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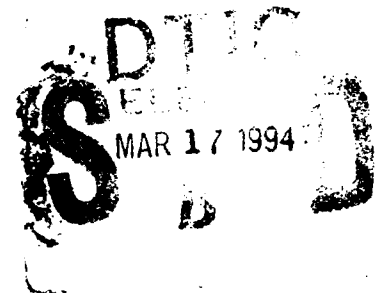
FINAL REPORT

ORBIT TRANSFER ROCKET ENGINE TECHNOLOGY PROGRAM ENHANCED HEAT TRANSFER COMBUSTOR TECHNOLOGY

By

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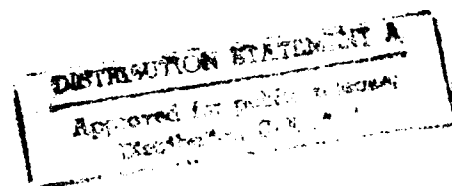


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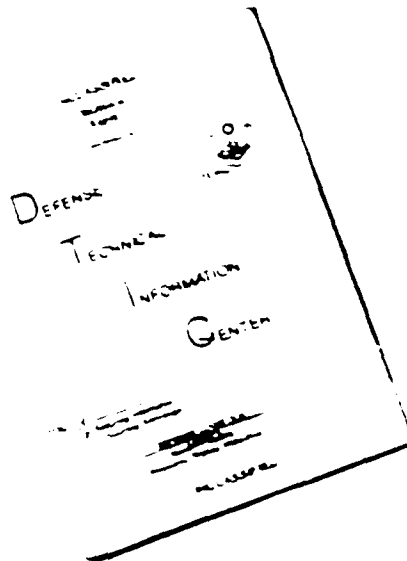
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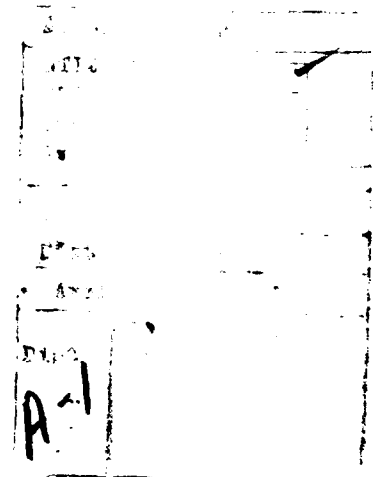
FOREWORD

This report documents the results of the third subtask of a program conducted for the NASA Lewis Research Center by Rocketdyne, a division of Rockwell International. Ms. Sybil Huang Morren was the NASA-LeRC Task Manager. At Rocketdyne, Mr. R. P. Pauckert was the Project Manager and Mr. William S. Brown the Project / Development Engineer.

The work was conducted by personnel in the Engineering and Test function of Rocketdyne. Important contributions to this program task were made by:

Ms. L. Davis	Integrated Component Evaluator (I.C.E.) Structural Analysis
Mr. G. Gladman	Integrated Component Evaluator (I.C.E.) Re-Configuration Design
Mr. J. Orr	Integrated Component Evaluator (I.C.E.) Thrust Chamber Transient and Performance Computer Simulation
Mr. S. Fischler and Mr. J. Pulte	Advanced Propulsion Test Facility Test Engineering
Mr. W. Wagner and Mr. J. Carroll	Thermal Analysis

Additional program support was obtained from Messrs. R. D. Baily and H. Dubrick, who provided important and invaluable technical continuity and assistance to the program.



REPORT ORGANIZATION

This report is divided into six sections; introduction, summary, program approach, thrust chamber hardware performance, calorimeter performance, and finally the sixth section discusses the conclusions of the technology task effort. Detail data is contained in the appendices.

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1.0 INTRODUCTION

The thrust chamber combustor of a high performance, advanced expander-cycle engine serves a dual function. First, it performs the function of containing the high pressure combustion process and accelerating the combusted gases to sonic velocity for expansion in the exhaust nozzle, producing thrust. Second, it provides a majority of the energy required to power the propellant turbopumps. In Rocketdyne's oxygen-hydrogen expander cycle engine, the turbopump turbines are powered by hydrogen heated by regenerative cooling of the thrust chamber components. Approximately 75% of the heat input to the hydrogen is derived from the combustor assembly. The remainder is supplied by the regenerative section of the nozzle assembly.

In general, a higher chamber pressure leads to higher engine performance due to improved expansion properties of the combustion gases. Higher chamber pressures also reduce engine size and weight for similar thrust levels.

Combustor thermal performance has a central role in determining the overall performance of the advanced expander cycle engine. Therefore, developing the technologies for enhancing combustor heat extraction and service life performance is crucial to meeting the goals of the advanced expander cycle engine technology program. Subsequently, the first portion of the Enhanced Heat Transfer Technology program dealt with various methods of increasing heat extraction. Two-D hot and cold flow experiments were conducted to: screen various combustor rib geometries, evaluate flow characteristics of candidate ribs, and compare the designs at hot-fire conditions. The results of 2-D testing indicated that a 0.040 in. rib configuration would be the optimum for enhancing heat transfer to the combustor. The total heat load enhancement, based on 2-D test data, of a full size combustor with a 16 in. barrel section was 42%. These findings are detailed in the Interim Report for the Orbit Transfer Rocket Engine Technology Program, entitled Enhanced Heat Transfer Combustor Technology, Task C.1 Subtasks I and II, under contract NAS3-23773.

The tasks covered in this report deal with applying the technology gained in the previous tasks and evaluating the optimum configurations in a hot-fire environment. Calorimeter combustors were fabricated and tested to determine the heat transfer enhancement effects of hot-gas wall ribs. The results of those tests were extrapolated and projected to full size combustor geometries where a direct comparison to the 2-d test results could be made. From this an evaluation could be made as to the overall enhancement capability of hot-gas wall ribs.

2.0 SUMMARY

In order to increase chamber pressure which increases engine performance, more heat energy needs to be extracted to drive the turbomachinery. The increased heat energy maximizes the efficiency of the turbomachinery operation and reduces the size and weight of the engine. In the past, the heat energy requirements of the turbopumps required longer combustion chambers. Size limitations created the need for a different method to increase heat extraction. This requirement was fulfilled by increasing the area exposed to the hot-gas by using combustor ribs. The ribs increased the total area exposed to the hot-gas by 80%, and thus increased the enthalpy in the coolant working fluid. To substantiate this theory, two-dimensional hot and cold flow experiments were conducted to determine an optimum rib height. The results indicated that a 0.040 in. rib height would be the optimum configuration for enhancing heat transfer to the combustor. A combustor calorimeter was fabricated to determine the enhancement of hot gas wall ribs. An existing Integrated Component Evaluator (I.C.E.) thrust chamber assembly was modified to accept the calorimeter and installed into the NAN-test stand position at the Advanced Test Propulsion Facility of Rocketdyne's Santa Susana Field Laboratory.

The 0.040 in. ribbed calorimeter combustor completed a total of four steady-state tests both in a ribbed and a smooth wall combustor configuration. The tests were conducted at ~850 and ~1050 psia chamber pressures with mixture ratio excursion sweeps between 5.0 and 7.0. The heat transfer results from the ribbed calorimeter 830 psia P_c test indicated that the mixture ratio excursions affected heat loads significantly. The mixture ratio varied from 4.0 to 5.6 and increased heat loading approximately 1.92 Btu/in²-sec. per 1.0 (O/F) mixture ratio change. The heat transfer data from the 830 psia and 1050 psia P_c tests showed an increased heat load rate with increasing P_c , while the heat rate profiles, as a function of length from the injector, were similar. The 850 psia P_c test, at a mixture ratio of 5.6, showed a 50% enhancement over a smooth wall. The 1050 psia P_c test, at a mixture ratio of 4.7, showed a 40% enhancement over a smooth wall. Normalizing the mixture ratio revealed the enhancement was greater for the 1050 psia P_c test than for the 850 psia P_c test. This indicates that the rib heat transfer enhancement factor is sensitive to changes in mixture ratio as well as chamber pressure.

The projected enhancement from the ribs for a 16 in. long cylindrical combustor at 15Klb_f nominal thrust level, is a 58% increase in heat transfer rate, which translates to a 46% increase for a full size 15Klb_f combustor. The combustor test results show that the ribs are as effective as previous analysis and 2-d subscale testing indicated. They also showed that higher mixture ratios and chamber pressures can increase the effectiveness of 0.040 in. ribs.

3.0 PROGRAM OBJECTIVES AND APPROACH

The primary objective of this task was to characterize the heat load enhancement capabilities of the 0.040 in. ribbed combustor. A secondary objective was to determine the effects of mixture ratio changes on that enhancement during hot-fire testing. Two hot-fire test series were conducted using two calorimeter configurations, ribbed and smooth wall. The program used the Integrated Component Evaluator (I.C.E.), Figure 3-1, re-configured into a thrust-chamber-only mode, i.e. no turbopumps were used in the system. Specific goals were to verify increase in heat transfer to the working fluid by the ribs as predicted in hot-air gas and cold flow 2-d tests, subtasks I and II of Tasks C.1 and C.2.

Three technical subtasks were identified to accomplish program objectives. These subtasks are listed below:

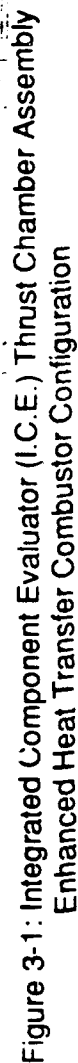
Enhanced Heat Transfer Combustor Technology Subtasks

- I. Heat Load Maximization Studies (Hot-Gas Wall Ribs)
 - Hot-Air Panel Chamber Tests
 - Cold Flow Boundary Layer Mapping Tests
- II. Increased Life Studies (Coolant Channel Enhancements)
 - Cold Flow Boundary Layer Mapping Tests
- III. Calorimeter Insert Hot-Fire Tests
 - High P_c Tests of Optimum Configurations
 - Evaluate Results and Determine Optimum Rib Configuration

Subtasks I and II were completed and are documented in NASA Report No. CR179541, 16 December 1986, Enhanced Heat Transfer Combustor Technology Task C.1, R.D. Baily. Subtask III is described and contained within this report.

Task III required the fabrication and hot-fire test of a calorimeter combustor with the optimum rib height. The results of 2-d testing indicated that a 0.040 in. rib configuration would be the optimum for enhancing heat transfer to the combustor. The total heat load enhancement, based on 2-d test data, of a 16 in. barrel section was 58%. Over a full size combustor, including the throat section, it would be 46%. The Subtasks I and II report used a different convergent/divergent section total heat load, resulting in a calculated enhancement of 42%.

The 2-d test results, shown in Figure 3-2, revealed the thermal enhancement was highest for a rib height of 0.04 inches. A 0.040 in. rib height was not expected to erode or melt due to hot-fire. A 6.55 in. long combustor with 11 circumferentially cooled calorimeter circuits was fabricated with 0.040 in. high hot-gas wall ribs, Figure 3-3. The system was installed between the existing injector and the tapered wall combustor of the ICE thrust chamber stack. The program culminated in a hot-fire test series, consisting of system blowdowns, start transient and steady state tests. Two



RIB THERMAL ENHANCEMENT FOR FULL COMBUSTOR BASED ON 2-d TEST RESULTS

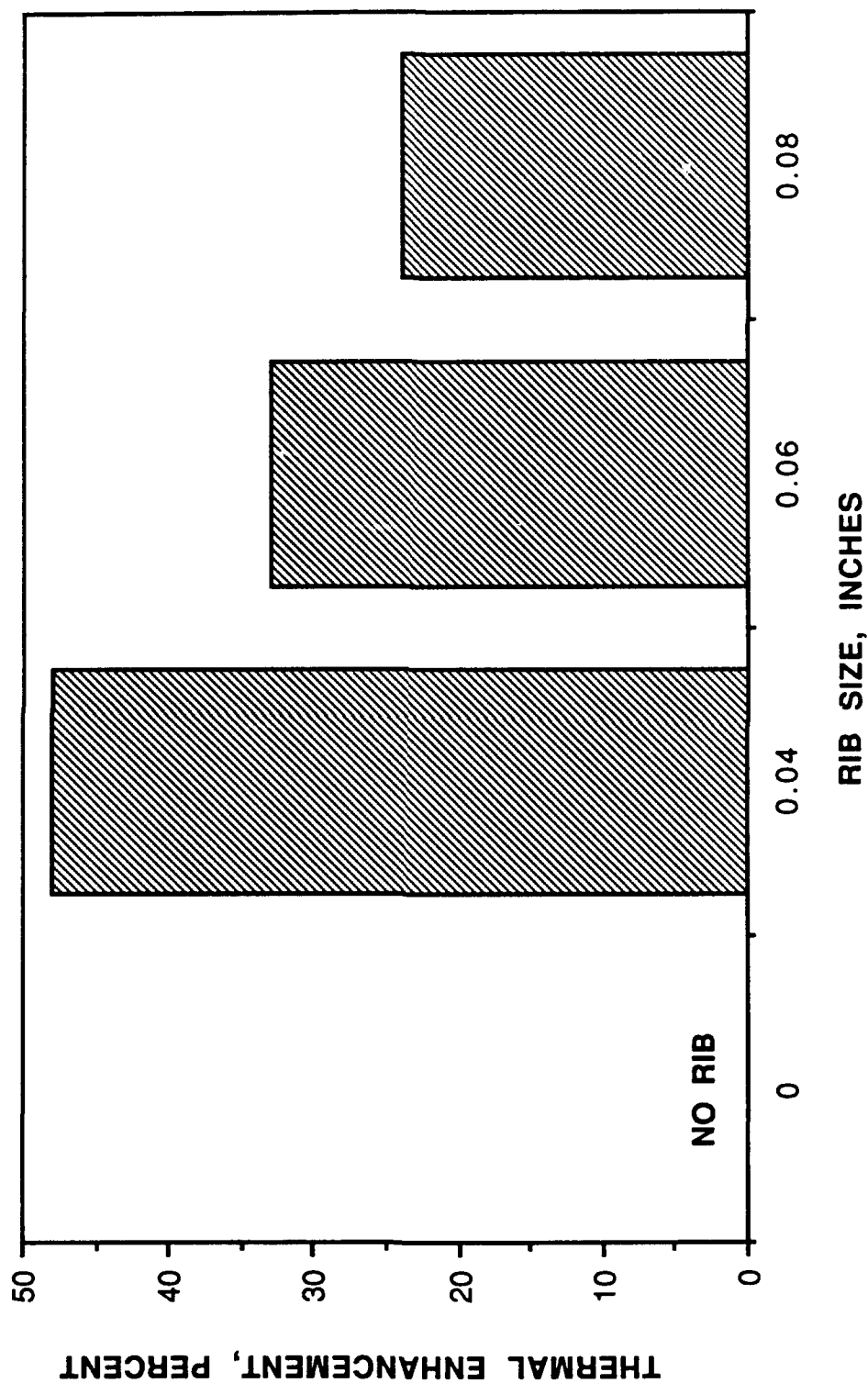


Figure 3-2

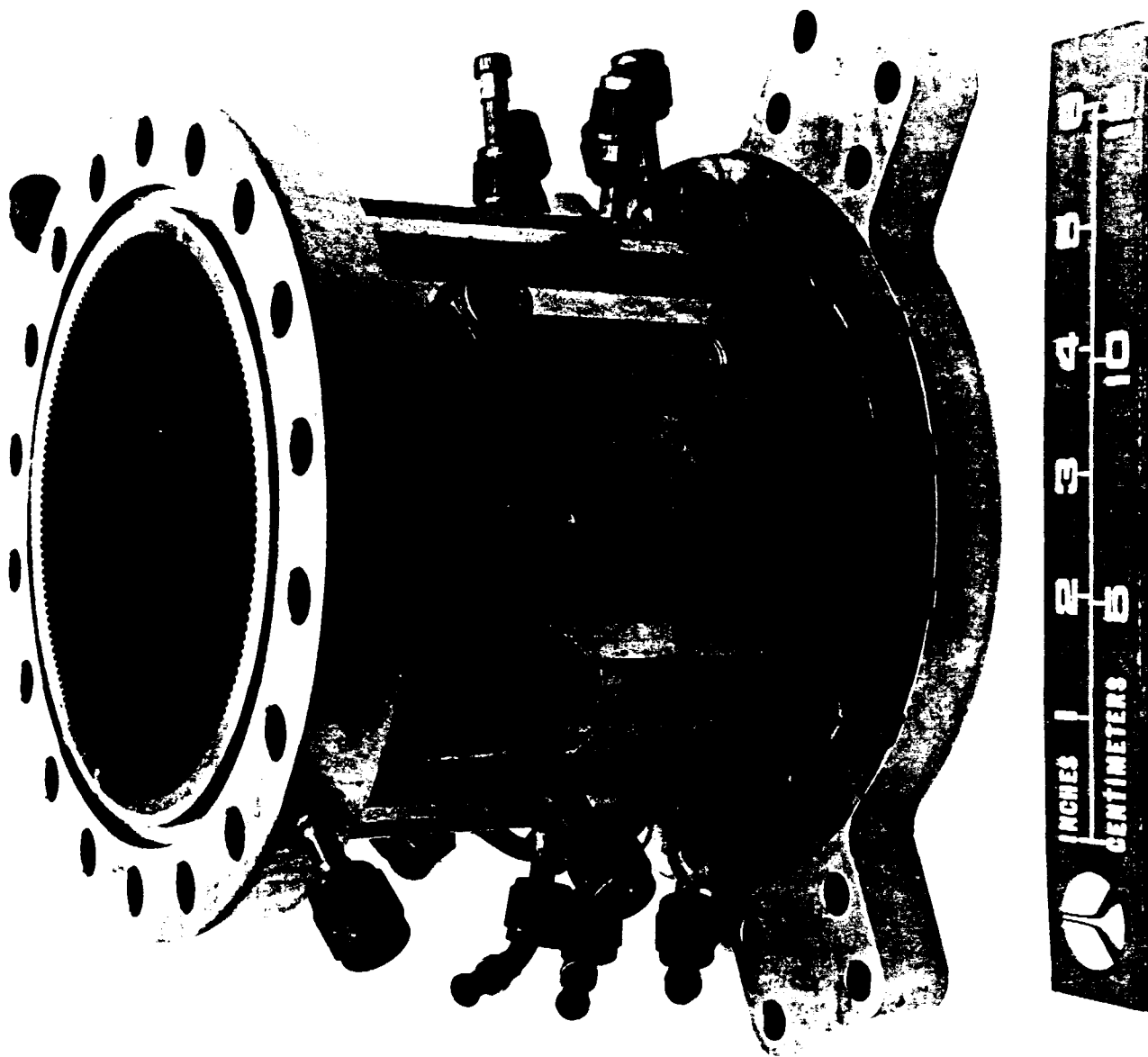


Figure 3-3: 0.040 in. Ribbed Circumferentially Cooled Calorimeter

calorimeter configurations were tested--the 0.04 in. rib configuration and a smooth wall configuration, using the same calorimeter with the ribs removed. During each steady state test the valves were modulated to vary the mixture ratio to at least four different set points. The data were reduced and then extrapolated to both 16 in. barrel and full size combustors. They could then be compared directly to the 2-D flow data.

3.1 TEST HARDWARE and FACILITY DESCRIPTION

The test hardware consisted of the following subsystems: Circumferentially Cooled Calorimeter Combustor, Calorimeter Combustor Coolant Management System, Ignition System, Injector, Tapered Wall Combustor, 35:1 Sea-level Nozzle and the Test Facility Systems. These systems are described in the following sections in detail.

3.1.1 Circumferentially Cooled Calorimeter Combustor - The calorimeter was fabricated from two major components; the liner and the housing (Ref. Dwg. 7R0016277-1). The liner was made from Amzirc, a copper material alloyed with zirconium. The liner outer diameter coolant channels were machined and gold plated. The inner diameter was machined so that the troughs cut at a later assembly stage would create the 0.040 in. ribs. The housing was made from Inconel 625, with the coolant channel side I.D. nickel plated. The liner and housing were brazed together along with the twenty two, 0.25 in. dia. x 0.020 in. wall thickness inlet and outlet tubes. The 0.040 in. hot-gas wall ribs were then machined into the Amzirc liner I.D. using a numerically controlled tungsten-carbide blade and successive longitudinal sweeps (~6 sweeps per rib trough) resulting in the ribs as seen in Figure 3-4.

The calorimeter was proof pressure tested to verify structural integrity and flow calibrated to determine coolant water flow characteristics. The water flow calibration of all eleven circuits indicated that the resistance was almost twice as large as predicted by analysis. The original analytical coolant requirements indicated that an inlet pressure of 2200 psig was needed at a flowrate per channel of 1.81 lbs/sec. The calibration results indicated that the operating inlet pressure would have to be increased to 3000 psig in order to properly cool the calorimeter channels.

Structural analysis of the 0.040 in. ribbed calorimeter liner indicated that the maximum pressure before yield, was 2420 psig. Operating at an inlet pressure of 3000 psig would give a 0.74 factor of safety on yield for the liner, at the worst structural location (assuming minimum material properties). This analysis was conservative in that it assumed only 50% braze joint attachment. Therefore the predicted liner yielding was expected to be minimal and would not affect operation. The analysis also indicated that coolant tube hoop strain was only 0.13 percent (a hoop strain of greater than 2% would have been cause for concern), indicating the calorimeter low cycle fatigue life was in excess of 10^4 cycles. This analysis and the fact that the combustor assembly was proof pressure tested and cycled to 2750 psig, indicated that minimal risk was involved in operating the calorimeter at 3000 psig.

3.1.2 Calorimeter Combustor Coolant Management System - The system used to feed the combustor calorimeters consisted of an inlet manifold which fed the eleven coolant circuits. The flowrate was controlled by flow control orifices located at the exit of the inlet manifold. Water circuited through 1/2 in. dia. tubing (shown in Figure 3-5) to the

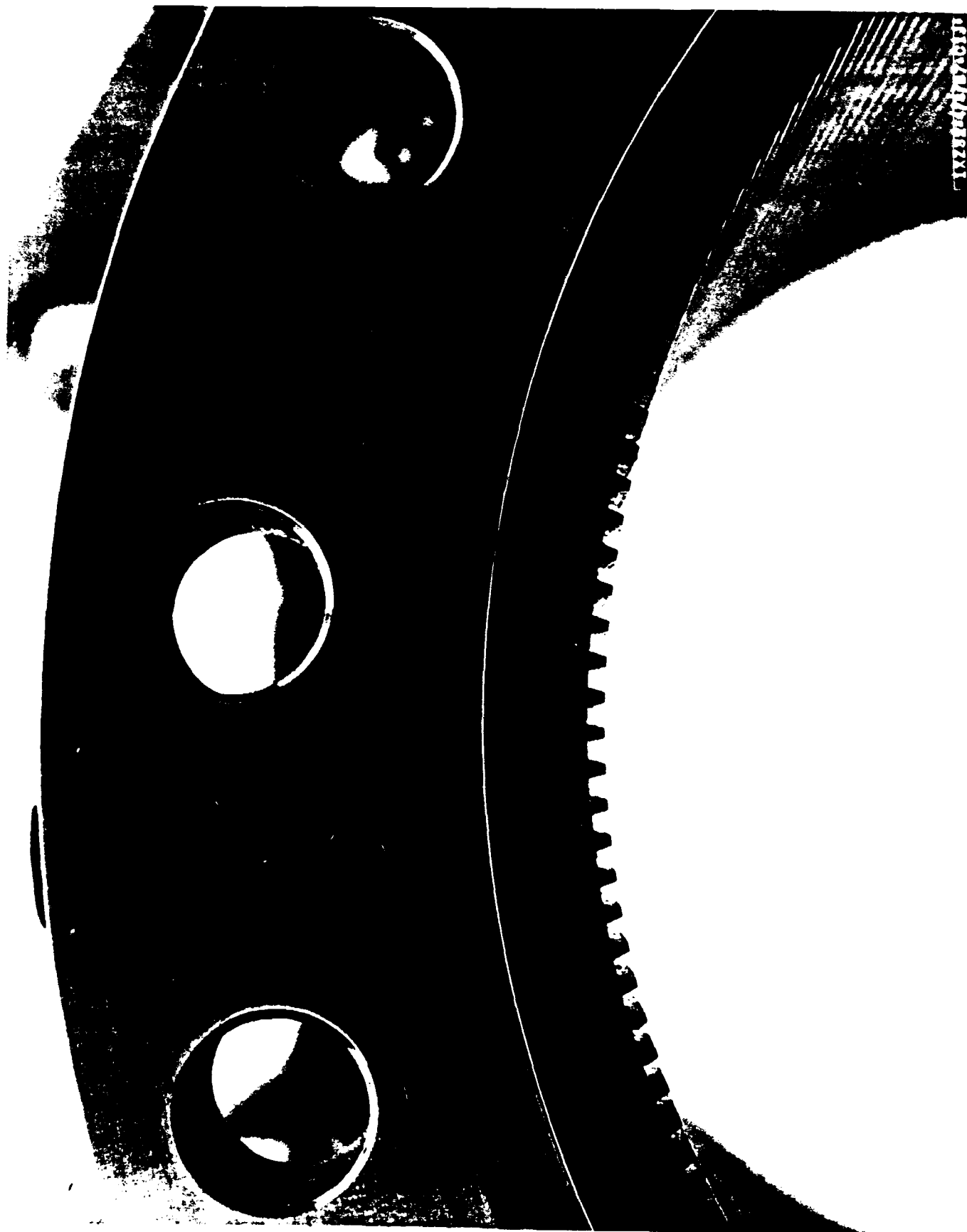
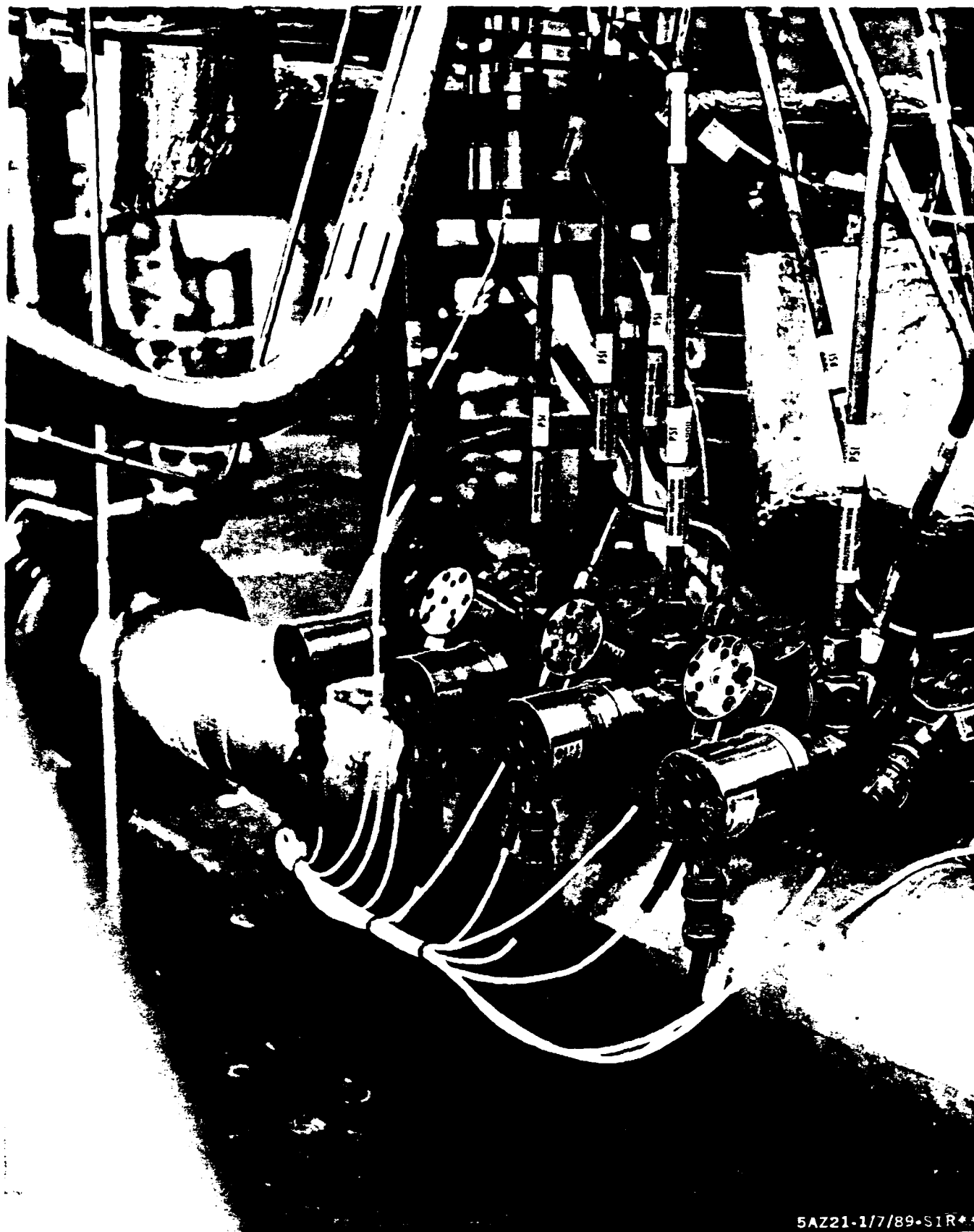


Figure 3-4: Detail of 0.040 in. Machined Ribs



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Figure 3-5: Calorimeter Coolant Inlet System

calorimeter and left the calorimeter at an average pressure and temperature of 1500 psig and 300 deg. F.

The coolant water was then passed through 1/4 in. dia. lines to an exit manifold, shown in Figure 3-6. Any flashing or boiling would result in improper cooling of the calorimeter channels. The flashing problem was resolved by adding coolant water from the inlet manifold directly into the exit manifold at a flowrate of 33.8 lbs/sec. This lowered the water temperature to below 116 deg. F prior to flowing from the exit manifold, Figure 3-7.

3.1.3 Ignition System - The I.C.E. system used a plasma-torch ignition system, Figure 3-8a. The plasma torch igniter element consists of an O_2/H_2 injection body, a combustor/nozzle for ducting the hot gas to the combustor, and a spark plug. Oxygen is injected from an annular manifold around the spark plug electrode. A small amount of fuel is injected into the igniter combustor/nozzle where it mixes with the oxygen downstream of the electrode, producing oxygen-rich combustion (MR = 40:1). The bulk of the igniter fuel flows around the combustor and flame tube, providing necessary cooling before being discharged at the injector face. A spark plug is attached to the igniter body through a threaded joint and seal. The ignition sequence was developed during an earlier I.C.E. engine test series. The same igniter propellant feed system was plumbed to eliminate ignition sequence variations. Sonic venturists were used to measure and control igniter propellant flowrates. The ignition system spark plug received energy from a J-2 exciter system.

3.1.4 Injector - The injector consists of 108 coaxial elements oriented in a series of concentric circular locations with a Rigimesh porous metal injector faceplate, Figure 3-8b. The elements are arranged to provide a homogeneous mass flux of injected propellants with uniform radial mass distribution. Individual element mixing efficiency is ensured by design features which are based on experience with high performance, gas-liquid coaxial element injectors. A high velocity ratio between the gaseous fuel and the liquid oxidizer provides the high shear forces required for droplet stripping. The injector element is patterned after the injector elements of the SSME main injector, SSME preburners and Advanced Space Engine Injector. The combustion efficiency of this injector configuration is in excess of 99.6%, at nominal thrust levels. Unfortunately further C^* data could not be acquired during the thrust chamber testing because 1 lb/sec of hydrogen was being introduced downstream of the injector at the calorimeter-thrust chamber interface to cool and protect this interface. This hydrogen coolant was necessary to protect the original fuel manifold which is welded to the tapered wall combustion chamber. This introduced a substantial error into the calculation of C^* as the additional fuel is 1/4 of the total fuel flow and almost 1/6 of the total flow.

3.1.5 Tapered Wall Combustor - The main combustion chamber located downstream of the water cooled calorimeter was a single pass, channel wall, copper base alloy (Narloy-Z) configuration, Figure 3-9. The chamber includes an expansion area ratio downstream of the throat of 14:1. The combustor was hydrogen cooled by a single up-pass circuit with ~ 4.09 lb/sec coolant flow. The head end of the combustor contained acoustic cavities to aid in combustion stability. Due to the calorimeter chamber these acoustic cavities were moved 6.55 in. downstream of the injector.

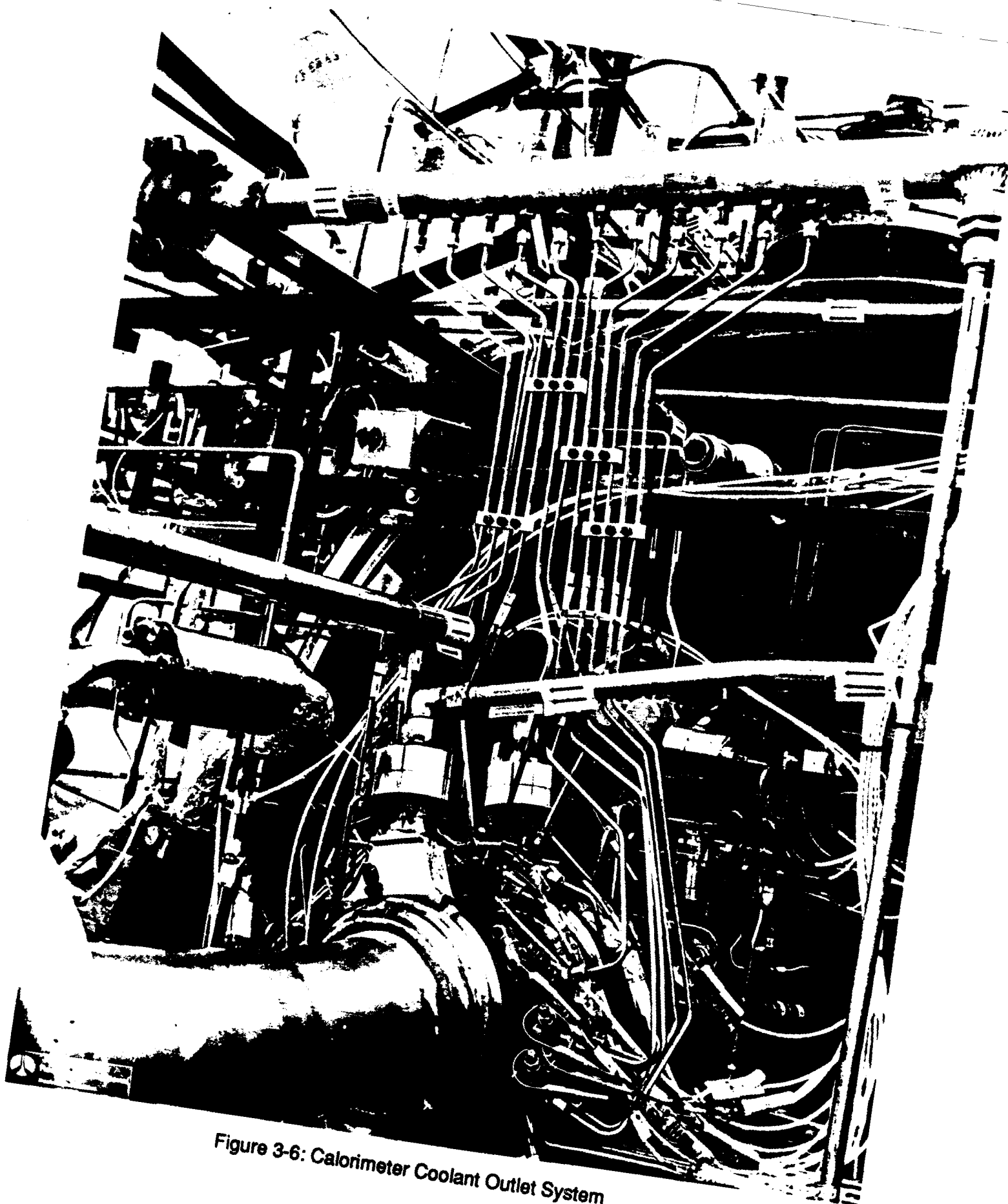
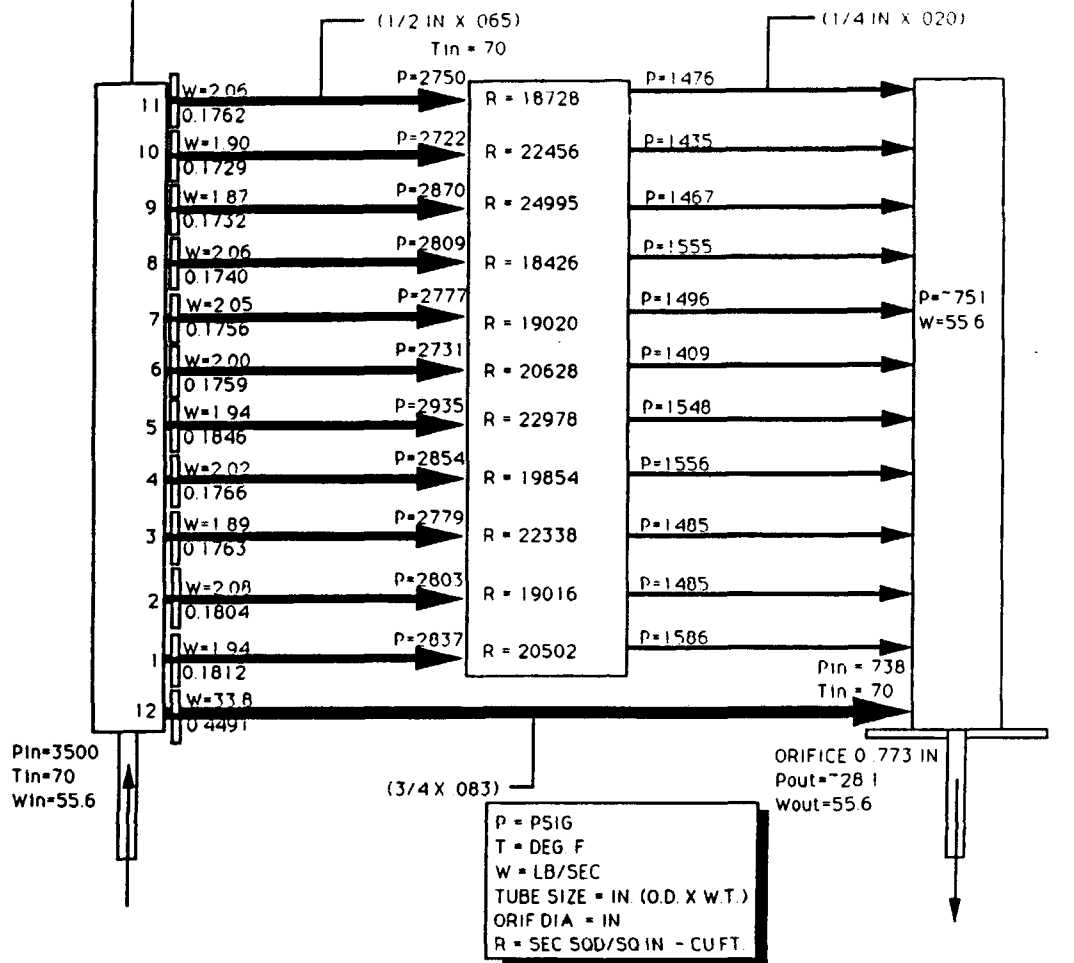


Figure 3-6: Calorimeter Coolant Outlet System

RELIEF VALVE
SET 4000
+/- 120 PSIG



(Inlet Manifold)

(Calorimeter)

(Exit Manifold)

Figure 3-7: Calorimeter Coolant System Balance

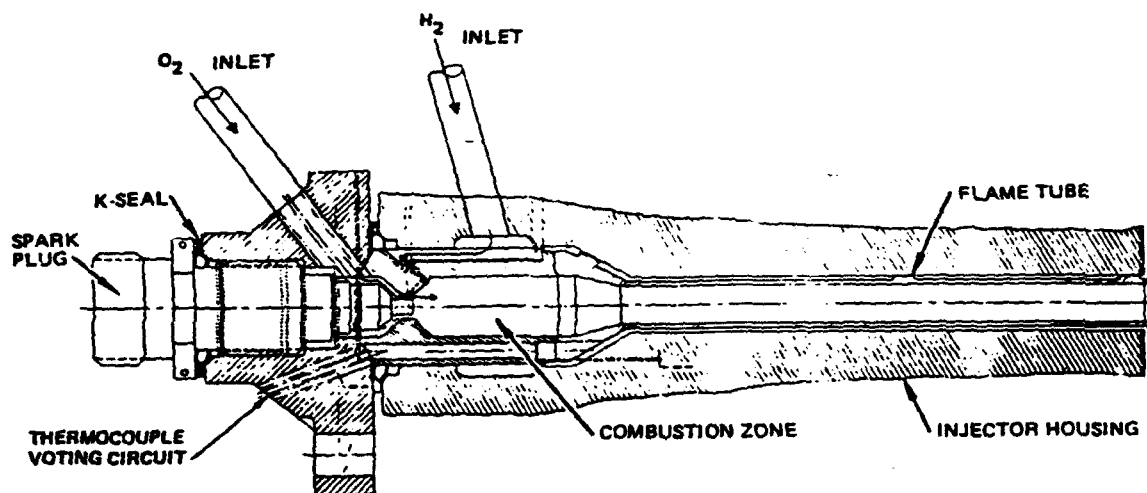


Figure 3-8a: I.C.E. Plasma Torch Igniter

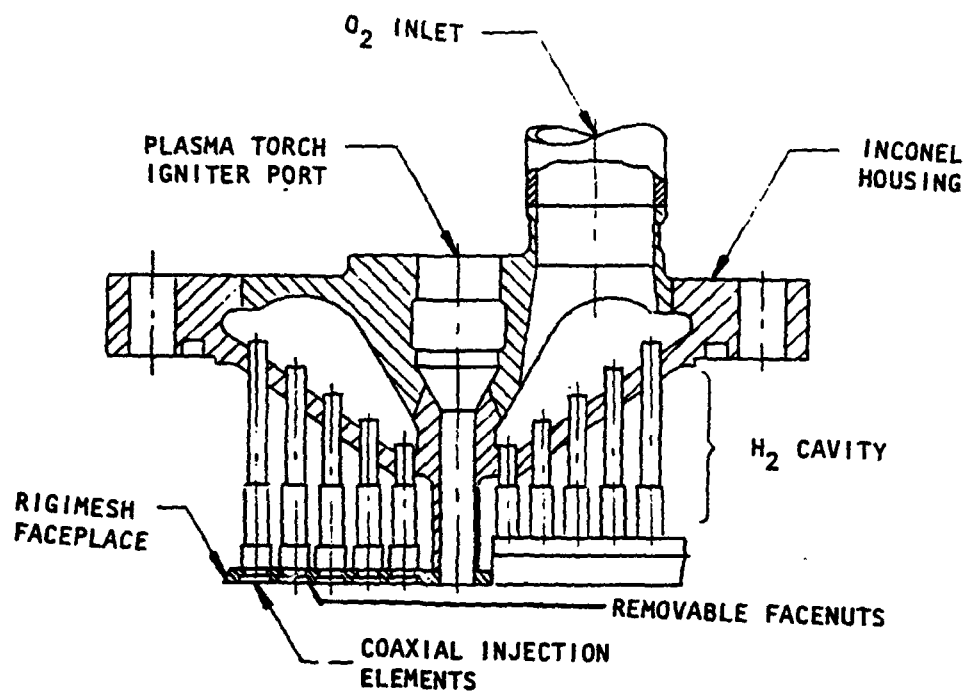


Figure 3-8b: I.C.E. Coaxial Injector

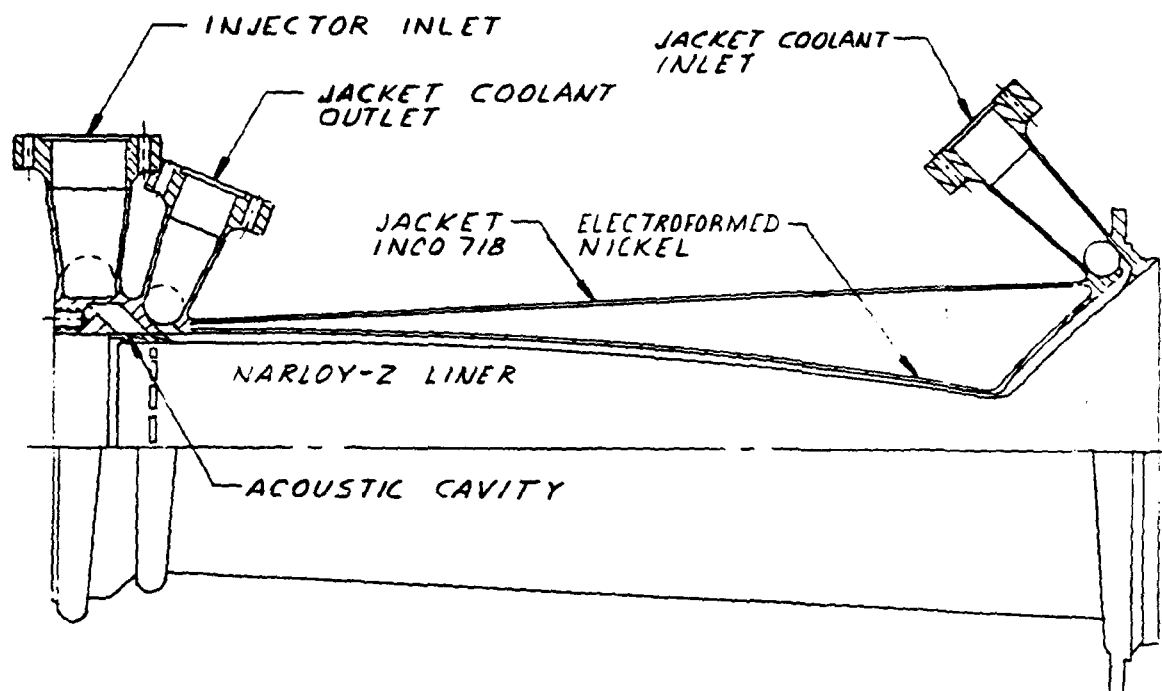


Figure 3-9: I.C.E. Tapered Wall Combustion Chamber

The acoustic cavities are normally cooled by the coolant passing along the channels on the backside of the liner. As a result of the thrust chamber modification, the cavities were placed in a position which had a much higher heat load than near the injector face where they are normally located. As a result, after the 1060 psia smooth wall test (017-042, the last of the steady state tests for this task effort), three of the 18 acoustic cavities had minor erosion. Should further testing occur, a series of 0.060 in. coolant holes would need to be drilled into the cavities from the inside of the original fuel manifold. These coolant holes would cool the cavity walls sufficiently to stop further deterioration of the acoustic cavities and allow for continued test.

3.1.6 35:1 Sea-level Nozzle - The nozzle was a single pass, channel wall, copper base alloy (Narloy-Z) configuration structurally reinforced to withstand sea-level operation and under-expanded transient flow. The nozzle extends the area ratio to 35:1 which allows the hot-gas flow to fully develop at a $P_c = 770$ psia. The nozzle was hydrogen cooled by a single down-pass circuit fed from the discharge of the combustor coolant jacket.

3.1.7 Test Facility Main Fuel and Oxidizer Valves - The main propellant valves were modified Advanced Space Engine pneumatically controlled valves. These ball valves were converted to hydraulic modulating control valves. Both valves were used in previous I.C.E. engine tests. For this hot-fire test series both were modulated in an open loop control mode to vary mixture ratio.

3.1.8 Fuel Feed Manifold - A new fuel manifold was required to feed the modified thrust chamber injector due to the fact that the original fuel manifold was welded to the combustion chamber. The new fuel manifold was identical to the original with the exception of bolt holes on the bottom which allow attachment to the calorimeter combustor.

3.1.9 Rigimesh Screen - In order to protect the original fuel manifold from hot-fire affects, a protective screen made of stainless steel Rigimesh was employed, figures 3-10 and 3-11. The Rigimesh allowed GH_2 coolant to permeate the screen and keep the original fuel manifold cooled during hot-fire. This Rigimesh was machine rolled to create the cylindrical shape. An electron beam weld was made to hold the two halves together as one piece. The Rigimesh is held structurally together by two stainless steel rings which are EB welded to the Rigimesh. The Rigimesh screen subsequently suffered a structural failure due to buckling, but did not allow hot-gas to damage the original fuel manifold.

3.1.10 Zirconium Oxide Coated, Transpiration Cooled Narloy-Z Cylinder - The Rigimesh screen replacement consisted of a Narloy-Z cylinder with forward and aft end coolant channels on the outer diameter, figures 3-12 and 3-13. These channels conducted hydrogen into coolant holes under flanges at the forward and aft end of the cylinder. The inner diameter (hot-gas side) was coated with a uniform 0.010 in. of Zirconium oxide to reduce thermal loading to the parent material. The cylinder has 2700, 0.010 in. diameter coolant holes, as seen in figure 3-13. These allow 0.9 lbs/sec GH_2 coolant to permeate the wall. Radial direction thermal growth of the Narloy-Z cylinder, considered a major contributor to the Rigimesh screen buckling failure has

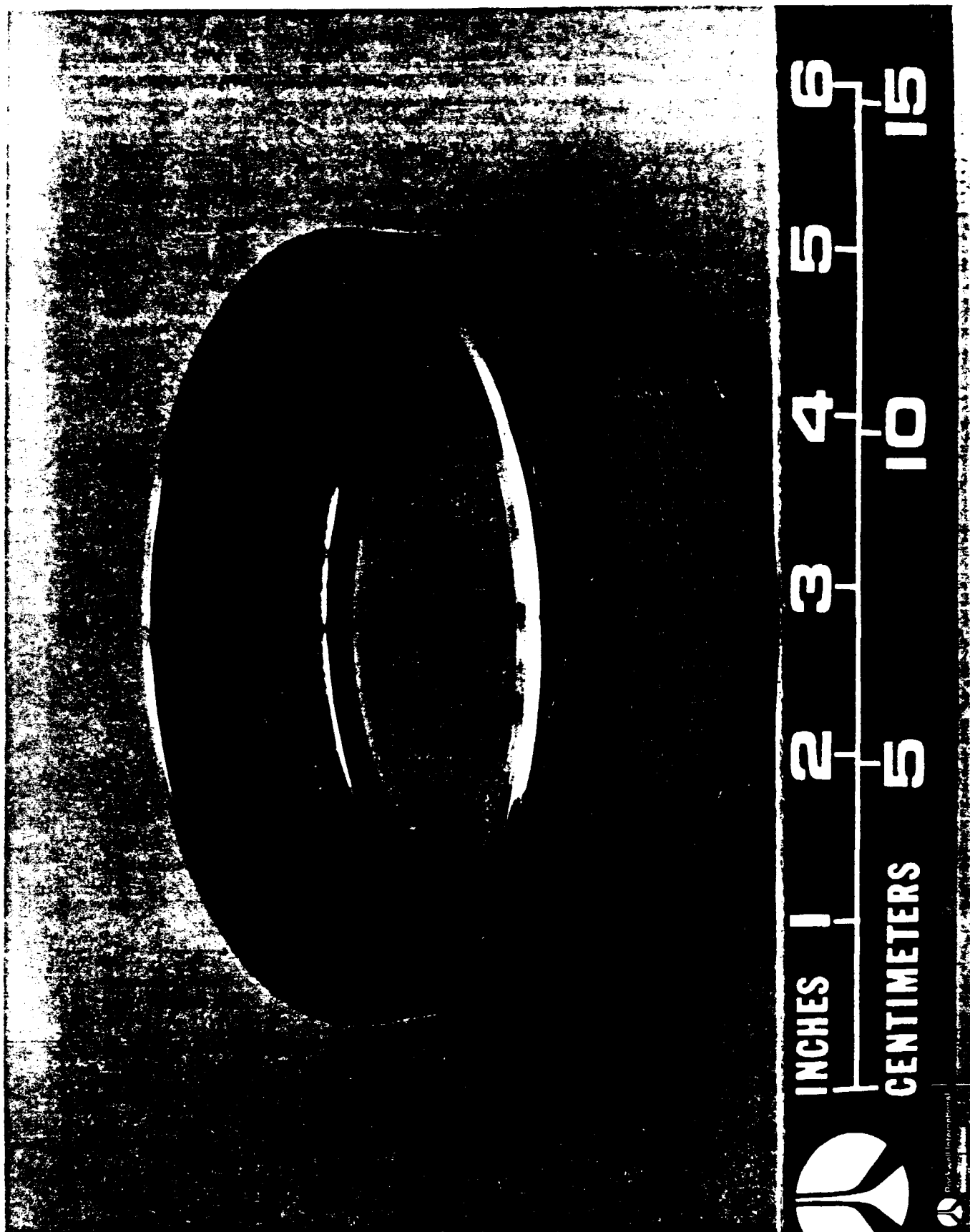


Figure 3-10: Stainless Steel Rigmesh Cylinder



Figure 3-11: Fuel Manifold with Rigimesh Cylinder Emplaced

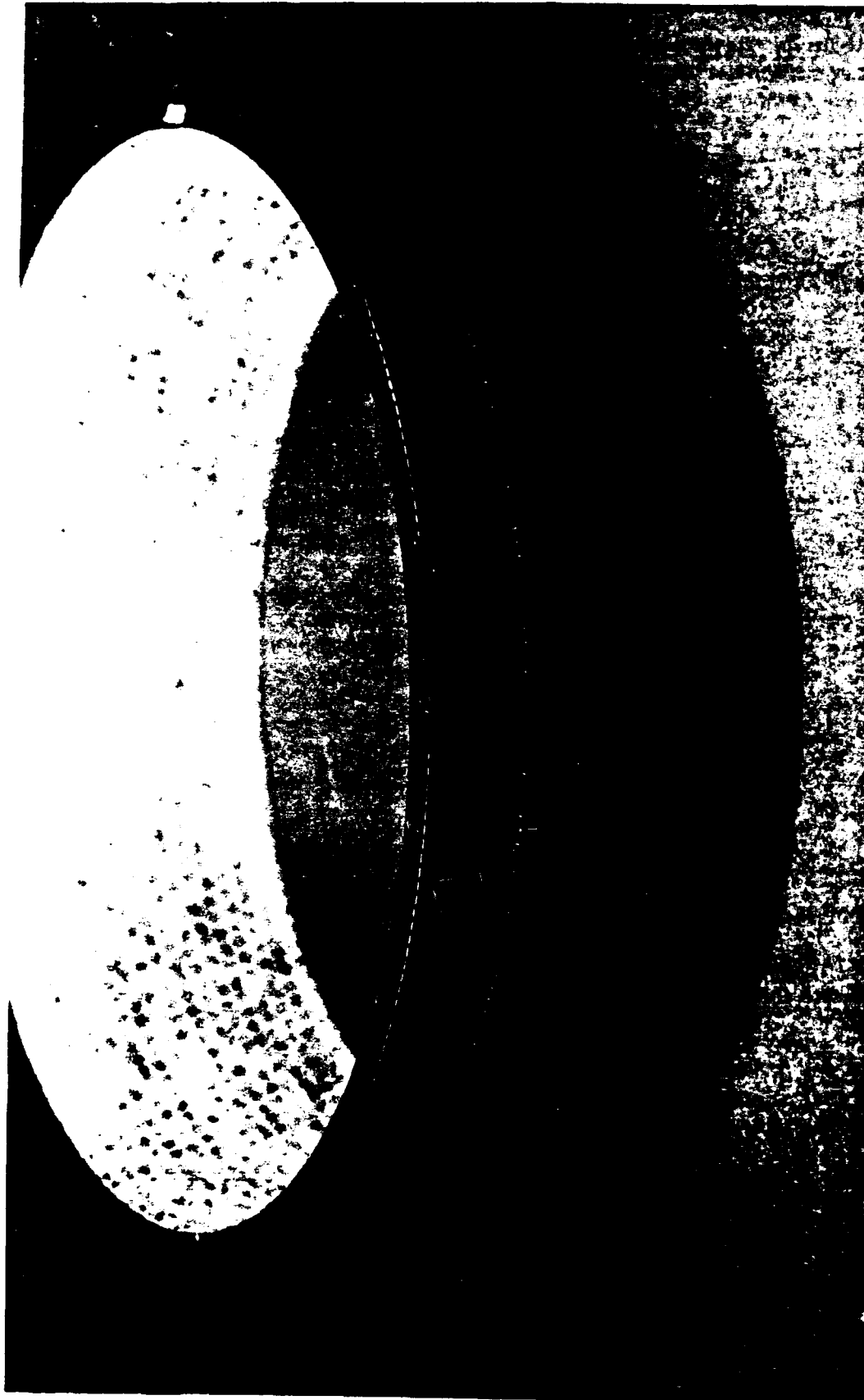


Figure 3-13: Zirconium oxide Coated NARloy-Z Cylinder Coolant Holes

been accommodated in the design by decreasing the outer diameter of the cylinder. A leading edge chamfer allows a smooth transition for the hot-gas flow assuming maximum radial displacement of the part.

3.1.11 I.C.E. Thrust Chamber Injector Feedline - The enhanced heat transfer combustor was tested with the I.C.E. in a thrust chamber only configuration instead of a complete engine, figure 3-1. This necessitated a new duct to be fabricated which would connect the nozzle outlet manifold with the new fuel manifold. These connections were previously made using various ducts and the high pressure oxidizer and fuel turbopumps. Orificing was provided to simulate the pressure loss created by the turbopumps.

3.1.12 APTF NAN-stand Preparation - The thrust chamber only testing was conducted on the NAN test stand position of the Advanced Propulsion Test Facility (APTF) at the Rocketdyne Santa Susana Field Laboratory (SSFL). The thrust chamber was mounted horizontally. The facility high pressure run tank and pressurizing tank systems were used. These provided test durations in excess of 15 seconds at mainstage in a high pressure blowdown mode.

3.1.13 Data Acquisition and Instrumentation - Details of the data acquisition and instrumentation systems are presented below:

3.1.13.1 Data Acquisition - The 128-channel Data General Digital Data Acquisition System (DDAS) was used to provide simultaneous data acquisition and test control functions. The system consists of three interfacing subsystems: 1) Data General S/140 CPU, 2) a basic input/output subsystem, and 3) Neff 620/500 amplifier/channel multiplexer. The DDAS operated at a sampling rate of 50,000 measurements per second. The test control program was loaded and executed by the Data General S/140 CPU. All data acquisition, control, and redline functions were controlled by the CPU. The Neff multiplexer continuously scans the 128 analog data channels and performs an analog-to-digital signal conversion; it then serially inputs the signal into the CPU. The CPU then performs comparison checks for signals exceeding any redline limits as specified in the test control program.

3.1.13.2 Temperature - Temp. Bulb sensors were used for critical temperature measurements (temperature range from cryogenic to 212 deg. F), and thermocouples were used for all other temperature measurements. A total of twenty-six temperature measurements were taken.

3.1.13.3 Pressure - All low frequency pressure measurements were made using strain-gage type transducers manufactured to Rocketdyne specifications. Approximately 38 pressure measurements were made. In addition, a high frequency piezoelectric pressure sensor was located on the LOX dome to monitor any flow or chamber instabilities.

3.1.13.4 Flow - Liquid flow measurements were made using sub-critical venturi flowmeters. Gas flows were measured using critical and subcritical flow venturis. Pressure, delta P and temperature measurements from these venturis were taken to obtain actual flowrates. Calorimeter water flowrates were obtained using calibrated orifices with known discharge coefficients.

3.1.13.5 Vibration - The thrust chamber had four accelerometers placed on the combustion chamber to monitor radial and axial loading.

4.0 THRUST CHAMBER TEST HARDWARE PERFORMANCE

4.1 HOT-FIRE TEST SERIES MATRIX AND SUMMARY OF TEST SERIES

The hot-fire test program was defined in a test plan approved by Rocketdyne OTV program and APTF management with NASA Lewis Research Center concurrence. The specific test plan was submitted at a Test Operational Readiness Review which insured that all NASA LeRC and Rocketdyne objectives, requirements and procedures were properly addressed. Test Requests were submitted for each individual test to define particular test objectives and requirements. The hot-fire test series was divided into two categories: start transient and the steady state tests. The start transient tests were designed to characterize the start sequence, hardware priming times and ignition.

