4.2650E 02 | 4.7208E 02 | 3.9103E 02 | 8.1043E 01 | 4.8250E 00 |
| 5 | 2.8412E 03 | 2.8422E 03 | 1.2192E 05 | 6.0732E 02 | 6.0993E 02 | 2.4110E 04 |

TOTAL IMPULSE = 1.4892E 06

TIME = 9.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2362E 05 | 4.3001E 02 | 5.2002E 02 | 4.3921E 02 | 8.0811E 01 | 5.4350E 00 |
| 2 | 7.0810E 01 | 4.3652E 00 | 7.1661E 00 | 3.4999E 00 | 3.6663E 00 | 9.5461F-01 |
| 3 | 2.2362E 05 | 4.2417E 02 | 5.2719E 02 | 4.4271E 02 | 8.4477E 01 | 5.2404E 00 |
| 4 | 2.0167E 05 | 4.2646E 02 | 4.7291E 02 | 3.9181E 02 | 8.1095E 01 | 4.8315E 00 |
| 5 | 2.8855E 03 | 2.8864E 03 | 1.2187E 05 | 6.1577E 02 | 6.1843E 02 | 2.4102E 04 |

TOTAL IMPULSE = 1.5115E 06

TIME = 9.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2412E 05 | 4.2991E 02 | 5.2132E 02 | 4.4033E 02 | 8.0989E 01 | 5.4369E 00 |
| 2 | 7.0810E 01 | 4.3658E 00 | 7.0320E 00 | 3.4395E 00 | 3.5926E 00 | 9.5738F-01 |
| 3 | 2.2412E 05 | 4.2419E 02 | 5.2835E 02 | 4.4377E 02 | 8.4581E 01 | 5.2467E 00 |
| 4 | 2.0201E 05 | 4.2642E 02 | 4.7373E 02 | 3.9258E 02 | 8.1147E 01 | 4.8380E 00 |
| 5 | 2.9299E 03 | 2.9308E 03 | 1.2183E 05 | 6.2423E 02 | 6.2693E 02 | 2.4093E 04 |

TOTAL IMPULSE = 1.5339E 06

TIME = 10.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2533E 05 | 4.2969E 02 | 5.2440E 02 | 4.4303E 02 | 8.1379E 01 | 5.4440E 00 |
| 2 | 7.0810E 01 | 4.3654E 00 | 6.9329E 00 | 3.4253F 00 | 3.5676E 00 | 9.6010F-01 |
| 3 | 2.2533E 05 | 4.2403E 02 | 5.3140E 02 | 4.4645E 02 | 8.4946E 01 | 5.2557E 00 |
| 4 | 2.0235E 05 | 4.2638E 02 | 4.7457E 02 | 3.9337E 02 | 8.1202E 01 | 4.8444F 00 |
| 5 | 2.9745E 03 | 2.9755E 03 | 1.2179E 05 | 6.3272E 02 | 6.3547E 02 | 2.4085E 04 |

TOTAL IMPULSE = 1.5565E 06

TIME = 20.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3098E 05 | 4.3042E 02 | 5.3663E 02 | 4.5699E 02 | 7.9637E 01 | 5.7385F 00 |
| 2 | 7.0799E 01 | 4.3638E 00 | 7.2959E 00 | 3.6448E 00 | 3.6511E 00 | 9.9826F-01 |
| 3 | 2.3098E 05 | 4.2465E 02 | 5.4392E 02 | 4.6064E 02 | 8.3288E 01 | 5.5307E 00 |
| 4 | 2.1864E 05 | 4.2501E 02 | 5.1444E 02 | 4.3137E 02 | 8.3069E 01 | 5.1929E 00 |
| 5 | 7.5477E 03 | 7.5496E 03 | 1.1721E 05 | 1.4762E 03 | 1.4818E 03 | 2.3236E 04 |

TOTAL IMPULSE = 3.8542E 06

TIME = 30.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3202E 05 | 4.2976E 02 | 5.3987E 02 | 4.5895E 02 | 8.0922E 01 | 5.6715E 00 |
| 2 | 7.0790E 01 | 4.3637E 00 | 7.0059E 00 | 3.5061F 00 | 3.4998E 00 | 1.0018E 00 |
| 3 | 2.3202E 05 | 4.2426E 02 | 5.4688E 02 | 4.6246E 02 | 8.4472E 01 | 5.4779E 00 |
| 4 | 2.2335E 05 | 4.2474E 02 | 5.2585E 02 | 4.4240E 02 | 8.3443E 01 | 5.3019E 00 |
| 5 | 1.2158E 04 | 1.2160E 04 | 1.1260E 05 | 2.3169E 03 | 2.3295E 03 | 2.2391E 04 |

TOTAL IMPULSE = 6.1669E 06

TIME = 40.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3173E 05 | 4.2985E 02 | 5.3910F 02 | 4.5835F 02 | 8.0755E 01 | 5.6761F 00 |
| 2 | 7.0787E 01 | 4.3631E 00 | 7.0509E 00 | 3.5310E 00 | 3.5194E 00 | 1.0037E 00 |
| 3 | 2.3173E 05 | 4.2410E 02 | 5.4615E 02 | 4.6188E 02 | 8.4270E 01 | 5.4810E 00 |
| 4 | 2.2539E 05 | 4.2462E 02 | 5.3080E 02 | 4.4717E 02 | 8.3635E 01 | 5.3466E 00 |
| 5 | 1.6757E 04 | 1.6761E 04 | 1.0800E 05 | 3.1584E 03 | 3.1760E 03 | 2.1544E 04 |

TOTAL IMPULSE = 8.4755E 06

28 September 1966

# TABLE AP 3-1 (Sheet 11 of 12)
## COMPUTER PROGRAM F823 (2ND BURN)

TIME = 50.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3084E 05 | 4.3080E 02 | 5.3583E 02 | 4.5955E 02 | 7.9887E 01 | 5.7929E 00 |
| 2 | 7.0773E 01 | 4.3614E 00 | 7.2055E 00 | 3.6064E 00 | 3.5991E 00 | 1.0020E 00 |
| 3 | 2.3084E 05 | 4.2509E 02 | 5.4304E 02 | 4.6056E 02 | 8.2481E 01 | 5.5934E 00 |
| 4 | 2.2657E 05 | 4.2455E 02 | 5.3366E 02 | 4.4994E 02 | 8.3726E 01 | 5.3740E 00 |
| 5 | 2.1358E 04 | 2.1363E 04 | 1.0340E 05 | 3.9990E 03 | 4.0215E 03 | 2.3698E 04 |

