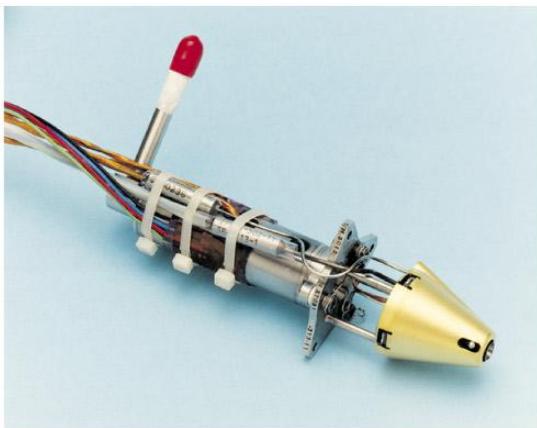
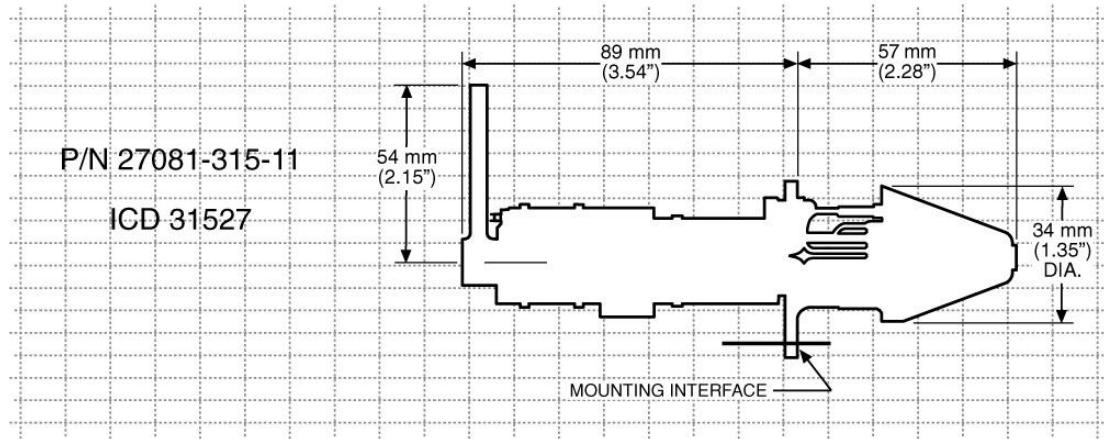


# MR-103D 1N (0.2-lbf) ROCKET ENGINE ASSEMBLY



4109-1



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405
- Thrust/Steady State ..... 1.02 – 0.22 N (0.230 – 0.05 lbf)
- Feed Pressure ..... 27.6 – 6.2 bar (400 – 90 psia)
- Chamber Pressure ..... 23.4 – 5.9 bar (340 – 85 psia)
- Expansion Ratio ..... 100:1
- Flow Rate ..... 0.5 – 0.09 g/sec (0.001 – 0.0002 lbfm-sec)
- Valve ..... Dual Seat
- Valve Power ..... 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power ..... 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr ..... 3.93 Watts Max @ 28 Vdc & 21°C
- Mass ..... 0.33 kg (0.73 lbf)
  - Engine ..... 0.13 kg (0.28 lbf)
  - Valve ..... 0.20 kg (0.45 lbf)

## Performance

- Specific Impulse ..... 224 – 209 sec (lbf-sec/lbm)
- Total Impulse ..... 186,000 N-sec (41,828 lbf-sec)
- Total Pulses ..... 275,028
- Minimum Impulse Bit ..... 0.027 N-sec @ 6.9 bar & 15 ms ON  
..... (0.006 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing ..... 5,000 sec – Single Firing  
..... 111.4 hrs – Cumulative

## Status

- Flight Proven

## Reference

- SC00-2000-XI-1

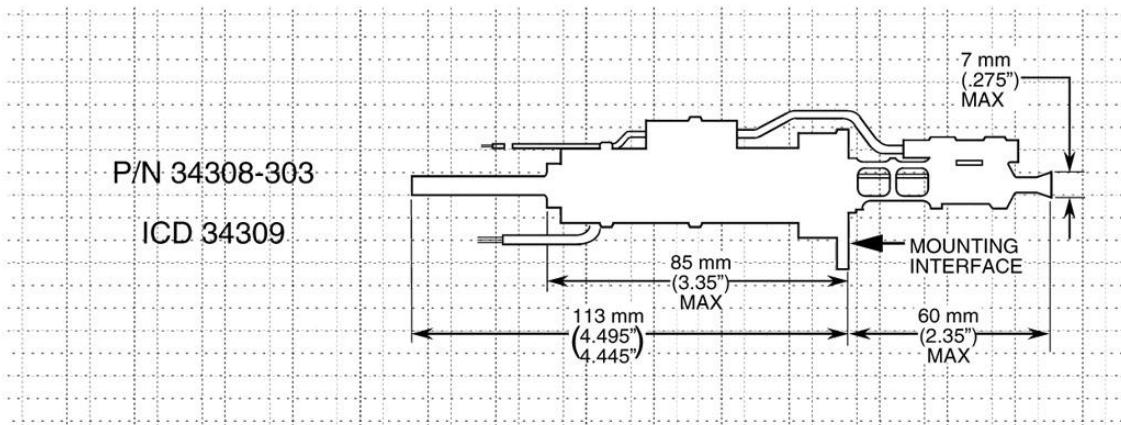
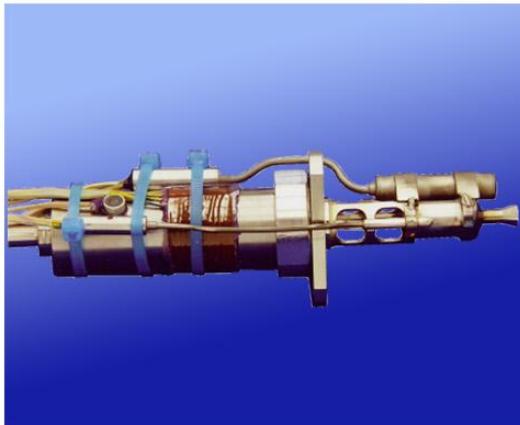
Rev. Date: 4/24/06

11411 139th Place NE • Redmond, WA 98052  
(425) 885-5000 FAX (425) 882-5747

**AEROJET**

Approved for public release and export

# MR-103G 1N (0.2-lbf) ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant..... Hydrazine
- Catalyst..... S405
- Thrust/Steady State ..... 1.13 – 0.19N (0.253 – 0.043 lbf)
- Specific Impulse..... 224 – 202 sec (lbf-sec/lbm)
- Feed Pressure..... 28.3 – 4.8 bar (420 – 70 psia)
- Chamber Pressure..... 23.8 – 4.5 bar (345 – 65 psia)
- Expansion Ratio..... 100:1
- Flow Rate..... 0.5 – 0.09 g/sec (0.0011 – 0.0002 lbm/sec)
- Valve..... Dual Seat
- Valve Power..... 8.25 Watts Max@28 Vdc & 21°C
- Cat. Bed Heater Pwr..... 6.32 Watts Max@28 Vdc & 21°C
- Mass ..... 0.33 kg (0.73 lbm)
  - Engine..... 0.127 kg (0.28 lbm)
  - Valve..... 0.204 kg (0.45 lbm)

## Performance

- Total Impulse..... 97,078 N-sec  
(21,825 lbf-sec)
- Total Pulses..... 835,017
- Minimum Impulse Bit..... 0.0133 N-sec@0.015sec ON & 6.9 bar  
(0.003 lbf-sec@0.015sec) (ON & 100psi)
- Steady State Firing      Single firing..... 300 sec      1,000 sec  
..... Cumulative..... 23.8 hrs — 40.6 hrs

