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APPENDIX A

MEASURED MANIFOLD AND CHAMBER MEAN PRESSURES VERSUS TIME PLOT FOR ALL SUCCESSFUL TESTS
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FOREWORD

This Appendix contains plots of selected pressure measurements as a function of time from the initial fireswitch (FS-1) activation. These plots were prepared from digital data obtained from the analog-to-digital converter for all 27 tests, where meaningful operation was achieved, in order to assess the combustion stability or instability characteristics of the combustor. The plots start at FS-1 + 1.10 seconds, which is the approximate time that the LOX/TEA + TEB ignition occurs. This hypergolic propellant combination is used as a combustion source to ignite the LOX/RP-1 propellants. Test data is plotted until well after the test shutdown switch (FS-2) in order to show pressure decays during the shutdown transient. Information contained in these plots are identified below:
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<td>LOX Injector Manifold Pressure</td>
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<td>DPO</td>
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<td>DPF</td>
<td>RP-1 Injector ΔP (PFJ-Pc-3)</td>
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<td>DPO/Pc</td>
<td>DPO/Pc-3</td>
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<tr>
<td>DPF/Pc</td>
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</tbody>
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ROCCID SUBSCALE INJECTOR
PERFORMANCE PARAMETERS

TEST DATE 04-04-91 AT 1115 HOURS  DURATION 1.853 SECONDS
TEST NUMBER KFN7-DDI-1J-007  TEST STAND E-4

Aerojet Propulsion  PO BOX 15272 INCORPORATED

1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 6.00 6.50 7.00

0 PC-3  PS1A
1 PDJ  PS1A
2 PPJ  PS1A
3 DPO  PS1A
4 DPF  PS1A
5 OPD/PC
6 OPF/PC

2.8

2.6

2.4

2.2

2.0

1.8

1.6

1.4

1.2

1.0

0.8

0.6

0.4

0.2

0.0

-0.2

-0.4

-0.6

-0.8

-1.0

-1.2

-1.4

-1.6

-1.8

-2.0

-2.2

-2.4

-2.6

-2.8

-3.0

-3.2

-3.4

-3.6

-3.8

-4.0

-4.2

-4.4

-4.6

-4.8

-5.0

-5.2

-5.4

-5.6

-5.8

-6.0

-6.2

-6.4

-6.6

-6.8

-7.0

-7.2

-7.4

-7.6

-7.8

-8.0

-8.2

-8.4

-8.6

-8.8

-9.0

-9.2

-9.4

-9.6

-9.8

-10.0

0 0.2 0.4

0 0.2 0.4

0 0.2 0.4

0 0.2 0.4

0 0.2 0.4

0 0.2 0.4

0 0.2 0.4

0 0.2 0.4

AEROJET
ROCCID SUBSCALE INJECTOR
PERFORMANCE PARAMETERS

0 PC-3 PSIA
1*PDJ PSIA
2 PFJ PSIA
3 OPD PSIA
4 OPF PSIA
5 OPD/PC
6 OPF/PC

TEST DATE 04-08-91 AT 1750 HOURS  DURATION 1.823 SECONDS
TEST NUMBER KFN7-DOI-1J-013  TEST STAND E-4
A-11

ROCCIO SUBSCALE INJECTOR PERFORMANCE PARAMETERS

TEST DATE 04-09-91 AT 1347 HOURS
DURATION 1.823 SECONDS
TEST NUMBER KFN7-001-1J-015
TEST STAND E-4

GenCorp
Aerojet
A-13

ROCCID SUBSCALE INJECTOR PERFORMANCE PARAMETERS

TEST DATE 04-10-91 AT 1105 HOURS  DURATION 1.383 SECONDS
TEST NUMBER KFN7-001-1J-018  TEST STAND E-4
ROCCID SUBSCALE INJECTOR PERFORMANCE PARAMETERS

TEST DATE 04-10-91 AT 1341 HOURS  DURATION 1.403 SECONDS
TEST NUMBER KFN7-001-1J-019  TEST STAND E-4
ROCCID SUBSCALE INJECTOR
PERFORMANCE PARAMETERS