The test series objectives were achieved by activating the propellant systems and building on each test. Successful water and LOX blowdowns were conducted on the calorimeter and thrust chamber systems. A successful ignition test characterized and confirmed the plasma-torch start sequence. This was followed by a successful fuel blowdown in which all systems (LH₂, GH₂, H₂O and ignition systems) were operated and characterized. A successful start transient test was achieved, characterizing the thrust chamber and facility performance.

The steady-state hot fire test matrix is presented in Table 4-1. A successful 15-second, 850 psia test with mixture ratio excursions was completed in test 017-016. The reduced data indicated that heat transfer to the calorimeter system was an average of 21% higher than predicted. Although heat loads were higher than predicted, testing at higher chamber pressures did not require modification of the water coolant system. Valve modulation and system performance were close to analytical model predictions. The mixture ratio excursions were varied, covering a range from 4 to 5.6 (O/F). NASA LeRC directed Rocketdyne to increase chamber pressure in smaller steps so as not to overload the calorimeter. The test plan was revised to conduct the next test at a chamber pressure of 1000 psia. Test 017-027 was a six-second, 1000 psia chamber pressure test.

Table 4-1. Steady State Hot Fire Test Matrix

<u>Test Number</u>	<u>Calorimeter Configuration</u>	<u>Target Pc psia</u>	<u>Max. Obtained Pc psia</u>	<u>Test Duration Sec.</u>
017-016	0.04 Rib	800	830	15
017-027	0.04 Rib	1000	1050	6
017-041	Smooth Wall	800	850	15
017-042	Smooth Wall	1000	1060	15

A close examination after test 017-027 showed that the Rigimesh screen, which protected the original fuel manifold from the hot-gas flow, had warped and buckled at the aft end. A failure analysis indicated that the Rigimesh failure was due to inadequate cooling of the forward and aft end stainless steel structural rings. The

replacement ring was a cylinder of Narloy-Z with 2700 laser-drilled coolant holes. A zirconium oxide coating was also applied to the hot-gas wall surface to preclude a high thermal gradient from structurally weakening the Narloy-Z.

The testing of the 0.040 in. ribbed calorimeter was discontinued in order to obtain smooth wall data. The calorimeter was machined smooth and re-installed into the test stand. After reassembly it was decided to use a complete series of blowdown, ignition and transient checkout tests, as some minor changes had been made to the system. Testing resumed to provide data for comparison with that obtained in the ribbed configuration. Prior to calorimeter data testing, checkout tests were completed to confirm that the replacement exciter system functioned properly and to characterize the performance of the Narloy-Z protective system (017-029). It was determined from test 017-029, that the delta P across the Narloy-Z was smaller than expected due to the mechanically floating nature of the cylinder. Therefore, it was decided to increase the GH_2 mass flowrate from 0.6 lbs/sec to 0.9 lbs/sec. This would provide sufficient coolant to the coolant holes and increase the delta P across the Narloy-Z. During the nominal start transient it was estimated that this delta P would approach 500 psid. The structural delta P maximum for the Narloy-Z at room temperature was 530 psid. Therefore the start transient was modified to minimize this effect. The GH_2 coolant valve was opened at the same time as the main fuel valve, with the main fuel valve initially set at a position which would increase the chamber pressure from less than 100 psia to over 200 psia. This action effectively managed the delta P across the Narloy-Z and kept it well below 300 psid. The cut-off transient was acceptable as the GH_2 coolant back pressure lagged slightly behind the decaying chamber pressure.

The smooth wall calorimeter 850 psia chamber pressure test, number 017-041, included a mixture ratio excursion. The mixture ratio excursion was not over as wide a band as anticipated. The 1060 psia chamber pressure test number 017-042 was then conducted. The mixture ratio excursions achieved values of 5.6, 6.5, 7.0 and 5.0 during the 1060 psia P_c test.

4.2 I.C.E. THRUST CHAMBER TRANSIENT SIMULATION MODELING

The Integrated Component Evaluator thrust chamber performance was modeled prior to the initial hot-fire test to predict thrust chamber characteristics during hot-fire. An existing feed system computer model of the pump-fed RS-44 engine was modified to simulate the test article in order to determine:

1. Main propellant valve positions, sequencing and system response for an initial hot fire test at a chamber pressure (P_c) of 800 psia and an injector mixture ratio (MR) of 5.0.
2. LH_2 and LOX system blowdown test responses. (Ref. Appendix I)
3. Main Propellant valve positions for MR excursions from 5.0 to 7.0 at constant chamber pressures of 800 psia and 1200 psia. The 1000 psia chamber pressure test was modeled generating only numerical data (no plots). (Ref. Appendix II)

Once steady-state valve positions were determined by the model, a fuel lead open loop start sequence was formulated. This fuel lead would be followed 0.2 seconds later by opening of the main oxidizer valve (MOV). A mainstage Pc of 800 psia was predicted about 1.25 seconds from start of main fuel valve (MFV) opening. At shutdown, the valves would be closed simultaneously with a fuel lag obtained by closing the MFV at 50%/sec and the MOV at 100%/sec.

The start sequence was subsequently modified to provide delta P relief to the Zirconium oxide coated Narloy-Z protective cylinder, Figures 4-1 and 4-2. The main fuel valve initial set point was modified to open wider and provide increased chamber pressure to minimize the large delta P across the Narloy-Z cylinder during start up. The valve opening at 100%/sec began to flow hydrogen at the 35% open position. The GH₂ coolant supply valve which provided coolant to the protective cylinder was a fast acting pneumatic valve, which opened 0.35 seconds after the MFV was commanded open. At the same time, the main oxidizer valve was commanded open. The MOV and MFV do not flow propellant until they are ~35% open. Therefore, redlines were armed at this time to insure that both GH₂ coolant and GH₂ main propellant were flowing and primed by the time the main oxidizer valve began to flow, 0.35 seconds later. Prior to the main oxidizer valve reaching the first set point the main fuel valve was commanded to its second set point. It was timed to arrive at that position at the exact time that the MOV reached its first set point position. At this point chamber pressure increased until steady state was achieved.

The hot fire test simulation proceeded through its mixture ratio variation program using step functions each time the valves were modulated to new positions. During cut-off, the MOV was closed at 100%/second and the MFV was closed at 50%/second. The GH₂ coolant valve was closed at the cutoff signal as the pressure decay of the GH₂ coolant in the original fuel manifold lagged the chamber pressure. The pneumatic GH₂ coolant valve closure rate was timed to be approximately the same as the MFV closure rate of 50%/second.

A LOX blowdown, test number 017-001, was conducted to characterize LOX side flow resistances and priming time. A fuel blowdown test, number 017-008, was conducted to characterize fuel and coolant system performance. This test consisted of operating the main fuel propellant, gaseous hydrogen fuel manifold coolant system, ignition system and the water combustor coolant system. A second fuel blowdown test, number 017-029, was conducted after the Rigimesh system had failed and was replaced by the transpiration cooled NARloy-Z ring. This was required to characterize the flow performance of the transpiration cooled ring and the modified start sequence which was formulated to keep the delta P across the protective ring to a minimum. The results of these tests were iterated into the performance model and used to more accurately predict thrust chamber response. The fuel and oxidizer blowdown model results are shown in Appendix I. The mainstage tests with the mixture ratio excursions at a constant Pc revealed that only a small range of valve position movement was required. For the 800 psia Pc operation the MFV position closed just over 5% and the

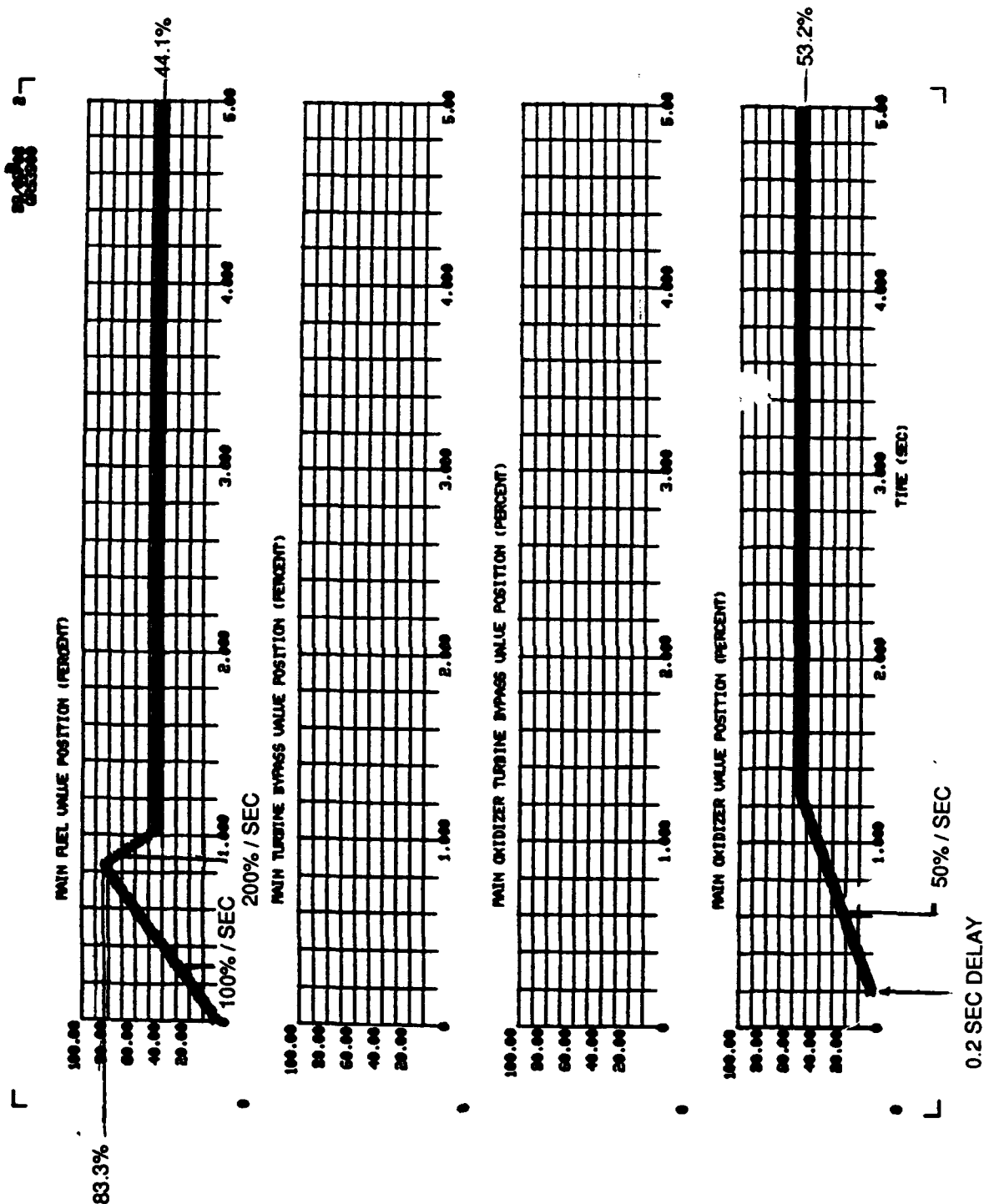


Figure 4-1: Transient Simulation Case I

CHANGED MFV SEQUENCE TO ELIMINATE "DIP"
IN CHAMBER PRESSURE CAUSED BY CASE I

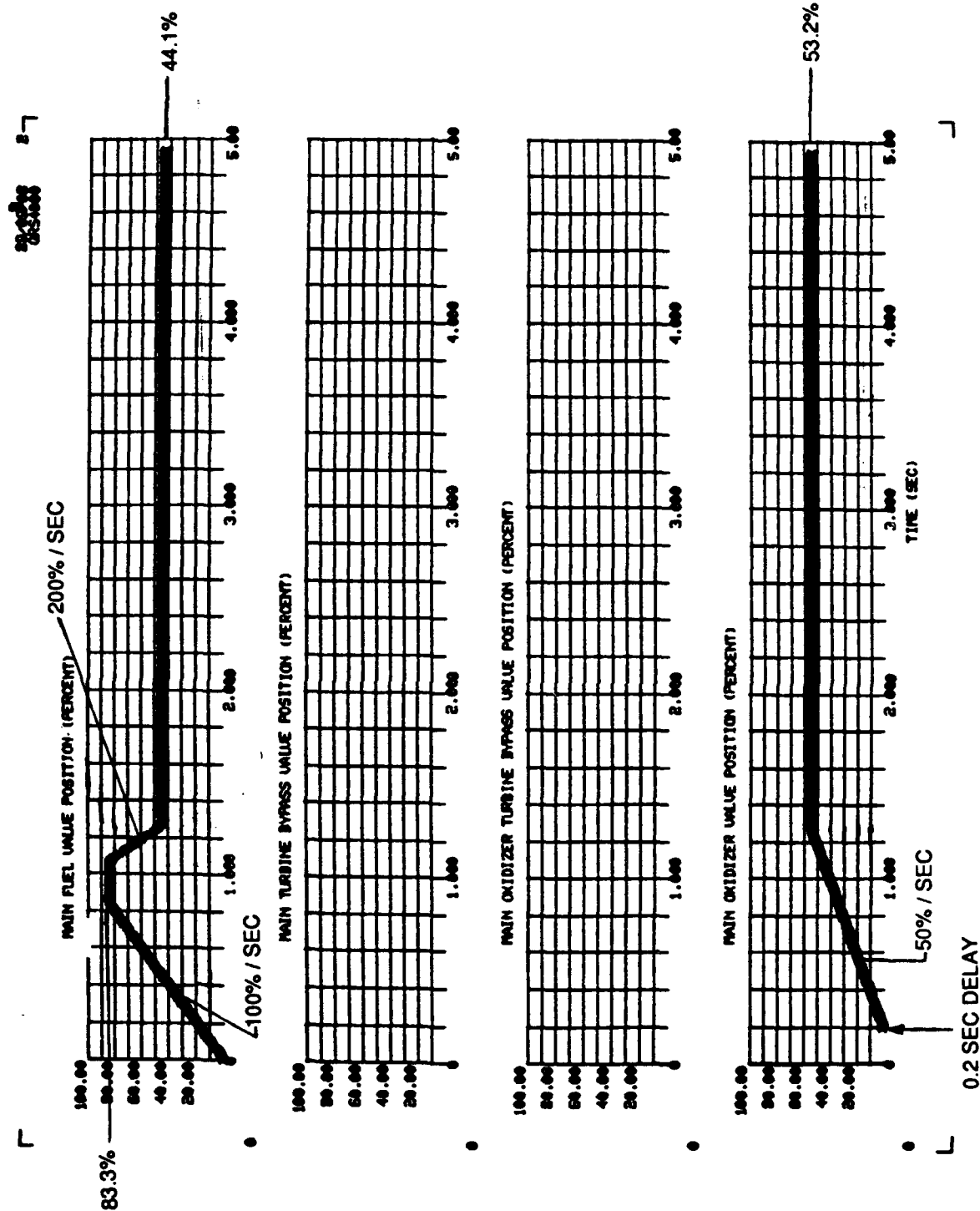


Figure 4-2: Transient Simulation Case II

MOV opened less than 2% to vary MR from 5 to 7. Corresponding adjustments at 1000 psia P_c were also small in nature, varying from 1 to 7% for mixture ratio variations from 5 to 7. Steady-state parameters of closed-loop simulations can be found in Appendix II. Chamber pressure, thrust chamber cooling channel delta P's, chamber, nozzle and component resistance predictions based on model results are shown in Table 4-2.

Table 4-2

<u>Parameter</u>	<u>Predicted Value</u>
Chamber Pressure	800 psia
Initial Mixture Ratio (O/F)	6.0
INJ. LOX side Resistance	47.6 $\text{sec}^2/\text{ft}^3\text{-in}^2$
INJ. Fuel side Resistance	8.0 $\text{sec}^2/\text{ft}^3\text{-in}^2$
Chamber Delta P	200 psid
Chamber Resistance	110.4 $\text{sec}^2/\text{ft}^3\text{-in}^2$
Nozzle Delta P	40 psid
Nozzle Resistance	3.8 $\text{sec}^2/\text{ft}^3\text{-in}^2$

4.3 I.C.E. THRUST CHAMBER PERFORMANCE RESULTS

The test series subjected the hardware to 25 starts and 51 seconds of steady state hot-fire time. The thrust chamber major component hardware did not exhibit any signs of structural fatigue or indication of hardware damage. The injector had minor faceplate discoloration and minor faceplate erosion. The faceplate coolant holes emplaced along the edge of the injector to alleviate areas of previous erosion were effective. No further material removal or damage to the injector face was done in those areas with coolant holes. The tapered wall combustor sustained minor blanching and discoloration of the liner. The 35:1 sea-level nozzle exhibited signs of minor blanching of the liner surface.

Specific performance parameters, chamber pressure, valve position, varied with each test. Test 017-041 thrust chamber performance is presented as an example of performance during a test. Test 017-041 was a 15-second, 850 psia chamber pressure test of the smooth wall calorimeter. The test plan called for operation at the nominal mixture ratio of 6.0, with mixture ratio excursions to 6.5, 7.0 and 5.0. The thrust chamber performance results, shown in table 4-2, indicate that test duration, chamber pressure and the mixture ratio excursions were all accomplished, however, the actual mixture ratios obtained were 5.6, 5.8, 6.1 and 5.7.

The thrust chamber resistance data varied slightly with previous engine data. The tapered wall combustor resistance was less than previously achieved due to lowered operating inlet pressures (which were dictated by the facility tankage system). The nozzle inlet pressure was also less than that run during the engine tests and therefore the resistance was slightly lower. Injector resistance data was a better indication of engine test resistance vs. thrust chamber resistance performance. The fuel side

Table 4-3 -- I.C.E. Performance Results

<u>Parameter</u>	<u>Predicted</u>	<u>Actual</u>	<u>% Difference</u>
017-041 -- Test Duration	15 sec.	15 sec.	--
Chamber Pressure	800 psia	850 psia	6.2
Initial Mixture Ratio (O/F)	6.0	5.6	6.7
Mixture Ratio Exclusions	6.5, 7.0, 5.0	5.8, 6.1, 5.7	10.7, 12.8, 14.0
Injector LOX Side Resistance	47.6 sec ² /in ² ft ³	42.2 sec ² /in ² ft ³	11.3
Injector Fuel Side Resistance	8.0 sec ² /in ² ft ³	9.8 sec ² /in ² ft ³	22.5
Chamber Resistance	110.45 sec ² /in ² ft ³	123.5 sec ² /in ² ft ³	11.8
Chamber Delta P	200 psid	209 psid	4.5
Nozzle Resistance	3.76 sec ² /in ² ft ³	3.98 sec ² /in ² ft ³	5.8
Nozzle Delta P	35 psid	30 psid	14.2

resistance was identical to that measured during engine tests. The LOX side resistance was slightly lower due to a slightly lower operating inlet pressure. This was from inaccuracies in predicting MOV resistance at the lower open area valve settings (caused by valve hysteresis). Table 4-3 presents thrust chamber resistance values.

The chamber pressure at ignition verification was 202 psia, which exceeded the minimum ignition chamber pressure (120 psia). The igniter core mixture ratio was 23.6, which was 2.43% off of the optimum core mixture ratio of 24.2. The coolant flow to the zirconium oxide coated Narloy-Z cylinder was 1.06 lbs/sec, which was 18% higher than the required 0.9 lbs/sec. This additional flowrate did not severely increase the delta P across the protective sleeve and aided in increased cooling of the sleeve.

5.0 CALORIMETER THERMAL PERFORMANCE

5.1 CALORIMETER THERMAL PERFORMANCE PREDICTIONS

The analysis performed to predict the rib and smooth wall heat flux was based on data obtained from the 40Klb SSME calorimeter data, scaled to the OTV engine thrust and chamber pressure levels. Results from the thermal analysis are presented to provide a direct comparison with the hot-fire test results. The analysis indicated that for the ribbed chamber at 850 psia chamber pressure, and a mixture ratio of 5.6, the average heat flux was 18.15 Btu/sq.in.-sec. For a chamber pressure of 1050 psia at a mixture ratio of 5.0, it would be 23.18 Btu/sq.in.-sec. **The I.C.E. calorimeter coolant system designed to operate at 1500 psia chamber pressure would operate well within the predicted heat load envelope.** The analysis indicated that for the smooth wall chamber at 850 psia chamber pressure, at a mixture ratio of 5.6, the average heat flux would be 11.88 Btu/sq.in.-sec. For 1050 psia chamber pressure it would be 13.68 Btu/sq.in.-sec, at a mixture ratio of 5.0. An overall enhancement of 42% was predicted (based on the 2-d lab results) for a 20-in. combustion chamber with a 16-in. barreled section as shown in Figure 5-1. In order to make comparisons between hot-fire ribbed data, smooth wall data and analytical data, comparisons were made at common mixture ratios obtained during all the hot-fire tests.

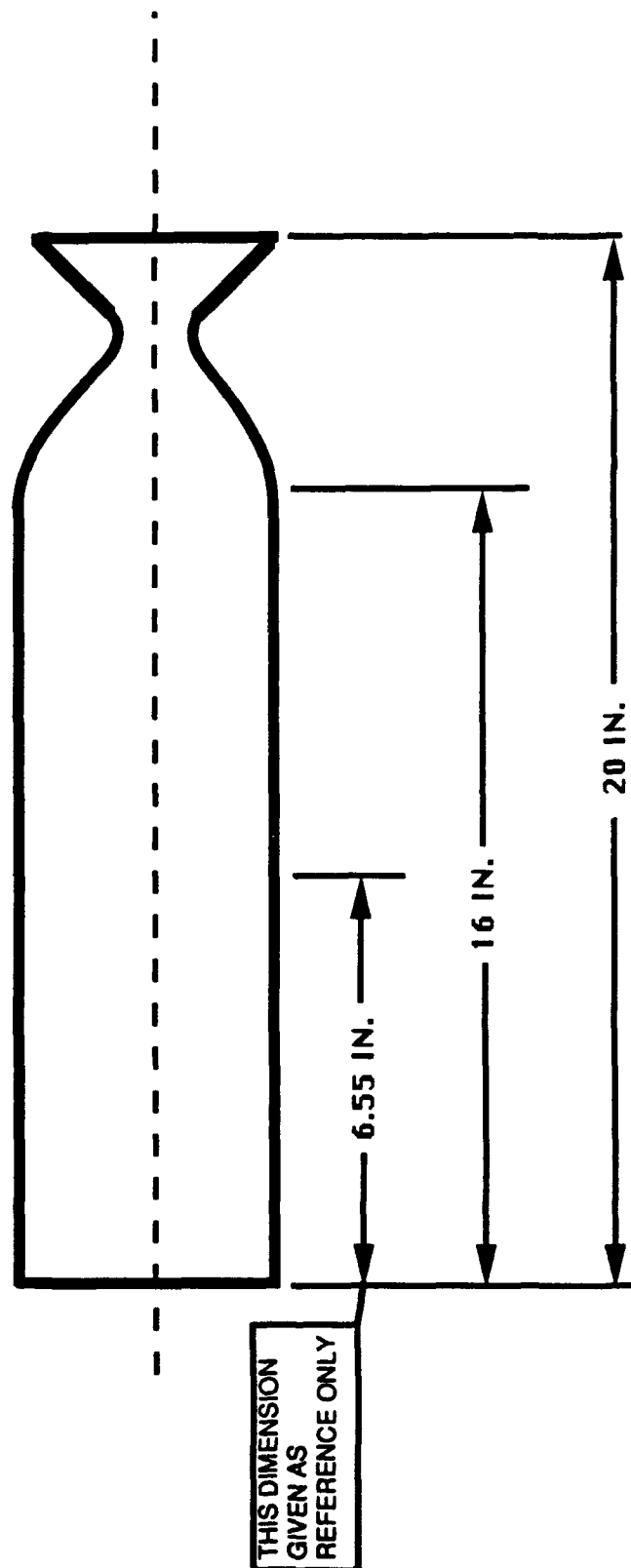
5.2 CALORIMETER THERMAL PERFORMANCE ACTUAL RESULTS

The heat transfer data from the 0.040 in. ribbed calorimeter combustor was obtained from two tests. Test 017-016, a 15-second 830 psi chamber pressure test and Test 017-027, a six-second, 1050 psia chamber pressure test. The heat load rate when plotted vs. combustor position (reference Figure 5-2) exhibited a pattern similar to previous calorimeter combustors. The heat load rate was higher at the calorimeter channel closest to the injector and then decreased in the second channel. This was followed by an increase in the third channel and a marked increase in the fourth channel. This pattern is characteristic of effects which occur close to the injector and has been noted in other calorimeter testing. The high heat load rate indicates that the hot-gas boundary layer has not attached to the wall of the combustor, and that possible re-circulation is occurring close to the injector faceplate outer edge which accounts for the high heat load rate close to the injector face. As the boundary layer attaches, around channel #4, the boundary layer thickness is very small and accounts for the increased heat load rate. As boundary layer thickness increased downstream of channel 4, slightly decreasing heat load rates were exhibited.

The heat transfer results from the ribbed combustor at 830 psia chamber pressure indicated that the mixture ratio excursions affected the heat flux as shown in Figure 5-3. The mixture ratio varied from 4.0 to 5.6 and increased the corresponding heat loading ~1.92 Btu/sec per 1.0 mixture ratio change over the specific range of 4.0 to 5.6. This increase was not observed during the smooth wall tests.

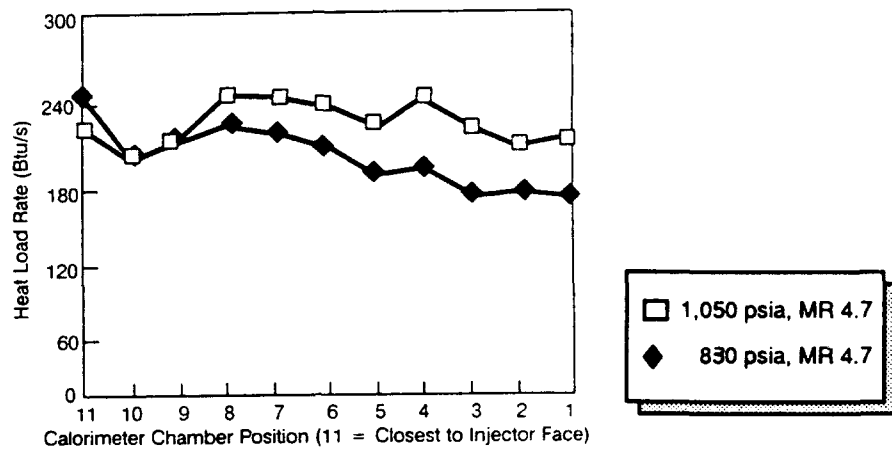
CYLINDRICAL RIBBED SECTION

CONVERGENT/DIVERGENT SECTION



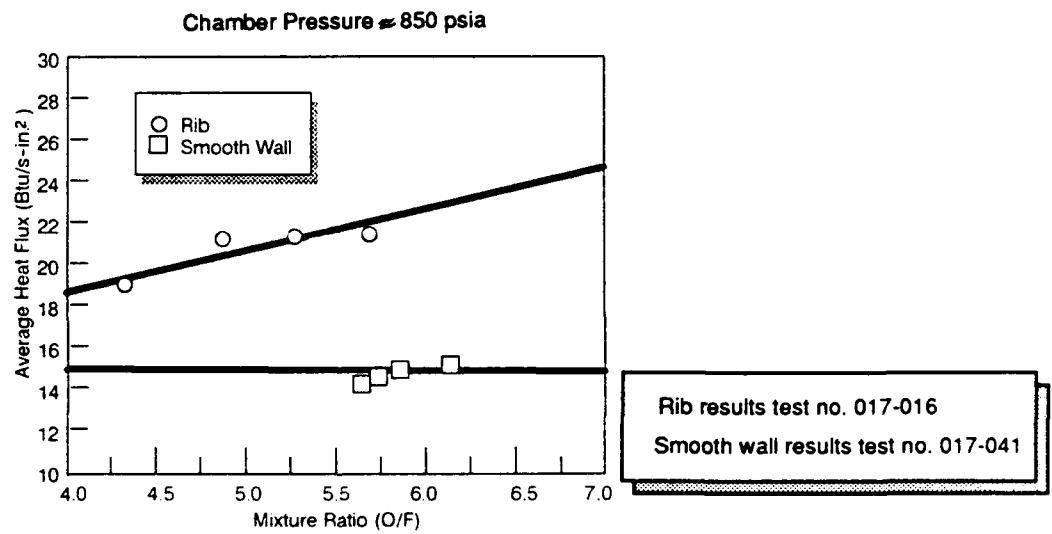
NOTE - DRAWING NOT TO SCALE

Figure 5-1: 15K1b Ribbed Combustor Geometry



5587-7

Figure 5-2: 0.040 in. Ribbed Calorimeter 830 & 1050 psia Pc Test Results (Tests 017-016 and 017-027)



5587-8

Figure 5-3: ~850 psia Pc Heat Flux vs. Mixture Ratio

The heat transfer data from the smooth wall calorimeter combustor was obtained from two tests: test 017-041, a 15-second, 850 psia chamber pressure test, and test 017-042, a 15-second, 1060 psia chamber pressure test. The heat load rate when plotted versus combustor position exhibited a pattern similar to previous combustor calorimeters, Figure 5-4. The injector end effects were similar to those seen in the ribbed combustor tests, though the changes in heat load rate were not as pronounced as in the ribbed testing, Figure 5-2. The smooth wall combustor heat transfer results from the 850 psia and the 1060 psia chamber pressure mixture ratio excursion tests showed no effect on heat loading from mixture ratio changes, as shown in Figure 5-5. Table 5-1 shows the total heat load rate and average heat flux for the calorimeter at their corresponding chamber pressure and mixture ratio. The change in heat load rate shown by comparisons between the ribbed and smooth wall calorimeter hot-fire tests indicates that the enhancement due to the ribs is more significant at higher chamber pressures. The results of the 850 psia chamber pressure test (017-016) at a mixture ratio of 5.6 indicate a 50% enhancement over a smooth wall. The 1050 psia chamber pressure test (017-027) indicated a 40% increase in heat transfer at a mixture ratio of 4.7. The decrease in enhancement between 850 psia and 1050 psia Pc tests can be attributed to the difference in mixture ratios. If the mixture ratios are normalized, then the enhancement is greater for the 1050 psia Pc test than for the 850 psia test, as shown in Figure 5-6. This indicates that the rib heat transfer enhancement is sensitive to changes in mixture ratio and chamber pressure.

5.3 PROJECTED FULL-SIZE RIBBED COMBUSTOR PERFORMANCE

A direct comparison between the hot-fire tests and the 2-D laboratory results was made by extrapolating the data to a full-size combustor of a 15,000 lb thrust engine. This combustor geometry has hot-gas wall ribs which extend the length of the 16 in. barrel section and a smooth wall convergent/divergent section. Figure 5-1 illustrates the 16 in. barrel section and full combustor geometry. The data was extrapolated to the nominal chamber pressure of 1500 psia, using curves generated from the hot-fire test data. The reduced data, generated at the respective chamber pressures of 850 psia and 1050 psia was extrapolated to a mixture ratio of 6.0, then extrapolated out to the geometry of the combustor. This total enhancement compares with 48% (60% for the 16 in. barrel section only) using the 2-D hot-air and cold flow velocimeter results, figure 5-7. The hot-fire test enhancement was obtained using curves from the heat transfer enhancement vs. chamber pressure graph, figure 5-8.

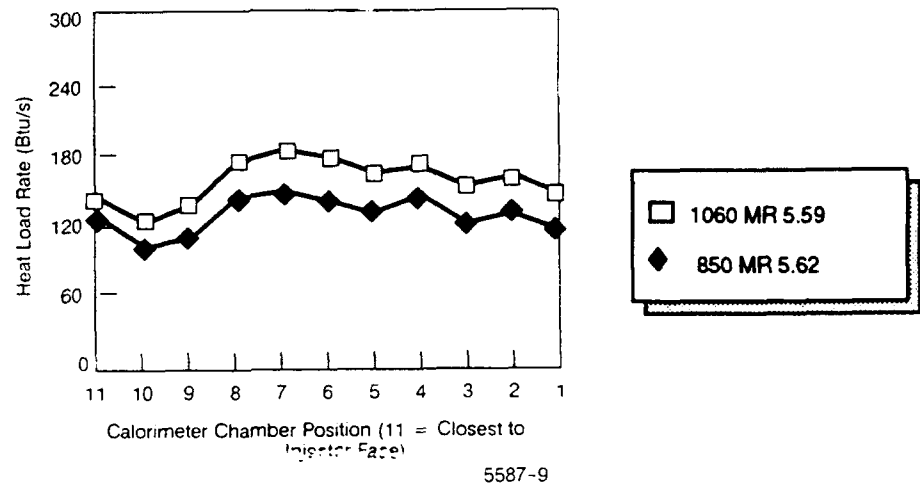


Figure 5-4: Smooth Wall Calorimeter 850 and 1060 psia Pc Test Results Tests 017-041 and 017-042

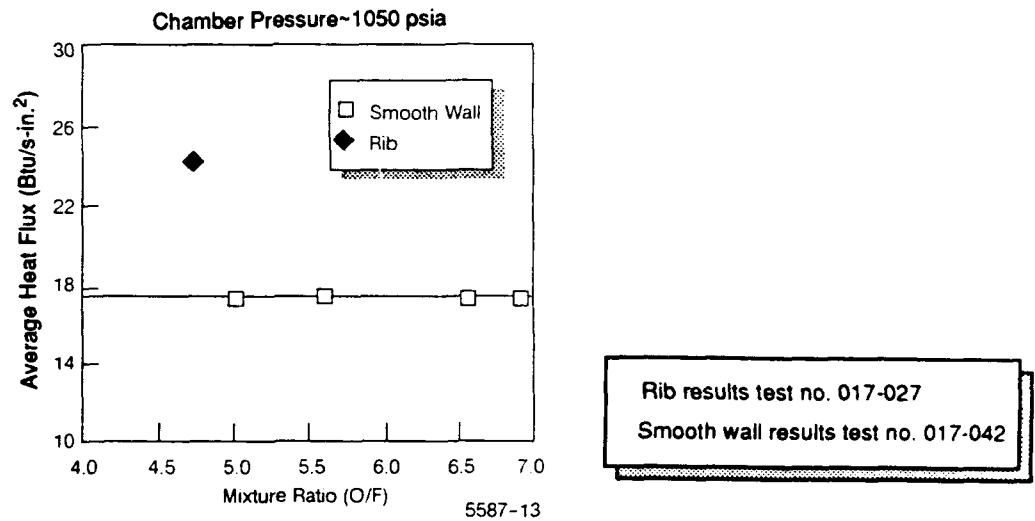


Figure 5-5: ~1050 psia Pc Heat Flux vs. Mixture Ratio

Table 5-1. Calorimeter Heat Transfer Performance Results

Calorimeter Configuration	Pc (psia)	MR (O/F)	Total Heat Load Rate (Btu/s)	Average Heat Flux (Btu/in ² -s)*
0.040-in. rib wall	830	5.6	2122	21.5
0.040-in. rib wall	1050	4.7	2392	24.2
Smooth wall	850	5.6	1415	14.3
Smooth wall	1060	4.7	1722	17.4

*Includes injector end effects and smooth wall
Total area = 98.8 in²

Table 5-1
TH/Bv 2/28/94

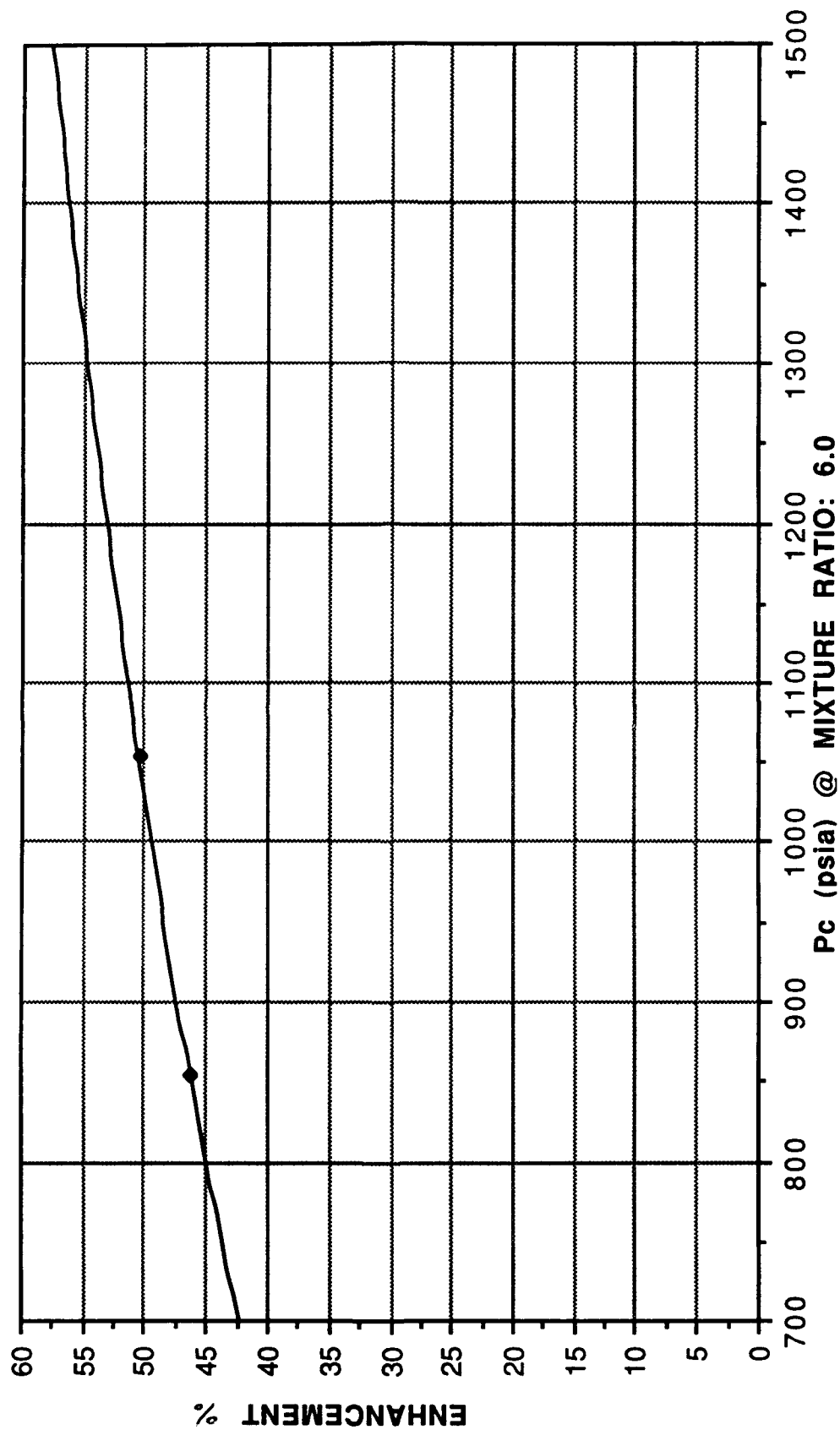


Figure 5-6: Enhancement vs. Pc for 6.55 in. Cylindrical Combustion Chamber

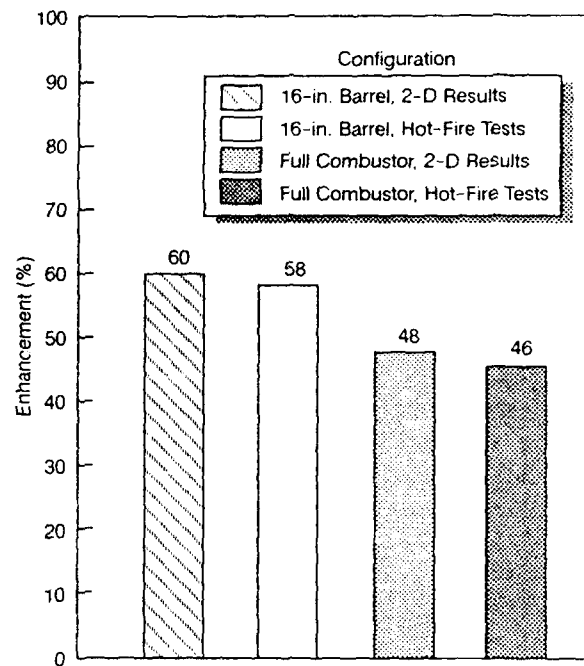


Figure 5-7: 15Klb Percent Enhancement Comparison

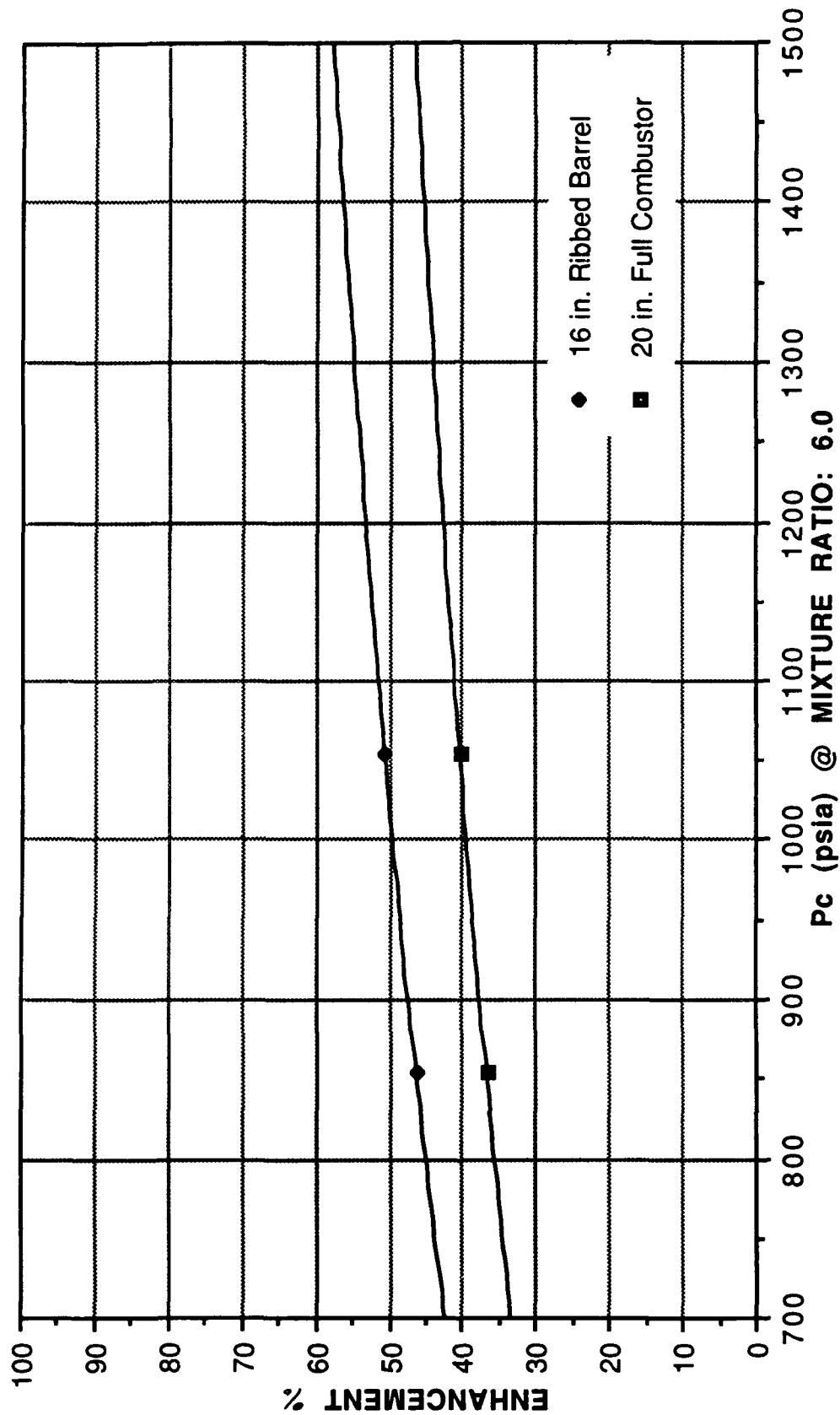


Figure 5-8: Enhancement vs. Pc for 16 in. Cylinder & 20 in. Full Combustor

If we use the relationship of P_c to the 0.8 exponent, which is proportional to the heat load, Q (Btu/sec).

$$\left(\frac{P_2}{P_1} \right)^{0.8} = \left(\frac{Q_2}{Q_1} \right)$$

where P_1 = Chamber pressure of 1050 psia
 P_2 = Chamber pressure of 1500 psia
 Q_1 = Total heat load (Btu/sec.) at 1050 psia
 Q_2 = Total heat load (Btu/sec.) at 1500 psia

The total enhancement for the full 20 in. ribbed combustor using hot-fire test data is 40%. The above relationship has been rewritten assuming that the hot-gas wall delta T ($T_{adiabatic} - T_{wg}$) and hot-gas wall area are constant. The actual relationship used, which comes from the Bartz equation for turbulent pipe flow, relates h_g as a function of the Reynolds number to the 0.8 exponent and Prandtl number to the 0.33 exponent but can be written as follows:

$$h_g = .023 \frac{k}{D} Re^{.8} Pr^{.33}$$

where k = conductivity
 D = diameter
 h_g = hot-gas film coefficient

The above equation predicts the variation of h_g is proportional to density to the 0.8 power (neglecting the small effect of Prandtl number variation) which is the same as saying the variation of h_g is proportional to pressure to the 0.8 power. Thus:

$$h_g \propto P_c^{0.8} \propto \rho^{0.8}$$

where h_g = hot-gas film coefficient
 P_c = pressure
 ρ = density

Therefore, heat transfer increases rapidly with increasing chamber pressure. The hot-fire test data indicated that the effectiveness of the ribs improves with increasing chamber pressure due to changes in boundary layer thickness. The data indicates that the rib heat transfer response is sensitive to changes in boundary layer when compared to a smooth wall combustor. It also indicates that the P_c power exponent, normally 0.8 in equation 1 is slightly higher for this test configuration, 0.82, over this range of chamber pressure.

6.0 CONCLUSION

A critical technology towards building an advanced expander cycle engine is achieving higher combustion chamber pressure, which gives higher overall engine performance. The increased heat energy extracted to drive the turbopumps maximizes the efficiency of the turbomachinery operation. In the past, the heat energy requirements of the turbopumps required longer combustion chambers. Size limitations created the need for a different method to increase heat extraction. This requirement was fulfilled by increasing the area exposed to the hot gas by using combustor ribs. The ribs increased the total area exposed to the hot gas by 80% and thus enhanced the heat energy level imparted to the coolant working fluid.

The resultant enhancement from the ribs for a 16-in. barrel section at 15Klb nominal performance levels is a 58% increase in heat transfer rate (when compared to a smooth wall combustor) which translates to a 46% increase in heat loading for a 15Klb combustor. The findings indicate that the ribs are as effective as previous analysis and 2-d subscale testing indicated. They also indicate that higher mixture ratios and chamber pressures can increase the effectiveness of 0.040-in. ribs. Continued hot-fire testing at higher chamber pressure (1,500 psia) and mixture ratios (>6.0) would more clearly define the relationship between P_c , mixture ratio, and enhancement in that regime.

APPENDIX

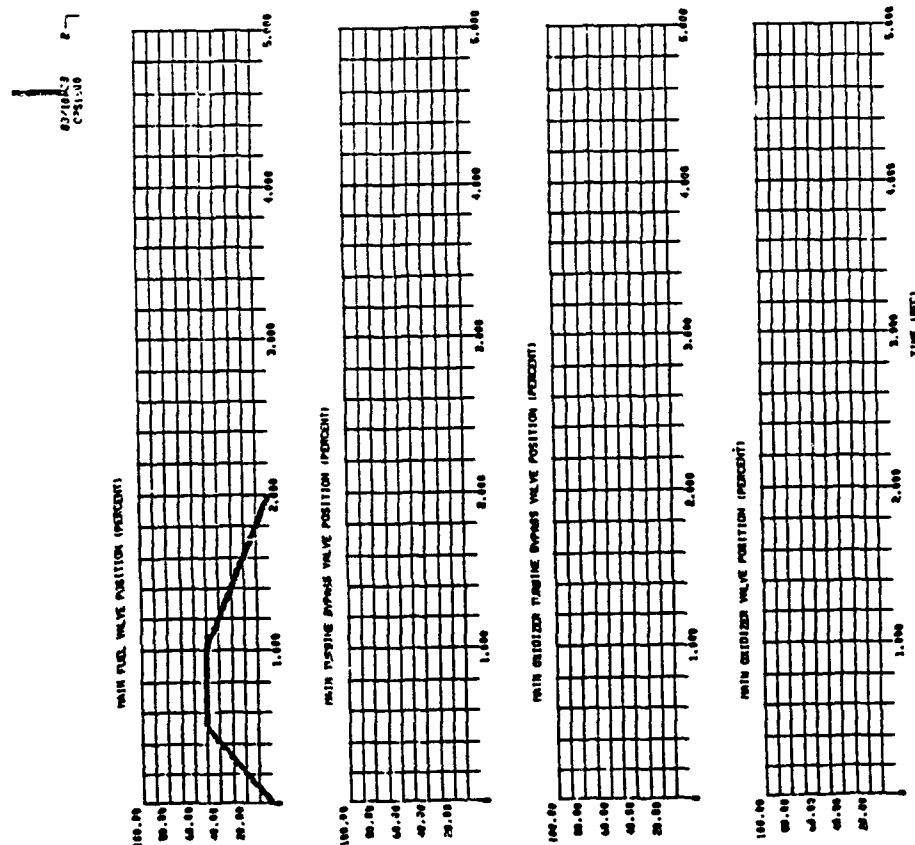
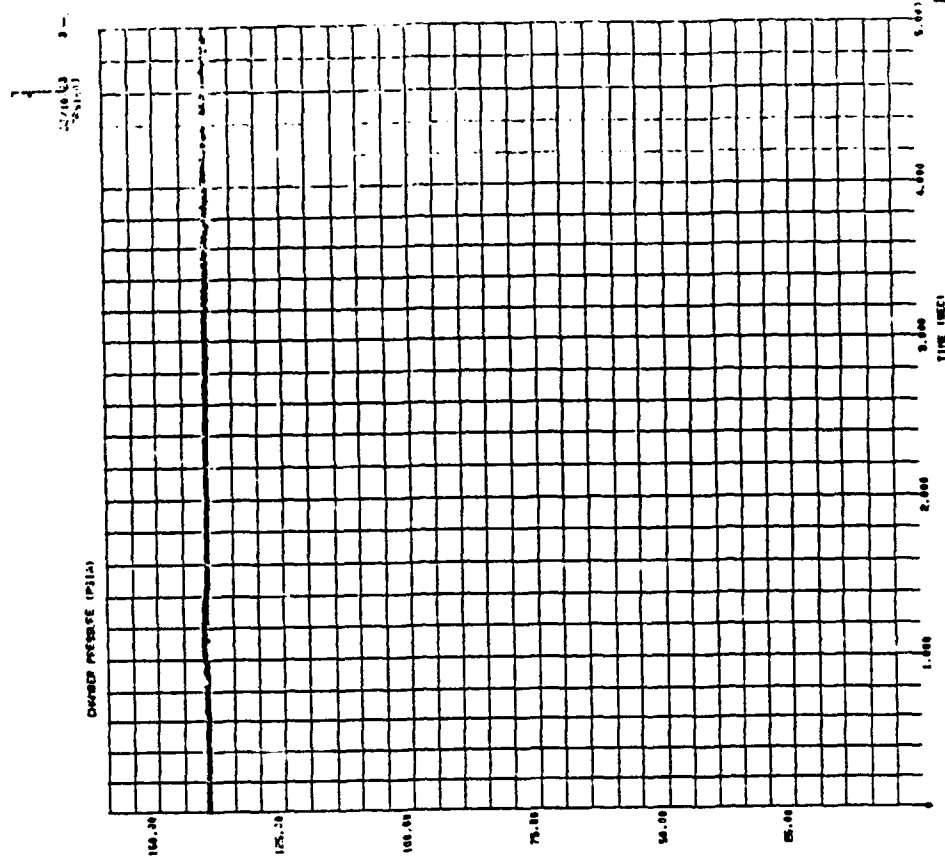
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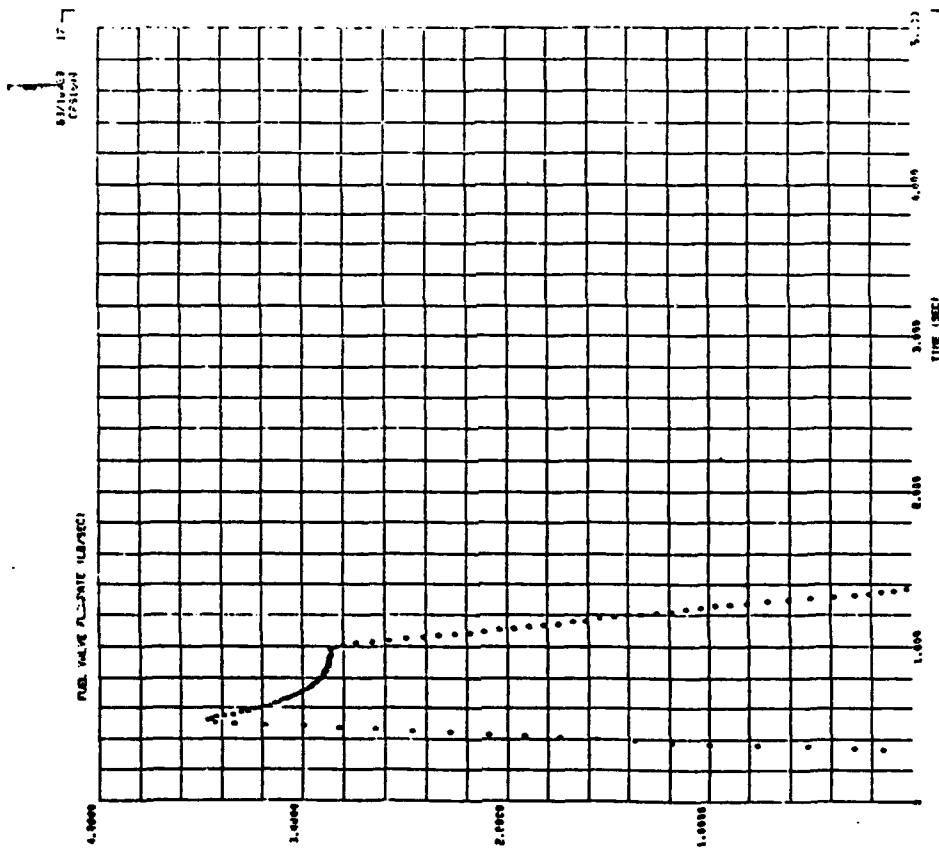
- I. Fuel System and Oxidizer System Blowdowns and Start Transient Simulation Runs**
- II. Steady State Mixture Ratio Variation Simulation Runs**
- III. Sample Reduced Data From 0.040 in. Rib and Smooth Wall Tests**
- IV. Plots of Average Heat Flux from Ribbed and Smooth Configurations**
- V. Drawings and Layouts of Calorimeter Insert and Related Hardware**