## Status

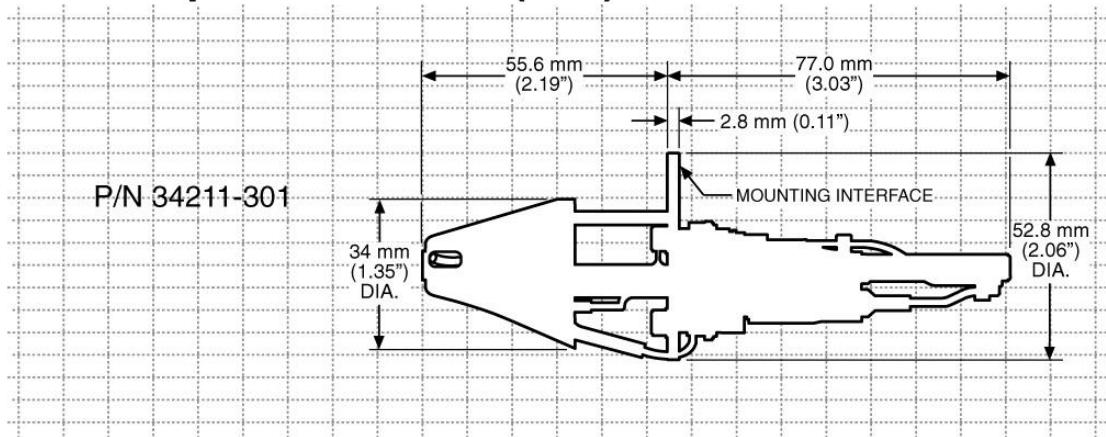
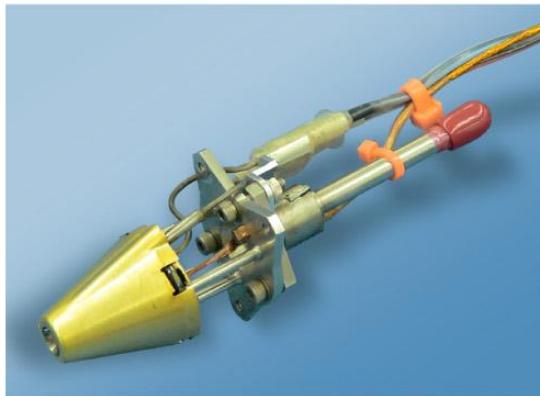
- Flight Proven

## Reference

- AIAA-2005-3952

# MR-103M 1 N (0.2-lbf) ROCKET ENGINE ASSEMBLY

## Minimum Impulse Thruster (MIT)



### Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405
- Thrust/Steady State ..... 0.99 – 0.28 N (0.22 – 0.06 lbf)
- Feed Pressure ..... 27.6 – 6.9 bar (400 – 100 psia)
- Chamber Pressure ..... 20.7 – 5.9 bar (300 – 85 psia)
- Expansion Ratio ..... 100:1
- Flow Rate ..... 0.45 – 0.14 g/sec (0.001 – 0.0003 lbm-sec)
- Valve ..... Single Seat
- Valve Power ..... 7.1 Watts @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr ..... 3.8 Watts @ 28 Vdc & 21°C
- Mass ..... 160 gm (0.35 lbm)
  - Engine ..... 135 gm (0.30 lbm)
  - Valve ..... 25 gm (0.05 lbm)

### Performance

- Specific Impulse ..... 221 – 206 sec (lbf-sec/lbm)
- Total Impulse ..... 121,817 N-sec (27,387 lbf-sec)
- Total Pulses ..... 515,344
- Minimum Impulse Bit ..... ~670E-6 N-sec @ 1.6 ms ON  
..... (~150E-6 lbf-sec @ 1.6 ms ON)
- Steady State Firing ..... 30,000 sec – Single Firing  
..... 60 hrs – Cumulative

### Status

- Qualified

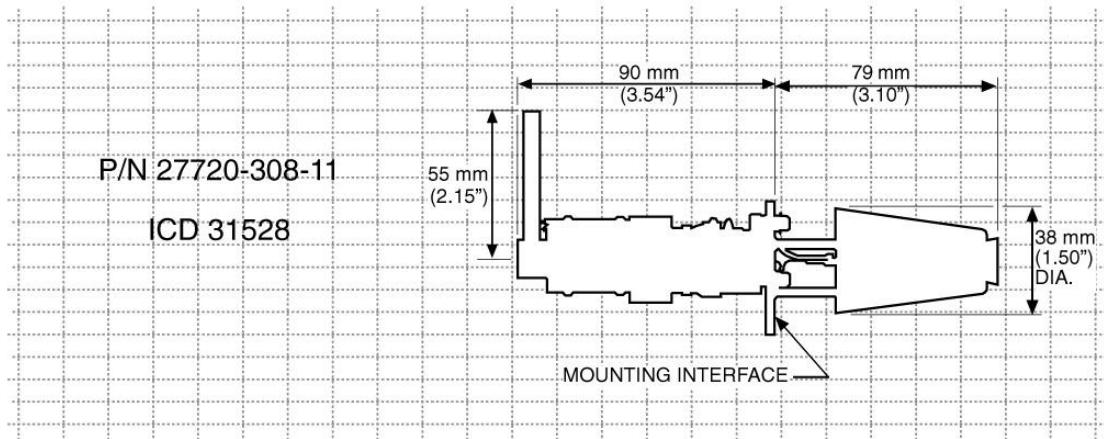
### Reference

- JANNAF-2005 – “The Minimum Impulse Thruster”

# MR-111C 4 N (1.0-lbf) ROCKET ENGINE ASSEMBLY



4448-3



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405
- Thrust/Steady State ..... 5.3 – 1.3 N (1.2 – 0.3 lbf)
- Feed Pressure ..... 27.6 – 5.5 bar (450 – 50 psia)
- Chamber Pressure ..... 12.1 – 3.4 bar (200 – 35 psia)
- Expansion Ratio ..... 74:1
- Flow Rate ..... 2.4 – 0.6 g/sec (0.0053 – 0.0014 lbfm-sec)
- Valve ..... Dual Seat
- Valve Power ..... 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power ..... 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr ..... 3.85 Watts Max @ 28 Vdc & 21°C
- Mass ..... 0.33 kg (0.73 lbf)
  - Engine ..... 0.13 kg (0.28 lbf)
  - Valve ..... 0.20 kg (0.45 lbf)

## Performance

- Specific Impulse ..... 229 – 215 sec (lbf-sec/lbm)
- Total Impulse ..... 260,000 N-sec (58,500 lbf-sec)
- Total Pulses ..... 420,000
- Minimum Impulse Bit ..... 0.08 N-sec @ 6.9 bar & 15 ms ON ..... (0.0171 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing ..... 5,000 sec min – Single Firing

