

# ORION MOTOR SERIES

## **AFFORDABLE, LOW-RISK FLEXIBLE CAPABILITIES**

The Orion family of motors began with three stages originally designed for use on the Pegasus® launch vehicle. Modifications to the original three Orion motors, first for extended length (XL) versions and subsequently for skirt, nozzle, and other smaller differences, have accommodated additional applications and enhanced performance capabilities. Vehicle applications successfully flown using Orion motors include Pegasus, Taurus®, Pegasus XL, Minotaur®, Hyper-X, Taurus® Lite, and Taurus XL launch vehicles, and the Ground-based Midcourse Defense ground-based interceptor. New applications continue to evolve, such as target vehicle configurations for the Missile Defense Agency.

The multiple configurations and applications currently existing demonstrate that these flight-proven motors are readily adaptable to a wide range of launch scenarios (e.g., ground-start, air-start, silo-launched, etc.) and missions. Northrop Grumman has also demonstrated support for their deployment and use at a wide range of launch sites and field locations, including multiple non-Continental United States launch sites. Further, it should be noted that much of the adaptation has been accomplished with only relatively minor changes (skirt thicknesses and hole patterns, nozzle length, etc.), with little or no changes to the basic motor.

The current major vehicle applications and variants for Orion motors are shown in the table on the following page. The motor identification key provides a further explanation for nomenclature designations in the Orion motor series.

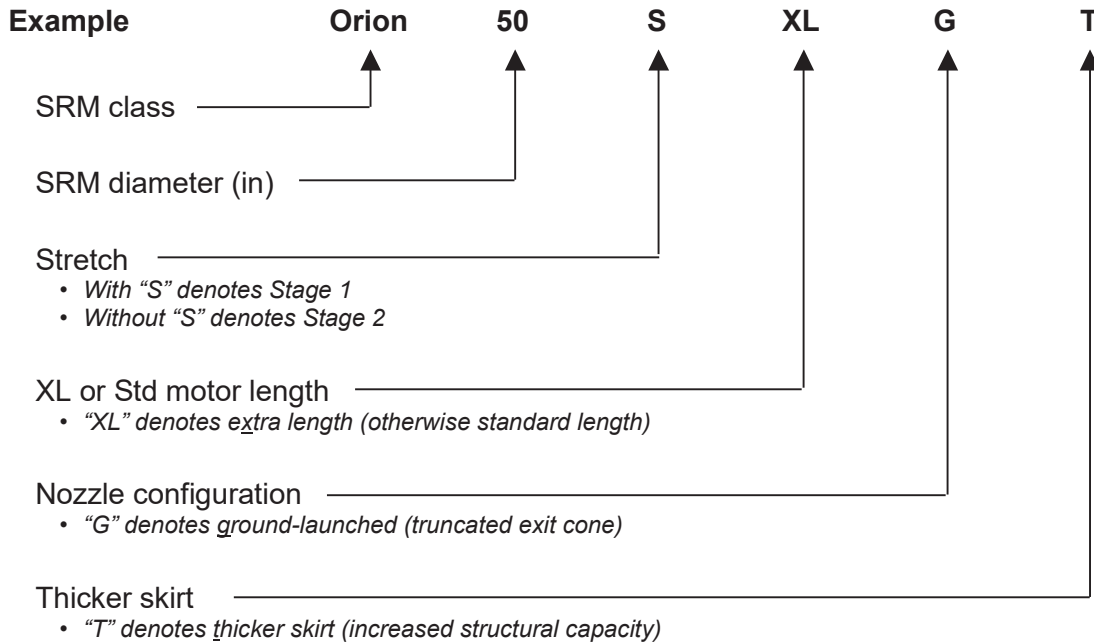
Inquiries regarding our Orion motor products should be directed to our business development representatives at [psbdev@ngc.com](mailto:psbdev@ngc.com).