APPENDIX I

I. Fuel System and Oxidizer System Blowdowns & Start Transient Simulation Runs

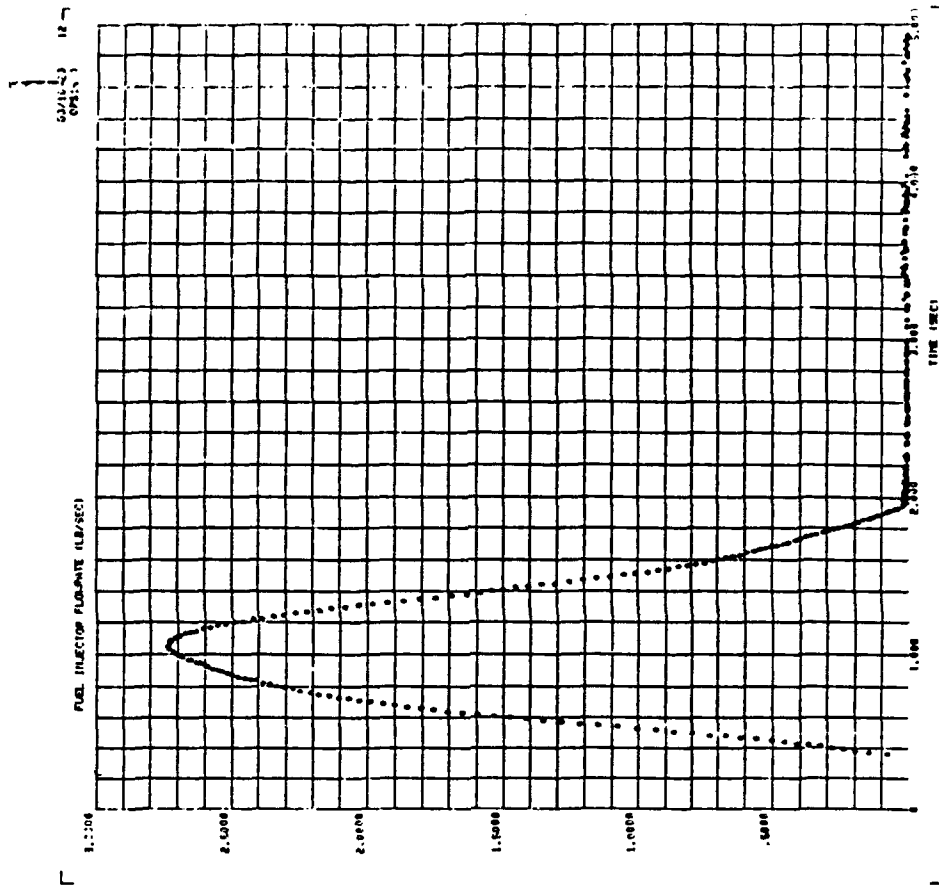
Fuel System Blowdown



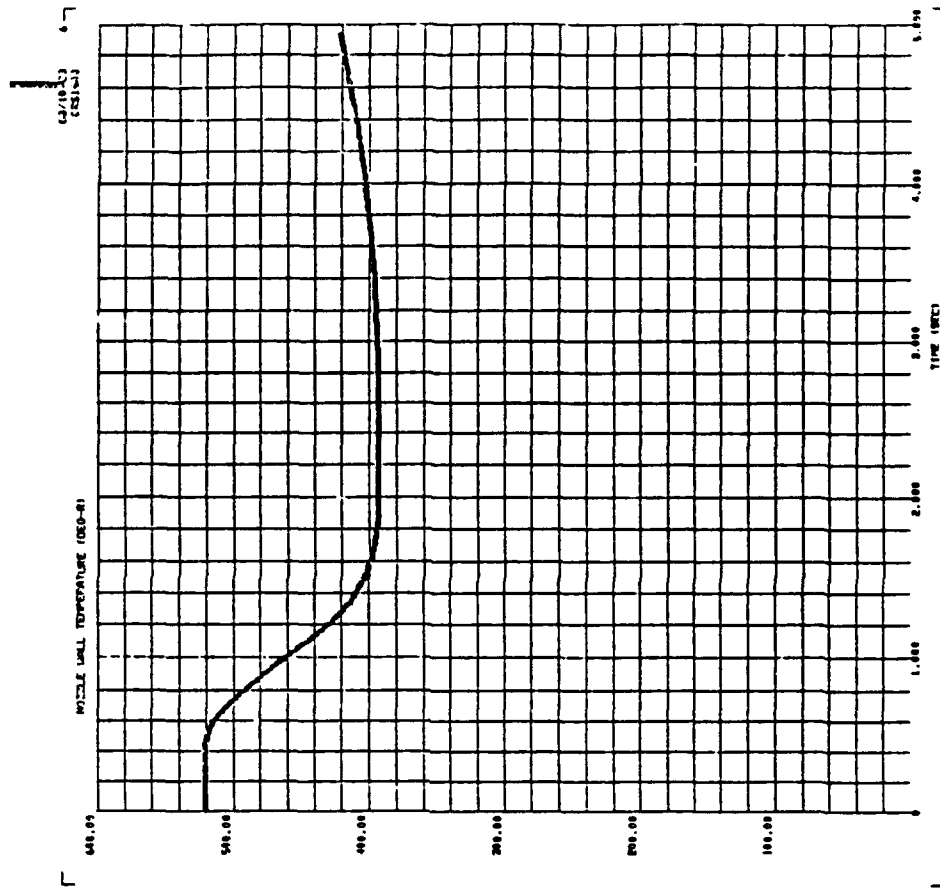


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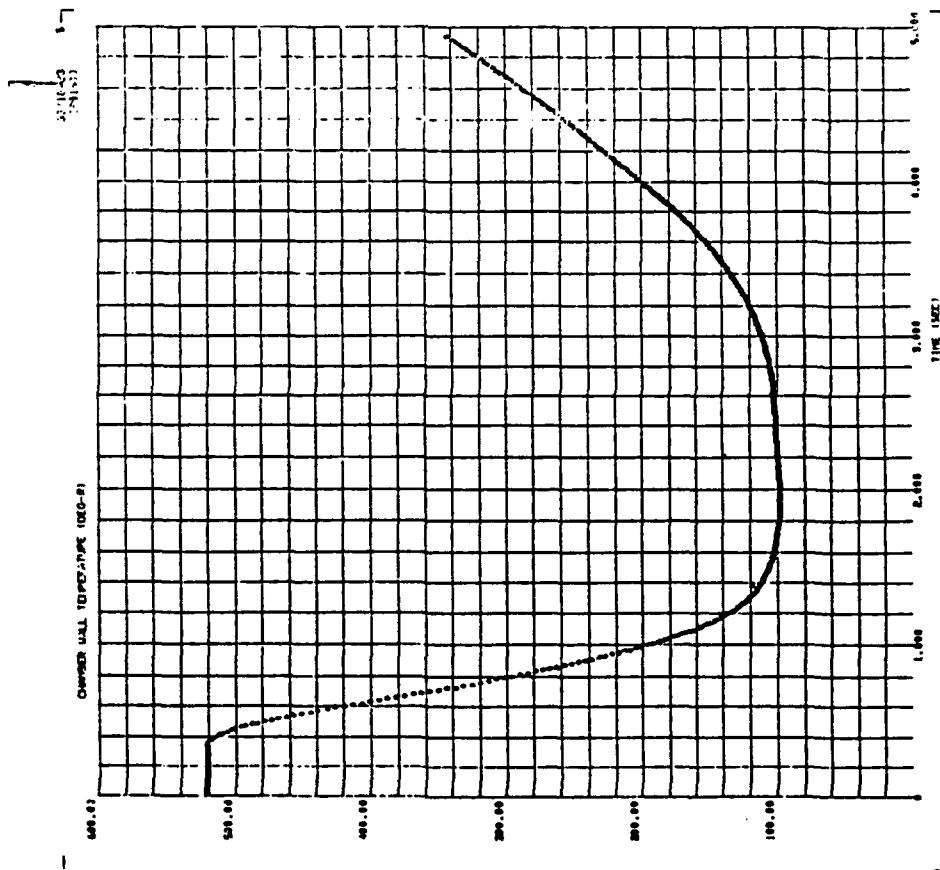
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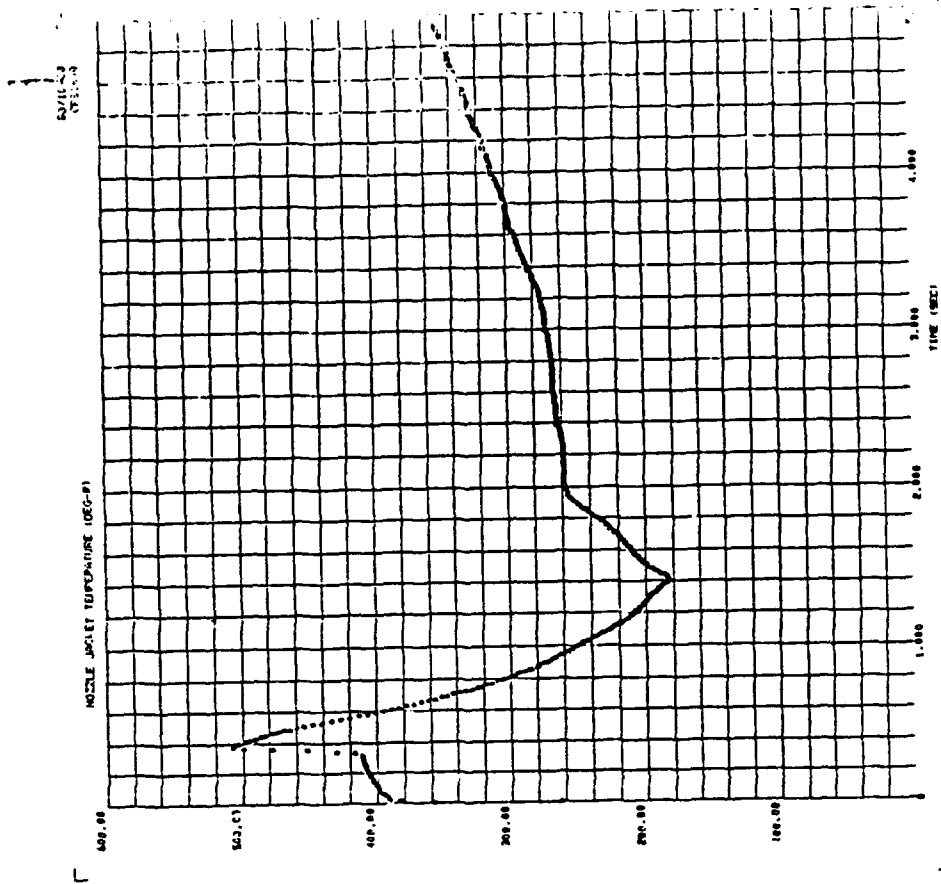
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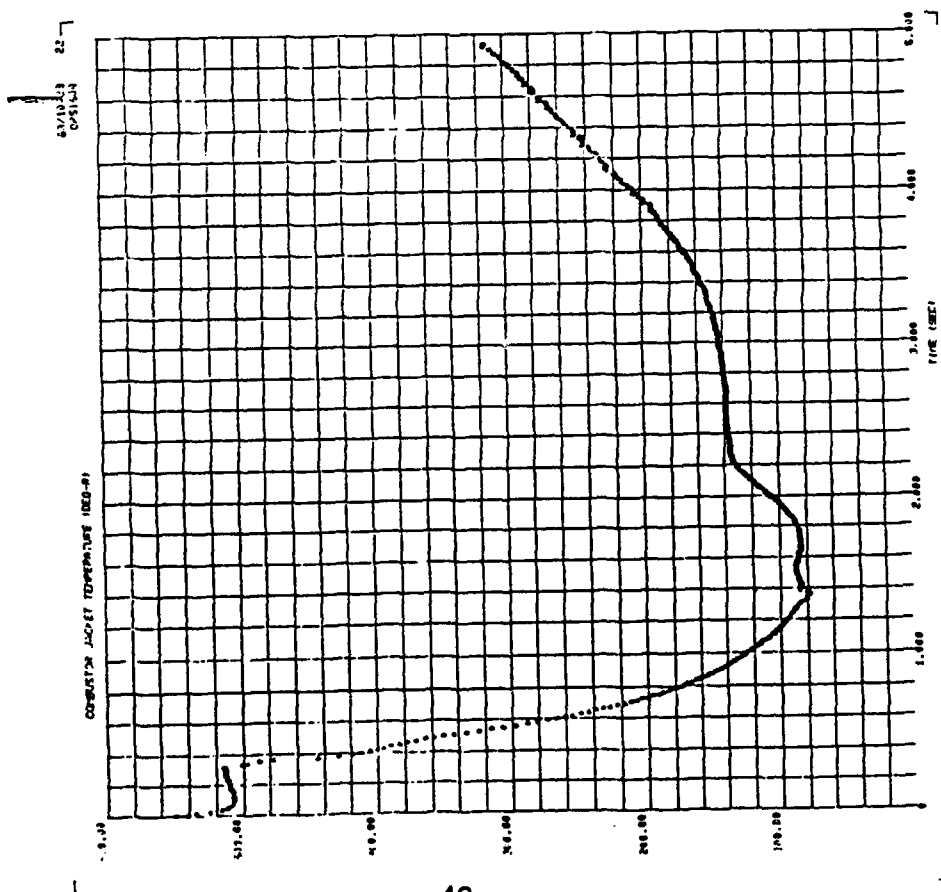
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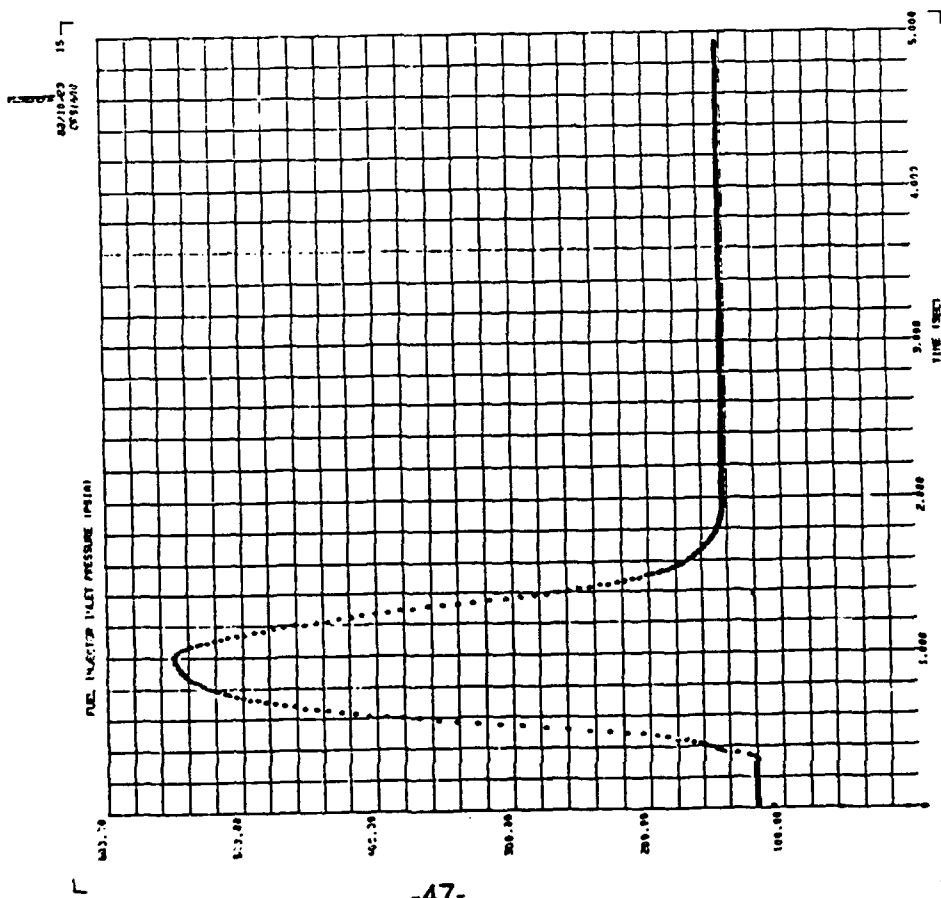
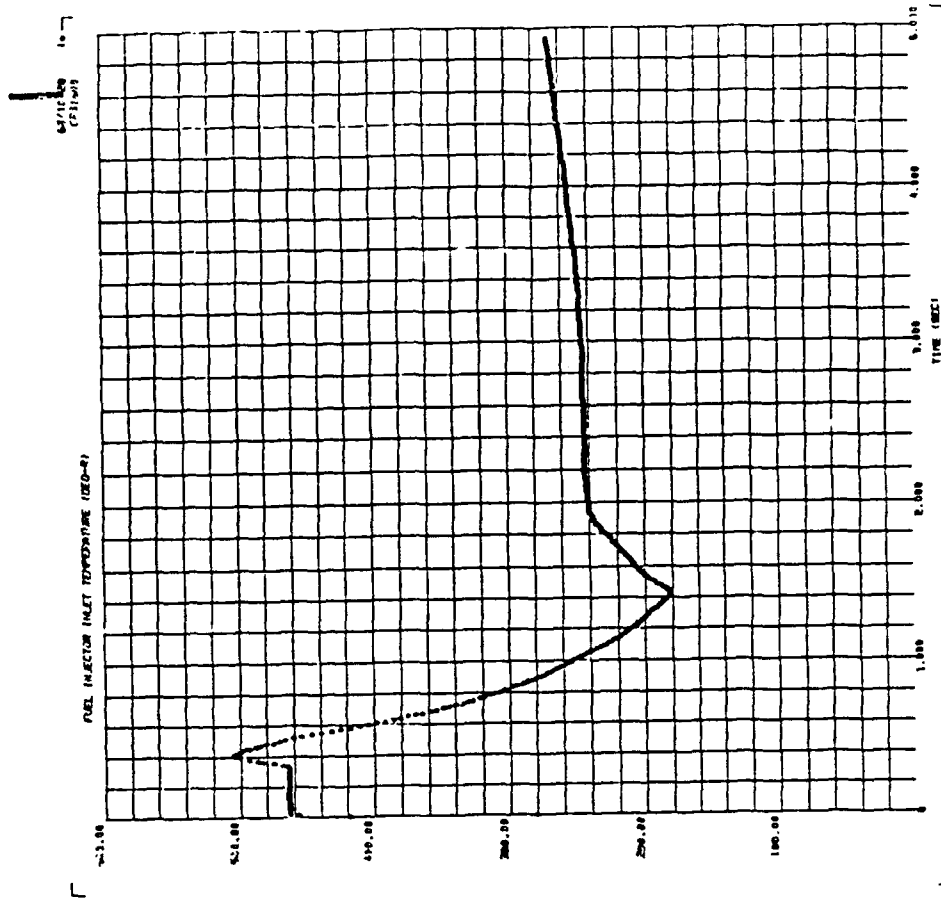
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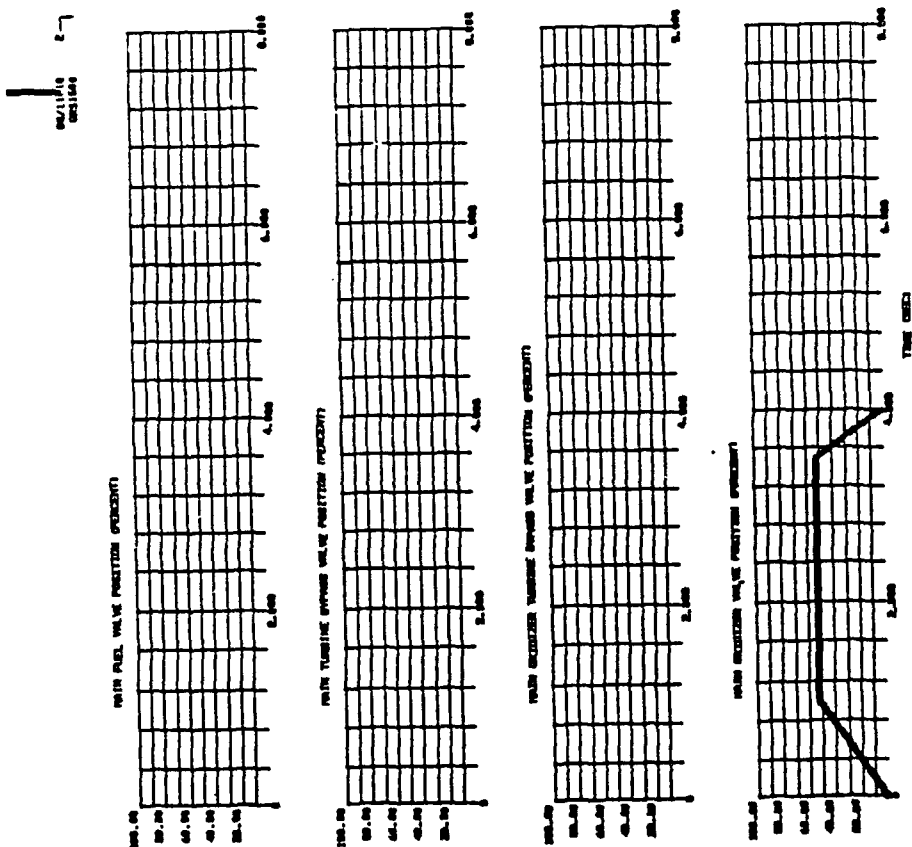
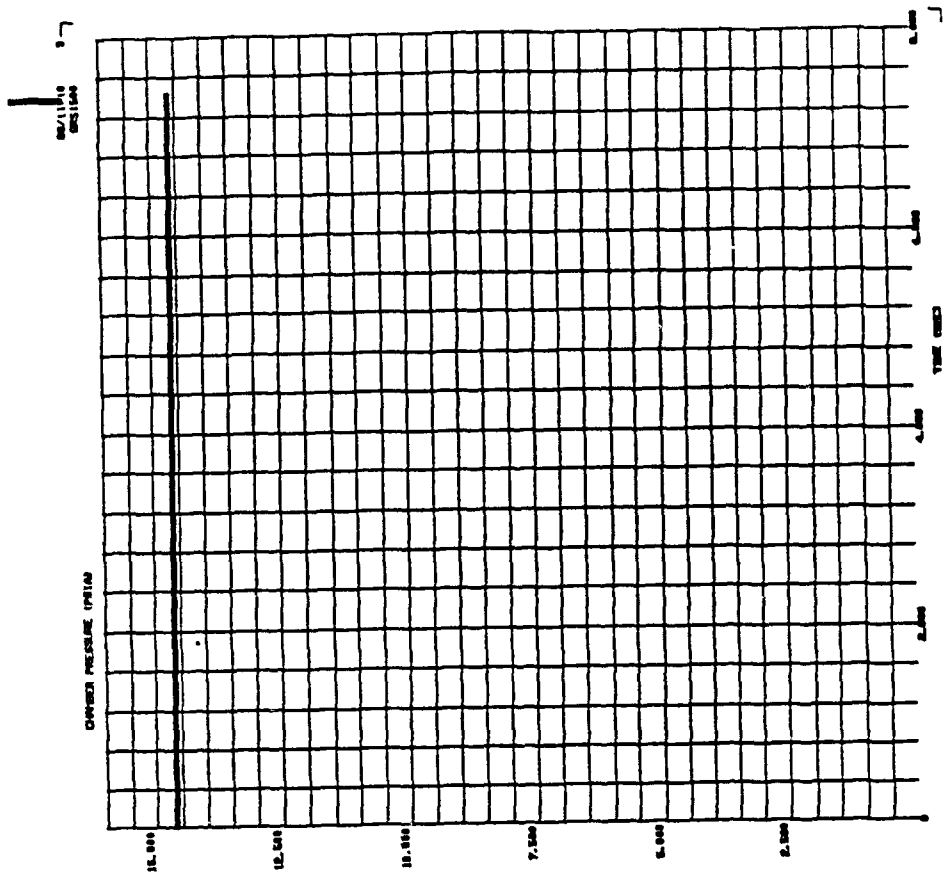
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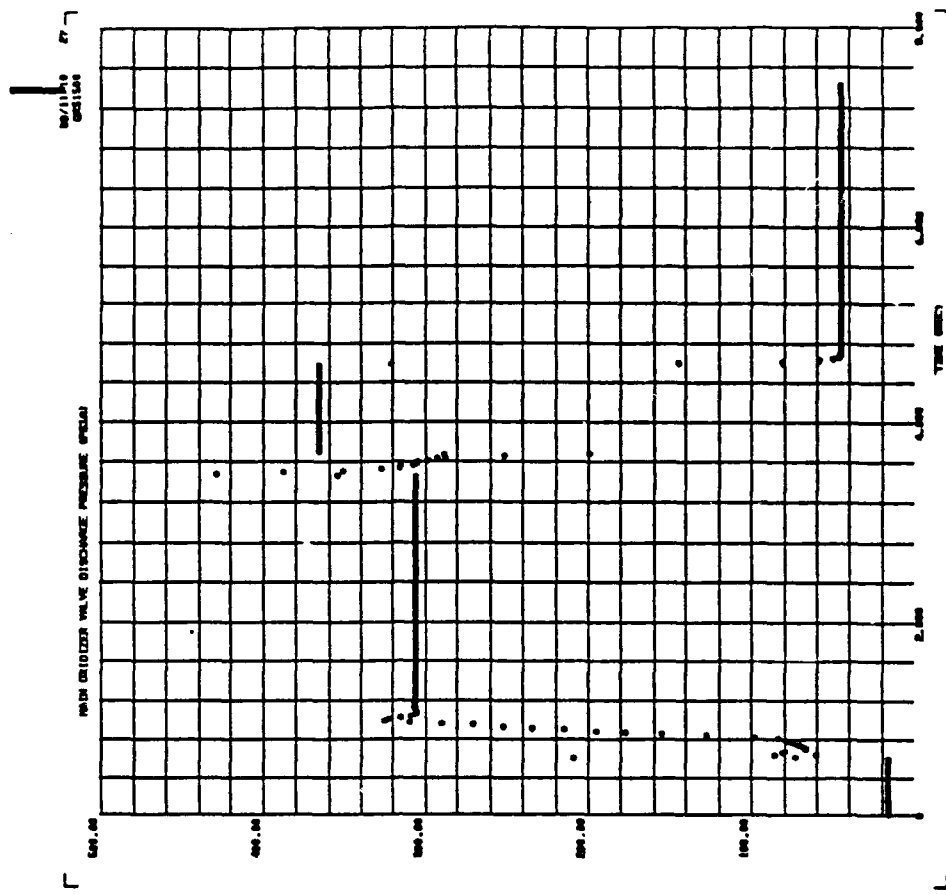
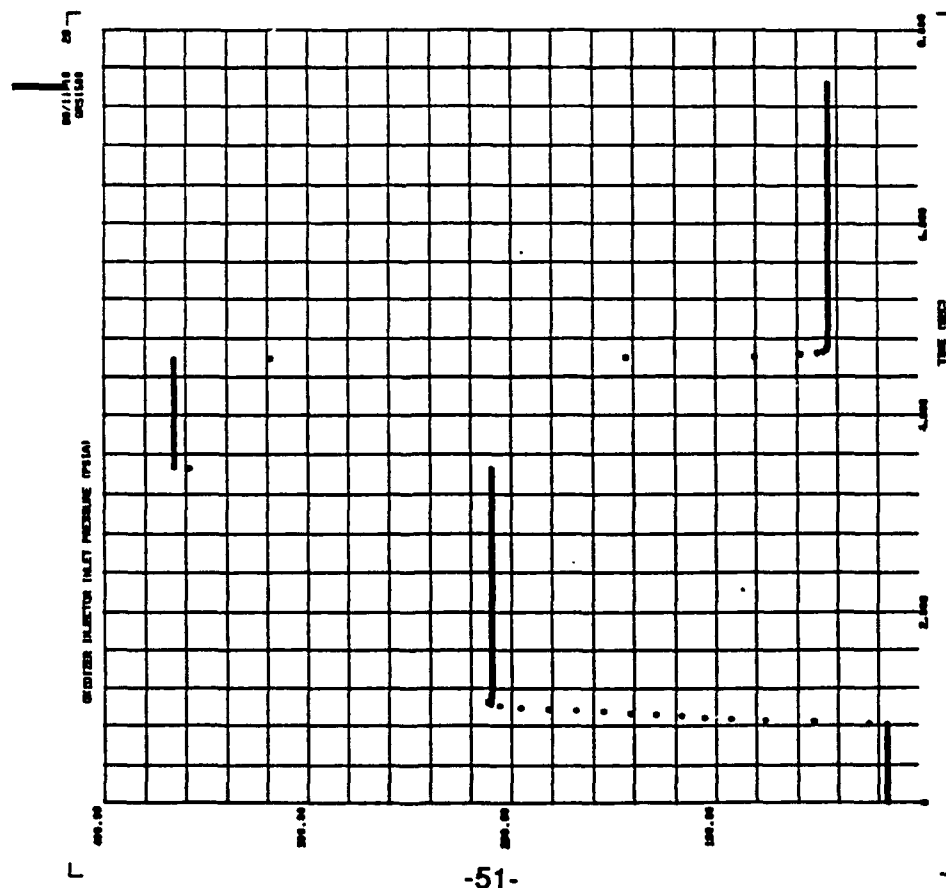


086



Oxidizer System Blowdown

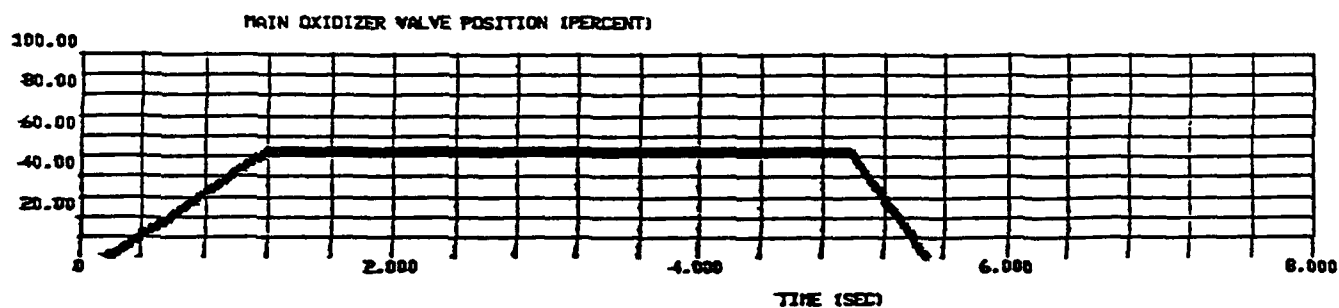
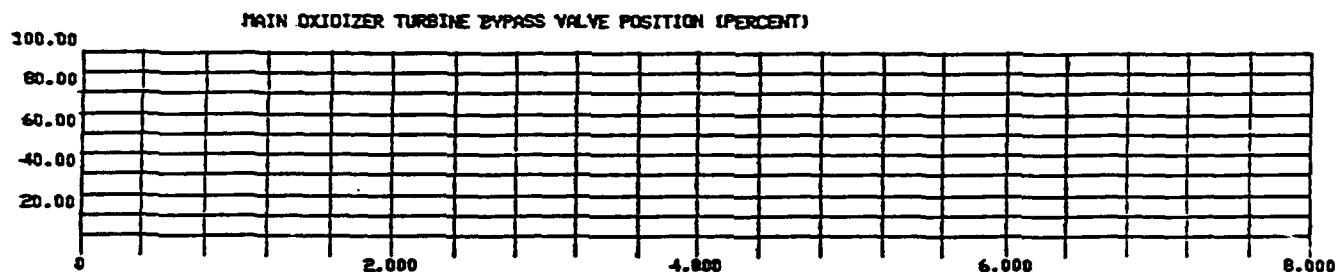
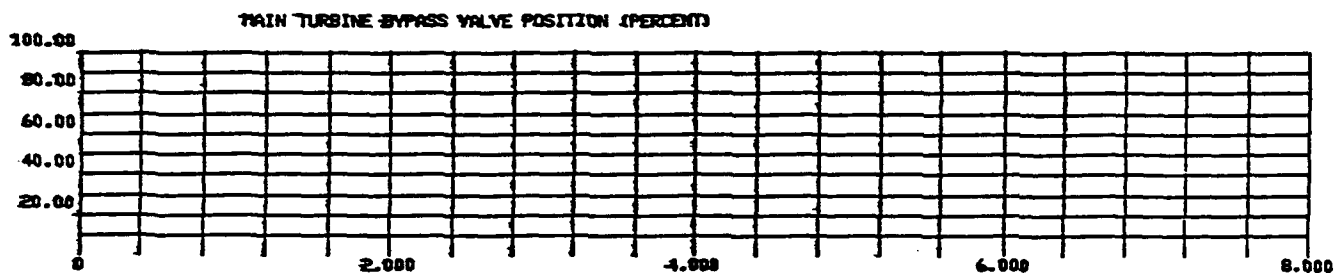
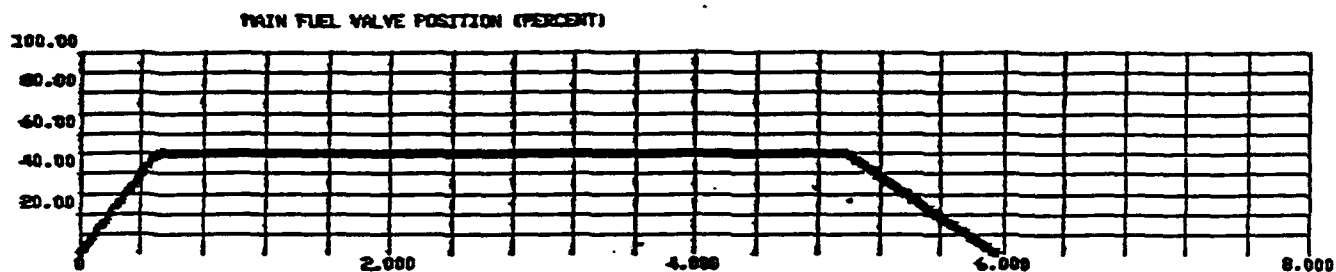


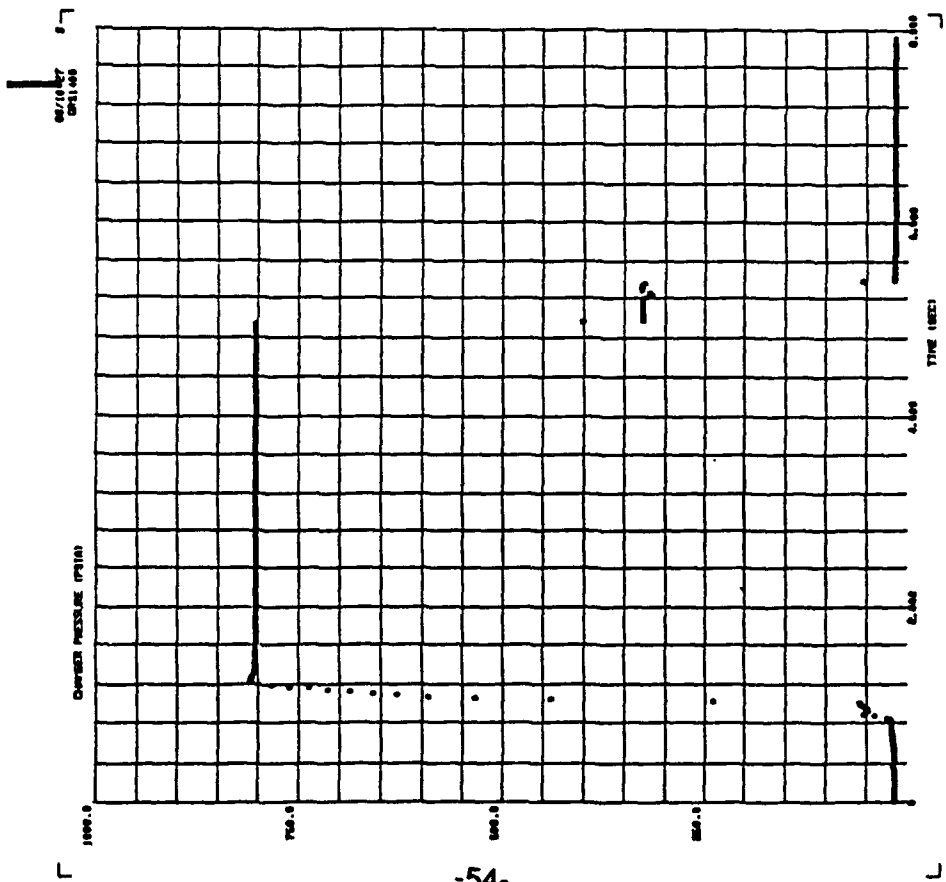
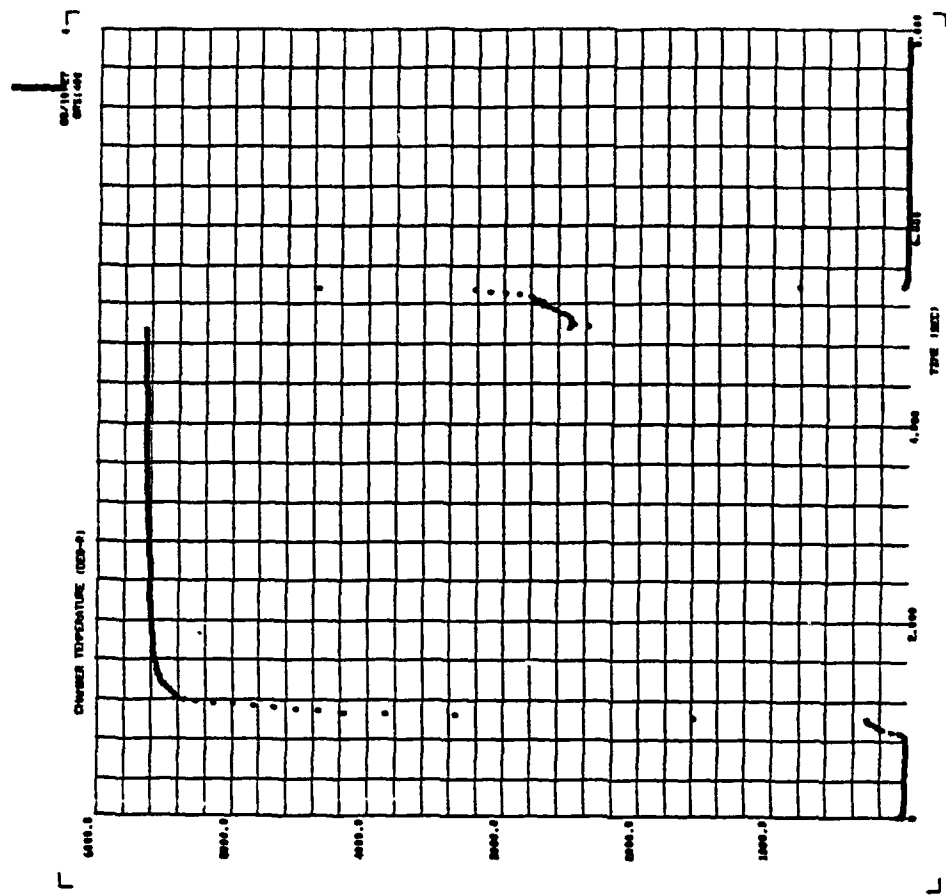


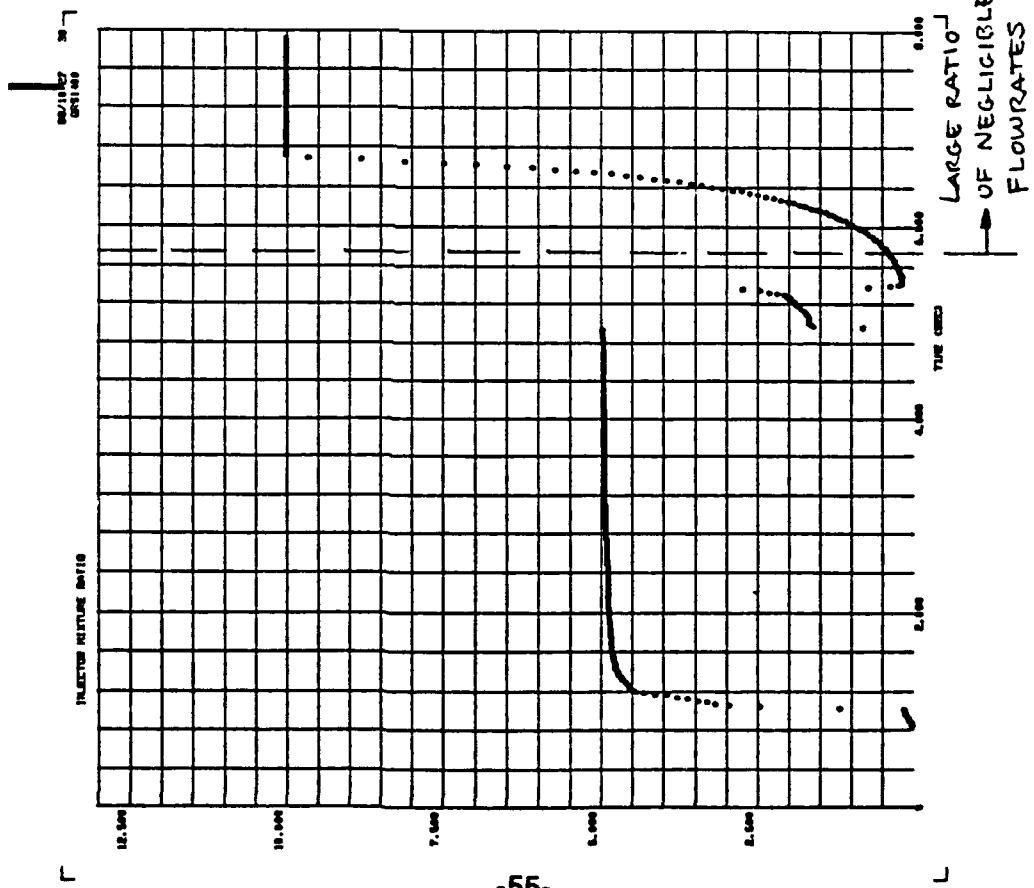
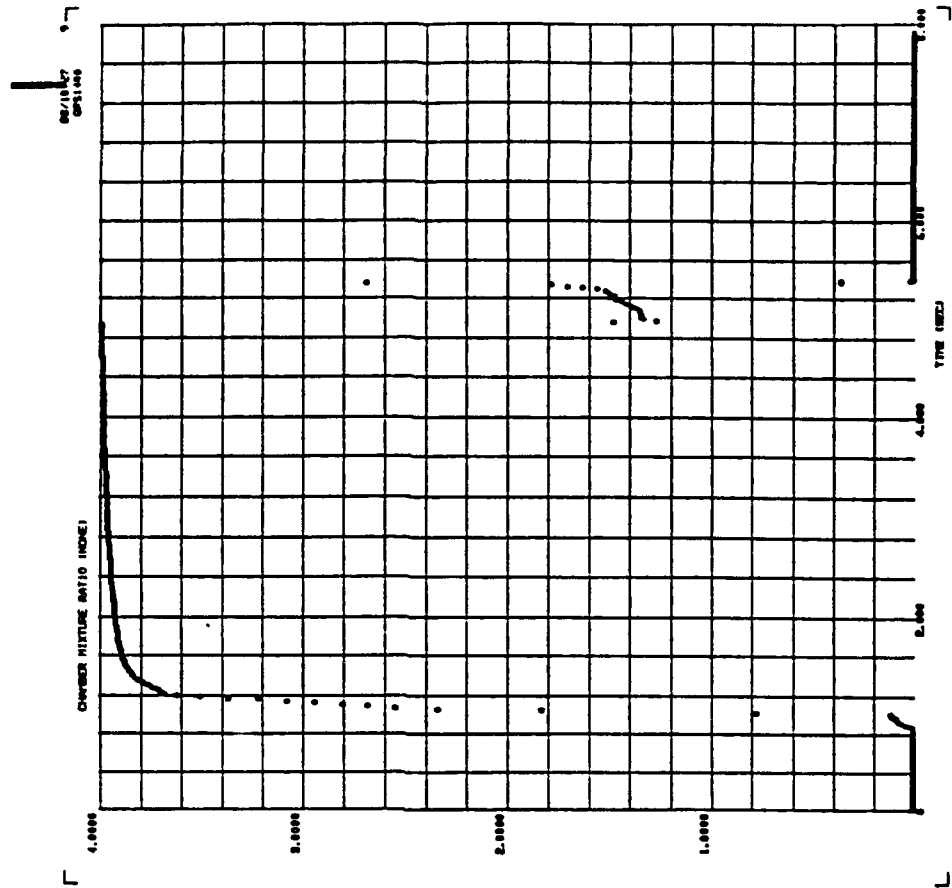
Start - Cutoff at $P_c=800$ psia, $MR=5$

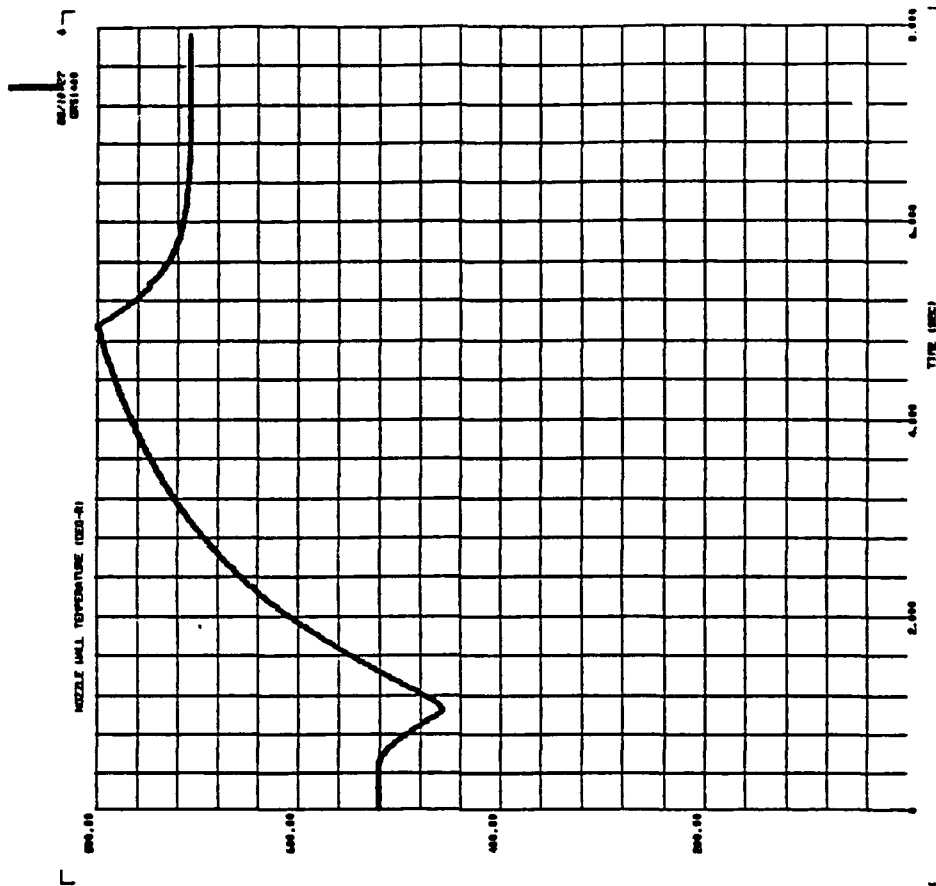
08/10/27
GRS1400

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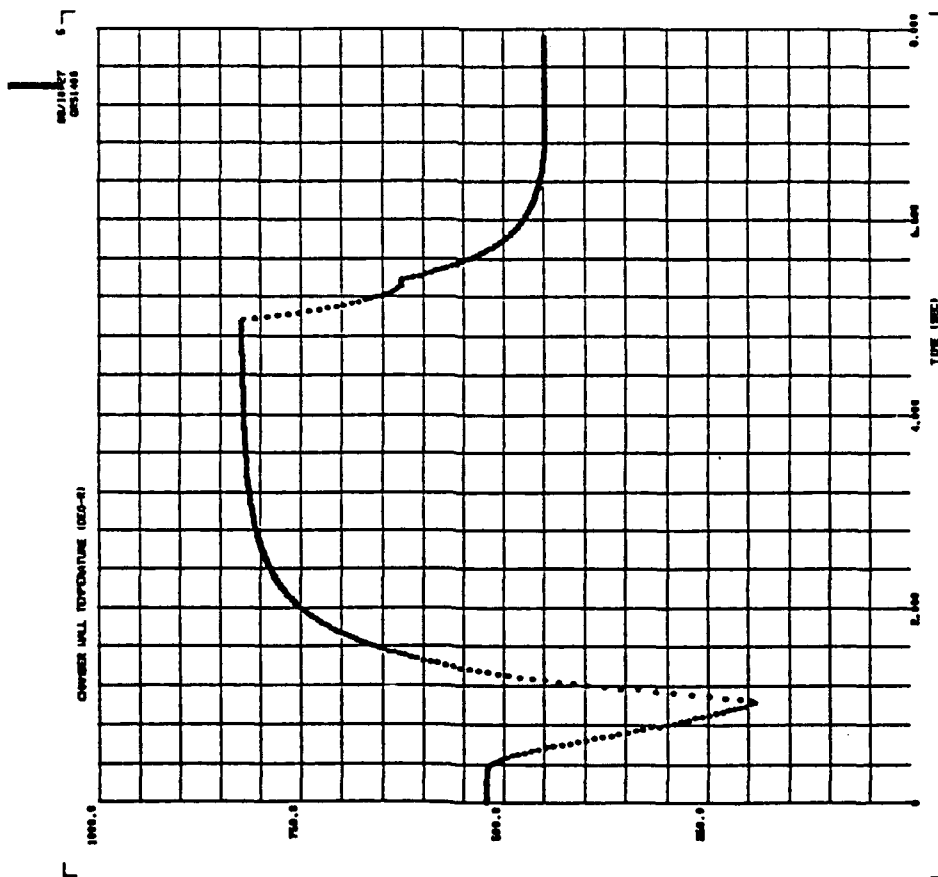




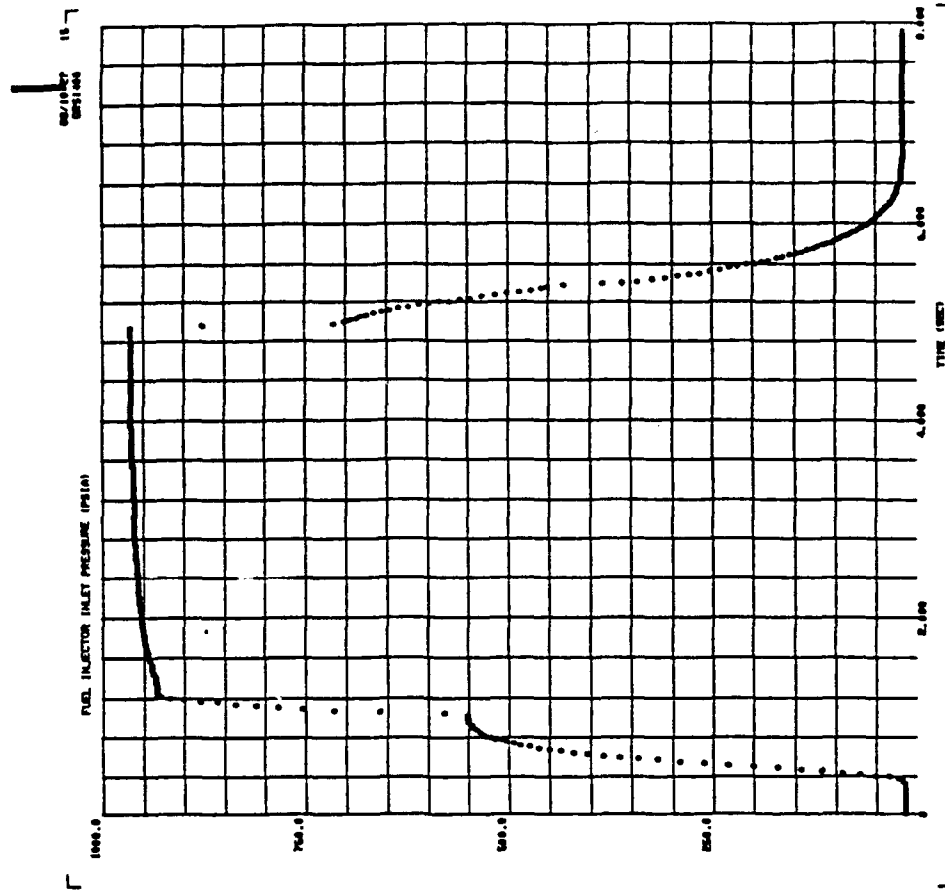




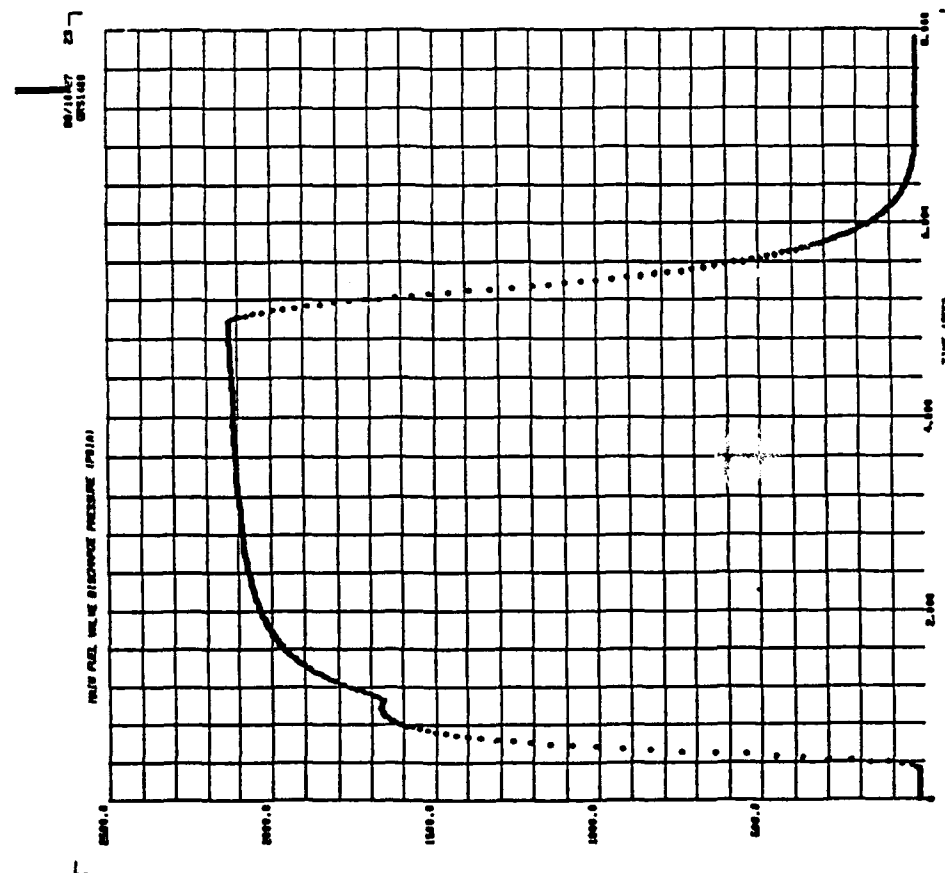
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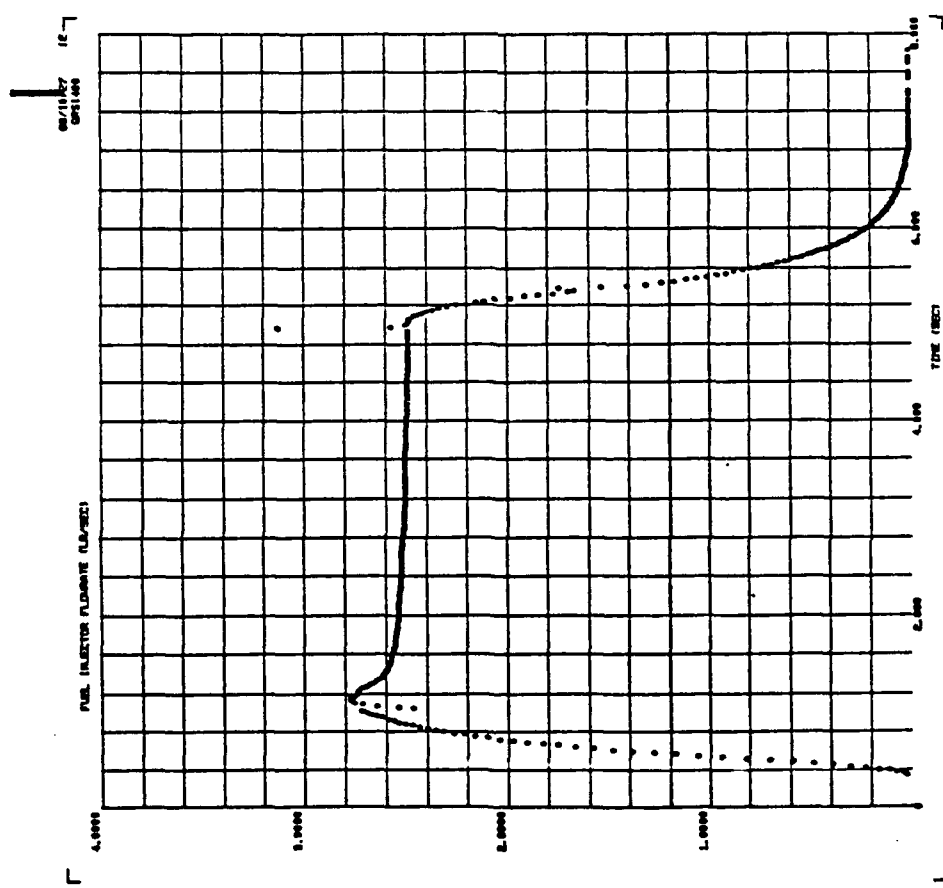
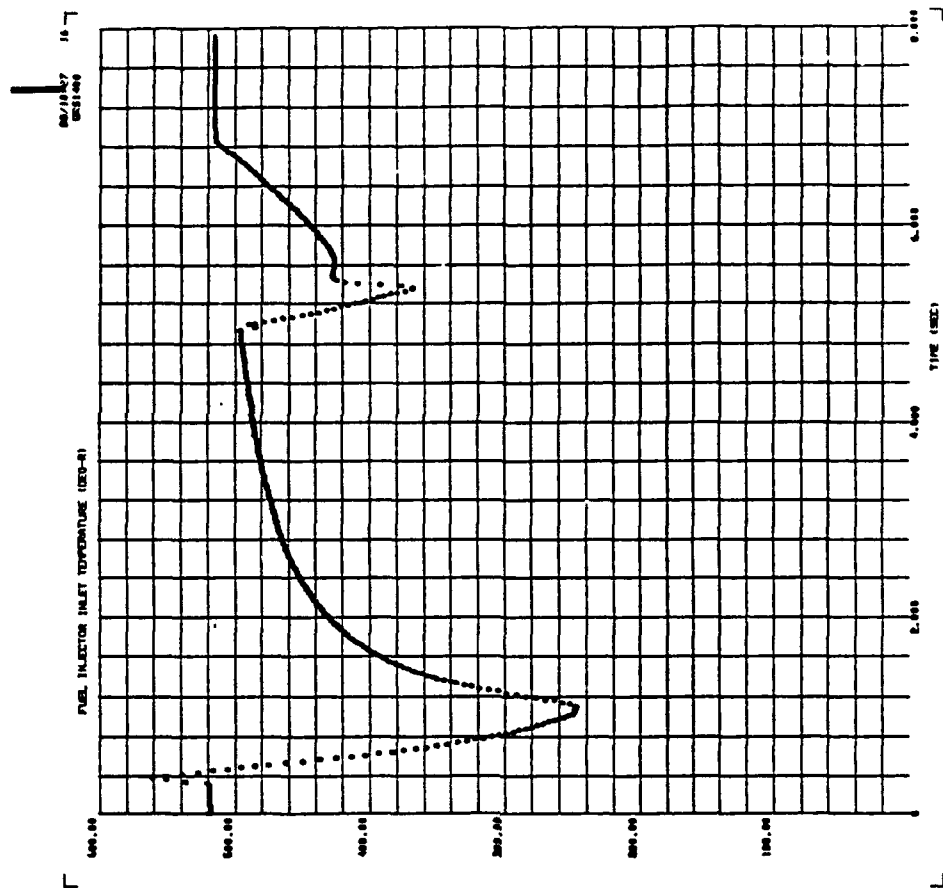
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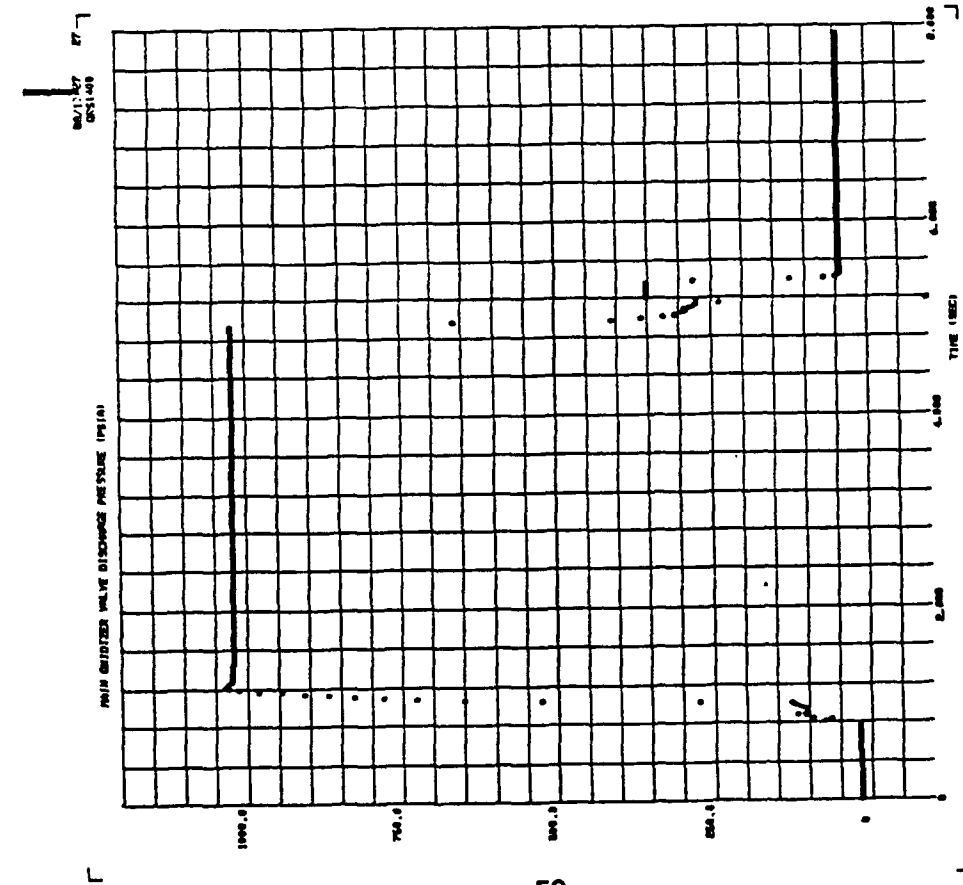