## Status

- Flight Proven

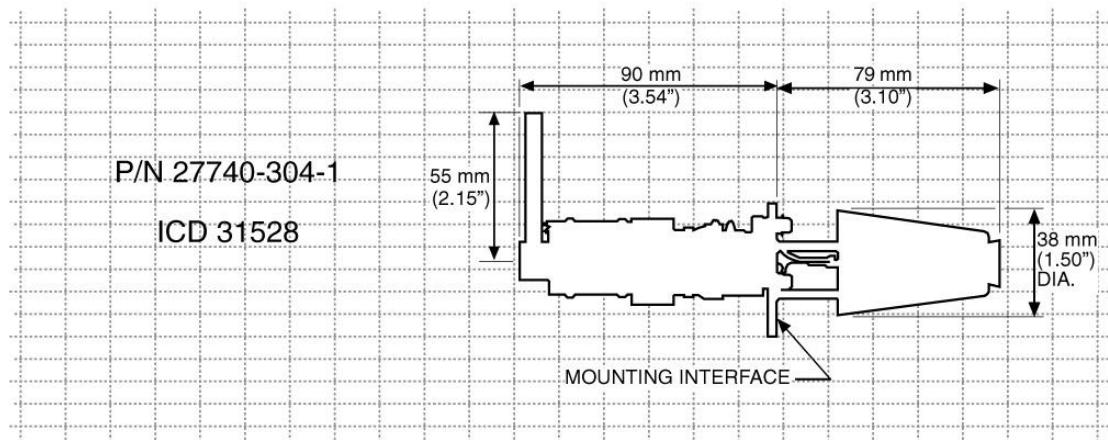
## Status

- AIAA-1999-2469

# MR-111E 2N (0.5-lbf) ROCKET ENGINE ASSEMBLY



4448-3



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405
- Thrust/Steady State ..... 2.2 – 0.5N (0.5 – 0.11 lbf)
- Feed Pressure ..... 25.5 – 4.1 bar (370 – 60 psia)
- Chamber Pressure ..... 14.1 – 3.1 bar (204 – 45 psia)
- Expansion Ratio ..... 200:1
- Flow Rate ..... 1.2 – 0.3 g/sec (0.0022 – 0.0005 lbfm-sec)
- Valve ..... Dual Seat
- Valve Power ..... 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power ..... 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr ..... 3.85 Watts Max @ 28 Vdc & 21°C
- Mass ..... 0.33 kg (0.73 lbf)
  - Engine ..... 0.13 kg (0.28 lbf)
  - Valve ..... 0.20 kg (0.45 lbf)

## Performance

- Specific Impulse ..... 224 – 213 sec (lbf-sec/lbm)
- Total Impulse ..... 260,000 N-sec (58,500 lbf-sec)
- Total Pulses ..... 420,000
- Minimum Impulse Bit ..... 0.02 N-sec @ 6.9 bar & 15 ms ON  
..... (0.006 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing ..... 15.5 hr – Single Firing  
..... 26.7 hr – Cumulative

## Status

- Flight Proven

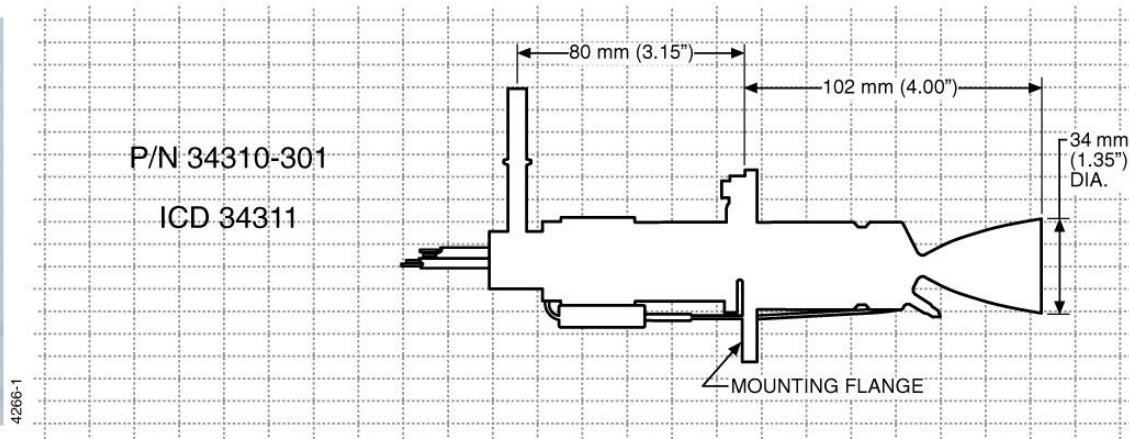
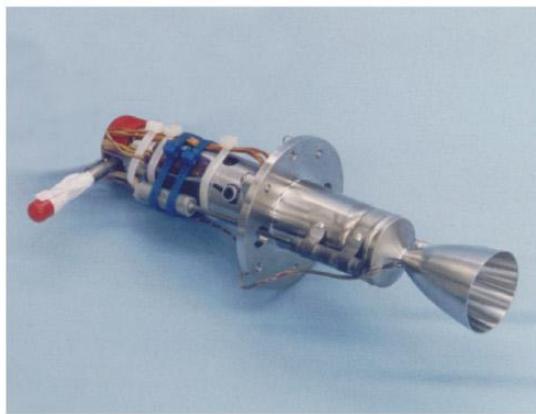
Rev. Date: 4/26/06

11411 139th Place NE • Redmond, WA 98052  
(425) 885-5000 FAX (425) 882-5747

**AEROJET**

Approved for public release and export

# MR-106E 22N (5.0-lbf) ROCKET ENGINE ASSEMBLY - 28 Vdc



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... LCH-227/202
- Thrust/Steady State ..... 30.7 – 11.6 N (6.9 – 2.6 lbf)
- Feed Pressure ..... 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure ..... 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio ..... 60:1
- Flow Rate ..... 13.1 – 5.0 g/sec (0.0289 – 0.011 lbm/sec)
- Valve ..... Dual Seat
- Cat. Bed Heater Pwr ..... 6.53 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power ..... 3.27 Watts @ 28 Vdc & 21°C
- Valve Power ..... 25.3 Watts Max @ 28 Vdc & 21°C
- Mass ..... 0.635 kg (1.4 lbm) Max

## Performance

- Specific Impulse ..... 235 – 229 sec (lbf-sec/lbm)  
REA 'A' ..... REA 'B' ..... Mars\*  
Total Impulse ..... 36,000 N-sec ..... 125,000 N-sec ..... 90,587 N-sec  
..... (26,958 lbf-sec) (28,044 lbf-sec) (20,366)
- Total Pulses ..... 12,405 ..... 186 ..... 66,631
- Minimum Impulse Bit ..... 0.46 N-sec @ 12.8 bar & 16 ms ON  
..... (0.103 lbf-sec @ 185 psia & 16 ms ON)
- Steady State Firing ..... 2,000 sec – Single Firing  
..... 4,670 sec – Cumulative

## Status

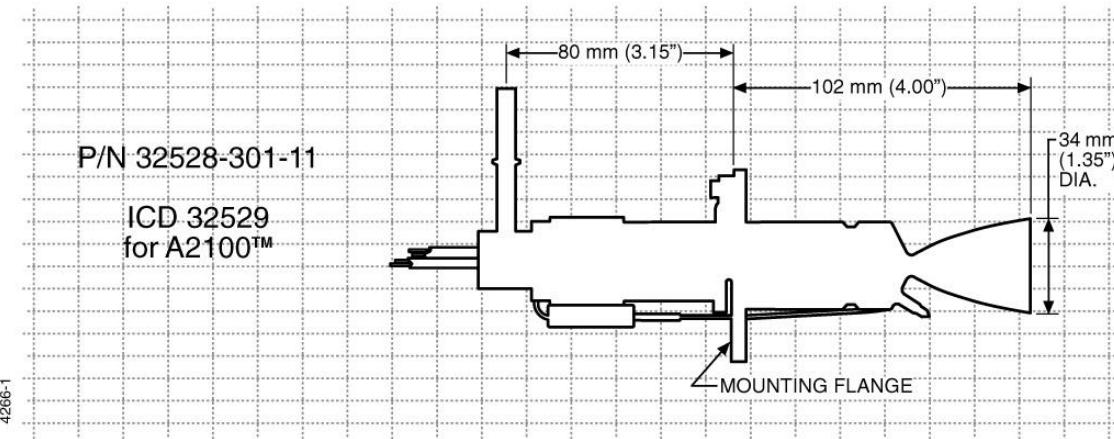
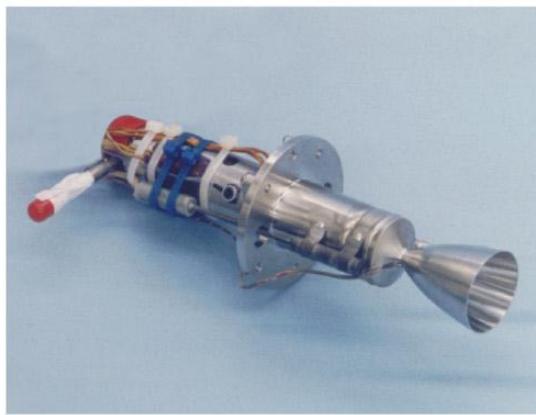
- Flight Proven

