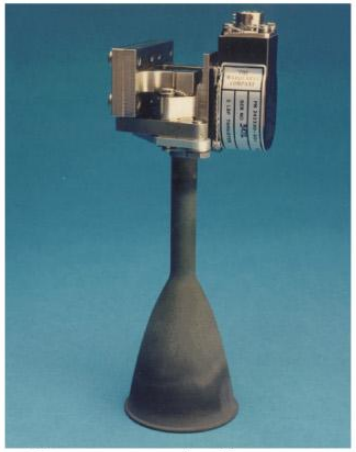
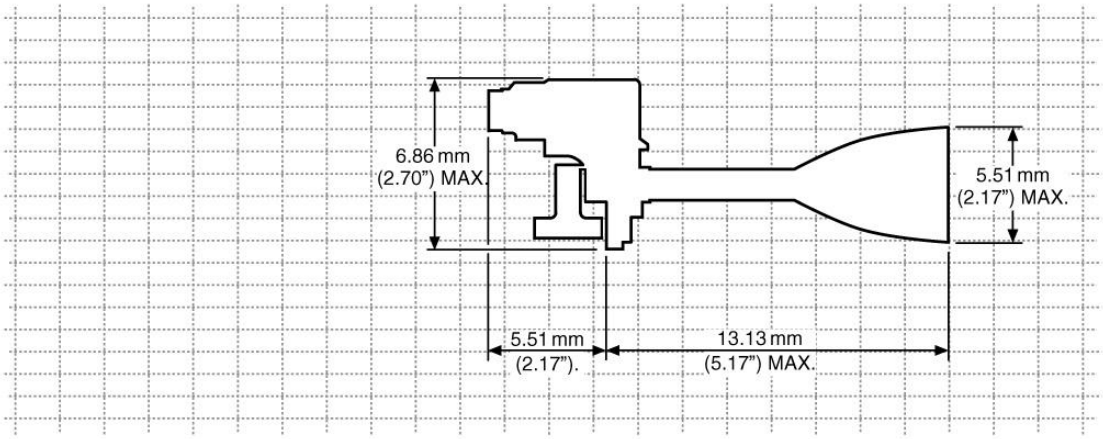
R-6D 5-lbf (22 N) BIPROPELLANT ROCKET ENGINE





Design Characteristics

- Propellant . . . . . MMH/NTO(MON-3)
- Thrust/Steady State . . . . . 22 N (5 lbf)
- Inlet Feed Pressure Range . . . . . 27.96 – 6.9 bar (400 – 100 psia)
- Chamber Pressure . . . . . 6.7 bar @ 22N (97 psia @ 5 lbf)
- Expansion Ratio 100:1
- Flow Rate . . . . . 7.71 g/sec (0.017 lbm/sec)
- Valve . . . . . Single Seat Torque Motor . . . . . Dual Seat Solenoid
- Valve Power . . . . . 5 Watts @ 28 Vdc (Moog Torque Motor)
- Mass . . . . . 0.454 kg (1.0 lbm)

Performance

- Specific Impulse . . . . . 294 sec (lbf-sec/lbm)
- Total Impulse . . . . . >1,334,400 N-sec (300,000 lbf-sec)
- Total Pulses 336,331
- Minimum Impulse Bit . . . . . 0.0089 N-sec (0.002 lbf-sec)
- Steady State Firing . . . . . 0.005 sec to Unlimited

Status

- Flight Qualified

Reference:

- AIAA-1989-2734

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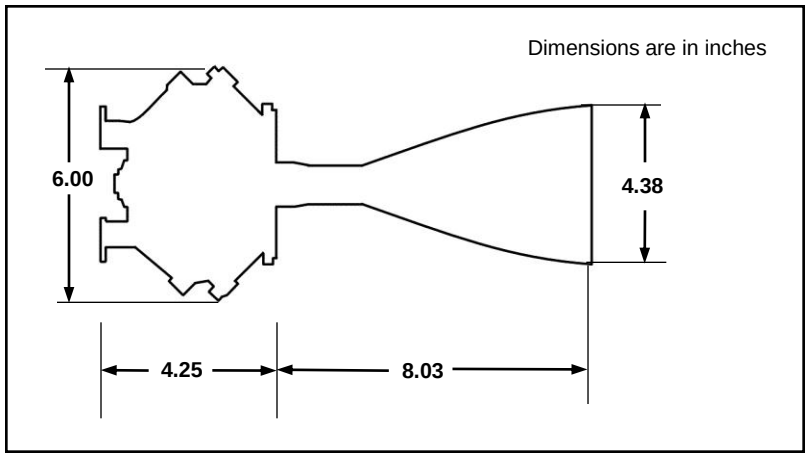
AEROJET

R-1E 110N (25 lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant . . . . . MMH/NTO(MON-3)
- Thrust/Steady State . . .. 111 N (25 lbf)
- Inlet Pressure Range . . . . . 27.6-6.9 bar (400-100 psia)
- Chamber Pressure*. . . . . 7.3 bar (106 psia)
- Expansion Ratio 100:1
- Flowrate* . . . . . 40.4 g/sec (0.089 lbm/sec)
- Valve. . . . . Aerojet Solenoid, Single Coil, Single Seat
- Valve Power . . . . . 36 Watts @ 28 Vdc
- Mass. . . . . 2 kg (4.4 lbm)

* *At rated thrust*

Performance

- Specific Impulse*. . . . . 280 sec (lbf-sec/lbm)
- Total Impulse. . . . .11,120,000 N-sec (2,500,000 lbf-sec)
- Total Pulses 330,000
- Minimum Impulse Bit . . . . . .0.89 N-sec (0.2 lbf-sec)
- Steady State Firing (sec). . . . . No Limitations

Status

- Flight Proven

Reference

- AIAA - 1990 - 1837

Rev. Date: 5/17/06

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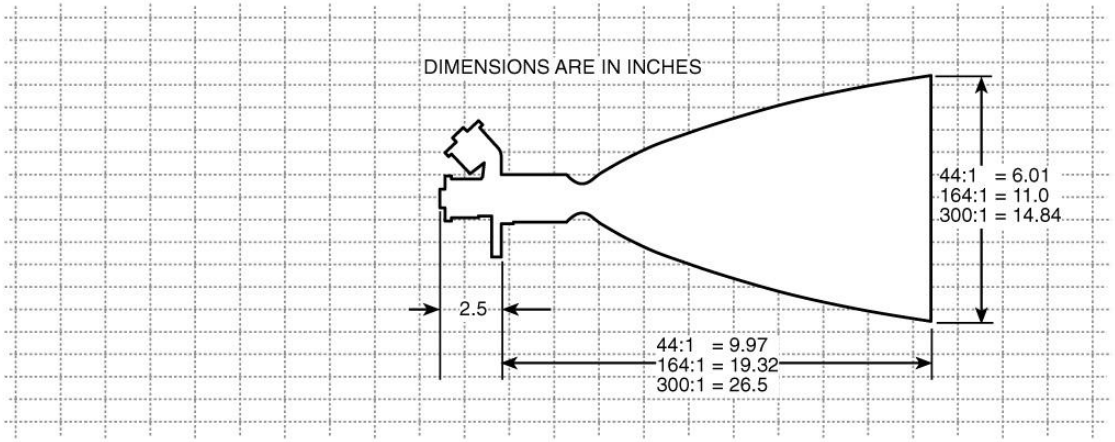
AEROJET