### Flight-Proven Orion Motor Configurations

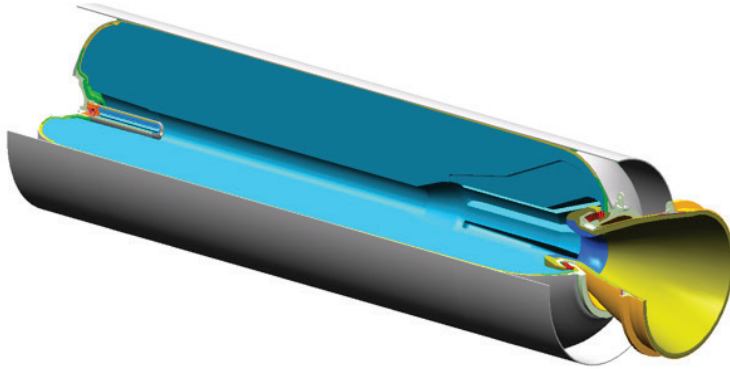
Orion Motor				Vehicle Application
First Stage	Second Stage	Third Stage	Fourth Stage	
50S	50	38		Pegasus
50S XL	50 XL	38		Pegasus XL
50ST	50T	38		Taurus
50S XLT	50 XLT	38		Taurus XL/ Minotaur-C
50S XLG	50 XL	38		Taurus Lite
		50 XL	38	Minotaur I
			38	Minotaur IV
50S				Hyper-X
50S XLG	50 XL	38		GMD GBI
50S XLG*	50 XLT			IRBM target

\* with lengthened nozzle

### Motor Identification Key

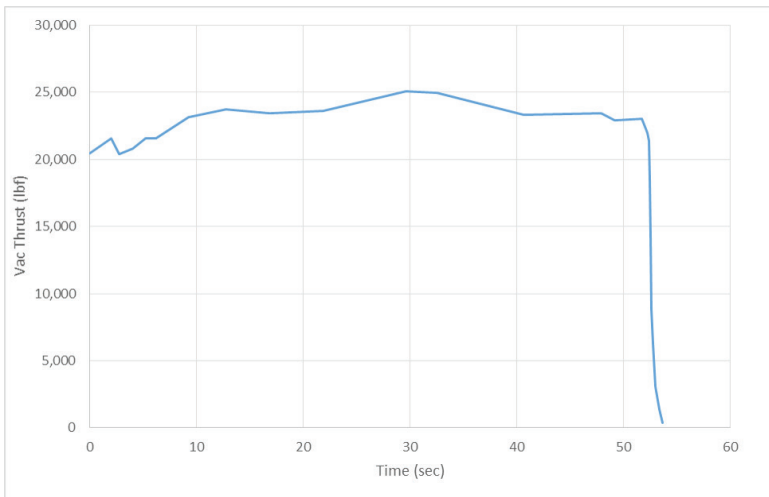


# ORION 32



## VECTORABLE NOZZLE IN-LINE BOOSTER

The Orion 32 is a low-cost, high-performance derivative of an existing upper-stage motor. This development motor is 120 inches long and nominally designed as a second-stage motor. A longer version (Orion 32XL) for potential first stage application is also in design evaluation. This motor configuration has not flown; however, all components, except skirts, are flight-proven.



### MOTOR DIMENSIONS

Motor diameter, in.....32.5  
 Overall motor length (including nozzle), in. .... 119.6

### MOTOR PERFORMANCE (73°F VACUUM, VACUUM)

Burn time, sec.....53.6  
 Average chamber pressure, psia.....756  
 Total impulse, lbf-sec.....1,231,750  
 Burn time average thrust, lbf .....22,970

### NOZZLE

Housing material.....Aluminum  
 Exit diameter, in. ....22.04  
 Expansion ratio, average.....21.8

### WEIGHTS, lbm

Total loaded .....4,908  
 Propellant .....4,429  
 Burnout.....449

### PROPELLANT DESIGNATION

..... QDL, HTPB POLYMER, 19% ALUMINUM

RACEWAY ..... OPTIONAL

ORDNANCE ..... OPTIONAL

TVA ..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....+20°-100°F  
 Storage.....+20°-100°F