\*Mars Odyssey Test Program –  
December, 2000

## Reference

- AIAA-2001-3632
- AIAA-1999-2469

# MR-106E 22N (5.0-lbf) ROCKET ENGINE ASSEMBLY - 70 Vdc



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... LCH-227/202
- Thrust/Steady State ..... 30.7 – 11.6 N (6.9 – 2.6 lbf)
- Feed Pressure ..... 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure ..... 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio ..... 60:1
- Flow Rate ..... 13.1 – 5.0 g/sec (0.0289 – 0.011 lbm/sec)
- Valve ..... Dual Seat
- Valve Power ..... 39.52 Watts Max @ 70 Vdc & 21°C
- Valve Heater Power ..... 3.27 Watts @ 70 Vdc & 21°C
- Cat. Bed Heater Pwr ..... 6.36 Watts Max @ 70 Vdc & 21°C
- Mass ..... 0.52 kg (1.14 lbm)
  - Engine ..... 0.23 kg (0.50 lbm)
  - Valve ..... 0.29 kg (0.64 lbm)

## Performance

- Specific Impulse ..... 235 – 229 sec (lbf-sec/lbm)
  - REA 'A'
  - REA 'B'
  - Mars\*
- Total Impulse ..... 120,000 N-sec 125,000 N-sec 90,587 N-sec
  - ..... (26,958 lbf-sec) (28,044 lbf-sec) (20,366)
- Total Pulses ..... 12,405 ..... 186 ..... 66,631
- Minimum Impulse Bit ..... 0.46 N-sec @ 12.8 bar & 16 ms ON
  - ..... (0.103 lbf-sec @ 185 psia & 16 ms ON)
- Steady State Firing ..... 2,000 sec – Single Firing
  - ..... 4,670 sec – Cumulative

## Status

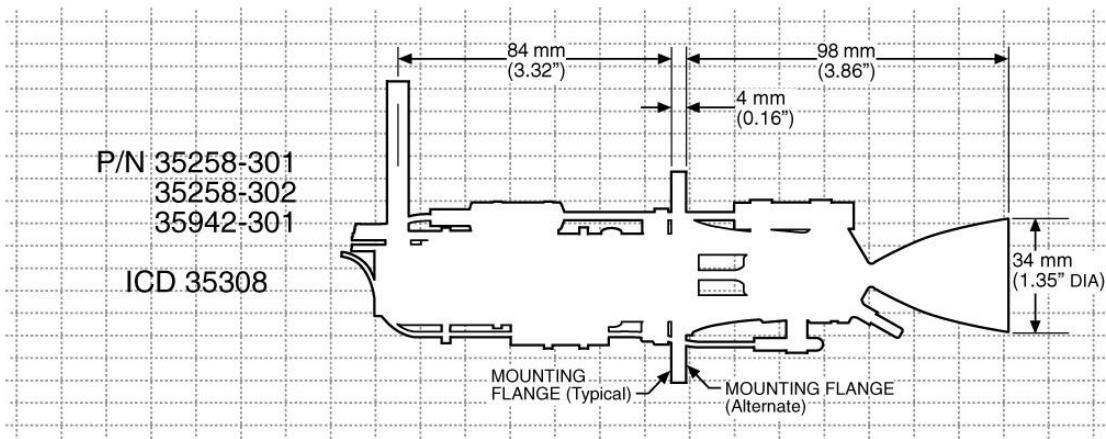
- Flight Proven

*\*Mars Odyssey Test Program – December, 2000*

## Reference

- AIAA-2001-3632
- AIAA-1999-2469

# MR-106L 22N (5.0-lbf) ENGINE ASSEMBLY - 28 Vdc



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405/LCH-202
- Thrust/Steady State ..... 34 – 10N (7.7 – 2.3 lbf)
- Feed Pressure ..... 27.6 – 5.9 bar (400 – 85 psia)
- Chamber Pressure ..... 13.4 – 4.1 bar (195 – 60 psia)
- Expansion Ratio ..... 60:1
- Flow Rate ..... 14.7 – 4.5 g/sec (0.032 – 0.010 lbfm-sec)
- Valve ..... Dual Seat
- Cat. Bed Heater Pwr ..... 13.2 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power ..... 4.0 Watts @ 28 Vdc & 21°C
- Valve Power ..... 24.5 Watts Max @ 28 Vdc & 21°C
- Mass ..... 0.590 kg (1.3 lbf) Nom

## Performance

- Specific Impulse ..... 235 – 229 sec (lbf-sec/lbm)
- Total Impulse ..... 561,388 N-sec (126,205 lbf-sec)
- Total Pulses ..... 120,511
- Minimum Impulse Bit ..... 0.15 N-sec @ 5.9 bar & 16 ms ON (0.034 lbf-sec @ 85 psia & 16 ms ON)
- Steady State Firing ..... 4,000 sec

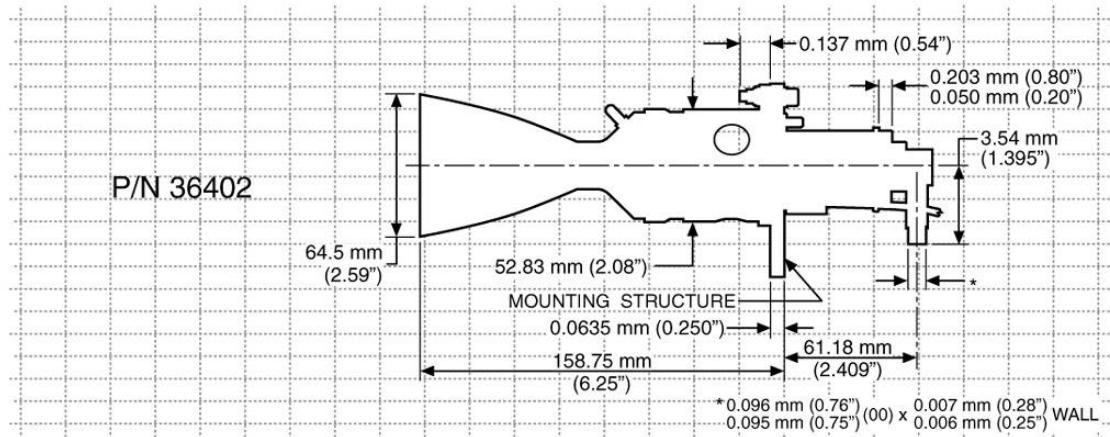
## Status

- Qualified: Integrated on 3 Spacecraft

## Reference

- AIAA-2005-3954

# MR-107S 275N (60-lbf) ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S-405 / LCH-202
- Thrust/Steady State ..... 360–85 N (81–19 lbf)
- Feed Pressure ..... 35–7 bar (500–100 psia)
- Chamber Pressure ..... 14–4 bar (197–45 psia)
- Expansion Ratio ..... 21.5:1
- Flow Rate ..... 154.7–36.3 g/sec (0.341–0.08 lbm/sec)
- Valve ..... Single Seat
- Valve Power ..... <34.8 Watts @ 28 Vdc & 20°C
- Mass ..... 1.01 kg (2.23 lbm)
  - Engine ..... 0.67 kg (1.48 lbm)
  - Valve ..... 0.34 kg (0.75 lbm)