R-4D 490N (110-lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant . . . . . MMH/NTO(MON-3)
- Thrust/Steady State 490N (110-lbf)
- Inlet Pressure Range . . . . . 29.3–4.1Bar (425–60 psia)
- Chamber Pressure* . . . . . 7.45 Bar (108 psia)
- Expansion Ratio 44:1, 164:1, 300:1
- Flow Rate* . . . . . 158 g/sec (0.348 lbm/sec) (300:1)
- Valve . . . . . Aerojet Solenoid, Single Coil, Single Seat
- Valve Power . . . . . Various (46 Watts @ 28 Vdc Typical)
- Mass . . . . . 44:1, 3.40 kg (7.5 lbm)
  . . . . . 164:1, 3.76 kg (8.3 lbm)
  . . . . . 300:1, 4.31 kg (9.5 lbm)
  - Engine . . . . . 44:1, 2.49 kg (5.5 lbm)
    . . . . . 164:1, 2.86 kg (6.3 lbm)
    . . . . . 300:1, 3.40 kg (7.5 lbm)
  - Valve . . . . . 0.9 kg (2.0 lbm)

**at Rated Thrust*

Performance

- Specific Impulse* . . . . . 44:1 = 300 sec (lbf-sec/lbm)
  . . . . . 164:1 = 311 sec (lbf-sec/lbm)
  . . . . . 300:1 = 315.5 sec (lbf-sec/lbm)
- Total Impulse Demonstrated
  . . . . . 20,016,000 N-sec (4,500,000 lbf-sec)
- Total Pulses 20,781
- Minimum Impulse Bit . . . . . 15.6 N-sec (3.5 lbf-sec)
- Demonstrated Steady State Firing . . . . . 12,000 sec

Status

- Flight Proven

References

- AIAA - 2004 - 3694
- AIAA - 1980 - 1294
- AIAA - 1979 - 1331

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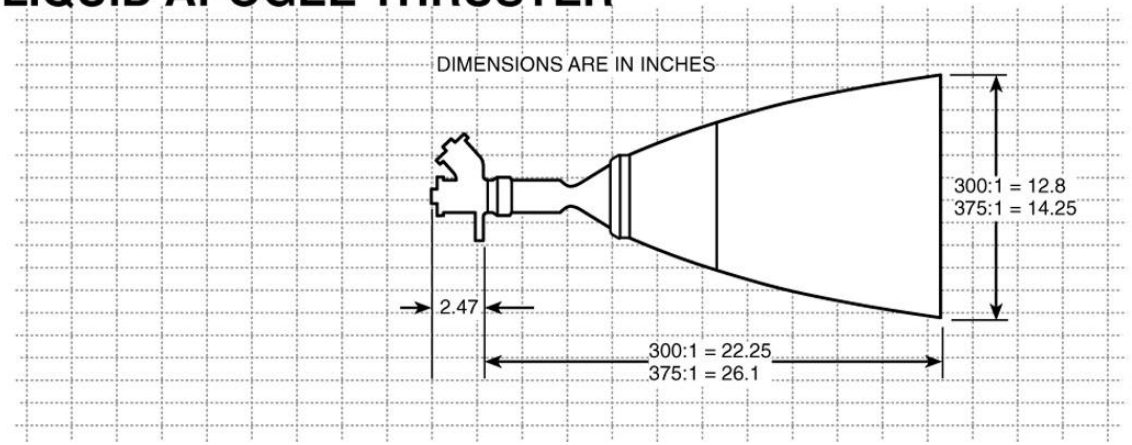
AEROJET

HiPAT™ 445 N (100-lbf) HIGH PERFORMANCE LIQUID APOGEE THRUSTER



Design Characteristics

- Propellant . . . . . MMH/NTO(MON-3)
- Thrust/Steady State . . . . . 445 N (100-lbf)
- Inlet Pressure Range . . . . . 27.6 – 6.9 bar (400 – 100 psia)
- Chamber Pressure* . . . . . 9.4 bar (137 psia)
- Expansion Ratio 300:1, 375:1
- Flow Rate* . . . . . 141 g/sec (0.31 lbm/sec)
- Valve . . . . . Aerojet Solenoid, Dual Coil, Single Seat
- Valve Power . . . . . Various (46 Watts @ 28 Vdc Typical)
- Mass . . . . . 300:1, 5.2 kg (11.5 lbm)
  . . . . . 375:1, 5.44 kg (12 lbm)