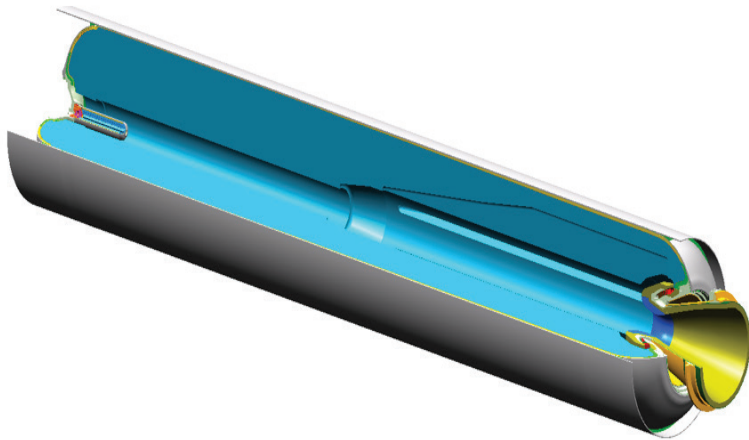
PRODUCTION STATUS..... DEVELOPMENT

**For more information, contact:**

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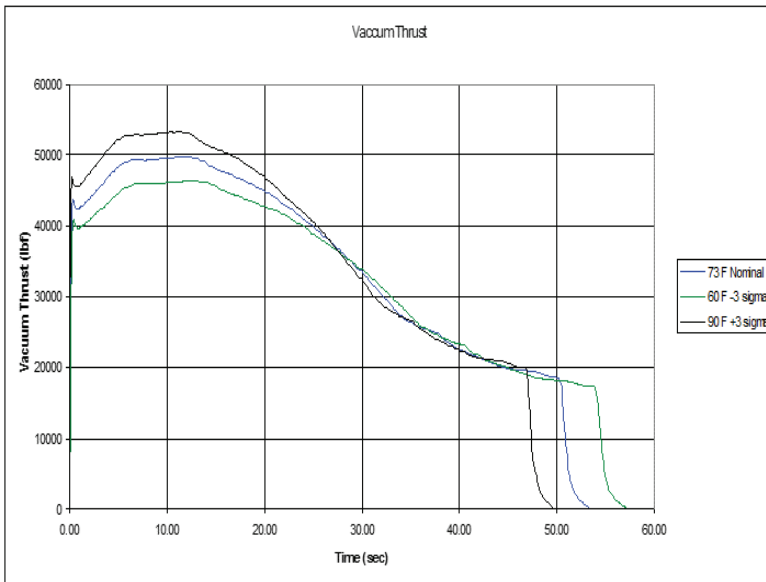
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# ORION 32XL



## VECTORABLE NOZZLE IN-LINE BOOSTER

The Orion 32XL is a low-cost, high-performance derivative of an existing upper-stage motor. This development motor is 180 inches long and nominally designed as a first-stage motor. A shorter version (Orion 32) for potential second stage application is also in design evaluation. This motor configuration has not flown; however, all components, except skirts, are flight-proven.



### MOTOR DIMENSIONS

Motor diameter, in.....32.5  
 Overall motor length (incl nozzle/fairing), in. ....179.5

### MOTOR PERFORMANCE (73°F VACUUM, VACUUM)

Burn time, sec.....52.4  
 Average chamber pressure, psia.....922  
 Total impulse, lbf-sec.....1,838,200  
 Burn time average thrust, lbf .....35,056

### NOZZLE

Housing material.....Aluminum  
 Exit diameter, in. ....15.5  
 Expansion ratio, average.....7.99

### WEIGHTS, lbm

Total loaded .....7,756  
 Propellant .....6,953  
 Burnout.....745

### PROPELLANT DESIGNATION

..... QEM, HTPB POLYMER, 19% ALUMINUM

RACEWAY ..... OPTIONAL

ORDNANCE ..... OPTIONAL

TVA ..... OPTIONAL

### TEMPERATURE LIMITS

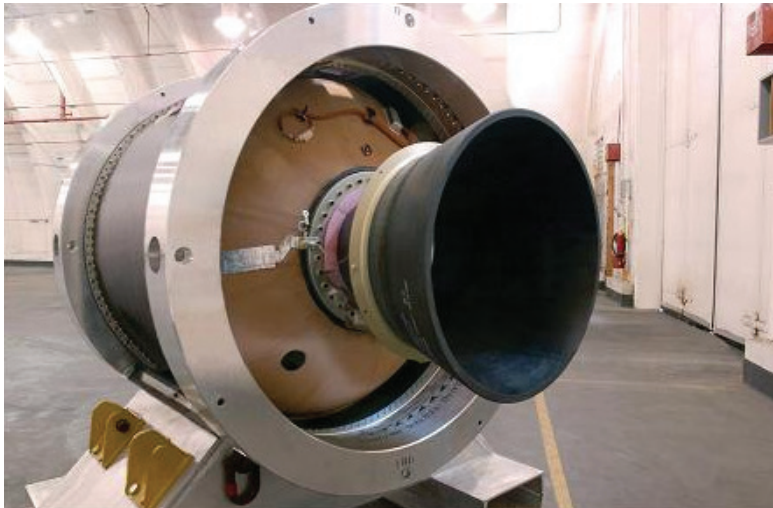
Operation.....+20°-100°F  
 Storage.....+20°-100°F