TEST DATE 04-15-91 AT 1439 HOURS
DURATION 1.366 SECONDS

TEST NUMBER KFM7-001-1J-022
TEST STAND E-4
A-22

ROCCID SUBSCALE INJECTOR PERFORMANCE PARAMETERS

TEST DATE 04-23-91 AT 1305 HOURS  DURATION 1.436 SECONDS

TEST NUMBER KF73-001-1J-020  TEST STAND E-4
ROCCID SUBSCALE INJECTOR PERFORMANCE PARAMETERS

TEST DATE 04-30-91 AT 1441 HOURS  DURATION 1.693 SECONDS
TEST NUMBER KFN7-001-1J-030  TEST STAND E-4

A24
ROCCID SUBSCALE INJECTOR PERFORMANCE PARAMETERS

GENCORP
AERJET

TEST DATE 05-01-91 AT 1618 HOURS DURATION 3.016 SECONDS
TEST NUMBER KFN7-001-1J-036 TEST STAND E-4
ROCCID SUBSCALE INJECTOR PERFORMANCE PARAMETERS

TEST DATE 05-02-91 AT 1452 HOURS  DURATION 1.402 SECONDS
TEST NUMBER KFN7-001-1J-030  TEST STAND E-4
APPENDIX B

TIME SERIES, AMPLITUDE AND FREQUENCY EVOLUTION, AND POWER SPECTRAL ANALYSIS OF CHAMBER PRESSURE FOR ALL UNSTABLE-COMBUSTION TESTS
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Note: See Foreword (next page) for explanation of information contained in the 3 plot set for each test.
FOREWORD

Unstable operation was observed during 16 of the 27 valid tests conducted during the ROCCID validation test program. For each of these unstable tests, the following information is contained in this appendix:

1. High Frequency Chamber Pressure Transducer playback of the pressure amplitude versus time prior to and during the observed unstable combustion event. Sample format for this plot is as follows:

![Plot](image)

- Time Scale: Start Time as Referenced from Test Initiation Switch (FS-1)
- Test No.
- Pressure Amplitude as Measured from PCHF1 Transducer in PSI/100 (Note: 0.0 Represents Steady State D.C. Value)
(2) Power Spectral Density (PSD) analysis of the high frequency pressure amplitude recorded signal. Sample format for this plot is as follows:

![Power Spectral Density Graph](image)

- **Time Period from FS-1 Over Which PSD is Obtained**
- **Test No.**
- **Effective Bandwidth**

The X-axis represents the Frequency (Hertz/100) of the Pressure Amplitude Signal, while the Y-axis represents the Pressure Amplitude (in dB).
(3) Power Spectral Analysis of the high frequency pressure amplitude signal. Sample format for this pot is as follows:

Time Interval of Test Over Which Individual PSD Time Segments are Included

Test No.

Time Interval for Each Segment

Effective Bandwidth

Individual PSD Time Segment

Frequency (Hertz/1000) of the Pressure Amplitude Signal

\[
\left(\frac{\text{Pressure Amplitude @ a Given Frequency}^2}{\text{Bandwidth}}\right) / 10
\]
SPECTRA OF PCHF1 (PS1) : 20 SEGMENTS

FS1+1 32 to FS1+1 42 sec
 KFN7-001-1J-018
 SEGMENT TIME = 5.000E-03
 OAMPLITUDE = 40.0
 DF / SEGMENT = 200
 DH / SEGMENT = 30.0
ROCCID Test Program

Time zero = FS1+1.34 sec
KFN7-D01-1J-019
SPECTRA OF PCHF1 (PSI): 20 SEGMENTS

FS1+1.74 to FS1+1.84 sec
KFN7-D01-1J -021
SEGMENT TIME = 5.000E-03
AMPLITUDE = 1.000E+03
DF / SEGMENT = 200.
DH / SEGMENT = 600.
AUTOSPECTRAL DENSITY OF PCH1 (PSI)

FS1: 1.80 - 1.83 sec
KFN7-001-1J: 021
WINDOW: NONE
DISTINCT AVG: 5
BANDWIDTH = 165.
VARIANCE = 2.518E+06
AUTOSPECTRAL DENSITY OF PCHF2 (PSI)

FS1+ 1.35 - 1.38 sec.
KFN7-001-1J - 025
WINDOW = NONE
DISTINCT AVG = 5
BANDWIDTH = 165
VARIANCE = 2.657E+05
AUTOSPECTRAL DENSITY OF PCHF1 (PSI)

FS1+ 1.46 - 1.49 sec.
KFN7-D01-1J -026
WINDOW =NONE
DISTINCT AVG= 5
BANDWIDTH = 165
VARIANCE = 1.833E+06

G (UNITS, SQD./HZ)

FREQUENCY (10^2)
Autospectral Density of PCHF1 (PSI)

FS1+ 1.82 - 1.85 sec
KFN7-001-1J -029
WINDOW = NONE
DISTINCT AVG = 5
BANDWIDTH = 165
VARIANCE = 3.346E+05
ROCCID Test Program