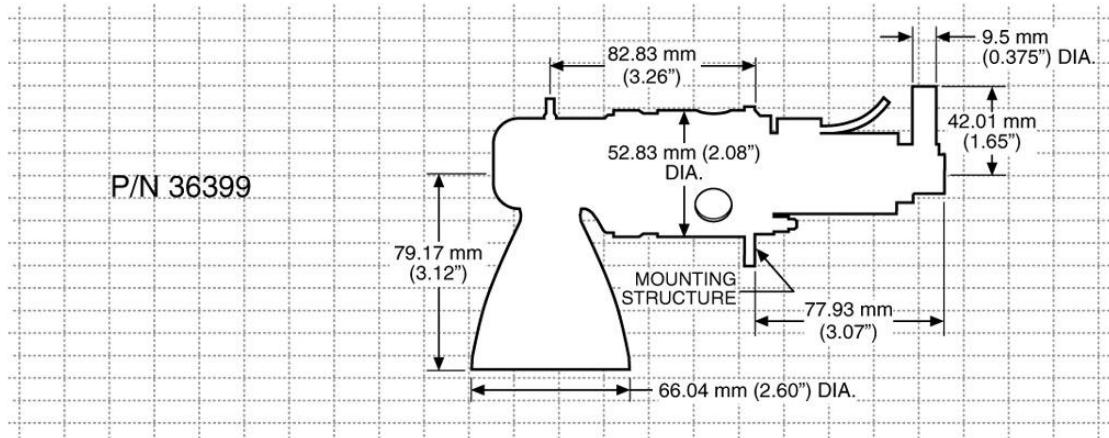
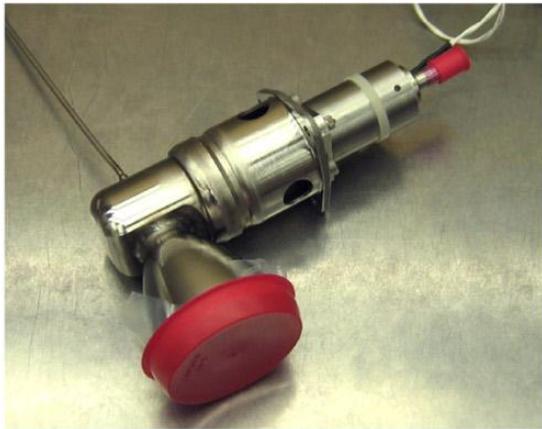
## Performance – Reference MR-107S/T Testing in 2007

- Specific Impulse ..... 225–236 sec (lbf-sec/lbm)
- Total Impulse ..... 337,620 N-sec (75,900 lbf-sec)
- Total Pulses ..... 30,300
- Steady State Firing ..... 41 sec @ 360N (81-lbf)
  - ..... 100 sec @ 236N (53-lbf)
  - ..... 30 sec @ 285N (64-lbf)

## Status

- Qualified

# MR-107T 110N (25-lbf) ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S-405 / LCH-202
- Thrust/Steady State ..... 125 – 54 N (28 – 12 lbf)
- Feed Pressure ..... 37 – 7 bar (500 – 100 psia)
- Chamber Pressure ..... 4.7 – 1.8 bar (69 – 26 psia)
- Expansion Ratio ..... 21.5:1
- Flow Rate ..... 55.8 – 22.7 g/sec (0.123 – 0.05 lbm/sec)
- Valve ..... Single Seat
- Valve Power ..... <34.8 Watts @ 28 Vdc & 20°C
- Mass ..... 1.01 kg (2.23 lbm)
  - Engine ..... 0.67 kg (1.48 lbm)
  - Valve ..... 0.34 kg (0.75 lbm)

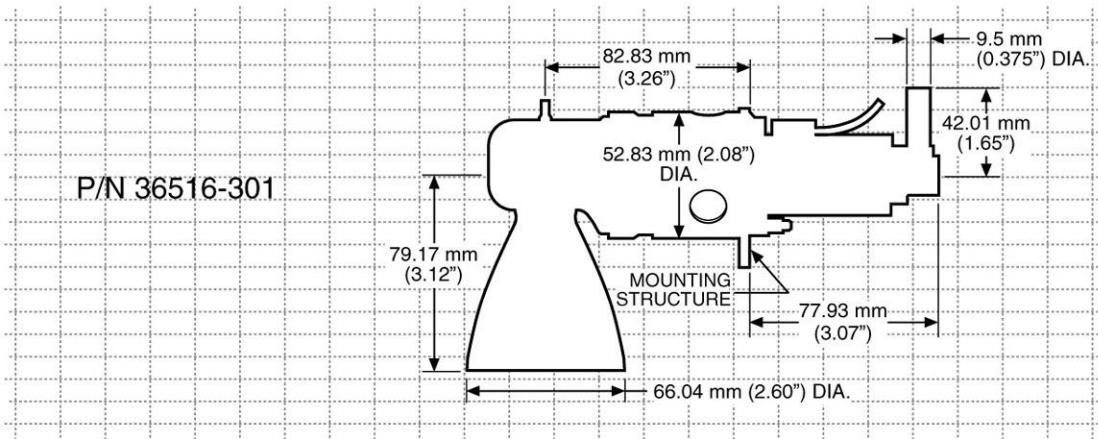
## Performance – Reference MR-107S/T Testing in 2007

- Specific Impulse ..... 222 – 228 sec (lbf-sec/lbm)
- Total Impulse ..... 92,967 N-sec (20,900 lbf-sec)
- Total Pulses ..... 14,300
- Steady State Firing ..... 100 sec @ 125N (28-lbf)  
..... 100 sec @ 54N (12-lbf)

## Status

- Qualified

# MR-107V 220N (49.5-lbf) ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S-405 / LCH-202
- Thrust/Steady State ..... 220–67 N (49.5–15 lbf)
- Feed Pressure ..... 26–5.5 bar (377–80 psia)
- Chamber Pressure ..... 8.4–2.6 bar (122–38 psia)
- Expansion Ratio ..... 21.5:1
- Flow Rate ..... 98–31 g/sec (0.216–0.07 lbfm/sec)
- Valve ..... Single Seat
- Valve Power ..... <34.8 Watts @ 28 Vdc & 20°C
- Mass ..... 1.01 kg (2.23 lbfm)
  - Engine ..... 0.67 kg (1.48 lbfm)
  - Valve ..... 0.34 kg (0.75 lbfm)

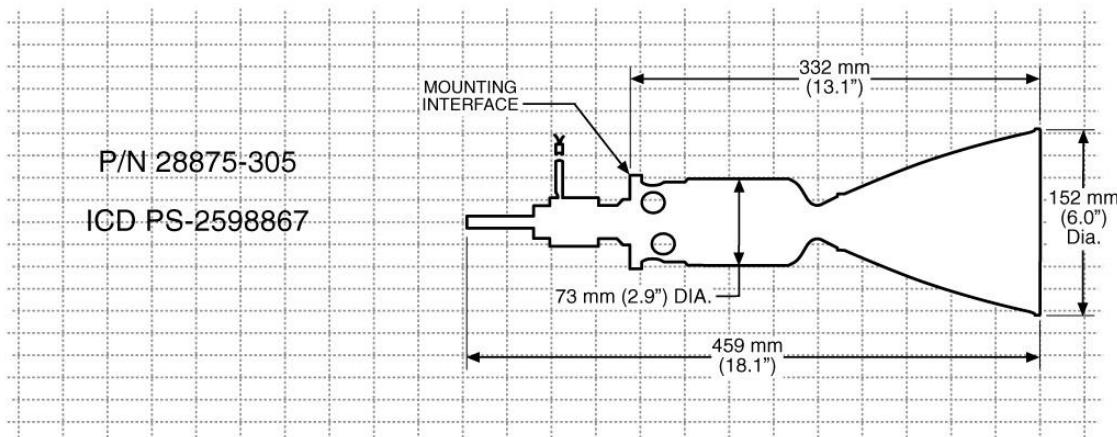
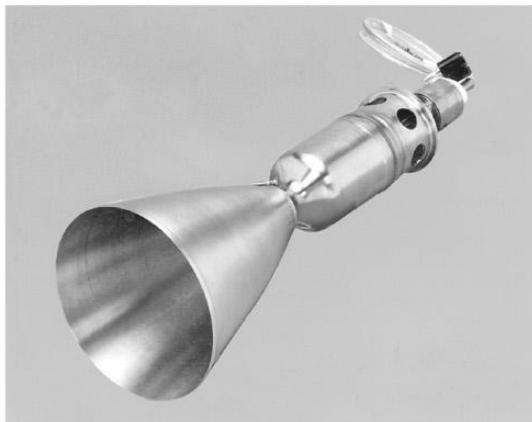
## Performance – Reference MR-107S/T Testing in 2007