TOTAL IMPULSE = 1.0785E 07

TIME = 60.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3071E 05 | 4.3021E 02 | 5.3627E 02 | 4.5621E 02 | 8.0067E 01 | 5.6978E 00 |
| 2 | 7.0763E 01 | 4.3602E 00 | 7.2244E 00 | 3.6158E 00 | 3.6096E 00 | 1.0020E 00 |
| 3 | 2.3071E 05 | 4.2450E 02 | 5.4350E 02 | 4.5982E 02 | 8.3576E 01 | 5.4953E 00 |
| 4 | 2.2735E 05 | 4.2451E 02 | 5.3556E 02 | 4.5177E 02 | 8.3798E 01 | 5.3918E 00 |
| 5 | 2.5962E 04 | 2.5968E 04 | 9.8793E 04 | 4.8398E 03 | 4.8573E 03 | 1.9853E 04 |

TOTAL IMPULSE = 1.3395E 07

TIME = 70.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3089E 05 | 4.2988E 02 | 5.3712E 02 | 4.5635E 02 | 8.0778E 01 | 5.6496E 00 |
| 2 | 7.0752E 01 | 4.3593E 00 | 7.2571E 00 | 3.6332E 00 | 3.6240E 00 | 1.0025E 00 |
| 3 | 2.3089E 05 | 4.2413E 02 | 5.4438E 02 | 4.5998E 02 | 8.4402E 01 | 5.4499E 00 |
| 4 | 2.2789E 05 | 4.2443E 02 | 5.3693E 02 | 4.5301E 02 | 8.3923E 01 | 5.1979E 00 |
| 5 | 3.0562E 04 | 3.0569E 04 | 9.4192E 04 | 5.6867E 03 | 5.7192E 03 | 1.9001E 04 |

TOTAL IMPULSE = 1.5404E 07

TIME = 80.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2882E 05 | 4.3013E 02 | 5.3199E 02 | 4.5166E 02 | 8.0335E 01 | 5.6227E 00 |
| 2 | 7.0743E 01 | 4.3567E 00 | 7.2350E 00 | 3.6185E 00 | 3.6165E 00 | 1.0025E 00 |
| 3 | 2.2882E 05 | 4.2435E 02 | 5.3921E 02 | 4.5526E 02 | 8.3951E 01 | 5.4229E 00 |
| 4 | 2.2828E 05 | 4.2440E 02 | 5.3789E 02 | 4.5390E 02 | 8.3499E 01 | 5.4042E 00 |
| 5 | 3.5161E 04 | 3.5168E 04 | 8.9593E 04 | 6.5310E 03 | 6.5686E 03 | 1.9151E 04 |

TOTAL IMPULSE = 1.7713E 07

TIME = 90.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.3037E 05 | 4.3031E 02 | 5.3536E 02 | 4.5548E 02 | 7.9884E 01 | 5.7017E 00 |
| 2 | 7.0733E 01 | 4.3568E 00 | 7.2368E 00 | 3.6220E 00 | 3.6144E 00 | 1.0020E 00 |
| 3 | 2.3037E 05 | 4.2457E 02 | 5.4260E 02 | 4.5910E 02 | 8.3499E 01 | 5.4983E 00 |
| 4 | 2.2858E 05 | 4.2439E 02 | 5.3451E 02 | 4.5451E 02 | 8.4006E 01 | 5.4119E 00 |
| 5 | 3.4762E 04 | 3.4770E 04 | 8.4991E 04 | 7.3721E 03 | 7.4147E 03 | 1.7305E 04 |

TOTAL IMPULSE = 2.0022E 07

TIME = 100.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.2056E 05 | 4.3158E 02 | 5.1105E 02 | 4.3311E 02 | 7.7942E 01 | 5.5569E 00 |
| 2 | 7.0723E 01 | 4.3563E 00 | 6.9556E 00 | 3.4397E 00 | 3.5159E 00 | 9.7833E-01 |
| 3 | 2.2056E 05 | 4.2578E 02 | 5.1401E 02 | 4.3655E 02 | 8.1458E 01 | 5.3593E 00 |
| 4 | 2.2835E 05 | 4.2442E 02 | 5.3402E 02 | 4.5409E 02 | 8.3925E 01 | 5.4108E 00 |
| 5 | 4.4258E 04 | 4.4267E 04 | 8.0494E 04 | 8.2067E 03 | 8.2572E 03 | 1.6468E 04 |

TOTAL IMPULSE = 2.2285E 07

TIME = 110.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.1064E 05 | 4.3259E 02 | 4.8683E 02 | 4.1030E 02 | 7.6533E 01 | 5.3611E 00 |
| 2 | 7.0714E 01 | 4.3555E 00 | 7.1247E 00 | 3.4649E 00 | 3.6598E 00 | 9.4675E-01 |
| 3 | 2.1064E 05 | 4.2644E 02 | 4.9396E 02 | 4.1376E 02 | 8.0192E 01 | 5.1596E 00 |
| 4 | 2.2710E 05 | 4.2454E 02 | 5.3449E 02 | 4.5125E 02 | 8.3641E 01 | 5.3951E 00 |
| 5 | 4.8495E 04 | 4.8505E 04 | 7.6256E 04 | 9.0135E 03 | 9.0656E 03 | 1.5654E 04 |

TOTAL IMPULSE = 2.4436E 07

TIME = 120.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0426E 05 | 4.3347E 02 | 4.7123E 02 | 3.9563E 02 | 7.5595E 01 | 5.2335E 00 |
| 2 | 7.0704E 01 | 4.3558E 00 | 6.9003E 00 | 3.0742E 00 | 3.3762E 00 | 9.2424E-01 |
| 3 | 2.0426E 05 | 4.2766E 02 | 4.7763E 02 | 3.9871E 02 | 7.8922E 01 | 5.0519E 00 |
| 4 | 2.2541E 05 | 4.2479E 02 | 5.3065E 02 | 4.4739E 02 | 8.3264E 01 | 5.3728E 00 |
| 5 | 5.2556E 04 | 5.2557E 04 | 7.2194E 04 | 9.8063E 03 | 9.8629E 03 | 1.4857E 04 |

TOTAL IMPULSE = 2.6510E 07

TIME = 130.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0171E 05 | 4.3428E-02 | 4.6447E 02 | 3.9008E 02 | 7.4385E 01 | 5.2441E 00 |
| 2 | 7.0692E 01 | 4.3542E 00 | 6.6515E 00 | 3.1724E 00 | 3.4788E 00 | 9.1204E-01 |
| 3 | 2.0171E 05 | 4.2815E 02 | 4.7112E 02 | 3.9325E 02 | 7.7864E 01 | 5.0505E 00 |
| 4 | 2.2367E 05 | 4.2499E 02 | 5.2630E 02 | 4.4337E 02 | 8.2925E 01 | 5.3468E 00 |
| 5 | 5.6521E 04 | 5.6533E 04 | 6.8228E 04 | 1.0596E 04 | 1.0656E 04 | 1.4064E 04 |