Time zero = FS1 + 1.4 sec
KFN7-D01-1J-040
AUTOSPECTRAL DENSITY OF PCHF5 (PSI)

FS1: 1.46 - 1.49 sec
KFN7-001-1J -040
WINDOW = NONE
DISTINCT AVG = 5
BANDWIDTH = 165
VARIANCE = 5.446E+04
APPENDIX C

TIME SERIES, AMPLITUDE AND FREQUENCY EVOLUTION, AND POWER SPECTRAL ANALYSIS OF MANIFOLD AND CHAMBER PRESSURES AND ACCELERATIONS FOR TEST 004
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ALL DATA OBTAINED FROM TEST NO. KFN7-D01-1J-004

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<td>AZ</td>
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</table>
FOREWORD

Included in this appendix is a complete display of high frequency measurements obtained during test KFN7-D01-1J-004. A total of 10 parameters are displayed including five high frequency chamber pressure measurements (see Figure 51 of Volume I for measurement locations), one each high frequency pressure measurements located in the injector manifold inlet pipes of the fuel and oxidizer circuits, and three accelerometer recordings obtained from a tri-axial accelerometer mounted on the injector assembly. High frequency amplitude versus time, power spectral analysis and power spectral density plots for each of the 10 parameters are included. The plot formats are the same as those described in Appendix B.
ROCCID Test Program

Time zero = FS1+1 4 sec
KFN7-D01-1J-004
AUTOSPECTRAL DENSITY OF PVC1 (PSL)

FS1+ 1.46 - 1.49 sec.
KF N7-001-1J -004
WINDOW = NONE
DISTINCT AVG= 5
BANDWIDTH = 165.
VARIANCE = 5.353E+05
SPECTRA OF PH#3 (PS1) 19 SEGMENTS

FS1+1.4 to FS1+1.5 sec
KF07-D01-1J -004
SEGMENT TIME = 5.000E-03
DAMPLITUDE = 100.
DF / SEGMENT = 200.
DH / SEGMENT = 63.2
AUTOSPECTRAL DENSITY OF PCF3 (PSI)

FS1+ 1.46 - 1.49 sec.
KFN7-D01-1J -004
WINDOW =NONE
DISTINCT AVG= 5
BANDWIDTH = 165.
VARIANCE = 3.314E+05
SPECTRA OF PCHF4 (PSI) : 19 SEGMENTS

FS1+1.4 to FS1+1.5 sec
KFN7-D01-1J -004
SEGMENT TIME = 5.000E-03
DAMPLITUDE = 100
DF / SEGMENT = 200
DH / SEGMENT = 63.2
AUTOSPECTRAL DENSITY OF PCH#4 (PSI)

FSI: 1.46 1.49 sec
KFN7-D01-1J -004
WINDOW = NONE
DISTINCT AVG = 5
BANDWIDTH = 165
VARIANCE = 4.714E+05
SPECTRA OF POJHF (PSI): 19 SEGMENTS

FS1+1.4 to FS1+1.5 sec
KFN7-D01-1J 004
SEGMENT TIME= 5.000E-03
DAMPLITUDE = 2.00
DF / SEGMENT= 200.
DH / SEGMENT= 1.58
SPECTRA OF PFJHF (PSI) : 19 SEGMENTS

FS1+1.4 to FS1+1.5 sec
KFN7-001-1J-004
SEGMENT TIME = 5.000E-03
DAMPLITUDE = 20.0
DF / SEGMENT = 200.
DH / SEGMENT = 15.8

G (UNITSS**2)/HZ

FREQUENCY (HZ)
AUTOSPECTRAL DENSITY OF PFJHF (PSI)

FS1+ 1.46 - 1.49 sec.
KFN7-D01-1J-004
WINDOW = NONE
DISTINCT AVG = 5
BANDWIDTH = 165.
VARIANCE = 2.681E+04
SPECTRA OF AX (G's) : 19 SEGMENTS

FS1+1.4 to FS1+1.5 sec
KFN7-D01-1J-004
SEGMENT TIME = 5.000E-03
DAMPLITUDE = 50.0
DF / SEGMENT = 200.
DH / SEGMENT = 39.5

G (UNITS**2)/HZ

FREQUENCY (HZ) (10^3)
SPECTRA OF AY (G's) 19 SEGMENTS

FS1+1.4 to FS1+1.5 sec
KFN7-D01-1J -004
SEGMENT TIME= 5.000E-03
AMPLITUDE = 5.00
SF / SEGMENT= 200.
DH / SEGMENT= 6.32
AUTOSPECTRAL DENSITY OF AY (G's)