711



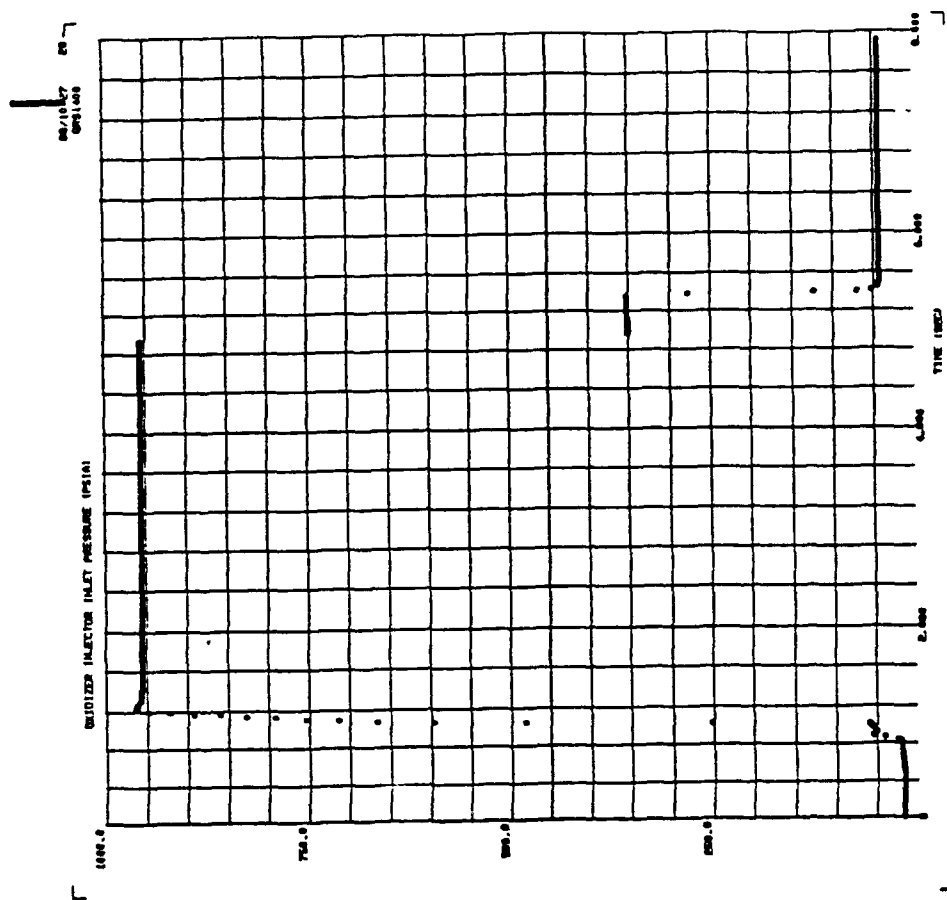
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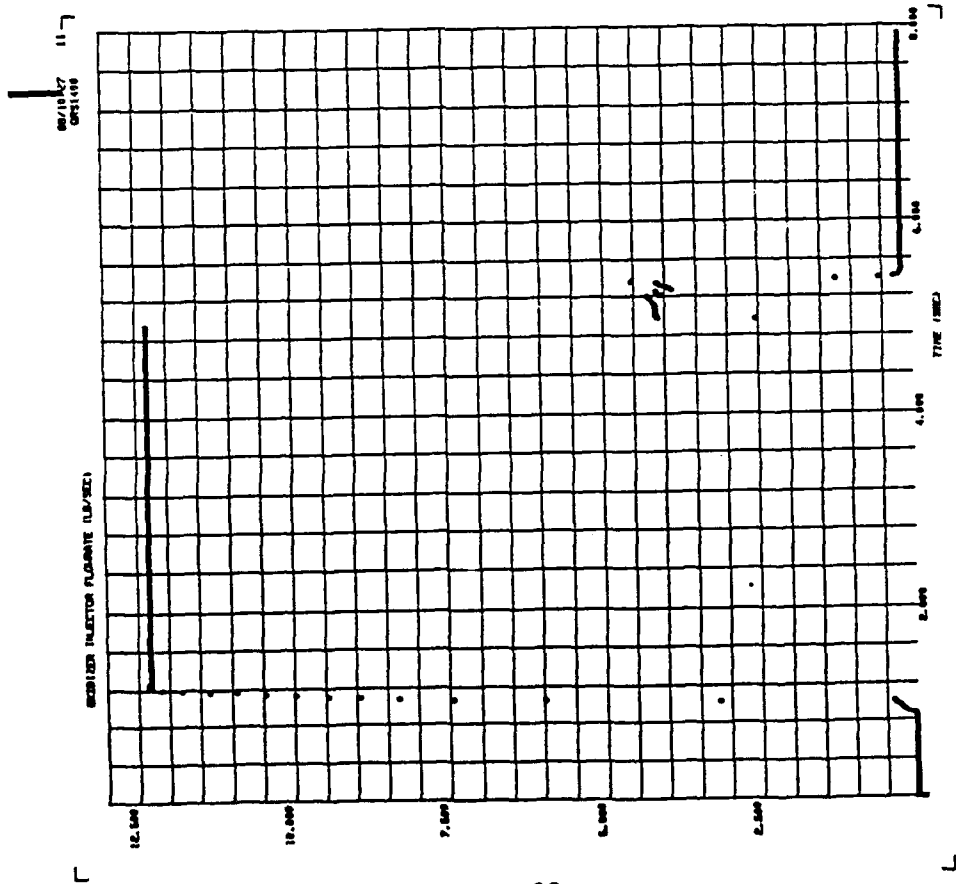


699

Cf



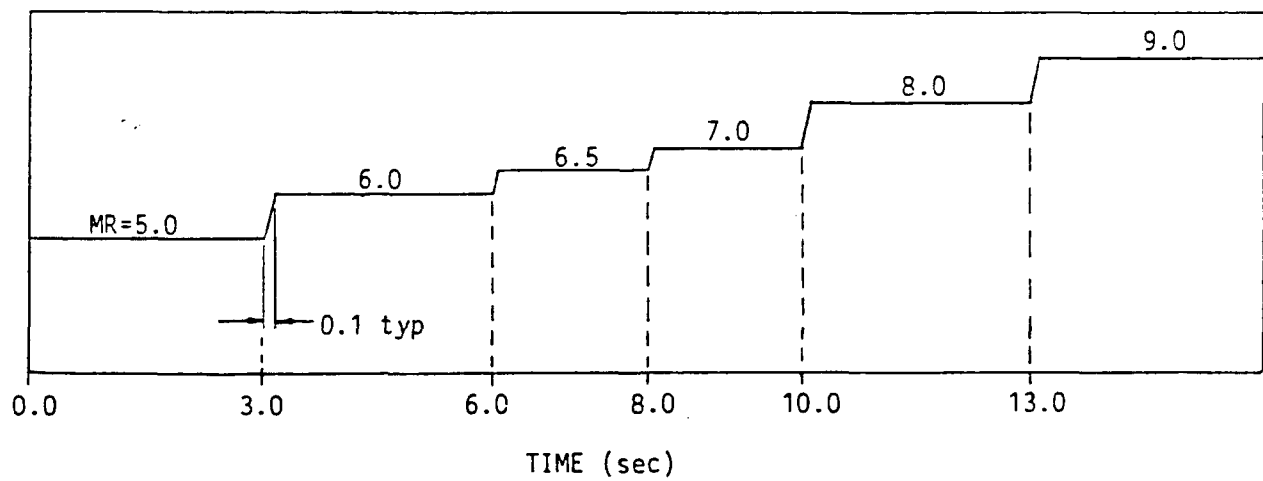
698



APPENDIX II

II. Steady State Mixture Ratio Variation Simulation Runs

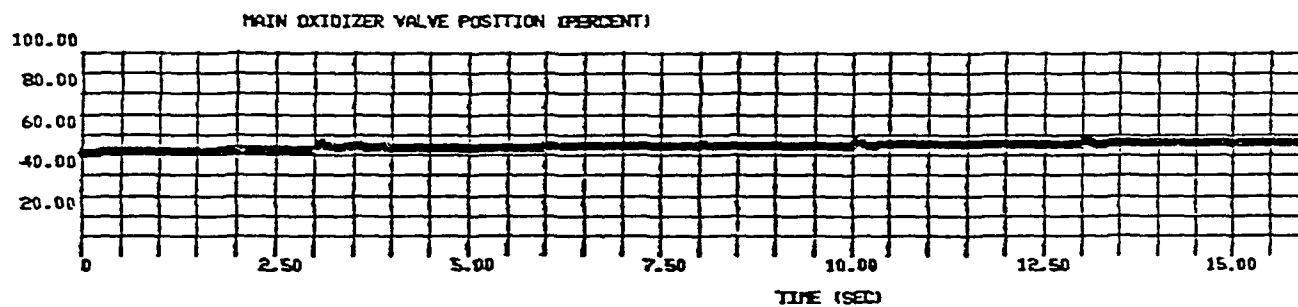
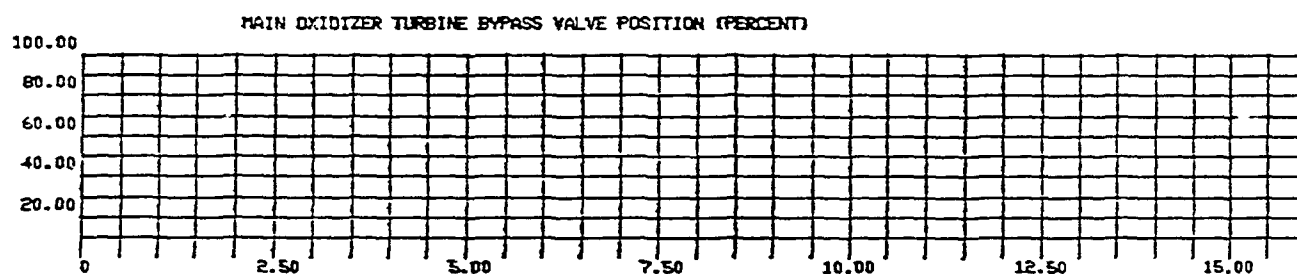
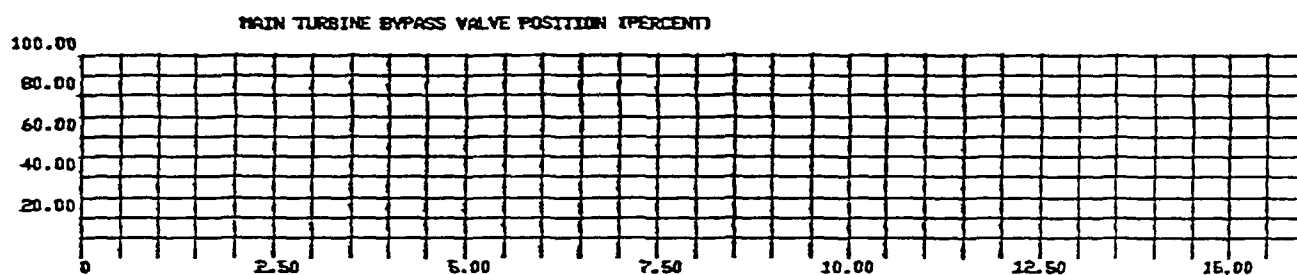
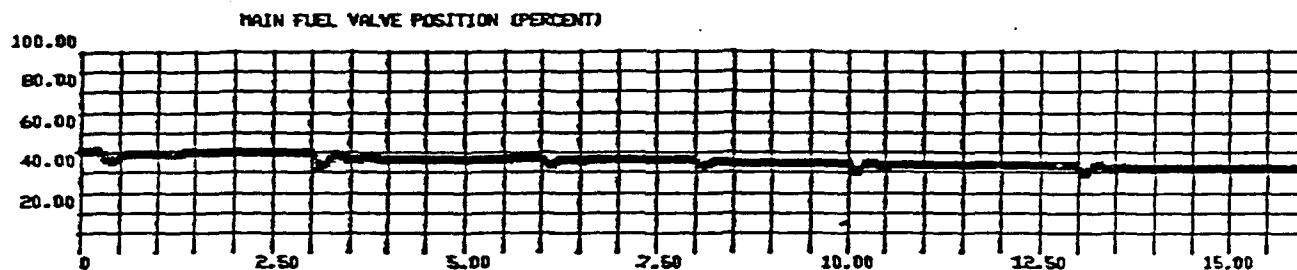
Closed-Loop Mixture Ratio Variations at $P_c=800$ psia

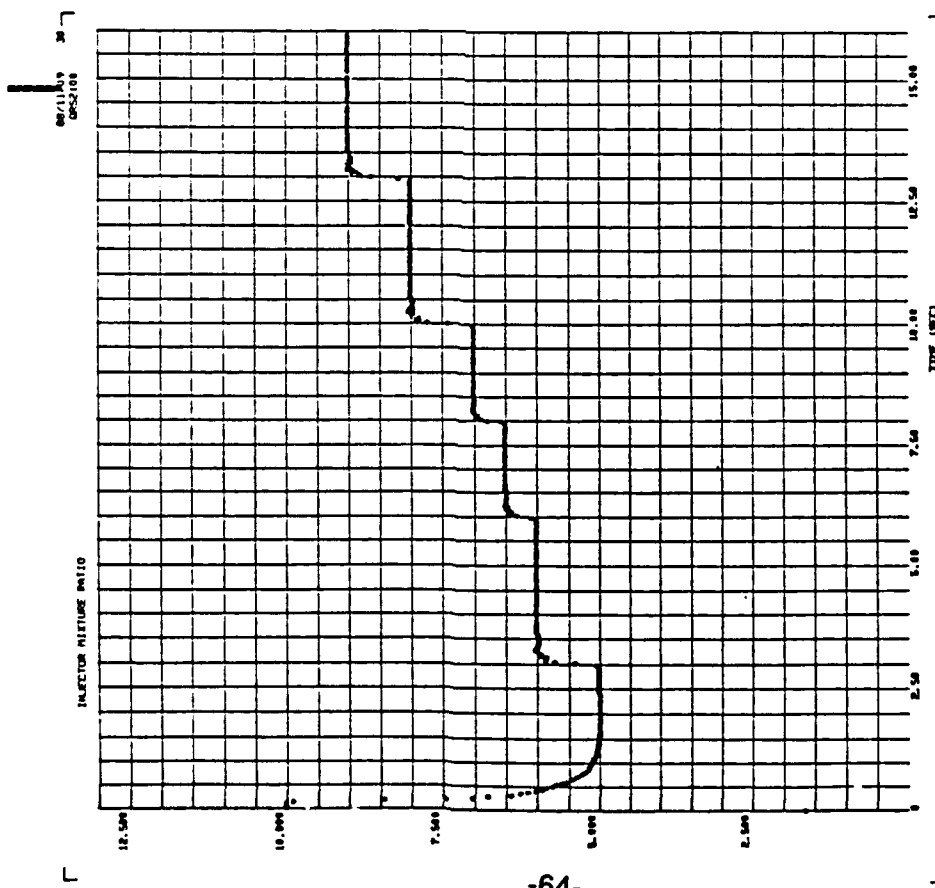


Injector Mixture Ratio Command

88/11/09
QRS2100

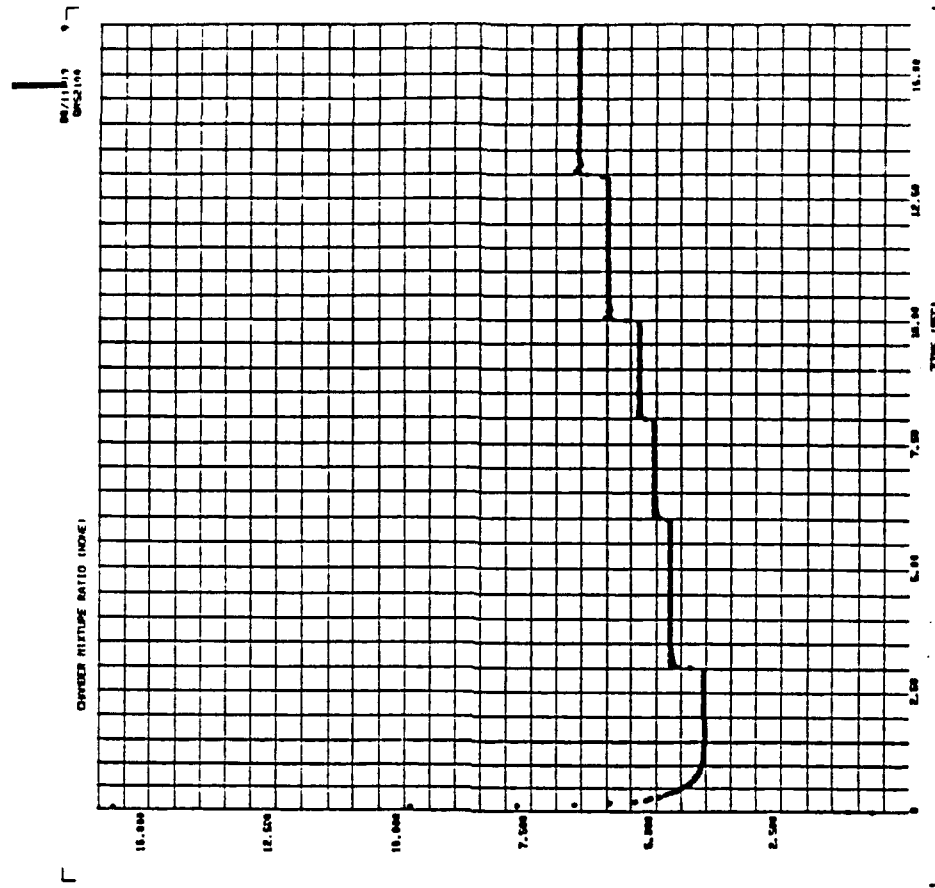
27



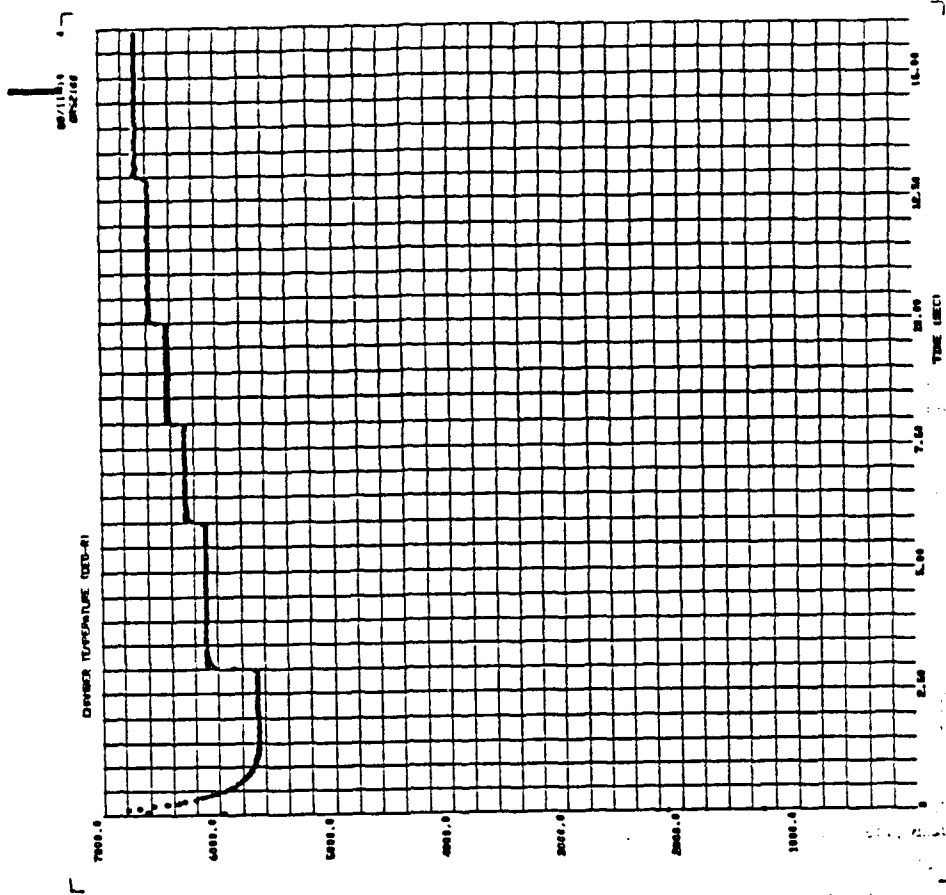


064

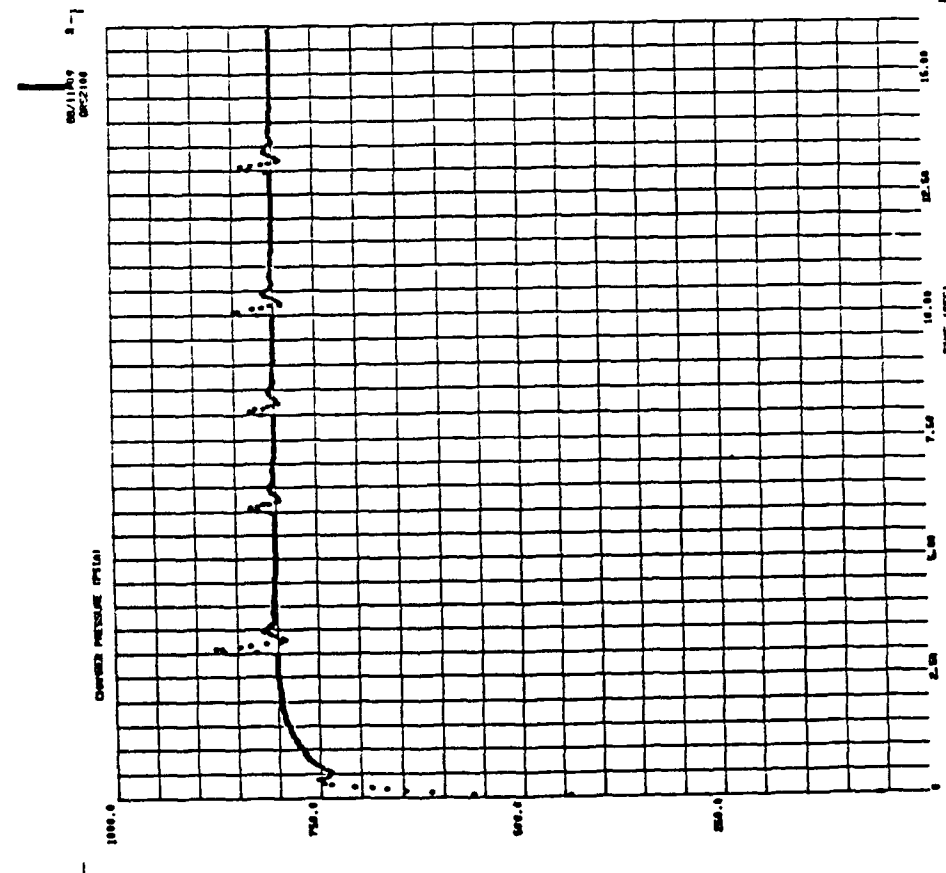
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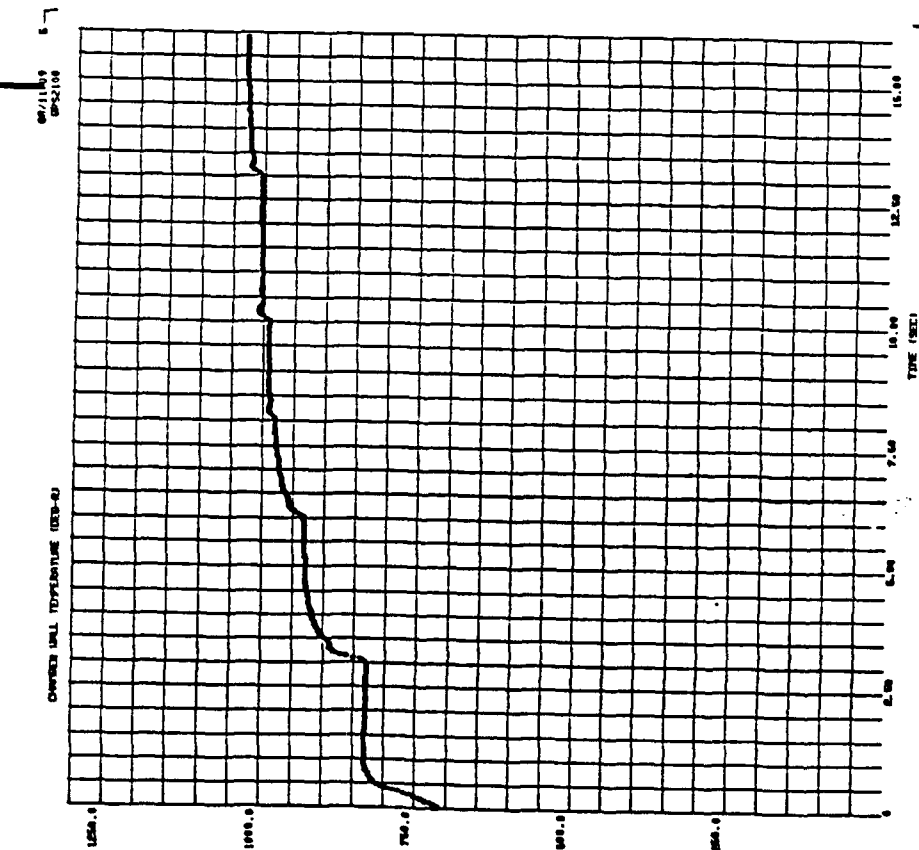
085



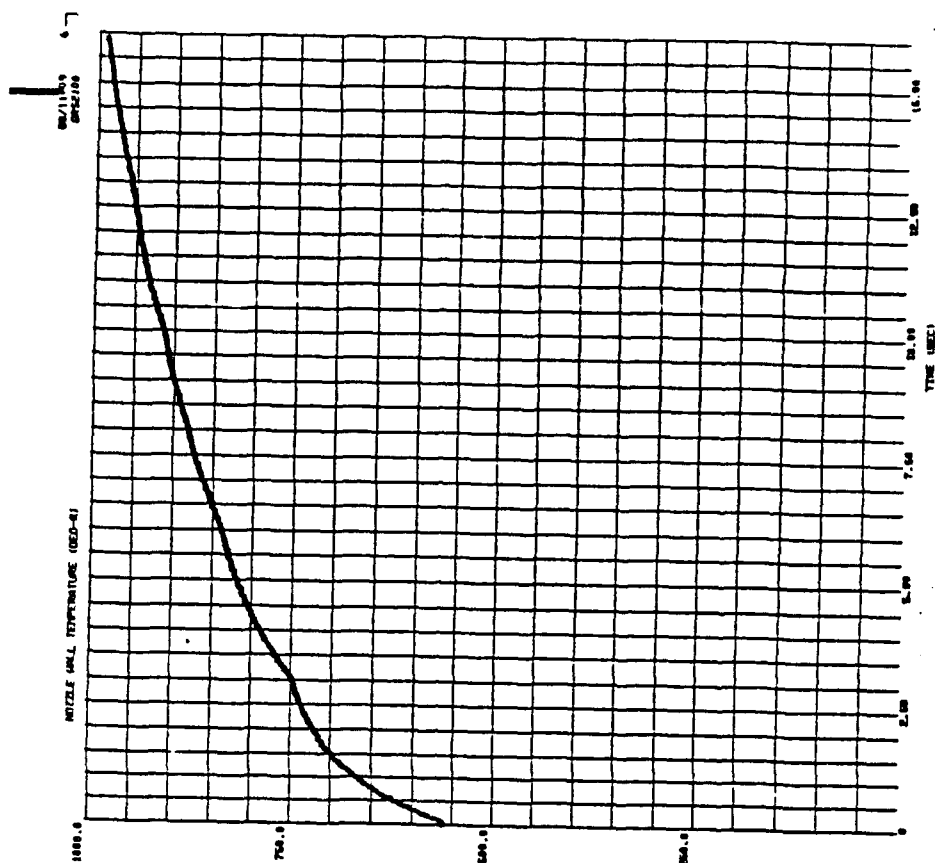
090



091

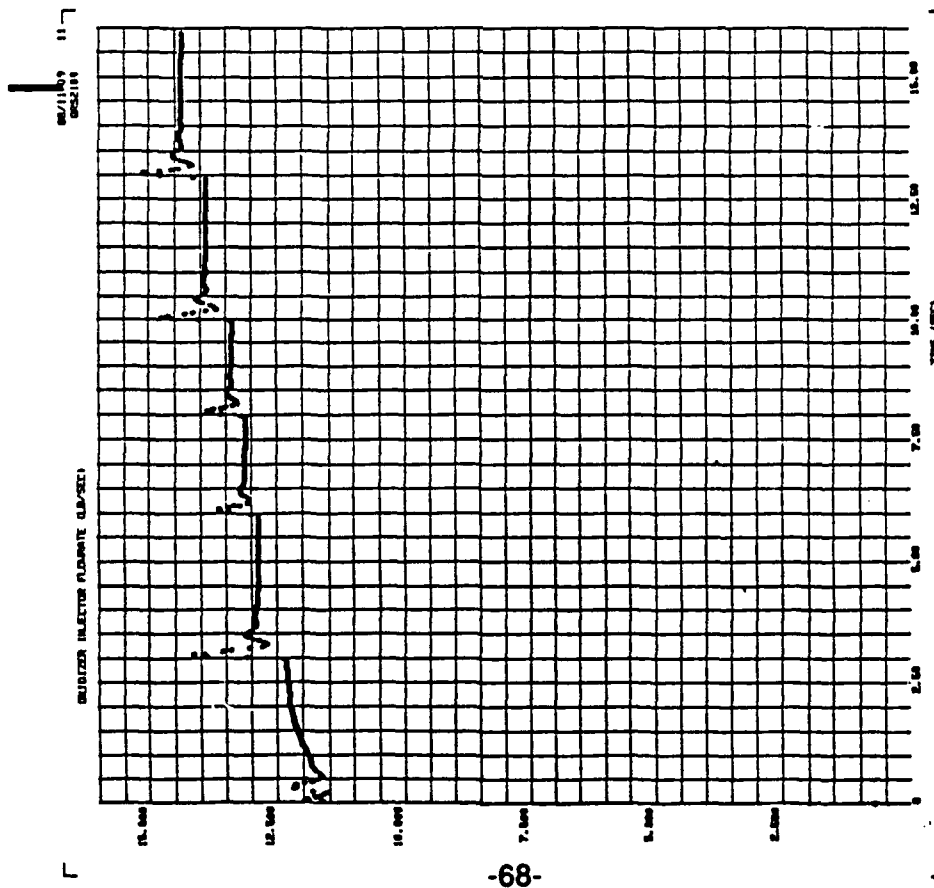


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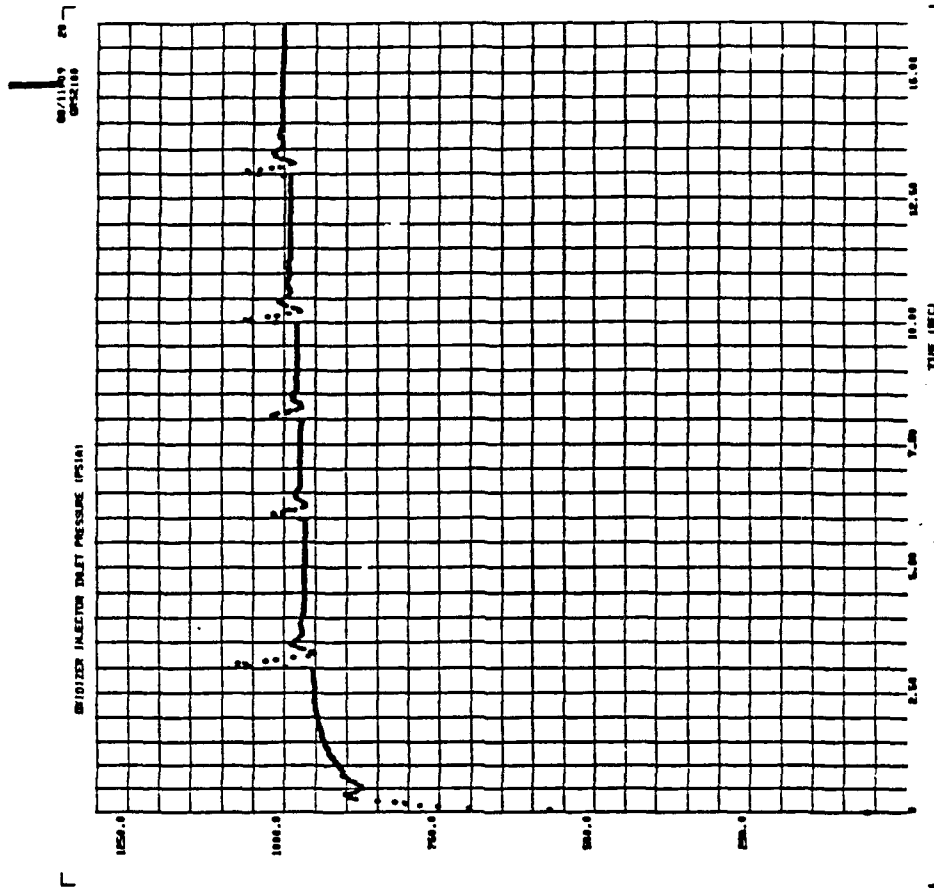


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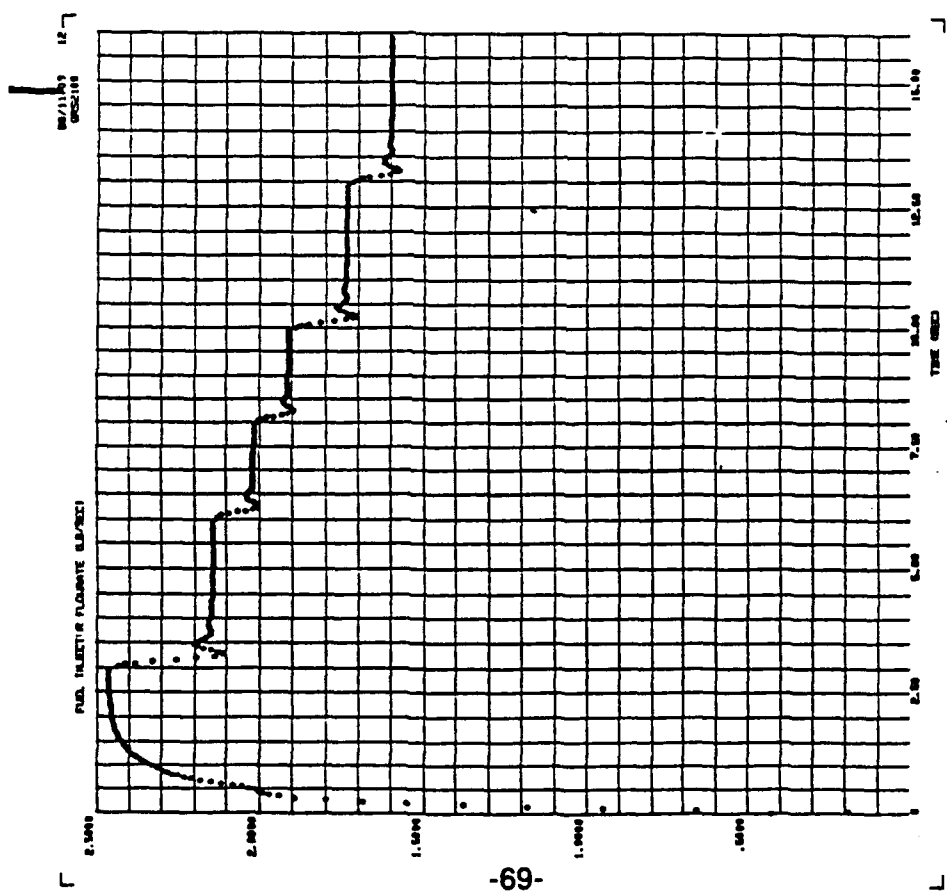
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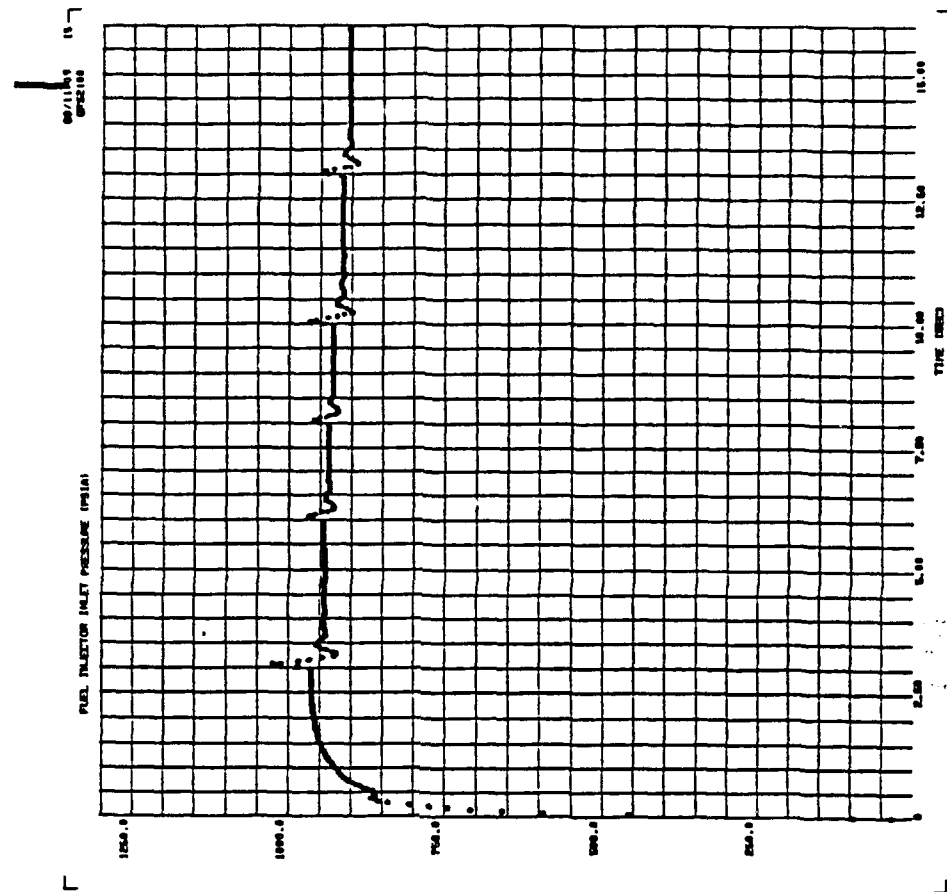
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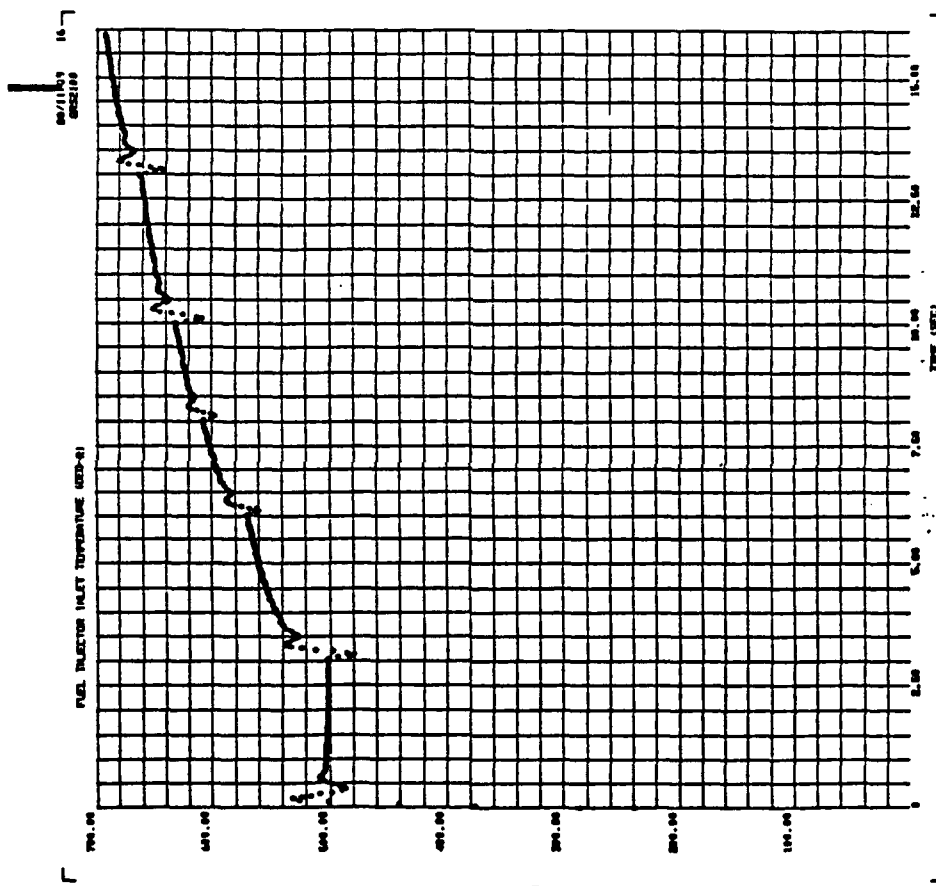
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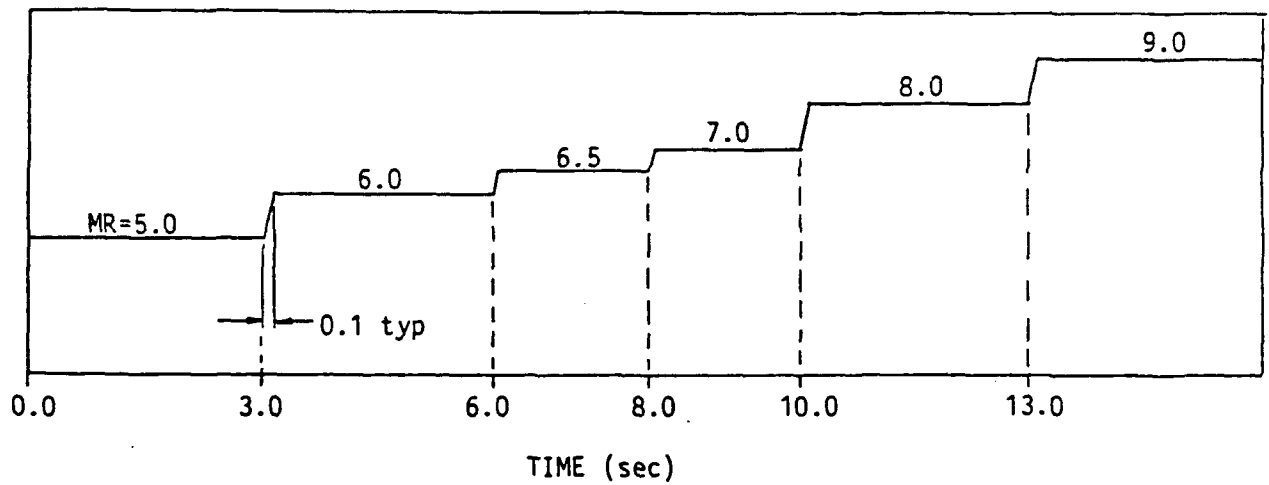
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079



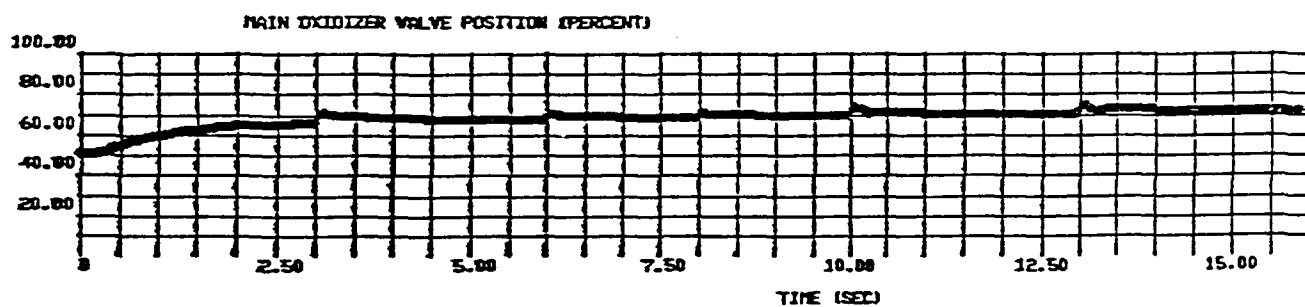
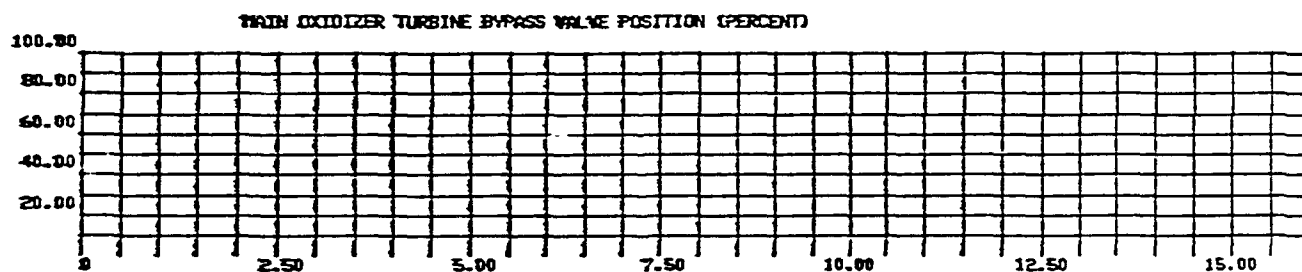
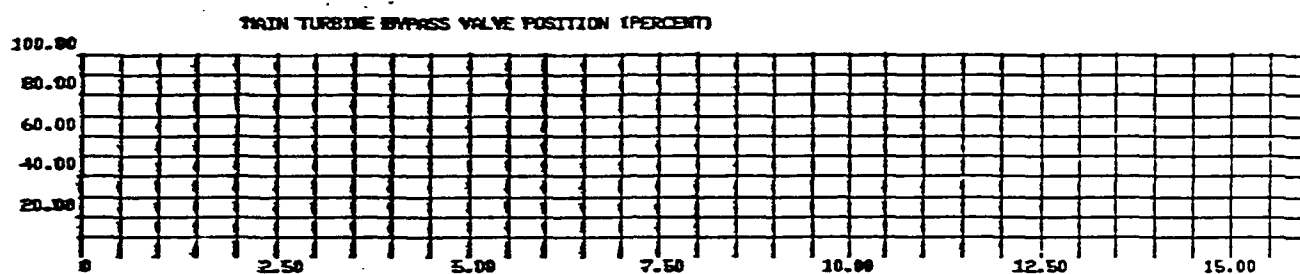
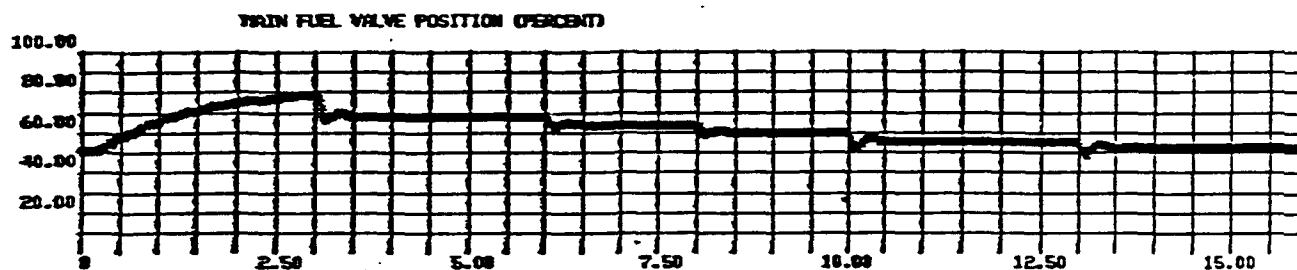
Closed-Loop Mixture Ratio Variations at $P_c=1200$ psia

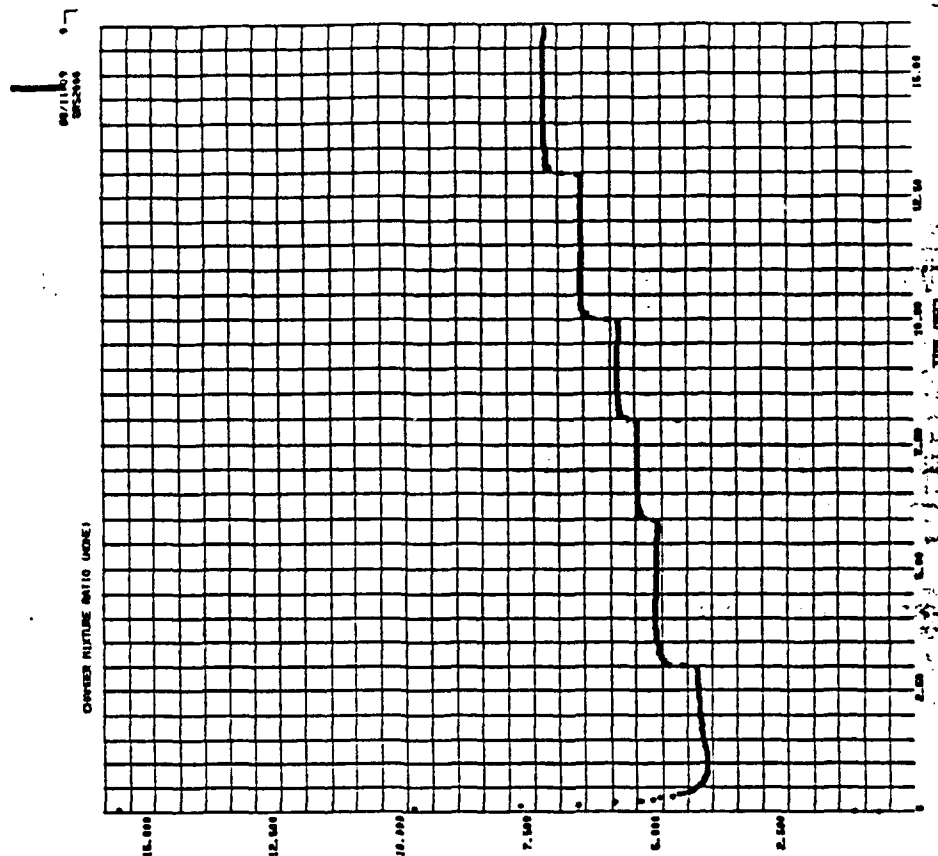


Injector Mixture Ratio Command

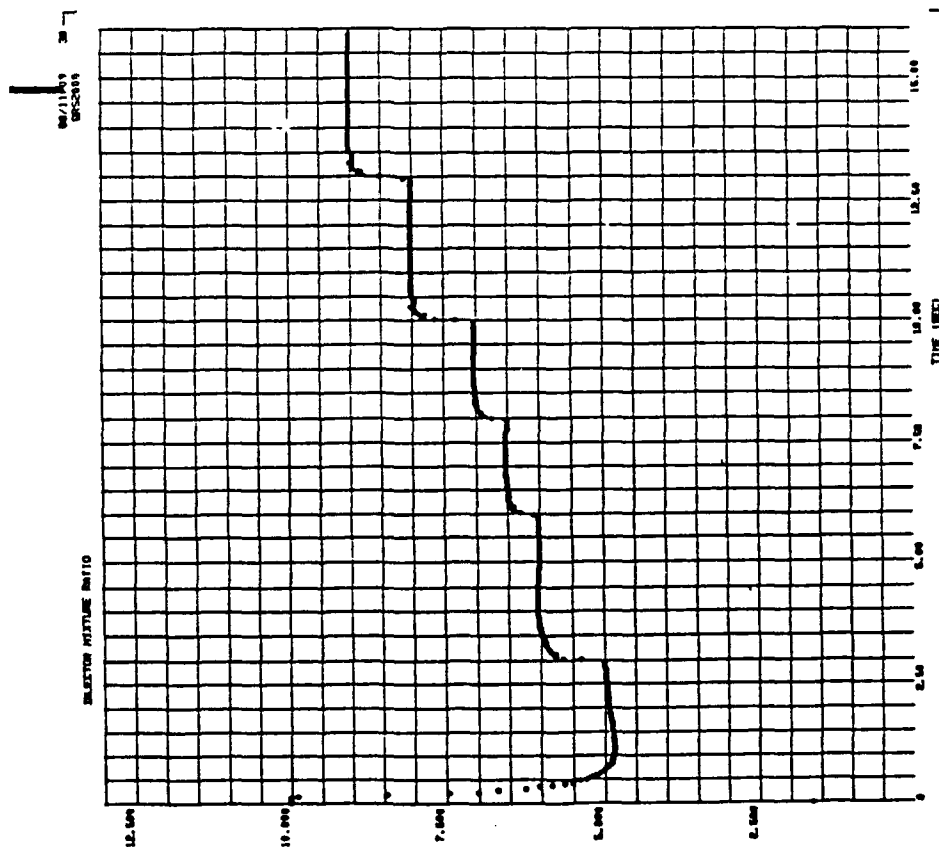
88/11/09
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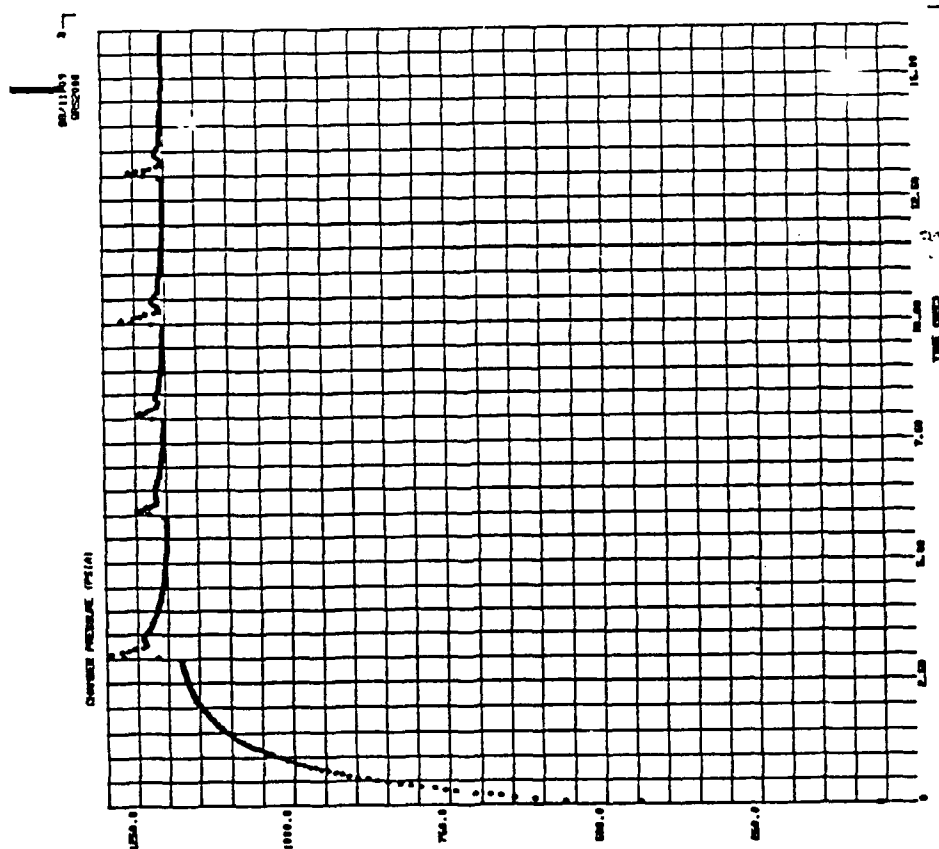
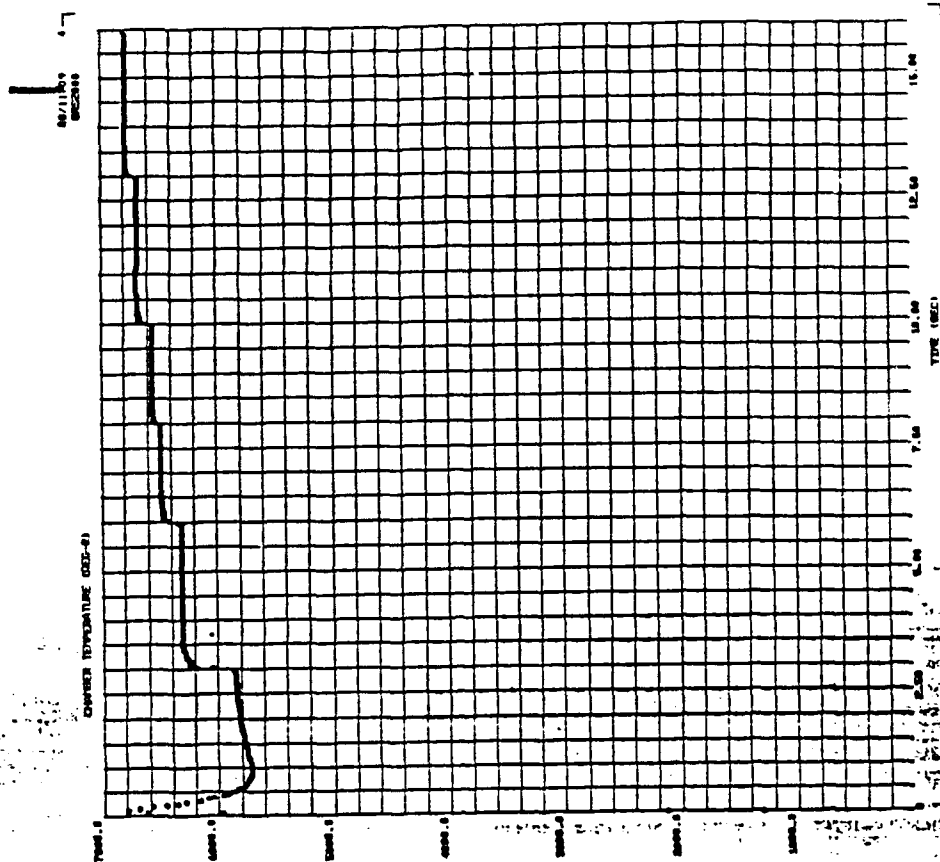


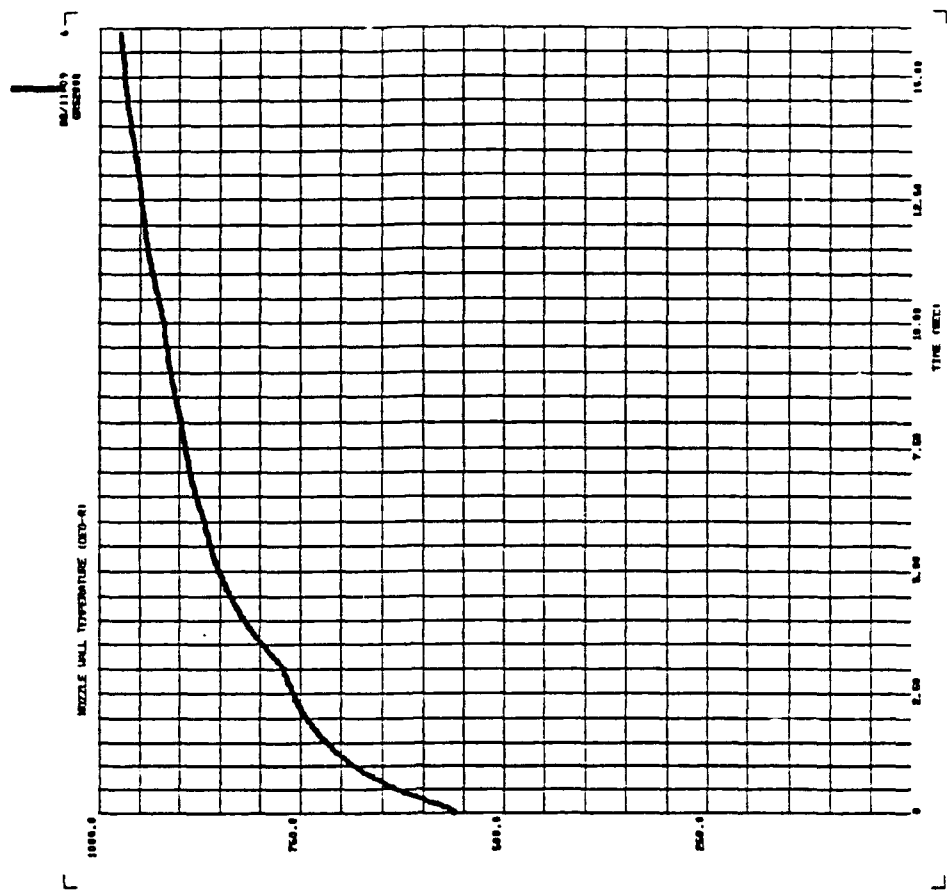
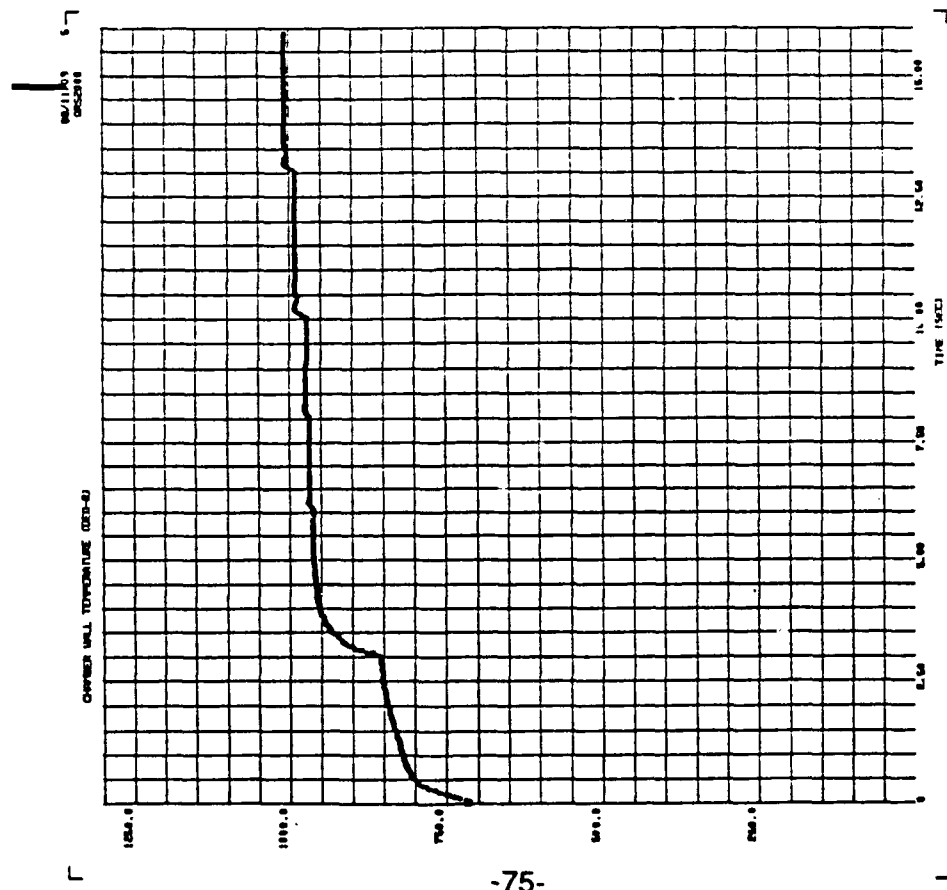