PRODUCTION STATUS..... DEVELOPMENT

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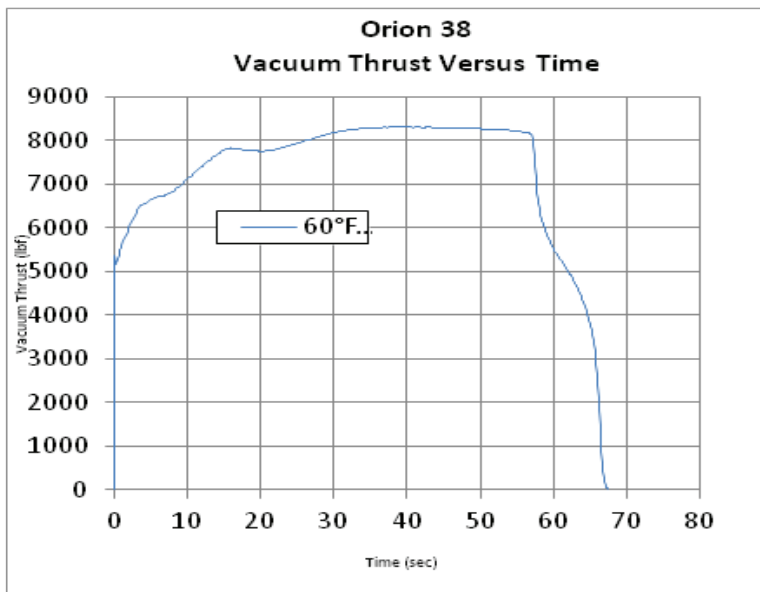
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# ORION 38



## AIR-IGNITED, VECTORABLE NOZZLE UPPER-STAGE BOOSTER

The Orion 38 was developed as a low-cost, high-performance third stage for the Pegasus launch vehicle and incorporates a  $\pm 5$ -degree vectorable nozzle. It also functions as the standard third-stage motor for other launch vehicles such as the Pegasus XL, Taurus, Taurus XL, Taurus Lite, and Minotaur-C launch vehicles and as the fourth stage of Minotaur-I and Minotaur IV vehicles. This motor has performed successfully in more than 80 flights over two decades of use.



### MOTOR DIMENSIONS

Motor diameter, in. ....38.0  
 Overall motor length (including nozzle), in. ....52.6  
 Nozzle exit cone diameter, in. ....20.7

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec. ....66.8  
 Maximum thrust, lbf. ....8,303  
 Effective specific impulse, lbf-sec/lbm ..... 286.97\*  
 Total impulse, lbf-sec ..... 491,140\*  
 Burn time average thrust, lbf .....7,352