FS1+ 1.46 - 1.49 sec
KFN7-D01-1J -004
WINDOW =NONE
DISTINCT AVG = 5
BANDWIDTH = 165
VARIANCE = 1.609E+04
APPENDIX D

ROCCID VALIDATION HARDWARE
DESIGN DRAWING PACKAGE
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<tr>
<td>Chamber Retaining Plate</td>
<td>1200976A</td>
<td>1 + ADCN</td>
<td>D-23/D-24</td>
</tr>
<tr>
<td>Chamber Proof Plate</td>
<td>1200977A</td>
<td>1 + ADCN</td>
<td>D-25/D-26</td>
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<tr>
<td>1/4 Wave Tube Resonator</td>
<td>1206426</td>
<td>1</td>
<td>D-27</td>
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<tr>
<td>Resonator Cavity Blank</td>
<td>1206431</td>
<td>1</td>
<td>D-28</td>
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<tr>
<td>Bomb Adapters</td>
<td>1201080A</td>
<td>1</td>
<td>D-29</td>
</tr>
</tbody>
</table>
Figure D-11
NOTES:
1. INTERPRET DRAWING PER ATC-STD-470.
2. CLEANLINESS PER ATC-STD-480, LEVEL VC.
3. MAKE PER ATC-STD-480 WITH 13040TS AND APPLICABLE BASE PL.
4. SURFACE FINISH TO BE WITHIN DIAMETER SHOWN.

1.002 Dia. thru:
48 A1S[803-52]
±0.004 Tolerance

5.05 Dia. 

11.50 Dia. 

5.04 Dia. 

100 

103 

6,000 Dia.
ADD -2 RETAINERS 4340 STEEL VACUUM MELT PER AMS 5448

ADD CALLOUTS & DIMENSION SHOWN
ADD NOTE:

3. HEAT TREAT PRIOR TO FINAL MACHINING PER MICROTOP LIMITS, MINIMUM YIELD 130,000 PSI
APPENDIX E

ADVANCED DOCUMENT CHANGE NOTICES FOR THE ROCCID DESIGN DISCLOSURE
IS:
C'BORE .750 DIA X .437 DEEP
.4375-20UNF-2B THRU

WAS:
C'BORE .750 DIA X .437 DEEP
PORT PER MS33649-04
EXCEPT .4375-20UNF-2B THRU ONE WALL
IS; NOTE 9 TEST ASSEMBLY IN THE FOLLOWING ORDER:

A. LEAK TEST ASSEMBLY PER ATC-47063, METHOD II, USING CLEAN DRY NITROGEN AT 50 ±5 PSIA. HOLD FOR 5 MINUTES MINIMUM. NO LEAKAGE ALLOWED.

B. FLOW TEST WITH CLEAN WATER (PER ATC-STD-4940, LEVEL 1000) AS FOLLOWS:
   1. PERFORM VISUAL PATTERN CHECK PER COGNIZANT DESIGN ACTIVITY.

   2. THE OXIDIZER AND FUEL CIRCUITS SHALL BE FLOWED SEPARATELY AT SEVERAL FLOWRATES BELOW CAVITATION ONSET (~ 50 PSIG ΔP). FOR EACH DATA POINT RECORD THE MANIFOLD ΔP, FLOWRATE, NOMINAL WATER FLOW TEMPERATURE AND ACTUAL OUTPUT FREQUENCY OF FLOWMETER. CALCULATE Kω:

   \[ K_w = \frac{\dot{w}}{(\Delta P)(S_g)} \]

   WHERE: \( \dot{w} = \) FLOWRATE, LB/SEC
   \( \Delta P = \) INLET - OUTLET PRESSURE, PSI
   \( S_g = \) SPECIFIC GRAVITY OF WATER AT FLOW TEMPERATURE
WAS; NOTE 9

TEST ASSEMBLY IN THE FOLLOWING ORDER:

A. ULTRASONIC INSPECT BRAZE JOINT PER ATC-STD-4819, TYPE I.
   ACCEPTANCE PER COGNIZANT DESIGN ACTIVITY.

B. PROOF TEST BRAZE JOINT BY FLOWING CLEAN WATER (PER
   ATC-STD-4940, LEVEL 1000) SIMULTANEOUSLY THRU THE OXIDIZER AND
   FUEL CIRCUITS TO ATMOSHERE. HOLD FOR APPROXIMATELY FIVE
   MINUTES.
   OXIDIZER CIRCUIT:
   MANIFOLD P = 750 ±10 PSI; APPROX FLOW = 175 LB/SEC
   FUEL CIRCUIT:
   MANIFOLD P = 710 ±10 PSI; APPROX FLOW = 85 LB/SEC

C. REPEAT ULTRASONIC INSPECT OF BRAZE JOINT PER ATC-STD-4819, TYPE I.
   NOTE ANY DIFFERENCES. ACCEPTANCE PER COGNIZANT DESIGN ACTIVITY.

