CR-193972

FINAL REPORT

p. 80

FOR THE

NASA RELOAD PROGRAM

Submitted To:

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER, AL 35812

Submitted Under:

NASA CONTRACT NO: NAS8-38668

Submitted By:

ATLANTIC RESEARCH CORPORATION
PROPULSION DIVISION
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

APRIL 1993

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LIST OF ATTACHMENTS

1.0 INTRODUCTION AND SUMMARY

Atlantic Research Corporation (ARC) contracted with NASA to manufacture and deliver thirteen small scale Solid Rocket Motors (SRM). These motors, containing five distinct propellant formulations, will be used for plume induced radiation studies. The information contained herein summarizes and documents the program accomplishments and results.

Several modifications were made to the scope of work during the course of the program. The effort was on hold from late 1991 through August, 1992 while propellant formulation changes were developed. Modifications to the baseline program were completed in late-August and Modification No. 6 was received by ARC on September 14, 1992. The modifications include changes to the propellant formulation and the nozzle design.

The required motor deliveries were completed in late-December, 1992. However, ARC agreed to perform an additional mix and cast effort at no cost to NASA and another motor was delivered in March, 1993.

2.0 ACTIVITIES

The initial program required refurbishment of NASA supplied hardware and the loading of fourteen motors with a specified propellant formulation. One motor was to be static tested as a demonstration or qualification unit. It was subsequently discovered that the motor cases and forward closures had been insulated with material containing asbestos. As a result of asbestos disposal issues, new cases and closures were purchased along with the required canted nozzles.

Prior to the initiation of propellant casting, NASA developed a need for motors containing a number of different propellant formulations in lieu of the original

single formulation. The nozzle design was also changed from canted to axisymmetric.

A Propellant Mix Plan (Attachment 1) and a Motor/Propellant Matrix (Attachment 2) were developed utilizing five distinct propellant formulations to meet the new requirements. Since Maximum Expected Operating Pressure (MEOP) was of major concern, the formulation for Motor #5 was selected for the demonstration test. This formulation was expected to yield the highest burn rate. Propellant checkout mixes were conducted to verify that burn rate and MEOP could be controlled within contract limits. The schedule by which the work was performed is included as Attachment 3.

Following a successful checkout mix and associated Rohm and Haas (R&H) testing, the demonstration motor was successfully tested on November 6, 1992. NASA representatives witnessed the test of motor SOSM-00. In addition to the thrust/pressure/time data measured by ARC, we assisted NASA personnel with the measurement of plume infrared radiation data. NASA provided instrumentation and ARC collected and recorded data.

Analysis of the R&H results yields maximum pressure predictions for the corresponding full scale motor. As can be seen from the analysis of Rohm and Haas 05 and 06, Motor #2 could experience peak pressures up to 750 psi which is approximately 4% above the allowable maximum pressure. Our structural analysis of the motor components indicated a factor of safety of 4 at this maximum pressure. Based upon the structural analysis, a deviation (Attachment 14) was issued granting relief from the 720 psi MEOP requirement.

Test data for each mix and the demonstration motor are included as Attachments 4 through 11. These data reports are keyed to the Propellant Mix Plan. The first propellant checkout mix (Mix #1) yielded results so close to requirements for the test motor that a second mix (Mix #2) was not needed. Therefore, there were no Rohm and Haas Motors 03 and 04.

X-ray results for Motor #6, the PBAN Motor, indicated the presence of two voids which rendered the motor unacceptable. Recognizing the importance of the PBAN motor to the planned NASA test program, ARC elected to perform an additional mix and cast at no cost to NASA. The effort was successful and the new motor was designated SOSM-14 PBAN/16.0. Motor #6 was subsequently scrapped at ARC.

3.0 SHIPMENTS

The 13 canted nozzles originally purchased for use on the program and the spent motors containing asbestos were shipped to NASA on October 30, 1992.

Motors 1 through 5 and 7 through 13 were shipped on December 28, 1992. The replacement for Motor #6, SOSM-14 PBAN/16.0, was shipped on March 8, 1993.

Copies of the DD Form 250 and the ARC Packing Lists for these shipments are included as Attachment 15.

PROPELLANT MIX PLAN
NASA Reload

Task Description	Notes
1. Mix #1: Formulation 5 in 60-qt Hobart Cast R&H-01 & -02 Perform physicals, strands, & bond tests	Checkout highest rb ASRM variation first
2. Assemble and fire R&H-01 & -02 Reduce data Adjust burn rate and physicals (AR)	
3. Mix #2: Formulation 5 in 60-qt Hobart Cast R&H-03 & -04 Perform physicals, strands, & bond tests	
4. Assemble and fire R&H-03 & -04 Reduce data	
5. Mix #3: Formulation 5 in 140-qt Hobart Cast R&H-05 & -06 Cast SOSM-00 for test Perform physicals, strands, & bond tests	
6. Assemble and fire R&H-05 & -06 Assemble and fire SOSM-00 Reduce data SCSM-00	
7. Mix #4: Formulation 2 in 140-qt Hobart Cast SOSM-02 and R&H-07 & 08 Perform physicals, strands, & bond tests Assemble and fire R&H-07 & 08 Deliver SOSM-02	
8. Mix #5: Formulation 1 in 140-qt Hobart Cast SOSM-01 and R&H-09 & 10 Perform physicals, strands, & bond tests Assemble and fire R&H-09 & 10 Deliver SOSM-01	Checkout lowest rb
9. Mix #6: Formulations 3,9,10,11,12,13 in 150-gal Hbrt. Cast SOSM-03,09,10,11,12,13 & R&H-11 & 12 Perform physicals, strands, & bond tests Assemble and fire R&H-11 & 12 Deliver SOSM-03,09,10,11,12,13	Interpolate based on formulations 5 & 2

MB902-92

ATTACHMENT 1

PROPELLANT MIX PLAN CONTINUED
NASA Reload

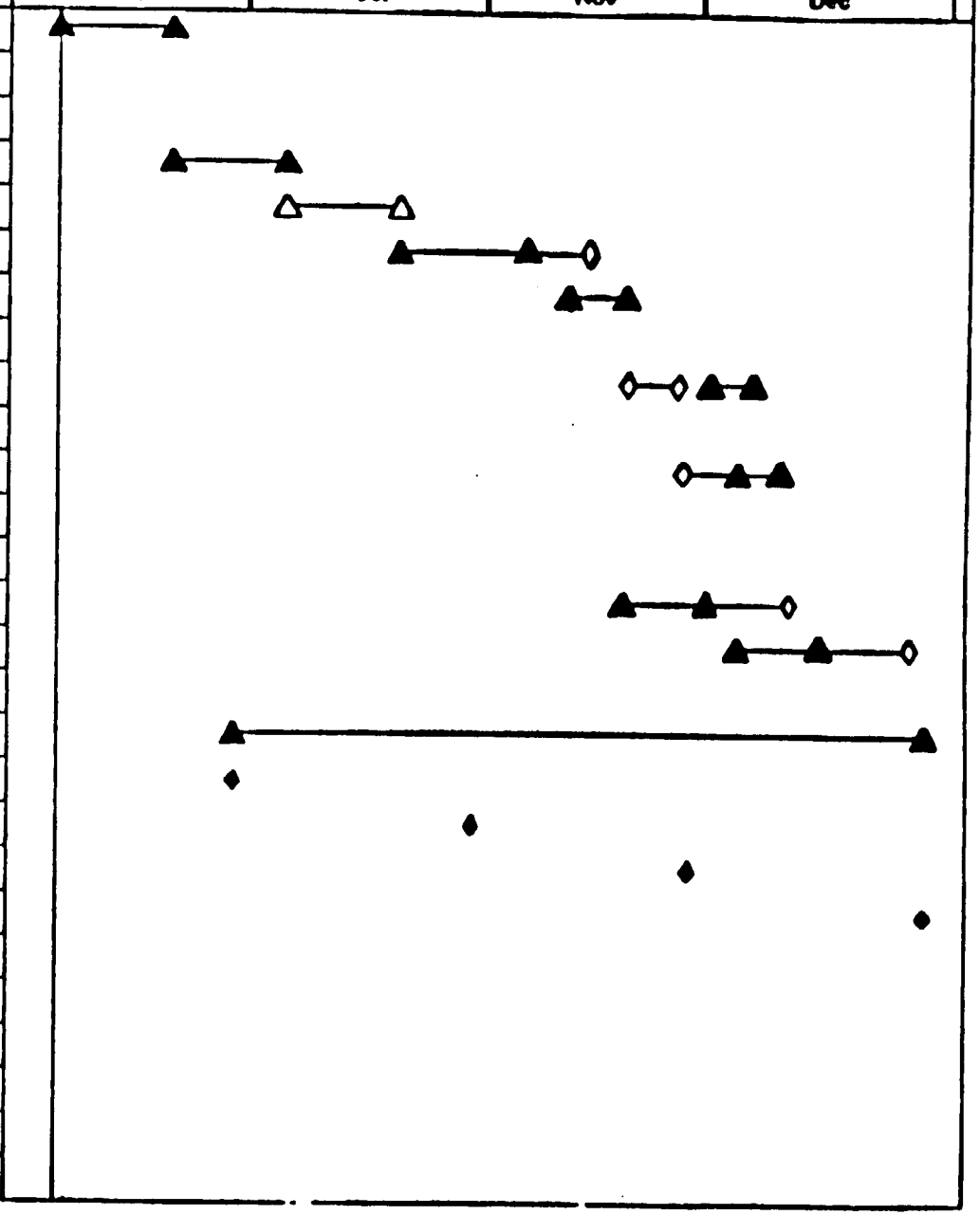
Task Description	Notes
10. Mix #7: Formulation 4 in 150-gal Hobart Cast SOSM-04,05,07,08 and R&H-13 & 14 Perform physicals, strands, & bont tests Assemble and fire R&H-13 & 14 Deliver SOSM-04,05,07,08	
11. Mix #8: Formulation 6 in 140-qt Hobart Cast SOSM-06 and R&H-15 & 16 Perform physicals, strands, & bond tests Assemble and fire R&H-15 & 16 Deliver SOSM-06	

NASA RELOAD
MOTOR/PROPELLANT MATRIX

Motor #	Binder Type	Al %	Al Size	Al Shape	Ox-Ap Cors/Fine	% Solids	Nozzle Geometry
1	HTPB	21.5	30um	Flake	200/20um 70/30%	88	Axisymmetric
2	HTPB	17.5	30um	Flake	200/20um 70/30%	88	Axisymmetric
3	HTPB	19.0	30um	Flake	200/20um 70/30%	88	Axisymmetric
4	HTPB	16.0	30um	Flake	200/20um 70/30%	86	Axisymmetric
5	HTPB	16.0	30um	Flake	200/20um 70/30%	86	Axisymmetric
6	PBAN	16.0	30um	Flake	200/20um 70/30%	86	Axisymmetric
7	HTPB	16.0	30um	Flake	200/20um 70/30%	86	Axisymmetric
8	HTPB	16.0	30um	Flake	200/20um 70/30%	86	Axisymmetric
9	HTPB	19.0	30um	Flake	200/20um 70/30%	88	Axisymmetric
10	HTPB	19.0	30um	Flake	200/20um 70/30%	88	Axisymmetric
11	HTPB	19.0	30um	Flake	200/20um 70/30%	88	Axisymmetric
12	HTPB	19.0	30um	Flake	200/20um 70/30%	88	Axisymmetric
13	HTPB	19.0	30um	Flake	200/20um 70/30%	88	Axisymmetric

NASA RELOAD 38-6464

Task Name	Durat'n (Wks)
ESTABLISH BUDGETS, ORDER MATL	2
FORMULATION #5	8
R&H 1&2	2
R&H 3&4	2
DEMO MTR #00 R&H 5&6	3
MTR #2 R&H 7&8	1
FORMULATION #1 R&H 9&10	1
FORMULATION #6 R&H 15&16	1
FORMULATION/MOTOR	8
MTR #3,9,10,11,12,13 R&H 11&12	3
MTR #4,5,7,8 R&H 13&14	3
MONTHLY REPORTS	12.2
SEPTEMBER	0
OCTOBER	0
NOVEMBER	0
DECEMBER	0



ATTACHMENT 3

NASA RELOAD

Ballistic Analysis

of

ROHM and HAAS Motors

01 and 02

INTRODUCTION

On October 13, 1992 two Rohm and Haas motors (F/N's 02447 and 02448) were fired from NASA Reload Mix 1. This mix was an 86% solids, 16% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. This was designated formulation 5 on the motor/propellant matrix. There were no anomalies noted in the firings.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate and burning rate exponent. Firing number 02447 used an eroding nozzle throat made from Durez. Firing number 02448 used a non-eroding, ATJ graphite throat. The burning rate exponent while the non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02447, the burning rate exponent was determined to be 0.445. Based on the analysis of F/N 02448, the burning rate was determined to be 0.415 inches/second at 669 psi. Using these results, the burning rate equation for this mix is:

$$r = 0.02295\ Pc^{0.445}$$

R. Schubert
1SC/114

TEST DATA REPORT

NASA RELOAD R/H

FIRING NOS:02447-02448
FIRING DATE:OCTOBER 13,1992
MOTOR NOS:15,JGB109

RB DATA

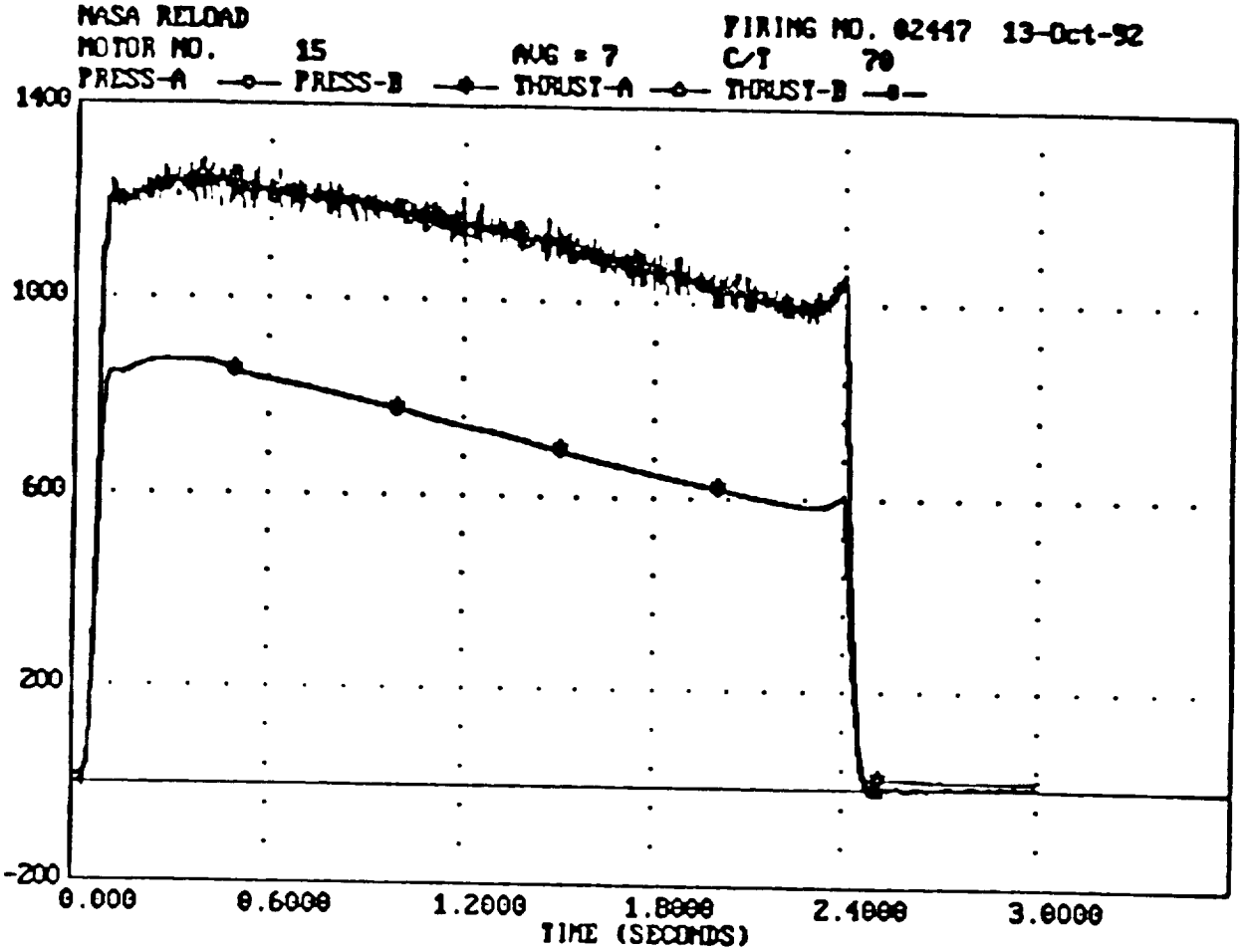
PRODUCT ASSURANCE APPROVAL: N/A 10-15-92

ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

PROPULSION TEST GROUP

OCTOBER 14,1992

SPECIFICATION:.....N/A.....
DATA REDUCTION:..Booster Facility.....
ENGINEERING APPROVAL:...9...3.....10/14/92



TEST DATA SUMMARY

Test ID : NASA RELOAD
Acct No. 38-6464-N6-1000
Motor No. 15
Grain No. BD9663-T
Pro. Wgt. 5144.0000 grams
Web 0.9800 in.

Firing Number 02447
Date Tested 13-Oct-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 57.00 Deg. F
Rel Humidity 60.00 %
Barometer 29.95 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0525
Ignition Rise (10% - 75%) 0.0320
Action Time (10% - 10%) 2.4000
Burn Time (10% - TAN) 2.3552
Total Time (0 - 0) 2.4781

CHN ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-A (PSIA)	1724.5	1722.6	1709.9	717.8	726.0	872.0
01 PRESS-B (PSIA)	1727.5	1725.5	1712.5	719.0	727.1	872.3
02 THRUST-A (LBF)	2655.5	2654.2	2634.8	1105.9	1118.7	1266.3
03 THRUST-B (LBF)	2674.4	2673.0	2653.4	1113.8	1126.6	1269.8

Observed Burn Rate = 0.4161 in/sec. @ 726.0 psia
Specific Impulse = 234.1590 lbf-s/lbm
Action / Burn Time = 1.0190

Propellant Characterization
LKB 10-13-92

TEST INFORMATION SHEET

PROGRAM NAME: NASA Reload

ACCT. NO. 38-6464-NC-N6-1000

MOTOR NO. 15

GRAIN NO. B09663-T

PURPOSE OF TEST BURN RATE (R+H)

DuREZ Nozzle Insert

PROPULSION TEST SPEC. NO. _____

SCHEDULE DATE: _____

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: R. Schubert, M. Brinegar, C. Harrod

X-RAY REVIEW: ACCEPTABLE: ___ UNACCEPTABLE: ___

MOTOR ASSEMBLY

Assy. Drawing No. _____
Motor: _____
Nozzle: Duraz
DT = 1.102
Insulation: _____
Other Components: _____

GRAIN PREPARATION

End Preparation: _____

Inhibiting: _____

Bonding: _____

IGNITER

Assy. Drawing No. _____
Squibs: Atlas match

Igniter Charge: 20 g-D
10 g C

Housing or Container: _____

PROPELLANT DATA

Motor Weight Before Firing: 87.0 LBS
Motor Weight After Firing: _____
Inhibited Grain Weight: _____
W_p, Propellant Weight: 5144 gm = 11.34 LBS
Grain I.D. 4.057, 4.055, 4.052, 4.057
Grain O.D. 6.016, 6.012, 6.017, 6.016
Web: _____
Grain Length: 11.290 + 11.295
D_t: Before: 1.1070
After: _____
D_e: Before: 3.540
After: _____

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value
t_b	3 Sec
2 Thrust	1000 lb
2 Pressure	1900 psi
Temp	Supply Location Dia

Other Instructions or Comments: _____

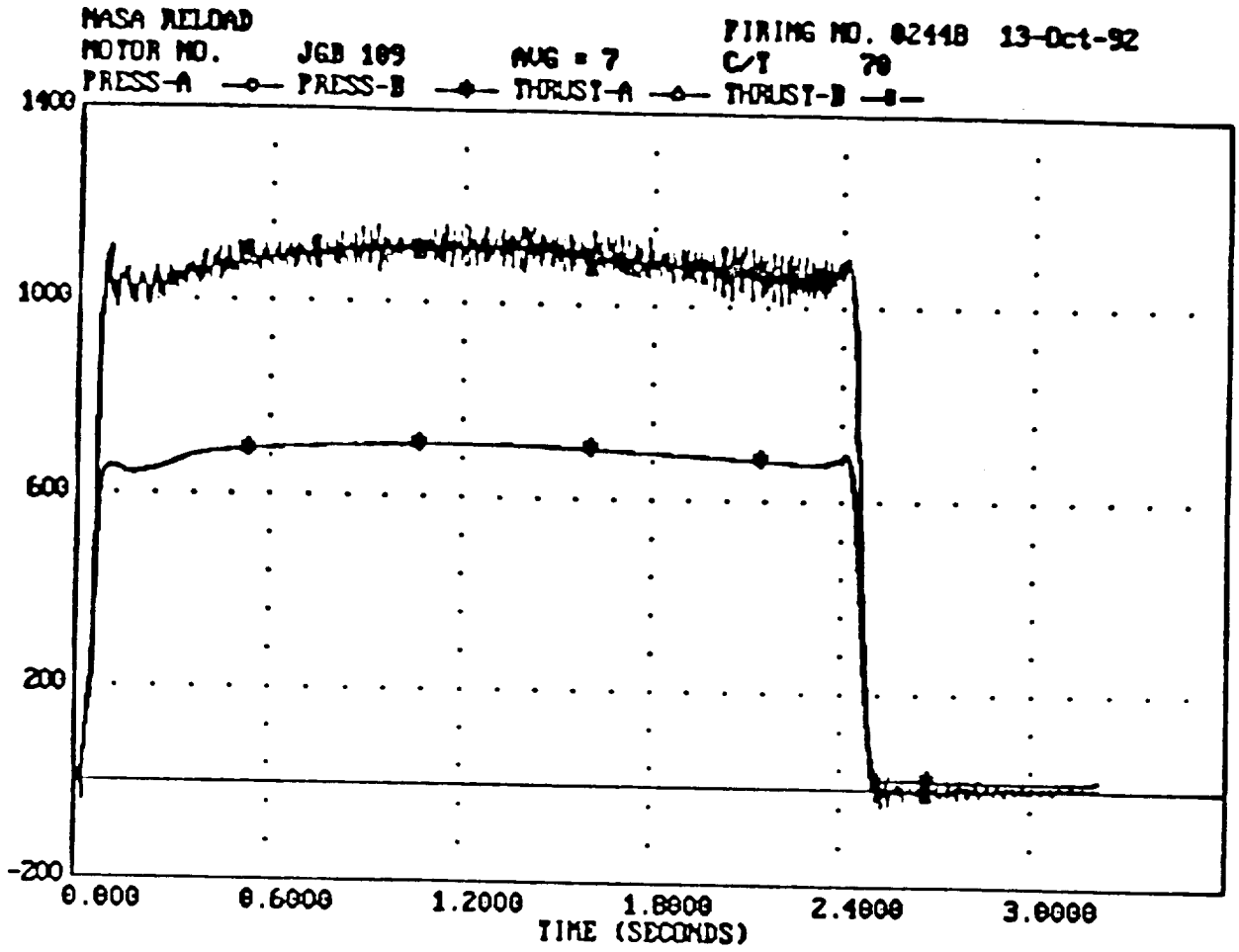
PRODUCT ASSURANCE

Garry S. Price 10/9/92
PROGRAM SIGNATURE

TEST

Not Req
ENGINEERING

In Box 6 @ 1320 +75.8" 10-12-92 WBty



TEST DATA SUMMARY

Test ID : NASA RELOAD
Acct No. 38-6464-N6-1000
Motor No. JGB 109
Grain No. 809663-T
Pro. Wgt. 5143.0000 grams
Web 0.9815 in.