\* Includes 14.6 lbm of expended inerts

### WEIGHTS, lbm

Total motor .....1,924  
 Propellant .....1,698  
 Burnout .....206

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... ..... 1.3

RACEWAY .....NO

ORDNANCE ..... OPTIONAL

TVA ..... OPTIONAL

### TEMPERATURE LIMITS

Operation .....+36°-100°F  
 Storage .....+30°-100°F

### PRODUCTION STATUS

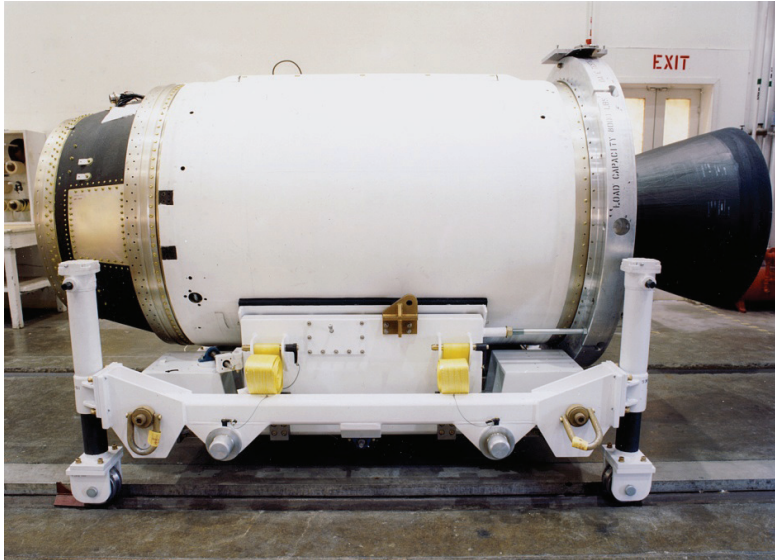
.....FLIGHT-PROVEN, PRODUCTION

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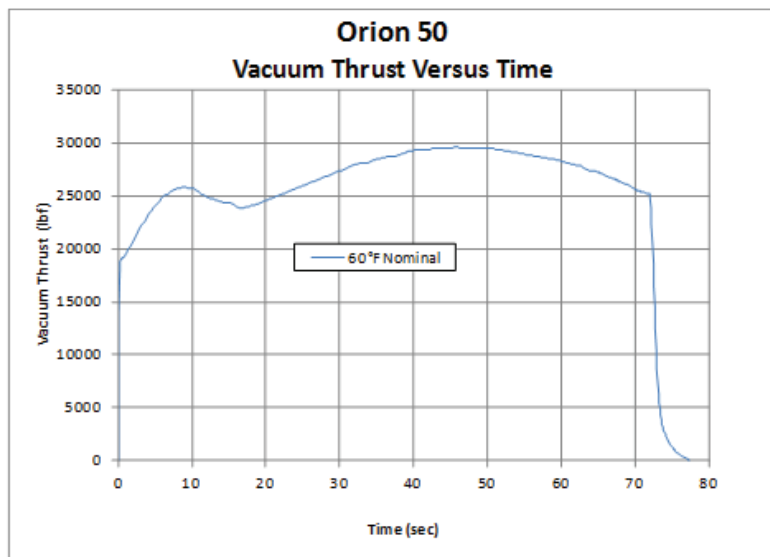
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# ORION 50 (50T)



## AIR-IGNITED, VECTORABLE NOZZLE

The Orion 50 was developed as a low-cost, high-performance second stage for the Pegasus launch vehicle. It incorporates a moveable nozzle with  $\pm 5$ -degree vector capability. The motor was designed for upper stage applications but can readily accommodate lower expansion ratios, such as for ground-launch application, using a truncated nozzle. The Orion 50 has propelled several satellite missions into successful orbit, including: Pegsat, Microsat, SCD-1 (Brazil's first data collection satellite), Alexis, and Space Test Experiment Platform (STEP)-2. A nearly identical version with slightly enhanced skirts, the Orion 50T, has also flown successfully as a second stage on Taurus launch vehicle flights.



### MOTOR DIMENSIONS

Motor diameter, in.....50.2  
 Overall motor length (including nozzle), in. ....103.2  
 Nozzle exit cone diameter, in.....33.9

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec.....75.1  
 Maximum thrust, lbf.....29,554  
 Effective specific impulse, lbf-sec/lbm ..... 290.23\*  
 Total impulse, lbf-sec..... 1,949,000\*  
 Burn time average thrust, lbf .....25,939  
 \* Includes 46.4 lbm of expended inerts