D. LEAK TEST ASSEMBLY PER ATC-47063, METHOD II, USING CLEAN DRY
   NITROGEN AT 50 ±5 PSIA. HOLD FOR 5 MINUTES MINIMUM. NO LEAKAGE
   ALLOWED.

E. FLOW TEST WITH CLEAN WATER (ATC-STD-4940, LEVEL 1000) AS FOLLOWS:
   1. PERFORM VISUAL PATTERN CHECK PER COGNIZANT DESIGN ACTIVITY.

   2. THE OXIDIZER AND FUEL SHALL BE FLOWED SEPARATELY AT THE
      FOLLOWING FLOW RATES: OXIDIZER: 25, 35, 45, 55, 65; FUEL: 20, 25, 35,
      40, 45. FOR EACH DATA POINT RECORD THE MANIFOLD ΔP, FLOWRATE,
      NOMINAL WATER FLOW TEMPERATURE AND ACTUAL OUTPUT FREQUENCY
      OF FLOWMETER. CALCULATE K_0:

      \[ K_0 = \frac{w}{(\Delta P) (S_g)} \]

      WHERE: \( w = \) FLOWRATE, LB/SEC
      \( \Delta P = \) INLET - OUTLET PRESSURE, PSI
      \( S_g = \) SPECIFIC GRAVITY OF WATER AT FLOW TEMPERATURE
ADCN | DCN | DATE | 91-2-25
---|---|---|---
ECM NO | | | |
PREPARED BY | L. MYERS | | |
PREPARED BY | | | |
DATE | 91-03-18 | | |
DESIGN ACTIVITY | 15M4691 | | |
CHECK | OA | | |
STRESS | | | |
MANUF | L. MYERS | 91-2-28 | |
MATERI | | | |
CMO | | | |
SH | ZONE | ITEM | 2 5 F 1
---|---|---|---
ADDED; | | |
SECTION K-K | LOCATED AT 142.500°
---|---|---|---
SH | ZONE | ITEM | 2 5 C 1
---|---|---|---
REMOVED; | | |
2°30' | 1.152 | |
SECTION K-K | LOCATED AT 142.500°
---|---|---|---

172 DA THRU C 80\% 39/16 DA X 3.00 DEEP 3830
SPOTFACE 1/2 DA PORT PER MS33449-04
A B C D O Z O W
SECTION K-K | 1/8
LOCATED AT 142.500°
<table>
<thead>
<tr>
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<th>ZONE</th>
<th>ITEM</th>
<th>IS;</th>
<th>WAS;</th>
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<tr>
<td>2</td>
<td>4 F</td>
<td>3</td>
<td>.172 DIA THRU&lt;br&gt;SPOTFACE 1.25 DIA&lt;br&gt;PORT PER MS33649-04&lt;br&gt;[A B C S]Ø.020</td>
<td>.172 DIA THRU&lt;br&gt;C'BORE 3916&lt;br&gt;DIA X 3.00 DEEP&lt;br&gt;SPOTFACE 1.25 DIA&lt;br&gt;PORT PER MS33649-04&lt;br&gt;[A B C S]Ø.020</td>
</tr>
<tr>
<td>1</td>
<td>6 F</td>
<td>4</td>
<td>1.062 DIA THRU&lt;br&gt;18 HOLES&lt;br&gt;[A B C S]Ø.010</td>
<td>1.062 DIA THRU&lt;br&gt;SPOTFACE 2.50 DIA FAR SIDE ONLY, 18 HOLES&lt;br&gt;[A B C S]Ø.010</td>
</tr>
<tr>
<td>1</td>
<td>1 C</td>
<td>5</td>
<td>1.062 DIA THRU&lt;br&gt;16 PL EQ SP&lt;br&gt;[A B C S]Ø.020</td>
<td>1.062 DIA THRU&lt;br&gt;SPOTFACE 2.50 DIA&lt;br&gt;FAR SIDE ONLY&lt;br&gt;[A B C S]Ø.020</td>
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<tr>
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<td>M551937-6C</td>
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**IS:** RADIUS THE ORIFICE INLETS USING ONE OF THE FOLLOWING PROCESS:

A. ELECTROPOLISH INDICATED SIDE USING
   A SOLUTION OF 50% PHOSPHORIC ACID/50% DEIONIZED WATER AND 100 AMP/FT² CURRENT. CONTINUE PROCESS UNTIL 0.001-0.0015 INCHES OF MATERIAL IS REMOVED AND ORIFICE INLETS HAVE A SLIGHT RADIUS.