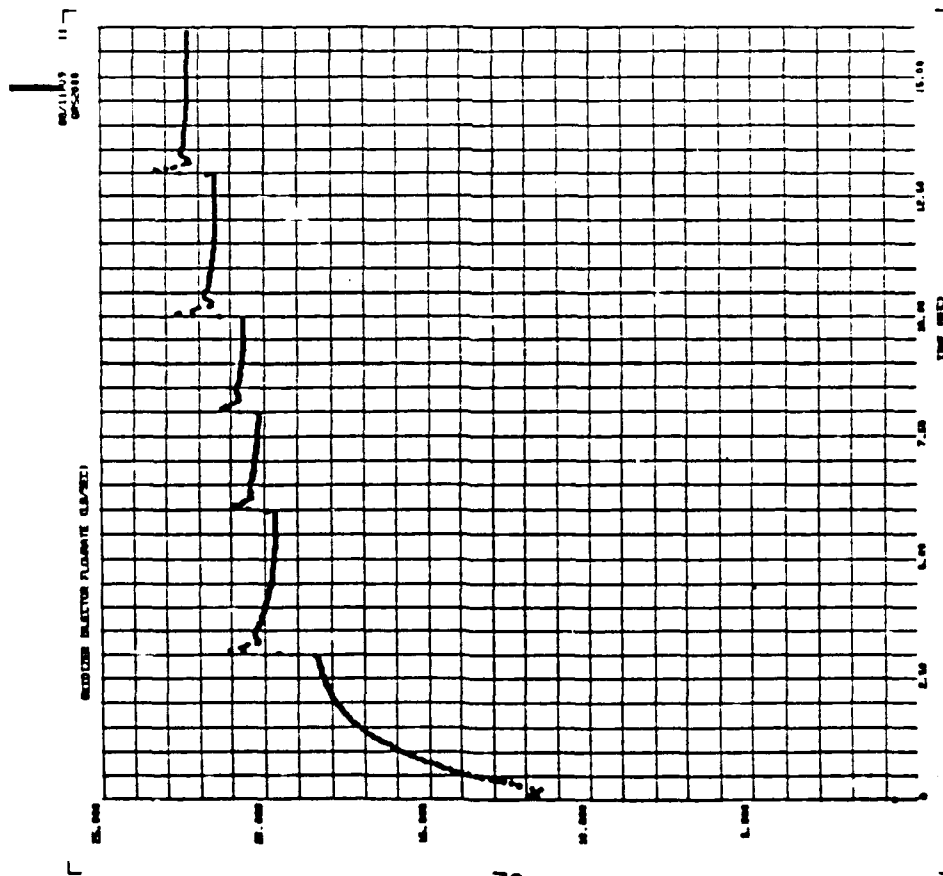
121



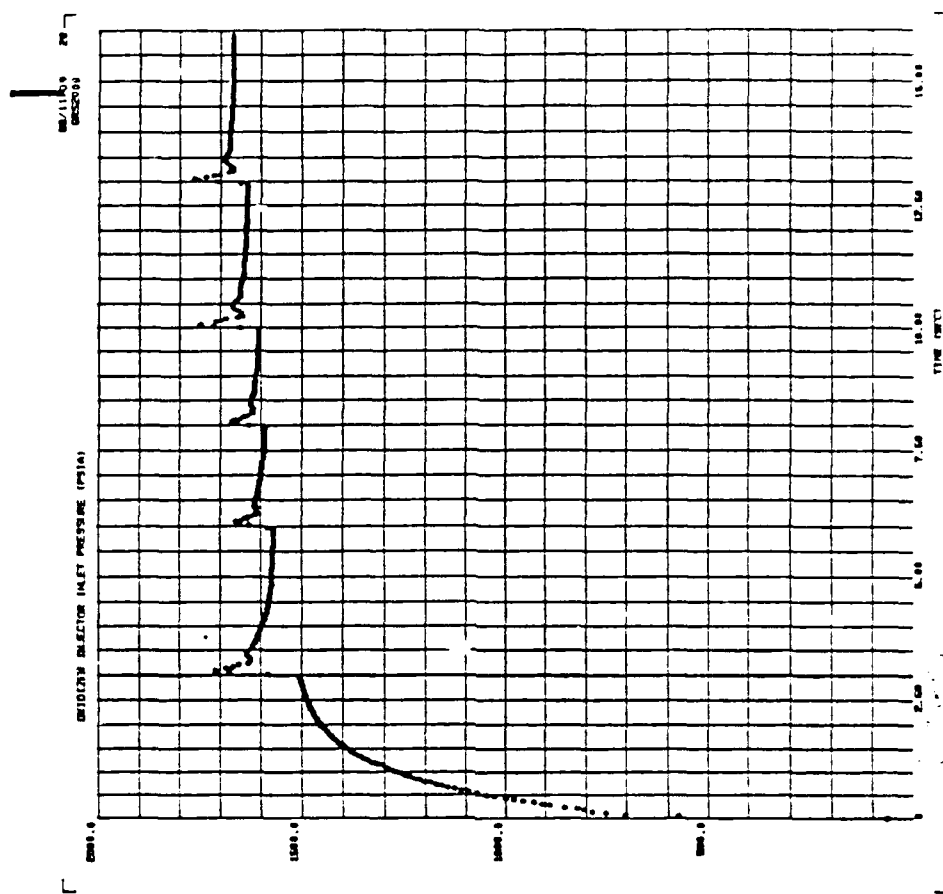
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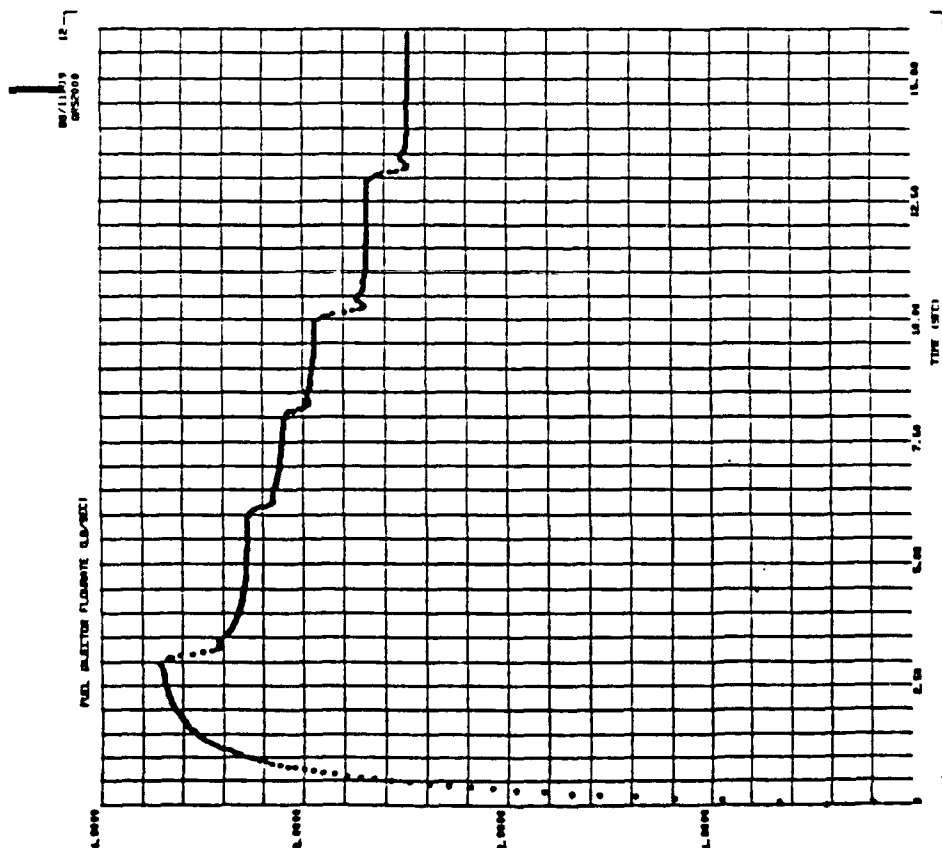




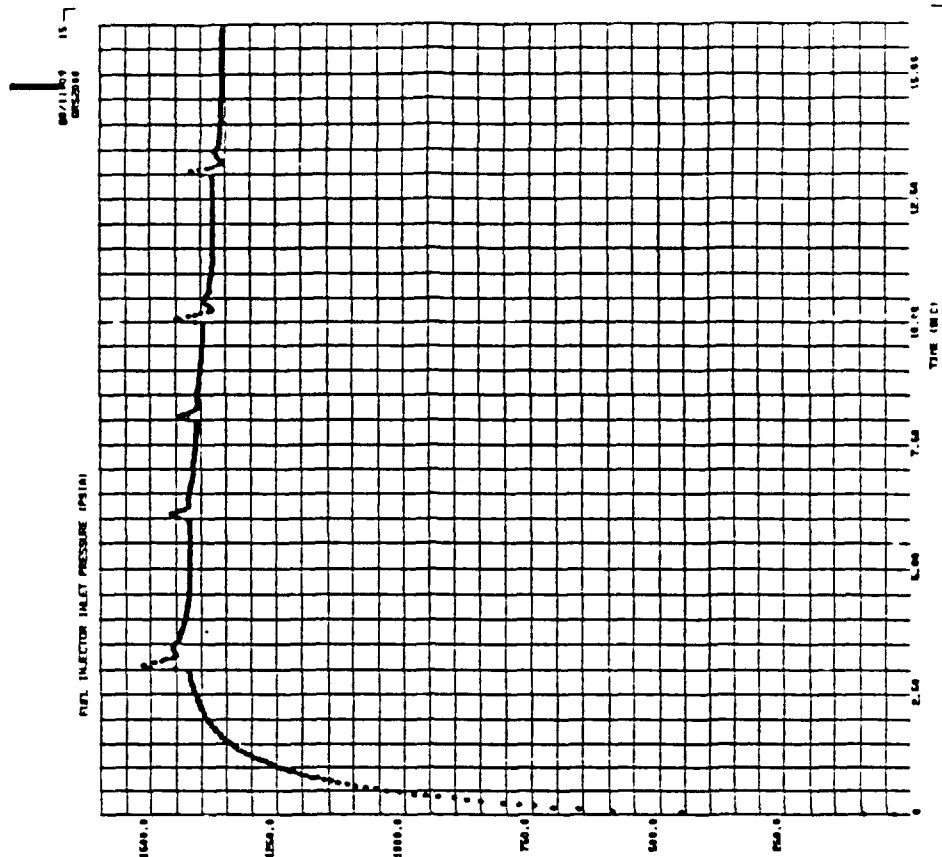
119



102



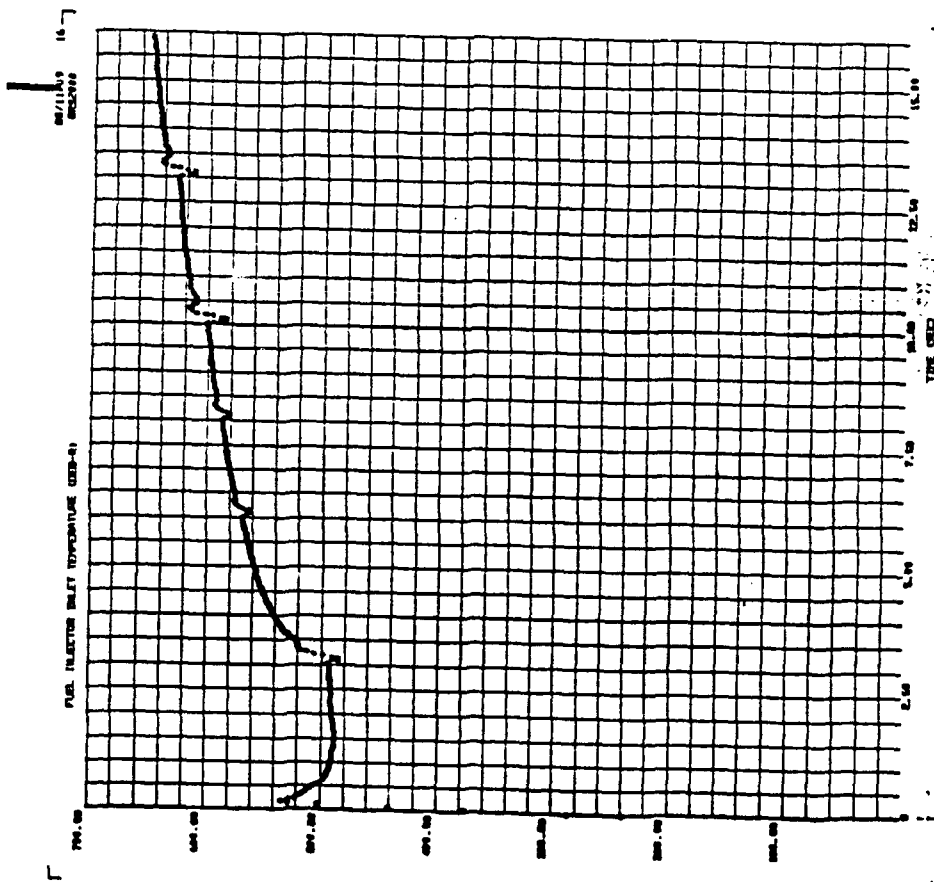
-77-



115

118

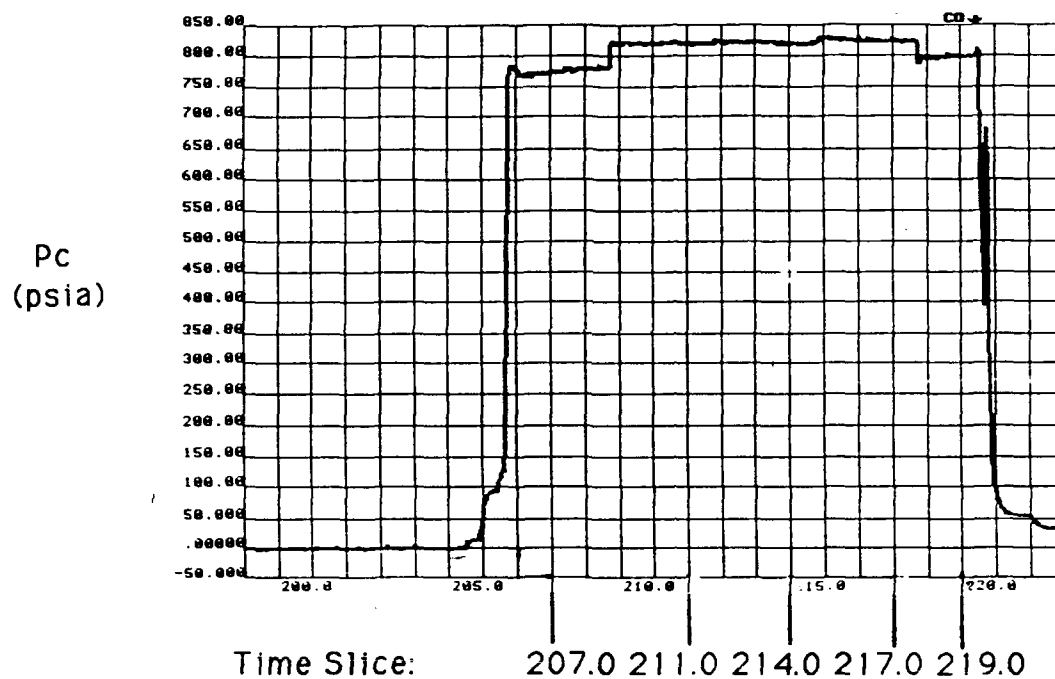
B7



APPENDIX III

III. Sample Reduced Data From 0.040 in. Rib & Smooth Wall Tests

Test 017 - 016: 0.040 in. Ribbed Combustor
Reduced Data Time Slices



SEC					
MR (PREDICTED)	5.0	6.0	6.5	7.0	5.0
MR (ACTUAL)	4.3	4.9	5.3	5.8	4.7

T= 207.0, MR:5.0 (vs 4.3 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE 3454.8300000 PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE 1578.4100000 PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET 1676.4800000 PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 1444.8900000 PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET 1427.6300000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET 1376.5900000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT 1376.5900000PSIG
NO PRESSURE AT P8
H2 PRESS. INLET TO THE FUEL MANIFOLD 916.3100000 PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD 1589.3800000 PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE 1575.5700000 PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE 1496.0200000 PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE 1452.8500000 PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE 1512.7000000 PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE 1530.8300000 PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE 1415.8600000 PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE 1483.9600000 PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE 1533.4600000 PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE 1436.3200000 PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE 1422.9200000 PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE 1485.0200000 PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE 2707.2300000 PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE 845.2300000 PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD 3491.0200000 PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI 2260.3500000 PSIG
NO PRESSURE AT P26
GH2 PRESS. INLET TO THE IGNITER VENTURI 2020.3500000 PSIG
NO PRESSURE AT P28
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER 2560.0000000 PSIG
CHAMBER PRESSURE 774.4100000 PSIG
CHAMBER PRESSURE 779.6400000 PSIG
IGNITER PRESSURE 809.6400000 PSIG
IGNITER PRESSURE 806.4000000 PSIG
GOX PRESS. EXHAUST FROM THE IGNITER VENTURI 823.7400000 PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI 912.6800000 PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM 756.7500000 PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE 2859.3600000 PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE 2846.7200000 PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE 2743.5100000 PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE 2887.4200000 PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE 2935.5100000 PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE 2729.6800000 PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE 2773.3300000 PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE 2809.1800000 PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE 2775.3200000 PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE 2709.4700000 PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE 2835.5000000 PSIG

LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE -389.0000000 DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE -389.0000000 DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET -367.7500000 DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET -12.8900000 DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET -12.0800000 DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET -119.4700000 DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE -268.5900000 DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE -268.5900000 DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD 19.8600000 DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD 61.9400000 DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP. 150.7800000 DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP. 147.0500000 DEG F

CALORIMETER CHANNEL 13 EXHAUST TEMP.	152.0200000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	153.6200000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	155.2500000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	159.9900000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	162.2400000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	163.0800000	DEG F
CALORIMETER CHANNEL 19 EXHAUST TEMP.	156.3800000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	152.3400000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	166.6100000	DEG F
GOX TEMP. INLET TO THE IGNITER VENTURI	44.4500000	DEG F
GH2 TEMP. INLET TO THE IGNITER VENTURI	55.5900000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	68.0000000	DE G F
TEMP. MAIN OXIDIZER VALVE OPERATOR	32.1200000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	84.8600000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	93.3600000	DE G F
LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2736.5100000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2707.6500000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3455.8600000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3421.8700000	PSIG
LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-272.8900000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-382.3100000	DEG F

THE NOZZLE MIXTURE RATIO IS 3.5265090

THE INJECTOR MIXTURE RATIO IS 4.3160000

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2839.1600000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2835.3200000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2726.1100000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2869.2200000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2924.6100000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2723.0800000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2762.5300000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2796.9800000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2761.4200000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2696.6700000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2818.7000000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	3.7940980	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	3.4582200	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	3.9117060	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	4.0680180	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	4.2326650	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	4.7438530	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	5.0041880	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	5.1044170	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	4.3500880	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	3.9425560	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	5.5443660	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .7759839 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	231.5900000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	51.0400400	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1263.5900000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1339.3000000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1273.2600000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1356.5200000	PSID

CALORIMETER CHANNEL	5	PRESSURE DROP	1393.7800000	PSID
CALORIMETER CHANNEL	6	PRESSURE DROP	1307.2200000	PSID
CALORIMETER CHANNEL	7	PRESSURE DROP	1278.5700000	PSID
CALORIMETER CHANNEL	8	PRESSURE DROP	1263.5200000	PSID
CALORIMETER CHANNEL	9	PRESSURE DROP	1325.1000000	PSID
CALORIMETER CHANNEL	10	PRESSURE DROP	1273.7500000	PSID
CALORIMETER CHANNEL	11	PRESSURE DROP	1333.6800000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER		354.8600000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE		-107.3900000	DEG F
CALORIMETER CHANNEL	1	TEMP. RISE	82.7799700 DEG F
CALORIMETER CHANNEL	2	TEMP. RISE	79.0499900 DEG F
CALORIMETER CHANNEL	3	TEMP. RISE	84.0199600 DEG F
CALORIMETER CHANNEL	4	TEMP. RISE	85.6200000 DEG F
CALORIMETER CHANNEL	5	TEMP. RISE	87.2500000 DEG F
CALORIMETER CHANNEL	6	TEMP. RISE	91.9899900 DEG F
CALORIMETER CHANNEL	7	TEMP. RISE	94.2399900 DEG F
CALORIMETER CHANNEL	8	TEMP. RISE	95.0799600 DEG F
CALORIMETER CHANNEL	9	TEMP. RISE	88.3800000 DEG F
CALORIMETER CHANNEL	10	TEMP. RISE	84.3399700 DEG F
CALORIMETER CHANNEL	11	TEMP. RISE	98.6099900 DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE		115.5707000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE		4.2023280	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	1	RESISTANCE	20277.4300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	2	RESISTANCE	19783.1600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	3	RESISTANCE	19932.3300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	4	RESISTANCE	20680.0400000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	5	RESISTANCE	22004.1600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	6	RESISTANCE	19700.6200000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	7	RESISTANCE	18165.3600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	8	RESISTANCE	17798.0600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	9	RESISTANCE	19503.1600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	10	RESISTANCE	21029.8900000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	11	RESISTANCE	21161.4300000 S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE		972.3984000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE		1303.1010000	S^2 PER FT^3-IN^2

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER		3646.7160000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE		-1093.9400000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	1	155.6225000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	2	154.1761000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	3	160.0299000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	4	164.9300000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	5	165.1067000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	6	179.1284000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	7	189.3281000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	8	191.9713000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	9	173.7297000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	10	156.4566000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	11	187.5301000	BTU PER S

LOX DENSITY UPSTREAM OF MOV		69.1890500	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MFV		4.7825600	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET		3.4366910	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET		.5743462	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET		.5670108	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET		.7160726	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD		62.9936100	LBM PER FT^3
CALORIMETER CHANNEL 1 INLET DENSITY		62.8711200	LBM PER FT^3

CALORIMETER CHANNEL 2	INLET DENSITY	62.8703900 LBM PER FT^3
CALORIMETER CHANNEL 3	INLET DENSITY	62.8497300 LBM PER FT^3
CALORIMETER CHANNEL 4	INLET DENSITY	62.8767600 LBM PER FT^3
CALORIMETER CHANNEL 5	INLET DENSITY	62.8872400 LBM PER FT^3
CALORIMETER CHANNEL 6	INLET DENSITY	62.8491300 LBM PER FT^3
CALORIMETER CHANNEL 7	INLET DENSITY	62.8566000 LBM PER FT^3
CALORIMETER CHANNEL 8	INLET DENSITY	62.8631500 LBM PER FT^3
CALORIMETER CHANNEL 9	INLET DENSITY	62.8564300 LBM PER FT^3
CALORIMETER CHANNEL 10	INLET DENSITY	62.8441500 LBM PER FT^3
CALORIMETER CHANNEL 11	INLET DENSITY	62.8672400 LBM PER FT^3
CALORIMETER CHANNEL 1	EXHAUST DENSITY	61.4729000 LBM PER FT^3
CALORIMETER CHANNEL 2	EXHAUST DENSITY	61.5282500 LBM PER FT^3
CALORIMETER CHANNEL 3	EXHAUST DENSITY	61.4266700 LBM PER FT^3
CALORIMETER CHANNEL 4	EXHAUST DENSITY	61.4070400 LBM PER FT^3
CALORIMETER CHANNEL 5	EXHAUST DENSITY	61.3789100 LBM PER FT^3
CALORIMETER CHANNEL 6	EXHAUST DENSITY	61.2645800 LBM PER FT^3
CALORIMETER CHANNEL 7	EXHAUST DENSITY	61.2323200 LBM PER FT^3
CALORIMETER CHANNEL 8	EXHAUST DENSITY	61.2246300 LBM PER FT^3
CALORIMETER CHANNEL 9	EXHAUST DENSITY	61.3394200 LBM PER FT^3
CALORIMETER CHANNEL 10	EXHAUST DENSITY	61.4150200 LBM PER FT^3
CALORIMETER CHANNEL 11	EXHAUST DENSITY	61.1439600 LBM PER FT^3
LH2 ENTHALPY INLET TO T.C. COOLANT JACKET		93.4148100 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET		1483.0340000 BTU PER LBM
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET		1485.8810000 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET		1069.0240000 BTU PER LBM
CALORIMETER CHANNEL 1	INLET ENTHALPY	43.9887400 BTU PER LBM
CALORIMETER CHANNEL 2	INLET ENTHALPY	43.9774900 BTU PER LBM
CALORIMETER CHANNEL 3	INLET ENTHALPY	43.6776600 BTU PER LBM
CALORIMETER CHANNEL 4	INLET ENTHALPY	44.0710800 BTU PER LBM
CALORIMETER CHANNEL 5	INLET ENTHALPY	44.2224100 BTU PER LBM
CALORIMETER CHANNEL 6	INLET ENTHALPY	43.6698800 BTU PER LBM
CALORIMETER CHANNEL 7	INLET ENTHALPY	43.7783900 BTU PER LBM
CALORIMETER CHANNEL 8	INLET ENTHALPY	43.8726500 BTU PER LBM
CALORIMETER CHANNEL 9	INLET ENTHALPY	43.7753200 BTU PER LBM
CALORIMETER CHANNEL 10	INLET ENTHALPY	43.5972400 BTU PER LBM
CALORIMETER CHANNEL 11	INLET ENTHALPY	43.9321800 BTU PER LBM
CALORIMETER CHANNEL 1	EXHAUST ENTHALPY	122.6118000 BTU PER LBM
CALORIMETER CHANNEL 2	EXHAUST ENTHALPY	118.7088000 BTU PER LBM
CALORIMETER CHANNEL 3	EXHAUST ENTHALPY	123.5451000 BTU PER LBM
CALORIMETER CHANNEL 4	EXHAUST ENTHALPY	125.2825000 BTU PER LBM
CALORIMETER CHANNEL 5	EXHAUST ENTHALPY	126.9478000 BTU PER LBM
CALORIMETER CHANNEL 6	EXHAUST ENTHALPY	131.3862000 BTU PER LBM
CALORIMETER CHANNEL 7	EXHAUST ENTHALPY	133.7902000 BTU PER LBM
CALORIMETER CHANNEL 8	EXHAUST ENTHALPY	134.7454000 BTU PER LBM
CALORIMETER CHANNEL 9	EXHAUST ENTHALPY	127.8426000 BTU PER LBM
CALORIMETER CHANNEL 10	EXHAUST ENTHALPY	123.7905000 BTU PER LBM
CALORIMETER CHANNEL 11	EXHAUST ENTHALPY	138.1440000 BTU PER LBM
GOX VENTURI FLOW	.0569646 LBM PER S	
GH2 VENTURI FLOW	.0558314 LBM PER S	
LOX INJECTOR FLOW	11.5102900 LBM PER S	
GH2 INJECTOR FLOW	2.6242560 LBM PER S	
CALORIMETER CHANNEL 1	H2O FLOW	1.9793490 LBM PER S
CALORIMETER CHANNEL 2	H2O FLOW	2.0630710 LBM PER S
CALORIMETER CHANNEL 3	H2O FLOW	2.0036930 LBM PER S
CALORIMETER CHANNEL 4	H2O FLOW	2.0308720 LBM PER S
CALORIMETER CHANNEL 5	H2O FLOW	1.9958410 LBM PER S
CALORIMETER CHANNEL 6	H2O FLOW	2.0421330 LBM PER S
CALORIMETER CHANNEL 7	H2O FLOW	2.1033700 LBM PER S

CALORIMETER CHANNEL 8 H2O FLOW	2.1125300 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	2.0665540 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9509940 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	1.9905150 LBM PER S

THE THEORETICAL CSTAR	8315.8290000
THE CSTAR	8163.6670000
CSTAR EFFICIENCY	98.1702100

T = 211.0, MR:6.0 (VS. 4.9 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE 3452.0300000 PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE 1591.8800000 PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET 1704.2100000 PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 1468.7200000 PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET 1452.3500000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET 1401.5100000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT 1401.5100000PSIG
NO PRESSURE AT P8
H2 PRESS. INLET TO THE FUEL MANIFOLD 961.2200000 PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD 1648.6400000 PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE 1573.7300000 PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE 1503.7100000 PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE 1454.9300000 PSIG
CALORIMETER CHANNEL 14 EXHAUST PKESSURE 1515.7200000 PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE 1533.6000000 PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE 1419.0800000 PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE 1487.5700000 PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE 1537.7800000 PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE 1450.4300000 PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE 1419.9300000 PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE 1484.6500000 PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE 2722.6200000 PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE 903.5200000 PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD 3488.4000000 PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI 2220.9500000 PSIG
NO PRESSURE AT P26
GH2 PRESS. INLET TO THE IGNITER VENTURI 2010.5400000 PSIG
NO PRESSURE AT P28
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER 2560.0000000 PSIG
CHAMBER PRESSURE 819.2100000 PSIG
CHAMBER PRESSURE 824.8300000 PSIG
IGNITER PRESSURE 854.3900000 PSIG
IGNITER PRESSURE 851.0700000 PSIG
GOX PRESS. EXHAUST FROM THE IGNITER VENTURI 866.2100000 PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI 949.9400000 PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM 759.3900000 PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE 2848.0600000 PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE 2877.9600000 PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE 2813.5700000 PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE 2781.9300000 PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE 2937.5400000 PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE 2739.0600000 PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE 2777.3500000 PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE 2811.5000000 PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE 2824.2300000 PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE 2686.9900000 PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE 2830.8400000 PSIG

LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE -375.0000000 DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE -375.0000000 DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET -364.7500000 DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 26.4700000 DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET 28.2300000 DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET 164.3000000 DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE -272.2500000 DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE -272.7500000 DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD -30.6700000 DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD 60.1400000 DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP. 156.9300000 DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP. 150.4100000 DEG F

CALORIMETER CHANNEL 13 EXHAUST TEMP.	156.9100000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	158.8800000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	159.9800000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	164.8900000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	167.7600000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	169.4500000	DEG F
CALORIMETER CHANNEL 19 EXHAUST TEMP.	161.6200000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	158.2800000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	176.3900000	DEG F
GOX TEMP. INLET TO THE IGNITER VENTURI	45.5300000	DEG F
GH2 TEMP. INLET TO THE IGNITER VENTURI	57.0500000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	64.0000000	DE G F
TEMP. MAIN OXIDIZER VALVE OPERATOR	32.6600000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	81.1800000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	89.9500000	DE G F
LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2757.4500000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2723.5800000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3452.2700000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3418.7900000	PSIG
LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-275.5400000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-380.6900000	DEG F

THE NOZZLE MIXTURE RATIO IS 3.9573940

THE INJECTOR MIXTURE RATIO IS 4.8783930

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2827.8600000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2866.5600000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2796.1700000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2763.7300000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2926.6400000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2732.4600000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2766.5500000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2799.3000000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2810.3300000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2674.1900000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2814.0400000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	4.4082230	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	3.7595890	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	4.4061040	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	4.6196940	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	4.7427200	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	5.3261690	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	5.6944140	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	5.9211210	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	4.9312740	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	4.5537330	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	6.9334220	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .6977708 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	235.4900000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	50.8399700	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1254.1300000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1362.8500000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1341.2400000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1248.0100000	PSID

CALORIMETER CHANNEL	5	PRESSURE DROP	1393.0400000	PSID
CALORIMETER CHANNEL	6	PRESSURE DROP	1313.3800000	PSID
CALORIMETER CHANNEL	7	PRESSURE DROP	1278.9800000	PSID
CALORIMETER CHANNEL	8	PRESSURE DROP	1261.5200000	PSID
CALORIMETER CHANNEL	9	PRESSURE DROP	1359.9000000	PSID
CALORIMETER CHANNEL	10	PRESSURE DROP	1254.2600000	PSID
CALORIMETER CHANNEL	11	PRESSURE DROP	1329.3900000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER		391.2200000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE		136.0700000	DEG F
CALORIMETER CHANNEL	1	TEMP. RISE	92.9299300 DEG F
CALORIMETER CHANNEL	2	TEMP. RISE	86.4099700 DEG F
CALORIMETER CHANNEL	3	TEMP. RISE	92.9099700 DEG F
CALORIMETER CHANNEL	4	TEMP. RISE	94.8800000 DEG F
CALORIMETER CHANNEL	5	TEMP. RISE	95.9799800 DEG F
CALORIMETER CHANNEL	6	TEMP. RISE	100.8900000 DEG F
CALORIMETER CHANNEL	7	TEMP. RISE	103.7599000 DEG F
CALORIMETER CHANNEL	8	TEMP. RISE	105.4500000 DEG F
CALORIMETER CHANNEL	9	TEMP. RISE	97.6200000 DEG F
CALORIMETER CHANNEL	10	TEMP. RISE	94.2799700 DEG F
CALORIMETER CHANNEL	11	TEMP. RISE	112.3900000 DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE		124.3983000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE		4.2349890	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	1	RESISTANCE	19851.9600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	2	RESISTANCE	21249.4900000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	3	RESISTANCE	23262.5900000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	4	RESISTANCE	16250.1300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	5	RESISTANCE	22178.1200000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	6	RESISTANCE	20110.8000000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	7	RESISTANCE	18340.9300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	8	RESISTANCE	17899.5300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	9	RESISTANCE	21571.2300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	10	RESISTANCE	20193.3300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	11	RESISTANCE	21027.4500000 S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE		809.4789000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE		1311.4810000	S^2 PER FT^3-IN^2

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER		3848.0560000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE		1236.1350000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	1	176.8346000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	2	164.6030000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	3	168.5093000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	4	199.2993000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	5	181.6499000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	6	195.6023000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	7	208.2664000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	8	212.9901000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	9	185.4414000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	10	178.0603000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	11	215.1903000	BTU PER S

LOX DENSITY UPSTREAM OF MOV		69.7651500	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MFV		4.4865690	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET		3.3615710	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET		.5374907	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET		.5300874	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET		.4045229	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD		63.0251600	LBM PER FT^3
CALORIMETER CHANNEL	1	INLET DENSITY	62.8999200 LBM PER FT^3

CALORIMETER CHANNEL 2	INLET DENSITY	62.9072800	LBM PER FT^3
CALORIMETER CHANNEL 3	INLET DENSITY	62.8939000	LBM PER FT^3
CALORIMETER CHANNEL 4	INLET DENSITY	62.8877000	LBM PER FT^3
CALORIMETER CHANNEL 5	INLET DENSITY	62.9187000	LBM PER FT^3
CALORIMETER CHANNEL 6	INLET DENSITY	62.8817100	LBM PER FT^3
CALORIMETER CHANNEL 7	INLET DENSITY	62.8882500	LBM PER FT^3
CALORIMETER CHANNEL 8	INLET DENSITY	62.8944500	LBM PER FT^3
CALORIMETER CHANNEL 9	INLET DENSITY	62.8965900	LBM PER FT^3
CALORIMETER CHANNEL 10	INLET DENSITY	62.8706200	LBM PER FT^3
CALORIMETER CHANNEL 11	INLET DENSITY	62.8972700	LBM PER FT^3
CALORIMETER CHANNEL 1	EXHAUST DENSITY	61.3541100	LBM PER FT^3
CALORIMETER CHANNEL 2	EXHAUST DENSITY	61.4666300	LBM PER FT^3
CALORIMETER CHANNEL 3	EXHAUST DENSITY	61.3325400	LBM PER FT^3
CALORIMETER CHANNEL 4	EXHAUST DENSITY	61.3050700	LBM PER FT^3
CALORIMETER CHANNEL 5	EXHAUST DENSITY	61.2866200	LBM PER FT^3
CALORIMETER CHANNEL 6	EXHAUST DENSITY	61.1667400	LBM PER FT^3
CALORIMETER CHANNEL 7	EXHAUST DENSITY	61.1208000	LBM PER FT^3
CALORIMETER CHANNEL 8	EXHAUST DENSITY	61.0953200	LBM PER FT^3
CALORIMETER CHANNEL 9	EXHAUST DENSITY	61.2384700	LBM PER FT^3
CALORIMETER CHANNEL 10	EXHAUST DENSITY	61.2991100	LBM PER FT^3
CALORIMETER CHANNEL 11	EXHAUST DENSITY	60.9393600	LBM PER FT^3
LH2 ENTHALPY INLET TO T.C. COOLANT JACKET		103.7786000	BTU PER LBM
GH2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET		1629.2050000	BTU PER LBM
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET		1635.4590000	BTU PER LBM
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET		2125.4810000	BTU PER LBM
CALORIMETER CHANNEL 1	INLET ENTHALPY	40.0130100	BTU PER LBM
CALORIMETER CHANNEL 2	INLET ENTHALPY	40.1203400	BTU PER LBM
CALORIMETER CHANNEL 3	INLET ENTHALPY	39.9251700	BTU PER LBM
CALORIMETER CHANNEL 4	INLET ENTHALPY	39.8362000	BTU PER LBM
CALORIMETER CHANNEL 5	INLET ENTHALPY	40.2857800	BTU PER LBM
CALORIMETER CHANNEL 6	INLET ENTHALPY	39.7499000	BTU PER LBM
CALORIMETER CHANNEL 7	INLET ENTHALPY	39.8436700	BTU PER LBM
CALORIMETER CHANNEL 8	INLET ENTHALPY	39.9343100	BTU PER LBM
CALORIMETER CHANNEL 9	INLET ENTHALPY	39.9651200	BTU PER LBM
CALORIMETER CHANNEL 10	INLET ENTHALPY	39.5878700	BTU PER LBM
CALORIMETER CHANNEL 11	INLET ENTHALPY	39.9748600	BTU PER LBM
CALORIMETER CHANNEL 1	EXHAUST ENTHALPY	128.7230000	BTU PER LBM
CALORIMETER CHANNEL 2	EXHAUST ENTHALPY	122.0682000	BTU PER LBM
CALORIMETER CHANNEL 3	EXHAUST ENTHALPY	128.4154000	BTU PER LBM
CALORIMETER CHANNEL 4	EXHAUST ENTHALPY	130.5226000	BTU PER LBM
CALORIMETER CHANNEL 5	EXHAUST ENTHALPY	131.6605000	BTU PER LBM
CALORIMETER CHANNEL 6	EXHAUST ENTHALPY	136.2730000	BTU PER LBM
CALORIMETER CHANNEL 7	EXHAUST ENTHALPY	139.2956000	BTU PER LBM
CALORIMETER CHANNEL 8	EXHAUST ENTHALPY	141.0985000	BTU PER LBM
CALORIMETER CHANNEL 9	EXHAUST ENTHALPY	133.0925000	BTU PER LBM
CALORIMETER CHANNEL 10	EXHAUST ENTHALPY	129.6938000	BTU PER LBM
CALORIMETER CHANNEL 11	EXHAUST ENTHALPY	147.8879000	BTU PER LBM
GOX VENTURI FLOW	.0558659	LBM PER S	
GH2 VENTURI FLOW	.0554993	LBM PER S	
LOX INJECTOR FLOW	12.5211700	LBM PER S	
GH2 INJECTOR FLOW	2.5226110	LBM PER S	
CALORIMETER CHANNEL 1	H2O FLOW	1.9934010	LBM PER S
CALORIMETER CHANNEL 2	H2O FLOW	2.0086320	LBM PER S
CALORIMETER CHANNEL 3	H2O FLOW	1.9042700	LBM PER S
CALORIMETER CHANNEL 4	H2O FLOW	2.1976750	LBM PER S
CALORIMETER CHANNEL 5	H2O FLOW	1.9879680	LBM PER S
CALORIMETER CHANNEL 6	H2O FLOW	2.0264820	LBM PER S
CALORIMETER CHANNEL 7	H2O FLOW	2.0941410	LBM PER S

CALORIMETER CHANNEL 8 H2O FLOW	2.1053900 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	1.9912670 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9761210 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	1.9941090 LBM PER S

THE THEORETICAL CSTAR 8235.0290000
THE CSTAR 8132.0590000
CSTAR EFFICIENCY 98.7496100

T = 214.0, MR:6.5 (VS. 5.3 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE 3454.6800000 PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE 1551.9400000 PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET 1648.5900000 PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 1422.9300000 PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET 1407.1200000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET 1358.2900000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT 1358.2900000PSIG
NO PRESSURE AT P8
H2 PRESS. INLET TO THE FUEL MANIFOLD 955.1700000 PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD 1649.3200000 PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE 1576.3300000 PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE 1496.6900000 PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE 1453.0700000 PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE 1511.9800000 PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE 1531.4100000 PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE 1414.9600000 PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE 1485.1200000 PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE 1536.9600000 PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE 1448.6100000 PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE 1421.8500000 PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE 1483.9300000 PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE 2721.3600000 PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE 913.5000000 PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD 3482.4700000 PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI 2193.1900000 PSIG
NO PRESSURE AT P26
GH2 PRESS. INLET TO THE IGNITER VENTURI 2002.7600000 PSIG
NO PRESSURE AT P28
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER 2560.0000000 PSIG
CHAMBER PRESSURE 820.6800000 PSIG
CHAMBER PRESSURE 826.4500000 PSIG
IGNITER PRESSURE 855.4800000 PSIG
IGNITER PRESSURE 852.7900000 PSIG
GOX PRESS. EXHAUST FROM THE IGNITER VENTURI 867.3800000 PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI 950.8600000 PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM 758.3900000 PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE 2864.8600000 PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE 2846.9400000 PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE 2864.2400000 PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE 2829.7500000 PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE 2932.0000000 PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE 2720.2700000 PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE 2770.5400000 PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE 2805.3500000 PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE 2824.3100000 PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE 2696.2600000 PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE 2829.4400000 PSIG

LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE -380.0000000 DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE -380.0000000 DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET -364.5000000 DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 64.6700000 DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET 66.4500000 DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET 206.7700000 DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE -273.4900000 DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE -273.4900000 DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD -78.7600000 DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD 60.9400000 DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP. 158.0200000 DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP. 151.9100000 DEG F

CALORIMETER CHANNEL 13 EXHAUST TEMP.	158.0800000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	159.9900000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	161.4700000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	167.0800000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	169.9700000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	171.6400000	DEG F
CALORIMETER CHANNEL 19 EXHAUST TEMP.	163.6100000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	160.0500000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	180.0300000	DEG F
GOX TEMP. INLET TO THE IGNITER VENTURI	46.0300000	DEG F
GH2 TEMP. INLET TO THE IGNITER VENTURI	57.6300000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	64.0000000	DEG F
TEMP. MAIN OXIDIZER VALVE OPERATOR	32.9100000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	79.7400000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	90.4100000	DEG F
LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2757.0100000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2721.2800000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3452.4600000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3422.9500000	PSIG
LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-277.6000000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-379.9300000	DEG F

THE NOZZLE MIXTURE RATIO IS 4.2379700

THE INJECTOR MIXTURE RATIO IS 5.2751410

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2844.6600000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2835.5400000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2846.8400000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2811.5500000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2921.1000000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2713.6700000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2759.7400000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2793.1500000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2810.4100000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2683.4600000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2812.6400000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	4.5253970	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	3.9011520	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	4.5319210	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	4.7438530	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	4.9137670	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	5.6052810	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	5.9923890	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	6.2261610	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	5.1685330	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	4.7506390	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	7.5200090	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .7079054 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	225.6599000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	48.8299600	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1268.3300000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1338.8500000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1393.7700000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1299.5700000	PSID

CALORIMETER CHANNEL	5	PRESSURE DROP	1389.6900000	PSID
CALORIMETER CHANNEL	6	PRESSURE DROP	1298.7100000	PSID
CALORIMETER CHANNEL	7	PRESSURE DROP	1274.6200000	PSID
CALORIMETER CHANNEL	8	PRESSURE DROP	1256.1900000	PSID
CALORIMETER CHANNEL	9	PRESSURE DROP	1361.8000000	PSID
CALORIMETER CHANNEL	10	PRESSURE DROP	1261.6100000	PSID
CALORIMETER CHANNEL	11	PRESSURE DROP	1328.7100000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER	429.1700000	DEG F		
COOLANT TEMP. RISE THROUGH THE NOZZLE	140.3200000	DEG F		
CALORIMETER CHANNEL	1	TEMP. RISE	94.0199600	DEG F
CALORIMETER CHANNEL	2	TEMP. RISE	87.9099700	DEG F
CALORIMETER CHANNEL	3	TEMP. RISE	94.0799600	DEG F
CALORIMETER CHANNEL	4	TEMP. RISE	95.9899900	DEG F
CALORIMETER CHANNEL	5	TEMP. RISE	97.4699700	DEG F
CALORIMETER CHANNEL	6	TEMP. RISE	103.0800000	DEG F
CALORIMETER CHANNEL	7	TEMP. RISE	105.9700000	DEG F
CALORIMETER CHANNEL	8	TEMP. RISE	107.6400000	DEG F
CALORIMETER CHANNEL	9	TEMP. RISE	99.6099900	DEG F
CALORIMETER CHANNEL	10	TEMP. RISE	96.0499900	DEG F
CALORIMETER CHANNEL	11	TEMP. RISE	116.0300000	DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE	129.9307000	S^2 PER FT^3-IN^2		
NOZZLE COOLANT JACKET RESISTANCE	4.0697660	S^2 PER FT^3-IN^2		
CALORIMETER CHANNEL	1	RESISTANCE	20817.0800000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	2	RESISTANCE	20049.6500000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	3	RESISTANCE	26391.3400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	4	RESISTANCE	18317.9200000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	5	RESISTANCE	22140.5100000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	6	RESISTANCE	19549.8900000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	7	RESISTANCE	18255.7800000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	8	RESISTANCE	17818.1200000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	9	RESISTANCE	21799.0400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	10	RESISTANCE	20705.3300000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	11	RESISTANCE	21162.7900000	S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE	762.5961000	S^2 PER FT^3-IN^2		
MAIN FUEL VALVE RESISTANCE	1521.9810000	S^2 PER FT^3-IN^2		

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER	3986.0800000	BTU PER S	
HEAT TRANSFER TO THE H2 IN NOZZLE	1198.0220000	BTU PER S	
HEAT TRANSFER TO CALORIMETER CHANNEL	1	175.7098000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	2	171.1486000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	3	163.1435000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	4	193.6015000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	5	184.5502000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	6	201.8155000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	7	213.0333000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	8	217.6472000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	9	188.5174000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	10	179.7684000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	11	221.6628000	BTU PER S

LOX DENSITY UPSTREAM OF MOV	69.9528400	LBM PER FT^3		
LH2 DENSITY UPSTREAM OF MFV	4.5934920	LBM PER FT^3		
LH2 DENSITY INLET TO T.C. COOLANT JACKET	3.3065160	LBM PER FT^3		
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET	.4852155	LBM PER FT^3		
H2 DENSITY INLET TO NOZZLE COOLANT JACKET	.4786260	LBM PER FT^3		
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET	.3685979	LBM PER FT^3		
H2O DENSITY CALORIMETER INLET MANIFOLD	63.0239800	LBM PER FT^3		
CALORIMETER CHANNEL	1	INLET DENSITY	62.9031300	LBM PER FT^3

CALORIMETER CHANNEL 2	INLET DENSITY	62.9014100	LBM PER FT^3
CALORIMETER CHANNEL 3	INLET DENSITY	62.9035300	LBM PER FT^3
CALORIMETER CHANNEL 4	INLET DENSITY	62.8967800	LBM PER FT^3
CALORIMETER CHANNEL 5	INLET DENSITY	62.9176800	LBM PER FT^3
CALORIMETER CHANNEL 6	INLET DENSITY	62.8781400	LBM PER FT^3
CALORIMETER CHANNEL 7	INLET DENSITY	62.8869800	LBM PER FT^3
CALORIMETER CHANNEL 8	INLET DENSITY	62.8933100	LBM PER FT^3
CALORIMETER CHANNEL 9	INLET DENSITY	62.8966000	LBM PER FT^3
CALORIMETER CHANNEL 10	INLET DENSITY	62.8724000	LBM PER FT^3
CALORIMETER CHANNEL 11	INLET DENSITY	62.8970600	LBM PER FT^3
CALORIMETER CHANNEL 1	EXHAUST DENSITY	61.3332700	LBM PER FT^3
CALORIMETER CHANNEL 2	EXHAUST DENSITY	61.4368600	LBM PER FT^3
CALORIMETER CHANNEL 3	EXHAUST DENSITY	61.3092500	LBM PER FT^3
CALORIMETER CHANNEL 4	EXHAUST DENSITY	61.2824600	LBM PER FT^3
CALORIMETER CHANNEL 5	EXHAUST DENSITY	61.2565800	LBM PER FT^3
CALORIMETER CHANNEL 6	EXHAUST DENSITY	61.1212200	LBM PER FT^3
CALORIMETER CHANNEL 7	EXHAUST DENSITY	61.0746700	LBM PER FT^3
CALORIMETER CHANNEL 8	EXHAUST DENSITY	61.0496100	LBM PER FT^3
CALORIMETER CHANNEL 9	EXHAUST DENSITY	61.1981800	LBM PER FT^3
CALORIMETER CHANNEL 10	EXHAUST DENSITY	61.2644800	LBM PER FT^3
CALORIMETER CHANNEL 11	EXHAUST DENSITY	60.8609100	LBM PER FT^3

LH2 ENTHALPY INLET TO T.C. COOLANT JACKET	104.3979000	BTU PER LBM	
GH2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET	1767.7700000	BTU PER LBM	
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET	1773.9950000	BTU PER LBM	
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET	2273.9240000	BTU PER LBM	
CALORIMETER CHANNEL 1	INLET ENTHALPY	40.0595900	BTU PER LBM
CALORIMETER CHANNEL 2	INLET ENTHALPY	40.0342300	BTU PER LBM
CALORIMETER CHANNEL 3	INLET ENTHALPY	40.0657600	BTU PER LBM
CALORIMETER CHANNEL 4	INLET ENTHALPY	39.9679800	BTU PER LBM
CALORIMETER CHANNEL 5	INLET ENTHALPY	40.2707900	BTU PER LBM
CALORIMETER CHANNEL 6	INLET ENTHALPY	39.6982300	BTU PER LBM
CALORIMETER CHANNEL 7	INLET ENTHALPY	39.8248800	BTU PER LBM
CALORIMETER CHANNEL 8	INLET ENTHALPY	39.9176300	BTU PER LBM
CALORIMETER CHANNEL 9	INLET ENTHALPY	39.9651100	BTU PER LBM
CALORIMETER CHANNEL 10	INLET ENTHALPY	39.6141400	BTU PER LBM
CALORIMETER CHANNEL 11	INLET ENTHALPY	39.9711600	BTU PER LBM
CALORIMETER CHANNEL 1	EXHAUST ENTHALPY	129.8135000	BTU PER LBM
CALORIMETER CHANNEL 2	EXHAUST ENTHALPY	123.5427000	BTU PER LBM
CALORIMETER CHANNEL 3	EXHAUST ENTHALPY	129.5749000	BTU PER LBM
CALORIMETER CHANNEL 4	EXHAUST ENTHALPY	131.6180000	BTU PER LBM
CALORIMETER CHANNEL 5	EXHAUST ENTHALPY	133.1381000	BTU PER LBM
CALORIMETER CHANNEL 6	EXHAUST ENTHALPY	138.4445000	BTU PER LBM
CALORIMETER CHANNEL 7	EXHAUST ENTHALPY	141.4911000	BTU PER LBM
CALORIMETER CHANNEL 8	EXHAUST ENTHALPY	143.2780000	BTU PER LBM
CALORIMETER CHANNEL 9	EXHAUST ENTHALPY	135.0693000	BTU PER LBM
CALORIMETER CHANNEL 10	EXHAUST ENTHALPY	131.4605000	BTU PER LBM
CALORIMETER CHANNEL 11	EXHAUST ENTHALPY	151.5159000	BTU PER LBM

GOX VENTURI FLOW	.0551141	LBM PER S	
GH2 VENTURI FLOW	.0552649	LBM PER S	
LOX INJECTOR FLOW	12.8776900	LBM PER S	
GH2 INJECTOR FLOW	2.3963850	LBM PER S	
CALORIMETER CHANNEL 1	H2O FLOW	1.9576830	LBM PER S
CALORIMETER CHANNEL 2	H2O FLOW	2.0494760	LBM PER S
CALORIMETER CHANNEL 3	H2O FLOW	1.8226460	LBM PER S
CALORIMETER CHANNEL 4	H2O FLOW	2.1123990	LBM PER S
CALORIMETER CHANNEL 5	H2O FLOW	1.9872460	LBM PER S
CALORIMETER CHANNEL 6	H2O FLOW	2.0437780	LBM PER S
CALORIMETER CHANNEL 7	H2O FLOW	2.0954170	LBM PER S

CALORIMETER CHANNEL 8 H2O FLOW	2.1057120 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	1.9822190 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9572730 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	1.9872100 LBM PER S

THE THEORETICAL CSTAR 8173.6420000
THE CSTAR 8031.0120000
CSTAR EFFICIENCY 98.2550000

T = 217.0, MR:7.0 (VS. 5.8 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE 3456.6300000 PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE 1535.8700000 PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET 1620.8000000 PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 1405.3600000 PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET 1389.4400000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET 1341.5600000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT 1341.5600000PSIG
NO PRESSURE AT P8
H2 PRESS. INLET TO THE FUEL MANIFOLD 954.6700000 PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD 1634.5000000 PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE 1571.1200000 PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE 1497.7000000 PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE 1452.5600000 PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE 1512.7800000 PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE 1530.6100000 PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE 1416.3100000 PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE 1484.2100000 PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE 1537.4700000 PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE 1442.3900000 PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE 1422.2500000 PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE 1482.7800000 PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE 2717.9100000 PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE 924.0500000 PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD 3483.6800000 PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI 2166.3500000 PSIG
NO PRESSURE AT P26
GH2 PRESS. INLET TO THE IGNITER VENTURI 1995.7700000 PSIG
NO PRESSURE AT P28
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER 2560.0000000 PSIG
CHAMBER PRESSURE 823.8900000 PSIG
CHAMBER PRESSURE 829.7500000 PSIG
IGNITER PRESSURE 858.5800000 PSIG
IGNITER PRESSURE 854.6700000 PSIG
GOX PRESS. EXHAUST FROM THE IGNITER VENTURI 870.3600000 PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI 952.7300000 PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM 757.4200000 PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE 2841.8300000 PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE 2849.3900000 PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE 2812.2000000 PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE 2879.0200000 PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE 2930.6300000 PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE 2728.0000000 PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE 2770.7800000 PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE 2810.3100000 PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE 2798.3200000 PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE 2700.4500000 PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE 2830.9900000 PSIG

LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE -376.0000000 DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE -376.0000000 DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET -366.8800000 DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 88.1700000 DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET 89.6600000 DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET 240.1300000 DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE -275.1300000 DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE -275.1300000 DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD -119.7000000 DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD 61.0100000 DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP. 158.9200000 DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP. 152.7300000 DEG F

CALORIMETER CHANNEL 13 EXHAUST TEMP.	158.6500000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	160.6400000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	162.0500000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	168.1400000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	171.4900000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	173.4800000	DEG F
CALORIMETER CHANNEL 19 EXHAUST TEMP.	166.0500000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	162.0900000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	182.9100000	DEG F
GOX TEMP. INLET TO THE IGNITER VENTURI	47.3900000	DEG F
GH2 TEMP. INLET TO THE IGNITER VENTURI	58.1200000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	64.0000000	DE G F
TEMP. MAIN OXIDIZER VALVE OPERATOR	33.0600000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	78.5700000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	88.8100000	DE G F
LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2755.0100000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2718.4600000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3453.3000000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3426.7900000	PSIG
LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-278.3400000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-380.2100000	DEG F

THE NOZZLE MIXTURE RATIO IS 4.5093410

THE INJECTOR MIXTURE RATIO IS 5.6828940

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2821.6300000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2837.9900000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2794.8000000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2860.8200000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2919.7300000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2721.4000000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2759.9800000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2798.1100000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2784.4200000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2687.6500000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2814.1900000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	4.6241190	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	3.9804340	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	4.5943150	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	4.8178520	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	4.9817440	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	5.7447460	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	6.2048610	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	6.4925730	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	5.4725160	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	4.9864630	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	8.0130970	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .6731969 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	215.4401000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	47.8798800	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1250.5100000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1340.2900000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1342.2400000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1348.0400000	PSID

CALORIMETER CHANNEL	5	PRESSURE DROP	1389.1200000	PSID
CALORIMETER CHANNEL	6	PRESSURE DROP	1305.0900000	PSID
CALORIMETER CHANNEL	7	PRESSURE DROP	1275.7700000	PSID
CALORIMETER CHANNEL	8	PRESSURE DROP	1260.6400000	PSID
CALORIMETER CHANNEL	9	PRESSURE DROP	1342.0300000	PSID
CALORIMETER CHANNEL	10	PRESSURE DROP	1265.4000000	PSID
CALORIMETER CHANNEL	11	PRESSURE DROP	1331.4100000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER		455.0500000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE		150.4700000	DEG F
CALORIMETER CHANNEL	1	TEMP. RISE	94.9199800 DEG F
CALORIMETER CHANNEL	2	TEMP. RISE	88.7299800 DEG F
CALORIMETER CHANNEL	3	TEMP. RISE	94.6499600 DEG F
CALORIMETER CHANNEL	4	TEMP. RISE	96.6399500 DEG F
CALORIMETER CHANNEL	5	TEMP. RISE	98.0499900 DEG F
CALORIMETER CHANNEL	6	TEMP. RISE	104.1400000 DEG F
CALORIMETER CHANNEL	7	TEMP. RISE	107.4900000 DEG F
CALORIMETER CHANNEL	8	TEMP. RISE	109.4800000 DEG F
CALORIMETER CHANNEL	9	TEMP. RISE	102.0500000 DEG F
CALORIMETER CHANNEL	10	TEMP. RISE	98.0899700 DEG F
CALORIMETER CHANNEL	11	TEMP. RISE	118.9100000 DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE		142.9819000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE		4.2895700	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	1	RESISTANCE	19748.0100000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	2	RESISTANCE	20110.5000000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	3	RESISTANCE	23396.2900000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	4	RESISTANCE	20514.3600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	5	RESISTANCE	22028.0000000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	6	RESISTANCE	19815.8100000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	7	RESISTANCE	18247.3100000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	8	RESISTANCE	17981.0100000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	9	RESISTANCE	20628.2700000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	10	RESISTANCE	20846.6900000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	11	RESISTANCE	21216.8400000 S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE		739.7127000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE		1710.2610000	S^2 PER FT^3-IN^2