**At rated thrust*

Performance

- Specific Impulse* . . . . . 300:1 = 320 sec (lbf-sec/lbm)
  . . . . . 375:1 = 323 sec (lbf-sec/lbm)
- Total Impulse Demonstrated
  . . . . . 20,016,500 N-sec (4,635,000 lbf-sec)
- Total Pulses 500
- Minimum Impulse Bit . . . . . 35.6 N-sec (8 lbf-sec)
- Demonstrated Steady State Firing . . . . . 3600 sec

Status

- Flight Proven

References

- AIAA - 2001 - 3253
- AIAA - 2000 - 3161

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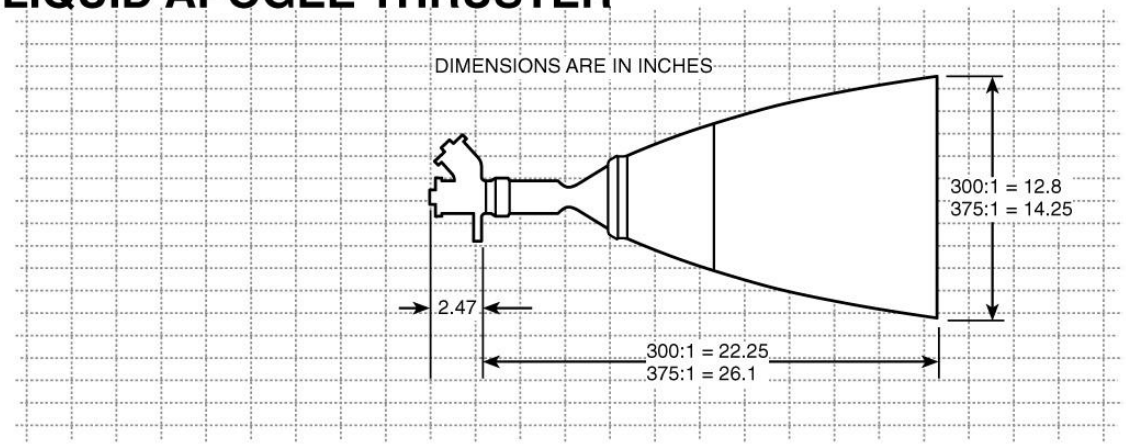
AEROJET

HiPAT™ 445 N (100-lbf) DUAL MODE HIGH PERFORMANCE LIQUID APOGEE THRUSTER



Design Characteristics

- Propellant . . . . . Hydrazine/NTO(MON-3)
- Thrust/Steady State . . . . . 445 N (100-lbf)
- Inlet Pressure Range . . . . . 21.4 – 15.2 bar (310 – 220 psia)
- Chamber Pressure* . . . . . 9.4 bar (137 psia)
- Expansion Ratio 300:1, 375:1
- Oxidizer/Fuel Ratio 0.85
- Flow Rate* . . . . . 141 g/sec (0.31 lbm/sec)
- Valve . . . . . Aerojet Solenoid, Dual Coil, Single Seat
- Valve Power . . . . . Various (46 Watts @ 28 Vdc Typical)
- Mass . . . . . 300:1, 5.2 kg (11.5 lbm)
  . . . . . 375:1, 5.44 kg (12 lbm)

**At rated thrust*

Performance

- Specific Impulse* . . . . . 300:1 = 326 sec (lbf-sec/lbm)
  . . . . . 375:1 = 329 sec (lbf-sec/lbm)
- Total Impulse Demonstrated . . . . In Excess of 9.55 x 10^6 N-sec
  . . . . . (2.15 x 10^6 N-sec)
- Total Pulses 672
- Total Thermal Cycles 345
- Minimum Impulse Bit . . . . . 35.6 N-sec (8 lbf-sec)
- Demonstrated Steady State Firing . . . . . 1800 sec