TOTAL IMPULSE = 2.9543E 07

TIME = 140.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0102E 05 | 4.3119E 02 | 4.6494E 02 | 3.8767E 02 | 7.6348E 01 | 5.2763E 00 |
| 2 | 7.0681E 01 | 4.3523E 00 | 6.4461E 00 | 3.0956E 00 | 3.4075E 00 | 9.0740E-01 |
| 3 | 2.0102E 05 | 4.2722E 02 | 4.7052E 02 | 3.9075E 02 | 7.9769E 01 | 4.8986E 00 |
| 4 | 2.2235E 05 | 4.2515E 02 | 5.2228E 02 | 4.3951E 02 | 8.2654E 01 | 5.3181E 00 |
| 5 | 6.0440E 04 | 6.0454E 04 | 6.4107E 04 | 1.1389E 04 | 1.1454E 04 | 1.3266E 04 |

TOTAL IMPULSE = 3.0557E 07

TIME = 150.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9914E 05 | 4.3460E 02 | 4.5623E 02 | 3.8417E 02 | 7.4057E 01 | 5.1874E 00 |
| 2 | 7.0670E 01 | 4.3515E 00 | 6.4222E 00 | 3.0535E 00 | 3.3437E 00 | 9.0110E-01 |
| 3 | 1.9914E 05 | 4.2858E 02 | 4.6467E 02 | 3.8722E 02 | 7.7446E 01 | 4.9999E 00 |
| 4 | 2.2055E 05 | 4.2531E 02 | 5.1457E 02 | 4.3614E 02 | 8.2408E 01 | 5.2927E 00 |
| 5 | 6.4329E 04 | 6.4343E 04 | 6.0418E 04 | 1.2178E 04 | 1.2252E 04 | 1.2468E 04 |

TOTAL IMPULSE = 3.2558E 07

TIME = 160.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0185E 05 | 4.3311E 02 | 4.6606E 02 | 3.8962E 02 | 7.4438E 01 | 5.3972E 00 |
| 2 | 7.0656E 01 | 4.3447E 00 | 6.4321E 00 | 3.0656E 00 | 3.3657E 00 | 9.1049E-01 |
| 3 | 2.0185E 05 | 4.2722E 02 | 4.7249E 02 | 3.9268E 02 | 7.9405E 01 | 4.9706E 00 |
| 4 | 2.1930E 05 | 4.2547E 02 | 5.1543E 02 | 4.3329E 02 | 8.2143E 01 | 5.2748E 00 |
| 5 | 6.8241E 04 | 6.8256E 04 | 5.6605E 04 | 1.2961E 04 | 1.3046E 04 | 1.1674E 04 |

TOTAL IMPULSE = 3.4567E 07

TIME = 170.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0057E 05 | 4.3350E 02 | 4.6268E 02 | 3.8683E 02 | 7.5855E 01 | 5.3996E 00 |
| 2 | 7.0641E 01 | 4.3489E 00 | 6.4194E 00 | 3.0587E 00 | 3.3611E 00 | 9.1005E-01 |
| 3 | 2.0057E 05 | 4.2757E 02 | 4.6910E 02 | 3.8989E 02 | 7.9216E 01 | 4.9214E 00 |
| 4 | 2.1828E 05 | 4.2559E 02 | 5.1289E 02 | 4.3094E 02 | 8.1951E 01 | 5.2585E 00 |
| 5 | 7.2181E 04 | 7.2198E 04 | 5.2563E 04 | 1.3750E 04 | 1.3847E 04 | 1.0873E 04 |

TOTAL IMPULSE = 3.6590E 07

TIME = 180.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0317E 05 | 4.3420E 02 | 4.6791E 02 | 3.9351E 02 | 7.4399E 01 | 5.2892E 00 |
| 2 | 7.0624E 01 | 4.3461E 00 | 6.4802E 00 | 3.0978E 00 | 3.3423E 00 | 9.1588E-01 |
| 3 | 2.0317E 05 | 4.2827E 02 | 4.7439E 02 | 3.9661E 02 | 7.7782E 01 | 5.0999E 00 |
| 4 | 2.1739E 05 | 4.2568E 02 | 5.1068E 02 | 4.2897E 02 | 8.1813E 01 | 5.2421E 00 |
| 5 | 7.6125E 04 | 7.6142E 04 | 4.8619E 04 | 1.4545E 04 | 1.4654E 04 | 1.0066E 04 |

TOTAL IMPULSE = 3.8615E 07

TIME = 190.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0401E 05 | 4.3381E 02 | 4.7028E 02 | 3.9525E 02 | 7.5021E 01 | 5.2688E 00 |
| 2 | 7.0614E 01 | 4.3444E 00 | 6.5976E 00 | 3.1595E 00 | 3.4390E 00 | 9.1843E-01 |
| 3 | 2.0401E 05 | 4.2780E 02 | 4.7687E 02 | 3.9841E 02 | 7.8460E 01 | 5.0779E 00 |
| 4 | 2.1665E 05 | 4.2577E 02 | 5.0484E 02 | 4.2717E 02 | 8.1663E 01 | 5.2399E 00 |
| 5 | 8.0097E 04 | 8.0115E 04 | 4.4646E 04 | 1.5335E 04 | 1.5455E 04 | 9.7646E 03 |

TOTAL IMPULSE = 4.0651E 07

TIME = 200.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0612E 05 | 4.3299E 02 | 4.7605E 02 | 3.9973E 02 | 7.6326E 01 | 5.2371E 00 |
| 2 | 7.0594E 01 | 4.3434E 00 | 6.7267E 00 | 3.2372E 00 | 3.4895E 00 | 9.2771E-01 |
| 3 | 2.0612E 05 | 4.2695E 02 | 4.8278E 02 | 4.0297E 02 | 7.9816E 01 | 5.0487E 00 |
| 4 | 2.1805E 05 | 4.2582E 02 | 5.0738E 02 | 4.2580E 02 | 8.1583E 01 | 5.2192E 00 |
| 5 | 8.4098E 04 | 8.4117E 04 | 4.0644E 04 | 1.6136E 04 | 1.6269E 04 | 8.4521E 03 |

TOTAL IMPULSE = 4.2700E 07

TIME = 210.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0879E 05 | 4.3142E 02 | 4.8339E 02 | 4.0533E 02 | 7.8063E 01 | 5.1924E 00 |
| 2 | 7.0575E 01 | 4.3416E 00 | 6.7067E 00 | 3.2505E 00 | 3.4562E 00 | 9.4048E-01 |
| 3 | 2.0879E 05 | 4.2601E 02 | 4.9010E 02 | 4.0858E 02 | 8.1519E 01 | 5.0121E 00 |
| 4 | 2.1563E 05 | 4.2586E 02 | 5.0635E 02 | 4.2482E 02 | 8.1526E 01 | 5.2108E 00 |
| 5 | 8.8153E 04 | 8.8173E 04 | 3.6588E 04 | 1.6940E 04 | 1.7084E 04 | 7.6363E 03 |