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER		3952.3990000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE		1199.6200000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	1	181.0141000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	2	172.6438000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	3	171.3732000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	4	187.3811000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	5	186.1367000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	6	203.0646000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	7	216.3485000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	8	220.8685000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	9	197.4037000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	10	183.3731000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	11	227.2993000	BTU PER S

LOX DENSITY UPSTREAM OF MOV		70.1986200	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MFV		4.5093960	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET		3.3611170	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET		.4597766	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET		.4537219	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET		.3475197	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD		63.0242700	LBM PER FT^3
CALORIMETER CHANNEL	1	INLET DENSITY	62.8987500 LBM PER FT^3

CALORIMETER CHANNEL	2	INLET DENSITY	62.9018600	LBM PER FT^3
CALORIMETER CHANNEL	3	INLET DENSITY	62.8936300	LBM PER FT^3
CALORIMETER CHANNEL	4	INLET DENSITY	62.9062000	LBM PER FT^3
CALORIMETER CHANNEL	5	INLET DENSITY	62.9174400	LBM PER FT^3
CALORIMETER CHANNEL	6	INLET DENSITY	62.8796000	LBM PER FT^3
CALORIMETER CHANNEL	7	INLET DENSITY	62.8869900	LBM PER FT^3
CALORIMETER CHANNEL	8	INLET DENSITY	62.8942500	LBM PER FT^3
CALORIMETER CHANNEL	9	INLET DENSITY	62.8916300	LBM PER FT^3
CALORIMETER CHANNEL	10	INLET DENSITY	62.8731300	LBM PER FT^3
CALORIMETER CHANNEL	11	INLET DENSITY	62.8973000	LBM PER FT^3
CALORIMETER CHANNEL	1	EXHAUST DENSITY	61.3145700	LBM PER FT^3
CALORIMETER CHANNEL	2	EXHAUST DENSITY	61.4213600	LBM PER FT^3
CALORIMETER CHANNEL	3	EXHAUST DENSITY	61.2979400	LBM PER FT^3
CALORIMETER CHANNEL	4	EXHAUST DENSITY	61.2696300	LBM PER FT^3
CALORIMETER CHANNEL	5	EXHAUST DENSITY	61.2448000	LBM PER FT^3
CALORIMETER CHANNEL	6	EXHAUST DENSITY	61.0997000	LBM PER FT^3
CALORIMETER CHANNEL	7	EXHAUST DENSITY	61.0428400	LBM PER FT^3
CALORIMETER CHANNEL	8	EXHAUST DENSITY	61.0110300	LBM PER FT^3
CALORIMETER CHANNEL	9	EXHAUST DENSITY	61.1474600	LBM PER FT^3
CALORIMETER CHANNEL	10	EXHAUST DENSITY	61.2238400	LBM PER FT^3
CALORIMETER CHANNEL	11	EXHAUST DENSITY	60.7978800	LBM PER FT^3

LH2 ENTHALPY INLET TO T.C. COOLANT JACKET	96.0895700	BTU PER LBM		
GH2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET	1852.3800000	BTU PER LBM		
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET	1857.5230000	BTU PER LBM		
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET	2390.5860000	BTU PER LBM		
CALORIMETER CHANNEL	1	INLET ENTHALPY	39.9959700	BTU PER LBM
CALORIMETER CHANNEL	2	INLET ENTHALPY	40.0407400	BTU PER LBM
CALORIMETER CHANNEL	3	INLET ENTHALPY	39.9220200	BTU PER LBM
CALORIMETER CHANNEL	4	INLET ENTHALPY	40.1041000	BTU PER LBM
CALORIMETER CHANNEL	5	INLET ENTHALPY	40.2666700	BTU PER LBM
CALORIMETER CHANNEL	6	INLET ENTHALPY	39.7186500	BTU PER LBM
CALORIMETER CHANNEL	7	INLET ENTHALPY	39.8256600	BTU PER LBM
CALORIMETER CHANNEL	8	INLET ENTHALPY	39.9310800	BTU PER LBM
CALORIMETER CHANNEL	9	INLET ENTHALPY	39.8932500	BTU PER LBM
CALORIMETER CHANNEL	10	INLET ENTHALPY	39.6262100	BTU PER LBM
CALORIMETER CHANNEL	11	INLET ENTHALPY	39.9753100	BTU PER LBM
CALORIMETER CHANNEL	1	EXHAUST ENTHALPY	130.6964000	BTU PER LBM
CALORIMETER CHANNEL	2	EXHAUST ENTHALPY	124.3608000	BTU PER LBM
CALORIMETER CHANNEL	3	EXHAUST ENTHALPY	130.1410000	BTU PER LBM
CALORIMETER CHANNEL	4	EXHAUST ENTHALPY	132.2671000	BTU PER LBM
CALORIMETER CHANNEL	5	EXHAUST ENTHALPY	133.7134000	BTU PER LBM
CALORIMETER CHANNEL	6	EXHAUST ENTHALPY	139.5036000	BTU PER LBM
CALORIMETER CHANNEL	7	EXHAUST ENTHALPY	143.0035000	BTU PER LBM
CALORIMETER CHANNEL	8	EXHAUST ENTHALPY	145.1127000	BTU PER LBM
CALORIMETER CHANNEL	9	EXHAUST ENTHALPY	137.4841000	BTU PER LBM
CALORIMETER CHANNEL	10	EXHAUST ENTHALPY	133.4921000	BTU PER LBM
CALORIMETER CHANNEL	11	EXHAUST ENTHALPY	154.3860000	BTU PER LBM

GOX VENTURI FLOW	.0543122	LBM PER S		
GH2 VENTURI FLOW	.0550558	LBM PER S		
LOX INJECTOR FLOW	13.0474900	LBM PER S		
GH2 INJECTOR FLOW	2.2504250	LBM PER S		
CALORIMETER CHANNEL	1	H2O FLOW	1.9957360	LBM PER S
CALORIMETER CHANNEL	2	H2O FLOW	2.0474800	LBM PER S
CALORIMETER CHANNEL	3	H2O FLOW	1.8995240	LBM PER S
CALORIMETER CHANNEL	4	H2O FLOW	2.0331490	LBM PER S
CALORIMETER CHANNEL	5	H2O FLOW	1.9919020	LBM PER S
CALORIMETER CHANNEL	6	H2O FLOW	2.0350220	LBM PER S
CALORIMETER CHANNEL	7	H2O FLOW	2.0968490	LBM PER S

CALORIMETER CHANNEL 8 H2O FLOW	2.0998780 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	2.0227690 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9535650 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	1.9866970 LBM PER S

THE THEORETICAL CSTAR	8109.0230000
THE CSTAR	8051.3790000
CSTAR EFFICIENCY	99.2891400

T = 219.0, MR:5.0 (VS. 4.7 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE 3449.7100000 PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE 1624.9700000 PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET 1729.0700000 PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 1502.4000000 PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET 1485.8100000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET 1433.3100000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT 1433.3100000PSIG
NO PRESSURE AT P8
H2 PRESS. INLET TO THE FUEL MANIFOLD 955.9200000 PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD 1426.4400000 PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE 1581.2400000 PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE 1500.6800000 PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE 1453.8600000 PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE 1512.2600000 PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE 1532.3200000 PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE 1416.7600000 PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE 1484.5200000 PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE 1536.0300000 PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE 1435.9900000 PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE 1417.6900000 PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE 1480.4200000 PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE 2729.9300000 PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE 884.9800000 PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD 3484.8600000 PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI 2149.3100000 PSIG
NO PRESSURE AT P26
GH2 PRESS. INLET TO THE IGNITER VENTURI 1992.3000000 PSIG
NO PRESSURE AT P28
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER 2560.0000000 PSIG
CHAMBER PRESSURE 800.6900000 PSIG
CHAMBER PRESSURE 806.2200000 PSIG
IGNITER PRESSURE 834.3500000 PSIG
IGNITER PRESSURE 830.8900000 PSIG
GOX PRESS. EXHAUST FROM THE IGNITER VENTURI 846.5500000 PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI 931.4700000 PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM 756.4700000 PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE 2878.2500000 PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE 2862.4600000 PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE 2841.1700000 PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE 2870.9200000 PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE 2933.3200000 PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE 2712.0800000 PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE 2770.0400000 PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE 2807.2700000 PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE 2775.1000000 PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE 2683.6900000 PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE 2815.4300000 PSIG

LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE -381.0000000 DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE -381.0000000 DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET -367.2500000 DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 29.6600000 DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET 31.3100000 DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET 206.2000000 DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE -275.2200000 DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE -275.2200000 DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD -80.6600000 DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD 61.6300000 DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP. 150.0400000 DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP. 148.0800000 DEG F

CALORIMETER CHANNEL 13 EXHAUST TEMP.	154.3700000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	156.1400000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	157.7300000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	163.6700000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	167.1700000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	170.4900000	DEG F
CALORIMETER CHANNEL 19 EXHAUST TEMP.	166.1000000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	164.3800000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	186.4300000	DEG F
GOX TEMP. INLET TO THE IGNITER VENTURI	48.0700000	DEG F
GH2 TEMP. INLET TO THE IGNITER VENTURI	58.2800000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	63.5000000	DE G F
TEMP. MAIN OXIDIZER VALVE OPERATOR	33.1900000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	77.8600000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	88.8700000	DE G F

LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2761.1900000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2730.1900000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3450.1600000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3417.6300000	PSIG

LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-278.4400000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-380.0400000	DEG F

THE NOZZLE MIXTURE RATIO IS 3.8005770

THE INJECTOR MIXTURE RATIO IS 4.6856760

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2858.0500000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2851.0600000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2823.7700000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2852.7200000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2922.4200000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2705.4800000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2759.2400000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2795.0700000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2761.2000000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2670.8900000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2798.6300000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	3.7253510	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	3.5483390	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	4.1430880	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	4.3249160	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	4.4939740	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	5.1758290	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	5.6170180	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	6.0643810	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	5.4788980	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	5.2628860	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	8.6522320	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .6744722 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	226.6699000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	52.5000000	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1276.8100000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1350.3800000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1369.9100000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1340.4600000	PSID

CALORIMETER CHANNEL	5	PRESSURE DROP	1390.1000000	PSID
CALORIMETER CHANNEL	6	PRESSURE DROP	1288.7200000	PSID
CALORIMETER CHANNEL	7	PRESSURE DROP	1274.7200000	PSID
CALORIMETER CHANNEL	8	PRESSURE DROP	1259.0400000	PSID
CALORIMETER CHANNEL	9	PRESSURE DROP	1325.2100000	PSID
CALORIMETER CHANNEL	10	PRESSURE DROP	1253.2000000	PSID
CALORIMETER CHANNEL	11	PRESSURE DROP	1318.2100000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER	396.9100000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE	174.8900000	DEG F
CALORIMETER CHANNEL 1 TEMP. RISE	86.5399800	DEG F
CALORIMETER CHANNEL 2 TEMP. RISE	84.5799600	DEG F
CALORIMETER CHANNEL 3 TEMP. RISE	90.8700000	DEG F
CALORIMETER CHANNEL 4 TEMP. RISE	92.6399500	DEG F
CALORIMETER CHANNEL 5 TEMP. RISE	94.2299800	DEG F
CALORIMETER CHANNEL 6 TEMP. RISE	100.1700000	DEG F
CALORIMETER CHANNEL 7 TEMP. RISE	103.6700000	DEG F
CALORIMETER CHANNEL 8 TEMP. RISE	106.9900000	DEG F
CALORIMETER CHANNEL 9 TEMP. RISE	102.6000000	DEG F
CALORIMETER CHANNEL 10 TEMP. RISE	100.8800000	DEG F
CALORIMETER CHANNEL 11 TEMP. RISE	122.9299000	DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE	123.4389000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE	4.4437530	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 1 RESISTANCE	21336.9100000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 2 RESISTANCE	20649.6600000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 3 RESISTANCE	24911.5600000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 4 RESISTANCE	20090.0500000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 5 RESISTANCE	22103.9400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 6 RESISTANCE	19133.2400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 7 RESISTANCE	18183.1700000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 8 RESISTANCE	17846.0700000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 9 RESISTANCE	19667.9600000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 10 RESISTANCE	20182.2500000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 11 RESISTANCE	20480.1000000	S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE	896.9855000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE	1324.0850000	S^2 PER FT^3-IN^2

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER	3897.7560000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE	1578.6340000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 1	159.6562000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 2	162.5850000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 3	160.6486000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 4	180.6995000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 5	178.3092000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 6	197.2996000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 7	208.6527000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 8	216.3401000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 9	202.1129000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 10	191.0190000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 11	238.3370000	BTU PER S

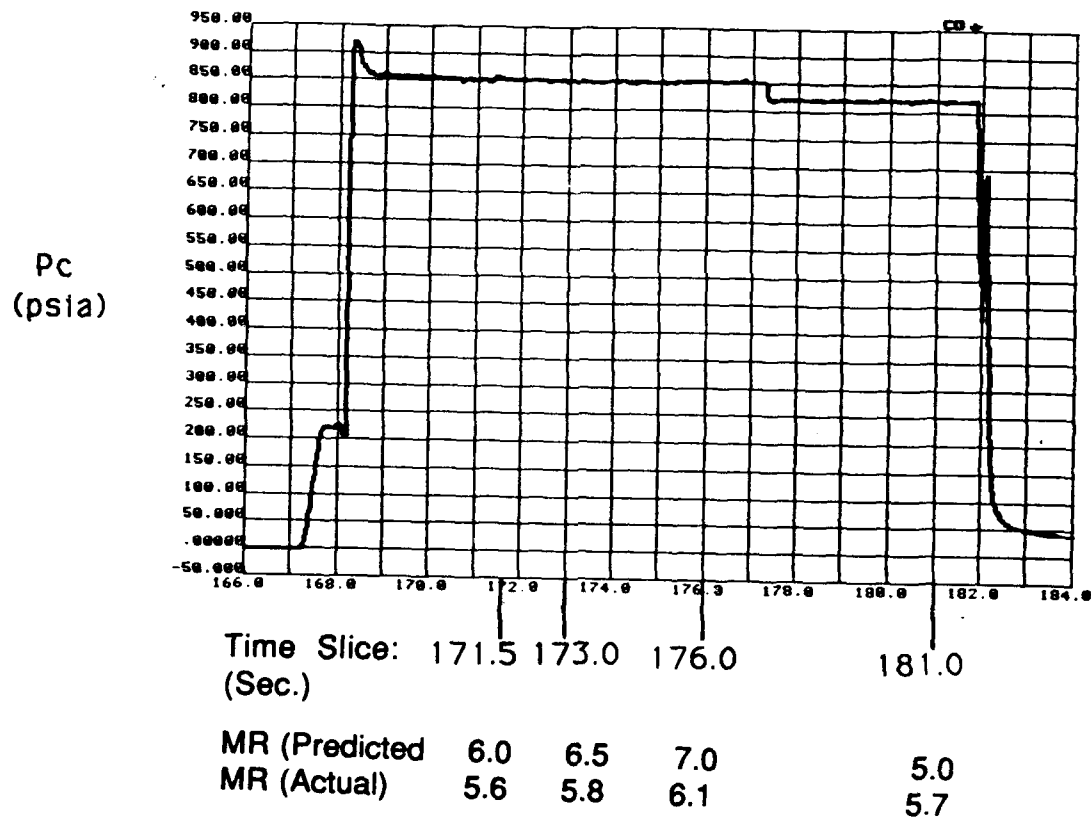
LOX DENSITY UPSTREAM OF MOV	70.2234300	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MFV	4.6132200	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET	3.4621640	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET	.5454462	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET	.5381212	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET	.3880433	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD	63.0282800	LBM PER FT^3
CALORIMETER CHANNEL 1 INLET DENSITY	62.9093300	LBM PER FT^3

CALORIMETER CHANNEL	2	INLET DENSITY	62.9079900	LBM PER FT^3
CALORIMETER CHANNEL	3	INLET DENSITY	62.9028100	LBM PER FT^3
CALORIMETER CHANNEL	4	INLET DENSITY	62.9083200	LBM PER FT^3
CALORIMETER CHANNEL	5	INLET DENSITY	62.9215900	LBM PER FT^3
CALORIMETER CHANNEL	6	INLET DENSITY	62.8802200	LBM PER FT^3
CALORIMETER CHANNEL	7	INLET DENSITY	62.8904900	LBM PER FT^3
CALORIMETER CHANNEL	8	INLET DENSITY	62.8973200	LBM PER FT^3
CALORIMETER CHANNEL	9	INLET DENSITY	62.8908700	LBM PER FT^3
CALORIMETER CHANNEL	10	INLET DENSITY	62.8735600	LBM PER FT^3
CALORIMETER CHANNEL	11	INLET DENSITY	62.8980000	LBM PER FT^3
CALORIMETER CHANNEL	1	EXHAUST DENSITY	61.4879100	LBM PER FT^3
CALORIMETER CHANNEL	2	EXHAUST DENSITY	61.5098800	LBM PER FT^3
CALORIMETER CHANNEL	3	EXHAUST DENSITY	61.3816900	LBM PER FT^3
CALORIMETER CHANNEL	4	EXHAUST DENSITY	61.3581700	LBM PER FT^3
CALORIMETER CHANNEL	5	EXHAUST DENSITY	61.3308100	LBM PER FT^3
CALORIMETER CHANNEL	6	EXHAUST DENSITY	61.1909900	LBM PER FT^3
CALORIMETER CHANNEL	7	EXHAUST DENSITY	61.1323700	LBM PER FT^3
CALORIMETER CHANNEL	8	EXHAUST DENSITY	61.0734400	LBM PER FT^3
CALORIMETER CHANNEL	9	EXHAUST DENSITY	61.1452100	LBM PER FT^3
CALORIMETER CHANNEL	10	EXHAUST DENSITY	61.1768100	LBM PER FT^3
CALORIMETER CHANNEL	11	EXHAUST DENSITY	60.7197100	LBM PER FT^3
LH2 ENTHALPY INLET TO T.C. COOLANT JACKET				95.4698000 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET				1641.3290000 BTU PER LBM
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET				1647.1680000 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET				2273.2580000 BTU PER LBM
CALORIMETER CHANNEL	1	INLET ENTHALPY	39.6031700	BTU PER LBM
CALORIMETER CHANNEL	2	INLET ENTHALPY	39.5846500	BTU PER LBM
CALORIMETER CHANNEL	3	INLET ENTHALPY	39.5086100	BTU PER LBM
CALORIMETER CHANNEL	4	INLET ENTHALPY	39.5884700	BTU PER LBM
CALORIMETER CHANNEL	5	INLET ENTHALPY	39.7819300	BTU PER LBM
CALORIMETER CHANNEL	6	INLET ENTHALPY	39.1820300	BTU PER LBM
CALORIMETER CHANNEL	7	INLET ENTHALPY	39.3298900	BTU PER LBM
CALORIMETER CHANNEL	8	INLET ENTHALPY	39.4297200	BTU PER LBM
CALORIMETER CHANNEL	9	INLET ENTHALPY	39.3354600	BTU PER LBM
CALORIMETER CHANNEL	10	INLET ENTHALPY	39.0862500	BTU PER LBM
CALORIMETER CHANNEL	11	INLET ENTHALPY	39.4395100	BTU PER LBM
CALORIMETER CHANNEL	1	EXHAUST ENTHALPY	121.8901000	BTU PER LBM
CALORIMETER CHANNEL	2	EXHAUST ENTHALPY	119.7444000	BTU PER LBM
CALORIMETER CHANNEL	3	EXHAUST ENTHALPY	125.8852000	BTU PER LBM
CALORIMETER CHANNEL	4	EXHAUST ENTHALPY	127.7880000	BTU PER LBM
CALORIMETER CHANNEL	5	EXHAUST ENTHALPY	129.4186000	BTU PER LBM
CALORIMETER CHANNEL	6	EXHAUST ENTHALPY	135.0523000	BTU PER LBM
CALORIMETER CHANNEL	7	EXHAUST ENTHALPY	138.7007000	BTU PER LBM
CALORIMETER CHANNEL	8	EXHAUST ENTHALPY	142.1302000	BTU PER LBM
CALORIMETER CHANNEL	9	EXHAUST ENTHALPY	137.5188000	BTU PER LBM
CALORIMETER CHANNEL	10	EXHAUST ENTHALPY	135.7619000	BTU PER LBM
CALORIMETER CHANNEL	11	EXHAUST ENTHALPY	157.8927000	BTU PER LBM
GOX VENTURI FLOW				.0538188 LBM PER S
GH2 VENTURI FLOW				.0549562 LBM PER S
LOX INJECTOR FLOW				12.0182300 LBM PER S
GH2 INJECTOR FLOW				2.5214170 LBM PER S
CALORIMETER CHANNEL	1	H2O FLOW	1.9402380	LBM PER S
CALORIMETER CHANNEL	2	H2O FLOW	2.0282640	LBM PER S
CALORIMETER CHANNEL	3	H2O FLOW	1.8598620	LBM PER S
CALORIMETER CHANNEL	4	H2O FLOW	2.0487570	LBM PER S
CALORIMETER CHANNEL	5	H2O FLOW	1.9892440	LBM PER S
CALORIMETER CHANNEL	6	H2O FLOW	2.0579840	LBM PER S
CALORIMETER CHANNEL	7	H2O FLOW	2.0997380	LBM PER S

CALORIMETER CHANNEL 8 H2O FLOW	2.1065150 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	2.0585270 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9758750 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	2.0120770 LBM PER S

THE THEORETICAL CSTAR 8266.8000000
THE CSTAR 8215.3280000
CSTAR EFFICIENCY 99.3773700

Test 017 - 041: Smooth Wall Combustor
Reduced Data Time Slices



T = 171.5, MR:6.0 (VS. 5.6 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE	3750.3000000	PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE	1500.9800000	PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET	1587.0600000	PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET	1377.2900000	PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET	1363.3300000	PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET	1334.5700000	PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT	1334.5700000	PSIG
NO PRESSURE AT P8		
H2 PRESS. INLET TO THE FUEL MANIFOLD	973.5400000	PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD	929.0000000	PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE	1576.2600000	PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE	1490.7000000	PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE	1475.8300000	PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE	1544.0200000	PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE	1549.2200000	PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE	1413.2600000	PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE	1489.9700000	PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE	1555.8600000	PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE	1460.3300000	PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE	1433.9900000	PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE	1467.0100000	PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE	2737.5700000	PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE	937.4400000	PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD	3477.9800000	PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI	2028.5700000	PSIG
NO PRESSURE AT P26		
GH2 PRESS. INLET TO THE IGNITER VENTURI	1965.3700000	PSIG
NO PRESSURE AT P28		
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER	2560.0000000	PSIG
CHAMBER PRESSURE	855.0700000	PSIG
CHAMBER PRESSURE	857.5900000	PSIG
IGNITER PRESSURE	891.8400000	PSIG
IGNITER PRESSURE	888.6700000	PSIG
IGNITER PRESS. EXHAUST FROM THE IGNITER VENTURI	888.3300000	PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI	991.6100000	PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM	759.9000000	PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE	2844.7800000	PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE	2805.8100000	PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE	2793.8200000	PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE	2762.5900000	PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE	2935.8700000	PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE	2737.8300000	PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE	2779.3400000	PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE	2819.5900000	PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE	2865.7800000	PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE	2721.0700000	PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE	2754.0600000	PSIG
LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE	-390.0000000	DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE	-390.0000000	DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET	-367.1900000	DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET	-62.1300000	DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET	-57.2300000	DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET	48.0200000	DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE	-274.0500000	DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE	-274.0500000	DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD	48.1200000	DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD	77.5500000	DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP.	128.1100000	DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP.	132.0100000	DEG F
CALORIMETER CHANNEL 13 EXHAUST TEMP.	133.2600000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	135.1100000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	136.2800000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	139.9700000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	141.1000000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	139.3400000	DEG F

CALORIMETER CHANNEL 19 EXHAUST TEMP.	127.8100000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	122.3400000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	129.0000000	DEG F
LOX TEMP. INLET TO THE IGNITER VENTURI	59.8300000	DEG F
H2O TEMP. INLET TO THE IGNITER VENTURI	75.7600000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	65.5700000	DEG F
TEMP. MAIN OXIDIZER VALVE OPERATOR	34.8700000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	84.3000000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	95.6400000	DEG F

LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2773.0000000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2732.8600000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3754.7000000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3727.2400000	PSIG

LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-279.3300000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-382.0200000	DEG F

THE NOZZLE MIXTURE RATIO IS 4.5159040

THE INJECTOR MIXTURE RATIO IS 5.6283470

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2824.5800000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2794.4100000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2776.4200000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2744.3900000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2924.9700000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2731.2300000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2768.5400000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2807.3900000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2851.8800000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2708.2700000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2737.2600000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	2.1153310	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	2.3475600	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	2.4264520	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	2.5473670	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	2.6264570	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	2.8897580	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	2.9747510	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	2.8432770	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	2.0983080	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	1.8078920	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	2.1665190	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .8324181 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	209.7700000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	28.7600100	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1248.3200000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1303.7100000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1300.5900000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1200.3700000	PSID
CALORIMETER CHANNEL 5 PRESSURE DROP	1375.7500000	PSID
CALORIMETER CHANNEL 6 PRESSURE DROP	1317.9700000	PSID
CALORIMETER CHANNEL 7 PRESSURE DROP	1278.5700000	PSID
CALORIMETER CHANNEL 8 PRESSURE DROP	1251.5300000	PSID
CALORIMETER CHANNEL 9 PRESSURE DROP	1391.5500000	PSID
CALORIMETER CHANNEL 10 PRESSURE DROP	1274.2800000	PSID
CALORIMETER CHANNEL 11 PRESSURE DROP	1270.2500000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER	305.0600000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE	105.2500000	DEG F
CALORIMETER CHANNEL 1 TEMP. RISE	62.5400400	DEG F
CALORIMETER CHANNEL 2 TEMP. RISE	66.4400000	DEG F

CALORIMETER CHANNEL	3	TEMP. RISE	67.6900000	DEG F
CALORIMETER CHANNEL	4	TEMP. RISE	69.5400400	DEG F
CALORIMETER CHANNEL	5	TEMP. RISE	70.7100200	DEG F
CALORIMETER CHANNEL	6	TEMP. RISE	74.4000200	DEG F
CALORIMETER CHANNEL	7	TEMP. RISE	75.5300300	DEG F
CALORIMETER CHANNEL	8	TEMP. RISE	73.7700200	DEG F
CALORIMETER CHANNEL	9	TEMP. RISE	62.2399900	DEG F
CALORIMETER CHANNEL	10	TEMP. RISE	56.7700200	DEG F
CALORIMETER CHANNEL	11	TEMP. RISE	63.4300500	DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE	123.5327000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE	3.0525080	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	1	RESISTANCE 19983.3700000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	2	RESISTANCE 18457.2400000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	3	RESISTANCE 22249.4400000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	4	RESISTANCE 15434.6300000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	5	RESISTANCE 22257.1100000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	6	RESISTANCE 20432.3800000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	7	RESISTANCE 18661.5600000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	8	RESISTANCE 18258.1700000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	9	RESISTANCE 23951.0000000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	10	RESISTANCE 21724.8900000 S^2 PER FT^3-IN^2
CALORIMETER CHANNEL	11	RESISTANCE 18246.6900000 S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE	675.9121000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE	1933.5280000	S^2 PER FT^3-IN^2

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER	2859.2350000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE	934.6414000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	1	116.0389000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	2	131.2649000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	3	121.8130000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	4	145.1343000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	5	130.7593000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	6	141.3126000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	7	148.1591000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	8	144.6893000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	9	110.6408000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	10	101.3511000BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL	11	124.2574000BTU PER S

LOX DENSITY UPSTREAM OF MOV	70.0532200	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MFV	4.8785580	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET	3.3421860	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET	.6153337	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET	.6023655	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET	.4715411	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD	63.0109600	LBM PER FT^3
CALORIMETER CHANNEL	1	INLET DENSITY 62.8875000 LBM PER FT^3
CALORIMETER CHANNEL	2	INLET DENSITY 62.8817500 LBM PER FT^3
CALORIMETER CHANNEL	3	INLET DENSITY 62.8783400 LBM PER FT^3
CALORIMETER CHANNEL	4	INLET DENSITY 62.8722800 LBM PER FT^3
CALORIMETER CHANNEL	5	INLET DENSITY 62.9065800 LBM PER FT^3
CALORIMETER CHANNEL	6	INLET DENSITY 62.8697800 LBM PER FT^3
CALORIMETER CHANNEL	7	INLET DENSITY 62.8768800 LBM PER FT^3
CALORIMETER CHANNEL	8	INLET DENSITY 62.8842200 LBM PER FT^3
CALORIMETER CHANNEL	9	INLET DENSITY 62.8926900 LBM PER FT^3
CALORIMETER CHANNEL	10	INLET DENSITY 62.8653900 LBM PER FT^3
CALORIMETER CHANNEL	11	INLET DENSITY 62.8709300 LBM PER FT^3
CALORIMETER CHANNEL	1	EXHAUST DENSITY 61.8763900 LBM PER FT^3
CALORIMETER CHANNEL	2	EXHAUST DENSITY 61.7952000 LBM PER FT^3
CALORIMETER CHANNEL	3	EXHAUST DENSITY 61.7711100 LBM PER FT^3
CALORIMETER CHANNEL	4	EXHAUST DENSITY 61.7517300 LBM PER FT^3
CALORIMETER CHANNEL	5	EXHAUST DENSITY 61.7322900 LBM PER FT^3
CALORIMETER CHANNEL	6	EXHAUST DENSITY 61.6421300 LBM PER FT^3
CALORIMETER CHANNEL	7	EXHAUST DENSITY 61.6359300 LBM PER FT^3
CALORIMETER CHANNEL	8	EXHAUST DENSITY 61.6795500 LBM PER FT^3

CALORIMETER CHANNEL 9 EXHAUST DENSITY	61.8601200 LBM PER FT^3
CALORIMETER CHANNEL 10 EXHAUST DENSITY	61.9441000 LBM PER FT^3
CALORIMETER CHANNEL 11 EXHAUST DENSITY	61.8415800 LBM PER FT^3

2 ENTHALPY INLET TO T.C. COOLANT JACKET	94.8955400 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET	1295.0960000 BTU PER LBM
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET	1313.8850000 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET	1706.2130000 BTU PER LBM
CALORIMETER CHANNEL 1 INLET ENTHALPY	41.5521000 BTU PER LBM
CALORIMETER CHANNEL 2 INLET ENTHALPY	41.4692500 BTU PER LBM
CALORIMETER CHANNEL 3 INLET ENTHALPY	41.4199300 BTU PER LBM
CALORIMETER CHANNEL 4 INLET ENTHALPY	41.3309700 BTU PER LBM
CALORIMETER CHANNEL 5 INLET ENTHALPY	41.8285500 BTU PER LBM
CALORIMETER CHANNEL 6 INLET ENTHALPY	41.2952300 BTU PER LBM
CALORIMETER CHANNEL 7 INLET ENTHALPY	41.3976200 BTU PER LBM
CALORIMETER CHANNEL 8 INLET ENTHALPY	41.5051200 BTU PER LBM
CALORIMETER CHANNEL 9 INLET ENTHALPY	41.6276700 BTU PER LBM
CALORIMETER CHANNEL 10 INLET ENTHALPY	41.2317800 BTU PER LBM
CALORIMETER CHANNEL 11 INLET ENTHALPY	41.3114800 BTU PER LBM
CALORIMETER CHANNEL 1 EXHAUST ENTHALPY	100.0975000 BTU PER LBM
CALORIMETER CHANNEL 2 EXHAUST ENTHALPY	103.7536000 BTU PER LBM
CALORIMETER CHANNEL 3 EXHAUST ENTHALPY	104.9577000 BTU PER LBM
CALORIMETER CHANNEL 4 EXHAUST ENTHALPY	106.9653000 BTU PER LBM
CALORIMETER CHANNEL 5 EXHAUST ENTHALPY	108.1401000 BTU PER LBM
CALORIMETER CHANNEL 6 EXHAUST ENTHALPY	111.4677000 BTU PER LBM
CALORIMETER CHANNEL 7 EXHAUST ENTHALPY	112.7806000 BTU PER LBM
CALORIMETER CHANNEL 8 EXHAUST ENTHALPY	111.1956000 BTU PER LBM
CALORIMETER CHANNEL 9 EXHAUST ENTHALPY	99.5075200 BTU PER LBM
CALORIMETER CHANNEL 10 EXHAUST ENTHALPY	94.0117300 BTU PER LBM
CALORIMETER CHANNEL 11 EXHAUST ENTHALPY	100.7058000 BTU PER LBM

GOX VENTURI FLOW	.0497286 LBM PER S
2 VENTURI FLOW	.0533710 LBM PER S
GOX INJECTOR FLOW	13.6590600 LBM PER S
GH2 INJECTOR FLOW	2.3822980 LBM PER S
CALORIMETER CHANNEL 1 H2O FLOW	1.9820330 LBM PER S
CALORIMETER CHANNEL 2 H2O FLOW	2.1075090 LBM PER S
CALORIMETER CHANNEL 3 H2O FLOW	1.9171730 LBM PER S
CALORIMETER CHANNEL 4 H2O FLOW	2.2112560 LBM PER S
CALORIMETER CHANNEL 5 H2O FLOW	1.9718940 LBM PER S
CALORIMETER CHANNEL 6 H2O FLOW	2.0137900 LBM PER S
CALORIMETER CHANNEL 7 H2O FLOW	2.0755530 LBM PER S
CALORIMETER CHANNEL 8 H2O FLOW	2.0761700 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	1.9115590 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9202570 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	2.0920770 LBM PER S

THE THEORETICAL CSTAR	8106.2280000
THE CSTAR	7966.8710000
CSTAR EFFICIENCY	98.2808700

T = 173.0, MR:6.5 (VS. 5.9 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE	3747.0800000	PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE	1494.8300000	PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET	1579.7400000	PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET	1371.3500000	PSIG
PRESS. INLET TO THE NOZZLE COOLING JACKET	1357.0100000	PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET	1328.3400000	PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT	1328.3400000	PSIG
NO PRESSURE AT P8		
H2 PRESS. INLET TO THE FUEL MANIFOLD	971.4100000	PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD	925.2100000	PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE	1577.8500000	PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE	1500.2700000	PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE	1479.0400000	PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE	1544.7100000	PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE	1553.4100000	PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE	1407.0400000	PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE	1495.3900000	PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE	1552.7100000	PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE	1464.5100000	PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE	1436.7800000	PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE	1472.9100000	PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE	2739.1800000	PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE	940.2900000	PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD	3486.6800000	PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI	2021.7600000	PSIG
NO PRESSURE AT P26		
GH2 PRESS. INLET TO THE IGNITER VENTURI	1964.7800000	PSIG
NO PRESSURE AT P28		
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER	2560.0000000	PSIG
CHAMBER PRESSURE	853.1500000	PSIG
CHAMBER PRESSURE	854.6700000	PSIG
IGNITER PRESSURE	889.0600000	PSIG
IGNITER PRESSURE	885.2700000	PSIG
X PRESS. EXHAUST FROM THE IGNITER VENTURI	885.3200000	PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI	988.9800000	PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM	760.8300000	PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE	2852.6900000	PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE	2844.1100000	PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE	2801.2900000	PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE	2762.5900000	PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE	2943.0400000	PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE	2714.4500000	PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE	2780.2400000	PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE	2819.7700000	PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE	2876.5300000	PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE	2726.3100000	PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE	2783.2400000	PSIG
LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE	-380.0000000	DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE	-380.0000000	DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET	-364.3100000	DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET	-36.6800000	DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET	-35.2000000	DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET	80.7600000	DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE	-276.9900000	DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE	-276.9900000	DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD	80.8100000	DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD	77.8400000	DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP.	128.9500000	DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP.	132.0100000	DEG F
CALORIMETER CHANNEL 13 EXHAUST TEMP.	134.2400000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	136.6400000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	137.3600000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	140.6900000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	142.0400000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	140.3300000	DEG F

CALORIMETER CHANNEL 19 EXHAUST TEMP.	128.8900000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	124.5100000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	132.3000000	DEG F
COX TEMP. INLET TO THE IGNITER VENTURI	59.5100000	DEG F
2 TEMP. INLET TO THE IGNITER VENTURI	76.4600000	DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	64.4900000	DEG F
TEMP. MAIN OXIDIZER VALVE OPERATOR	35.0400000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	83.6700000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	94.5800000	DEG F

LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2776.4000000	P	SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2736.1300000	PSIG	
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3751.5500000	P	SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3724.7300000	PSIG	

LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-280.1400000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-380.6200000	DEG F

THE NOZZLE MIXTURE RATIO IS 4.6559310

THE INJECTOR MIXTURE RATIO IS 5.8404290

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2832.4900000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2832.7100000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2783.8900000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2744.3900000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2932.1400000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2707.8500000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2769.4400000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2807.5700000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2862.6300000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2713.5100000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2766.4400000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	2.1636140	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	2.3475600	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	2.4898830	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	2.6512110	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	2.7013110	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	2.9436650	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	3.0470650	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	2.9166060	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	2.1601340	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	1.9186900	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	2.3656690	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .8057542 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	208.3900000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	28.6700400	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1254.6400000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1332.4400000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1304.8500000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1199.6800000	PSID
CALORIMETER CHANNEL 5 PRESSURE DROP	1378.7300000	PSID
CALORIMETER CHANNEL 6 PRESSURE DROP	1300.8100000	PSID
CALORIMETER CHANNEL 7 PRESSURE DROP	1274.0500000	PSID
CALORIMETER CHANNEL 8 PRESSURE DROP	1254.8600000	PSID
CALORIMETER CHANNEL 9 PRESSURE DROP	1398.1200000	PSID
CALORIMETER CHANNEL 10 PRESSURE DROP	1276.7300000	PSID
CALORIMETER CHANNEL 11 PRESSURE DROP	1293.5300000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER	327.6300000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE	115.9600000	DEG F
CALORIMETER CHANNEL 1 TEMP. RISE	64.4599600	DEG F
CALORIMETER CHANNEL 2 TEMP. RISE	67.5199600	DEG F

CALORIMETER CHANNEL 3	TEMP. RISE	69.7500000	DEG F
CALORIMETER CHANNEL 4	TEMP. RISE	72.1499600	DEG F
CALORIMETER CHANNEL 5	TEMP. RISE	72.8700000	DEG F
CALORIMETER CHANNEL 6	TEMP. RISE	76.1999500	DEG F
CALORIMETER CHANNEL 7	TEMP. RISE	77.5499900	DEG F
CALORIMETER CHANNEL 8	TEMP. RISE	75.8399700	DEG F
CALORIMETER CHANNEL 9	TEMP. RISE	64.3999600	DEG F
CALORIMETER CHANNEL 10	TEMP. RISE	60.0199600	DEG F
CALORIMETER CHANNEL 11	TEMP. RISE	67.8100000	DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE	126.9958000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE	3.0730230	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 1 RESISTANCE	20059.3800000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 2 RESISTANCE	19734.6400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 3 RESISTANCE	22282.0600000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 4 RESISTANCE	15239.9300000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 5 RESISTANCE	22242.3400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 6 RESISTANCE	19326.6100000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 7 RESISTANCE	18389.7400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 8 RESISTANCE	18072.3300000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 9 RESISTANCE	24144.9800000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 10 RESISTANCE	21667.2700000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 11 RESISTANCE	19123.1600000	S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE	673.2639000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE	1982.2380000	S^2 PER FT^3-IN^2

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER	2968.0640000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE	983.2320000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 1	119.8508000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 2	130.3808000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 3	125.8195000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 4	151.7791000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 5	135.1556000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 6	148.1192000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 7	153.1917000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 8	149.8965000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 9	114.5068000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 10	107.7742000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 11	131.3150000	BTU PER S

LOX DENSITY UPSTREAM OF MOV	70.4993100	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MFV	4.6765270	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET	3.2381470	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET	.5770505	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET	.5695366	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET	.4419635	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD	63.0210800	LBM PER FT^3
CALORIMETER CHANNEL 1 INLET DENSITY	62.8971900	LBM PER FT^3
CALORIMETER CHANNEL 2 INLET DENSITY	62.8972100	LBM PER FT^3
CALORIMETER CHANNEL 3 INLET DENSITY	62.8879100	LBM PER FT^3
CALORIMETER CHANNEL 4 INLET DENSITY	62.8803900	LBM PER FT^3
CALORIMETER CHANNEL 5 INLET DENSITY	62.9161300	LBM PER FT^3
CALORIMETER CHANNEL 6 INLET DENSITY	62.8734400	LBM PER FT^3
CALORIMETER CHANNEL 7 INLET DENSITY	62.8851700	LBM PER FT^3
CALORIMETER CHANNEL 8 INLET DENSITY	62.8924200	LBM PER FT^3
CALORIMETER CHANNEL 9 INLET DENSITY	62.9029200	LBM PER FT^3
CALORIMETER CHANNEL 10 INLET DENSITY	62.8744800	LBM PER FT^3
CALORIMETER CHANNEL 11 INLET DENSITY	62.8846300	LBM PER FT^3
CALORIMETER CHANNEL 1 EXHAUST DENSITY	61.8627300	LBM PER FT^3
CALORIMETER CHANNEL 2 EXHAUST DENSITY	61.7969500	LBM PER FT^3
CALORIMETER CHANNEL 3 EXHAUST DENSITY	61.7548500	LBM PER FT^3
CALORIMETER CHANNEL 4 EXHAUST DENSITY	61.7251500	LBM PER FT^3
CALORIMETER CHANNEL 5 EXHAUST DENSITY	61.7141300	LBM PER FT^3
CALORIMETER CHANNEL 6 EXHAUST DENSITY	61.6280900	LBM PER FT^3
CALORIMETER CHANNEL 7 EXHAUST DENSITY	61.6200000	LBM PER FT^3
CALORIMETER CHANNEL 8 EXHAUST DENSITY	61.6612900	LBM PER FT^3

CALORIMETER CHANNEL 9	EXHAUST DENSITY	61.8429500	LBM PER FT^3
CALORIMETER CHANNEL 10	EXHAUST DENSITY	61.9097900	LBM PER FT^3
CALORIMETER CHANNEL 11	EXHAUST DENSITY	61.7870000	LBM PER FT^3

2	ENTHALPY INLET TO T.C. COOLANT JACKET	104.9529000	BTU PER LBM
GH2	ENTHALPY EXHAUST FROM T.C. COOLANT JACKET	1392.5540000	BTU PER LBM
GH2	ENTHALPY INLET TO NOZZLE COOLANT JACKET	1398.0360000	BTU PER LBM
GH2	ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET	1824.5800000	BTU PER LBM
CALORIMETER CHANNEL 1	INLET ENTHALPY	40.5091700	BTU PER LBM
CALORIMETER CHANNEL 2	INLET ENTHALPY	40.5090800	BTU PER LBM
CALORIMETER CHANNEL 3	INLET ENTHALPY	40.3754800	BTU PER LBM
CALORIMETER CHANNEL 4	INLET ENTHALPY	40.2659800	BTU PER LBM
CALORIMETER CHANNEL 5	INLET ENTHALPY	40.7838100	BTU PER LBM
CALORIMETER CHANNEL 6	INLET ENTHALPY	40.1650300	BTU PER LBM
CALORIMETER CHANNEL 7	INLET ENTHALPY	40.3348400	BTU PER LBM
CALORIMETER CHANNEL 8	INLET ENTHALPY	40.4407200	BTU PER LBM
CALORIMETER CHANNEL 9	INLET ENTHALPY	40.5923400	BTU PER LBM
CALORIMETER CHANNEL 10	INLET ENTHALPY	40.1799700	BTU PER LBM
CALORIMETER CHANNEL 11	INLET ENTHALPY	40.3273800	BTU PER LBM
CALORIMETER CHANNEL 1	EXHAUST ENTHALPY	100.9352000	BTU PER LBM
CALORIMETER CHANNEL 2	EXHAUST ENTHALPY	103.7777000	BTU PER LBM
CALORIMETER CHANNEL 3	EXHAUST ENTHALPY	105.9389000	BTU PER LBM
CALORIMETER CHANNEL 4	EXHAUST ENTHALPY	108.4862000	BTU PER LBM
CALORIMETER CHANNEL 5	EXHAUST ENTHALPY	109.2228000	BTU PER LBM
CALORIMETER CHANNEL 6	EXHAUST ENTHALPY	112.1677000	BTU PER LBM
CALORIMETER CHANNEL 7	EXHAUST ENTHALPY	113.7280000	BTU PER LBM
CALORIMETER CHANNEL 8	EXHAUST ENTHALPY	112.1709000	BTU PER LBM
CALORIMETER CHANNEL 9	EXHAUST ENTHALPY	100.5904000	BTU PER LBM
CALORIMETER CHANNEL 10	EXHAUST ENTHALPY	96.1725200	BTU PER LBM
CALORIMETER CHANNEL 11	EXHAUST ENTHALPY	103.9972000	BTU PER LBM

GOX VENTURI FLOW	.0495820	LBM PER S
2 VENTURI FLOW	.0533204	LBM PER S
X INJECTOR FLOW	13.7246800	LBM PER S
GH2 INJECTOR FLOW	2.3051120	LBM PER S
CALORIMETER CHANNEL 1	H2O FLOW	1.9834280 LBM PER S
CALORIMETER CHANNEL 2	H2O FLOW	2.0607480 LBM PER S
CALORIMETER CHANNEL 3	H2O FLOW	1.9190500 LBM PER S
CALORIMETER CHANNEL 4	H2O FLOW	2.2248400 LBM PER S
CALORIMETER CHANNEL 5	H2O FLOW	1.9748330 LBM PER S
CALORIMETER CHANNEL 6	H2O FLOW	2.0571340 LBM PER S
CALORIMETER CHANNEL 7	H2O FLOW	2.0872750 LBM PER S
CALORIMETER CHANNEL 8	H2O FLOW	2.0897280 LBM PER S
CALORIMETER CHANNEL 9	H2O FLOW	1.9085090 LBM PER S
CALORIMETER CHANNEL 10	H2O FLOW	1.9247960 LBM PER S
CALORIMETER CHANNEL 11	H2O FLOW	2.0624370 LBM PER S

THE THEORETICAL CSTAR	8071.2590000
THE CSTAR	7950.6300000
CSTAR EFFICIENCY	98.5054600

T = 176.0, MR:7.0 (VS. 6.1 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE 3744.1800000 PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE 1483.5600000 PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET 1561.3500000 PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET 1362.1800000 PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET 1347.9600000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET 1321.2800000 PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT 1321.2900000 PSIG
NO PRESSURE AT P8
H2 PRESS. INLET TO THE FUEL MANIFOLD 971.2100000 PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD 926.3300000 PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE 1577.6800000 PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE 1491.8900000 PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE 1478.5600000 PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE 1539.6400000 PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE 1557.0000000 PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE 1408.9200000 PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE 1495.8900000 PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE 1549.4700000 PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE 1462.7300000 PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE 1433.1500000 PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE 1469.4400000 PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE 2737.5100000 PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE 944.9300000 PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD 3478.4400000 PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI 2007.9000000 PSIG
NO PRESSURE AT P26
GH2 PRESS. INLET TO THE IGNITER VENTURI 1964.9000000 PSIG
NO PRESSURE AT P28
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER 2560.0000000 PSIG
CHAMBER PRESSURE 853.4300000 PSIG
CHAMBER PRESSURE 855.2400000 PSIG
IGNITER PRESSURE 888.8000000 PSIG
IGNITER PRESSURE 885.1200000 PSIG
X PRESS. EXHAUST FROM THE IGNITER VENTURI 886.3500000 PSIG
.2 PRESS. EXHAUST FROM THE IGNITER VENTURI 989.6900000 PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM 760.1600000 PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE 2846.2500000 PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE 2820.3300000 PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE 2799.4700000 PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE 2765.5900000 PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE 2976.7700000 PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE 2715.1300000 PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE 2792.4900000 PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE 2804.7800000 PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE 2870.3900000 PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE 2714.6200000 PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE 2766.7800000 PSIG

LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE -384.0000000 DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE -384.0000000 DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET -365.8100000 DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET -13.5900000 DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET -13.6500000 DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET 116.0500000 DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE -278.3900000 DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE -278.3900000 DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD 116.3800000 DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD 78.6200000 DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP. 129.2900000 DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP. 132.7700000 DEG F
CALORIMETER CHANNEL 13 EXHAUST TEMP. 134.7300000 DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP. 137.3100000 DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP. 138.1500000 DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP. 141.6500000 DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP. 142.9900000 DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP. 143.0600000 DEG F

CALORIMETER CHANNEL 19 EXHAUST TEMP.	130.6200000	DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	126.2500000	DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	135.1900000	DEG F
GOX TEMP. INLET TO THE IGNITER VENTURI	61.3200000	DEG F
LH2 TEMP. INLET TO THE IGNITER VENTURI	78.1400000	DEG F
O TEMP. CALORIMETER INLET MANIFOLD	64.4900000	DE G F
TEMP. MAIN OXIDIZER VALVE OPERATOR	35.1300000	DEG F
TEMP. MAIN FUEL VALVE OPERATOR	82.6600000	DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	93.7300000	DE G F
LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2774.3900000	P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2733.2700000	PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3746.0900000	P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3721.4500000	PSIG
LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-280.4900000	DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-382.9300000	DEG F

THE NOZZLE MIXTURE RATIO IS 4.8371660

THE INJECTOR MIXTURE RATIO IS 6.1092580

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2826.0500000	PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2808.9300000	PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2782.0700000	PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2747.3900000	PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2965.8700000	PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2708.5300000	PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2781.6900000	PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2792.5800000	PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2856.4900000	PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2701.8200000	PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2749.9800000	PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	2.1834240	PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	2.3952600	PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	2.5221210	PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	2.6978040	PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	2.7572100	PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	3.0168810	PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	3.1216610	PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	3.1272160	PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	2.2624170	PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	2.0116850	PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	2.5527080	PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .7849099 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	199.1699000	PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	26.6799300	PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1248.3700000	PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1317.0400000	PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1303.5100000	PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1207.7500000	PSID
CALORIMETER CHANNEL 5 PRESSURE DROP	1408.8700000	PSID
CALORIMETER CHANNEL 6 PRESSURE DROP	1299.6100000	PSID
CALORIMETER CHANNEL 7 PRESSURE DROP	1285.8000000	PSID
CALORIMETER CHANNEL 8 PRESSURE DROP	1243.1100000	PSID
CALORIMETER CHANNEL 9 PRESSURE DROP	1393.7600000	PSID
CALORIMETER CHANNEL 10 PRESSURE DROP	1268.6700000	PSID
CALORIMETER CHANNEL 11 PRESSURE DROP	1280.5400000	PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER	352.2200000	DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE	129.7000000	DEG F
CALORIMETER CHANNEL 1 TEMP. RISE	64.7999900	DEG F
CALORIMETER CHANNEL 2 TEMP. RISE	68.2799700	DEG F

CALORIMETER CHANNEL 3	TEMP. RISE	70.2399900	DEG F
CALORIMETER CHANNEL 4	TEMP. RISE	72.8199500	DEG F
CALORIMETER CHANNEL 5	TEMP. RISE	73.6599700	DEG F
CALORIMETER CHANNEL 6	TEMP. RISE	77.1599700	DEG F
CALORIMETER CHANNEL 7	TEMP. RISE	78.5000000	DEG F
CALORIMETER CHANNEL 8	TEMP. RISE	78.5699500	DEG F
CALORIMETER CHANNEL 9	TEMP. RISE	66.1300000	DEG F
CALORIMETER CHANNEL 10	TEMP. RISE	61.7600100	DEG F
CALORIMETER CHANNEL 11	TEMP. RISE	70.6999500	DEG F
THRUST CHAMBER COOLANT JACKET RESISTANCE		131.2498000	S^2 PER FT^3-IN^2
NOZZLE COOLANT JACKET RESISTANCE		2.8988520	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 1	RESISTANCE	20016.0700000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 2	RESISTANCE	19045.0500000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 3	RESISTANCE	22470.1000000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 4	RESISTANCE	15584.9000000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 5	RESISTANCE	24633.1800000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 6	RESISTANCE	19534.9400000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 7	RESISTANCE	19114.9200000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 8	RESISTANCE	17723.3700000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 9	RESISTANCE	24152.9600000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 10	RESISTANCE	21433.0100000	S^2 PER FT^3-IN^2
CALORIMETER CHANNEL 11	RESISTANCE	18711.9800000	S^2 PER FT^3-IN^2
MAIN LOX VALVE RESISTANCE		657.0362000	S^2 PER FT^3-IN^2
MAIN FUEL VALVE RESISTANCE		2165.6260000	S^2 PER FT^3-IN^2
HEAT TRANSFER TO THE H2 IN THRUST CHAMBER		3074.7590000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE		1052.9320000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 1		120.3805000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 2		133.6118000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 3		126.1642000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 4		152.0168000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 5		131.1607000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 6		149.2156000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 7		152.8255000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 8		156.4194000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 9		117.6044000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 10		111.3917000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 11		138.1094000	BTU PER S
LOX DENSITY UPSTREAM OF MOV		70.7084700	LBM PER FT^3
LH2 DENSITY UPSTREAM OF MPV		4.7565750	LBM PER FT^3
LH2 DENSITY INLET TO T.C. COOLANT JACKET		3.2720000	LBM PER FT^3
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET		.5446880	LBM PER FT^3
H2 DENSITY INLET TO NOZZLE COOLANT JACKET		.5394854	LBM PER FT^3
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET		.4136847	LBM PER FT^3
H2O DENSITY CALORIMETER INLET MANIFOLD		63.0195200	LBM PER FT^3
CALORIMETER CHANNEL 1	INLET DENSITY	62.8959700	LBM PER FT^3
CALORIMETER CHANNEL 2	INLET DENSITY	62.8927000	LBM PER FT^3
CALORIMETER CHANNEL 3	INLET DENSITY	62.8876100	LBM PER FT^3
CALORIMETER CHANNEL 4	INLET DENSITY	62.8809700	LBM PER FT^3
CALORIMETER CHANNEL 5	INLET DENSITY	62.9225400	LBM PER FT^3
CALORIMETER CHANNEL 6	INLET DENSITY	62.8735600	LBM PER FT^3
CALORIMETER CHANNEL 7	INLET DENSITY	62.8875300	LBM PER FT^3
CALORIMETER CHANNEL 8	INLET DENSITY	62.8896200	LBM PER FT^3
CALORIMETER CHANNEL 9	INLET DENSITY	62.9017600	LBM PER FT^3
CALORIMETER CHANNEL 10	INLET DENSITY	62.8722700	LBM PER FT^3
CALORIMETER CHANNEL 11	INLET DENSITY	62.8814700	LBM PER FT^3
CALORIMETER CHANNEL 1	EXHAUST DENSITY	61.8570200	LBM PER FT^3
CALORIMETER CHANNEL 2	EXHAUST DENSITY	61.7824700	LBM PER FT^3
CALORIMETER CHANNEL 3	EXHAUST DENSITY	61.7463000	LBM PER FT^3
CALORIMETER CHANNEL 4	EXHAUST DENSITY	61.7124600	LBM PER FT^3
CALORIMETER CHANNEL 5	EXHAUST DENSITY	61.7008600	LBM PER FT^3
CALORIMETER CHANNEL 6	EXHAUST DENSITY	61.6111700	LBM PER FT^3
CALORIMETER CHANNEL 7	EXHAUST DENSITY	61.6028700	LBM PER FT^3
CALORIMETER CHANNEL 8	EXHAUST DENSITY	61.6114500	LBM PER FT^3

CALORIMETER CHANNEL 9 EXHAUST DENSITY	61.8136000 LBM PER FT^3
CALORIMETER CHANNEL 10 EXHAUST DENSITY	61.8808100 LBM PER FT^3
CALORIMETER CHANNEL 11 EXHAUST DENSITY	61.7366300 LBM PER FT^3

2 ENTHALPY INLET TO T.C. COOLANT JACKET	99.6481200 BTU PER LBM
2 ENTHALPY EXHAUST FROM T.C. COOLANT JACKET	1479.5300000 BTU PER LBM
GH2 ENTHALPY INLET TO NOZZLE COOLANT JACKET	1479.1550000 BTU PER LBM
GH2 ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET	1951.6870000 BTU PER LBM
CALORIMETER CHANNEL 1 INLET ENTHALPY	40.4917500 BTU PER LBM
CALORIMETER CHANNEL 2 INLET ENTHALPY	40.4441200 BTU PER LBM
CALORIMETER CHANNEL 3 INLET ENTHALPY	40.3702500 BTU PER LBM
CALORIMETER CHANNEL 4 INLET ENTHALPY	40.2744600 BTU PER LBM
CALORIMETER CHANNEL 5 INLET ENTHALPY	40.8770500 BTU PER LBM
CALORIMETER CHANNEL 6 INLET ENTHALPY	40.1672400 BTU PER LBM
CALORIMETER CHANNEL 7 INLET ENTHALPY	40.3689900 BTU PER LBM
CALORIMETER CHANNEL 8 INLET ENTHALPY	40.3986100 BTU PER LBM
CALORIMETER CHANNEL 9 INLET ENTHALPY	40.5754200 BTU PER LBM
CALORIMETER CHANNEL 10 INLET ENTHALPY	40.1485100 BTU PER LBM
CALORIMETER CHANNEL 11 INLET ENTHALPY	40.2815000 BTU PER LBM
CALORIMETER CHANNEL 1 EXHAUST ENTHALPY	101.2720000 BTU PER LBM
CALORIMETER CHANNEL 2 EXHAUST ENTHALPY	104.5114000 BTU PER LBM
CALORIMETER CHANNEL 3 EXHAUST ENTHALPY	106.4242000 BTU PER LBM
CALORIMETER CHANNEL 4 EXHAUST ENTHALPY	109.1390000 BTU PER LBM
CALORIMETER CHANNEL 5 EXHAUST ENTHALPY	110.0164000 BTU PER LBM
CALORIMETER CHANNEL 6 EXHAUST ENTHALPY	113.1264000 BTU PER LBM
CALORIMETER CHANNEL 7 EXHAUST ENTHALPY	114.6731000 BTU PER LBM
CALORIMETER CHANNEL 8 EXHAUST ENTHALPY	114.8751000 BTU PER LBM
CALORIMETER CHANNEL 9 EXHAUST ENTHALPY	102.3036000 BTU PER LBM
CALORIMETER CHANNEL 10 EXHAUST ENTHALPY	97.8903100 BTU PER LBM
CALORIMETER CHANNEL 11 EXHAUST ENTHALPY	106.8586000 BTU PER LBM

GOX VENTURI FLOW	.0490731 LBM PER S
GH2 VENTURI FLOW	.0532396 LBM PER S
X INJECTOR FLOW	13.8893000 LBM PER S
GH2 INJECTOR FLOW	2.2282770 LBM PER S
CALORIMETER CHANNEL 1 H2O FLOW	1.9805860 LBM PER S
CALORIMETER CHANNEL 2 H2O FLOW	2.0854920 LBM PER S
CALORIMETER CHANNEL 3 H2O FLOW	1.9100170 LBM PER S
CALORIMETER CHANNEL 4 H2O FLOW	2.2074770 LBM PER S
CALORIMETER CHANNEL 5 H2O FLOW	1.8970480 LBM PER S
CALORIMETER CHANNEL 6 H2O FLOW	2.0451940 LBM PER S
CALORIMETER CHANNEL 7 H2O FLOW	2.0567560 LBM PER S
CALORIMETER CHANNEL 8 H2O FLOW	2.1002510 LBM PER S
CALORIMETER CHANNEL 9 H2O FLOW	1.9051980 LBM PER S
CALORIMETER CHANNEL 10 H2O FLOW	1.9291340 LBM PER S
CALORIMETER CHANNEL 11 H2O FLOW	2.0744270 LBM PER S