Status

- Qualified

Reference

- AIAA - 2003 - 4775

Rev. Date: 5/24/05

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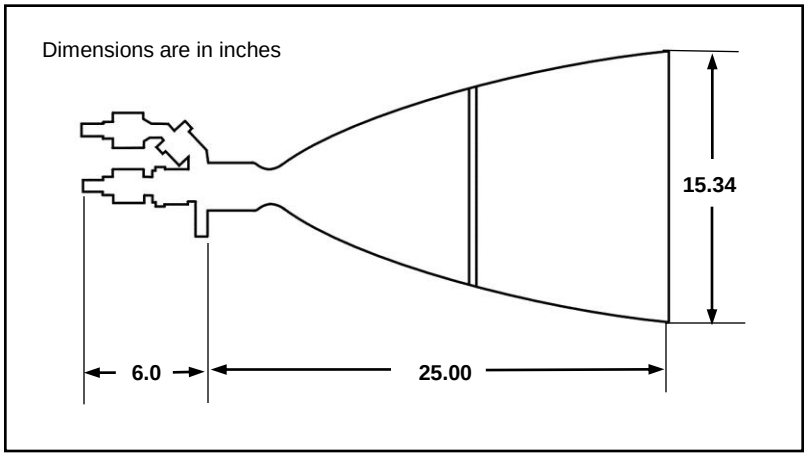
AEROJET

R-42 890N (200 lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant . . . . . MMH/NTO(MON-3)
- Thrust/Steady State. . . . . 890 N (200 lbf)
- Inlet Pressure Range . . . . . 29.3-6.9 bar (425-100 psia)
- Chamber Pressure*. . . . . 7.1 bar (103 psia)
- Expansion Ratio 160:1
- Flowrate*.. . . . . 300 g/sec (0.66 lbm/sec)
- Valve . . . . . Aerojet Solenoid, Single Coil, Single Seat
- Valve Power . . . . . 46 Watts @ 28 Vdc
- Mass. . . . . .4.53 kg (10.0 lbm)

**At rated thrust*

Performance

- Specific Impulse* . . . . . 303 sec (lbf-sec/lbm)
- Total Impulse . . . . . 24,271,000 N-sec (5,456,700 lbf-sec)
- Total Pulses 134
- Minimum Impulse Bit . . . . . 44.48 N-sec (10.0 lbf-sec)
- Steady State Firing Cumulative . . . . . 27,000 sec
- Steady State Firing (Single Firing) . . . . . 3,940 sec

Reference

- AIAA - 1990 - 2055

Rev. Date: 5/17/06

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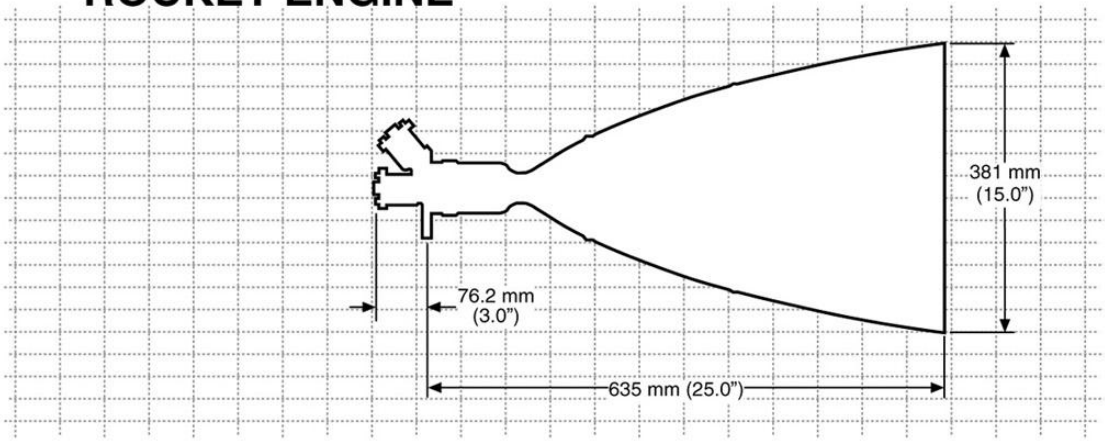
AEROJET