- Specific Impulse ..... 229–223 sec (lbf-sec/lbm)
- Total Impulse ..... 337,175 N-sec (75,800 lbf-sec)
- Total Pulses ..... 30,275
- Steady State Firing ..... 100 sec @ 111N (25-lbf)

## Status

- Qualification Testing in 2007

# MR-104A/C 440N (100-lbf) ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405 / LCH-202
- Thrust/Steady State ..... 572.5 – 204.6 N (128.7 – 46 lbf)
- Feed Pressure ..... 28.9 – 6.9 bar (420 – 100 psia)
- Chamber Pressure ..... 10.7 – 3.9 bar (155 – 56 psia)
- Expansion Ratio ..... 53:1
- Flow Rate ..... 240.4 – 90.72 g/sec (0.53 – 0.20 lbfm-sec)
- Valve ..... Single Seat
- Valve Power ..... 30 Watts @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr ..... 13.1 Watts @ 28 Vdc & 21°C
- Mass ..... 1.86 kg (4.11 lbfm)
- Engine ..... 1.44 kg (3.17 lbfm)
- Valve ..... 0.43 kg (0.94 lbfm)

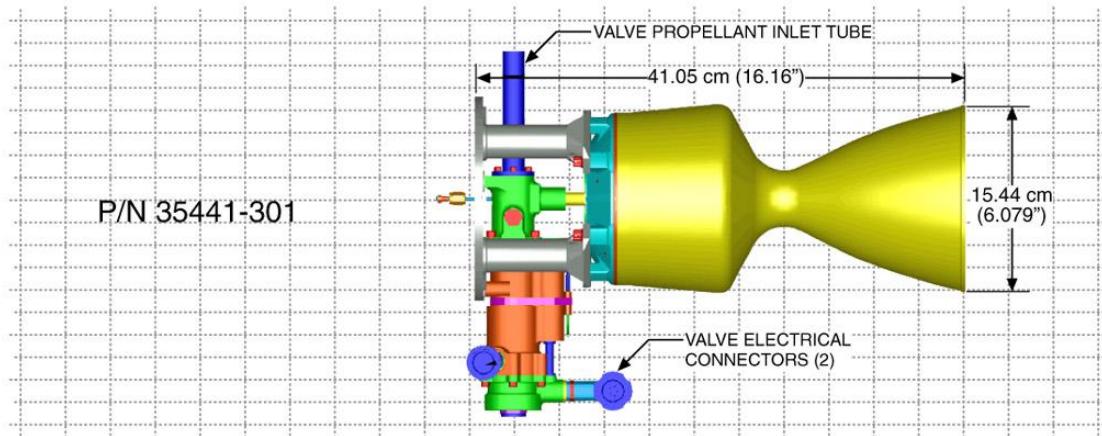
## Performance

- Specific Impulse ..... 239 – 223 sec (lbf-sec/lbfm)
- Total Impulse ..... 693,900 N-sec (156,000 lbf-sec)
- Total Pulses ..... 1,742
- Minimum Impulse Bit ..... 8.23 N-sec @ 24.13 bar & 22 ms ON  
..... (1.85 lbf-sec @ 350 psia & 22 ms ON)
- Steady State Firing ..... 2,000 sec – Single Firing  
..... 2,654 sec – Cumulative

## Status

- Flight Proven

# MR-80B 3,100N (700-lbf) THROTTLING ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405
- Vacuum Thrust/Steady State ..... 3780 – 31N (850 – 7 lbf)
- Feed Pressure ..... 41.7 Bar (605 psia)
- Chamber Pressure ..... 20.4 – 0.14 Bar (296 – 2 psia)
- Expansion Ratio ..... 16.7:1
- Cat. Bed Heater Pwr ..... 6.3 Watts/Element Max @ 30 Vdc
- Valve Heater Power ..... 9.45 Watts/Element @ 30 Vdc
- Valve ..... Cavitating Throttle
- Valve Power ..... 168 Watts Max @ 28 Vdc
- Weight ..... 8.51 kg (18.76 lbf)
- Engine ..... 6.92 kg (15.26 lbf)
- Valve ..... 1.59 kg (3.50 lbf)

## Performance

|                         | ■ Vacuum Specific Impulse | .....      | 225- 200 sec (lbf-sec/lbm) |            |       |
|-------------------------|---------------------------|------------|----------------------------|------------|-------|
|                         | ■ Starts                  | Dev. #1    | Dev. #2                    | Dev. #3R   | Qual. |
| ■ Total                 | 292.1 kg                  | 8          | 8                          | 12         | 8     |
| ■ Throughput            | (644 lbfm)                | (405 lbfm) | (995 lbfm)                 | (680 lbfm) |       |
| ■ Total Firing Time     | 334 sec                   | 418 sec    | 806 sec                    | 560 sec    |       |
| ■ Longest Single Firing | 76 sec                    | 117 sec    | 137 sec                    | 214 sec    |       |

## Status

- Flight Qualified

## Reference

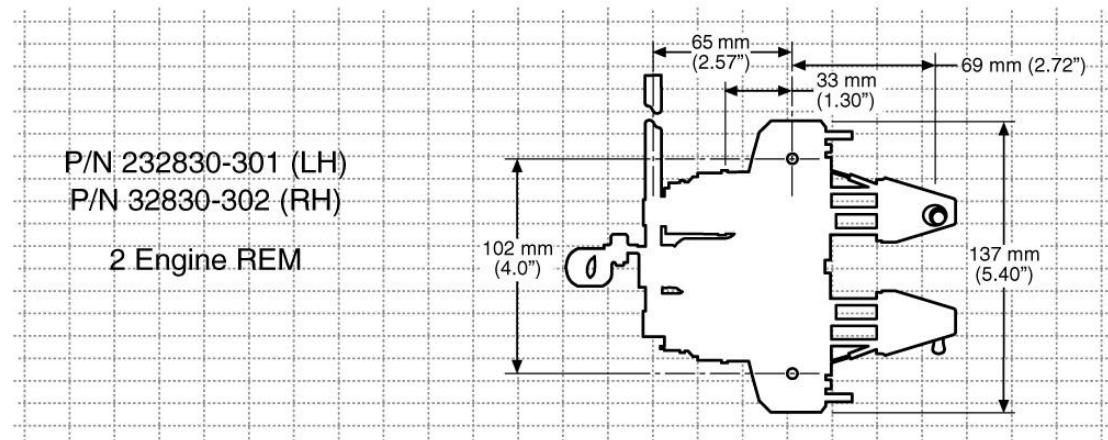
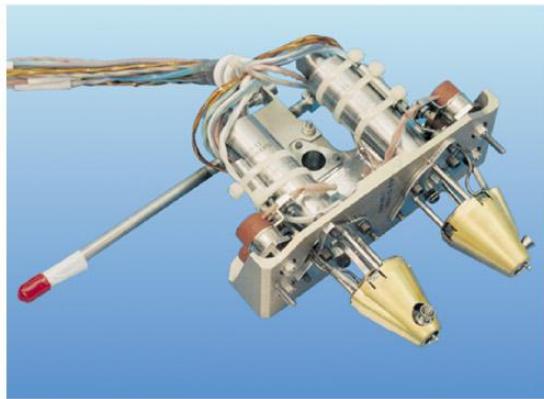
- JP&P-1992: Volume 8, No. 2, P. 320-331
- 2007-AIAA-5481