THE THEORETICAL CSTAR	8024.4840000
THE CSTAR	7913.6440000
CSTAR EFFICIENCY	98.6187300

T = 181.0, MR:5.0 (VS. 5.7 ACTUAL)

LH2 PRESS. UPSTREAM OF THE MAIN FUEL VALVE	3737.9700000	PSIG
LH2 PRESS. DOWNSTREAM OF THE MAIN FUEL VALVE	1435.8500000	PSIG
LH2 PRESS. INLET TO THE THRUST CHAMBER COOLANT JACKET	1535.4900000	PSIG
H2 PRESS. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET	1341.8800000	PSIG
H2 PRESS. INLET TO THE NOZZLE COOLING JACKET	1329.4900000	PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET	1301.6800000	PSIG
H2 PRESS. EXHAUST FROM THE NOZZLE COOLING JACKET-REDUNDANT	1301.6800000	PSIG
NO PRESSURE AT P8		
H2 PRESS. INLET TO THE FUEL MANIFOLD	942.1300000	PSIG
GH2 PRESS. INLET TO THE OLD FUEL MANIFOLD	894.9400000	PSIG
CALORIMETER CHANNEL 11 EXHAUST PRESSURE	1574.6900000	PSIG
CALORIMETER CHANNEL 12 EXHAUST PRESSURE	1487.9500000	PSIG
CALORIMETER CHANNEL 13 EXHAUST PRESSURE	1477.9000000	PSIG
CALORIMETER CHANNEL 14 EXHAUST PRESSURE	1541.1500000	PSIG
CALORIMETER CHANNEL 15 EXHAUST PRESSURE	1546.5900000	PSIG
CALORIMETER CHANNEL 16 EXHAUST PRESSURE	1403.9600000	PSIG
CALORIMETER CHANNEL 17 EXHAUST PRESSURE	1491.8000000	PSIG
CALORIMETER CHANNEL 18 EXHAUST PRESSURE	1550.0600000	PSIG
CALORIMETER CHANNEL 19 EXHAUST PRESSURE	1459.9500000	PSIG
CALORIMETER CHANNEL 20 EXHAUST PRESSURE	1433.6600000	PSIG
CALORIMETER CHANNEL 21 EXHAUST PRESSURE	1462.5200000	PSIG
LOX PRESS. INLET TO THE MAIN OXIDIZER VALVE	2743.5800000	PSIG
LOX PRESS. EXHAUST FROM THE MAIN OXIDIZER VALVE	897.5600000	PSIG
H2O PRESS. CALORIMETER INLET MANIFOLD	3476.6200000	PSIG
GOX PRESS. INLET TO THE IGNITER VENTURI	1985.2500000	PSIG
NO PRESSURE AT P26		
GH2 PRESS. INLET TO THE IGNITER VENTURI	1964.0800000	PSIG
NO PRESSURE AT P28		
LOX DOME HIGH FREQUENCY PRESSURE TRANSDUCER	2560.0000000	PSIG
CHAMBER PRESSURE	820.8600000	PSIG
CHAMBER PRESSURE	822.9600000	PSIG
IGNITER PRESSURE	855.7400000	PSIG
IGNITER PRESSURE	852.6900000	PSIG
LOX PRESS. EXHAUST FROM THE IGNITER VENTURI	853.3800000	PSIG
GH2 PRESS. EXHAUST FROM THE IGNITER VENTURI	960.7400000	PSIG
H2O PRESS. CALORIMETER EXHAUST PLENUM	760.3100000	PSIG
CALORIMETER CHANNEL 1 INLET PRESSURE	2841.3800000	PSIG
CALORIMETER CHANNEL 2 INLET PRESSURE	2807.0400000	PSIG
CALORIMETER CHANNEL 3 INLET PRESSURE	2799.4300000	PSIG
CALORIMETER CHANNEL 4 INLET PRESSURE	2762.5900000	PSIG
CALORIMETER CHANNEL 5 INLET PRESSURE	2935.4000000	PSIG
CALORIMETER CHANNEL 6 INLET PRESSURE	2705.3300000	PSIG
CALORIMETER CHANNEL 7 INLET PRESSURE	2774.5700000	PSIG
CALORIMETER CHANNEL 8 INLET PRESSURE	2808.8200000	PSIG
CALORIMETER CHANNEL 9 INLET PRESSURE	2886.1300000	PSIG
CALORIMETER CHANNEL 10 INLET PRESSURE	2722.3000000	PSIG
CALORIMETER CHANNEL 11 INLET PRESSURE	2741.4100000	PSIG
LH2 TEMP. UPSTREAM OF THE MAIN FUEL VALVE	-390.0000000	DEG F
LH2 TEMP. DOWNSTREAM OF THE MAIN FUEL VALVE	-390.0000000	DEG F
LH2 TEMP. INLET TO THE THRUST CHAMBER COOLING JACKET	-367.1300000	DEG F
H2 TEMP. EXHAUST FROM THE THRUST CHAMBER COOLING JACKET	-31.6900000	DEG F
H2 TEMP. INLET TO THE NOZZLE COOLING JACKET	-30.7300000	DEG F
H2 TEMP. EXHAUST FROM THE NOZZLE COOLING JACKET	111.3300000	DEG F
LOX TEMP. INLET TO THE MAIN OXIDIZER VALVE	-278.6900000	DEG F
LOX TEMP. EXHAUST FROM THE MAIN OXIDIZER VALVE	-278.6900000	DEG F
H2 TEMP. INLET TO THE FUEL MANIFOLD	112.1300000	DEG F
GH2 TEMP. INLET TO THE OLD FUEL MANIFOLD	79.3200000	DEG F
CALORIMETER CHANNEL 11 EXHAUST TEMP.	126.8200000	DEG F
CALORIMETER CHANNEL 12 EXHAUST TEMP.	130.4600000	DEG F
CALORIMETER CHANNEL 13 EXHAUST TEMP.	132.4600000	DEG F
CALORIMETER CHANNEL 14 EXHAUST TEMP.	135.2400000	DEG F
CALORIMETER CHANNEL 15 EXHAUST TEMP.	136.2500000	DEG F
CALORIMETER CHANNEL 16 EXHAUST TEMP.	139.8100000	DEG F
CALORIMETER CHANNEL 17 EXHAUST TEMP.	141.0100000	DEG F
CALORIMETER CHANNEL 18 EXHAUST TEMP.	140.4500000	DEG F

CALORIMETER CHANNEL 19 EXHAUST TEMP.	129.5000000 DEG F
CALORIMETER CHANNEL 20 EXHAUST TEMP.	125.5300000 DEG F
CALORIMETER CHANNEL 21 EXHAUST TEMP.	134.9100000 DEG F
COX TEMP. INLET TO THE IGNITER VENTURI	63.7200000 DEG F
2 TEMP. INLET TO THE IGNITER VENTURI	78.8600000 DEG F
H2O TEMP. CALORIMETER INLET MANIFOLD	64.4900000 DE G F
TEMP. MAIN OXIDIZER VALVE OPERATOR	35.3300000 DEG F
TEMP. MAIN FUEL VALVE OPERATOR	81.2000000 DEG F
H2O TEMP. CALORIMETER EXHAUST PLENUM	94.0900000 DE G F

LOX PRESS. UPSTREAM OF SYSTEM VENTURI	2774.8600000 P SIG
LOX PRESS. DOWNSTREAM OF SYSTEM VENTURI	2737.7500000 PSIG
LH2 PRESS. UPSTREAM OF SYSTEM VENTURI	3740.2500000 P SIG
LH2 PRESS. DOWNSTREAM OF SYSTEM VENTURI	3715.4400000 PSIG

LOX TEMP. UPSTREAM OF THE SYSTEM VENTURI	-280.8400000 DEG F
LH2 TEMP. UPSTREAM OF THE SYSTEM VENTURI	-383.0000000 DEG F

THE NOZZLE MIXTURE RATIO IS 4.5416990

THE INJECTOR MIXTURE RATIO IS 5.7178430

CORRECTED CALORIMETER CHANNEL 1 INLET PRESS.	2821.1800000 PSIG
CORRECTED CALORIMETER CHANNEL 2 INLET PRESS.	2795.6400000 PSIG
CORRECTED CALORIMETER CHANNEL 3 INLET PRESS.	2782.0300000 PSIG
CORRECTED CALORIMETER CHANNEL 4 INLET PRESS.	2744.3900000 PSIG
CORRECTED CALORIMETER CHANNEL 5 INLET PRESS.	2924.5000000 PSIG
CORRECTED CALORIMETER CHANNEL 6 INLET PRESS.	2698.7300000 PSIG
CORRECTED CALORIMETER CHANNEL 7 INLET PRESS.	2763.7700000 PSIG
CORRECTED CALORIMETER CHANNEL 8 INLET PRESS.	2796.6200000 PSIG
CORRECTED CALORIMETER CHANNEL 9 INLET PRESS.	2872.2300000 PSIG
CORRECTED CALORIMETER CHANNEL 10 INLET PRESS.	2709.5000000 PSIG
CORRECTED CALORIMETER CHANNEL 11 INLET PRESS.	2724.6100000 PSIG

CALORIMETER CHANNEL 1 EXHAUST SATURATION PRESS.	2.0429740 PSIA
CALORIMETER CHANNEL 2 EXHAUST SATURATION PRESS.	2.2527810 PSIA
CALORIMETER CHANNEL 3 EXHAUST SATURATION PRESS.	2.3757060 PSIA
CALORIMETER CHANNEL 4 EXHAUST SATURATION PRESS.	2.5560540 PSIA
CALORIMETER CHANNEL 5 EXHAUST SATURATION PRESS.	2.6244060 PSIA
CALORIMETER CHANNEL 6 EXHAUST SATURATION PRESS.	2.8778870 PSIA
CALORIMETER CHANNEL 7 EXHAUST SATURATION PRESS.	2.9679030 PSIA
CALORIMETER CHANNEL 8 EXHAUST SATURATION PRESS.	2.9256000 PSIA
CALORIMETER CHANNEL 9 EXHAUST SATURATION PRESS.	2.1957400 PSIA
CALORIMETER CHANNEL 10 EXHAUST SATURATION PRESS.	1.9727450 PSIA
CALORIMETER CHANNEL 11 EXHAUST SATURATION PRESS.	2.5340510 PSIA

THE CALORIMETER EXHAUST PLENUM SATURATION PRESSURE .7936804 PSIA

COOLANT PRESSURE DROP ACROSS THRUST CHAMBER	193.6100000 PSID
COOLANT PRESSURE DROP ACROSS NOZZLE	27.8099400 PSID
CALORIMETER CHANNEL 1 PRESSURE DROP	1246.4900000 PSID
CALORIMETER CHANNEL 2 PRESSURE DROP	1307.6900000 PSID
CALORIMETER CHANNEL 3 PRESSURE DROP	1304.1300000 PSID
CALORIMETER CHANNEL 4 PRESSURE DROP	1203.2400000 PSID
CALORIMETER CHANNEL 5 PRESSURE DROP	1377.9100000 PSID
CALORIMETER CHANNEL 6 PRESSURE DROP	1294.7700000 PSID
CALORIMETER CHANNEL 7 PRESSURE DROP	1271.9700000 PSID
CALORIMETER CHANNEL 8 PRESSURE DROP	1246.5600000 PSID
CALORIMETER CHANNEL 9 PRESSURE DROP	1412.2800000 PSID
CALORIMETER CHANNEL 10 PRESSURE DROP	1275.8400000 PSID
CALORIMETER CHANNEL 11 PRESSURE DROP	1262.0900000 PSID

COOLANT TEMP. RISE THROUGH THE THRUST CHAMBER	335.4400000 DEG F
COOLANT TEMP. RISE THROUGH THE NOZZLE	142.0600000 DEG F
CALORIMETER CHANNEL 1 TEMP. RISE	62.3299600 DEG F
CALORIMETER CHANNEL 2 TEMP. RISE	65.9699700 DEG F

CALORIMETER CHANNEL	3	TEMP. RISE	67.9699700	DEG F
CALORIMETER CHANNEL	4	TEMP. RISE	70.7500000	DEG F
CALORIMETER CHANNEL	5	TEMP. RISE	71.7600100	DEG F
CALORIMETER CHANNEL	6	TEMP. RISE	75.3199500	DEG F
CALORIMETER CHANNEL	7	TEMP. RISE	76.5199600	DEG F
CALORIMETER CHANNEL	8	TEMP. RISE	75.9599600	DEG F
CALORIMETER CHANNEL	9	TEMP. RISE	65.0100100	DEG F
CALORIMETER CHANNEL	10	TEMP. RISE	61.0399800	DEG F
CALORIMETER CHANNEL	11	TEMP. RISE	70.4199800	DEG F

THRUST CHAMBER COOLANT JACKET RESISTANCE	124.4371000	S ² PER FT ³ -IN ²
NOZZLE COOLANT JACKET RESISTANCE	3.0020760	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 1 RESISTANCE	19889.7800000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 2 RESISTANCE	18585.2600000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 3 RESISTANCE	22539.9900000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 4 RESISTANCE	15500.9800000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 5 RESISTANCE	22328.6600000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 6 RESISTANCE	19260.3700000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 7 RESISTANCE	18474.7600000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 8 RESISTANCE	17928.8100000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 9 RESISTANCE	25203.0400000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 10 RESISTANCE	21826.2300000	S ² PER FT ³ -IN ²
CALORIMETER CHANNEL 11 RESISTANCE	17850.3500000	S ² PER FT ³ -IN ²
MAIN LOX VALVE RESISTANCE	749.7332000	S ² PER FT ³ -IN ²
MAIN FUEL VALVE RESISTANCE	2190.2780000	S ² PER FT ³ -IN ²

HEAT TRANSFER TO THE H2 IN THRUST CHAMBER	2979.5490000	BTU PER S
HEAT TRANSFER TO THE H2 IN NOZZLE	1176.3400000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 1	115.8174000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 2	130.0022000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 3	121.6962000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 4	147.6276000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 5	132.6882000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 6	146.2643000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 7	150.5965000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 8	150.2936000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 9	113.7113000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 10	109.2904000	BTU PER S
HEAT TRANSFER TO CALORIMETER CHANNEL 11	139.9007000	BTU PER S

LOX DENSITY UPSTREAM OF MOV	70.7589600	LBM PER FT ³
LH2 DENSITY UPSTREAM OF MFV	4.8755100	LBM PER FT ³
LH2 DENSITY INLET TO T.C. COOLANT JACKET	3.2936000	LBM PER FT ³
H2 DENSITY EXHAUST FROM T.C. COOLANT JACKET	.5591724	LBM PER FT ³
H2 DENSITY INLET TO NOZZLE COOLANT JACKET	.5531850	LBM PER FT ³
H2 DENSITY EXHAUST FROM NOZZLE COOLANT JACKET	.4111857	LBM PER FT ³
H2O DENSITY CALORIMETER INLET MANIFOLD	63.0191600	LBM PER FT ³
CALORIMETER CHANNEL 1 INLET DENSITY	62.8950600	LBM PER FT ³
CALORIMETER CHANNEL 2 INLET DENSITY	62.8901600	LBM PER FT ³
CALORIMETER CHANNEL 3 INLET DENSITY	62.8876000	LBM PER FT ³
CALORIMETER CHANNEL 4 INLET DENSITY	62.8803900	LBM PER FT ³
CALORIMETER CHANNEL 5 INLET DENSITY	62.9146700	LBM PER FT ³
CALORIMETER CHANNEL 6 INLET DENSITY	62.8716800	LBM PER FT ³
CALORIMETER CHANNEL 7 INLET DENSITY	62.8840600	LBM PER FT ³
CALORIMETER CHANNEL 8 INLET DENSITY	62.8903300	LBM PER FT ³
CALORIMETER CHANNEL 9 INLET DENSITY	62.9047500	LBM PER FT ³
CALORIMETER CHANNEL 10 INLET DENSITY	62.8737600	LBM PER FT ³
CALORIMETER CHANNEL 11 INLET DENSITY	62.8766200	LBM PER FT ³
CALORIMETER CHANNEL 1 EXHAUST DENSITY	61.8973800	LBM PER FT ³
CALORIMETER CHANNEL 2 EXHAUST DENSITY	61.8209600	LBM PER FT ³
CALORIMETER CHANNEL 3 EXHAUST DENSITY	61.7852100	LBM PER FT ³
CALORIMETER CHANNEL 4 EXHAUST DENSITY	61.7489300	LBM PER FT ³
CALORIMETER CHANNEL 5 EXHAUST DENSITY	61.7323300	LBM PER FT ³
CALORIMETER CHANNEL 6 EXHAUST DENSITY	61.6432600	LBM PER FT ³
CALORIMETER CHANNEL 7 EXHAUST DENSITY	61.6379400	LBM PER FT ³
CALORIMETER CHANNEL 8 EXHAUST DENSITY	61.6586800	LBM PER FT ³

CALORIMETER CHANNEL 9	EXHAUST DENSITY	61.8319100	LBM PER FT^3
CALORIMETER CHANNEL 10	EXHAUST DENSITY	61.8926600	LBM PER FT^3
CALORIMETER CHANNEL 11	EXHAUST DENSITY	61.7402400	LBM PER FT^3

2	ENTHALPY INLET TO T.C. COOLANT JACKET	94.9796900	BTU PER LBM
GH2	ENTHALPY EXHAUST FROM T.C. COOLANT JACKET	1411.1930000	BTU PER LBM
GH2	ENTHALPY INLET TO NOZZLE COOLANT JACKET	1414.7050000	BTU PER LBM
GH2	ENTHALPY EXHAUST FROM NOZZLE COOLANT JACKET	1934.3520000	BTU PER LBM
CALORIMETER CHANNEL 1	INLET ENTHALPY	40.4776000	BTU PER LBM
CALORIMETER CHANNEL 2	INLET ENTHALPY	40.4073800	BTU PER LBM
CALORIMETER CHANNEL 3	INLET ENTHALPY	40.3698800	BTU PER LBM
CALORIMETER CHANNEL 4	INLET ENTHALPY	40.2659800	BTU PER LBM
CALORIMETER CHANNEL 5	INLET ENTHALPY	40.7629600	BTU PER LBM
CALORIMETER CHANNEL 6	INLET ENTHALPY	40.1400700	BTU PER LBM
CALORIMETER CHANNEL 7	INLET ENTHALPY	40.3194500	BTU PER LBM
CALORIMETER CHANNEL 8	INLET ENTHALPY	40.4101000	BTU PER LBM
CALORIMETER CHANNEL 9	INLET ENTHALPY	40.6185600	BTU PER LBM
CALORIMETER CHANNEL 10	INLET ENTHALPY	40.1686900	BTU PER LBM
CALORIMETER CHANNEL 11	INLET ENTHALPY	40.2110600	BTU PER LBM
CALORIMETER CHANNEL 1	EXHAUST ENTHALPY	98.8135500	BTU PER LBM
CALORIMETER CHANNEL 2	EXHAUST ENTHALPY	102.2078000	BTU PER LBM
CALORIMETER CHANNEL 3	EXHAUST ENTHALPY	104.1684000	BTU PER LBM
CALORIMETER CHANNEL 4	EXHAUST ENTHALPY	107.0871000	BTU PER LBM
CALORIMETER CHANNEL 5	EXHAUST ENTHALPY	108.1036000	BTU PER LBM
CALORIMETER CHANNEL 6	EXHAUST ENTHALPY	111.2855000	BTU PER LBM
CALORIMETER CHANNEL 7	EXHAUST ENTHALPY	112.6956000	BTU PER LBM
CALORIMETER CHANNEL 8	EXHAUST ENTHALPY	112.2834000	BTU PER LBM
CALORIMETER CHANNEL 9	EXHAUST ENTHALPY	101.1844000	BTU PER LBM
CALORIMETER CHANNEL 10	EXHAUST ENTHALPY	97.1770800	BTU PER LBM
CALORIMETER CHANNEL 11	EXHAUST ENTHALPY	106.5630000	BTU PER LBM

GOX VENTURI FLOW	.0482893	LBM PER S
2 VENTURI FLOW	.0531819	LBM PER S
X INJECTOR FLOW	13.1994400	LBM PER S
GH2 INJECTOR FLOW	2.2637290	LBM PER S

CALORIMETER CHANNEL 1	H2O FLOW	1.9853530	LBM PER S
CALORIMETER CHANNEL 2	H2O FLOW	2.1035820	LBM PER S
CALORIMETER CHANNEL 3	H2O FLOW	1.9075070	LBM PER S
CALORIMETER CHANNEL 4	H2O FLOW	2.2092970	LBM PER S
CALORIMETER CHANNEL 5	H2O FLOW	1.9704030	LBM PER S
CALORIMETER CHANNEL 6	H2O FLOW	2.0558510	LBM PER S
CALORIMETER CHANNEL 7	H2O FLOW	2.0807470	LBM PER S
CALORIMETER CHANNEL 8	H2O FLOW	2.0910900	LBM PER S
CALORIMETER CHANNEL 9	H2O FLOW	1.8774820	LBM PER S
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CALORIMETER CHANNEL 11	H2O FLOW	2.1084650	LBM PER S

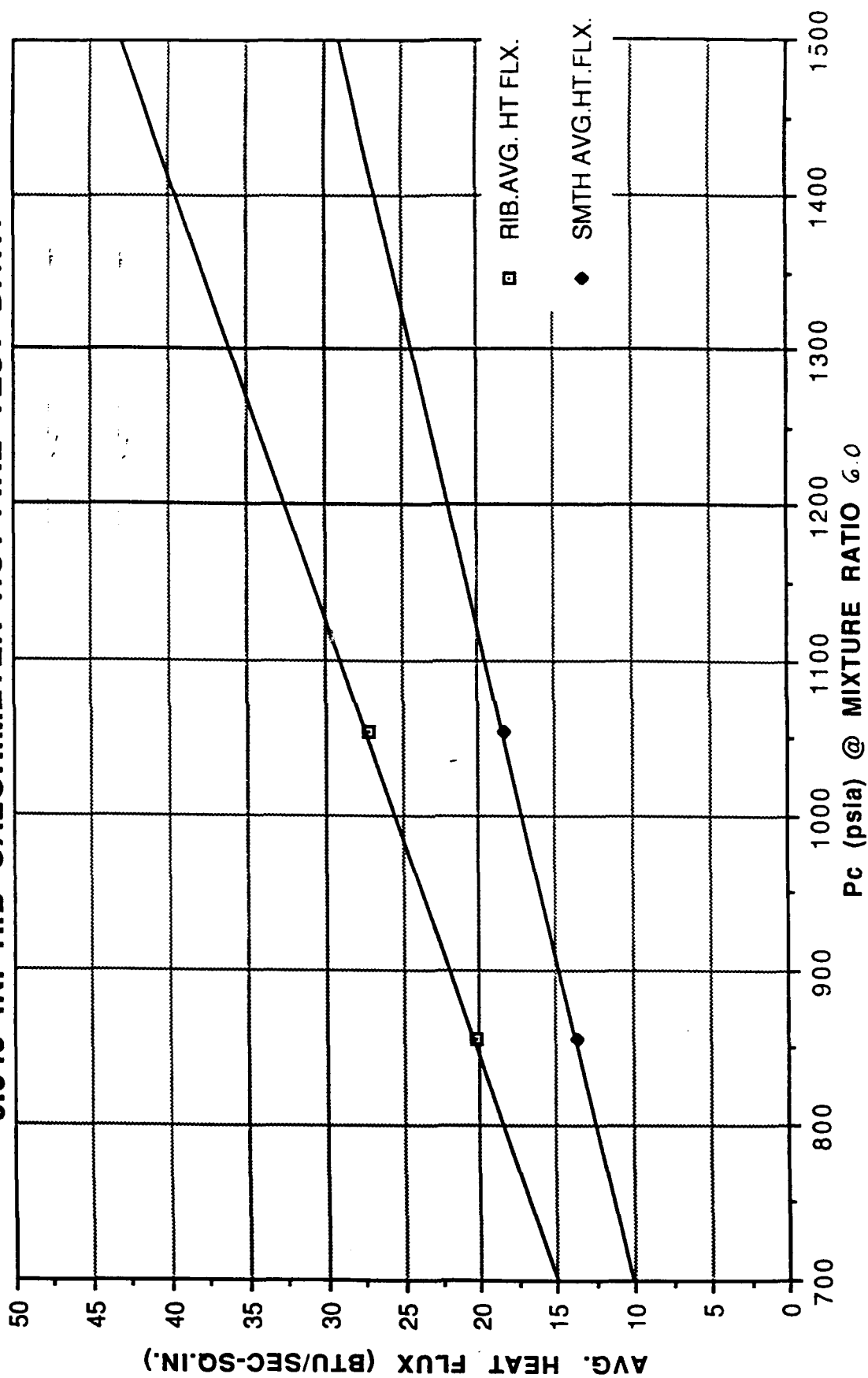
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APPENDIX IV

IV. Plots and Graphs from Reduced Calorimeter Heat Transfer Data

NASA
RI/RD 91-235

15k₁INTEGRATED COMPONENT EVALUATOR (I.C.E.) 0.040 IN. RIB CALORIMETER HOT-FIRE TEST DATA



APPENDIX V

V. List of Drawings

7R0016273, Layout - Calorimeter Insert, Expander Cycle
Combustion Chamber

7R0016274, Housing - Calorimeter Insert, Expander Cycle
Combustion Chamber

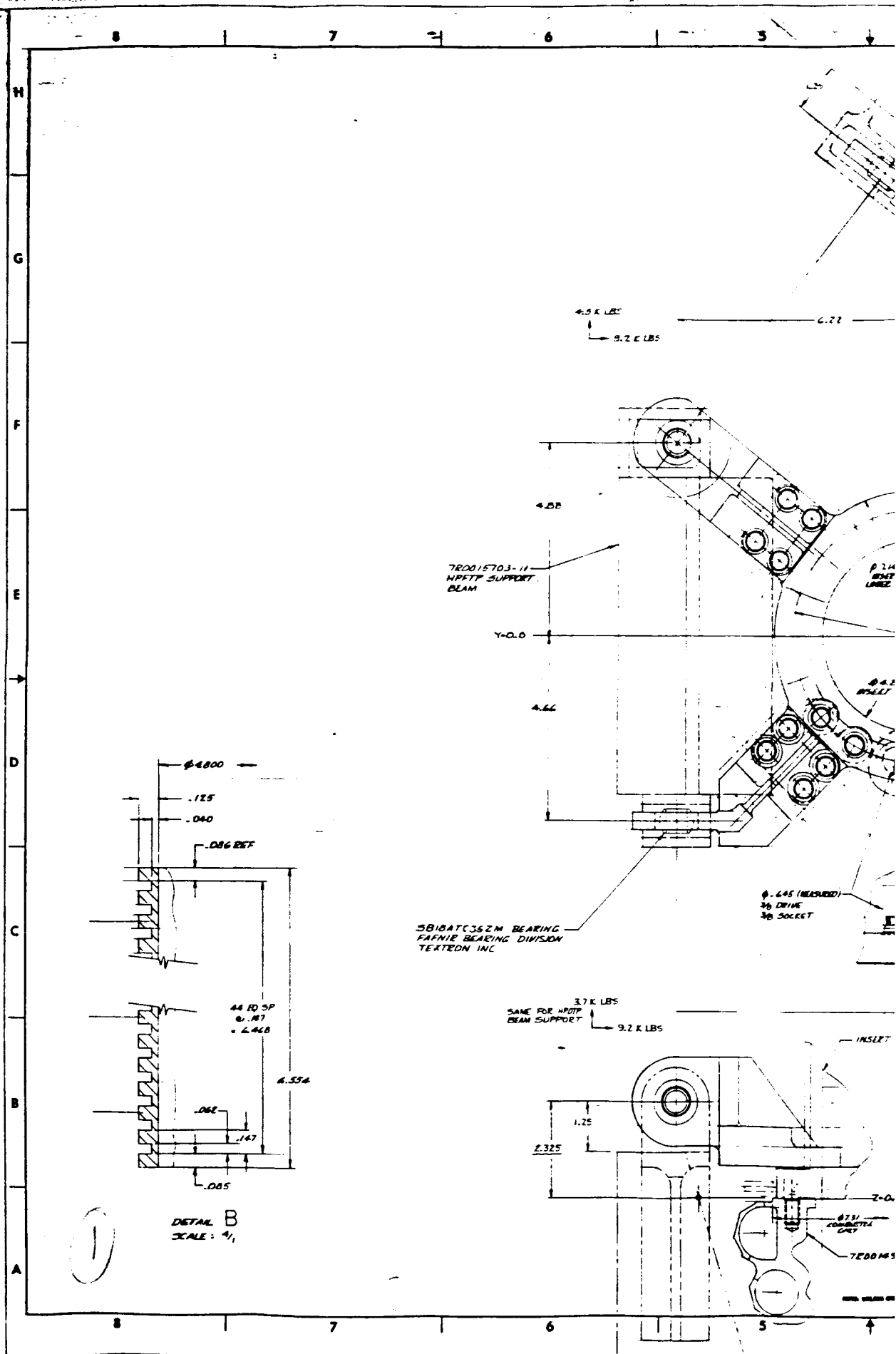
7R0016275, Liner - Calorimeter Insert, Expander Cycle
Combustion Chamber

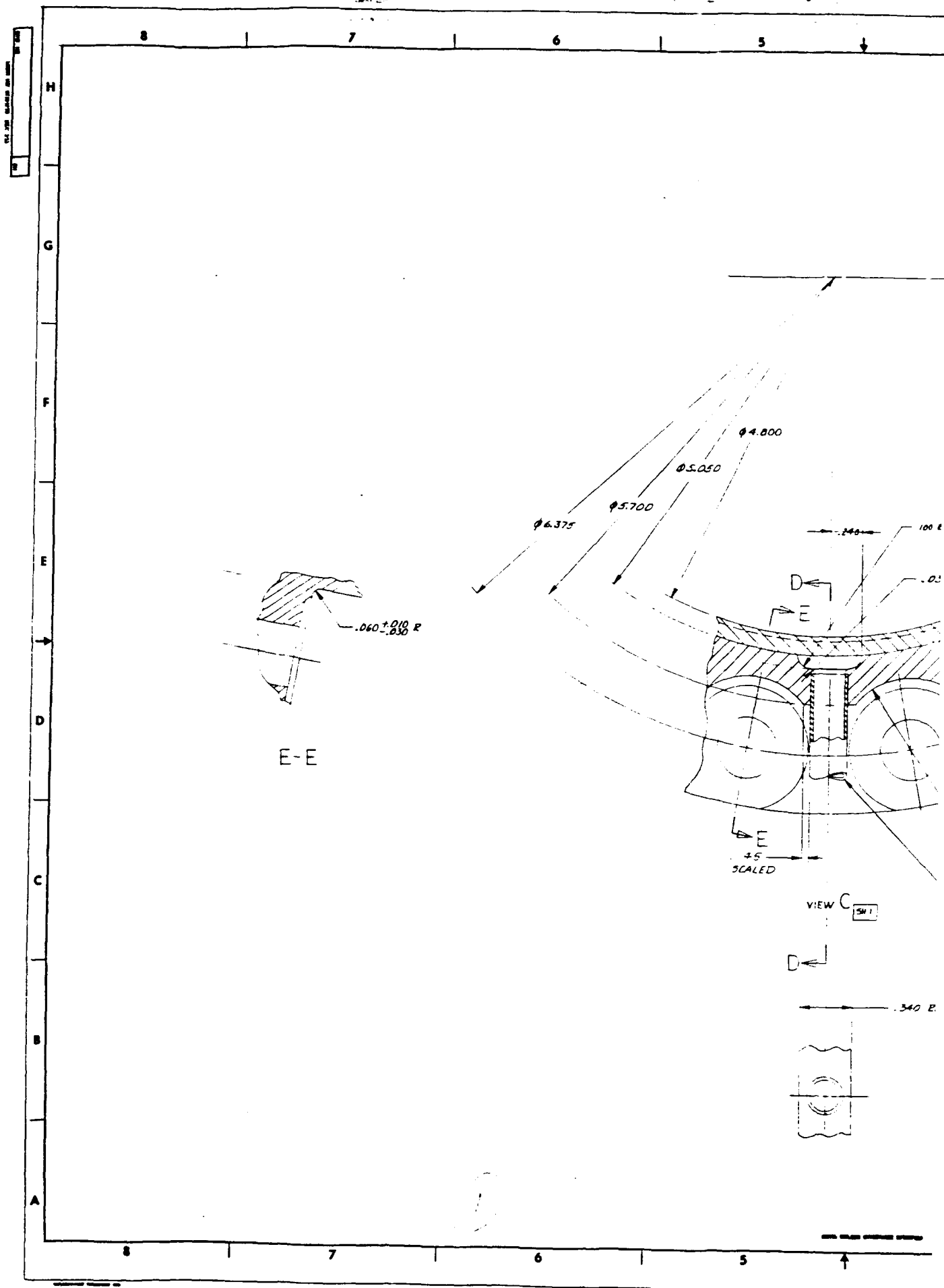
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Combustion Chamber

7R0016277, Insert - Calorimeter, Expander Cycle
Combustion Chamber, Assy. of

7R0016278, Insert - Calorimeter Insert, Expander Cycle
Combustion Chamber, Assy. of

7R0016279, Fuel Manifold - Expander Cycle Combustion Chamber,
Assy. of



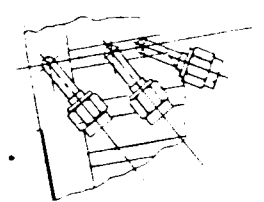
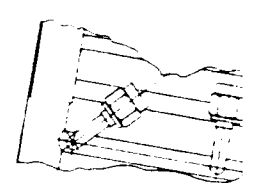
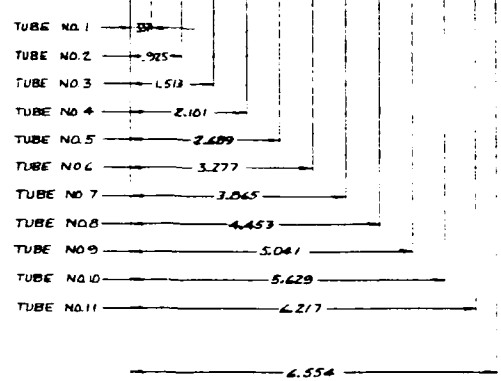


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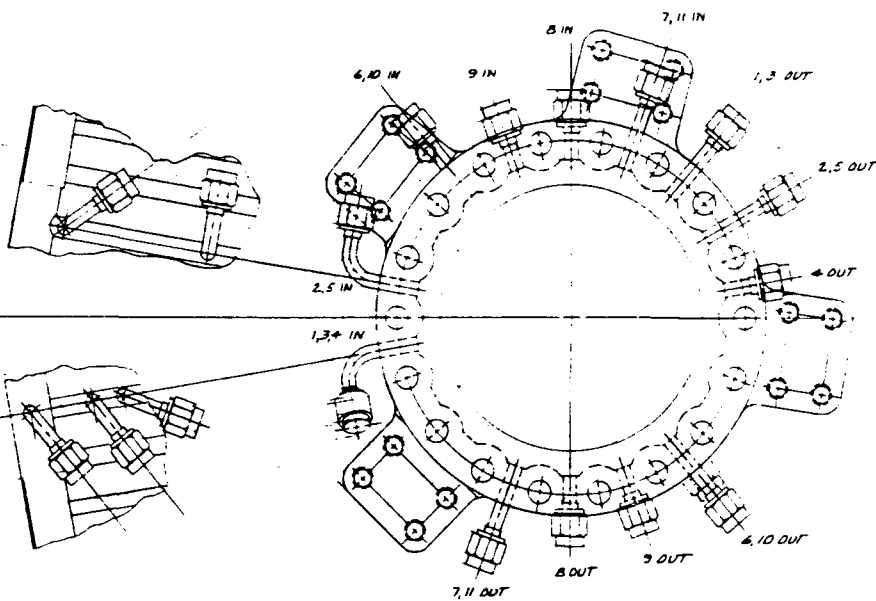
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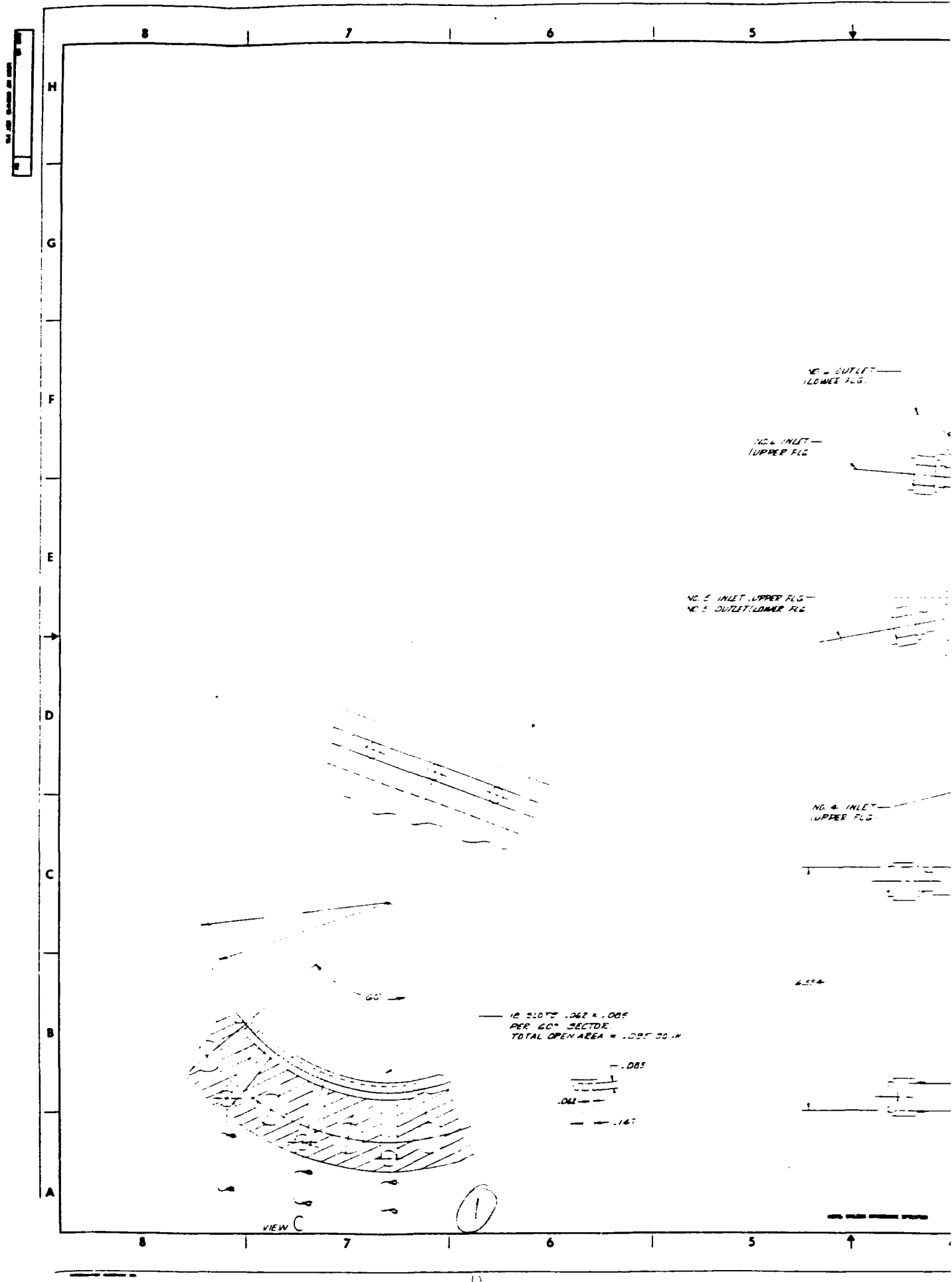
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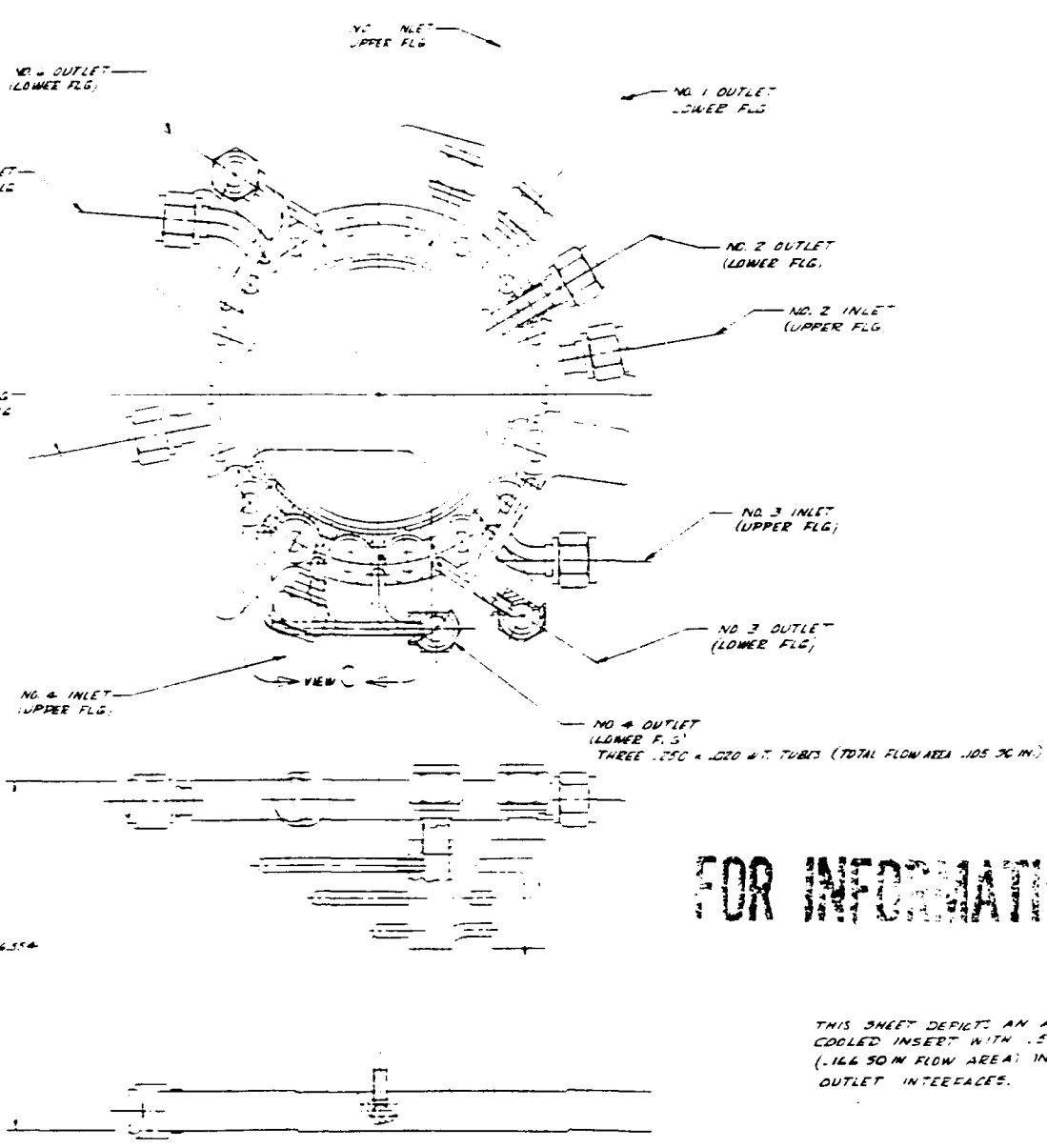


FOR INFORMATION

Pg 128

Rockwell International Corporation Manufacturing Division Group, Fort Collins		REV	FIGURE NO	DATE
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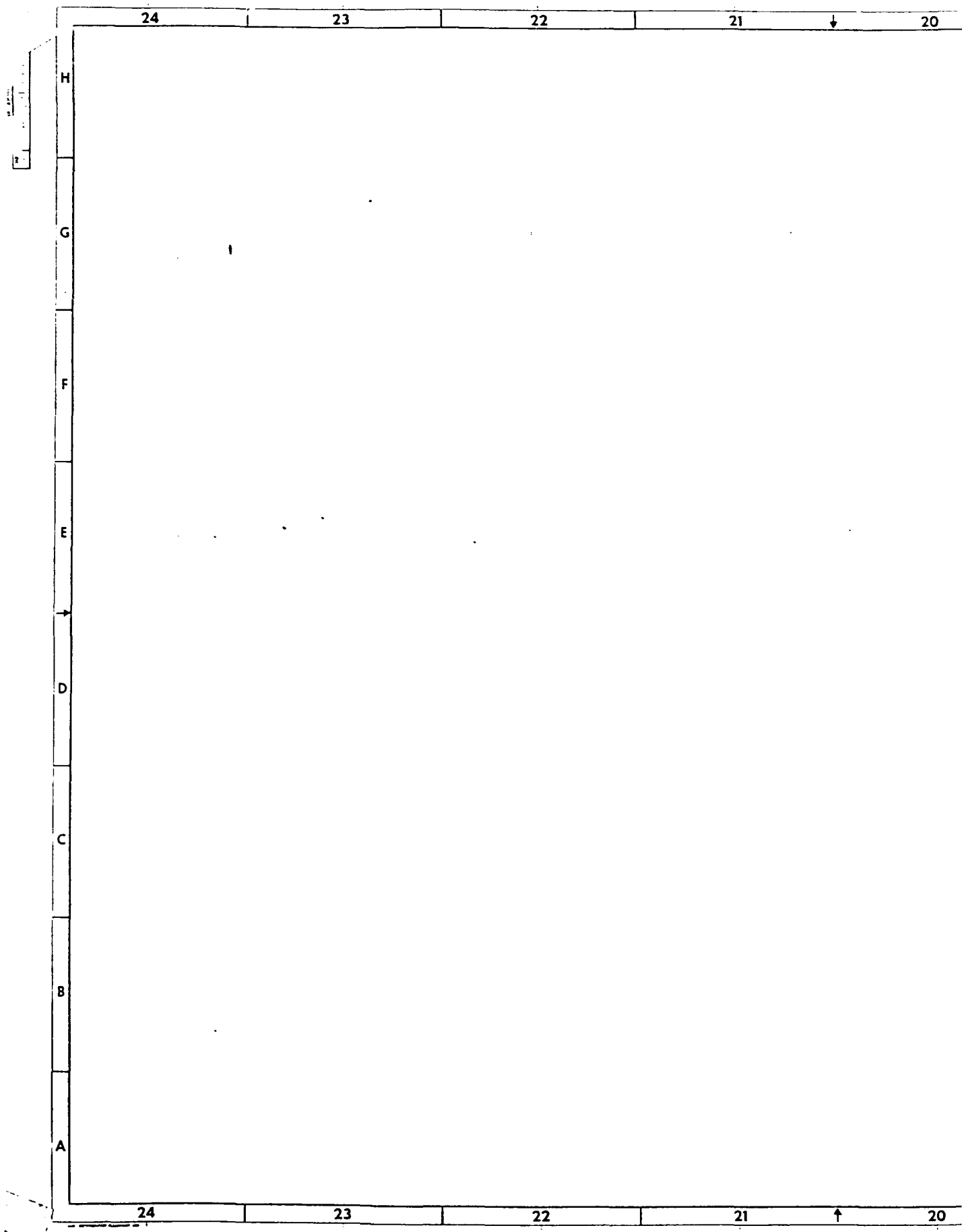


FOR OFFICIAL USE ONLY

THIS SHEET DEPICTS AN AXIAL FLOW
COOLED INSERT WITH .500 D/A X .070 W.T.
(.144 SQ IN FLOW AREA) INLET AND
OUTLET INTERFACES.

Pg 129

Rockwell International Corporation Rockadynamics Division Long Beach, California	SIZE E	FSCN NO 02602	DISC NO 7E00-6273
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Rockwell International Corporation
Rockwell International Division
Canoga Park, California

FORM NO. 112202	PHASE 1
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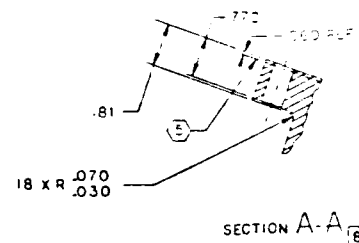
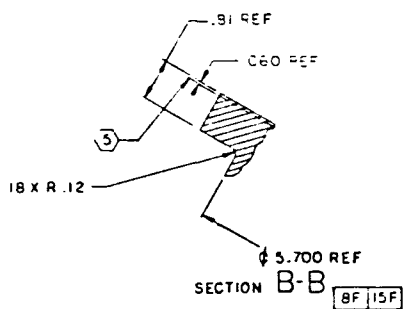
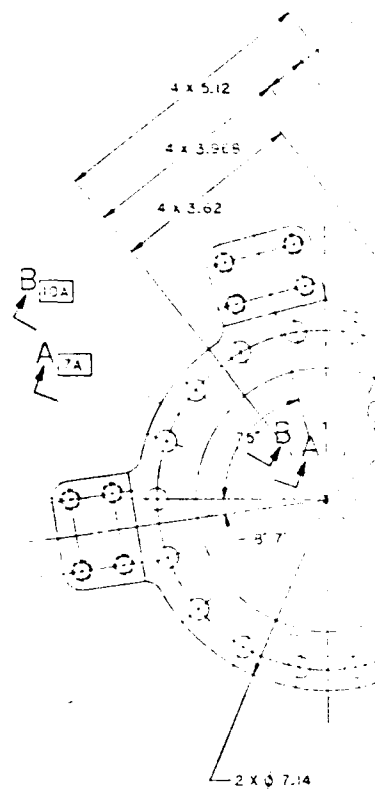
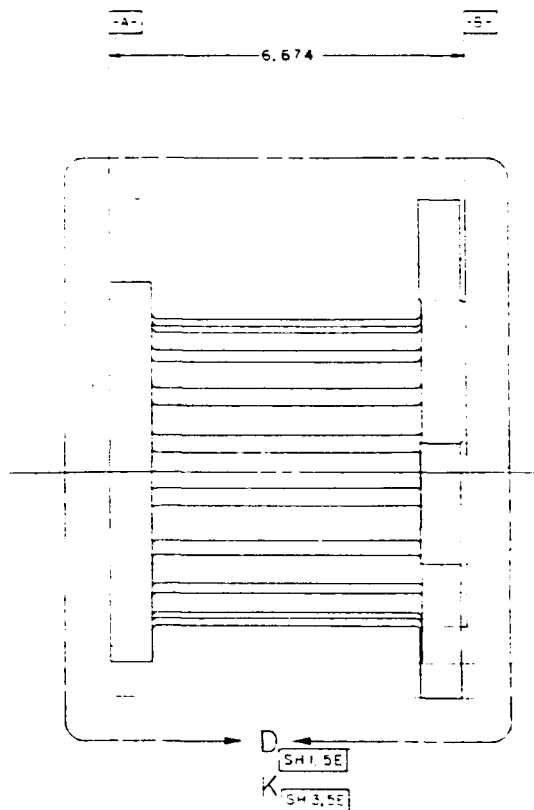
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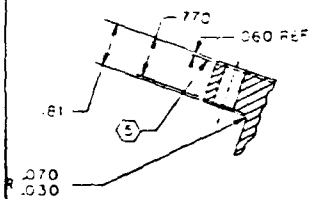
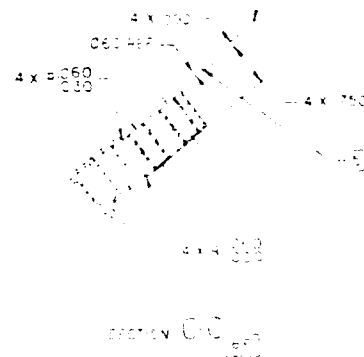
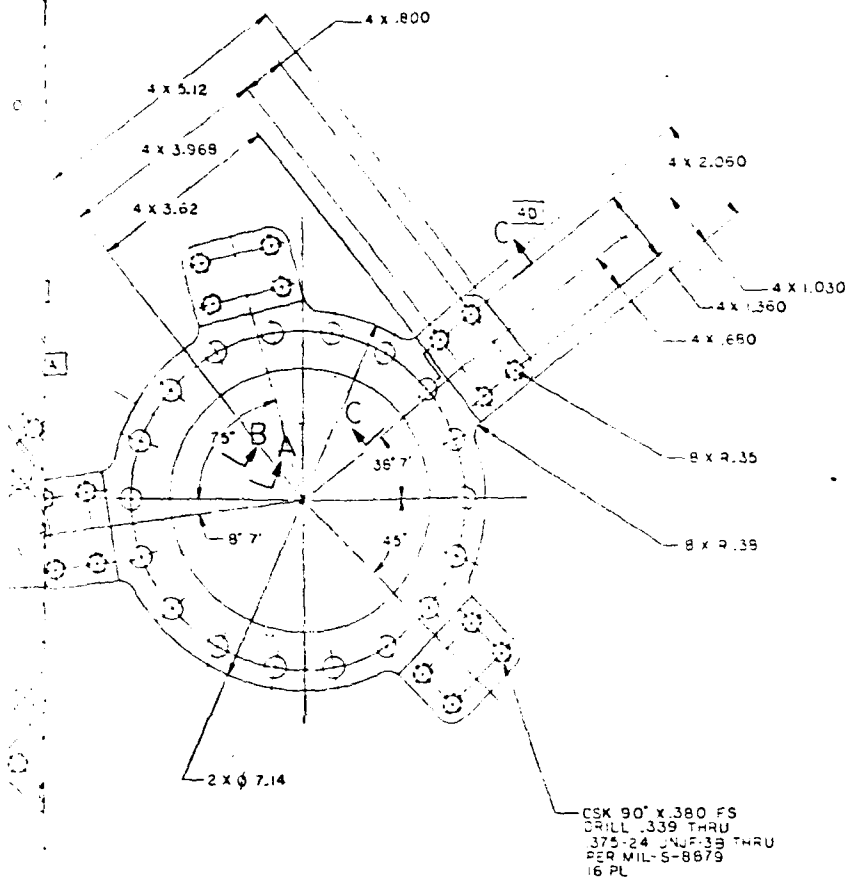
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Radiant International Corporation
Racine, Wisconsin
Chicago, Illinois

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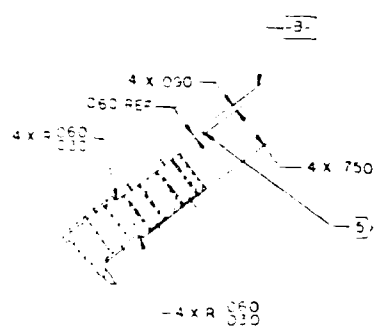


SECTION A-A
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- 7 DEEP ELECTROCHEMICAL ETCH PER STOIC4RA0016
- 6 DUCTILE NICKEL PLATE PER RA1609 .023 CLASS A, 0.0002 TO 0.0004 THICKNESS
- 5 FINISHED MACHINED AFTER BRAZING ON NEXT ASSY
- 4 DEEP ELECTROCHEMICAL ETCH IDENTIFY PER RAD104-008
- 3 CLEAN PER RAD110-018
- 2 PENETRANT INSPECT PER RAD113-116
- 1 MACHINE PER RAD103-002

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SECTION C-C 67

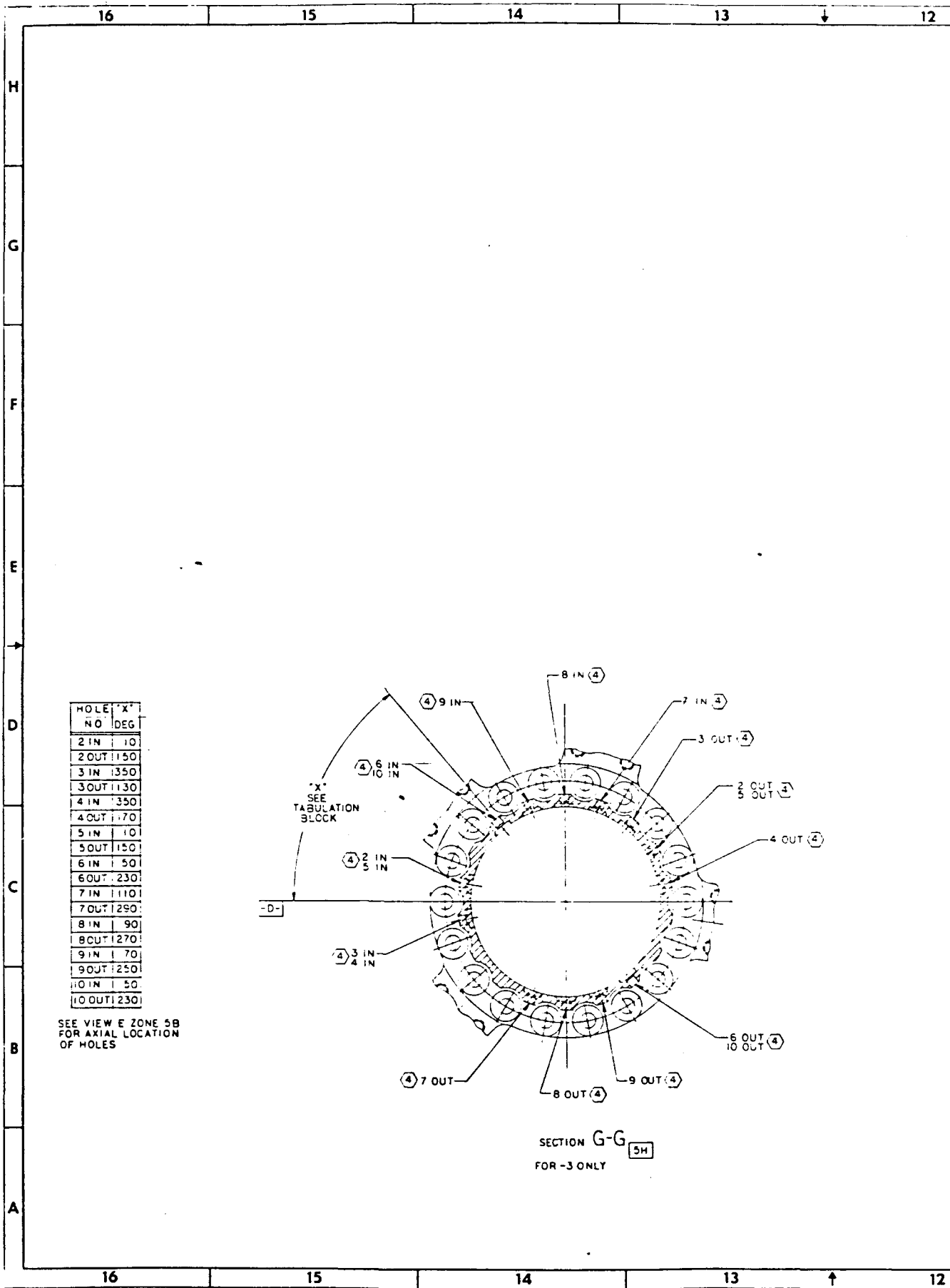
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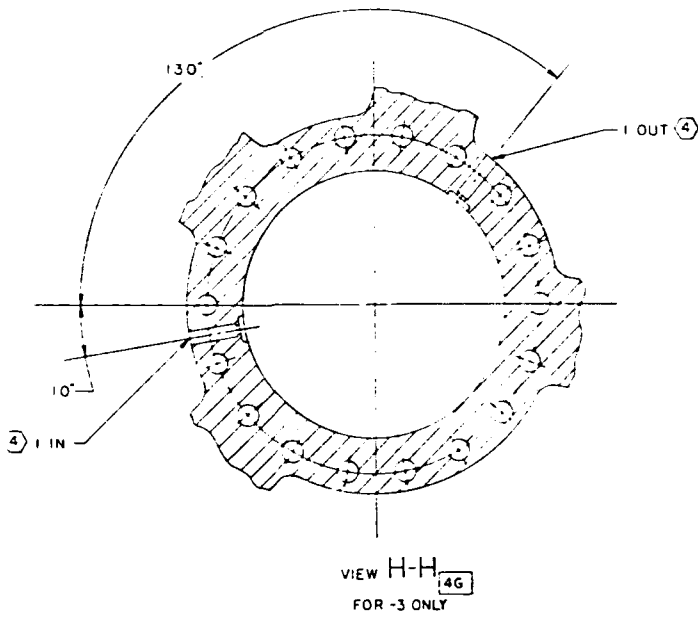
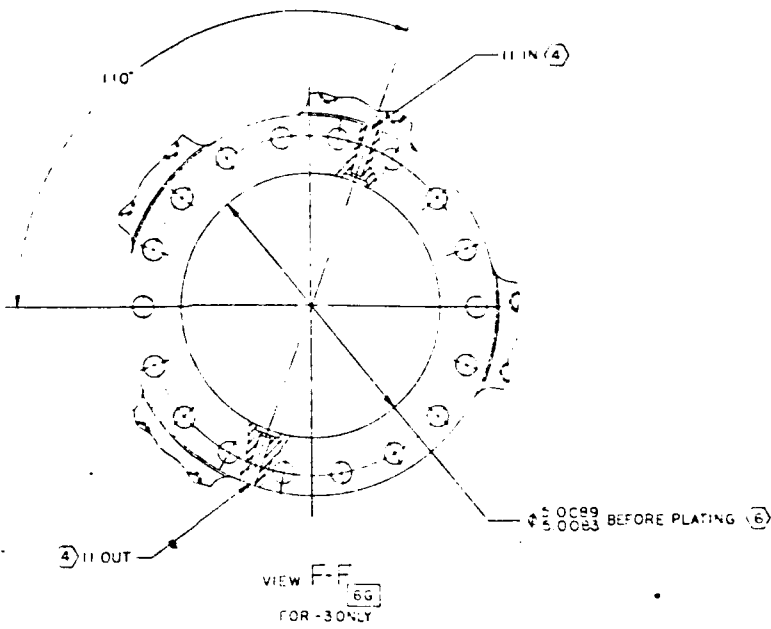
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2 DUCTILE NICKEL PLATE PER RA1609 023 CLASS A, 0.0002 TO 0.0004 THICKNESS
2 FINISHED MACHINED AFTER BRAZING CN NEXT ASSY
4 DEEP ELECTROCHEMICAL ETCH IDENTIFY PER RA0104-008
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1 MACHINE PER RA0103-002