R-42DM 890 N (200 lbf) DUAL MODE HIGH PERFORMANCE ROCKET ENGINE



Design Characteristics

- Propellant . . . . . Hydrazine / NTO(MON-3)
- Thrust/Steady State . . . . . 890 N (200 lbf)
- Inlet Pressure Range . . . . . 25.5 – 13.8 bar (370 – 200 psia)
- Chamber Pressure* . . . . . 9.6 bar (140 psia)
- Expansion Ratio 200:1
- Oxidizer / Fuel Ratio . . . . . 0.8 – 1.2 (1.0 nominal)
- Flow Rate* . . . . . 277 g/sec (0.61 lbm/sec)
- Valve . . . . . Aerojet Single or Dual Seat
- Valve Power . . . . . Various (45 Watts @ 28 Vdc Typical)
- Mass . . . . . with single seat valves 7.3 kg (16 lbm)

**at rated thrust*

Performance

- Specific Impulse . . . . . 327 sec (lbf-sec/lbm)
- Total Impulse . . . . . >20.0 x 10^6 N-sec (4.5 x 10^6 lbf-sec)
- Total Pulses . . . . . >100
- Total Thermal Cycles . . . . . >50
- Steady State Firing . . . . . 1000 sec

Status

- FY2008 IR&D, TRL 6
- Ready for final flight design and analysis, and formal qualification (program specific)

Rev. Date: 10/16/09
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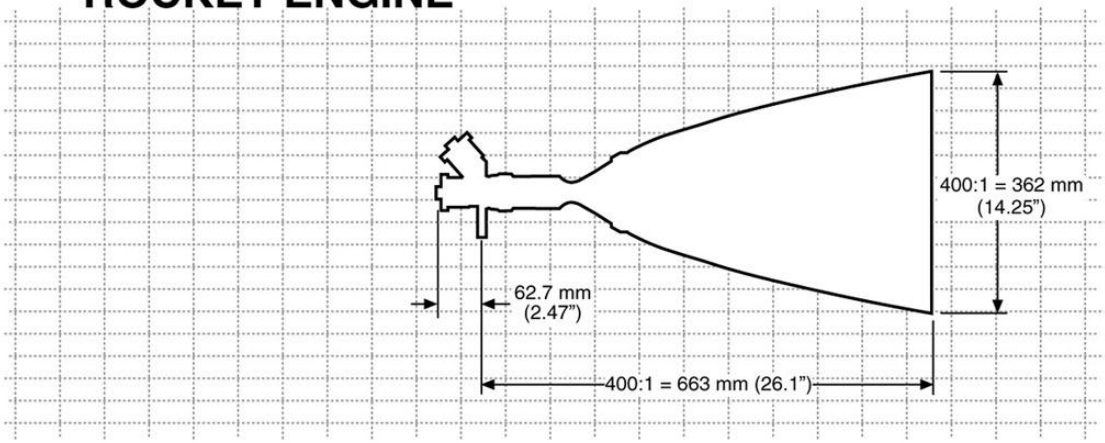
AEROJET