Date: 5/19/08

11411 139th Place NE • REDMOND, WA 98073-9709  
(425) 885-5000 fax (425) 882-5747

**AEROJET**

# MRM-103D 1N (0.2-lbf) ROCKET ENGINE ASSEMBLY



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... S405
- Thrust/Steady State ..... 1.02 – 0.22 N (0.230 – 0.050 lbf)
- Feed Pressure ..... 27.6 – 6.2 bar (400 – 90 psia)
- Chamber Pressure ..... 23.4 – 5.9 bar (340 – 85 psia)
- Expansion Ratio ..... 100:1
- Flow Rate ..... 0.45 – 0.09 g/sec (0.001 – 0.0002 lbfm-sec)
- Valve ..... Dual Seat
- Valve Power (per Valve) ..... 8.25 Watts Max @ 28 Vdc & 20°C
- Mass ..... 1.27 kg (2.8 lbfm)
- Bed Heaters and Temp. Sensors
- REM Plate Htrs (Thermostat Controlled) & Temp. Sensor
- MLI Blanket
- Electrical Interface: 1016 – 1118 mm (40 – 44") Leadwires

## Performance

- Specific Impulse ..... 224 – 209 sec (lbf-sec/lbm)
- Total Impulse ..... 125,700 N-sec (28,263 lbf-sec)\*
- Total Pulses ..... 210,238\*
- Minimum Impulse Bit ..... 0.03 N-sec @ 6.9 bar & 15 ms ON  
..... (0.006 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing ..... 0.8 hr\* – Single Firing  
..... 176.9 hr\* sec – Cumulative

## Status

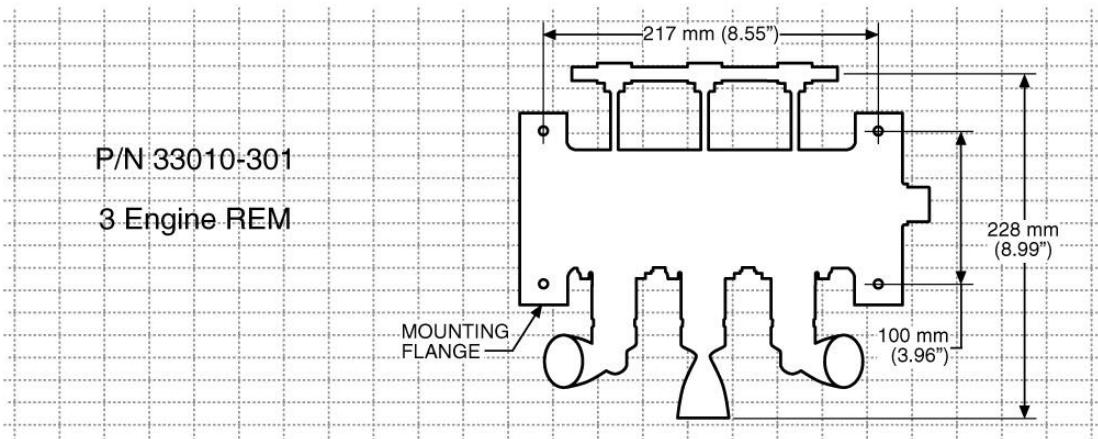
- Flight Proven

*\*As qualified for the MRM-103D  
Basic MR-103D qualified to slightly higher levels.*

# MRM-106C 40N (9.0-lbf) ROCKET ENGINE MODULE



4934-1



## Design Characteristics

- Propellant ..... Monopropellant Hydrazine
- Catalyst ..... LCH-207/202
- Thrust/Steady State ..... 40N (9.0 lbf)
- Feed Pressure ..... 31 bar (450 psia)
- Chamber Pressure ..... 16 bar (237 psia)
- Expansion Ratio ..... 61:1
- Flow Rate ..... 17.7 g/sec (0.039 lbm/sec)
- Valve ..... Single Seat
- Valve Power ..... 15 Watts Max @ 28 Vdc & 20°C
- Mass ..... Axial: 0.12 kg (0.259 lbm) ..... Lateral: 0.36 kg (0.801 lbm)
  - Engine .... " 0.15 kg (0.319 lbm) .... " 0.16 kg (0.361 lbm)
  - Valve .... " 0.20 kg (0.440 lbm) .... " 0.20 kg (0.440 lbm)
- No Catalyst Bed Heaters or Valve Heaters
- 22 Pin Electrical Connectors

## Performance

- Specific Impulse ..... 231 sec (lbf-sec/lbm)
- Total Impulse ..... 136,000 N-sec (30,618 lbf-sec)
- Total Pulses ..... 1,570
- Minimum Impulse Bit ..... 2.62 N-sec @ 31 bar & 60 ms ON  
..... (0.59 lbf-sec @ 450 psia & 60 ms ON)
- Steady State Firing ..... 1,000 sec – Single Firing  
..... 2,991 sec – Cumulative

## Status

- Flight Proven

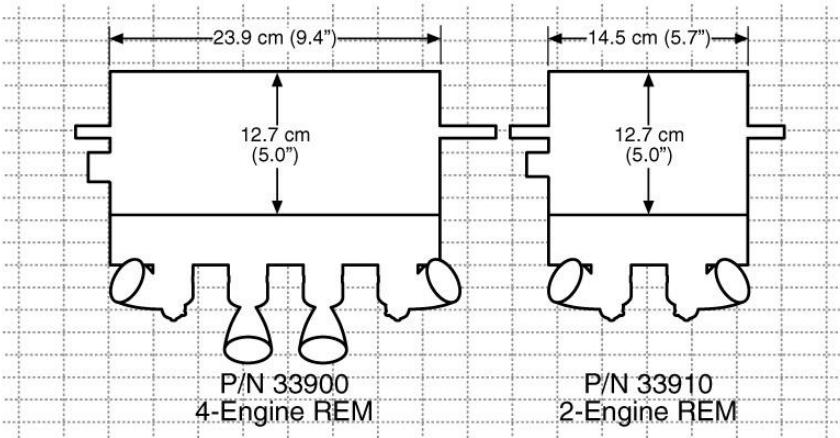
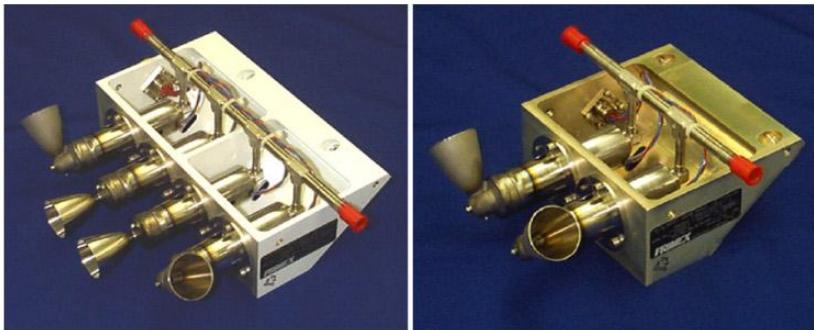
Rev. Date: 5/23/06

