# SPACE LAUNCH SYSTEM (SLS) MOTORS

For NASA's Space Launch System (SLS), Northrop Grumman manufactures the five-segment SLS heavy-lift boosters, the booster separation motors (BSM), and the Launch Abort System's (LAS) launch abort motor and attitude control motor.

The SLS five-segment booster is the largest solid rocket motor ever built for flight. The SLS booster shares some design heritage with flight-proven four-segment space shuttle reusable solid rocket motors (RSRM), but generates 20 percent greater average thrust and 24 percent greater total impulse. While space shuttle RSRM production has ended, sustained booster production for SLS helps provide cost savings and access to reliable material sources.

Designed to push the spent RSRMs safely away from the space shuttle, Northrop Grumman BSMs were rigorously qualified for human space flight and successfully used on the last fifteen space shuttle missions. These same motors are a critical part of NASA's SLS. Four BSMs are installed in the forward frustum of each five-segment booster and four are installed in the aft skirt, for a total of 16 BSMs per launch.

The launch abort motor is an integral part of NASA's LAS. The LAS is designed to safely pull the Orion crew module away from the SLS launch vehicle in the event of an emergency on the launch pad or during ascent. Northrop Grumman is on contract to Lockheed Martin to build the abort motor and attitude control motor—Lockheed is the prime contractor for building the Orion Multi-Purpose Crew Vehicle designed for use on NASA's SLS.

Inquiries regarding our SLS motor products should be directed to our business development representatives at psbdev@ngc.com.

# SLS BOOSTER

NORTHROP GRUMMAN

## VECTORABLE NOZZLE GROUND LAUNCH

The SLS five-segment booster generates a maximum thrust of approximately 3.6 million pounds. The SLS booster also incorporates new technologies and materials, such as non-asbestos insulation that provides cost and weight savings. Originally baselined for Ares I/V under NASA's Constellation program, the SLS five-segment booster is currently slated as the baseline design for the initial SLS flights. SLS boosters have completed qualification, are in production, and are on schedule to meet NASA's 2021 initial SLS flight and subsequent flights.

### MOTOR DIMENSIONS

Motor diameter, in. ..... 146.1
Motor length, in. ..... 1,864.7

### MOTOR PERFORMANCE (70°F NOMINAL, VACUUM)

Burn time, sec ..... 132.8
Average chamber pressure, psia ..... 572
Total impulse, lbf-sec ..... 298,000,000
Burn time average thrust, lbf ..... 2,247,233

### NOZZLE

Housing material ..... D6AC steel
Exit diameter, in. ..... 149.6
Expansion ratio, average ..... 7.72

### WEIGHTS, lbm

Total loaded ..... 1,616,123
Propellant ..... 1,427,807
Case ..... 99,326
Nozzle ..... 24,140
Other ..... 40,456
Burnout ..... 158,604

### PROPELLANT DESIGNATION

..... TP-H1148 VIII, PBAN POLYMER, 86% SOLIDS

### HAZARDS CLASSIFICATION .... ..... 1.3

### TEMPERATURE LIMITS

Operation ..... +40°-90°F

### PRODUCTION STATUS

..... IN PRODUCTION

**For more information, contact:**
psbdev@ngc.com

northropgumman.com



Pressure, psia

# BSM

## VERSATILE BOOSTER SEPARATION, DECELERATION, OR TUMBLE MOTOR

Designed to push the spent reusable solid rocket motors safely away from the capsule, Northrop Grumman BSMs were rigorously qualified for human space flight and successfully used on the last fifteen space shuttle missions. These same motors are a critical part of NASA's SLS. Four BSMs are installed in the forward frustum of each booster and four are installed in the aft skirt, for a total of 16 BSMs per launch. All 16 BSMs fire simultaneously at booster separation a little over two minutes into the mission, approximately 25 nautical miles above the earth's surface. Traveling 3,000 miles per hour at ignition, each BSM provides about 20,000 pounds average thrust over its one-second burn, ensuring successful launch to orbit.

Variants of the BSM have also been developed and successfully used as first stage deceleration and tumble motors on NASA's Ares I-X vehicle in 2009.