B. MICRO BLAST INDICATED SIDE USING 100 MICRON SILICON CARBIDE GLASS BEADS FOR ~10 SEC. CONTINUE PROCESS UNTIL ALL BURRS ARE REMOVED AND A 0.001-0.0015 INCH RADIUS IS ACHIEVED ON THE ORIFICE INLETS.

**WAS:** ELECTROPOLISH INDICATED SIDE USING A SOLUTION OF 50% PHOSPHORIC ACID/50% DEIONIZED WATER AND 100 AMP/FT² CURRENT. CONTINUE PROCESS UNTIL 0.001-0.0015 INCHES OF MATERIAL IS REMOVED AND ORIFICE INLETS HAVE A SLIGHT RADIUS.
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<td>BOSS</td>
<td>CRES</td>
<td>GS-5-763 CL-304 COND A</td>
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<tr>
<td>AR</td>
<td>WELD ROD</td>
<td>ER316</td>
<td>AWS A5.9</td>
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<td>1</td>
<td>ASSY</td>
<td>CRES</td>
<td>GS-5-763 CL-304 COND A</td>
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<td>14713</td>
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<td>2&quot; GR 20 SCH 160</td>
<td>5A182-F316</td>
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<td>CRES</td>
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<tr>
<td>-1</td>
<td>INNER RING</td>
<td>CRES</td>
<td>ASTM A473 OR ASTM A167 TYPE 304</td>
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</tbody>
</table>
WAS;
APPENDIX F
NONCONFORMANCE REPORTS
Accept As Is providing the forging will meet ultrasonic inspection per ATC-STD-4819 with all available records substantiating the material meets MIL-S-5000E requirements.

**B/P note 5 requires ultrasonic inspection to ATC-Std Class II and Class III. Forging is rejected to Class IV.**

The heat of #340AQ used was not adequate for Class II sonic requirement.
**NONCONFORMANCE REPORT**

**ITEM 1**

**RESIN CONTENT**
31.4% is 36.83 FWD
36.61 AFT

**DISPOSITION/COMMENTS**
Us As Is: the higher resin content will not affect the performance of the liner in the hot fire environment.

**CAUSE**
Buoyant method for silica phenolic materials historically has been higher than the raw material certifications. In this case the fiberite costs report 32%, also the req'd cure cycle reduces resin flow during cure.

**CORRECTIVE ACTION**
Raise part resin content limits, or procure MX 2600 with a lower resin content which would not be their standard product.
# NONCONFORMANCE REPORT

**PART NUMBER:** 1206429  
**NOMENCLATURE:** N/C INSERT THRUST CHAMBER  
**SERIAL NO.:** 2873-1-002

## 1. NONCONFORMANCE

### ITEM 1: RESIN CONTENT

- **SPECIFIED:** 31 ± 4% is
- **ACTUAL:** 36.89 FWD  
  36.23 AFT

**CAUSE:** Us As Is; the higher resin content will not affect the performance of the Insert in the hot fire environment.

## DISPOSITION

- **RESPONSIBILITY:** G.M.
- **DATE:** 1-14-91
- **DISCREPANT MATERIAL DISPOSITION:**  
  - **RESPONSIBILITY:** G.M.
  - **DATE:** 1-14-91

---

**DISCLAIMER:**

- **METHOD FOR SILICA PHENOLIC MATERIALS:** HISTORICALLY HAS BEEN HIGHER THAN THE RAW MATERIAL CERTIFICATIONS (FIBERITE CERTS REPORT 92%)
- **AFFECTED CURE CYCLE:** REDUCES RESIN FLOW DURING CURE.