Firing Number 02448
Date Tested 13-Oct-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 57.00 Deg. F
Rel Humidity 60.00 %
Barometer 29.95 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0333
Ignition Rise (10% - 75%) 0.0352
Action Time (10% - 10%) 2.4640
Burn Time (10% - TAN) 2.4096
Total Time (0 - 0) 2.5197

CHN ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-A (PSIA)	1664.8	1663.6	1645.9	675.1	683.1	708.2
01 PRESS-B (PSIA)	1665.5	1664.1	1646.7	675.4	683.4	707.6
02 THRUST-A (LBF)	2603.1	2602.3	2577.9	1056.2	1069.9	1152.1
03 THRUST-B (LBF)	2618.6	2617.7	2593.1	1062.4	1076.2	1160.0

Observed Burn Rate = 0.4073 in/sec. @ 683.1 psia
Specific Impulse = 229.5882 lbf-s/lbm
Action / Burn Time = 1.0226

Propellant Characterization
FHD 10-12-92

TEST INFORMATION SHEET

PROGRAM NAME: NASA Reload

ACCT. NO. 38-6464-~~A5-1000~~ A6-1000

MOTOR NO. IGB-107

GRAIN NO. B09663-T

PURPOSE OF TEST Burn Rate (R+H)

ATJ Nozzle Insert

PROPULSION TEST SPEC. NO.

SCHEDULE DATE:

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: R. Schubert, C. Harrod, M. Arrington

X-RAY REVIEW: ACCEPTABLE: ____ UNACCEPTABLE: ____

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: ATJ
DT = 1.186 in
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No.
Squibs: Atlas match
Igniter Charge: 20g 2-D
10g 2C
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 89.3 LBS
Motor Weight After Firing:
Inhibited Grain Weight:
W_p Propellant Weight: 5143 gm = 11.33 LBS
Grain I.D. 4.045, 4.043, 4.047, 4.052
Grain O.D. 6.010, 6.011, 6.009
Web:
Grain Length: 11.283 11.382
D_t: Before: 1.186
After:
D_e: Before: 3.524
After:

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value
____ t_b	3 Sec
2 Thrust	1000 lb
2 Pressure	590 psi
____ Temp	Supply Location D

Other Instructions or Comments:

SIGNATURE

PRODUCT ASSURANCE

Harry E. Price 10/9/92
PROGRAM

TEST

Not REQ.
ENGINEERING

FU BOX @ 1320 f 75.8° 10-12-92 WBS

NASA RELOAD

Ballistic Analysis

of

ROHM and HAAS Motors

05 and 06

INTRODUCTION

On November 3, 1992 two Rohm and Haas motors (F/N's 02478 and 02479) were fired from NASA Reload Mix 3. This mix was an 86% solids, 16% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. This was designated formulation 5 on the motor/propellant matrix and was identical to Mix 1. Due to an operator error, the thrust data on F/N 02479 was not properly acquired. No meaningful data can be acquired from this firing since the thrust data is critical to the analysis of this motor. The data from the remaining motor is sufficient to determine the acceptability of this batch.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate. Firing number 02478 used a non-eroding, ATJ graphite throat. The non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02478, the burning rate was determined to be 0.383 inches/second at 565 psi. Using these results, and the burning rate exponent of 0.445 obtained from Mix 1, the burning rate equation for this mix is:

$$r = 0.02283\ Pc^{0.445}$$

This is 0.52% lower than Mix 1 and is within the acceptable range.

R. Schubert
450/114

TEST DATA REPORT

NASA RELOAD R/H

FIRING NOS:02478-02479
FIRING DATE:NOVEMBER 3,1992
MOTOR NOS:RRSM-5,RRSM-14

RB DATA

PRODUCT ASSURANCE APPROVAL: N/A 11/6/92

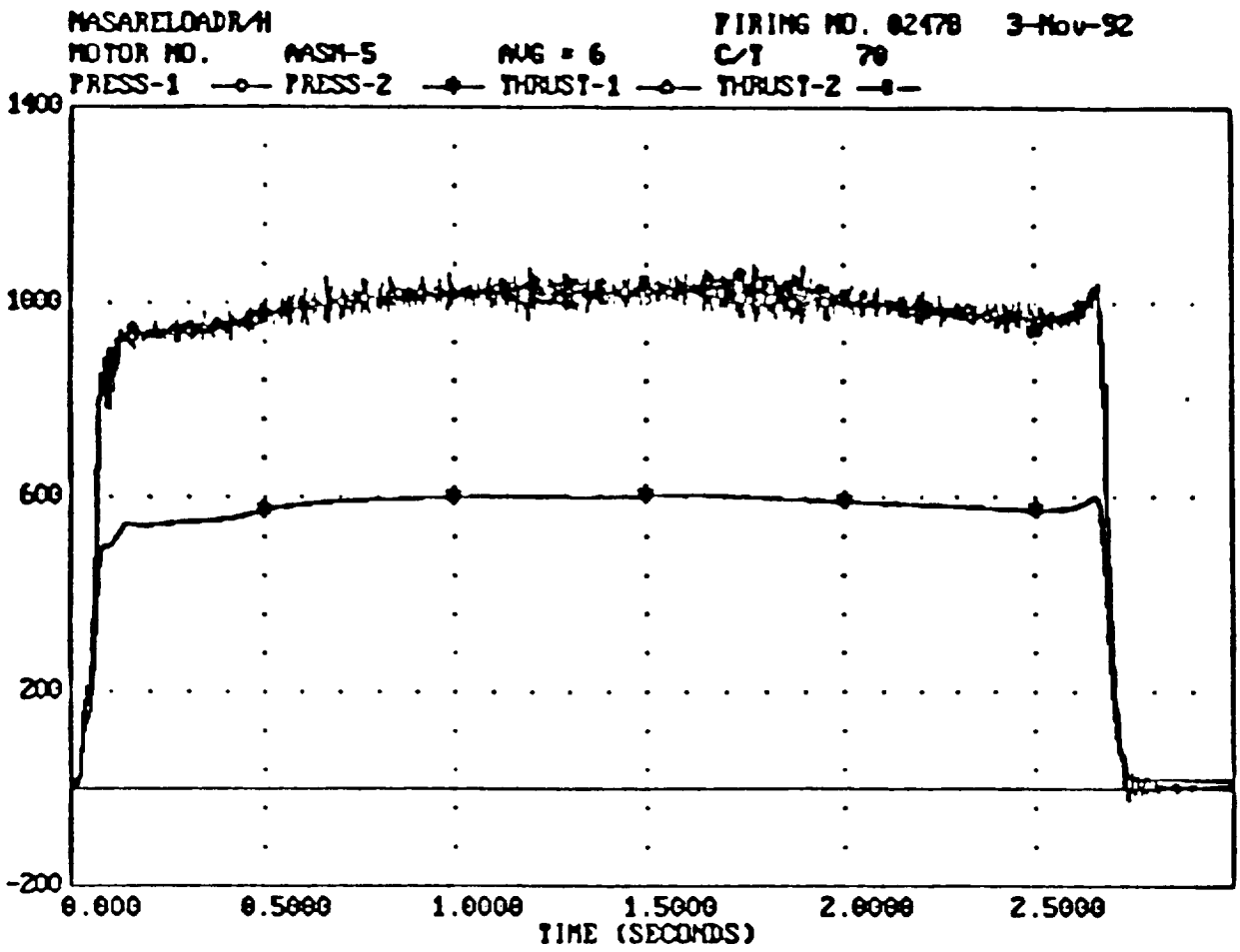
ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

PROPULSION TEST GROUP

NOVEMBER 3,1992

SPECIFICATION: N/A
DATA REDUCTION: Baseline Facility
ENGINEERING APPROVAL: J. Pate

DISCREPANCIES NOTED:
Thrust clipped on PTN 02479 - operator error - left top step cal on Amplifier



TEST DATA SUMMARY

Test ID : MASARELOADR/H		Firing Number	02478
Acct No.	38-6464-M6-1000	Date Tested	3-Nov-92
Motor No.	AASM-5	Cond. Temp.	70.00 Deg. F
Grain No.	BU9681-T	Ambient Temp.	64.00 Deg. F
Pro. Wgt.	5225.6001 grams	Rel Humidity	68.00 %
Web	0.9940 in.	Barometer	29.83 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%)	0.0309	Ignition Rise (10% - 75%)	0.0440
Action Time (10% - 10%)	2.6860	Burn Time (10% - TAN)	2.6400
Total Time (0 - 0)	2.7449		

CHN ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-1 (PSIA)	1538.1	1536.8	1524.5	572.2	577.5	603.8
01 PRESS-2 (PSIA)	1534.7	1533.5	1521.4	570.9	576.3	601.7
02 THRUST-1 (LBF)	2611.4	2610.6	2592.2	971.9	981.9	1077.9
03 THRUST-2 (LBF)	2614.1	2613.3	2594.9	972.9	982.9	1079.2

Observed Burn Rate =	0.3765 in/sec. @	577.5 psia
Specific Impulse =	226.6741 lbf-s/lbm	
Action / Burn Time =	1.0174	

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-N6-1000

MOTOR NO. AASM-5

GRAIN NO. B09681-T

PURPOSE OF TEST R+H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 10-29-92

DELIVER EXPENDED MOTOR TO: Bldg 97 C. Harrod, G. Price

DISTRIBUTE DATA TO: R. Schubert, M. Byington

X-RAY REVIEW: ACCEPTABLE: ____ UNACCEPTABLE: ____

ATJ INSERT

MOTOR ASSEMBLY

Assy. Drawing No. ____

Motor: ____

Nozzle: ATJ

Insulation: ____

Other Components: ____

GRAIN PREPARATION

End Preparation: ____

Inhibiting: ____

Bonding: ____

IGNITER

Assy. Drawing No. ____

Squibs: Atlas match

Igniter Charge: 20 expelled pellets + 10.0 gm 3 Composition

Housing or Container: ____

PROPELLANT DATA

Motor Weight Before Firing: 89.6 Lbs

Motor Weight After Firing: ____

Inhibited Grain Weight: ____

W_p, Propellant Weight: 5225.6 g

Grain I.D.	4.041	4.042	4.044
Grain O.D.	6.029	6.030	6.031
Web:			
Grain Length:	11.309	11.310	11.315
D_t: Before:	1.2406		
After:			
D_e: Before:	3.502		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F

Equilibrium Time: 4 Hrs

Other Conditioning: Supply Temperature Cycling Instrument Sheet*

Instrumentation Required	Expected Max. Value	
____ lb	3	Sec
2 Thrust	1000	lb
2 Pressure	1000	psi
____ Temp	Supply Location Dia	

Other Instructions or Comments: ____

11-3-92

PRODUCT ASSURANCE

Harry E. Price 10/27/92

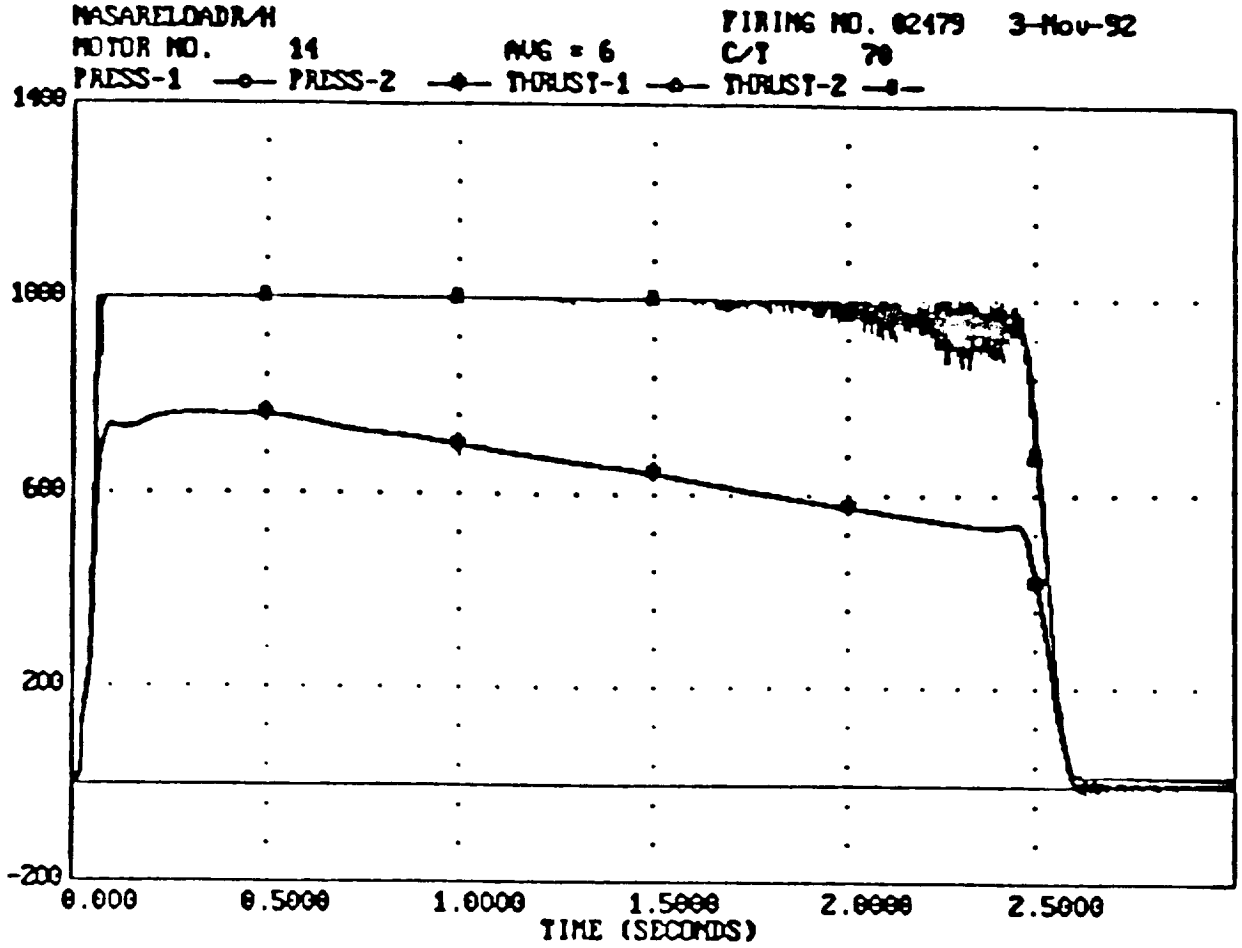
PROGRAM

SIGNATURE

TEST

NOT REQ

ENGINEERING



TEST DATA SUMMARY

Test ID : NASARELOADR/H
Acct No. 38-6464-M6-1000
Motor No. 14
Grain No. B09681T
Pro. Wgt. 5162.3999 grams
Web 0.9845 in.

Firing Number 02479
Date Tested 3-Nov-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 64.00 Deg. F
Rel Humidity 68.00 %
Barometer 29.83 inHg

TIME VALUES
(seconds)

Ignition Delay	(0 - 10%)	0.0289	Ignition Rise	(10% - 75%)	0.0360
Action Time	(10% - 10%)	2.5440	Burn Time	(10% - TAN)	2.4440
Total Time	(0 - 0)	2.5989			

CHN ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-1 (PSIA)	1630.9	1629.3	1597.4	640.5	653.6	762.3
01 PRESS-2 (PSIA)	1629.0	1627.5	1595.8	639.7	652.9	761.1
02 THRUST-1 (LBF)	2442.4	2441.3	2389.4	959.6	977.7	997.0
03 THRUST-2 (LBF)	2448.9	2447.6	2395.4	962.1	980.1	998.7

Observed Burn Rate = 0.4028 in/sec. @ 653.6 psia
Specific Impulse = 214.6023 lbf-s/lbm
Action / Burn Time = 1.0409

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-NG-1000

MOTOR NO. AASM-14

GRAIN NO. B09681-T

PURPOSE OF TEST R+A

PROPULSION TEST SPEC. NO. GTP9606

SCHEDULE DATE: 10-29-92

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: C. Nasood, G. Price
R. Schubert, M. Arrington

X-RAY REVIEW: ACCEPTABLE: ____ UNACCEPTABLE: ____

Durez Throat

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: Durez
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No.
Squibs: Ordnance

Igniter Charge: 2 w. Dop 2d Pellets + 10.0 gm 2C granules

Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 88.4 LBS
Motor Weight After Firing:
Inhibited Grain Weight:
W_p. Propellant Weight: 5162.4 g

Grain I.D.	4.041	4.043	4.044
Grain O.D.	6.010	6.012	6.014
Web:			
Grain Length:	11.304	11.305	
D_t: Before:	1.1401		
After:			
D_e: Before:	3.500		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value
____ lb	3 Sec
2 Thrust	1000 lb
2 Pressure	1000 psi
____ Temp	Supply Location D

Other Instructions or Comments:

11-3-92
PRODUCT ASSURANCE

Garry E. Price 10/27/92
PROGRAM

SIGNATURE

TEST

NOT REQ.
ENGINEERING

Both units in Box 6 @ +69°F on 11-2-92 @ 14:15. WJY

NASA RELOAD

Ballistic Analysis

of

Demonstration Motor

SOSM-00

INTRODUCTION

On November 6, 1992 a full scale motor from NASA Reload Mix 3 was fired (F/N 80956). This mix was an 86% solids, 16% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. This was designated formulation 5 on the motor/propellant matrix and was identical to Mix 1.

The motor operation closely matched expectations with no performance or data acquisition anomalies.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor operating performance. The results of this analysis are summarized in Table 1.

The propellant burning rate was determined to be 0.426 inches/second at 655 psia. Assuming that the burning rate exponent is unchanged from Mix 1 at 0.445, then the burning rate equation for this motor is calculated to be:

$$r = 0.02378\ Pc^{0.445}\ \text{inches/second}$$

This is 4.1% higher than the burning rate determined in the Rohm and Haas firing for this mix. This is typical for this type of propellant.

CONCLUSIONS AND RECOMMENDATIONS

The maximum pressure observed of 720 psia precisely equaled the requirement. Because of this, it is recommended that the iron oxide content of the propellant be decreased from 0.5% to 0.25% in all future mixes. This will allow some margin on the maximum pressure requirement in subsequent firings.

Table 1. Ballistic Performance Summary

Burn Time, seconds	5.087
Action Time, seconds	5.539
Burn Time Average Pressure, psia	654.6
Action Time Average Pressure, psia	634.2
Maximum Pressure, psia	720.0
Burn Time Average Thrust, lbf	4451
Action Time Average Thrust, lbf	4302
Maximum Thrust, lbf	5677
Nozzle Throat Efficiency	0.998
Thrust Efficiency	0.956
Total Pressure Integral, psia-sec	3515
Total Impulse, lbf-sec	23839
Propellant Weight, lbm	100.7
Delivered Specific Impulse, lbf-sec/lbm	236.7

TEST DATA REPORT

NASA RELOAD

FIRING NO:80956
FIRING DATE:NOVEMBER 6,1992
MOTOR NO:SOSM-00

LOT ACCEPTANCE TEST

PRODUCT ASSURANCE APPROVAL: N/A 11/11/92

ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

PROPULSION TEST GROUP

NOVEMBER 6,1992

SPECIFICATION:.....MTS-270.....
DATA REDUCTION:.....DLC.....
ENGINEERING APPROVAL:.....

TEST DATA SUMMARY

Test ID NASA RELOAD
Account No. 36-6464-N6-2###
Motor No. SOSM-##
Grain No. B#9681-T
Propellant Weight 1##.699997
Web #.######

Firing Number ##956
Date Tested 6-NOV-92
Conditioning Temp. 7#.#
Ambient Temp. 45.#
Relative Humidity 5#.#
Barometer 3#.#5

TIME VALUES

Ignition Delay Time	Burn Time	Action Time	Total Time
#.#112 sec.	5.2488 sec.	5.5538 sec.	5.74## sec.

SUMMARY BY CHANNEL

Channel:		TOTAL	INTEGRAL ACTION	INTEGRAL BURN	AVERAGE ACTION	AVERAGE BURN	MAXIMUM	
1	THRUST-A	23911.9	23897.9	23224.6	43#3.#	4424.8	56#6.3	(#.#92 sec.)
2	THRUST-B	23915.3	239#1.5	23228.2	43#3.7	4425.5	5613.1	(#.#92 sec.)
3	PRESS-A	3527.9	3523.3	3416.8	634.4	651.#	72#.7	(#.9#2 sec.)