11411 139th Place NE • Redmond, WA 98052  
(425) 885-5000 FAX (425) 882-5747

**AEROJET**

Approved for public release and export

# MRM-106D 27/40N (6.0/9.0-lbf) ROCKET ENGINE MODULE



## Design Characteristics

- Propellant ..... Monopropellant Hydrazine
- Catalyst ..... LCH-207/ 202
- Thrust/Steady State .....
  - ..... per Axial Rocket: 27 – 17 N (6.0 – 3.8 lbf)
  - ..... per Lateral Rocket: 40 – 21 N (9.0 – 4.7 lbf)
- Feed Pressure ..... 31 – 13.8 bar (450 – 200 psia)
- Chamber Pressure ... Axial: 11.0 – 6.9 bar (160 – 100 psia)
  - ..... Lateral: 17.2 – 8.6 bar (250 – 125 psia)
- Expansion Ratio ..... 61:1
- Flow Rate .....
  - ..... Axial: 11.8 – 7.51 g/sec (0.026 – 0.017 lbm/sec)
  - ..... Lateral: 17.7 – 9.52 g/sec (0.039 – 0.021 lbm/sec)
- Valve ..... Single Seat, Non-Sliding Fit
- Valve Power ..... 20.1 Watts Nominal @ 28 Vdc & 21°C
- Mass ..... 4-Engine REM: 2.7 kg (5.96 lbm)
  - ..... 2-Engine REM: 1.5 kg (3.34 lbm)

- No Catalyst Bed Heaters or Valve Heaters
- 10 Pin Electrical Connectors on 4-Engine REM
- 6 Pin Electrical Connectors on 2-Engine REM

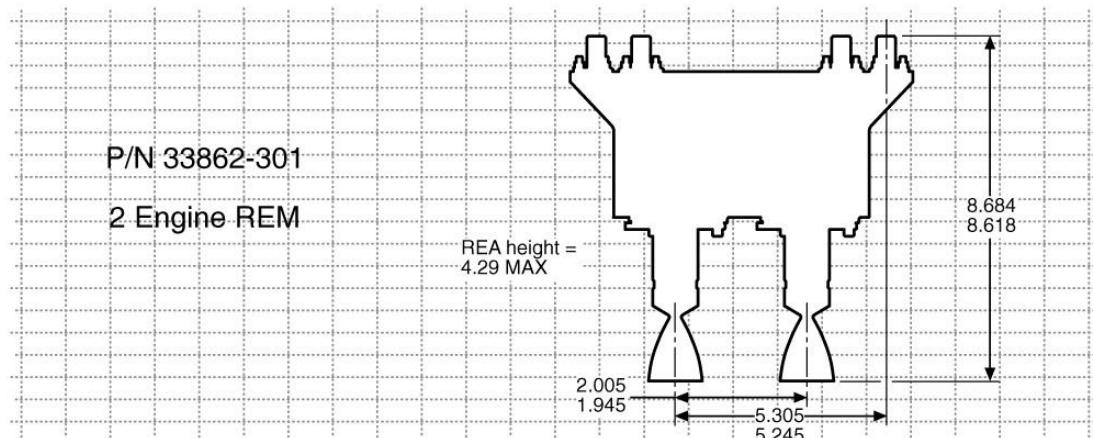
## Performance

- Specific Impulse ..... 234 – 227 sec (lbf-sec/lbm)
- Total Impulse (Axial & Lateral) .... 91,200 N-sec (20,500 lbf-sec)
- Total Pulses ..... >7,629 (Lateral) >1,500 (Axial)
- Minimum Impulse Bit ..... 0.63 N-sec @ 31 bar & 20 ms ON
  - ..... (0.142 lbf-sec @ 450 psia & 20 ms ON)
- Steady State Firing ..... 1,000 sec – Single Firing

## Status

- Flight Proven

# MRM-106E 22N (5.0-lbf) ROCKET ENGINE MODULE (REM)



## Design Characteristics

- Propellant ..... Hydrazine
- Catalyst ..... LCH-227/202
- Thrust/Steady State ..... 30.7 – 11.6 N (6.9 – 2.6 lbf)
- Feed Pressure ..... 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure ..... 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio ..... 60:1
- Flow Rate ..... 12.1 – 5.0 g/sec (0.0289 – 0.011 lbm/sec)
- Valve Power ..... 25.3 Watts Max @ 28 Vdc & 21°C
- Mass ..... 4.1 kg (1.86 lbm) Max

\*Mars Odyssey Test Program  
December 2000

## Performance

- Specific Impulse ..... 235 – 229 sec (lbf-sec/lbm)  
REA 'A' REA 'B' Mars\*
- Total Impulse ..... 120,000 N-sec 125,000 N-sec 90,587 N-sec  
..... (26,958 lbf-sec) (28,044 lbf-sec) (20,366 lbf-sec)
- Total Pulses ..... 12,405 ..... 186 ..... 66,631
- Minimum Impulse Bit ..... 0.46 N-sec @ 12.8 bar & 16 ms ON  
..... (0.103 lbf-sec @ 185 psia & 16 ms ON)
- Steady State Firing ..... 2,000 sec – Single Firing  
..... 4,670 sec – Cumulative

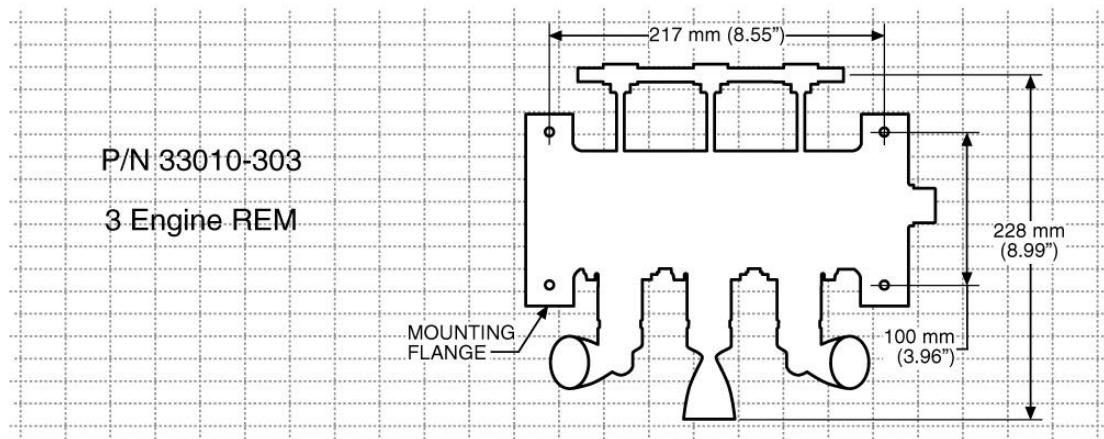
## Status

- Flight Proven

# MRM-106F 40N (9.0-lbf) ROCKET ENGINE MODULE



4934-1



## Design Characteristics

- Propellant ..... Monopropellant Hydrazine
- Catalyst ..... LCH-207/ 202
- Thrust/Steady State (per Rocket)..... 40N (9.0 lbf)
- Feed Pressure ..... 31 bar (450 psia)
- Chamber Pressure ..... 16 bar (237 psia)
- Expansion Ratio..... 61:1
- Flow Rate ..... 17.7 g/sec (0.039 lbm/sec)
- Valve ..... Single Seat, Non-Sliding Fit
- Valve Power ..... 20.1 Watts Nominal @ 28 Vdc & 21°C
- Mass ..... <2.23 kg (4.9 lbm) per REM
- No Catalyst Bed Heaters or Valve Heaters
- 22 Pin Electrical Connector

## Performance

- Specific Impulse ..... 231 sec (lbf-sec/lbm)
- Total Impulse ..... 136,000 N-sec (30,618 lbf-sec)
- Total Pulses ..... 1,570
- Minimum Impulse Bit ..... 2.62 N-sec @ 31 bar & 20 ms ON  
..... (0.59 lbf-sec @ 450 psia & 60 ms ON)
- Steady State Firing ..... 1,000 sec – Single Firing  
..... 2,991 sec – Cumulative

## Status

- Flight Proven