TOTAL IMPULSE = 4.4774E 07

TIME = 220.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0934E 05 | 4.3246E 02 | 4.8407E 02 | 4.0703E 02 | 7.7034E 01 | 5.2838E 00 |
| 2 | 7.0547E 01 | 4.3381E 00 | 6.7346E 00 | 3.2700E 00 | 3.4445E 00 | 9.4382E-01 |
| 3 | 2.0934E 05 | 4.2652E 02 | 4.9080E 02 | 4.1030E 02 | 8.0499E 01 | 5.0970E 00 |
| 4 | 2.1537E 05 | 4.2589E 02 | 5.0569E 02 | 4.2421E 02 | 8.1476E 01 | 5.2065E 00 |
| 5 | 9.2269E 04 | 9.2290E 04 | 3.2471E 04 | 1.7745E 04 | 1.7900E 04 | 6.8270E 03 |

TOTAL IMPULSE = 4.6872E 07

TIME = 230.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0730E 05 | 4.3276E 02 | 4.7499E 02 | 4.0239E 02 | 7.6604E 01 | 5.2528E 00 |
| 2 | 7.0524E 01 | 4.3372E 00 | 6.7936E 00 | 3.2865E 00 | 3.5071E 00 | 9.3712E-01 |
| 3 | 2.0730E 05 | 4.2673E 02 | 4.8579E 02 | 4.0567E 02 | 8.0111E 01 | 5.0639E 00 |
| 4 | 2.1506E 05 | 4.2592E 02 | 5.0493E 02 | 4.2350E 02 | 8.1427E 01 | 5.2010E 00 |
| 5 | 9.6351E 04 | 9.6373E 04 | 2.8388E 04 | 1.8548E 04 | 1.8715E 04 | 6.0047E 03 |

TOTAL IMPULSE = 4.8957E 07

TIME = 240.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0769E 05 | 4.3247E 02 | 4.8025E 02 | 4.0311E 02 | 7.7142E 01 | 5.2256E 00 |
| 2 | 7.0499E 01 | 4.3344E 00 | 6.7980E 00 | 3.2930E 00 | 3.5050E 00 | 9.3950E-01 |
| 3 | 2.0769E 05 | 4.2643E 02 | 4.8705E 02 | 4.0640E 02 | 8.0647E 01 | 5.0393E 00 |
| 4 | 2.1473E 05 | 4.2595E 02 | 5.0413E 02 | 4.2274E 02 | 8.1387E 01 | 5.1942E 00 |
| 5 | 1.0041E 05 | 1.0043E 05 | 2.4333E 04 | 1.9353E 04 | 1.9532E 04 | 5.1882E 03 |

TOTAL IMPULSE = 5.1029E 07

TIME = 250.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0697E 05 | 4.3251E 02 | 4.7952E 02 | 4.0141E 02 | 7.7111E 01 | 5.2056E 00 |
| 2 | 7.0468E 01 | 4.3300E 00 | 6.6768E 00 | 3.2207E 00 | 3.4561E 00 | 9.3187E-01 |
| 3 | 2.0697E 05 | 4.2656E 02 | 4.8520E 02 | 4.0463E 02 | 8.0567E 01 | 5.0222E 00 |
| 4 | 2.1462E 05 | 4.2598E 02 | 5.0335E 02 | 4.2201E 02 | 8.1345E 01 | 5.1879E 00 |
| 5 | 1.0445E 05 | 1.0448E 05 | 2.0285E 04 | 2.0156E 04 | 2.0341E 04 | 4.3767E 03 |

TOTAL IMPULSE = 5.3099E 07

TIME = 260.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0417E 05 | 4.3322E 02 | 4.7129E 02 | 3.9524E 02 | 7.6044E 01 | 5.1975E 00 |
| 2 | 7.0428E 01 | 4.3270E 00 | 6.7217E 00 | 3.2282E 00 | 3.4936E 00 | 9.2404E-01 |
| 3 | 2.0417E 05 | 4.2713E 02 | 4.7801E 02 | 3.9847E 02 | 7.9538E 01 | 5.0098E 00 |
| 4 | 2.1466E 05 | 4.2602E 02 | 5.0247E 02 | 4.2118E 02 | 8.1289E 01 | 5.1813E 00 |
| 5 | 1.0846E 05 | 1.0848E 05 | 1.6277E 04 | 2.0955E 04 | 2.1147E 04 | 3.5730E 03 |

TOTAL IMPULSE = 5.5151E 07

TIME = 270.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0388E 05 | 4.3288E 02 | 4.7099E 02 | 3.9431E 02 | 7.6689E 01 | 5.1416E 00 |
| 2 | 7.0362E 01 | 4.3232E 00 | 6.5973E 00 | 3.1671E 00 | 3.4300E 00 | 9.2343E-01 |
| 3 | 2.0388E 05 | 4.2690E 02 | 4.7759E 02 | 3.9747E 02 | 8.0119E 01 | 4.9610E 00 |
| 4 | 2.1368E 05 | 4.2606E 02 | 5.0133E 02 | 4.2013E 02 | 8.1222E 01 | 5.1748E 00 |
| 5 | 1.1244E 05 | 1.1247E 05 | 1.2296E 04 | 2.1751E 04 | 2.1947E 04 | 2.7732E 03 |

TOTAL IMPULSE = 5.7191E 07

TIME = 280.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0151E 05 | 4.3391E 02 | 4.6440E 02 | 3.8935E 02 | 7.5050E 01 | 5.1878E 00 |
| 2 | 7.0278E 01 | 4.3199E 00 | 6.6187E 00 | 3.1626E 00 | 3.4561E 00 | 9.1506E-01 |
| 3 | 2.0151E 05 | 4.2731E 02 | 4.7101E 02 | 3.9251E 02 | 7.8506E 01 | 4.9997E 00 |
| 4 | 2.1328E 05 | 4.2610E 02 | 5.0054E 02 | 4.1937E 02 | 8.1163E 01 | 5.1671E 00 |
| 5 | 1.1838E 05 | 1.1841E 05 | 8.3512E 03 | 2.2546E 04 | 2.2747E 04 | 1.9727E 03 |

TOTAL IMPULSE = 5.9216E 07

TABLE AP 3-1 (Sheet 12 of 12)
COMPUTER PROGRAM F823 (2ND BURN)

TIME = 290.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0227E 05 | 4.3341E 02 | 4.6670E 02 | 3.9083E 02 | 7.5873E 01 | 5.1511E 00 |
| 2 | 7.0098E 01 | 4.3162E 00 | 6.5576E 00 | 3.1355E 00 | 3.4221E 00 | 9.1676E-01 |
| 3 | 2.0227E 05 | 4.2740E 02 | 4.7326E 02 | 3.9397E 02 | 7.9295E 01 | 4.9684E 00 |
| 4 | 2.1287E 05 | 4.2616E 02 | 4.9950E 02 | 4.1844E 02 | 8.1066E 01 | 5.1617E 00 |
| 5 | 1.2031E 05 | 1.2034E 05 | 4.4257E 03 | 2.3330E 04 | 2.3536E 04 | 1.1843E 03 |