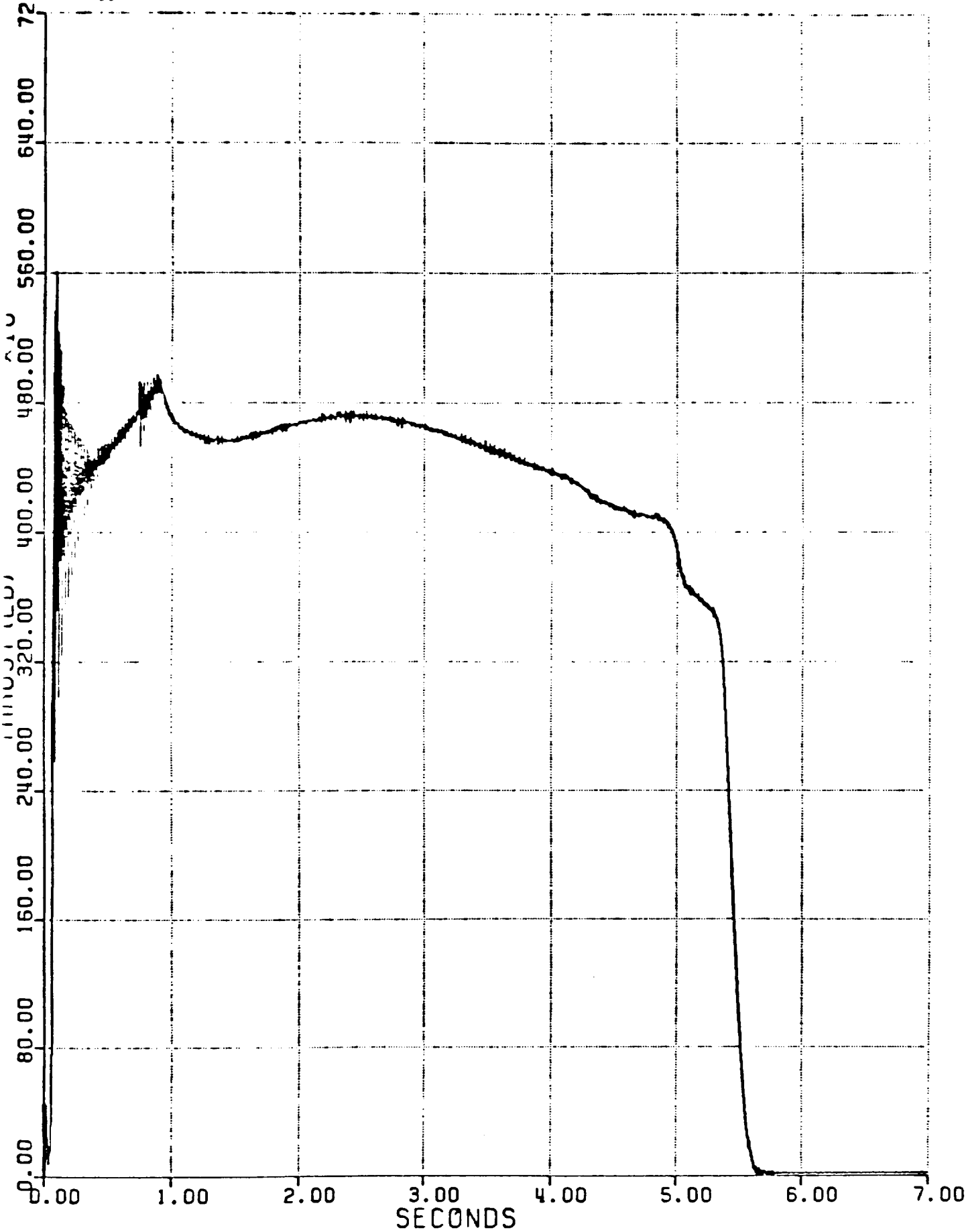
SENSOR TYPE AVERAGES

Sensor Type:	TOTAL	INTEGRAL ACTION	INTEGRAL BURN	AVERAGE ACTION	AVERAGE BURN	MAXIMUM	UNITS
Load Cell	23913.6	23899.7	23226.4	43#3.3	4425.1	56#9.7	Lbf
Pressure (PR)	3527.9	3523.3	3416.8	634.4	651.#	72#.7	Psi

TEST ID: NASA RELOAD
MOTOR S/N: SOSM-00
POINTS DIGITIZED: 20
PLOT TITLE:
THRUST-A

FIRING NO: 80956
TEST DATE: 6-NOV-92
E/T: 70.0

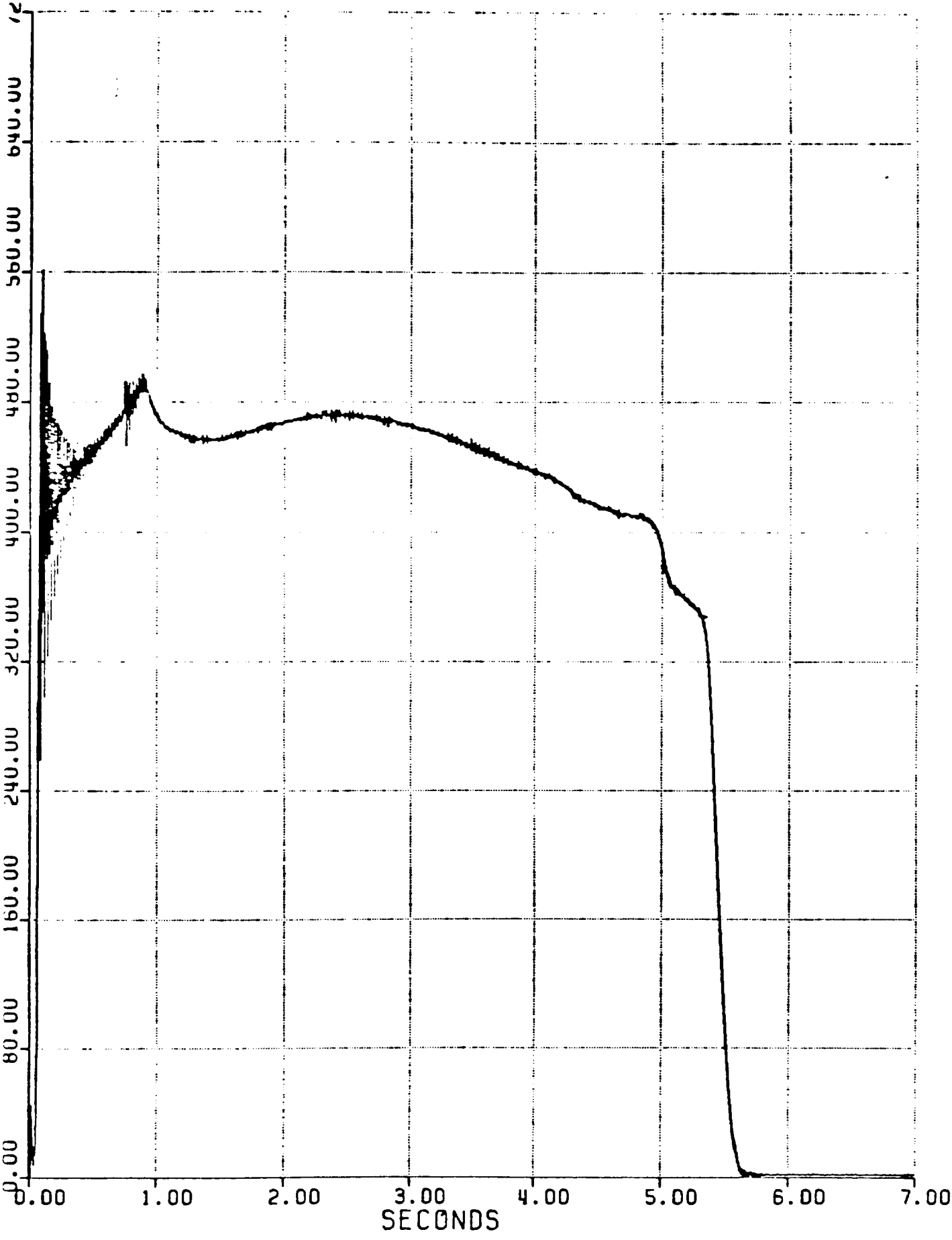
THRUST-A



TEST ID: NASA RELOAD
MOTOR S/N: SOSM-00
POINTS AVERAGED: 20
PLOT TITLE:
THRUST-B

FIRING NO: 80956
TEST DATE: 6-NOV-92
ET: 70.0

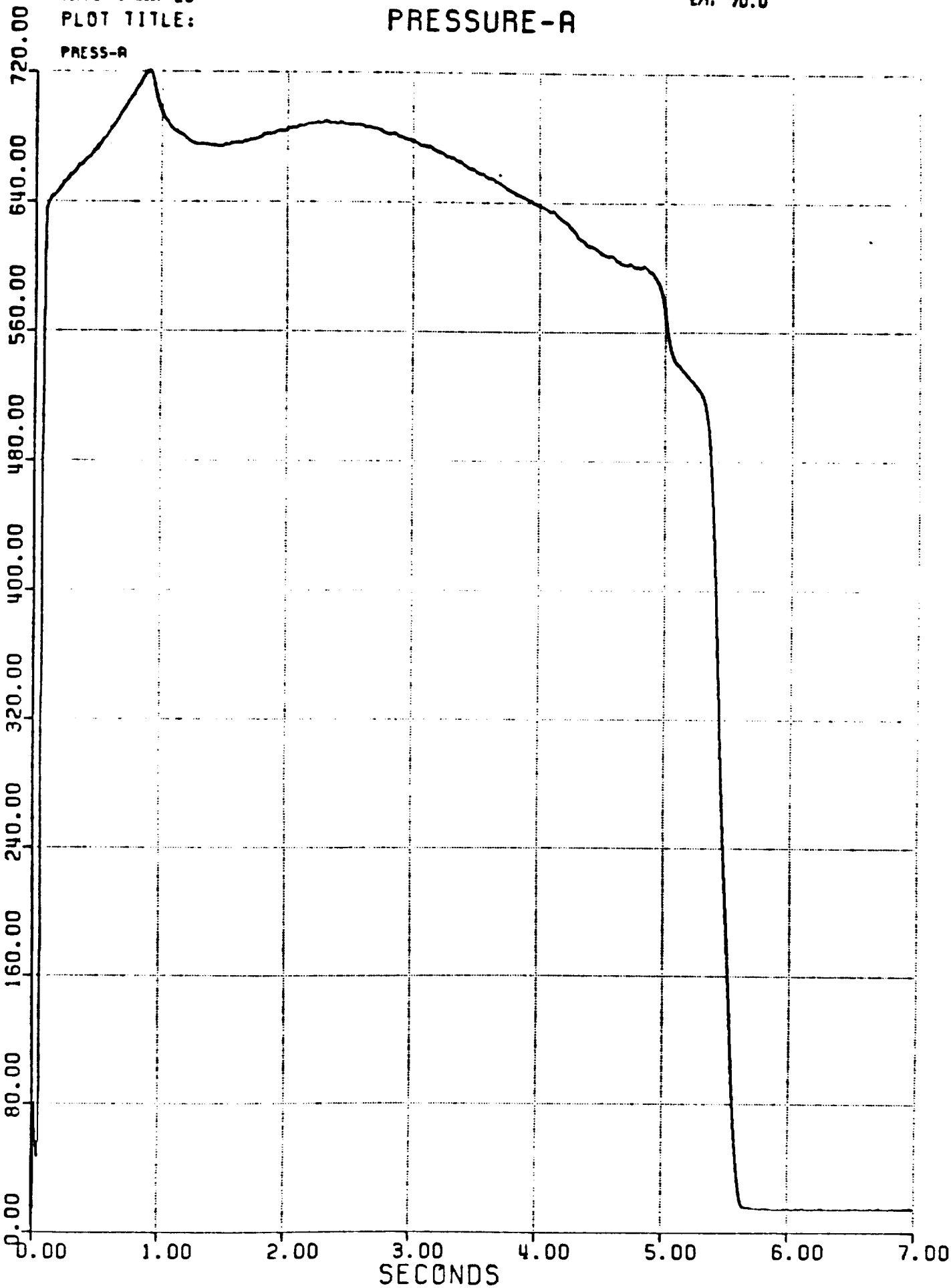
THRUST-B



TEST ID: NASA RELOAD
MOTOR S/N: 50SM-DD
POINTS AVERAGED: 20
PLOT TITLE:
PRESS-A

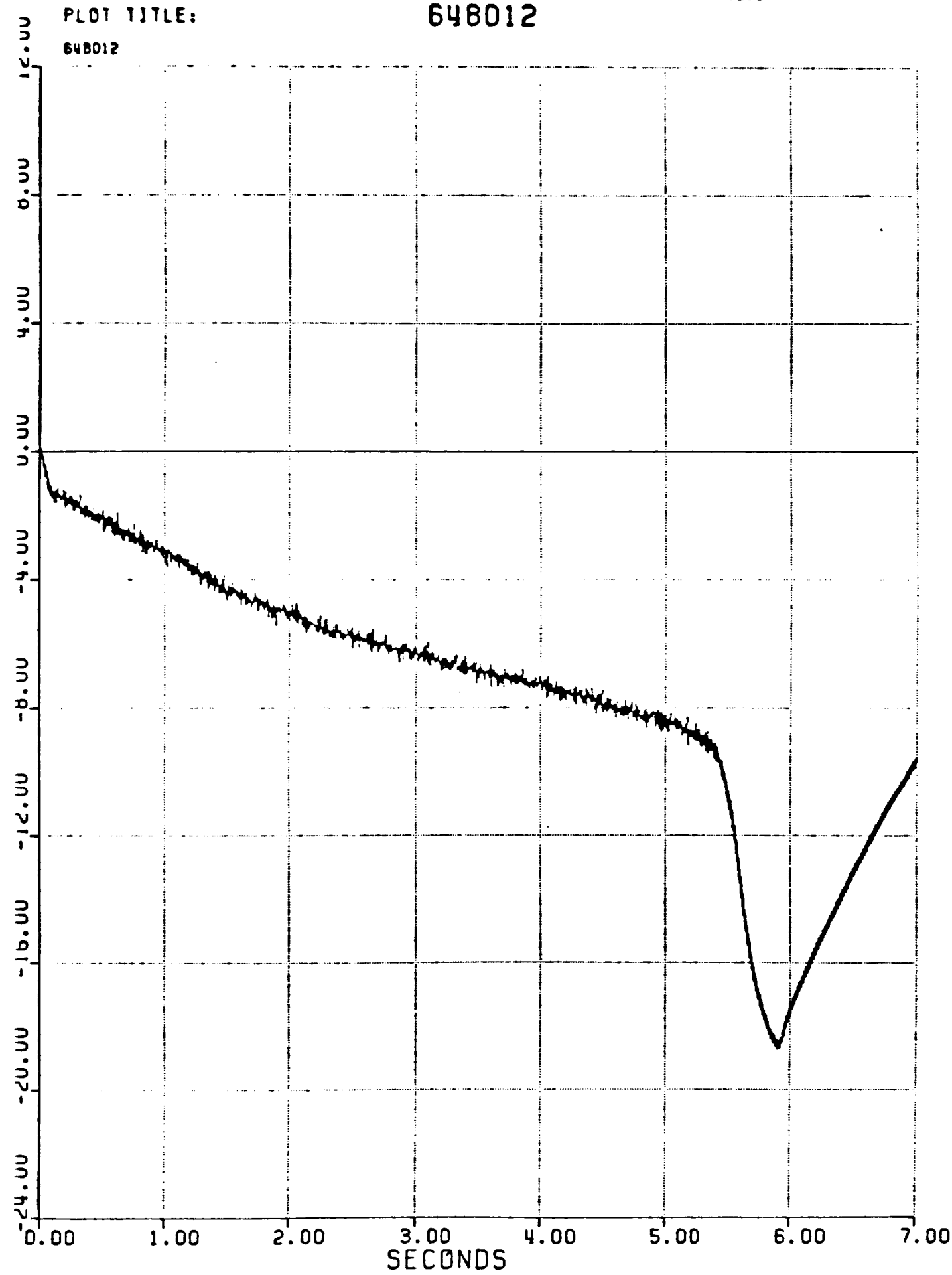
PRESSURE-A

FIRING NO: 80956
TEST DATE: 6-NOV-92
E/T: 70.0



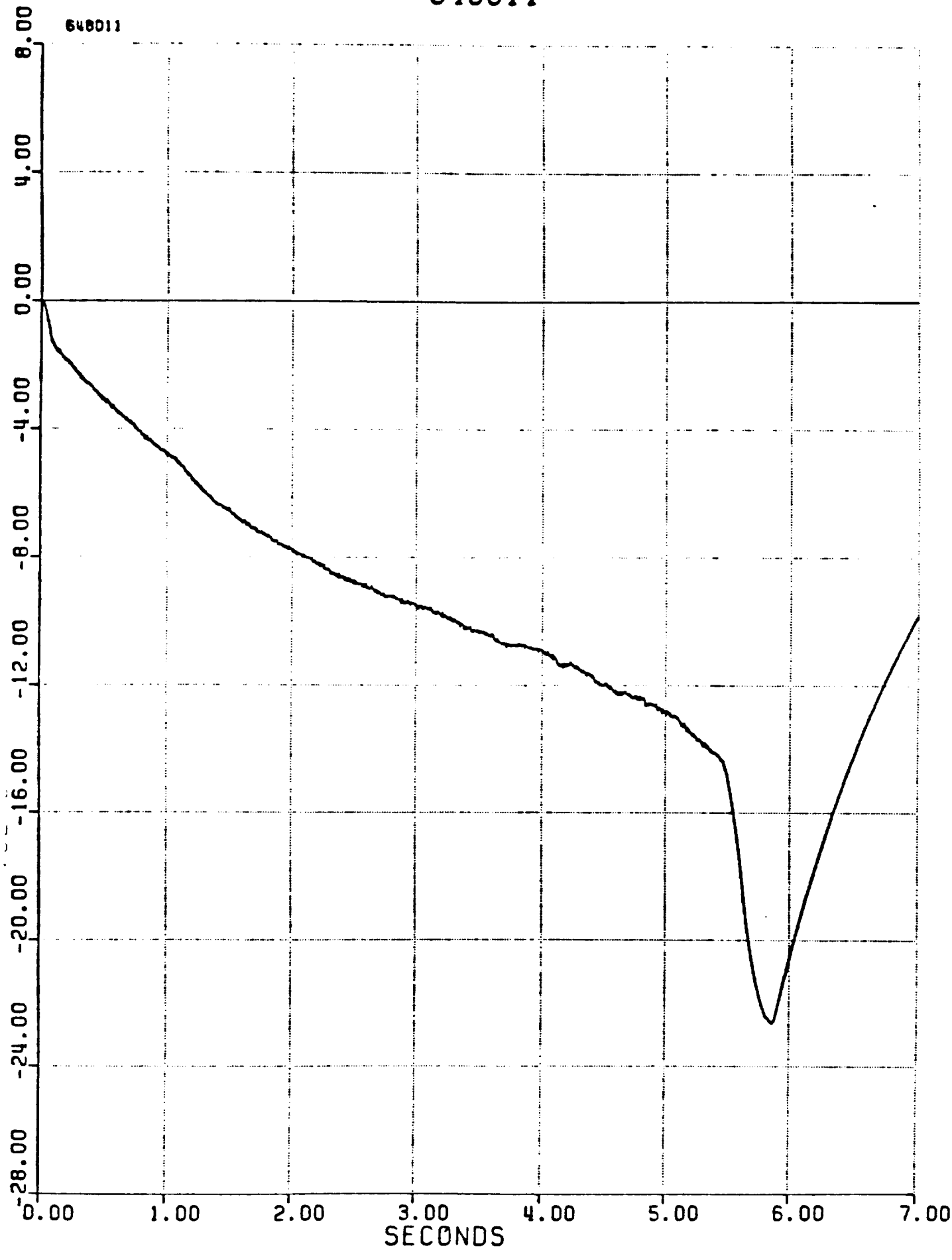
TEST ID: NASA RELOAD
MOTOR S/N: SOSM-00
POINTS AVERAGED: 20
PLOT TITLE:
648012

FIRING NO: 80956
TEST DATE: 6-NOV-92
ET: 70.0



TEST ID: NASA RELOAD
MOTOR S/N: SDSM-00
POINTS AVERAGED: 20
PLOT TITLE: 648011

FIRING NO: 80956
TEST DATE: 6-NOV-92
C/I: 70.0

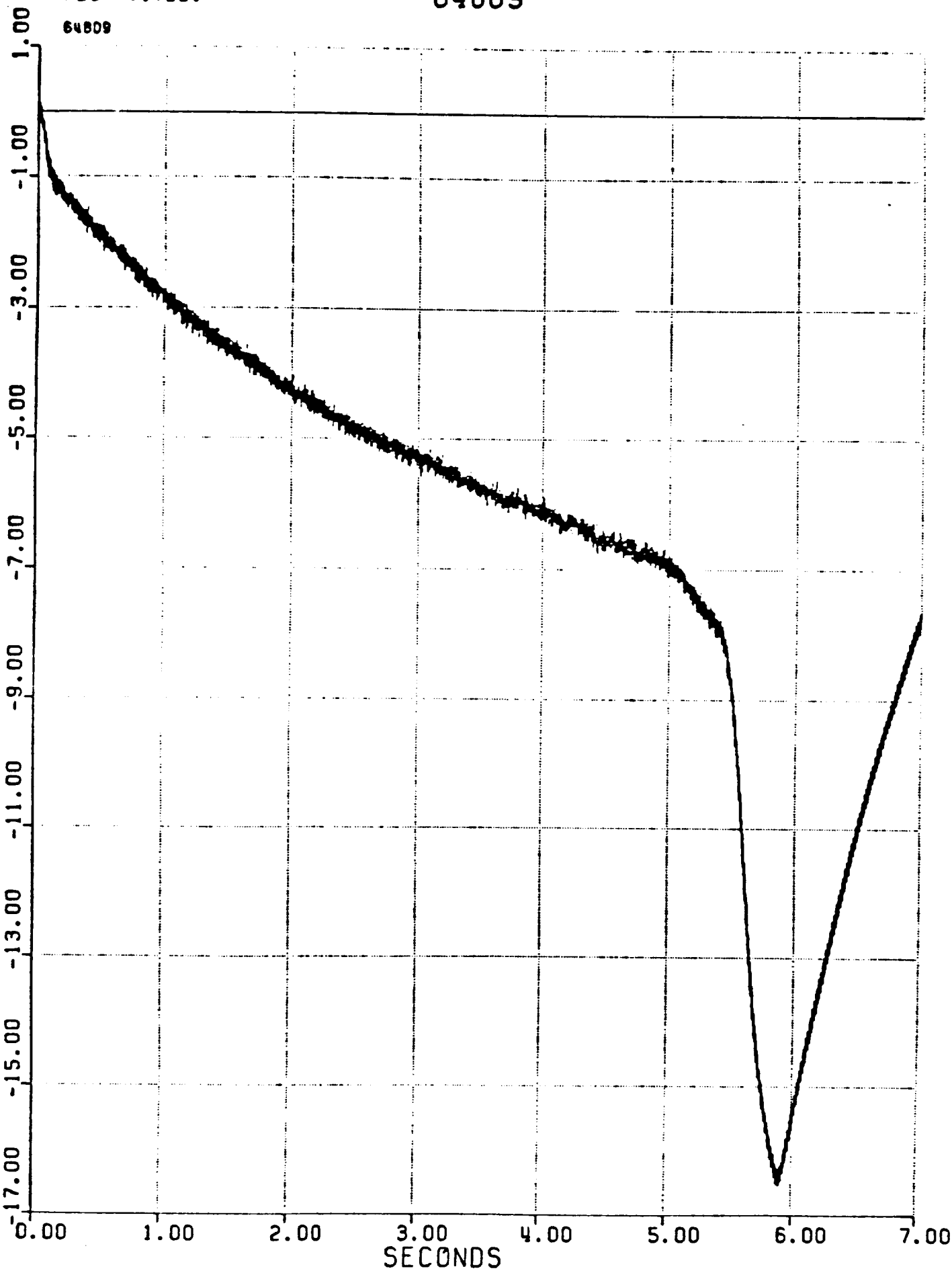


TEST ID: NASA RELOAD
MOTOR S/N: SOSM-00
POINTS AVERAGED: 20
PLOT TITLE:

FIRING NO: 80956
TEST DATE: 6-NOV-92
ETI: 70.0

64809

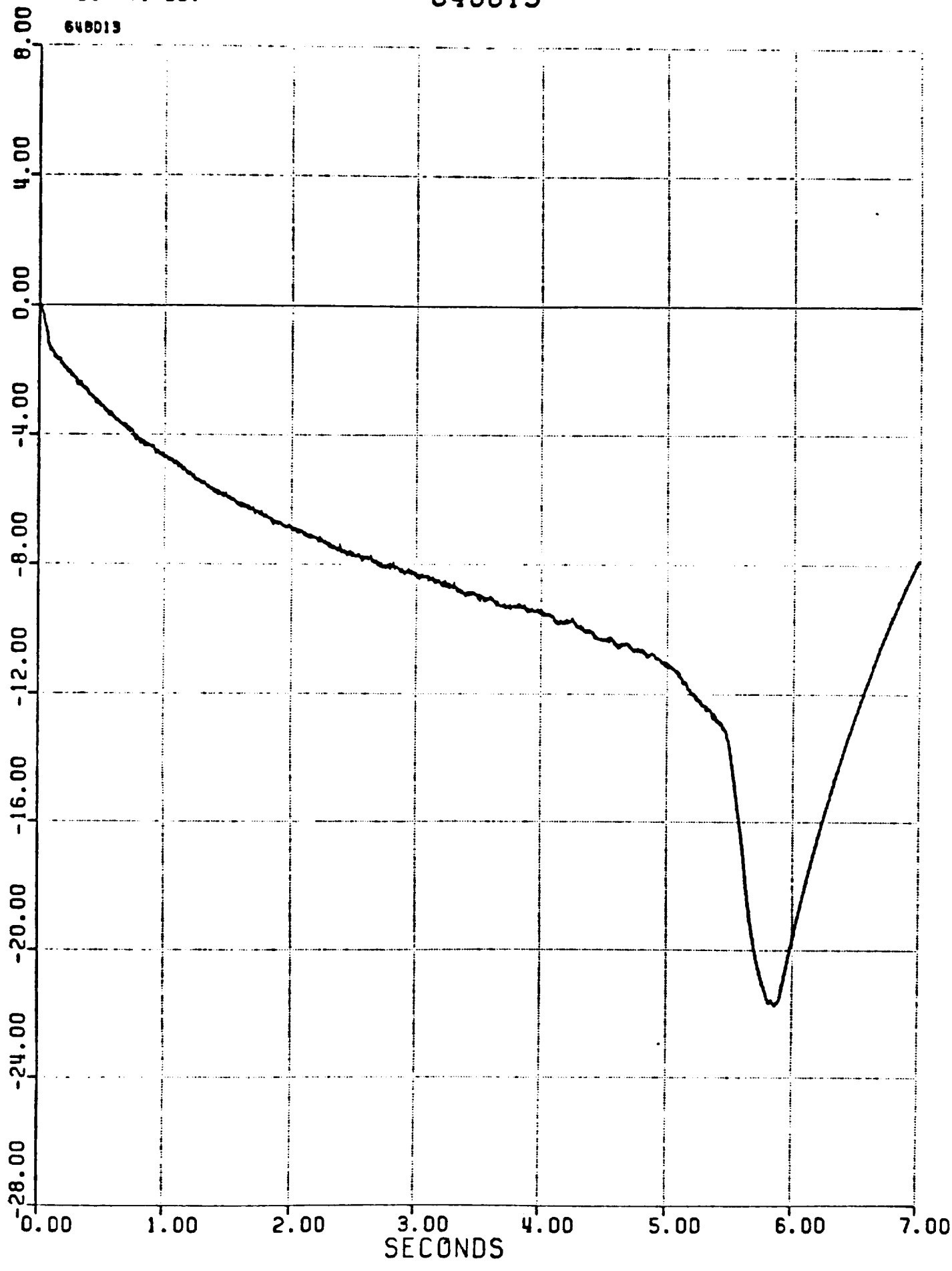
64809



TEST ID: NASA RELOAD
MOTOR S/N: SOSM-00
POINTS AVERAGED: 20
PLOT TITLE:

FIRING NO: 80956
TEST DATE: 6-NOV-92
E/T: 70.0

648013

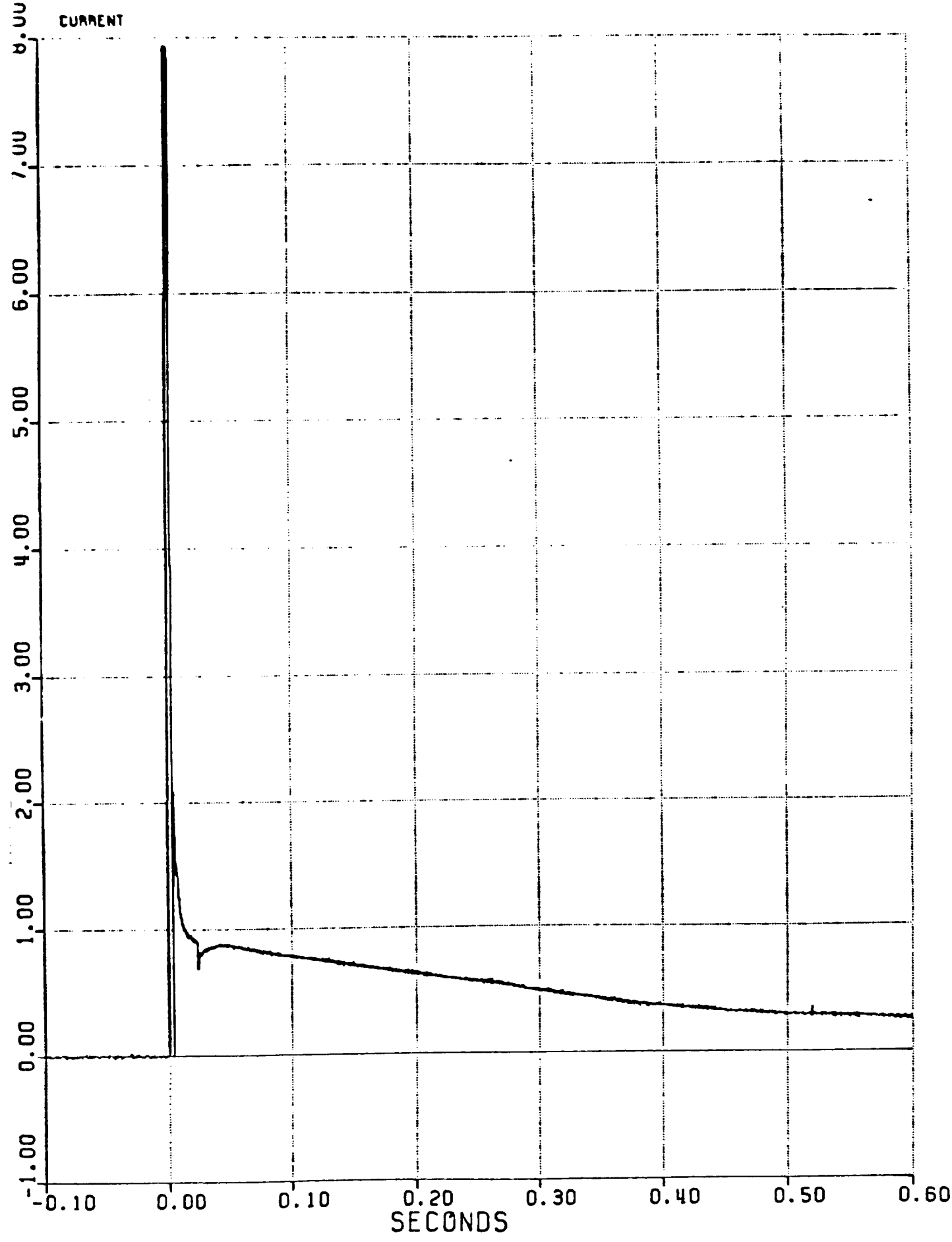


TEST ID: NASA RELOAD
MOTOR S/N: SOSM-00
POINTS AVERAGED: 2
PLOT TITLE:

FIRING NO: 80956
TEST DATE: 6-NOV-92
E/T: 70.0

CURRENT

CURRENT



i.3

IN Box 6
+70, 11-4-92, 1735h
S/N DM-15

11/6/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 36-6464-N6-2000

MOTOR NO. SDSM-00

GRAIN NO. B09681-T / DM-15

PURPOSE OF TEST LAT

PROPULSION TEST SPEC. NO. MTS-270

SCHEDULE DATE: 11-6-92

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: G. Schlubert, M. Ayingdon, G Price

X-RAY REVIEW: ACCEPTABLE: X UNACCEPTABLE: ____

MOTOR ASSEMBLY

Assy. Drawing No.
Motor: A0327001-002 A
Nozzle: H4501 A

Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No. B14248-01-01
Squibs: RESISTANCE -54
Igniter Charge: -XLT

Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 319.8
Motor Weight After Firing:
Inhibited Grain Weight:
W_p, Propellant Weight: 100.7
Grain I.D.
Grain O.D.
Web:
Grain Length:
D_t: Before: 2.3995
After:
D_e: Before: 6.558
After:

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 24 Hrs
Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required		Expected Max. Value
	t_b	5.5 Sec
2	Thrust	4500 lb
2	Pressure	700 psi
~~1~~ 11/4/92	Temp	Supply Location D

Other Instructions or Comments: Current Req 8±.5 amps

PRODUCT ASSURANCE 11/4/92

Garry C Price PROGRAM 11/4/92

SIGNATURE

TEST

4Nov92 ENGINEERING

N.Tc No EB at This Time.

NASA RELOAD

Ballistic Analysis

of

ROHM and HAAS Motors

07 and 08

INTRODUCTION

On December 3, 1992 two Rohm and Haas motors (F/N's 02527 and 02528) were fired from NASA Reload Batch B09722-T. This mix was an 88% solids, 17.5% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. From this batch, full scale Motor #2 was also cast. There were no anomalies noted in the firings.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate and burning rate exponent. Firing number 02527 used an eroding nozzle throat made from Durez. Firing number 02528 used a non-eroding, ATJ graphite throat. The burning rate exponent with the non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02527, the burning rate exponent was determined to be 0.4305. Based on the analysis of F/N 02528, the burning rate was determined to be 0.394 inches/second at 598 psi. Using these results, the burning rate equation for this mix is:

$$r = 0.02513\ Pc^{0.4305}$$

Full scale motor maximum pressure was calculated by comparing burning rates, exponents and propellant thermochemical properties to the mix 3 full scale motor. This was done using a mass balance equation, with a 3.8% scale factor applied to the subscale burning rate. This value was required to calibrate the calculation to the actual mix 3 full scale motor. The calculated full scale maximum pressure for batch B09722-T is 750 psi which is above the requirement of 720 psi.

TEST DATA REPORT

NASA RELOAD R/H

FIRING NOS:02527-02528
FIRING DATE:DECEMBER 3,1992
MOTOR NOS:AASM-2.88

RB DATA:B097227

PRODUCT ASSURANCE APPROVAL: [signature] 12-7-92

ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

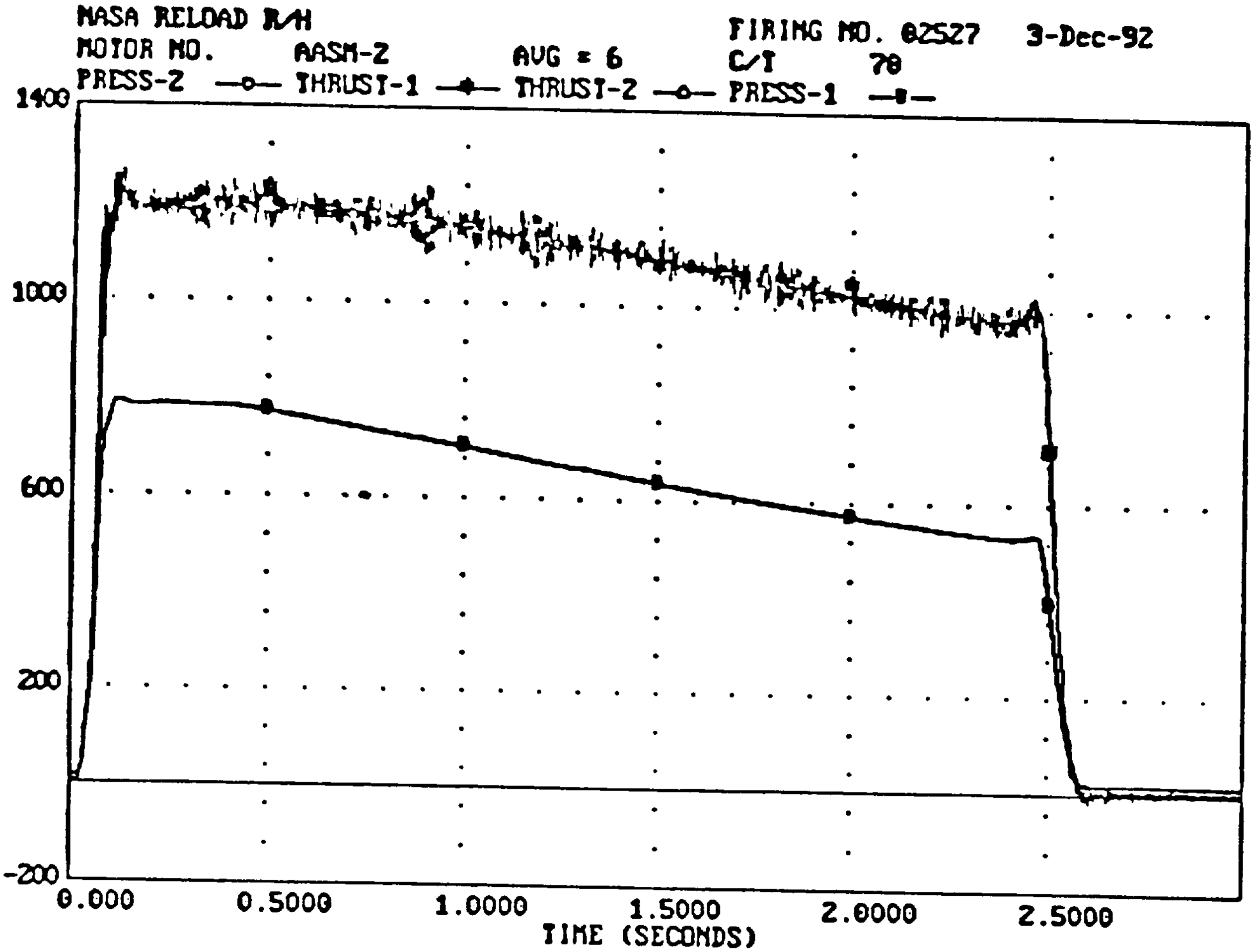
PROPULSION TEST GROUP

DECEMBER 3,1992

SPECIFICATION:.....n/a.....

DATA REDUCTION:..Baseline...Facility

ENGINEERING APPROVAL:....[signature]



TEST DATA SUMMARY

Test ID : NASA RELOAD R/H
Acct No. 38-6464-N6-1000
Motor No. AASM-2
Grain No. B09722T
Pro. Wgt. 5288.8999 grams
Web 0.9960 in.

Firing Number 02527
Date Tested 3-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 41.00 Deg. F
Rel Humidity 35.00 %
Barometer 29.90 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0387
Action Time (10% - 10%) 2.5200
Total Time (0 - 0) 2.5867

Ignition Rise (10% - 75%) 0.0340
Burn Time (10% - TAN) 2.4480

	INTEGRALS			AVERAGES		
CHN ID	TOTAL	ACTION	BURN	ACTION	BURN	MAXIMUM
00 PRESS-1 (PSIA)	1630.1	1628.3	1608.2	646.2	656.9	786.7
01 PRESS-2 (PSIA)	1629.2	1627.3	1607.3	645.8	656.6	787.3
02 THRUST-1 (LBF)	2714.4	2712.9	2679.6	1076.6	1094.6	1282.5
03 THRUST-2 (LBF)	2717.2	2715.6	2682.2	1077.6	1095.7	1284.6

Observed Burn Rate = 0.4069 in/sec. @ 656.9 psia
Specific Impulse = 232.8006 lbf-s/lbm
Action / Burn Time = 1.0294

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-N6-1000

MOTOR NO. AASM-2

GRAIN NO. B09722-T-AASM 2

PURPOSE OF TEST R+H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-2-92

DELIVER EXPENDED MOTOR TO: Bldg 97 c Harrod, c Price

DISTRIBUTE DATA TO: R. Schubert, M. Byington

X-RAY REVIEW: ACCEPTABLE: ____ UNACCEPTABLE: ____

Durex Insert

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: Durex
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No.
Squibs: Atlas match
Igniter Charge: 20g 2D Pellets
10.9 2C Granules
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: EST'D.
Motor Weight After Firing:
Inhibited Grain Weight:
W_p, Propellant Weight: 11.66

Grain I.D.	4.029	4.033	4.035
Grain O.D.	6.020	6.021	6.025
Web:	.996		
Grain Length:	11.321		
D_t: Before:	1.0+0	1.1396	
After:			
D_p: Before:	3.503		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply Temperature
Cycling Instrument Sheet*

Instrumentation Required		Expected Max. Value	
	lb	3	Sec
2	Thrust	1000	lb
2	Pressure	1000	psi
	Temp		Supply Location D

Other Instructions or Comments:

PRODUCT ASSURANCE 12/10/92

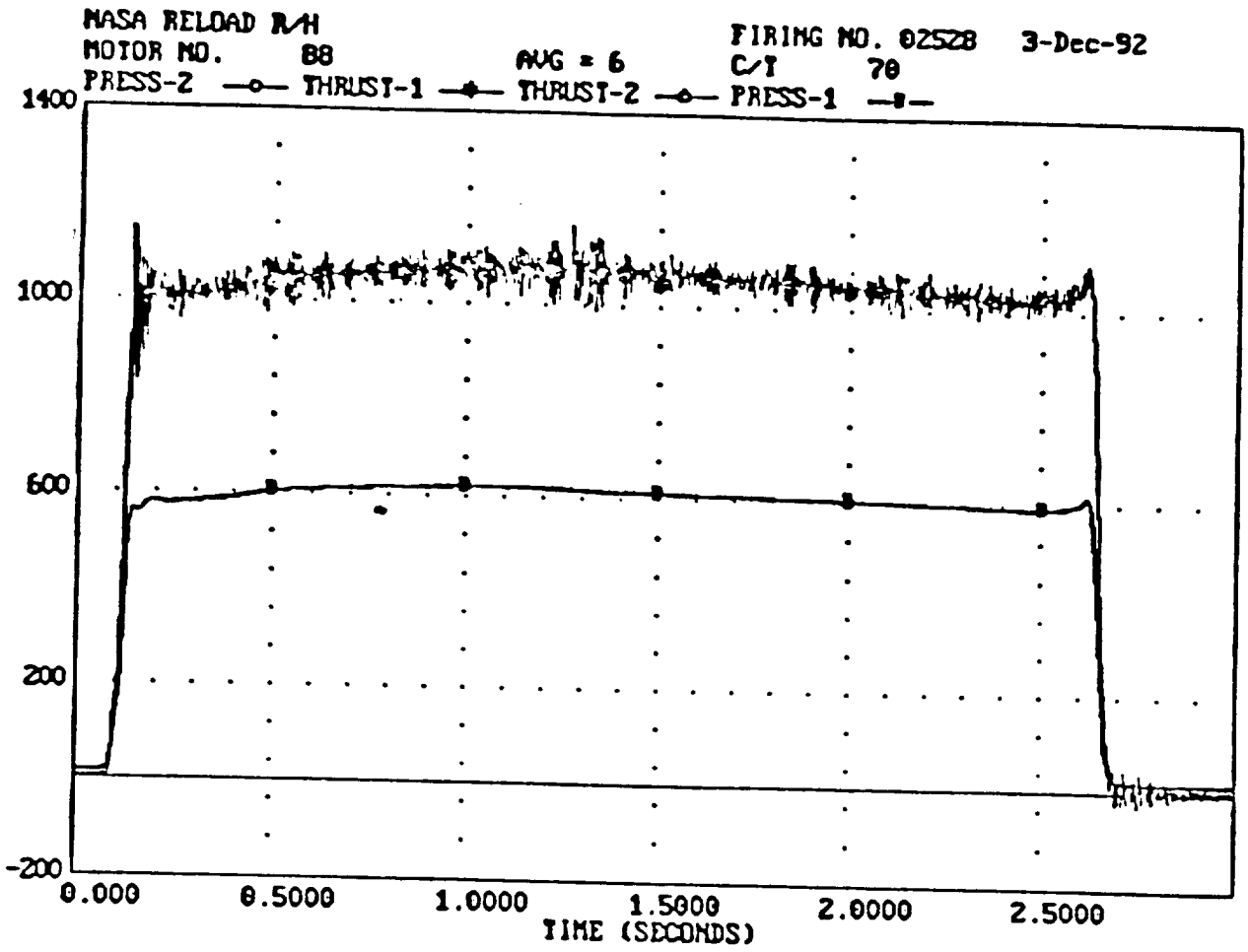
Garry E. Price 12/10/92
PROGRAM

SIGNATURE

TEST

Not Req
ENGINEERING

IN BOX 6 @ 1625 +65° 12-2-92 WDty.