**CORRECTIVE ACTION:**

- **RESIN CONTENT LIMITS:** RAISE PART RESIN CONTENT LIMITS, OR PRODUCE MX2600 WITH A LOWER RESIN CONTENT WHICH WOULD NOT BE THEIR STANDARD PRODUCT.
- **CURE CYCLE:** RAISE THE CURE CYCLE TO IMPROVE RESIN FLOW.
## NONCONFORMANCE REPORT

**G.F.M. NO.: Y21284**

### 1. PART NUMBER
1200729

### 2. NOMENCLATURE
- A INJECTOR CORE

### 3. SERIAL NO.

### 4. PROGRAM
3D SUBSCALE

### 5. LOT SIZE
1

### 6. ACC.
0

### 7. DISC.
1

### 8. WORK ORDER
- S/O 4444

### 9. SHOP ORDER

### 10. OPER. NO.

### 11. SUPPLIER NAME
MARTINEZ & TUREK

### 12. P.O. NUMBER
L823839

### 13. DISTRIBUTION NO.

### 14. NONCONFORMANCE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>(A) DWG. ZONE, SPEC., PARA., SHOP ORDER OPER., ETC. AS APPLICABLE</th>
<th>(B) STATE REQUIREMENT</th>
<th>(C) INSPECTION RESULTS</th>
<th>(D) CAUSE OF OCCUR</th>
<th>M/RB ITEMS</th>
<th>16. DISPOSITION/COMMENTS</th>
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<tr>
<td>1</td>
<td>REF. DWG. SHEET 4/7, ZONE: F-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Us As Is; the smaller diametrical dimension will not affect the assembly nor will it jeopardize the seal of the o-ring.</td>
</tr>
<tr>
<td></td>
<td>SHOULD BE: φ11.336+.000 .002</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>IS: φ11.331 at 68° F</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>REF. DWG SHEET 3/7, ZONE: A-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Us As Is; the difference of .001&quot; in channel depth will not change the flow characteristics to detriment the hardware performance.</td>
</tr>
<tr>
<td></td>
<td>SHOULD BE: .022 + .001 @ 8 places, (BRAZE CHANNEL DEPTH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>IS: ACCEPTABLE AT (7) LOCATIONS, (1) LOCATION (φ 1.888) FOUND TO BE .024&quot; DEEP.</td>
<td></td>
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</tbody>
</table>

### 21. M/RB/REV ADVANCEMENTS

### 22. M/RB/REV SUBMIT DECISIONS

### 23. CAUSE
Items 1&2: OPERATOR ERROR

### 24. CORRECTIVE ACTION
OPERATOR HAD PROPER INSTRUCTIONS AND DID NOT FOLLOW. THIS OPERATOR HAS BEEN COUNSELED ON CRITICAL NATURE OF THIS ASSEMBLY. VERBAL WARNING ISSUED.

### 25. EFFECTIVITY: (DATE/SERIAL NUMBER/ETC.)
1/23/91
**NONCONFORMANCE REPORT**

**G.F.M. NO. V21221**

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<th>DASH</th>
<th>REV</th>
<th>2 NOMENCLATURE</th>
<th>3 SERIAL NO.</th>
<th>4 PROGRAM</th>
<th>5 LOT SIZE</th>
<th>6 ACC.</th>
<th>7 DISC.</th>
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<tbody>
<tr>
<td>1200729</td>
<td>-1</td>
<td>A</td>
<td>INJECTOR CORE</td>
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**WORK ORDER**

<table>
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<tr>
<th>9 WORK ORDER</th>
<th>SHOP ORDER</th>
<th>VENDOR</th>
<th>10 OPER No</th>
<th>11 SUPPLIER NAME</th>
<th>NUMBER</th>
<th>12 P.O NUMBER</th>
<th>13 DISTRIBUTION NO</th>
<th>14 WINNER/.nr NUMBER</th>
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<tr>
<td>KFN 600</td>
<td>S/0 4444</td>
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<td>MARTINEZ &amp; TUREK</td>
<td>MA2557</td>
<td>L823839</td>
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</table>

**14. NONCONFORMANCE**

1. REF: DWG. SHEET -4, Zone: D-5
   Should be: Ø .156 ± .005, 7-Holes Eq. Spaced

2. Equal Spacing
   IS: True position varies up to .020
   (See Attached for Discrepant locations) 7 pls.

3. Accept as is providing all metal chips have been deburred so there will be nothing dislodged during testing.

**24. CORRECTIVE ACTION**

Due to the length of the drill required to complete this configuration (Approx. 5" Long) Deflection occurred thus causing drilled hole to be off location.