TOTAL IMPULSE = 6.1231E 07

TIME = 291.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0312E 05 | 4.3311E 02 | 4.6896E 02 | 3.9263E 02 | 7.6330E 01 | 5.1439E 00 |
| 2 | 7.0066E 01 | 4.3162E 00 | 6.7279E 00 | 3.2161E 00 | 3.5118E 00 | 9.1578E-01 |
| 3 | 2.0312E 05 | 4.2699E 02 | 4.7569E 02 | 3.9585E 02 | 7.9842E 01 | 4.9580E 00 |
| 4 | 2.1283E 05 | 4.2616E 02 | 4.9961E 02 | 4.1835E 02 | 8.1061E 01 | 5.1609E 00 |
| 5 | 1.2070E 05 | 1.2073E 05 | 4.0324E 03 | 2.3410E 04 | 2.3616E 04 | 1.1040E 03 |

TOTAL IMPULSE = 6.1433E 07

TIME = 292.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0147E 05 | 4.3334E 02 | 4.6493E 02 | 3.8886E 02 | 7.6070E 01 | 5.1119E 00 |
| 2 | 7.0021E 01 | 4.2851E 00 | 6.4259E 00 | 3.0774E 00 | 3.3485E 00 | 9.1905E-01 |
| 3 | 2.0147E 05 | 4.2743E 02 | 4.7136E 02 | 3.9194E 02 | 7.9418E 01 | 4.9351E 00 |
| 4 | 2.1279E 05 | 4.2617E 02 | 4.9932E 02 | 4.1826E 02 | 8.1056E 01 | 5.1601E 00 |
| 5 | 1.2109E 05 | 1.2112E 05 | 3.6395E 03 | 2.3490E 04 | 2.3696E 04 | 1.0239E 03 |

TOTAL IMPULSE = 6.1635E 07

TIME = 293.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0147E 05 | 4.3380E 02 | 4.6443E 02 | 3.8918E 02 | 7.5247E 01 | 5.1720E 00 |
| 2 | 6.9979E 01 | 4.2329E 00 | 6.6387E 00 | 3.1885E 00 | 3.4501E 00 | 9.2418E-01 |
| 3 | 2.0147E 05 | 4.2769E 02 | 4.7107E 02 | 3.9237E 02 | 7.8698E 01 | 4.9854E 00 |
| 4 | 2.1275E 05 | 4.2617E 02 | 4.9922E 02 | 4.1817E 02 | 8.1050E 01 | 5.1594E 00 |
| 5 | 1.2149E 05 | 1.2151E 05 | 3.2464E 03 | 2.3569E 04 | 2.3776E 04 | 9.4428E 02 |

TOTAL IMPULSE = 6.1837E 07

TIME = 293.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0183E 05 | 4.3370E 02 | 4.6536E 02 | 3.8997E 02 | 7.5388E 01 | 5.1729E 00 |
| 2 | 6.9973E 01 | 4.2209E 00 | 6.6176E 00 | 3.1782E 00 | 3.4394E 00 | 9.2437E-01 |
| 3 | 2.0183E 05 | 4.2762E 02 | 4.7198E 02 | 3.9315E 02 | 7.8827E 01 | 4.9875E 00 |
| 4 | 2.1275E 05 | 4.2617E 02 | 4.9921E 02 | 4.1816E 02 | 8.1049E 01 | 5.1594E 00 |
| 5 | 1.2153E 05 | 1.2155E 05 | 3.2071E 03 | 2.3577E 04 | 2.3784E 04 | 9.3635E 02 |

TOTAL IMPULSE = 6.1857E 07

TIME = 293.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0065E 05 | 4.3403E 02 | 4.6230E 02 | 3.8739E 02 | 7.4914E 01 | 5.1711E 00 |
| 2 | 6.9966E 01 | 4.2144E 00 | 6.3836E 00 | 3.0675E 00 | 3.3162E 00 | 9.2501E-01 |
| 3 | 2.0065E 05 | 4.2812E 02 | 4.6868E 02 | 3.9045E 02 | 7.8230E 01 | 4.9911E 00 |
| 4 | 2.1275E 05 | 4.2617E 02 | 4.9920E 02 | 4.1815E 02 | 8.1048E 01 | 5.1593E 00 |
| 5 | 1.2156E 05 | 1.2159E 05 | 3.1680E 03 | 2.3585E 04 | 2.3792E 04 | 9.2848E 02 |

TOTAL IMPULSE = 6.1877E 07

TIME = 293.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0074E 05 | 4.3402E 02 | 4.6251E 02 | 3.8759E 02 | 7.4925E 01 | 5.1730E 00 |
| 2 | 6.9955E 01 | 4.2116E 00 | 6.7253E 00 | 3.2348E 00 | 3.4905E 00 | 9.2674E-01 |
| 3 | 2.0074E 05 | 4.2780E 02 | 4.6924E 02 | 3.9082E 02 | 7.8415E 01 | 4.9840E 00 |
| 4 | 2.1274E 05 | 4.2617E 02 | 4.9919E 02 | 4.1814E 02 | 8.1047E 01 | 5.1593E 00 |
| 5 | 1.2160E 05 | 1.2163E 05 | 3.1289E 03 | 2.3592E 04 | 2.3799E 04 | 9.2060E 02 |

TOTAL IMPULSE = 6.1897E 07

TIME = 293.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0169E 05 | 4.3378E 02 | 4.6496E 02 | 3.8969E 02 | 7.5268E 01 | 5.1774E 00 |
| 2 | 6.9944E 01 | 4.2133E 00 | 6.5665E 00 | 3.1605E 00 | 3.4060E 00 | 9.2791E-01 |
| 3 | 2.0169E 05 | 4.2774E 02 | 4.7153E 02 | 3.9285E 02 | 7.8674E 01 | 4.9934E 00 |
| 4 | 2.1274E 05 | 4.2617E 02 | 4.9918E 02 | 4.1814E 02 | 8.1046E 01 | 5.1592E 00 |
| 5 | 2.2164E 05 | 1.2167E 05 | 3.0897E 03 | 2.3600E 04 | 2.3807E 04 | 9.1268E 02 |

TOTAL IMPULSE = 6.1917E 07

TIME = 293.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0023E 05 | 4.3442E 02 | 4.6092E 02 | 3.8664E 02 | 7.4275E 01 | 5.2056E 00 |
| 2 | 6.9939E 01 | 4.2150E 00 | 6.6192E 00 | 3.1855E 00 | 3.4337E 00 | 9.2770E-01 |
| 3 | 2.0023E 05 | 4.2827E 02 | 4.6754E 02 | 3.8983E 02 | 7.7709E 01 | 5.0166E 00 |
| 4 | 2.1273E 05 | 4.2617E 02 | 4.9917E 02 | 4.1813E 02 | 8.1045E 01 | 5.1592E 00 |
| 5 | 1.2168E 05 | 1.2171E 05 | 3.0507E 03 | 2.3608E 04 | 2.3815E 04 | 9.0487E 02 |