AMBR 623 N (140 lbf) DUAL MODE HIGH PERFORMANCE ROCKET ENGINE



Design Characteristics

- Propellant . . . . . Hydrazine / NTO(MON-3)
- Thrust/Steady State . . . . . 623 N (140 lbf)
- Inlet Pressure Range . . . . . 22.4 – 12.1 bar (325 – 125 psia)
- Chamber Pressure* . . . . . 13.8 bar (200 psia)
- Expansion Ratio 400:1
- Oxidizer / Fuel Ratio . . . . . 1.0 – 1.3 (1.1 nominal)
- Flow Rate* . . . . . 204 g/sec (0.45 lbm/sec)
- Valve . . . . . Aerojet Single or Dual Seat
- Valve Power . . . . . Various (45 Watts @ 28 Vdc Typical)
- Mass . . . . . with single seat valves 5.4 kg (12 lbm)

**at rated thrust*

Performance

- Specific Impulse . . . . . 333 sec (lbf-sec/lbm)
- Total Impulse . . . . . 5,586,000 N-sec (1,255,800 lbf-sec)
- Total Pulses . . . . . >100
- Total Thermal Cycles . . . . . >50
- Steady State Firing . . . . . 2700 sec

Status

- FY2008-9 NASA funded, TRL 6
- Ready for final flight design and analysis, and formal qualification (program specific)

Reference:

- AIAA-2009-5125

Rev. Date: 10/16/09
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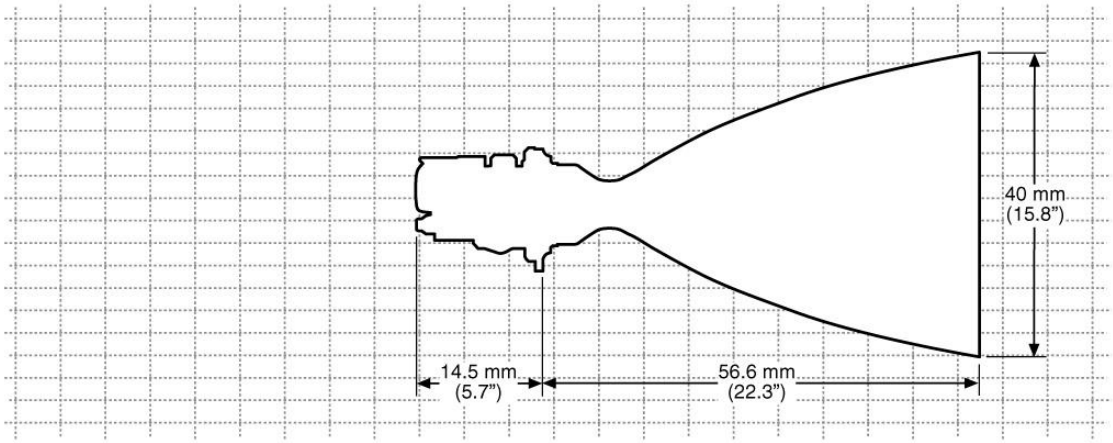
AEROJET

R-40B 4,000 N (900-lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant . . . . . MMH/NTO (MON-3)
- Thrust/Steady State . . . . . 4,000 N (900 lbf)
- Inlet Pressure Range . . . . . 27.6 – 10.3 bar (400 – 150 psia)
- Chamber Pressure* . . . . . 10.34 bar (150 psia)
- Expansion Ratio 60:1
- Flow Rate* . . . . . 1.40 kg/sec (3.07 lbm-sec)
- Valve . . . . . Aerojet
- Valve Power . . . . . 70 Watts @ 28 Vdc
- Mass . . . . . 6.8 kg (15.0 lbm)

**At rated thrust*

Performance

- Specific Impulse* . . . . . 293 sec (lbf-sec/lbm)
- Total Impulse . . . . . 92,073,600 N-sec (20,700,000 lbf-sec)
- Total Pulses 50,000
- Minimum Impulse Bit . . . . . 111 N-sec (25.0 lbf-sec)
- Steady State Firing . . . . . 23,000 sec

Reference

- IAF-1987-0283

Rev. Date: 6/08/06

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