TEST DATA SUMMARY

Test ID : NASA RELOAD R/H
Acct No. 38-6464-NS-1000
Motor No. 88,
Grain No. B097227
Pro. Wgt. 5252.6001 grams
Web 0.9900 in.

Firing Number 02528
Date Tested 3-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 41.00 Deg. F
Rel Humidity 35.00 %
Barometer 29.90 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0989
Action Time (10% - 10%) 2.5780
Total Time (0 - 0) 2.7069
Ignition Rise (10% - 75%) 0.0300
Burn Time (10% - TAN) 2.5360

CHN ID		INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-1	(PSIA)	1528.4	1526.8	1515.3	592.2	597.5	618.2
01 PRESS-2	(PSIA)	1527.7	1526.1	1514.6	592.0	597.3	617.4
02 THRUST-1	(LBF)	2652.2	2651.1	2633.8	1028.4	1038.6	1188.0
03 THRUST-2	(LBF)	2648.1	2646.9	2629.8	1026.7	1037.0	1188.5

Observed Burn Rate = 0.3904 in/sec. @ 597.5 psia
Specific Impulse = 229.0377 lbf-s/lbm
Action / Burn Time = 1.0166

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-N6-1000

MOTOR NO. 88

GRAIN NO. B09722-T-88

PURPOSE OF TEST R+H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-2-92

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: C. Narrod, G. Price
R. Schubert, M Byington

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

ATJ Insert

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: ATJ
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No.
Squibs: Atlas match

Igniter Charge: 20.0 g 2T pellets
10 g 2C Granules
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 896 lb
Motor Weight After Firing:
Inhibited Grain Weight:
W_p Propellant Weight: 11.58

Grain I.D.	4.032	4.034	4.035
Grain O.D.	6.012	6.014	6.015
Web:	.990		
Grain Length:	11.326		
D_t: Before:	1.2404		
After:			
D_e: Before:	3.3065		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply Temperature Cycling Instrument Sheet*

Instrumentation Required		Expected Max. Value	
	lb	5	Sec
2	Thrust	1000	lb
2	Pressure	1000	psi
	Temp		
		Supply Location D	

Other Instructions or Comments:

PRODUCT ASSURANCE 11/30/92

Harry E. Price
PROGRAM

SIGNATURE

TEST

Not Req
ENGINEERING

FN 10x6 @ 1625 + 65° 12.3.92 WBJ

NASA RELOAD

Ballistic Analysis

of

ROHM and HAAS Motors

09 and 10

INTRODUCTION

On December 17, 1992 two Rohm and Haas motors (F/N's 02583 and 02582) were fired from NASA Reload Batch B09749-T. This mix was an 88% solids, 21.5% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. From this batch, full scale Motor #1 was also cast. There were no anomalies noted in the firings.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate and burning rate exponent. Firing number 02583 used an eroding nozzle throat made from Durez. Firing number 02582 used a non-eroding, ATJ graphite throat. The burning rate exponent with the non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02583, the burning rate exponent was determined to be 0.4326. Based on the analysis of F/N 02582, the burning rate was determined to be 0.3583 inches/second at 546 psi. Using these results, the burning rate equation for this mix is:

$$r = 0.02345\ Pc^{0.4326}$$

Full scale motor maximum pressure was calculated by comparing burning rates, exponents and propellant thermochemical properties to the mix 3 full scale motor. This was done using a mass balance equation, with a 3.8% scale factor applied to the subscale burning rate. This value was required to calibrate the calculation to the actual mix 3 full scale motor. The calculated full scale maximum pressure for batch B09749-T is 693 psi which is below the requirement of 720 psi. This batch should yield acceptable performance in full scale motors.

TEST DATA REPORT

NASA RELOAD R/H

02582 - 02583
FIRING NOS: ~~[illegible]~~
FIRING DATE: DECEMBER 17, 1992

STATIC TESTS

PRODUCT ASSURANCE APPROVAL: [signature] 12/17/92

ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

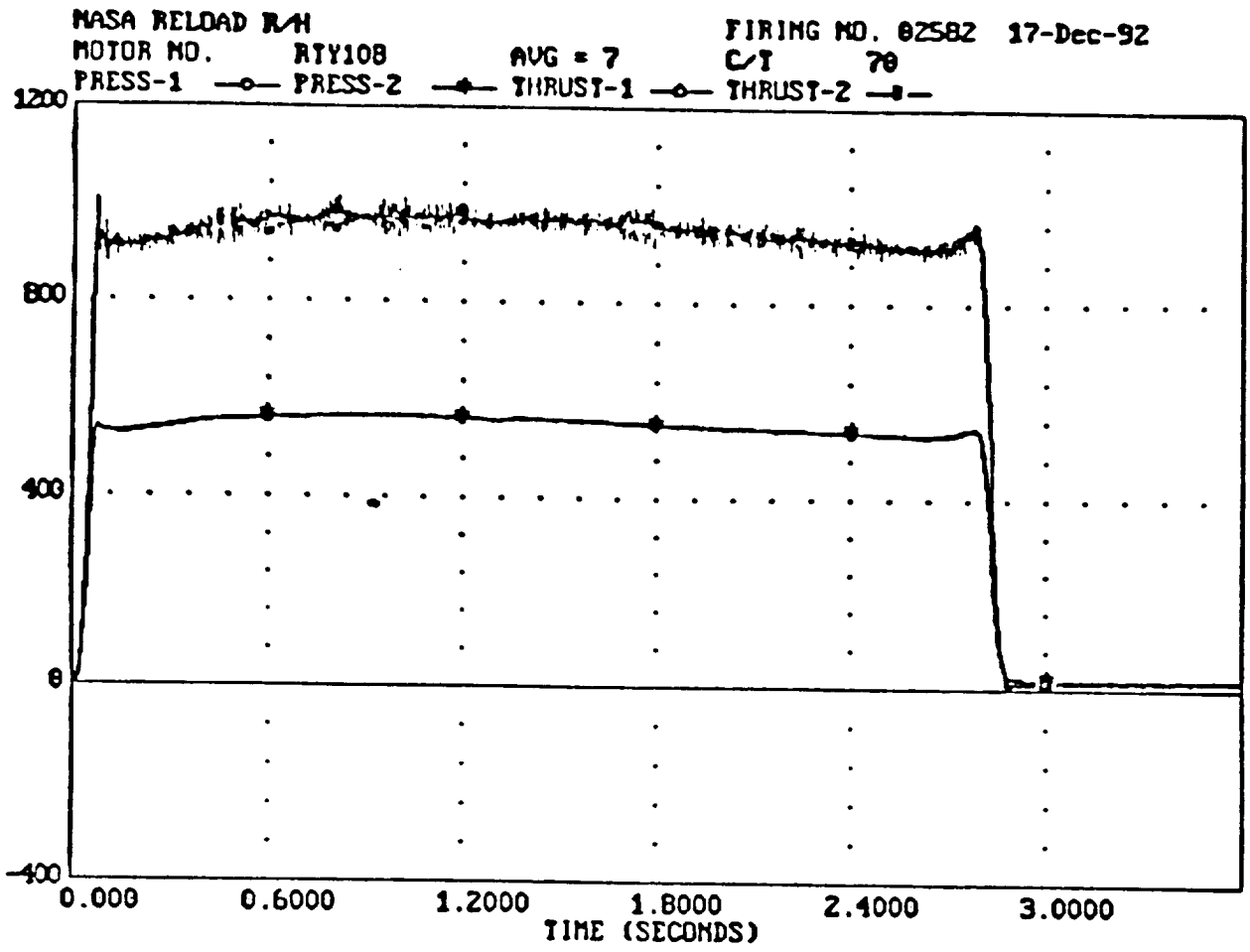
PROPULSION TEST GROUP

DECEMBER 17, 1992

SPECIFICATION: N/A

DATA REDUCTION: Remote Facility

ENGINEERING APPROVAL: [signature]



TEST DATA SUMMARY

Test ID : NASA RELOAD R/H
Acct No. 38-6464-N6-1000
Motor No. RTY108
Grain No. B09749-T
Pro. Wgt. 5311.6001 grams
Web 0.9850 in.

Firing Number 02582
Date Tested 17-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 48.00 Deg. F
Rel Humidity 100.00 %
Barometer 30.10 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0340
Ignition Rise (10% - 90%) 0.0360
Action Time (10% - 10%) 2.8296
Burn Time (10% - TAN) 2.7720
Total Time (0 - 0) 2.8889

CHN	ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00	PRESS-1 (PSIA)	1526.4	1525.2	1509.8	539.0	544.7	563.7
01	PRESS-2 (PSIA)	1532.3	1531.0	1515.7	541.1	546.8	565.1
02	THRUST-1 (LBF)	2628.5	2627.4	2603.7	928.5	939.3	997.9
03	THRUST-2 (LBF)	2627.2	2626.1	2602.4	928.1	938.8	996.5

Observed Burn Rate = 0.3553 in/sec. @ 544.7 psia
Specific Impulse = 224.4685 lbf-s/lbm
Action / Burn Time = 1.0208

12/17/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-NK-1000

MOTOR NO. RTX 108

GRAIN NO. 609749-T

PURPOSE OF TEST R & H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-17-92

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: C. Harrod, G. Price
R. Schubert, M. Axington

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

ATJ

MOTOR ASSEMBLY

Assy. Drawing No. ____

Motor: ____

Nozzle: ATJ

Insulation: ____

Other Components: ____

GRAIN PREPARATION

End Preparation: ____

Inhibiting: ____

Tooling: ____

IGNITER

Assy. Drawing No. ____

Squibs: Atlas match

Igniter Charge: 20.0 g 2D Pellets
10 g 2C Granules

Housing or Container: ____

PROPELLANT DATA

Motor Weight Before Firing: 895 Lbs

Motor Weight After Firing: ____

Inhibited Grain Weight: ____

W_p, Propellant Weight: 11.71

Grain I.D.	4.056	4.057	4.058
Grain O.D.	6.024	6.025	6.027
Web:	.985		
Grain Length:	11.322	11.325	
D_t: Before:	~~1.277~~	1.2396	
After:			
D_e: Before:	3.521		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70. °F

Equilibrium Time: 4 Hr

Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required		Expected Max. Value	
____	lb	3	Sec
3	Thrust	1000	lb
2	Pressure	1000	psi
____	Temp	Supply	Location

Other Instructions or Comments: ____

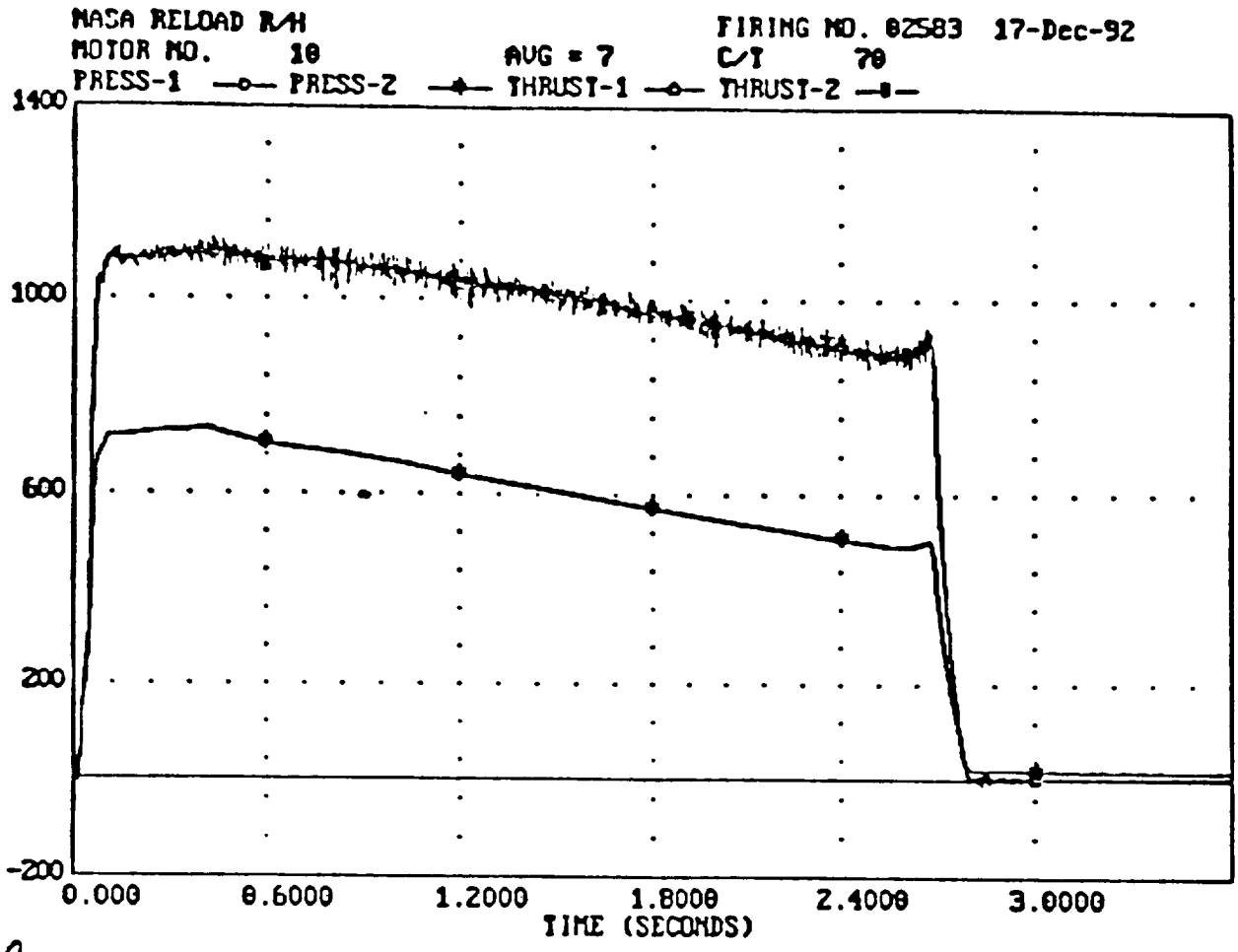
PRODUCT ASSURANCE 12/15/92

Garry E Price 12/15/92
PROGRAM

SIGNATURE

TEST

Not Req
ENGINEERING



#523

TEST DATA SUMMARY

Test ID : NASA RELOAD R/H
Acct No. 38-6464-N6-1000
Motor No. 10
Grain No. B09749-T
Pro. Wgt. 5347.8999 grams
Web 0.9980 in.

Firing Number 02583
Date Tested 17-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 48.00 Deg. F
Rel Humidity 100.00 %
Barometer 30.10 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0304
Ignition Rise (10% - 90%) 0.0432
Action Time (10% - 10%) 2.7468
Burn Time (10% - TAN) 2.6604
Total Time (0 - 0) 2.8024

CHN	ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00	PRESS-1 (PSIA)	1651.8	1650.2	1628.6	600.8	612.2	731.7
01	PRESS-2 (PSIA)	1654.8	1653.2	1631.6	601.8	613.3	732.6
02	THRUST-1 (LBF)	2694.3	2693.1	2658.5	980.4	999.3	1118.2
03	THRUST-2 (LBF)	2691.2	2689.9	2655.4	979.3	998.1	1117.3

Observed Burn Rate = 0.3751 in/sec. @ 612.2 psia
Specific Impulse = 228.5288 lbf-s/lbm
Action / Burn Time = 1.0325

12/17/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-NL-1000

MOTOR NO. 10

GRAIN NO. B09749-T

PURPOSE OF TEST R & H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-17-92

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: C. Harrod, G. Price
R. Schubert, M. Axington

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

Duez

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: DUEZ
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No.
Squibs: Atlas match
Igniter Charge: 20.0 g 2D pellets
10 g 2C Granules
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 87.3 LBS
Motor Weight After Firing:
Inhibited Grain Weight:
W_p Propellant Weight: 11.79

Grain I.D.	4.029	4.030	4.035
Grain O.D.	6.027	6.027	6.029
Web:	.998		
Grain Length:	11.312	11.310	
D_t: Before:	1.370	1.3795	
After:			
D_e: Before:	3.554		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply Temperature Cycling Instrument Sheet

Instrumentation Required		Expected Max. Value	
____	lb	3	Sec
3	Thrust	1000	lb
2	Pressure	1000	psi
____	Temp	Supply	Location

Other Instructions or Comments:

SIGNATURE

PRODUCT ASSURANCE

Garry E Price 12/15/92
PROGRAM

TEST

Not R&D
ENGINEERING

NASA RELOAD

Ballistic Analysis

of

ROHM and HAAS Motors

11 and 12

INTRODUCTION

On December 4, 1992 two Rohm and Haas motors (F/N's 02530 and 02529) were fired from NASA Reload Batch 3457. This mix was an 88% solids, 19% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. From this batch, full scale motors 3, 9, 10, 11, 12, and 13 were also cast. There were no anomalies noted in the firings.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate and burning rate exponent. Firing number 02530 used an eroding nozzle throat made from Durez. Firing number 02529 used a non-eroding, ATJ graphite throat. The burning rate exponent with the non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02530, the burning rate exponent was determined to be 0.431. Based on the analysis of F/N 02529, the burning rate was determined to be 0.381 inches/second at 587 psi. Using these results, the burning rate equation for this mix is:

$$r = 0.02441\ Pc^{0.431}$$

Full scale motor maximum pressure was calculated by comparing burning rates, exponents and propellant thermochemical properties to the mix 3 full scale motor. This was done using a mass balance equation, with a 3.8% scale factor applied to the subscale burning rate. This value was required to calibrate the calculation to the actual mix 3 full scale motor. The calculated full scale maximum pressure for batch 3457 is 717 psi which is below the requirement of 720 psi. This batch should yield acceptable performance in full scale motors.

TEST DATA REPORT

NASA RELOAD R/H

FIRING NOS:02529-02530
FIRING DATE:DECEMBER 4,1992
MOTOR NOS:18,101

RB DATA

PRODUCT ASSURANCE APPROVAL: 12/17/92

ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

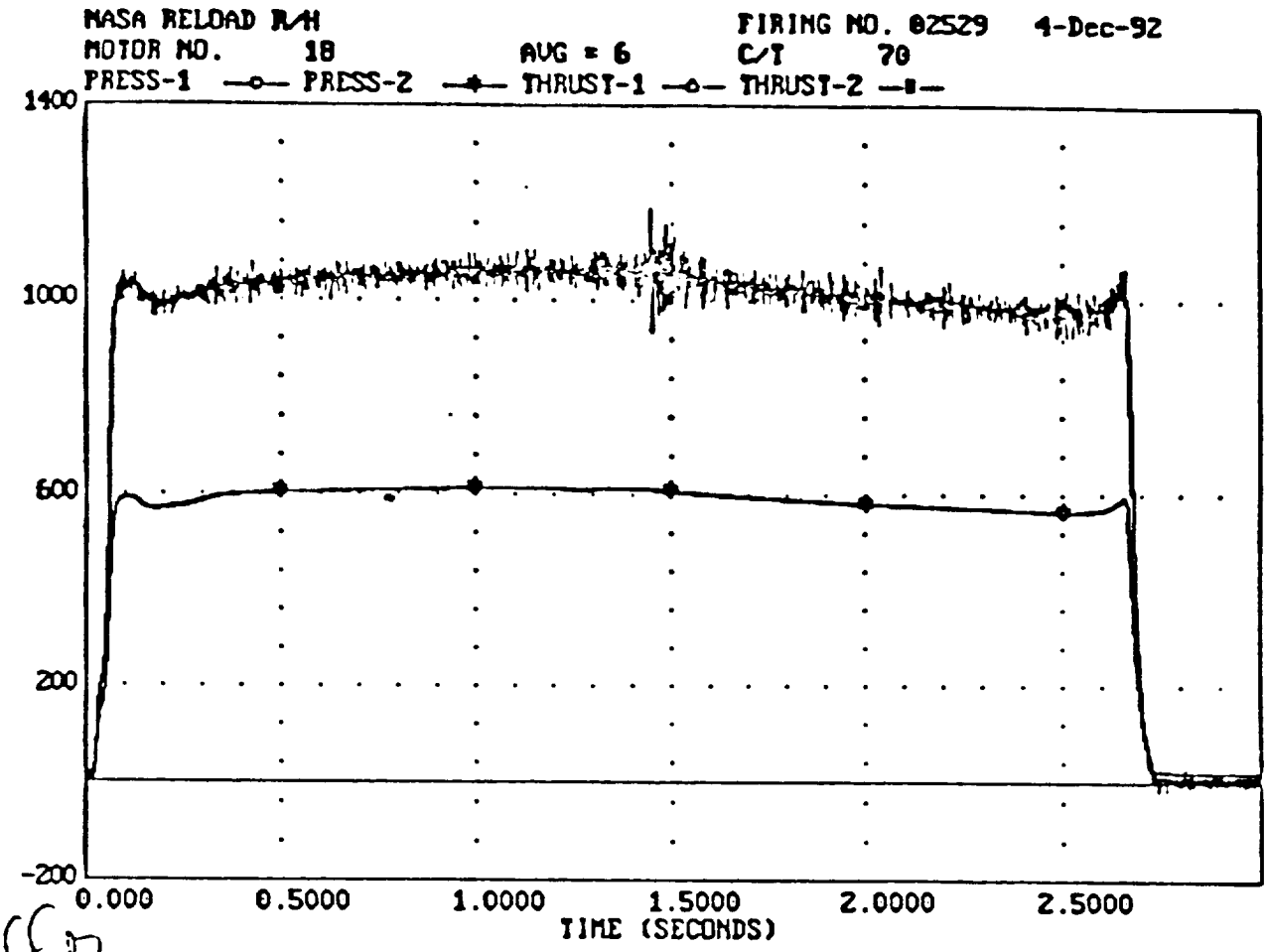
PROPULSION TEST GROUP

DECEMBER 4,1992

SPECIFICATION:.....c.14.....