TOTAL IMPULSE = 6.1937E 07

TIME = 293.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9821E 05 | 4.3575E 02 | 4.5488E 02 | 3.8271E 02 | 7.2172E 01 | 5.3027E 00 |
| 2 | 6.9939E 01 | 4.2156E 00 | 6.5299E 00 | 3.1460E 00 | 3.3839E 00 | 9.2972E-01 |
| 3 | 1.9821E 05 | 4.2958E 02 | 4.6141E 02 | 3.8585E 02 | 7.5556E 01 | 5.1068E 00 |
| 4 | 2.1273E 05 | 4.2617E 02 | 4.9916E 02 | 4.1811E 02 | 8.1043E 01 | 5.1591E 00 |
| 5 | 1.2172E 05 | 1.2175E 05 | 3.0121E 03 | 2.3616E 04 | 2.3823E 04 | 8.9726E 02 |

TOTAL IMPULSE = 6.1957E 07

TIME = 293.6660

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9983E 05 | 4.3599E 02 | 4.5832E 02 | 3.8672E 02 | 7.1597E 01 | 5.4014E 00 |
| 2 | 6.9939E 01 | 4.2131E 00 | 6.0562E 00 | 2.9218E 00 | 3.1343E 00 | 9.3220E-01 |
| 3 | 1.9983E 05 | 4.3031E 02 | 4.6438E 02 | 3.8965E 02 | 7.4731E 01 | 5.2140E 00 |
| 4 | 2.1273E 05 | 4.2618E 02 | 4.9915E 02 | 4.1811E 02 | 8.1042E 01 | 5.1592E 00 |
| 5 | 2.1175E 05 | 1.2177E 05 | 2.9863E 03 | 2.3620E 04 | 2.3828E 04 | 8.9230E 02 |

TOTAL IMPULSE = 6.1970E 07

TIME = 293.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0066E 05 | 4.3612E 02 | 4.6010E 02 | 3.8879E 02 | 7.1308E 01 | 5.4523E 00 |
| 2 | 6.9938E 01 | 4.2118E 00 | 5.8121E 00 | 2.8061E 00 | 3.0060E 00 | 9.3348E-01 |
| 3 | 2.0066E 05 | 4.3068E 02 | 4.6591E 02 | 3.9159E 02 | 7.4314E 01 | 5.2695E 00 |
| 4 | 2.1272E 05 | 4.2618E 02 | 4.9915E 02 | 4.1811E 02 | 8.1041E 01 | 5.1592E 00 |
| 5 | 1.2176E 05 | 1.2179E 05 | 2.9730E 03 | 2.3623E 04 | 2.3830E 04 | 8.8976E 02 |

TOTAL IMPULSE = 6.1977E 07

TIME = 293.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.6752E 05 | 4.4615E 02 | 3.7548E 02 | 3.1489E 02 | 6.0595E 01 | 5.1965E 00 |
| 2 | 6.9937E 01 | 4.2024E 00 | 2.9331E 00 | 1.4131E 00 | 1.5200E 00 | 9.2968E-01 |
| 3 | 1.6752E 05 | 4.4270E 02 | 3.7842E 02 | 3.1630E 02 | 6.2116E 01 | 5.0921E 00 |
| 4 | 2.1271E 05 | 4.2618E 02 | 4.9910E 02 | 4.1807E 02 | 8.1035E 01 | 5.1592E 00 |
| 5 | 1.2179E 05 | 1.2182E 05 | 2.9414E 03 | 2.3629E 04 | 2.3836E 04 | 8.8350E 02 |

TOTAL IMPULSE = 6.1994E 07

TIME = 293.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.8898E 04 | 9.7380E 02 | 3.9944E 01 | 3.2605E 01 | 7.3392E 00 | 4.4426E 00 |
| 2 | 6.9943E 01 | 4.1869E 00 | 1.7541E 00 | 8.4100E-01 | 9.1311E-01 | 9.2103E-01 |
| 3 | 3.8898E 04 | 9.3284E 02 | 4.1698E 01 | 3.3446E 01 | 8.2523E 00 | 4.0529E 00 |
| 4 | 2.1265E 05 | 4.2620E 02 | 4.9895E 02 | 4.1794E 02 | 8.1010E 01 | 5.1591E 00 |
| 5 | 1.2179E 05 | 1.2182E 05 | 2.9380E 03 | 2.3630E 04 | 2.3837E 04 | 8.8263E 02 |

TOTAL IMPULSE = 6.1998E 07

TIME = 294.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.9274E 04 | 2.1407E 03 | 9.0035E 00 | 7.0473E 00 | 1.9562E 00 | 3.6025E 00 |
| 2 | 6.9946E 01 | 4.1477E 00 | 1.3694E 00 | 6.5594E-01 | 7.1343E-01 | 9.1942E-01 |
| 3 | 1.9274E 04 | 1.8581E 03 | 1.0373E 01 | 7.7032E 00 | 2.6697E 00 | 2.8855E 00 |
| 4 | 2.1258E 05 | 4.2621E 02 | 4.9878E 02 | 4.1780E 02 | 8.0983E 01 | 5.1591E 00 |
| 5 | 1.2180E 05 | 1.2182E 05 | 2.9373E 03 | 2.3630E 04 | 2.3838E 04 | 8.8232E 02 |

TOTAL IMPULSE = 6.2000E 07

TIME = 294.1000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.5161E 04 | 2.1364E 03 | 7.0962E 00 | 5.5294E 00 | 1.5668E 00 | 3.5290E 00 |
| 2 | 6.9946E 01 | 4.0616E 00 | 1.3598E 00 | 6.5448E-01 | 7.0536E-01 | 9.2786E-01 |
| 3 | 1.5161E 04 | 1.7929E 03 | 8.4561E 00 | 6.1839E 00 | 2.2722E 00 | 2.7215E 00 |
| 4 | 2.1251E 05 | 4.2621E 02 | 4.9861E 02 | 4.1766E 02 | 8.0956E 01 | 5.1591E 00 |
| 5 | 1.2180E 05 | 1.2182E 05 | 2.9366E 03 | 2.3631E 04 | 2.3838E 04 | 8.8205E 02 |

TOTAL IMPULSE = 6.2001E 07

TIME = 294.2000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.5366E 04 | 2.1668E 03 | 7.0917E 00 | 5.7110E 00 | 1.3807E 00 | 4.1363E 00 |
| 2 | 6.9946E 01 | 3.9767E 00 | 1.3286E 00 | 6.4194E-01 | 6.8667E-01 | 9.3485E-01 |
| 3 | 1.5366E 04 | 1.8249E 03 | 8.4203E 00 | 6.3529E 00 | 2.0674E 00 | 3.0730E 00 |
| 4 | 2.1245E 05 | 4.2622E 02 | 4.9844E 02 | 4.1751E 02 | 8.0929E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9360E 03 | 2.3631E 04 | 2.3838E 04 | 8.8179E 02 |