Operator has been instructed to pilot drill holes first and then bore to size.
ATC PN# 1200729
-1 INJECTOR CORE
P.O.# L823839

VIEW S 426
9 PL THRU EQ SP
SCALE: 2/1

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<td>.006</td>
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<tr>
<td>2</td>
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<tr>
<td>6</td>
<td>.007</td>
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<tr>
<td>7</td>
<td>.0085</td>
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</table>

\( \sqrt{21221} \)
**NONCONFORMANCE REPORT**

1. PART NUMBER: 1206423  
   DASH: -9  
   REV: A-2  
   2. NOMENCLATURE: INJECTOR CORE ASSY  
   3. SERIAL NO: S/N-01  
   4. PROGRAM:  
   5. LOT SIZE:  
   6. ACC:  
   7. DISC:  

8. WORK ORDER:  
   9. SHOP ORDER:  
   10. OPER. NO:  
   11. SUPPLIER NAME: martinez & Turek  
   12. P.O. NUMBER: 1823839  
   13. DISTRIBUTION NO:  
   14. PREVIOUS NR NUMBER:  

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<td>SHOULD BE: 10.75 ± .030</td>
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<tr>
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<td>IS: 10.685</td>
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**15. DISPOSITION/COMMENTS**

Us As Is; the difference in length will be accommodated between the seal and the test stand interface.

**21. MRD/ERB APPROVALS**

ENG REPR:  
QA REPR:  
CLST REPR:  
ENG REPR:  
QA REPR:  

**23. CAUSE**

This is attributed to Weld Shrinkage during the welding of -19 Assembly onto -1 Assembly

**24. CORRECTIVE ACTION**

This problem has been presented to M&T Engineering & Mfg. Engineer for solution on all XXX future projects
# LOX/Hydrocarbon Rocket Engine Analytical Design Methodology Development and Validation

## Authors
Karen E. Niiya and Richard E. Walker

## Performing Organization Name(s) and Address(es)
Aerojet Propulsion Division
P.O. Box 13222
Sacramento, California 95813

## Sponsor/Monitoring Agency Name(s) and Address(es)
National Aeronautics and Space Administration
Lewis Research Center
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## Abstract
This final report includes a discussion of the work accomplished on contract NAS 3-25556 during the period from December 1988 through November 1991. The objective of the program was to assemble existing performance and combustion stability models into a usable design methodology capable of designing and analyzing high-performance and stable LOX/Hydrocarbon booster engines. The methodology was then used to design a validation engine. The capabilities and validity of the methodology were demonstrated using this engine in an extensive hot fire test program. The engine used LOX/RP-1 propellants and was tested over a range of mixture ratios, chamber pressures and acoustic damping device configurations. This volume contains time domain and frequency domain stability plots which indicate the pressure perturbation amplitudes and frequencies from approximately 30 tests of a 50K thrust rocket engine using LOX/RP-1 propellants over a range of chamber pressures from 240 to 1750 psia with mixture ratios of from 1.2 to 7.5. The data is from test configurations which used both bitune and monotune acoustic cavities and from tests with no acoustic cavities. The engine had a length of 14 inches and a contraction ratio of 2.0 using a 7.68 inch diameter injector. The data was taken from both stable and unstable tests. All combustion instabilities were spontaneous in the first tangential mode. Although stability bombs were used and generated over pressures of approximately 20%, no tests were driven unstable by the bombs. The stability instrumentation included six high-frequency Kistler transducers in the combustion chamber, a high-frequency Kistler transducer in each propellant manifold, and tri-axial accelerometers. Performance data is presented, both characteristic velocity efficiencies and energy release efficiencies, for those tests of sufficient duration to record steady state values.

## Subject Terms
- Combustion stability
- Combustion efficiency
- Rocket engine design
- Combustion chambers
- Rocket thrust chambers
- Design analysis
- Injectors

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- Unclassified

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This report was prepared by Aerojet Propulsion Division under contract NAS 3-25556 for the National Aeronautics and Space Administration. The work described in this report was performed under the supervision of Mark D. Klem, Project Manager. The report includes a comprehensive discussion of the methodology developed for designing and analyzing high-performance and stable LOX/Hydrocarbon booster engines, with emphasis on the LOX/RP-1 engine tested in an extensive hot fire program. The methodology was validated through testing on a 50K thrust rocket engine, which was tested over a range of mixture ratios, chamber pressures, and acoustic damping configurations, yielding valuable data on combustion stability and performance.

The report is structured to provide a clear overview of the methodology, its development, and the results of the testing. It includes detailed descriptions of the engine design, test configurations, and the data collected from the tests, which are presented in both time and frequency domains. The data is analyzed to demonstrate the capabilities and validity of the methodology, showcasing its effectiveness in designing and analyzing high-performance rocket engines.

The report also highlights the importance of stability bombs in the testing, noting that although they were used, no tests were driven unstable by the bombs. This indicates the robustness of the methodology in handling potential instabilities. Overall, the report provides a comprehensive understanding of the methodology and its application in the development of high-performance rocket engines, making it a valuable resource for engineers and researchers in the field of rocket propulsion.