DATA REDUCTION: Burnette Facility

ENGINEERING APPROVAL:.....



TEST DATA SUMMARY

Test ID : NASA RELOAD R/H
Acct No. 38-6464-N6-1000
Motor No. 18
Grain No. 3457
Pro. Wgt. 5329.7002 grams
Web 1.0030 in.

Firing Number 02529
Date Tested 4-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 34.00 Deg. F
Rel Humidity 35.00 %
Barometer 29.90 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0521
Action Time (10% - 10%) 2.6460
Total Time (0 - 0) 3.3715

Ignition Rise (10% - 75%) 3.3193
Burn Time (10% - TAN) 2.6136

CHN	ID		INTEGRALS TOTAL	ACTION	BURN	AVERAGES ACTION	BURN	MAXIMUM
00	PRESS-1	(PSIA)	1575.6	1553.7	1543.0	587.2	590.4	1665.6
01	PRESS-2	(PSIA)	1573.0	1551.5	1540.9	586.4	589.6	1682.4
02	THRUST-1	(LBF)	2717.5	2697.6	2680.4	1019.5	1025.6	3328.4
03	THRUST-2	(LBF)	2695.0	2676.2	2659.3	1011.4	1017.5	3342.2

Observed Burn Rate = 0.3838 in/sec. @ 590.4 psia
Specific Impulse = 231.2790 lbf-s/lbm
Action / Burn Time = 1.0124

CK LMP 12/4/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-N6-1000

MOTOR NO. 18

GRAIN NO. Batch 3457-18

PURPOSE OF TEST R+H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-4-92

DELIVER EXPENDED MOTOR TO: Bldg 97 C. Harrod, G. Price

DISTRIBUTE DATA TO: R. Schubert, M. Axington

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

ATJ

MOTOR ASSEMBLY

Assy. Drawing No. ____

Motor: ____

Nozzle: ATJ

Insulation: ____

Other Components: ____

GRAIN PREPARATION

End Preparation: ____

Inhibiting: ____

Bonding: ____

IGNITER

Assy. Drawing No. ____

Squibs: Atlas match

Igniter Charge: 20.0 g 2D Pellets
10 g 2C Granules

Housing or Container: ____

PROPELLANT DATA

Motor Weight Before Firing: 29 4 L35

Motor Weight After Firing: ____

Inhibited Grain Weight: ____

W_p, Propellant Weight: 11.750

Grain I.D.	4.041		
Grain O.D.	6.032	6.034	
Web:	.995	1.010	
Grain Length:	11.320		
D_t: Before:	1.240"		
After:			
D_e: Before:	3.499		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F

Equilibrium Time: 4 Hrs

Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value
____ t_b	3 Sec
3 Thrust	1000 lbf
2 Pressure	1000 psia
____ Temp	Supply Location D

Other Instructions or Comments: ____

PROJECT ENGINEER 12-3-92

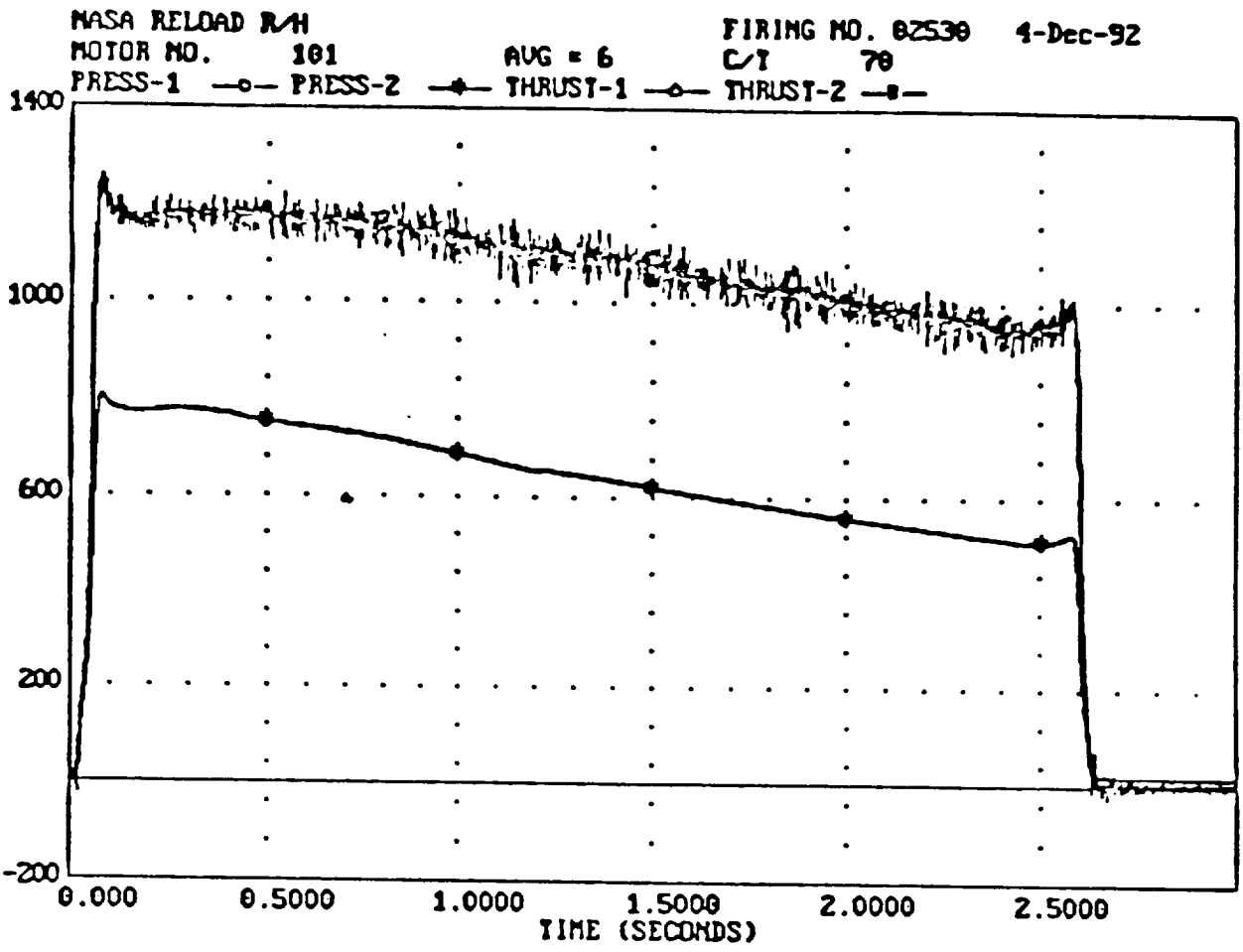
Garry L Price 12/3/92
PROGRAM

SIGNATURE

TEST

Not Req'd
ENGINEERING

In Box 6 @ 1130 +69° 12-3-92 WBS



TEST DATA SUMMARY

Test ID : NASA RELOAD R/M
Acct No. 38-6464-N6-1000
Motor No. 101
Grain No. 3457
Pro. Wgt. 5349.7002 grams
Web 1.0000 in.

Firing Number 02530
Date Tested 4-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 34.00 Deg. F
Rel Humidity 35.00 %
Barometer 29.90 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0349
Ignition Rise (10% - 75%) 0.0252
Action Time (10% - 10%) 2.5928
Burn Time (10% - TAN) 2.5592
Total Time (0 - 0) 2.6473

CHN	ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00	PRESS-1 (PSIA)	1650.0	1648.9	1640.3	636.0	640.9	802.0
01	PRESS-2 (PSIA)	1648.0	1646.9	1638.3	635.2	640.2	802.6
02	THRUST-1 (LBF)	2766.3	2765.6	2750.7	1066.7	1074.8	1242.6
03	THRUST-2 (LBF)	2746.9	2746.2	2731.5	1059.2	1067.3	1235.1

Observed Burn Rate = 0.3907 in/sec. @ 640.9 psia
Specific Impulse = 234.5541 lbf-s/lbm
Action / Burn Time = 1.0131

OK Fld 12/4/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-NL-1000

MOTOR NO. 101

GRAIN NO. & BATCH 3457-101

PURPOSE OF TEST R & H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-4-92

DELIVER EXPENDED MOTOR TO: Bldg 97
C. Harrod, C. Price

DISTRIBUTE DATA TO: R. Schubert, M. Axiaster

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

Durez

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: Durez
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:
Inhibiting:
Tooling:

IGNITER

Assy. Drawing No.
Squibs: Atlas match
Igniter Charge: 20.0 g 2D Pellets
10g. 2C Granules
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 97.0 LBS
Motor Weight After Firing:
Inhibited Grain Weight:
W_p, Propellant Weight: 11.794
Grain I.D. 4.039
Grain O.D. 6.039 6.034
Web: .989 1.011
Grain Length: 11.330
D_t: Before: 1.1406
After:
D_e: Before: 3.549
After:

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply Temperature
Cycling Instrument Sheet*

Instrumentation Required		Expected Max. Value
____	t_b	3 Sec
3	Thrust	~~1000 LBF~~
2	Pressure	1000 PSI
____	Temp	Supply Location

Other Instructions or Comments:

PRODUCTION ASSURANCE 12-3-92

Garry C Price 12/3/92
PROGRAM

SIGNATURE

TEST

Not Req'd
ENGINEERING

IN BOX 6 @ 1130 +68° 12-3-92 WCH

NASA RELOAD

Ballistic Analysis

of

ROHM and HAAS Motors

13 and 14

INTRODUCTION

On December 17, 1992 two Rohm and Haas motors (F/N's 02586 and 02587) were fired from NASA Reload Batch 3467. This mix was an 86% solids, 16% aluminum, HTPB formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. From this batch, full scale Motors 4, 5, 7 and 8 were also cast. There were no anomalies noted in the firings.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate and burning rate exponent. Firing number 02586 used an eroding nozzle throat made from Durez. Firing number 02587 used a non-eroding, ATJ graphite throat. The burning rate exponent with the non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02586, the burning rate exponent was determined to be 0.4163. Based on the analysis of F/N 02587, the burning rate was determined to be 0.3292 inches/second at 497 psi. Using these results, the burning rate equation for this mix is:

$$r = 0.02483\ Pc^{0.4163}$$

Full scale motor maximum pressure was calculated by comparing burning rates, exponents and propellant thermochemical properties to the mix 3 full scale motor. This was done using a mass balance equation, with a 3.8% scale factor applied to the subscale burning rate. This value was required to calibrate the calculation to the actual mix 3 full scale motor. The calculated full scale maximum pressure for batch 3467 is 596 psi which is below the requirement of 720 psi. This batch should yield acceptable performance in full scale motors.

TEST DATA REPORT

NASA RELOAD R/H

02586-02587
FIRING NOS: ~~02552-02587~~
FIRING DATE: DECEMBER 17, 1992

STATIC TESTS

PRODUCT ASSURANCE APPROVAL:

ATLANTIC RESEARCH CORP
5945 WELLINGTON ROAD
GAINESVILLE, VA 22065

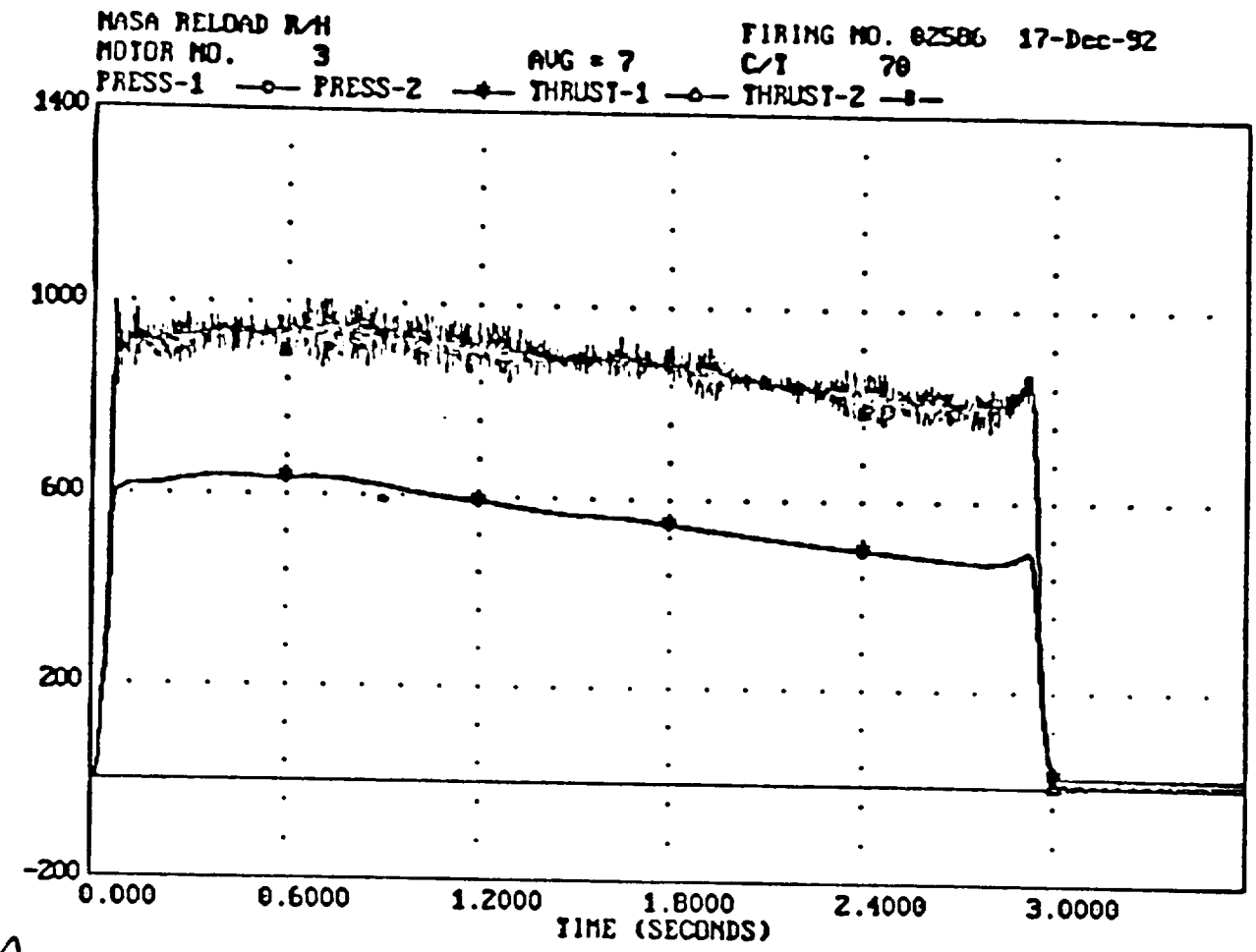
PROPULSION TEST GROUP

DECEMBER 17, 1992

SPECIFICATION: N/A

DATA REDUCTION: Bucsafe Facility

ENGINEERING APPROVAL:



TEST DATA SUMMARY

Test ID : NASA RELOAD R/M
Acct No. 38-6464-N6-1000
Motor No. 3
Grain No. 3467
Pro. Wgt. 5115.2002 grams
Web 0.9890 in.

Firing Number 02586
Date Tested 17-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 48.00 Deg. F
Rel Humidity 100.00 %
Barometer 30.10 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0305
Action Time (10% - 10%) 2.9557
Total Time (0 - 0) 3.0113
Ignition Rise (10% - 90%) 0.0396
Burn Time (10% - TAN) 2.9088

CHN ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-1 (PSIA)	1634.6	1633.2	1622.1	552.6	557.7	637.3
01 PRESS-2 (PSIA)	1639.2	1637.8	1626.7	554.1	559.2	638.5
02 THRUST-1 (LBF)	2561.8	2560.9	2544.0	866.5	874.6	1005.4
03 THRUST-2 (LBF)	2557.5	2556.6	2539.8	865.0	873.1	1003.1

Observed Burn Rate = 0.3400 in/sec. @ 557.7 psia
Specific Impulse = 227.1721 lbf-s/lbm
Action / Burn Time = 1.0161

12/17/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-N6-1000

MOTOR NO. 3

BATCH GRAIN NO. 3467

PURPOSE OF TEST R+H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-17-92

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: C. Harrod, G. Price
R. Schubert, M. Axiaatan

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: D4REZ
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Tooling:

IGNITER

Assy. Drawing No.
Squibs: Atlas match
Igniter Charge: 20.0 g 2D Pellets
10g. 2C Granules
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 88.54
Motor Weight After Firing:
Inhibited Grain Weight:
W_p, Propellant Weight: 11.277
Grain I.D. 4.033
Grain O.D. 6.010 6.010
Web:
Grain Length: 11.313
D_t: Before: ~~1.005~~ 1.1915
After:
D_e: Before: 3.556
After:

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply Temperatures
Cycling Instrument Sheet*

Instrumentation Required	Expected Max. Value
____ lb	3 Sec
3 Thrust	1000 lb
2 Pressure	1000 psi
____ Temp	Supply Location

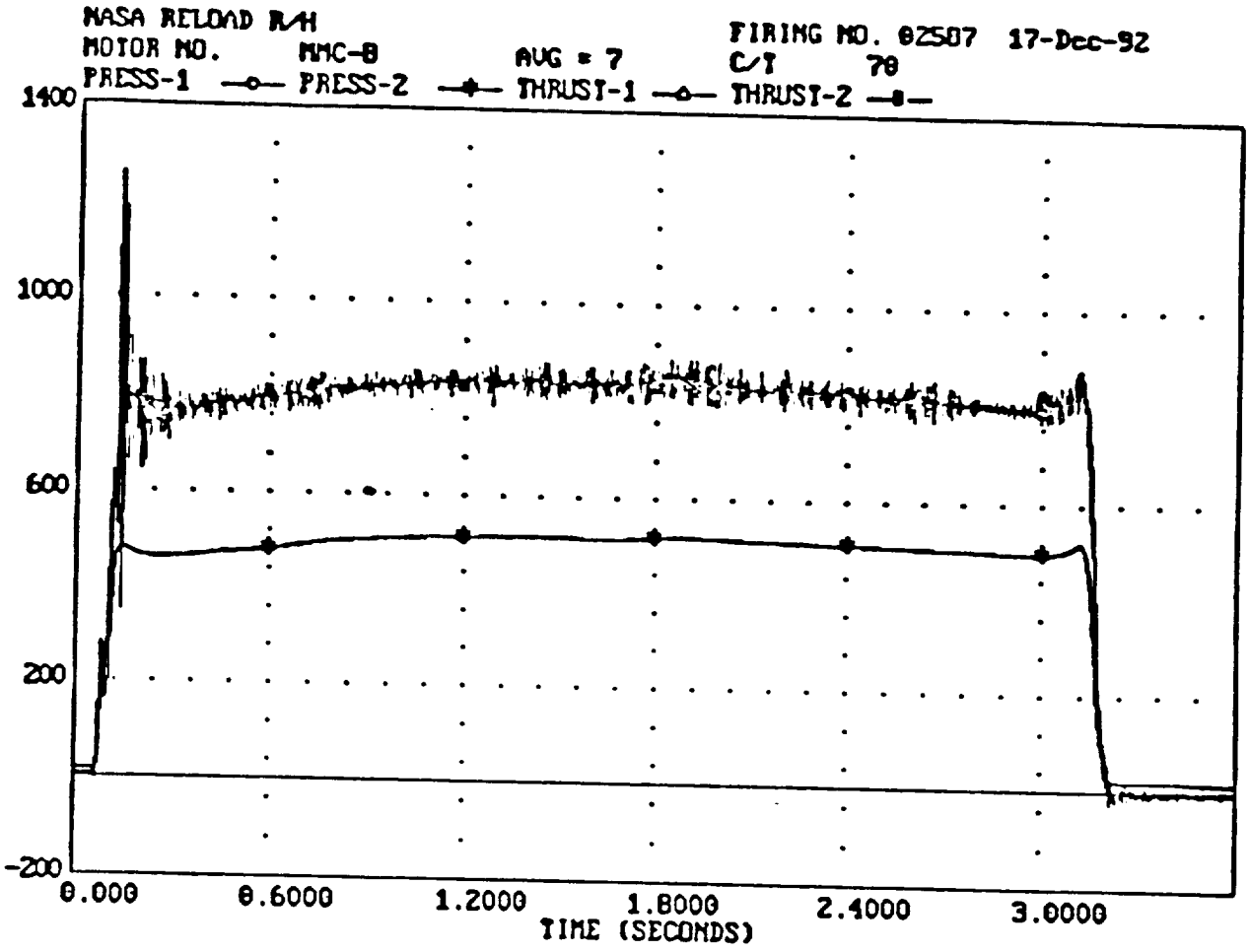
Other Instructions or Comments:

PROJECT ASSURANCE 12/17/92

Harry E. Trill 12/17/92
PROGRAM SIGNATURE

TEST

Not R&D
ENGINEERING



TEST DATA SUMMARY

Test ID : NASA RELOAD R/H
Acct No. 38-6464-N6-1000
Motor No. MMC-8
Grain No. 3467
Pro. Wgt. 5167.2998 grams
Web 0.9990 in.