TOTAL IMPULSE = 6.2003E 07

TIME = 294.3000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 1.1534E 04 | 2.1997E 03 | 5.2435E 00 | 4.3696E 00 | 8.7384E-01 | 5.0004E 00 |
| 2 | 6.9940E 01 | 3.9248E 00 | 1.3477E 00 | 6.5219E-01 | 6.9554E-01 | 9.3748E-01 |
| 3 | 1.1534E 04 | 1.7499E 03 | 6.5912E 00 | 5.0218E 00 | 1.5694E 00 | 3.1999E 00 |
| 4 | 2.1238E 05 | 4.2623E 02 | 4.9827E 02 | 4.1737E 02 | 8.0901E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9355E 03 | 2.3631E 04 | 2.3838E 04 | 8.8159E 02 |

TOTAL IMPULSE = 6.2004E 07

TIME = 294.4000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 7.0226E 03 | 2.2181E 03 | 3.1661E 00 | 2.6867E 00 | 4.7935E-01 | 5.6048E 00 |
| 2 | 6.9941E 01 | 3.8944E 00 | 1.3458E 00 | 6.5166E-01 | 6.9412E-01 | 9.3883E-01 |
| 3 | 7.0226E 03 | 1.5565E 03 | 4.5118E 00 | 3.3384E 00 | 1.1735E 00 | 2.8449E 00 |
| 4 | 2.1231E 05 | 4.2623E 02 | 4.9810E 02 | 4.1723E 02 | 8.0874E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9351E 03 | 2.3631E 04 | 2.3839E 04 | 8.8143E 02 |

TOTAL IMPULSE = 6.2005E 07

TIME = 294.5000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 4.4283E 03 | 2.2299E 03 | 1.9859E 00 | 1.7023E 00 | 2.8357E-01 | 6.0033E 00 |
| 2 | 6.9941E 01 | 3.8797E 00 | 1.3484E 00 | 6.5306E-01 | 6.9529E-01 | 9.3925E-01 |
| 3 | 4.4283E 03 | 1.3281E 03 | 3.3343E 00 | 2.3554E 00 | 9.7886E-01 | 2.4063E 00 |
| 4 | 2.1224E 05 | 4.2623E 02 | 4.9793E 02 | 4.1709E 02 | 8.0846E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9349E 03 | 2.3631E 04 | 2.3839E 04 | 8.8128E 02 |

TOTAL IMPULSE = 6.2005E 07

TIME = 294.6000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.5520E 03 | 2.2385E 03 | 1.5868E 00 | 1.3687E 00 | 2.1810E-01 | 6.2754E 00 |
| 2 | 6.9943E 01 | 3.8788E 00 | 1.3527E 00 | 6.5516E-01 | 6.9756E-01 | 9.3921E-01 |
| 3 | 3.5520E 03 | 1.2084E 03 | 2.9395E 00 | 2.0239E 00 | 9.1567E-01 | 2.2103E 00 |
| 4 | 2.1216E 05 | 4.2623E 02 | 4.9776E 02 | 4.1695E 02 | 8.0819E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9347E 03 | 2.3631E 04 | 2.3839E 04 | 8.8115E 02 |

TOTAL IMPULSE = 6.2006E 07

TIME = 294.7000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.4658E 03 | 2.2468E 03 | 1.5426E 00 | 1.3373E 00 | 2.0527E-01 | 6.5148E 00 |
| 2 | 6.9941E 01 | 3.8839E 00 | 1.3376E 00 | 6.4792E-01 | 6.8969E-01 | 9.3944E-01 |
| 3 | 3.4658E 03 | 1.2033E 03 | 2.8802E 00 | 1.9852E 00 | 8.9496E-01 | 2.2182E 00 |
| 4 | 2.1209E 05 | 4.2624E 02 | 4.9759E 02 | 4.1680E 02 | 8.0792E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9345E 03 | 2.3631E 04 | 2.3839E 04 | 8.8101E 02 |

TOTAL IMPULSE = 6.2006E 07

TIME = 294.8000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 2.0198E 03 | 2.2541E 03 | 8.9603E-01 | 7.7974E-01 | 1.1629E-01 | 6.7053E 00 |
| 2 | 6.9942E 01 | 3.8839E 00 | 1.3477E 00 | 6.5191E-01 | 6.9576E-01 | 9.3697E-01 |
| 3 | 2.0198E 03 | 9.0019E 02 | 2.2437E 00 | 1.4317E 00 | 8.1205E-01 | 1.7630E 00 |
| 4 | 2.1202E 05 | 4.2624E 02 | 4.9742E 02 | 4.1666E 02 | 8.0764E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9343E 03 | 2.3631E 04 | 2.3839E 04 | 8.8088E 02 |

TOTAL IMPULSE = 6.2006E 07

TIME = 294.9000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 3.8394E 02 | 2.2607E 03 | 1.6984E-01 | 1.4823E-01 | 2.1610E-02 | 6.8591E 00 |
| 2 | 6.9941E 01 | 3.8857E 00 | 1.3433E 00 | 6.4871E-01 | 6.9459E-01 | 9.3396E-01 |
| 3 | 3.8394E 02 | 2.5374E 02 | 1.5131E 00 | 7.9694E-01 | 7.1620E-01 | 1.1127E 00 |
| 4 | 2.1195E 05 | 4.2624E 02 | 4.9725E 02 | 4.1652E 02 | 8.0737E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9342E 03 | 2.3631E 04 | 2.3839E 04 | 8.8077E 02 |

TOTAL IMPULSE = 6.2006E 07

TIME = 295.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 6.9715E 00 |
| 2 | 6.9940E 01 | 3.8865E 00 | 1.3290E 00 | 6.4121E-01 | 6.8777E-01 | 9.3230E-01 |
| 3 | 0. | 0. | 1.3290E 00 | 6.4121E-01 | 6.8777E-01 | 9.3230E-01 |
| 4 | 2.1188E 05 | 4.2624E 02 | 4.9708E 02 | 4.1638E 02 | 8.0709E 01 | 5.1590E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9341E 03 | 2.3632E 04 | 2.3839E 04 | 8.8065E 02 |

TOTAL IMPULSE = 6.2006E 07

TIME = 300.0000

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | 0. | 0. | 0. | 0. | 0. | 8.1995E 00 |
| 2 | 6.9930E 01 | 3.9226E 00 | 1.3664E 00 | 6.5160E-01 | 7.1480E-01 | 9.1159E-01 |
| 3 | 0. | 0. | 1.3664E 00 | 6.5160E-01 | 7.1480E-01 | 9.1159E-01 |
| 4 | 2.0831E 05 | 4.2622E 02 | 4.8873E 02 | 4.0937E 02 | 7.9362E 01 | 5.1593E 00 |
| 5 | 1.2180E 05 | 1.2183E 05 | 2.9304E 03 | 2.3635E 04 | 2.3845E 04 | 8.7683E 02 |