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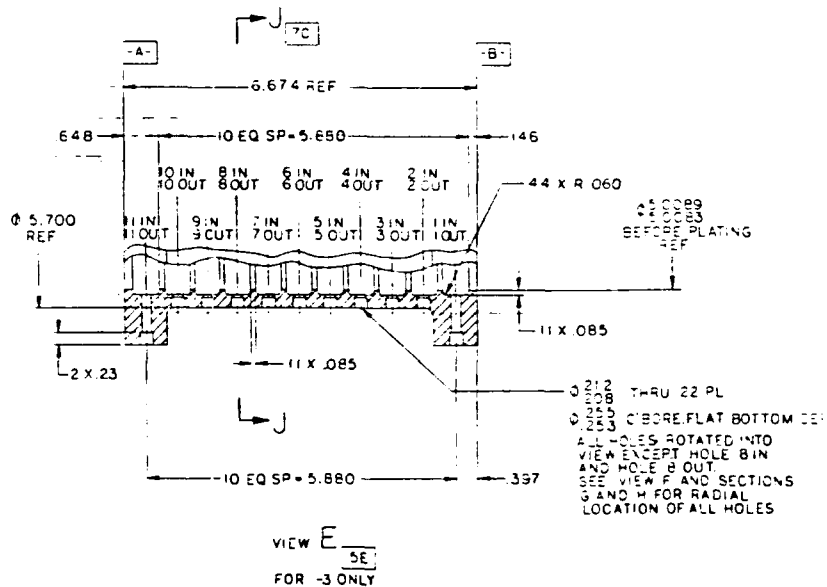
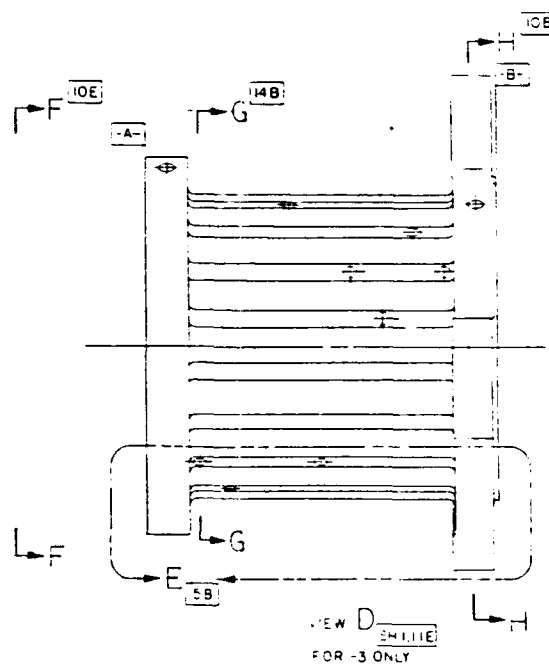
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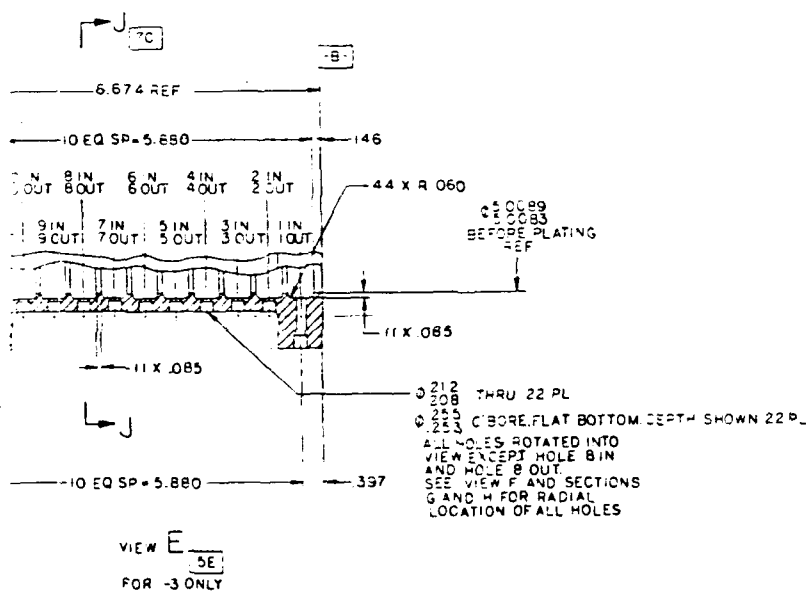
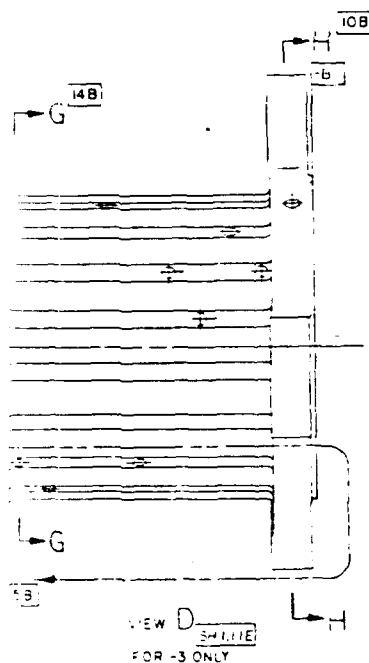


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INFORMATION ONLY

PG 138

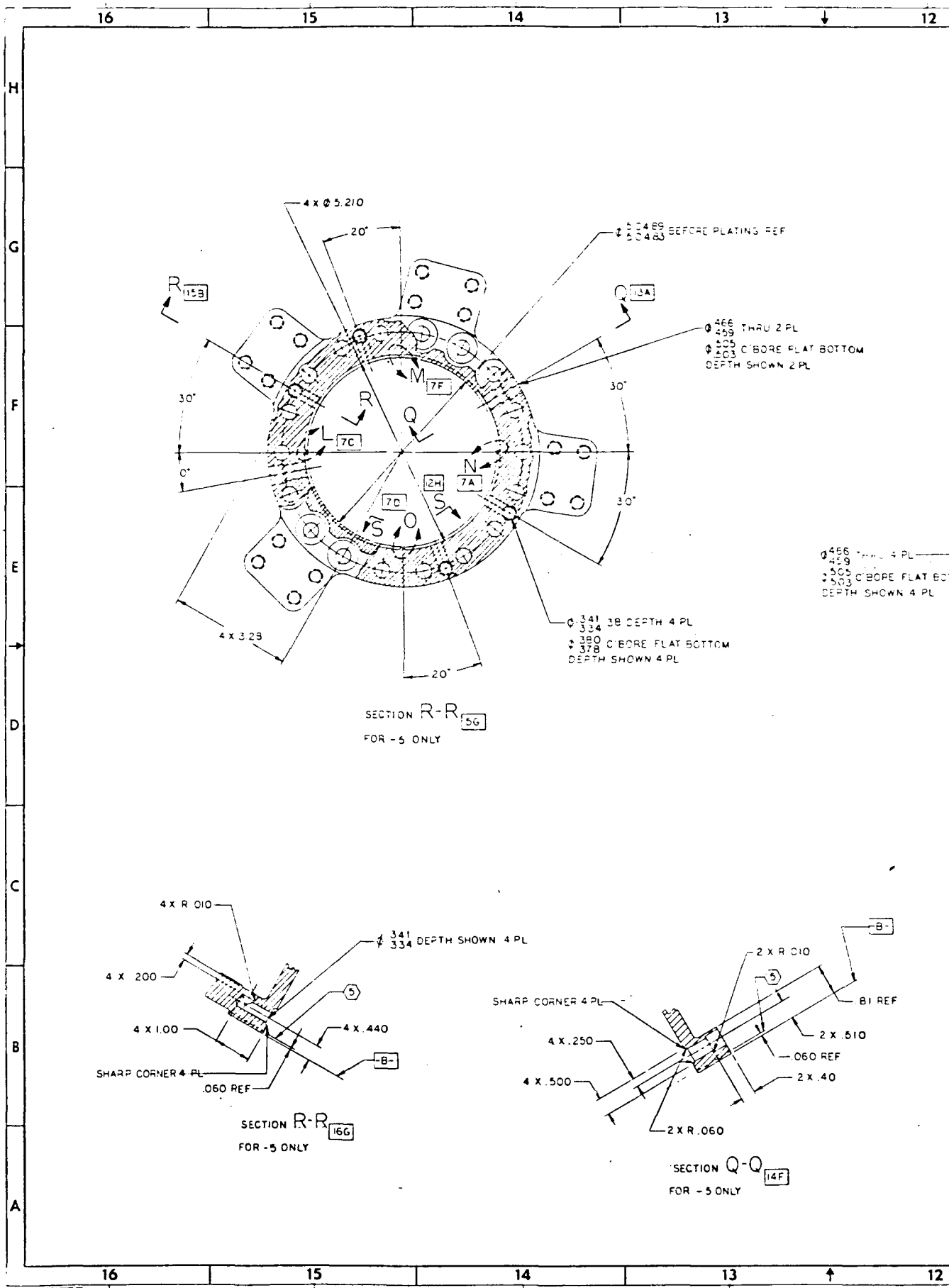
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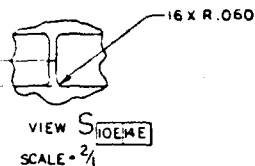
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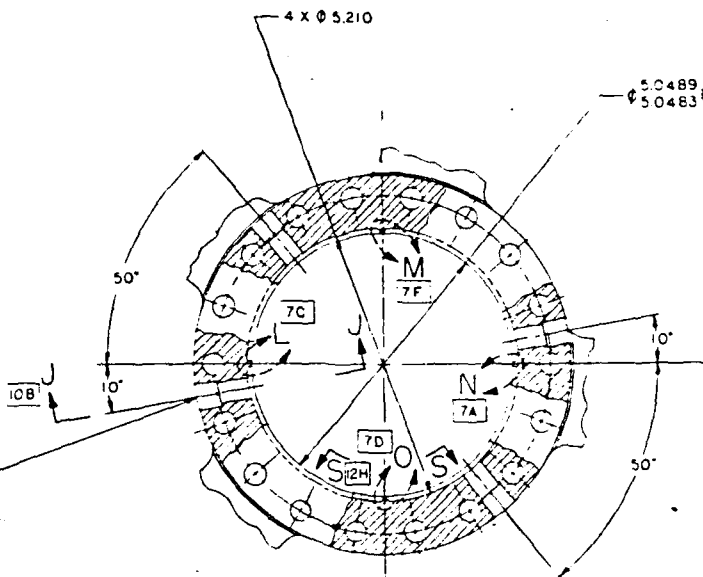




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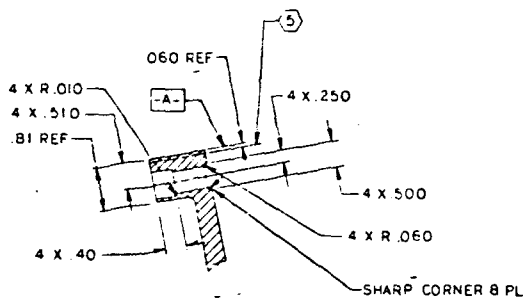
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Ø.466 THRU 4 PL
Ø.459
Ø.505 C'BORE FLAT BOTTOM
Ø.503
DEPTH SHOWN 4 PL

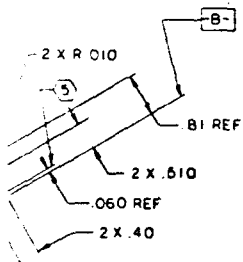


SHARP CORNER 2 PL

VIEW P 10E14E
FOR -5 ONLY



SECTION J-J 11E
FOR -5 ONLY



2-Q 14F

Rockwell International Corporation
Rockwell International Division
Carpenter Park, California

7R0016274 31

LM OVERLAP AREA

8

7

6

5

4

SHARP CORNER 2 PL

031
027
041
037

$\phi 5.210 \text{ REF}$

2 X R.060

VIEW M 10F 15F

SCALE = 2/1
FOR -5 ONLY

2 X R.060

$\phi 5.210 \text{ REF}$

SHARP CORNER 2 PL

VIEW C 10E 14E

SCALE = 2/1
FOR -5 ONLY

SHARP CORNER 2 PL

041
037
041
037

$\phi 5.210 \text{ REF}$

2 X R.060

VIEW L 11F 15F

SCALE = 2/1
FOR -5 ONLY

SHARP CORNER 2 PL

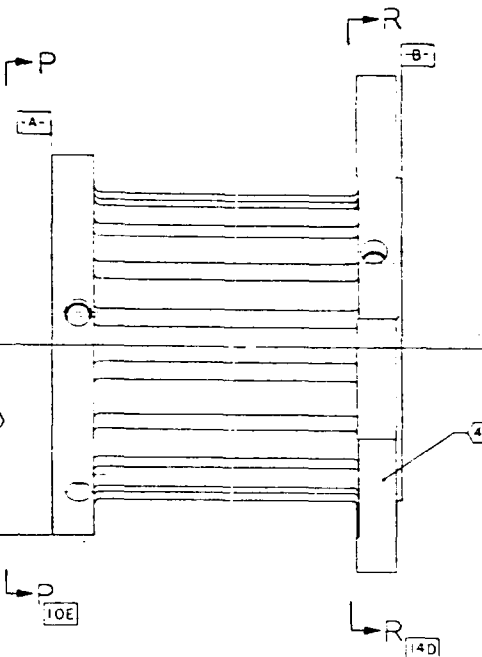
031
027
041
037

2 X R.060

$\phi 5.210 \text{ REF}$

VIEW N 10F 14F

SCALE = 2/1
FOR -5 ONLY



VIEW K SHI, 11D

FOR -5 ONLY

LM OVERLAP AREA

8

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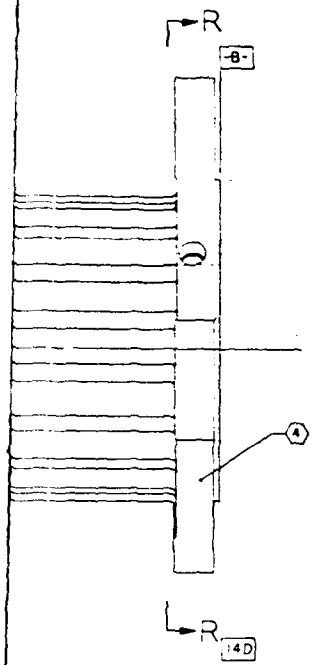
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WELD VIEWS SHOWN UNLESS SPECIFIED

5 4 3 2 1

REVISIONS		DATE	APPROVED
1.	NOT BE REVISIONED		
2.	REVISION CHANGES		
3.	CHANGE OF REVISIONS		
4.	REVISIONS		

H
G
F
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D
C
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A



SHIELD
- 5 ONLY

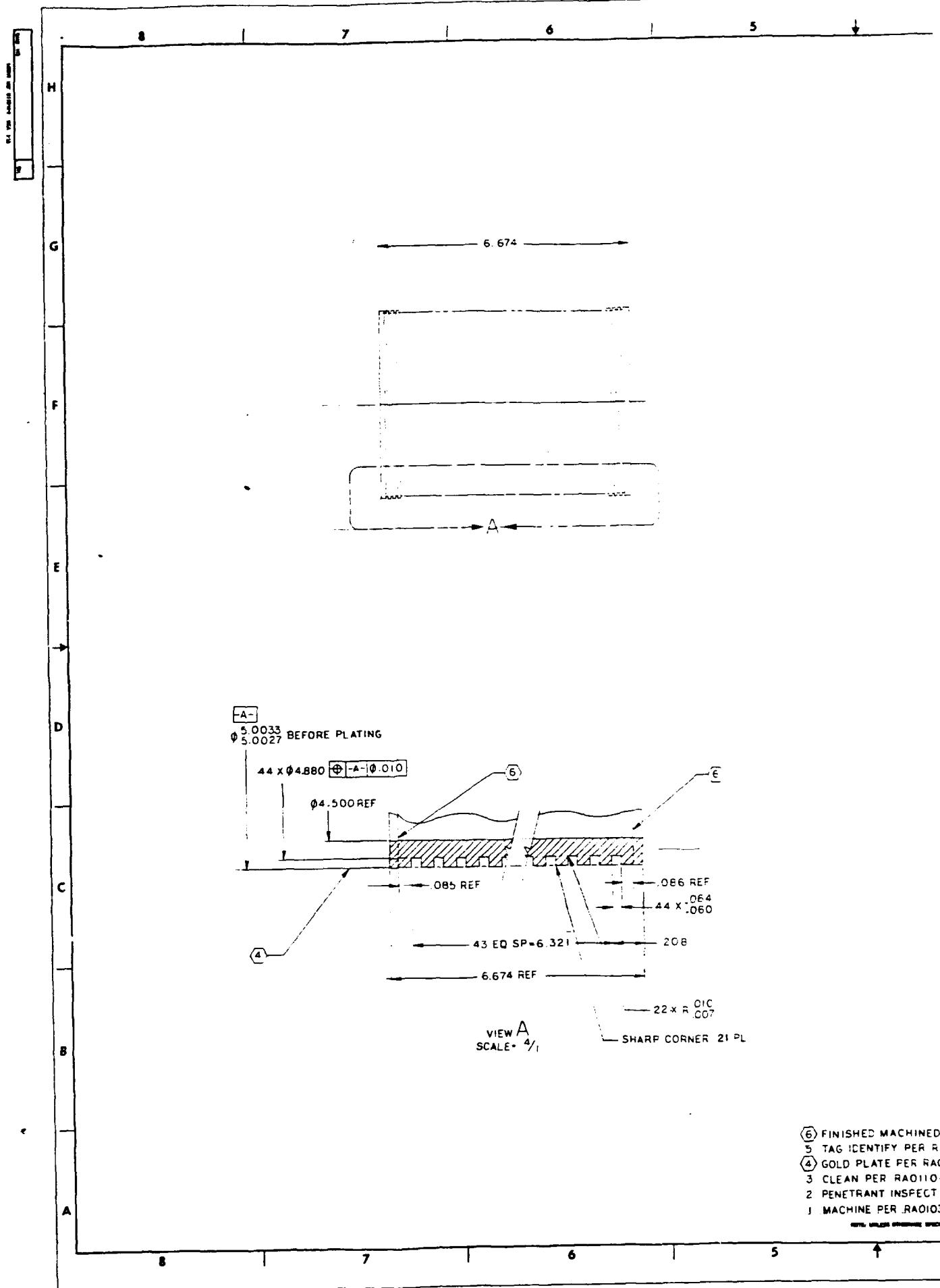
INFORMATION ONLY

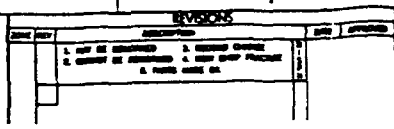
P6 132

REVISIONS 1. NOT BE REVISIONED 2. REVISION CHANGES 3. CHANGE OF REVISIONS 4. REVISIONS		DATE APPROVED	
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J 02602 7R0016274

5 4 3 2 1



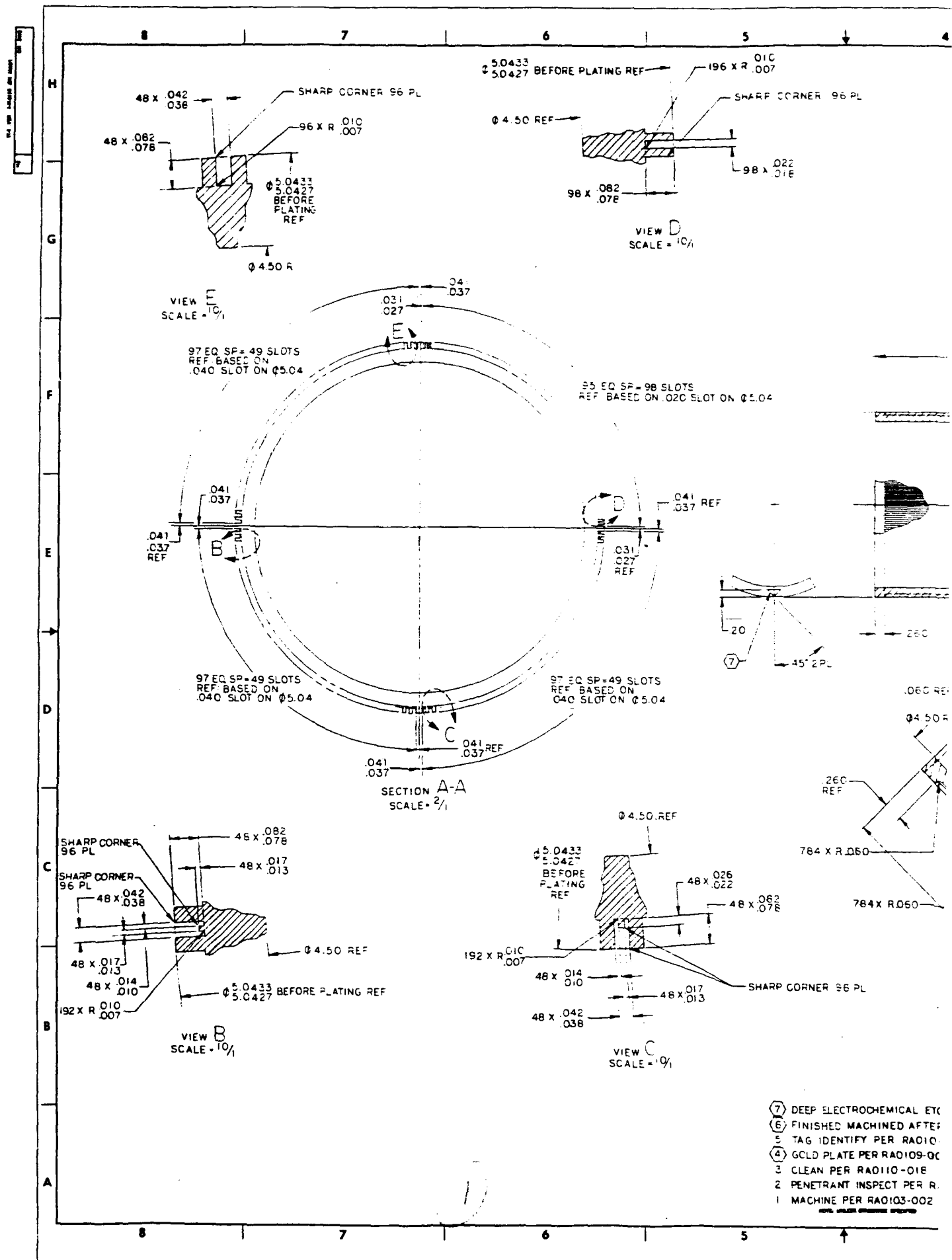


- 3	OFHC COPPER		COMMERCIAL GRADE
NO	MATERIAL	SIZE	SPECIFICATION

⑥ FINISHED MACHINED AFTER BRAZING ON NEXT ASSY
5 TAG IDENTIFY PER RA0104-008
④ GOLD PLATE PER RA0108-007 TYPE 1, 0.0004 TO 0.0006 THICKNESS
3 CLEAN PER RA0110-018
2 PENETRANT INSPECT PER RA0115-116
1 MACHINE PER RA0103-002

NAME	ALLEN STEPHEN SPENCER	DATE	95285	National International Corporation Research Division Detroit, Mich., U.S.A.
TEST	VALVE SEQUENCE AS SHOWN AND APPLY PRESS. TO VALVE	NAME	H. DUBRICK	
TEST	VALVE SEQUENCE AS SHOWN AND APPLY PRESS. TO VALVE	NAME	H. DUBRICK	LINER-CALORIMETER. EXPANDER CYCLE COMBUSTION CHAMBER
TEST	VALVE SEQUENCE AS SHOWN AND APPLY PRESS. TO VALVE	NAME	H. DUBRICK	
TEST	VALVE SEQUENCE AS SHOWN AND APPLY PRESS. TO VALVE	NAME	G. LOBERG	
TEST	VALVE SEQUENCE AS SHOWN AND APPLY PRESS. TO VALVE	NAME	G. LOBERG	
TEST	VALVE SEQUENCE AS SHOWN AND APPLY PRESS. TO VALVE	NAME	G. LOBERG	NO. 02602 7R0016275

ACKNOWLEDGMENTS

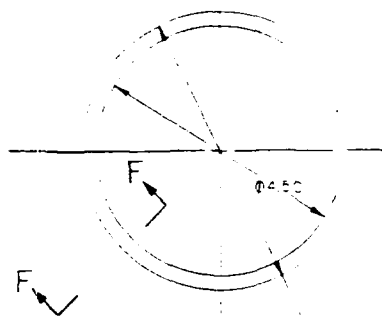
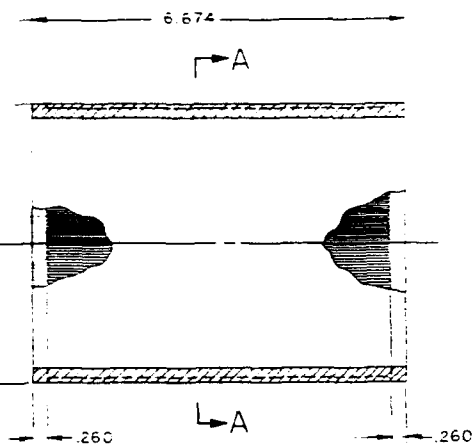


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007

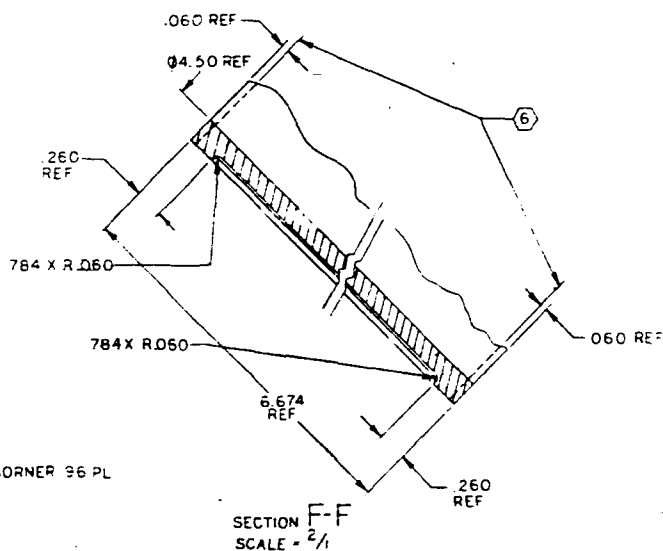
SHARP CORNER 196 PL

1
1
98 X 022
018

REVISIONS		
DATE	REV	DESCRIPTION
	1	REV AS REQUIRED
	2	REV AS REQUIRED
	3	REV AS REQUIRED
	4	REV AS REQUIRED
	5	REV AS REQUIRED



Ø4.50
Ø4.43
Ø4.42 BEFORE PLATING (4)



INFORMATION ONLY

NO	MATERIAL	SIZE	SPECIFICATION
1-3	OFHC COPPER		COMMERCIAL GRADE

- (7) DEEP ELECTROCHEMICAL ETCH PER STD104RA0016
- (6) FINISHED MACHINED AFTER BRAZING ON NEXT ASSY
- 5 TAG IDENTIFY PER RAO104-008
- (4) GOLD PLATE PER RAO109-007 TYPE I, 0.0004 TO 0.0006 THICKNESS
- 3 CLEAN PER RAO110-018
- 2 PENETRANT INSPECT PER RAO115-116
- 1 MACHINE PER RAO103-002

TREAT		FINISH		MATERIAL		SIZE		SPECIFICATION	
1-3		OFHC COPPER		COMMERCIAL GRADE					
NO		MATERIAL		SIZE		SPECIFICATION			
1-3		OFHC COPPER		COMMERCIAL GRADE					
NO		MATERIAL		SIZE		SPECIFICATION			
1-3		OFHC COPPER		COMMERCIAL GRADE					

PG 134

7R0016276

7R0016276

12
13
14
15
16

H

G

F

E

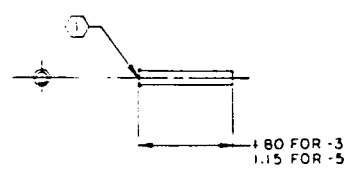
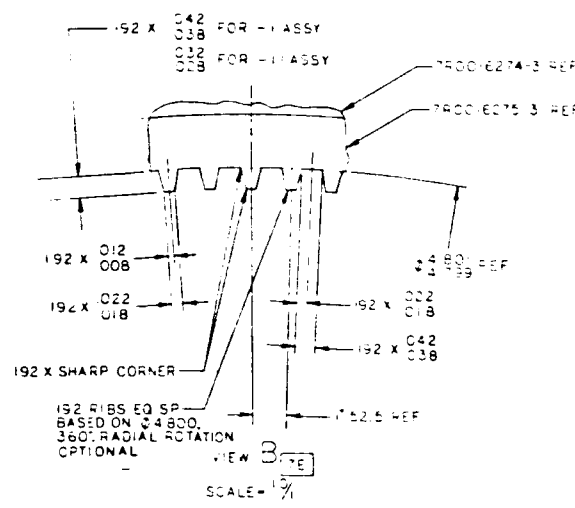
D

C

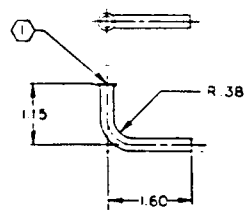
B

A

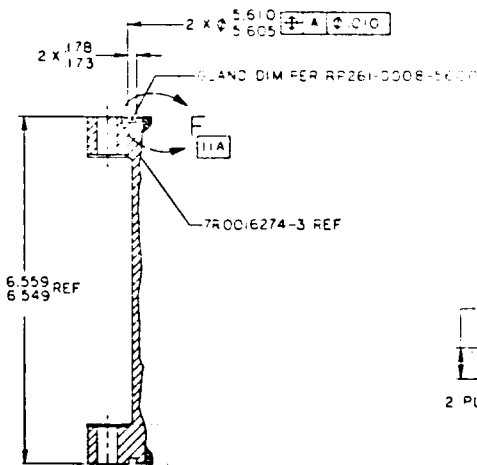
16 15 14 13 12



DETAIL E
 8G, 6E
 DETAIL -5 C-7 TUBE

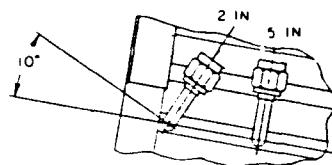
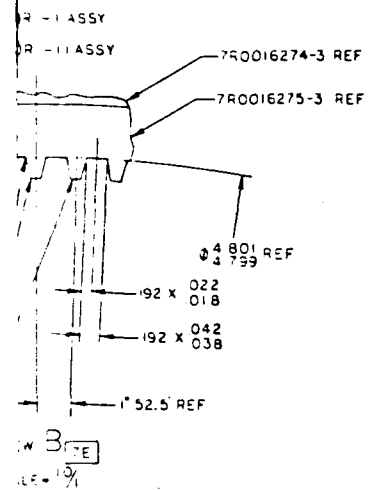


DETAIL D
 9F
 DETAIL -7 TUBE

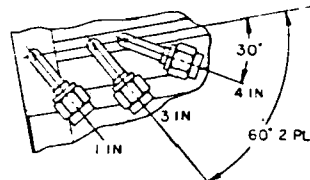


SECTION C-C
 8E

16 15 14 13 12



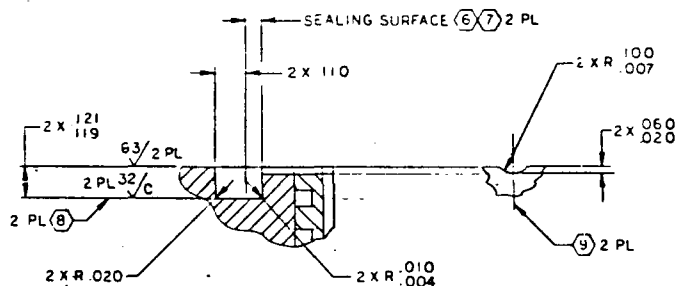
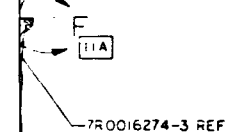
-7 TUBE 5 REQD
SEE DETAIL D
ZONE 16B



5 0045 REF FOR 7R0016274-3 REF
5 0075 REF FOR 7R0016275-3 REF
-A-

2 x 5.510
5.605

GLAND DIM PER RP261-0008-5600 2 PL REF



VIEW F
13C
SCALE = 5/1

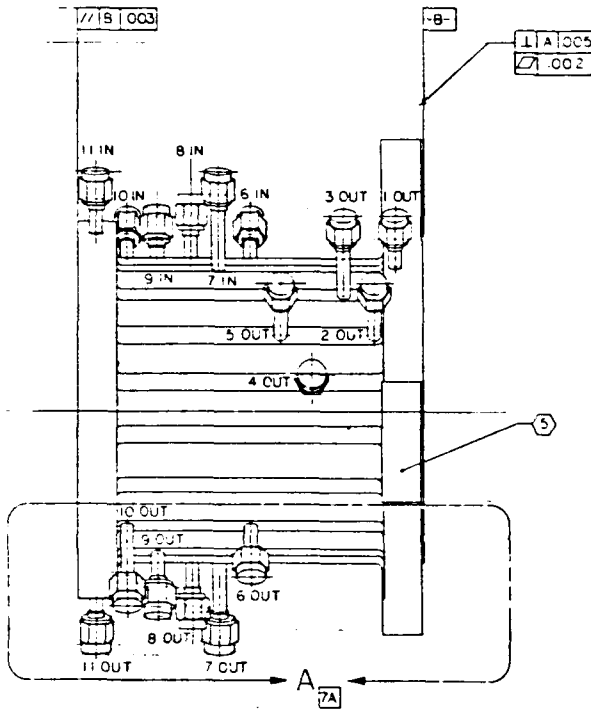
5 0045 REF FOR 7R0016274-3 REF
5 0035 REF FOR 7R0016275-3 REF
5 0065 REF FOR 7R0016276-3 REF
5 0075 REF FOR 7R0016277-3 REF

(11) 12 PL

SECTION C-C
8E

Radco International Corporation
Riverside, California
Corona Park, California

7R0016277



INFORMATION ONLY

ALLOWABLE ALTERNATE: 304L, 316 OR 347
 CRES. COMMERCIAL GRADE
 PROOF PRESSURE TEST AT 70° ± 5°F WITH WATER AT
 1000 ± 50 PSIG. MAINTAIN PRESSURE FOR 2 MINUTES MIN.
 REDUCE TO ZERO. REPEAT FOR A TOTAL OF 3 CYCLES
 CALCULATED BURST PRESSURE = PSIG AT 70°F
 BRAZE PER RAO107-010 AND ME AND T INSTRUCTIONS
 ALL MACHINING TO BE ACCOMPLISHED AFTER BRAZE ASSEMBLY
 VENT ONE PLACE. RADIAL ROTATION OPTIONAL
 FLATNESS AND WAVINESS MAY DEViate AT THE RATE OF
 .0003 INCHES PER INCH CIRCUMFERENTIALLY AND
 .0020 INCHES PER INCH RADIALY
 CRITICAL REQUIREMENT-TO BE VERIFIED BY QUALITY ASSURANCE
 SHALL BE FREE OF NICKS, SCRATCHES OR OTHER IMPERFECTIONS
 WHICH WOULD IMPAIR ITS SEALING FUNCTION
 DEEP ELECTROCHEMICAL ETCH IDENTIFY PER RAO104-008
 CLEAN PER RAO110-010
 MACHINE PER RAO103-002
 INSTALL FITTINGS AND TUBE ASSEMBLIES PER RAO102-005
 FABRICATE TUBING PER RAO102-003

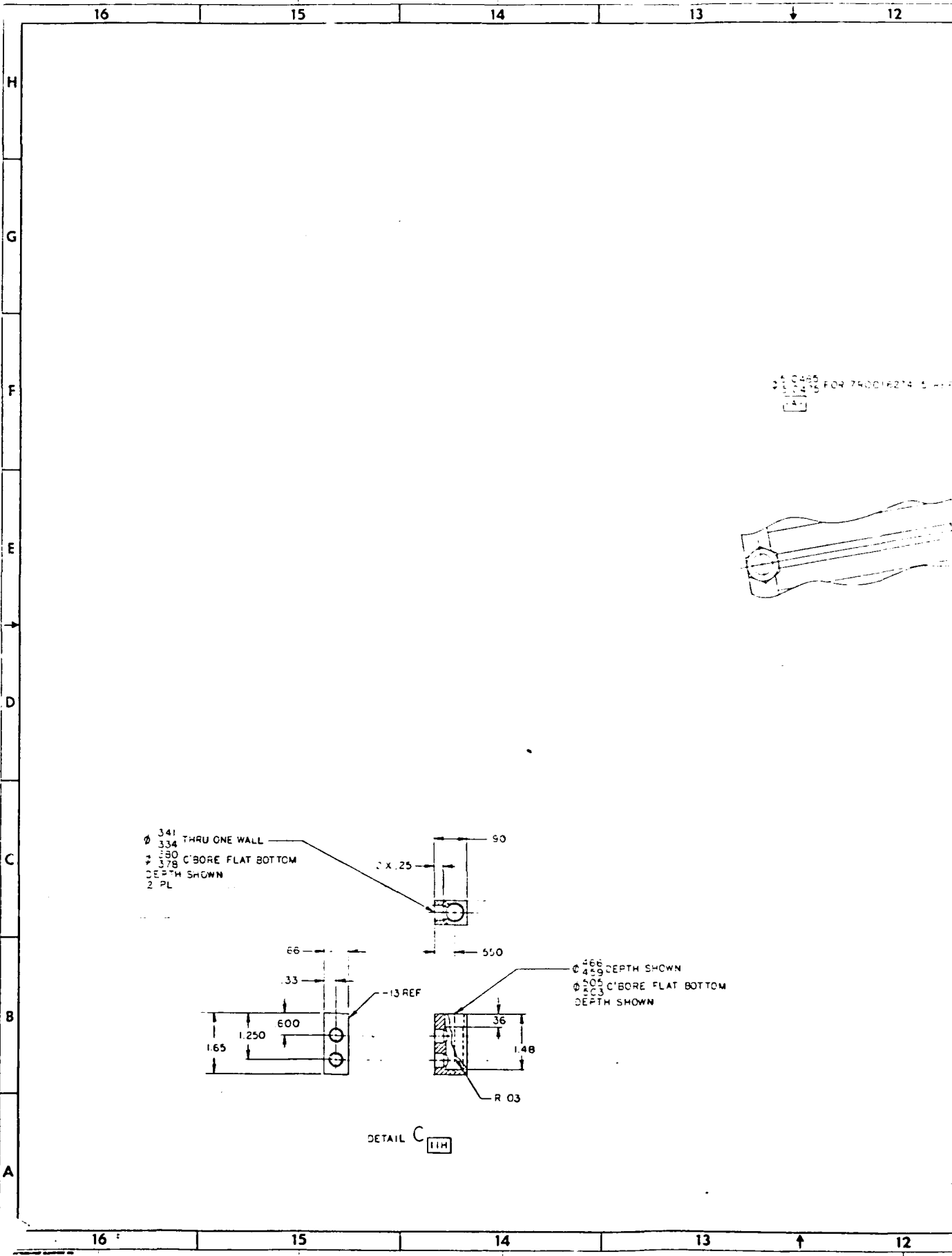
	1	1	7P0016275-3	LINER			
	1	1	7R0016274-3	HOUSING			
	22		1MS20819-4J	SLEEVE			
	22		1AN815-4J	INUT			
(13)	5	5	-7 1304 CRES TUBE	1250 OD X .020 W.T.	MIL-T-8504 COMP	304 SMLS	
(13)	6	6	-5 1304 CRES TUBE	1250 OD X .020 W.T.	MIL-T-8504 COMP	304 SMLS	
(13)	11	11	-3 1304 CRES TUBE	1250 OD X .020 W.T.	MIL-T-8504 COMP	304 SMLS	
	-11	-1	PART NO.	DESCRIPTION	SIZE -	SPECIFICATION	
	QTY REQD			PARTS LIST			

PG 135

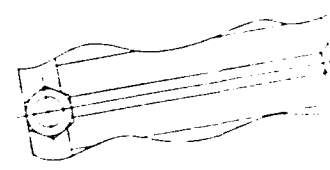
INSERT - CALORIMETER, EXPANDER CYCLE COMB CHAMBER, ASSY OF

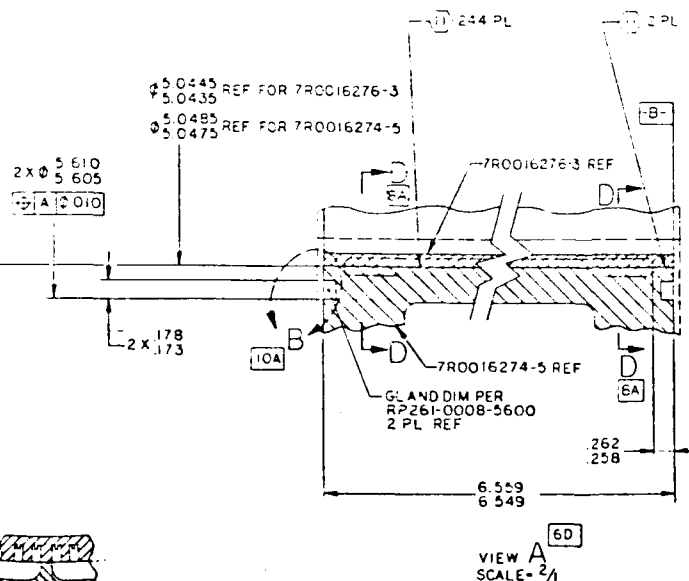
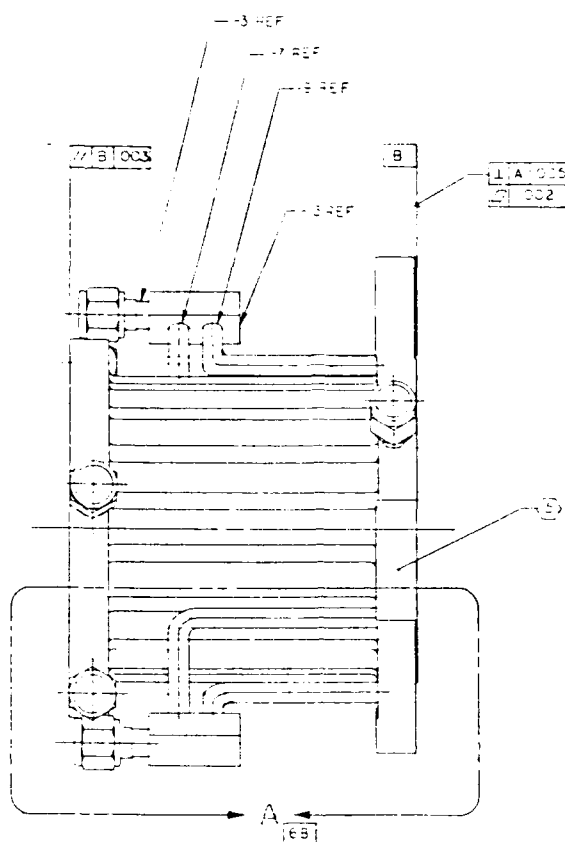
02602 7R0016277

155810047



5 C485 FOR 740016274 1 117
5 C485
A





SECTION D-D
SCALE - 4/1

- ⑤ ALLOW 25 MIN EXTRA TRIM STOCK TR MAT ADD TO ASSURE PROPER FIT
- ⑬ ALLOWABLE ALTERNATE: 304L, 316 OR 347
OR S COMMERCIAL GRADE
- ⑫ PROOF PRESSURE TEST AT 70° ± 15°F WITH WATER AT 2000 ± 50 PSIG MAINTAIN PRESSURE FOR 2 MINUTES MIN REDUCE TO ZERO REPEAT FOR A TOTAL OF 5 CYCLES.
(CALCULATED BURST PRESSURE = _____ PSIG AT 70°F)
- ⑪ BRAZE PER RA0107-010 AND M.E. AND I INSTRUCTIONS
- ⑩ ALL MACHINING TO BE ACCOMPLISHED AFTER BRAZE ASSEMBLY
- ⑨ VENT ONE PLACE; RADIAL ROTATION OPTIONAL
- ⑧ FLATNESS AND WAVINESS MAY DEVIATE AT THE RATE OF .0003 INCHES PER INCH CIRCUMFERENTIALLY AND .0020 INCHES PER INCH RADIALY
- ⑦ CRITICAL REQUIREMENT TO BE VERIFIED BY QUALITY ASSURANCE
- ⑥ SHALL BE FREE OF NICKS, SCRATCHES OR OTHER IMPERFECTIONS WHICH WOULD IMPAIR ITS SEALING FUNCTION
- ⑤ DEEP ELECTROCHEMICAL ETCH IDENTIFY PER RA0104-008
- 4 CLEAN PER RA0110-018
- 3 MACHINE PER RA0103-002
- 2 INSTALL FITTINGS AND TUBE ASSEMBLIES PER RA0102-005
- 1 FABRICATE TUBING PER RA0102-003

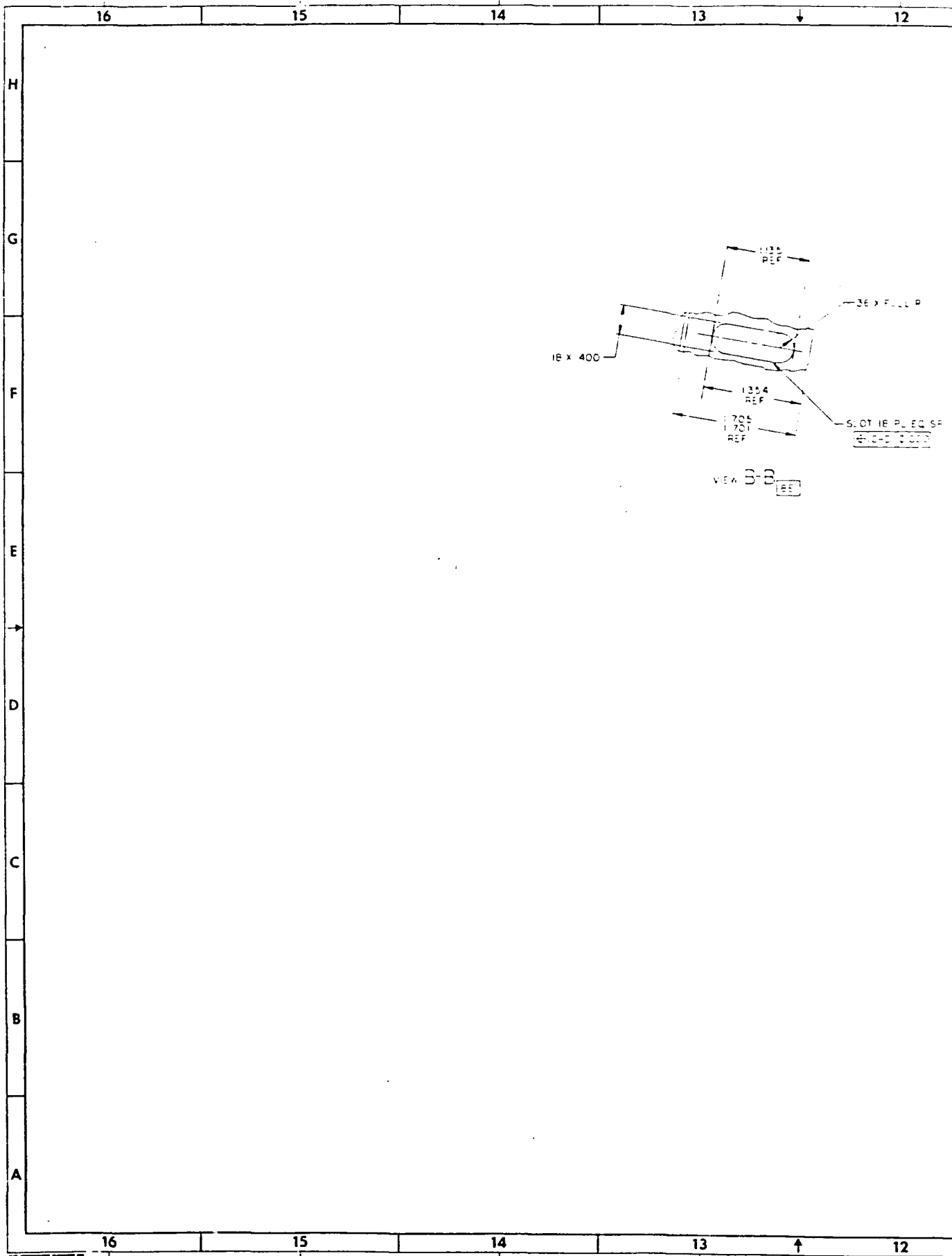
14,005
002

- (3) ALLOW 25 MIN EXTRA TRIM STOCK TRIM AT ASSY TO ASSURE PROPER FIT
- (3) ALLOWABLE ALTERNATE: 304L, 316 OR 347
CRS COMMERCIAL GRADE
- (2) PROOF PRESSURE TEST AT 70° ±15°F WITH WATER AT 2000 ±50 PSIG. MAINTAIN PRESSURE FOR 2 MINUTES MIN. REDUCE TO ZERO. REPEAT FOR A TOTAL OF 5 CYCLES.
(CALCULATED BURST PRESSURE* PSIG AT 70°F)
- (1) BRAZE PER RAO107-010 AND M.E. AND I. INSTRUCTIONS
- (10) ALL MACHINING TO BE ACCOMPLISHED AFTER BRAZE ASSEMBLY
- (3) VENT ONE PLACE; RADIAL ROTATION OPTIONAL
- (8) FLATNESS AND WAVINESS MAY DEViate AT THE RATE OF .0003 INCHES PER INCH CIRCUMFERENTIALLY AND .0020 INCHES PER INCH RADIALY
- (7) CRITICAL REQUIREMENT TO BE VERIFIED BY QUALITY ASSURANCE
- (6) SHALL BE FREE OF NICKS, SCRATCHES OR OTHER IMPERFECTIONS WHICH WOULD IMPAIR ITS SEALING FUNCTION
- (5) DEEP ELECTROCHEMICAL ETCH IDENTIFY PER RAO104-008
- 4 CLEAN PER RAO110-018
- 3 MACHINE PER RAO103-002
- 2 INSTALL FITTINGS AND TUBE ASSEMBLIES PER RAO102-005
- 1 FABRICATE TUBING PER RAO102-003

1	7R0016276-3 LINER		
1	7R0016274-5 HOUSING		
6	MS20B19-BJ SLEEVE		
6	AN615-BJ NUT		
13	2	-131304 CRES BAR	COMMERCIAL GRADE
13	2	-9 304 CRES TUBE	375 OD X 020 WT COMMERCIAL GRADE SMLS
13	2	-71	375 OD X 020 WT
13	2	-51	500 OD X 020 WT
13	6	-31304 CRES TUBE	500 OD X 020 WT COMMERCIAL GRADE SMLS
1	PART NO	DESCRIPTION	SPECIFICATION
QTY	PARTS LIST		

PG 136

[illegible]



12

11

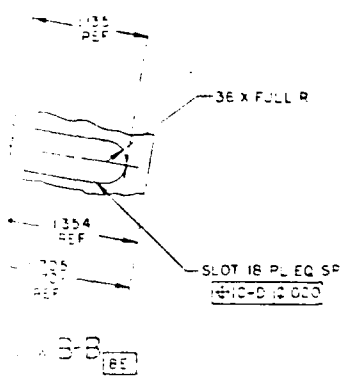
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9

8

7R0016778-3 PORT 1 REQD

RD273-6004-DDC2 PLUG 1 REQD
RE 261-3005-1002 SEAL 1 REQD
TORQUE 95 ± 5 IN-LBS



36 X R 12

Ø 6.375

13E

B-H

7R0014972-25 SHELL 1 REQD

3 3

7R0014969-5 1N

7R0014972-17 1

Rockwell International Corporation
Rockaway Division
Carpenter, California

FORM NO 07652	FIGURE 1	REV	REV
7R0016279		REV	REV

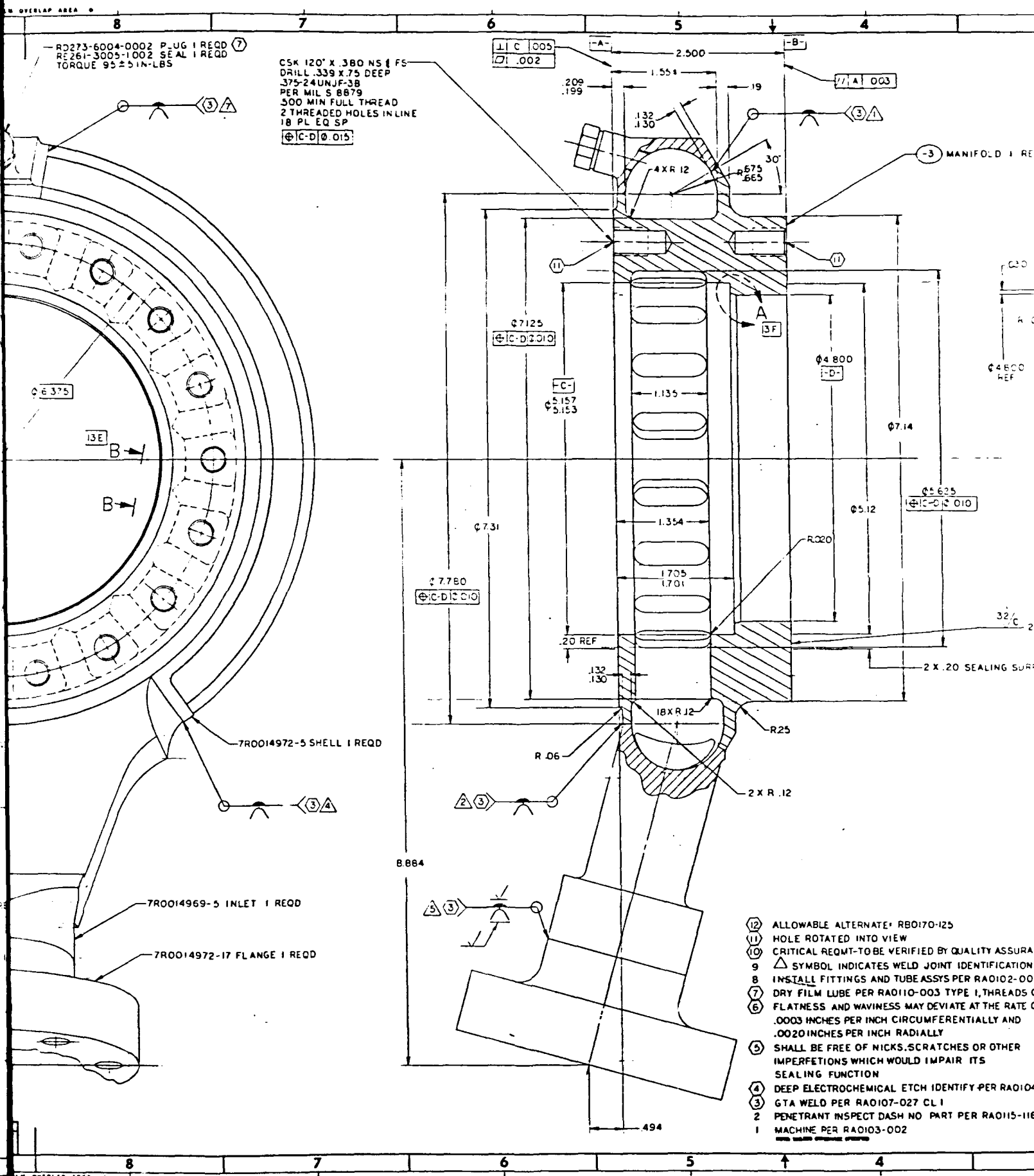
12

11

10

9

8



Report Documentation Page

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4. Title and Subtitle Orbit Transfer Rocket Engine Technology Program Task C.5 Enhanced Heat Transfer Combustor Technology		5. Report Date Dec. 1991	
		6. Performing Organization Code	
7. Authors William S. Brown		8. Performing Organization Report No. RI/RD 91-235	
		10. Work Unit No.	
9. Performing Organization Name and Address Rockwell International Rocketdyne Division 6633 Canoga Avenue Canoga Park, CA 91304		11. Contract or Grant No. NAS 3-23773	
		13. Type of Report and Period Covered Final Report, Jan 86-Dec 91	
12. Sponsoring Agency Name and Address National Aeronautic Space Administration-Lewis Research Center Space Vehicle Propulsion Branch 21000 Brookpark Road Cleveland, OH 44135		14. Sponsoring Agency Code	
		15. Supplementary Notes Program Manager, G. P. Richter, NASA Lewis Research Center, Cleveland, OH Technical Manager, S. H. Morren, NASA Lewis Research Center, Cleveland, OH	
16. Abstract In order to increase the performance of a high performance, advanced expander-cycle engine combustor, higher chamber pressures are required. In order to increase chamber pressure, more heat energy is required to be transferred to the combustor coolant circuit fluid which drives the turbomachinery. This requirement was fulfilled by increasing the area exposed to the hot-gas by using combustor ribs. A previous technology task conducted 2-d hot air and cold flow tests to determine an optimum rib height and configuration. In task C.5 a combustor calorimeter was fabricated with the optimum rib configuration, 0.040 in. high ribs, in order to determine their enhancing capability. A secondary objective was to determine the effects of mixture ratio changers on the enhancement during hot-fire testing. The program used the Rocketdyne Integrated Component Evaluator (ICE) reconfigured into a thrust chamber only mode. The test results were extrapolated to give a projected enhancement from the ribs for a 16 in. long cylindrical combustor at 15Klb nominal thrust level. The hot-gas wall ribs resulted in a 58% increase in heat transfer. When projected to a full size 15K combustor, it becomes a 46% increase. The results of those tests, a comparison with previous 2-d results, the effects of mixture ratio and combustion gas flow on the ribs and the potential ramifications for expander cycle combustors are detailed.			
17. Key Words (Suggested by Author(s)) Enhanced Heat Transfer Combustor, Ribbed Combustor, Hot-Gas Wall Ribs, Heat Transfer Enhancement		18. Distribution Statement Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages	22. Price*