MOTOR DIMENSIONS

| | |
|---|---|
| Motor diameter, in. | 12.88 |
| Motor length, in. | 31.1 |
| Nozzle exit cone diameter, in. | 7.564 |

MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

| | |
|---|---|
| Burn time, sec | 0.68 |
| Maximum thrust, lbf | 22,500 |
| Effective specific impulse, lbf-sec/lbm | 239 |
| Total impulse, lbf-sec | 18,400 |
| Burn time average thrust, lbf | 22,100 |

WEIGHTS, LBM

| | |
|---|---|
| Total loaded | 167 |
| Propellant | 77 |

| | |
|---|---|
| PROPELLANT DESIGNATION | TP-H1262 |
| HAZARDS CLASSIFICATION | 1.3 |
| RACEWAY | NO |
| ORDNANCE | NO |
| THRUST VECTOR CONTROL | NO |

TEMPERATURE LIMITS

| | |
|---|---|
| Operation | 30-120 °F |
| Storage | 30-120 °F |

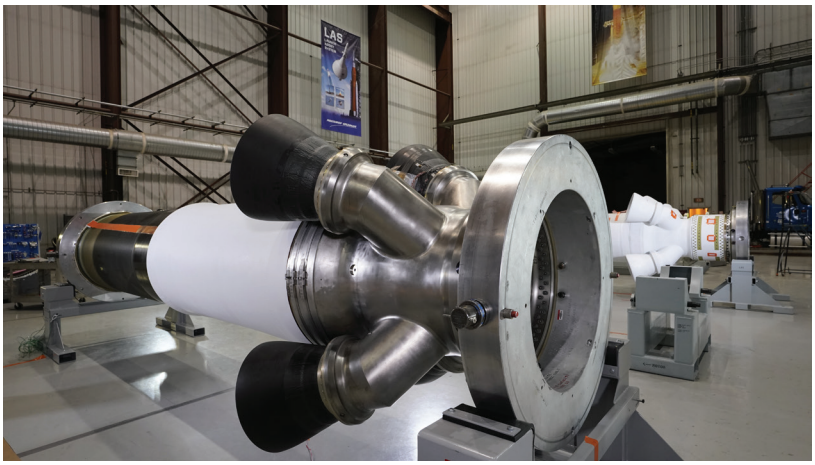
PRODUCTION STATUS

FLIGHT-PROVEN, IN PRODUCTION

**For more information, contact:**
psbdev@ngc.com

northropgumman.com

# LAUNCH ABORT MOTOR



### INNOVATIVE TURN-FLOW MANIFOLD TECHNOLOGY

The Launch Abort Motor is an integral part of the Launch Abort System (LAS). Attached atop of Orion spacecraft on the SLS, the LAS is designed to safely pull the Orion crew module away from the launch vehicle in the event of an emergency on the launch pad or during ascent. The abort motor is more than 17 feet tall and measures three feet in diameter, and includes a revolutionary turn-flow rocket manifold technology. The abort motor was successfully static tested by Northrop Grumman in November 2008, June 2017, and December 2018 and successfully flight tested during Orion's Pad Abort 1 test in 2010 and Ascent Abort-2 test in 2019.

MOTOR DIMENSIONS

Motor diameter, in. ..... 36.7
Overall motor length (incl. nozzle/fairing, in. ..... 223.7
Nozzle exit cone diameter, in. ..... 20.2

MOTOR PERFORMANCE (70°F VACUUM, VACUUM))

Burn time, sec ..... 4.3
Maximum thrust, lbf ..... 412,240
Effective specific impulse, lbf-sec/lbm ..... 226.4
Total impulse, Mlbf-sec ..... 1,046,600
Burn time average thrust, lbf ..... 261,000

WEIGHTS, LBM

Total motor ..... 7,629
Propellant ..... 4,750
Burnout (est) ..... N/A

PROPELLANT DESIGNATION ..... TP-H1264, HTPB POLYMER, 6% ALUMINUM

HAZARDS CLASSIFICATION…. ..... 1.3

RACEWAY ..... YES

ORDNANCE ..... NO

THRUST VECTOR CONTROL ..... NO

TEMPERATURE LIMITS

Operation ..... 27-100 °F
Storage ..... 27-100 °F

PRODUCTION STATUS ..... COMPLETING DEVELOPMENT AND QUALIFICATION

**For more information, contact:**
psbdev@ngc.com

northropgumman.com