TOTAL IMPULSE = 6.2006E 07

TABLE AP 4-1 (Sheet 1 of 2)
ABBREVIATIONS

| ITEM | TERM | ITEM | TERM |
|---|---|---|---|
| ac | Alternating current | He | Helium |
| Act | Actuator | hr | Hour |
| APS | Auxiliary Propulsion System | Hyd | Hydraulic |
| Attch | Attach | in. | Inch |
| Btu | British thermal unit | IP&CL | Instrumentation Program and Component List |
| Cfm | Cubic feet per minute | IU | Instrumentation unit |
| Contr | Control | K | Kilo = 1,000 or $10^3$ |
| cps | Cycles per second | kc | Kilocycle |
| DAC | Douglas Aircraft Company, Inc. | KSC | Kennedy Space Center |
| db | Decibel | lbf | Pounds force |
| dc | Direct current | lbm | Pounds mass |
| DDAS | Digital Data Acquisition System | LH2 | Liquid hydrogen |
| Disch | Discharge | Loc | Location |
| DPF | Differential Pressure Feedback | LOX | Liquid oxygen |
| EBW | Exploding bridgewire | ms | Millisecond |
| ECC | Engine Cutoff | MSFC | Marshall Space Flight Center |
| E/I | External/Internal | NASA | National Aeronautics and Space Administration |
| EMI | Electromagnetic Interference | NPSH | Net positive suction head |
| EMR | Engine mixture ratio | PAM | Pulse amplitude modulation |
| ESC | Engine Start Command | PCM | Pulse code modulation |
| FLT | Flight | pf | Pico farad |
| ft | Feet | Posit | Position |
| FM | Frequency modulation | pps | Pulses per second |
| FTC | Florida Test Center | Press | Pressure |
| Fwd | Forward | psia | Pounds per square inch, absolute |
| GG | Gas generator | psid | Pounds per square inch, differential |
| GH2 | Gaseous hydrogen | psig | Pounds per square inch, gauge |
| GN2 | Gaseous nitrogen | Pt | Point |
| gpm | Gallons per minute | | |
| GSE | Ground support equipment | | |

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TABLE AP 4-1 (Sheet 2 of 2)
ABBREVIATIONS

| ITEM | TERM | ITEM | TERM |
|---|---|---|---|
| PU | Propellant utilization | sw | Switch |
| Pwr | Power | Syst | System |
| R | Rankine | TAN | Tangential |
| RAD | Radial | Temp | Temperature |
| Refl | Reflected | T/M | Telemetry |
| Reg | Regulator | TP&E | Test Planning and Evaluation |
| RF | Radio frequency | TRW | Thompson-Ramo-Wooldrige |
| RMR | Reference mixture ratio | Vac | Volts alternating current (100 vac) |
| RSS | Root sum square | V | Volts |
| SCI | Standard cubic inch | Vib | Vibration |
| scim | Standard cubic inch per minute | vdc | volts direct current |
| scfm | Standard cubic foot per minute | W | Watts |
| sec | Second | | |
| STC | Sacramento Test Center | | |

## DISTRIBUTION LIST

### HUNTINGTON BEACH (A3)

| | |
|---|---|
| K010 | Senior Director - Saturn Apollo Programs |
| KW00 | Director - Saturn System Development |
| KY00 | Director - Saturn Program Production |
| K100 | Director - Saturn Development Engineering |
| K010 | Special Assistant to Senior Director for 501 |
| KWA0 | Manager - Saturn Program System Engineering |
| KWB0 | Manager - Saturn Program Test Engineering |
| KWE0 | Branch Manager - Saturn Program Contract Data |
| KYD0 | Manager - 500 Series Stages Production Project |
| 4050 | Manager - Vehicle Flight Readiness |
| KN00 | Chief Design Engineer - Saturn Development |
| KN00 | Deputy Chief Design Engineer - Saturn Devlmt. |
| KA00 | Chief Engineer - Mechanics & Reliability |
| KAF0 | Branch Chief - S-IVB Mechanics & Reliability |
| KABA | Section Chief - Strength |
| KABC | Section Chief - Acoustics & Structural Dynamics |
| KACA | Section Chief - Flight Dynamics & Control |
| KACB | Section Chief - Aero/Thermodynamics |
| KADA | Section Chief - Reliability Analysis |
| KBBA | Section Chief - Structures Design |
| KBC0 | Branch Chief - Mechanical |
| KC00 | Chief Engineer - Propulsion |
| KCF0 | Branch Chief - S-IVB Propulsion |
| KCB0 | Branch Chief - Propulsion Analysis |
| KCBA | Propulsion Requirements Support |
| KCBC | Section Chief - Propulsion Performance & TP&E |
| KCBC | Propulsion Performance and TP&E - Analysis |
| KCC0 | Branch Chief - Propulsion Design |
| KCD0 | Branch Chief - Propulsion Test |
| KCDE | Propulsion Test |
| KD00 | Chief Engineer - Electronics |
| KDBA | Section Chief - Test Planning & Evaluation |
| KDC0 | Branch Chief - Electronics S-IVB Stage Design |
| KDCA | Section Chief - Networks & Subsystem Design |
| KDFB | Section Chief - Vehicle Instrumentation |
| KEC0 | Branch Chief - Computing Engineering |
| KF00 | Chief Engineer - Vehicle Checkout Laboratory |
| KK00 | Chief Project Engineer - Saturn Development |
| KKB0 | Project Engineer - Test |
| KKB0 | Deputy Project Engineer - Test |
| KKBA | Assistant Project Engineer - TP&E |
| KKBA | Supervisor - S-IVB Static Test |
| 5284 | Library |
| KEBG | Records |

## S-IVB TP&E COMMITTEE MEMBERS (A3)

| | |
|---|---|
| AFD3 | Materials Research/Production Methods |
| KABA | Strength |
| KABB | Weight Control |
| KABC | Acoustics & Structural Dynamics |
| KACA | Flight Dynamics & Control |
| KACB | Aero/Thermodynamics |
| KADA | Reliability Engineering |
| KBDC | Structural Mechanical |
| KCBC | Propulsion Performance and TP&E |
| KDBA | Electronics |
| KDFA | Data Processing |
| KKBA | TP&E Group Engineer, Static |
| KKBA | Propellant Utilization Panel (A3) |

## FLORIDA TEST CENTER (A41)

| | |
|---|---|
| AJBO | M. F. Cooper |
| KOCO | H. T. Gardner |
| KKCO | R. S. Spain |
| KKGO | H. H. Nichols |

## SACRAMENTO TEST CENTER (A45)

| | |
|---|---|
| KKHO | R. J. Mohr |

## MANNED SPACE CENTER (A57)

| | |
|---|---|
| KO10 | R. A. Ammons |

## MARSHALL SPACE FLIGHT CENTER (A61)

| | |
|---|---|
| KLCO | W. F. Shaver |
| KKBA | J. A. Tobias |
| KDBD | W. E. Naymola |

## NASA/MARSHALL SPACE FLIGHT CENTER

H. S. Garrett