Firing Number 02587
Date Tested 17-Dec-92
Cond. Temp. 70.00 Deg. F
Ambient Temp. 48.00 Deg. F
Rel Humidity 100.00 %
Barometer 30.10 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0776
Action Time (10% - 10%) 3.1177
Total Time (0 - 0) 3.2238

Ignition Rise (10% - 90%) 0.0540
Burn Time (10% - TAN) 3.0637

CHN ID	INTEGRALS TOTAL	INTEGRALS ACTION	INTEGRALS BURN	AVERAGES ACTION	AVERAGES BURN	MAXIMUM
00 PRESS-1 (PSIA)	1532.5	1531.2	1518.0	491.1	495.5	516.6
01 PRESS-2 (PSIA)	1535.1	1533.9	1520.6	492.0	496.3	517.2
02 THRUST-1 (LBF)	2498.3	2497.8	2478.7	801.2	809.1	1160.8
03 THRUST-2 (LBF)	2491.9	2491.5	2472.6	799.2	807.1	1173.5

Observed Burn Rate = 0.3261 in/sec. @ 495.5 psia
Specific Impulse = 219.3088 lbf-s/lbm
Action / Burn Time = 1.0176

12/17/92

TEST INFORMATION SHEET

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-NK-1000

MOTOR NO. MNC-8

BATCH GRAIN NO. 3467

PURPOSE OF TEST R & H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 12-17-92

DELIVER EXPENDED MOTOR TO: Bldg 97
C. Harrod, G. Price

DISTRIBUTE DATA TO: R. Schubert, M Axington

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

MOTOR ASSEMBLY

Assy. Drawing No. ____

Motor: ____

Nozzle: ATJ

Insulation: ____

Other Components: ____

GRAIN PREPARATION

End Preparation: ____

Inhibiting: ____

Bonding: ____

IGNITER

Assy. Drawing No. ____

Squibs: Atlas match

Igniter Charge: 20.0 g 2D Pellets
10g. 2C Granules

Housing or Container: ____

PROPELLANT DATA

Motor Weight Before Firing: 89.14 Lb.

Motor Weight After Firing: ____

Inhibited Grain Weight: ____

W_p Propellant Weight: 11.392 lb

Grain I.D. 4.030

Grain O.D. 6.027 6.028

Web: ____

Grain Length: 11.296

D_t: Before: 1.2405
After: ____

D_e: Before: 3.499
After: ____

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F

Equilibrium Time: 4 Hrs

Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value
____ lb	3 Sec
3 Thrust	1000 lb
2 Pressure	1000 psi
____ Temp	Supply Location
____ ____	____

Other Instructions or Comments: ____

PROJECT ASSURANCE 12/17/92

PROGRAM Carroll S Price 12/15/92

SIGNATURE

TEST ____

Not Req
ENGINEERING

NASA RELOAD

Ballistic Analysis
of
ROHM and HAAS Motors
(PBAN Mix 2)

15 + 16

INTRODUCTION

On February 18, 1993 two Rohm and Haas motors (F/N's 02724 and 02725) were fired from NASA Reload Batch 3502. This mix was an 86% solids, 16% aluminum, PBAN formulation with a bi-modal (200/20 micron) AP distribution in a 70/30 ratio. From this batch, full scale motor DM-06 was also cast. There were no anomalies noted in the firings.

ANALYSIS RESULTS

The firing data was processed using the standard firing analysis code to determine the motor burning rate and burning rate exponent. Firing number 02725 used an eroding nozzle throat made from Durez. Firing number 02724 used a non-eroding, ATJ graphite throat. The eroding throat firing provides an accurate assessment of the burning rate exponent while the non-eroding throat provides an accurate burning rate value at the motor average operating pressure.

Based on the analysis of F/N 02725, the burning rate exponent was determined to be 0.3401. Based on the analysis of F/N 02724, the burning rate was determined to be 0.361 inches/second at 550 psi. Using these results, the burning rate equation for this mix is:

$$r = 0.04222\ Pc^{0.3401}$$

Full scale motor maximum pressure was calculated by comparing burning rates, exponents and propellant thermochemical properties to the mix 2 full scale motor. This was done using a mass balance equation, with a 3.8% scale factor applied to the subscale burning rate. This value was required to calibrate the calculation to the actual mix 2 full scale motor. The calculated full scale maximum pressure for batch 3502 is 652 psi which is below the requirement of 720 psi. This batch should yield acceptable performance in full scale motors.

TEST DATA REPORT

NASA RELOAD R/H

Firing No. : 02724-02725
Firing Date : 18-FEB-1993
Motor No. : 30,RTY-111

RB DATA

PRODUCT ASSURANCE APPROVAL : N/A 2/24/93

ARC
PROPULSION TEST GROUP

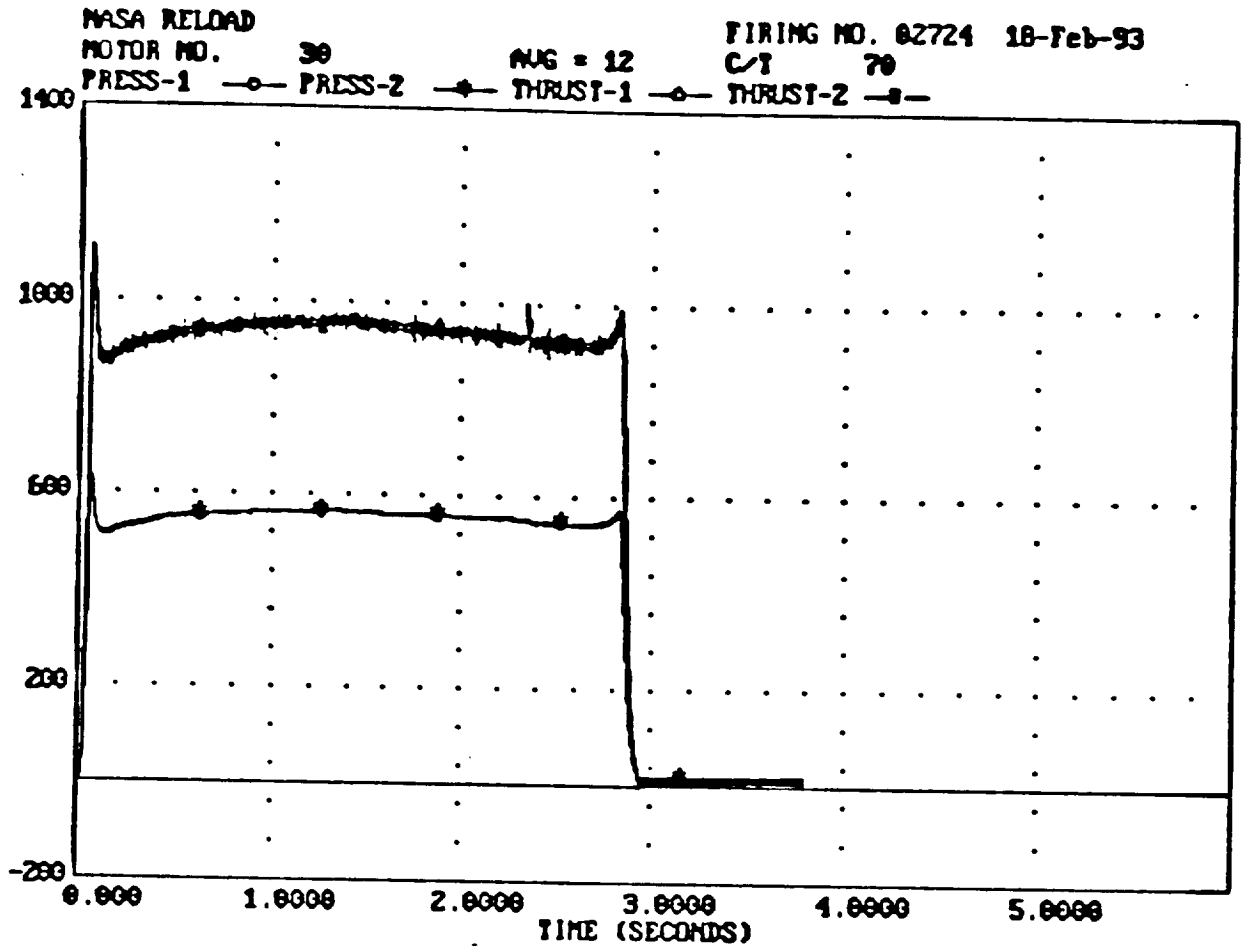
ATLANTIC RESEARCH CORPORATION
5945 Wellington Road
Gainesville, VA 22065

February 19, 1993

SPECIFICATION: .....N/A.....

DATA REDUCTION: ....Borgwarner Facility.....

ENGINEERING APPROVAL: .....



TEST DATA SUMMARY

Test ID : NASA RELOAD
Acct No. 38-6464-86-1000
Motor No. 30
Grain No. 3502
Pro. Wgt. 5266.2080 grams
Web 1.0045 in.

Firing Number 02724
Date Tested 18-Feb-93
Cond. Temp. 70.00 Deg. F
Ambient Temp. 28.00 Deg. F
Rel Humidity 65.00 %
Barometer 29.78 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0349
Ignition Rise (10% - 75%) 0.0196
Action Time (10% - 10%) 2.8336
Burn Time (10% - TAN) 2.8168
Total Time (0 - 0) 2.9385

CHN ID	INTEGRALS TOTAL	ACTION	BURN	AVERAGES ACTION	BURN	MAXIMUM
00 PRESS-1 (PSIA)	1550.0	1550.0	1543.5	547.0	548.0	628.9
01 PRESS-2 (PSIA)	1557.6	1557.3	1550.8	549.6	550.6	629.9
02 THRUST-1 (LBF)	2654.9	2654.8	2644.2	936.9	938.7	1128.5
03 THRUST-2 (LBF)	2622.6	2622.5	2612.1	925.5	927.3	1121.2

Observed Burn Rate = 0.3566 in/sec. @ 548.0 psia
Specific Impulse = 228.6732 lbf-s/lbm
Action / Burn Time = 1.0060

Time 14:44
Temp +69
Box 6
Br SB

TEST INFORMATION SHEET

2/18/93

PROGRAM NAME: NASA Reload

ACCT. NO. 38-6464-N6-1000

MOTOR NO. 30

GRAIN NO. 3502

PURPOSE OF TEST R&H

ATJ

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 2-17-93

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: G Price, C Harrod. R Schubert, M Overton

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

MOTOR ASSEMBLY

Assy. Drawing No. ____

Motor: ____

Nozzle: ATJ

Insulation: ____

Other Components: ____

GRAIN PREPARATION

End Preparation: ____

Inhibiting: ____

Bonding: ____

IGNITER

Assy. Drawing No. ____

Squibs: Atlas March

Igniter Charge: 20.g 2D Pellets
10 g 2C Granules

Housing or Container: ____

PROPELLANT DATA

Motor Weight Before Firing: 892.695

Motor Weight After Firing: ____

Inhibited Grain Weight: ____

W_p, Propellant Weight: 11.610

Grain I.D.	4.027	____	____
Grain O.D.	6.048	6.045	6.0465
Web:	.996	1.013	1.0045
Grain Length:	11.300	____	____
D_t: Before:	2.4205	____	____
After:	____	____	____
D_e: Before:	3.492	____	____
After:	____	____	____

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F

Equilibrium Time: 4 Hrs

Other Conditioning: Supply "Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value	
____	3	Sec
2 Thrust	1600	lb
2 Pressure	1000	psi
____ Temp	____	Supply Location Diag

Other Instructions or Comments: ____

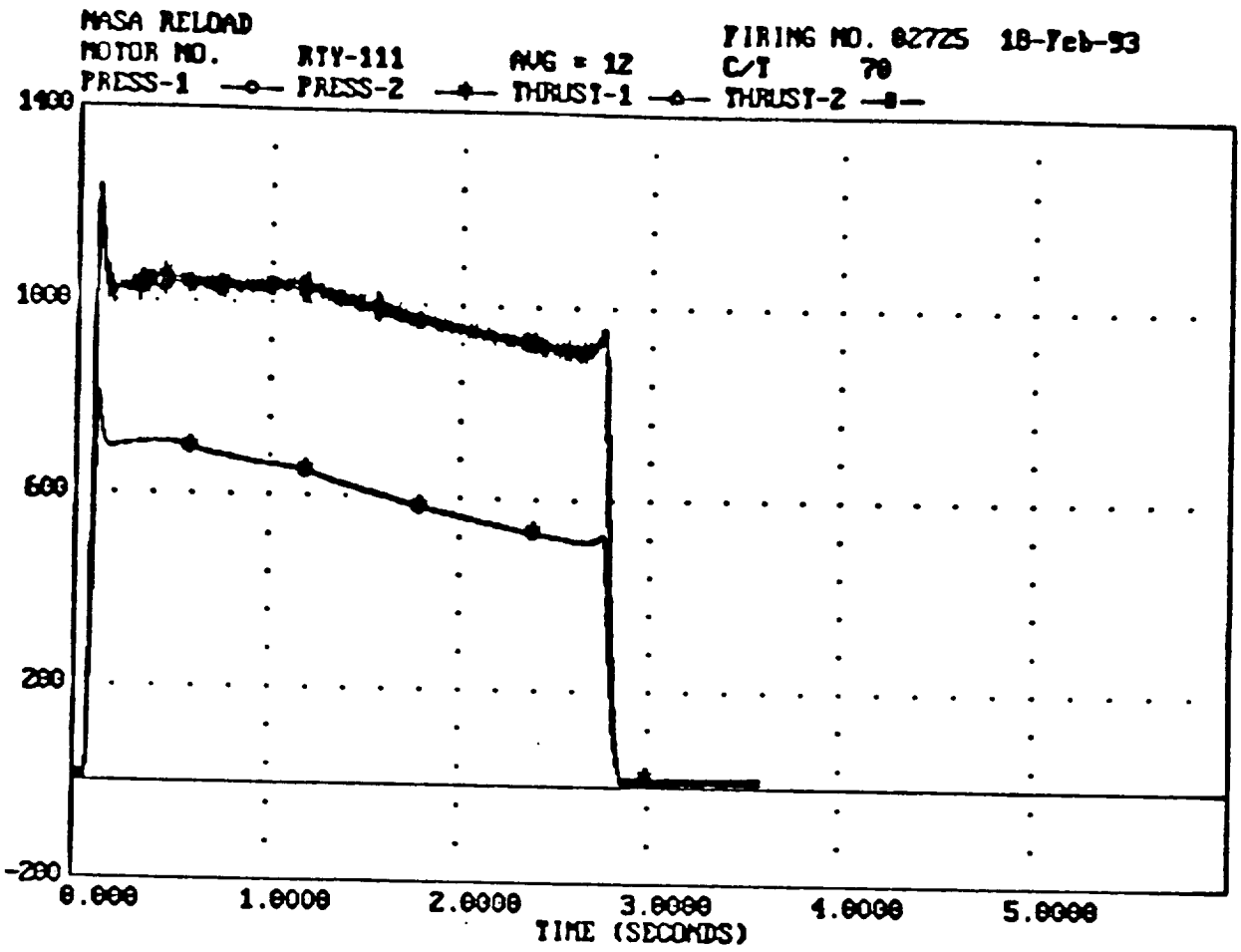
SIGNATURE

PRODUCT ASSURANCE 2.16.93

PROGRAM Harry E. Price 2/8/93

TEST ____

ENGINEERING Not R&Q



TEST DATA SUMMARY

Test ID : NASA RELOAD
Acct No. 38-6464-N6-1000
Motor No. RTY-111
Grain No. 3502
Pro. Wgt. 5545.6206 grams
Web 0.9940 in.

Firing Number 02725
Date Tested 18-Feb-93
Cond. Temp. 70.00 Deg. F
Ambient Temp. 28.00 Deg. F
Rel Humidity 65.00 %
Barometer 29.78 inHg

TIME VALUES
(seconds)

Ignition Delay (0 - 10%) 0.0769
Ignition Rise (10% - 75%) 0.0224
Action Time (10% - 10%) 2.7524
Burn Time (10% - TAN) 2.6908
Total Time (0 - 0) 2.8573

		INTEGRALS			AVERAGES		
CHN	ID	TOTAL	ACTION	BURN	ACTION	BURN	MAXIMUM
00	PRESS-1 (PSIA)	1668.1	1666.5	1650.6	605.5	613.4	807.5
01	PRESS-2 (PSIA)	1672.5	1670.8	1654.9	607.0	615.0	807.9
02	THRUST-1 (LBF)	2695.6	2693.9	2667.9	978.7	991.5	1267.6
03	THRUST-2 (LBF)	2665.3	2663.9	2638.5	967.8	980.6	1254.9

Observed Burn Rate = 0.3694 in/sec. @ 613.4 psia
Specific Impulse = 220.4824 lbf-s/lbm
Action / Burn Time = 1.0229

Time 14:44
Temp +69
Box 6
By SP

TEST INFORMATION SHEET

2/16/93

PROGRAM NAME: NASA RELOAD

ACCT. NO. 38-6464-N6-1000

MOTOR NO. RTY III

BATCH NO. 3502

PURPOSE OF TEST R+H

PROPULSION TEST SPEC. NO. GTP 9606

SCHEDULE DATE: 2-12-93

DELIVER EXPENDED MOTOR TO: Bldg 97

DISTRIBUTE DATA TO: C. Harrod, D. Price R. Schubert, M. Byington

X-RAY REVIEW: ACCEPTABLE: ✓ UNACCEPTABLE: ____

DUREZ

MOTOR ASSEMBLY

Assy. Drawing No.
Motor:
Nozzle: Durez
Insulation:
Other Components:

GRAIN PREPARATION

End Preparation:

Inhibiting:

Bonding:

IGNITER

Assy. Drawing No.
Squibs: Atlas match
Igniter Charge: 20.0 g 2D Alloy 10.0 2C Granules
Housing or Container:

PROPELLANT DATA

Motor Weight Before Firing: 87.4 LBS
Motor Weight After Firing:
Inhibited Grain Weight:
W_p, Propellant Weight: 12.226

Grain I.D.	4.028		
Grain O.D.	6.032	6.026	6.029
Web:	.983	1.005	.994
Grain Length:	11.310		
D_t: Before:	~~1.150~~ 1.1393		
After:			
D_n: Before:	3.548		
After:			

TEST PLAN AND EXPECTED PERFORMANCE

Conditioning Temp. 70 °F
Equilibrium Time: 4 Hrs
Other Conditioning: Supply Temperature Cycling Instrument Sheet"

Instrumentation Required	Expected Max. Value	
____ lb	3	Sec
2 Thrust	1000	lb
2 Pressure	1000	psi
____ Temp	Supply Location D	

Other Instructions or Comments:

SIGNATURE

PRODUCT ASSURANCE 2.16.93

PROGRAM Harry E. Price 3/8/93

TEST

ENGINEERING Not R+A

MOTOR INFORMATION CHART

MOTOR #	SERIAL #	BATCH #	MIX DATE	
1	SOSM-01 HTPB/21.5	B-09479-T	12/2/92	
2	S0SM-02 HTPB/17.5	B-09722-5	11/11/92	
3	SOSM-03 HTPB/19.0	3457	11/18/92	
4	SOSM-04 HTPB/16.0	3467	12/4/92	
5	S0SM-05 HTPB/16.0	3467	12/4/92	
6	SOSM-06 PBAN/16.0	B-09750-T	12/3/92	Not Shipped
7	SOSM-07 HTPB/16.0	3467	12/4/92	
8	S0SM-08 HTPB/16.0	3467	12/4/92	
9	SOSM-09 HTPB/19.0	3457	11/18/92	
10	SOSM-10 HTPB/19.0	3457	11/18/92	
11	S0SM-11 HTPB/19.0	3457	11/18/92	
12	SOSM-12 HTPB/19.0	3457	11/18/92	
13	SOSM-13 HTPB/19.0	3457	11/18/92	
14	SOSM-14 PBAN/16.0	3502	2/1/93	

PROPELLANT COMPOSITION

MOTOR #00 (DEMO MOTOR)

SERIAL # SOSM-00 HTPB/16.0

PERCENT	INGREDIENT
10.558	R45 (HTPB)
0.150	TEPAN (BONDING AGENT)
2.000	DOA
0.500	FE203
16.000	AL
0.025	MGO
49.000	AP200
21.000	AP20
0.717	IPDI
0.025	TPB
0.025	MALEIC ANHYDRIDE
100%	

ATTACHMENT 13

PROPELLANT COMPOSITION

MOTOR #1

SERIAL # SOSM-01 HTPB/21.5

PERCENT	INGREDIENT
8.937	R45 (HTPB)
0.150	TEPAN (BONDING AGENT)
2.000	DOA
0.200	FE203
21.500	AL
0.025	MGO
46.550	AP200
19.950	AP20
0.638	IPDI
0.025	TPB
0.025	MALEIC ANHYDRIDE
100%	

ATTACHMENT 5

PROPELLANT COMPOSITION

MOTOR #2

SERIAL # SOSM-02 HTPB/17.5

PERCENT	INGREDIENT
8.937	R45 (HTPB)
0.150	TEPAN (BONDING AGENT)
2.000	DOA
0.200	FE203
17.500	AL
0.025	MGO
49.350	AP200
21.150	AP20
0.638	IPDI
0.025	TPB
0.025	MALEIC ANHYDRIDE
100%	

PROPELLANT COMPOSITION

MOTOR #3,9,10,11,12,13

SERIAL # SOSM-03 HTPB/19.0
SERIAL # SOSM-09 HTPB/19.0
SERIAL # SOSM-10 HTPB/19.0
SERIAL # SOSM-11 HTPB/19.0
SERIAL # SOSM-12 HTPB/19.0
SERIAL # SOSM-13 HTPB/19.0

PERCENT	INGREDIENT
8.937	R45 (HTPB)
0.150	TEPAN (BONDING AGENT)
2.000	DOA
0.200	FE203
19.000	AL
0.025	MGO
48.300	AP200
20.700	AP20
0.638	IPDI
0.025	TPB
0.025	MALEIC ANHYDRIDE
100%	

PROPELLANT COMPOSITION

MOTOR #4, 5, 7, 8

SERIAL # SOSM-04 HTPB/16.0
SERIAL # SOSM-05 HTPB/16.0
SERIAL # SOSM-07 HTPB/16.0
SERIAL # SOSM-08 HTPB/16.0

PERCENT	INGREDIENT
10.804	R45 (HTPB)
0.150	TEPAN (BONDING AGENT)
2.000	DOA
0.200	FE203
16.000	AL
0.025	MGO
49.000	AP200
21.000	AP20
0.771	IPDI
0.025	TPB
0.025	MALEIC ANHYDRIDE
100%	

PROPELLANT COMPOSITION

MOTOR # 14

SERIAL # SOSM-14 PBAN/16.0

PERCENT	INGREDIENT
11.980	PBAN
1.820	DER 331
0.200	FE203
16.000	AL
49.000	AP200
21.000	AP20
100%	

DEVIATION APPROVAL REQUEST

SHEET 1 OF 1

1. FOR: [X] DEVIATION [ ] SUMMARY OF MINOR NONCONFORMANCES

2. FROM CONTRACTOR:	3. CONTRACT NUMBER:	4. REQUEST NUMBER:
Atlantic Research Corporation	NAS8-38668	ARC-1

5. NOMENCLATURE:	6. NUMBER:	7. REVISION:	8. DATE:
Strap-On Solid Motor			12/23/92

9. NONCONFORMANCE:	10. MRB ACTION NO.:	11. SERIAL NUMBER(S):	12. LOT NUMBER:	13. QUANTITY:
[X] MINOR [ ] MAJOR	--	SOSM-02 HTPB/17.5	--	1

14. SUPPLIER OR SUBCONTRACTOR (GIVE NAME AND ADDRESS):
--

15. SPECIFIED REQUIREMENTS:	16. DESCRIPTION OF DEPARTURE FROM REQUIREMENTS:
Refurbishment Specification 1. Maximum Expected Operating Pressure (MEOP) = 720 psia	Predicted MEOP for SOSM-02 = 750 psia

17. REASON FOR REQUEST AND/OR CORRECTIVE ACTION TAKEN:
Calculated MEOP does not affect test series objectives or test firing safety due to margin in factor of safety (approx. 4.0 for primary failure mode)

18. REMARKS:
No other motors exceed MEOP requirement

19. CONTRACTOR CERTIFICATION: THE CONTRACTOR HEREBY CERTIFIES THAT THE ABOVE DESCRIBED DEVIATION IS A DEPARTURE FROM THE CONTRACTUAL REQUIREMENTS IN THE QUANTITIES AND/OR CONDITIONS AS STATED ABOVE.

[X] _____ COST ADJUSTMENT (EXPLAIN)
[ ] NO COST ADJUSTMENT

/ _____ / _____ / _____
TITLE | SIGNATURE OF AUTHORIZED REPRESENTATIVE | DATE

20. GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE COMMENTS:

_____ _____ _____
TITLE | SIGNATURE | DATE

21. MSFC REVIEW:

ORGANIZATION SYMBOL	REPRESENTATIVE	CONCURRENCE	NON-CONCURRENCE	DATE
~~EP73~~	~~Richard L. Thompson~~			
~~ED33~~	Mark D'Agostino			
~~ED01~~	Rosalyn Patrick			
~~CC24~~	~~Christena Shepherd~~			

22. CONTRACTING OFFICER'S REPRESENTATIVE OR OTHER DULY DELEGATED AUTHORITY:

[ ] DISAPPROVAL (RECOMMENDED)
[ ] APPROVAL (RECOMMENDED)(WITH) (WITHOUT) PRICE ADJUSTMENT. $ _____

_____ 1/22/93
SIGNATURE | DATE

23. CONTRACTING OFFICER:

[ ] APPROVED
[ ] DISAPPROVED
[ ] SUBJECT TO CONDITIONS STATED ON MSFC FORM _____-1.

_____ _____
SIGNATURE | DATE

MSFC - Form 847 (Rev. May 1969) COPY #4 CONTRACTOR'S - RECORD F

ATTACHMENT 14

MATERIAL INSPECTION AND RECEIVING REPORT

Form Approved
OMB No. 0704-0248

Public reporting burden for this collection of information is estimated to average 35 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0248), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO EITHER OF THESE ADDRESSES.

1. PROC. INSTRUMENT IDEN (CONTRACT)	ORDER NO	6. INVOICE NO / DATE	7. PAGE	OF	8. ACCEPTANCE POINT
NAS8-38668			1	1	D

2. SHIPMENT NO	3. DATE SHIPPED	4. BL 233923 / TCN	5. DISCOUNT TERMS
ARC00 01	300CT92	Q	Net 30

9. PRIME CONTRACTOR CODE 28244	10. ADMINISTERED BY CODE S2404A
Atlantic Research Corporation 5945 Wellington Road Gainesville, Virginia 22065	DCMAO Baltimore Attention: Chesapeake 200 Towsontown Blvd., West Towson, MD 21204-5299
11. SHIPPED FROM (If other than 9) CODE / FOB	**12. PAYMENT WILL BE MADE BY CODE BF52**
SAME AS BLOCK 9	Financial Management Office George C. Marshall Space Flight Center, NASA Marshall Space Flight Center, AL 35812
13. SHIPPED TO CODE	**14. MARKED FOR CODE**
Transportation Property Officer National Aeronautics & Space Administration Bldg. 4971 Marshall Space Flight Center, AL 35812	Accountability Property Officer Bldg. 4471 Attn: Richard Thompson EP73

15. ITEM NO	16. STOCK/PART NO. (Indicate number of shipping containers - type of container - container number) DESCRIPTION	17. QUANTITY SHIP/REC'D *	18. UNIT	19. UNIT PRICE	20. AMOUNT
	Motor Case	13	ea	NSP	NSP
	Nozzle Insert A0327004-100	13	ea	NSP	NSP
	Retaining Ring B14236-03-01	13	ea	NSP	NSP

21. CONTRACT QUALITY ASSURANCE

A ORIGIN

☐ CQA ☐ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.

DATE _____ SIGNATURE OF AUTH GOVT REP _____

TYPED NAME AND TITLE

B DESTINATION

☐ CQA ☒ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.

DATE _____ SIGNATURE OF AUTH GOVT REP _____

TYPED NAME AND TITLE

22. RECEIVER'S USE

Quantities shown in column 17 were received in apparent good condition except as noted.

DATE RECEIVED _____ SIGNATURE OF AUTH GOVT REP _____

TYPED NAME AND OFFICE

* If quantity received by the Government is the same as quantity shipped, indicate by (✓) mark, if different, enter actual quantity received below quantity shipped and encircle.

23. CONTRACTOR USE ONLY

38-6464

Packing List 233923

DD Form 250, DEC 91 — Previous editions are obsolete.

ATTACHMENT 15

ARC

Atlantic Research Corporation
a subsidiary of Sequa Corporation

SHIPPED FROM:

☐ ARC AEROSPACE GROUP
5390 CHEROKEE AVE.
ALEXANDRIA, VA. 22312-2302
TEL. 703-642-4000
FAX. 703-642-4021

☐ ARC PROFESSIONAL SERVICES GROUP
5390 CHEROKEE AVE.
ALEXANDRIA, VA. 22312-2302
TEL. 703-642-4000
FAX. 703-642-4313

☒ VIRGINIA PROPULSON DIVISION
5945 WELLINGTON ROAD
GAINESVILLE, VA. 22065-1099
TEL. 703-642-6000
TWX. 703-754-2521
FAX. 703-642-6281

PACKING LIST

No. 233923

SHIP TO: ACCOUNTABILITY PROPERTY OFFICER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
BUILDING 4471
MARSHALL SPACE FLIGHT CENTER, ALABAMA
35812
ATTN: RICHARD COOPER EP73

DATE SHIPPED: 10/30/92

RFS# RP0001

CUSTOMER ORDER NO.	BILL OF LADING NO.	NUMBER OF CARTONS IN THIS SHIPMENT	SHIPPING CHARGES:
NAS8-38668	233923	3 W/B	PREPAID ☒ COLLECT ☐
GOV'T. CONTRACT NO.	INSURE FOR	WEIGHT: 5000 # ESTIMATED	FOB: SHIPPING PT. ☐ DESTINATION ☐
ARC ORDER NO. 38-6464-N7-0000	SHIP VIA: ROADWAY EXPRESS	CUBE	

CONTR. ITEM	QUANTITY ORDERED	QUANTITY SHIPPED	BACK ORDERED	ARC PART NUMBER	DESCRIPTION
		13			MOTOR CASE
		13		A0327004-100	NOZZLE INSERT
		13		B14236-03-01	RETAINING RING

VERIFIED BY: [signature] DATE: 10/30/92

CUSTOMER FURNISHED MATERIAL BEING RETURNED

METHOD TRADEMARK AFFIXED: LABEL ☐ TAG ☐ ENGRAVE ☐ CAST ☐ OTHER _____

TRADEMARK APPLIED TO: PRODUCT ☐ CONTAINER ☐ OTHER _____

☐ SHIPMENT OF END ITEM
☐ MATERIAL FURNISHED FOR FURTHER PROCESSING ON P.O. NO _____
☐ MATERIAL RETURNED FOR REPLACEMENT
☐ MATERIAL RETURNED FOR FULL CREDIT ON P.O. NO _____
☐ MATERIAL RETURNED FOR REPAIR ON P.O. NO _____ OTHER (SPECIFY) _____

ARC-P-18
REV. 3-89

ORIGINAL

MATERIAL INSPECTION AND RECEIVING REPORT

Form Approved
OMB No. 0704-0248

1 PROC INSTRUMENT IDEN (CONTRACT)	(ORDER) NO	6 INVOICE NO / DATE	7 PAGE	OF	8 ACCEPTANCE POINT
NAS8-38668			1	2	D

2 SHIPMENT NO	3 DATE SHIPPED	4 B/L	5 DISCOUNT TERMS
ARC0002	92DEC23E	TCN B	NET 30

9 PRIME CONTRACTOR	CODE 28244	10 ADMINISTERED BY	CODE S2404A
ATLANTIC RESEARCH CORPORATION 5945 WELLINGTON ROAD GAINESVILLE, VIRGINIA 22065		DCMAO BALTIMORE ATTENTION: CHESAPEAKE 200 TOWSONTOWN BLVD., WEST TOWSON, MARYLAND 21204-5299	

11 SHIPPED FROM (If other than 9)	CODE W31P4Q	FOB D	12 PAYMENT WILL BE MADE BY	CODE BF52
SAME AS BLOCK 9			FINANCIAL MANAGEMENT OFFICE GEORGE C. MARSHALL SPACE FLIGHT CENTER, NASA MARSHALL SPACE FLIGHT CENTER, AL. 35812	

13 SHIPPED TO	CODE	14 MARKED FOR	CODE
TRANSPORTATION OFFICER EXPLOSIVES STORAGE & DEMOLITIONS BRANCH BLDG. 8700 REDSTONE ARSENAL, SUPPORT ACTIVITY REDSTONE, ALABAMA 35898-5330		ATTN: GARRETT WHALAN DCN H-9-EP-00215	

15 ITEM NO	16 STOCK/PART NO. DESCRIPTION (Indicate number of shipping container - type of container - container number)	17 QUANTITY SHIP / REC'D *	18 UNIT	19 UNIT PRICE	20 AMOUNT
	FSCM 95335 MFR P/N: A0327001-002 REV. A MOTOR ASSEMBLY S/N: SOSM-01-HTPB-21.5, SOSM-02-HTPB-17.5, SOSM-03-HTPB-19.0, SOSM-04-HTPB-16.0, SOSM-05-HTPB-16.0, SOSM-07-HTPB-16.0, SOSM-08-HTPB-16.0, SOSM-09-HTPB-19.0, SOSM-10-HTPB-19.0, SOSM-11-HTPB-19.0, SOSM-12-HTPB-19.0, SOSM-13-HTPB-19.0 ROCKET MOTOR, UN0186, EXPLOSIVE 1.3C	12	EA.	NSP	NSP
	MFR P/N: 17411-1 CARTRIDGE, IGNITER CARTRIDGES, POWER DEVICE, UN0323	12	EA.	NSP	NSP

21 CONTRACT QUALITY ASSURANCE		22 RECEIVER'S USE
A. ORIGIN ☐ CQA ☐ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.	B. DESTINATION ☐ CQA ☒ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.	Quantities shown in column 17 were received in apparent good condition except as noted.
DATE / SIGNATURE OF AUTH GOVT REP TYPED NAME AND OFFICE	DATE / SIGNATURE OF AUTH GOVT REP TYPED NAME AND TITLE	DATE RECEIVED / SIGNATURE OF AUTH GOVT REP TYPED NAME AND OFFICE

* If quantity received by the Government is the same as quantity shipped, indicate by (✓) mark, if different, enter actual quantity received below quantity shipped and encircle.

23 CONTRACTOR USE ONLY

38-6464-N7-1000
PACKING LIST NO. 234039

MATERIAL INSPECTION AND RECEIVING REPORT - *CONTINUATION SHEET*

SHIPMENT NO.	DATE SHIPPED	PROC. INSTRUMENT IDEN. (CONTRACT)	ORDERING	INVOICE NO.
ARC0002	92DEC23E	NAS8-38668		

ITEM NO.	STOCK/PART NO. DESCRIPTION (Indicate number of shipping containers - type of container - container number.)	QUANTITY SHIP/REC'D	UNIT	UNIT PRICE	AMOUNT
	PROPELLANT SAMPLES PROPELLANT EXPLOSIVE, SOLID, CLASS "B" EXPLOSIVE	4	EA.	NSP	NSP

U.S.GOVERNMENT PRINTING OFFICE: 1993 -606-625

ARC

Atlantic Research Corporation

a subsidiary of Sequa Corporation

SHIPPED FROM:

☐ ARC AEROSPACE GROUP
5390 CHEROKEE AVE.
ALEXANDRIA, VA. 22312-2302
TEL. 703-642-4000
FAX. 703-642-4021

☐ ARC PROFESSIONAL SERVICES GROUP
5390 CHEROKEE AVE.
ALEXANDRIA, VA. 22312-2302
TEL. 703-642-4000
FAX. 703-642-4213

☒ VIRGINIA PROPULSION DIVISION
5945 WELLINGTON ROAD
GAINESVILLE, VA. 22065-1699
TEL. 703-642-4000
TWX. 703-754-3521
FAX. 703-642-4381

PACKING LIST

No. 234039

SHIP TO:

TRANSPORTATION OFFICER
EXPLOSIVES STORAGE & DEMOLITIONS BRANCH
BLDG. 8700
REDSTONE ARSENAL, SUPPORT ACTIVITY
REDSTONE, ALABAMA 35898-5330

DATE SHIPPED
92DEC23E
RFS#RWP010

CUSTOMER ORDER NO.	BILL OF LADING NO.	NUMBER OF CARTONS IN THIS SHIPMENT	SHIPPING CHARGES: PREPAID / COLLECT
	COMM B/L	14 W/B	XXX / ☐
GOV'T. CONTRACT NO.	INSURE FOR	WEIGHT	FOB: SHIPPING PT / DESTINATION
NAS8-38668		4685.0 LBS.	☐ / ☐
ARC ORDER NO.	SHIP VIA	CUBE	
38-6464-N7-1000	MOTOR FREIGHT	148.09 CU. FT.	

CONTR. ITEM	QUANTITY ORDERED	QUANTITY SHIPPED	BACK ORDERED	ARC PART NUMBER	DESCRIPTION
		28 EA.			SEE ATTACHED DD FORM 250 FOR ALL INFORMATION REQUIRED (ARC0002)
TOTAL NET EXPLOSIVE WT.		1290.0 LBS.			

METHOD TRADEMARK AFFIXED LABEL ☐ TAG ☐ ENGRAVE ☐ CAST ☐ OTHER _____

TRADEMARK APPLIED TO PRODUCT ☐ CONTAINER ☐ OTHER _____

XXX SHIPMENT OF END ITEM ☐ MATERIAL FURNISHED FOR FURTHER PROCESSING ON P.O. NO. _____

☐ MATERIAL RETURNED FOR REPLACEMENT ☐ MATERIAL RETURNED FOR FULL CREDIT ON P.O. NO. _____

☐ MATERIAL RETURNED FOR REPAIR ON P.O. NO. _____ OTHER (SPECIFY) _____

ARC-P-16
REV. 3-89

ORIGINAL

MATERIAL INSPECTION AND RECEIVING REPORT

Form Approved
OMB No. 0704-0248

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PLEASE DO NOT RETURN YOUR COMPLETED FORM TO EITHER OF THESE ADDRESSES.

1. PROC. INSTRUMENT IDEN. (CONTRACT)	(ORDER) NO.	6. INVOICE NO./DATE	7. PAGE	OF	8. ACCEPTANCE POINT
NAS8-38668			1	1	D

2. SHIPMENT NO.	3. DATE SHIPPED	4. B/L / TCN	5. DISCOUNT TERMS
ARC0003	93MAR08E	B	NET 30

9. PRIME CONTRACTOR CODE 28244
ATLANTIC RESEARCH CORPORATION
5945 WELLINGTON ROAD
GAINESVILLE, VIRGINIA 22065

10. ADMINISTERED BY CODE S2404A
DCMAO BALTIMORE
ATTN: CHESAPEAKE
200 TOWSONTOWN BLVD., WEST
TOWSON, MARYLAND 21204-5299

11. SHIPPED FROM (if other than 9) CODE FOB D
SAME AS BLOCK 9

12. PAYMENT WILL BE MADE BY CODE BF52
FINANCIAL MANAGEMENT OFFICE
GEORGE C. MARSHALL SPACE FLIGHT CENTER, NASA
MARSHALL SPACE FLIGHT CENTER, AL. 35812

13. SHIPPED TO CODE W31P4Q
TRANSPORTATION OFFICER
EXPLOSIVES STORAGE & DEMOLITIONS BRANCH
BLDG 8700, REDSTONE ARSENAL SUPPORT ACTIVITY
REDSTONE, ALABAMA 35898-5330

14. MARKED FOR CODE
ATTN: GARRETT WHALAN

15. ITEM NO.	16. STOCK/PART NO. DESCRIPTION (Indicate number of shipping containers - type of container - container number.)	17. QUANTITY SHIP/REC'D*	18. UNIT	19. UNIT PRICE	20. AMOUNT
0002	FSCM 95335 MFR P/N: A0327001-002 REV. A MOTOR ASSEMBLY (P-BAN) S/N: SOSM-14-PBAN-16.0 ROCKET MOTOR, UN0186, EXPLOSIVE 1.3C	1	EA.	NSP	NSP
	MFR P/N: 17411-1 CARTRIDGE, IGNITER CARTRIDGES, POWER DEVICE, UN0323	1	EA.	NSP	NSP
	PROPELLANT SAMPLE PROPELLANT EXPLOSIVE, SOLID, CLASS "B" EXPLOSIVE	1	EA.	NSP	NSP
	SHIPPED IN 3 W/B GROSS WT 440.0 LBS.				

21. CONTRACT QUALITY ASSURANCE

A. ORIGIN
☐ CQA ☐ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.

DATE — SIGNATURE OF AUTH GOVT REP
TYPED NAME AND OFFICE

B. DESTINATION
[X] CQA [X] ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.

DATE — SIGNATURE OF AUTH GOVT REP
TYPED NAME AND TITLE

22. RECEIVER'S USE
Quantities shown in column 17 were received in apparent good condition except as noted.

DATE RECEIVED — SIGNATURE OF AUTH GOVT REP
TYPED NAME AND OFFICE

** If quantity received by the Government is the same as quantity shipped, indicate by (✓) mark, if different, enter actual quantity received below quantity shipped and encircle.*

23. CONTRACTOR USE ONLY
38-6464-N7-1000
PACKING LIST NO. 236359

DD Form 250, DEC 91 — *Previous editions are obsolete.*

ARC.

Atlantic Research Corporation

a subsidiary of Sequa Corporation

SHIPPED FROM:

☐ ARC AEROSPACE GROUP
[illegible]
ALEXANDRIA VA 22312 2302
TEL 703-642-4000
FAX 703-642-4021

XXX PROPULSION DIVISION
[illegible]
GAINESVILLE VA 22065 1699
TEL 703-347-8000
TWX 703 754 7521
FAX 703-347-8791

☐ PROPULSION DIVISION ORANGE COUNTY
7695 PINE STAKE RD
CULPEPER VA 22701
TEL 703 854 2000
FAX 703-854 2040

PACKING LIST

No. 236359

SHIP TO:

TRANSPORTATION OFFICER
EXPLOSIVES STORAGE AND DEMOLITIONS BRANCH
BLDG. 8700
REDSTONE SUPPORT ACTIVITY
REDSTONE ARSENAL, ALABAMA 35898-5330
ATTN: GARRETT WHALAN

DATE SHIPPED
93MAR08E
RFS#RWP021

CUSTOMER ORDER NO	BILL OF LADING NO	NUMBER OF CARTONS IN THIS SHIPMENT	SHIPPING CHARGES: PREPAID / COLLECT
	COMM B/L	3 W/B	XXX / ☐
GOVT CONTRACT NO	INSURE FOR	WEIGHT	FOB: SHIPPING PT / DESTINATION
NAS8-38668		440.0 LBS.	☐ / ☐
ARC ORDER NO	SHIP VIA	CUBE	
38-6464-N7-1000	MOTOR FREIGHT	10.40 CU. FT.	

3 EA.	SEE ATTACHED DD FORM 250 FOR ALL INFORMATION REQUIRED (ARC0003)

METHOD TRADEMARK AFFIXED LABEL ☐ TAG ☐ ENGRAVE ☐ CAST ☐ OTHER _____

TRADEMARK APPLIED TO PRODUCT ☐ CONTAINER ☐ OTHER _____

XXX SHIPMENT OF END ITEM

☐ MATERIAL FURNISHED FOR FURTHER PROCESSING ON P.O. NO. _____

☐ MATERIAL RETURNED FOR REPLACEMENT

☐ MATERIAL RETURNED FOR FULL CREDIT ON P.O. NO. _____

☐ MATERIAL RETURNED FOR REPAIR ON P.O. NO. _____ OTHER (SPECIFY) _____

ARC P 16

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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Marshall Byington

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5945 Wellington Road
Gainesville, VA 22065

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Marshall Space Flight Center, AL 35812

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12a. DISTRIBUTION/AVAILABILITY STATEMENT
Final Report prepared and distributed IAW contract requirements. ARC has made no other distribution, nor places any limitation on availability to the public.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Atlantic Research Corporation (ARC) contracted with NASA to manufacture and deliver thirteen small scale Solid Rocket Motors (SRM). These motors, containing five distinct propellant formulations, will be used for plume induced radiation studies. The information contained herein summarizes and documents the program accomplishments and results.

Several modifications were made to the scope of work during the course of the program. The effort was on hold from late 1991 through August 1992 while propellant formulation changes were developed. Modifications to the baseline program were completed in late-August and Modification No. 6 was received by ARC on September 14, 1992. The modifications include changes to the propellant formulation and the nozzle design. The required motor deliveries were completed in late-Dec. 1992. ARC agreed to perform an additional mix & cast effort at no cost to NASA & another motor was delivered in March, 1993.

14. SUBJECT TERMS
SRM (Solid Rocket Motors)
Propellant Composition

15. NUMBER OF PAGES
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16. PRICE CODE
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