### WEIGHTS, LBM

Total motor.....7,395  
 Propellant .....6,669  
 Burnout.....670

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... ..... 1.3

RACEWAY..... YES

ORDNANCE..... OPTIONAL

TVA..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....+36°-100°F

STORAGE..... +30°-100°F

### PRODUCTION STATUS

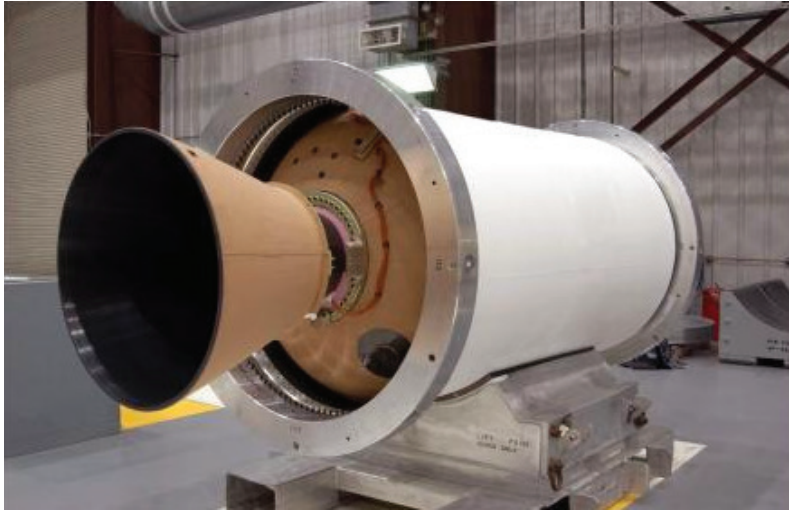
..... FLIGHT-PROVEN, INACTIVE PRODUCTION

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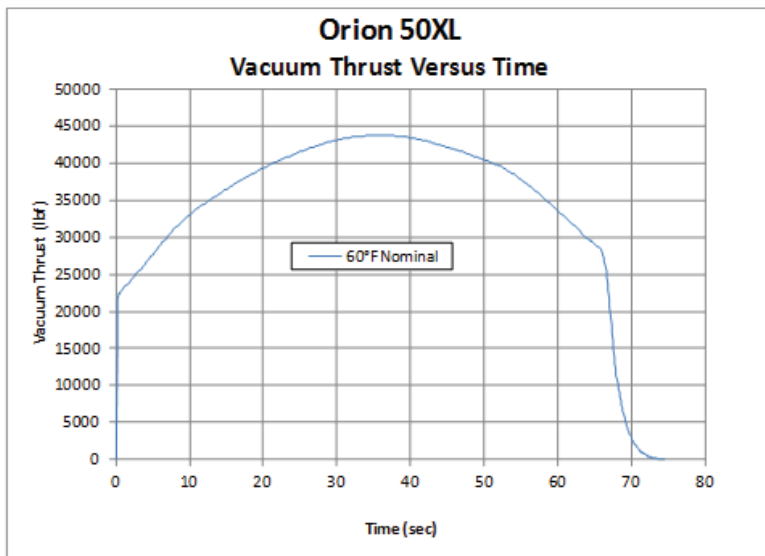
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# ORION 50 XL (50 XLT)



## AIR-IGNITED, VECTORABLE NOZZLE

A flight-proven, extended-length version of the initial Orion 50 is also available. The Orion 50 XL is 18 inches longer and contains almost 2,000 lbm more propellant than the Orion 50. It flew on the 1995 Space Test Experiment Platform (STEP)-3 mission as the second stage of the Pegasus XL. It has also flown as the third-stage motor for the Air Force's Minotaur launch vehicle as part of the Orbital/Suborbital Program and as the second stage on the Taurus Lite vehicle. In addition, a nearly identical version with heavier skirts, the Orion 50 XLT, launched in May 2004 as a second-stage motor on the enhanced Taurus XL launch vehicle and in October 2017 on Minotaur-C.



### MOTOR DIMENSIONS

Motor diameter, in.....	50.2
Overall motor length (including nozzle), in.....	120.9
Nozzle exit cone diameter, in.....	33.9

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec.....	71.0
Maximum thrust, lbf.....	43,713
Effective specific impulse, lbf-sec/lbm.....	290.65*
Total impulse, lbf-sec.....	2,521,900*
Burn time average thrust, lbf.....	35,511

\* Includes 46.4 lbm of expended inerts

### WEIGHTS, lbm

Total motor.....	9,494
Propellant.....	8,631
Burnout.....	808

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... .. 1.3

RACEWAY..... YES

ORDNANCE..... OPTIONAL

TVA..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....	+36°-100°F
Storage.....	+30°-100°F

### PRODUCTION STATUS

..... FLIGHT-PROVEN, PRODUCTION

**For more information, contact:**

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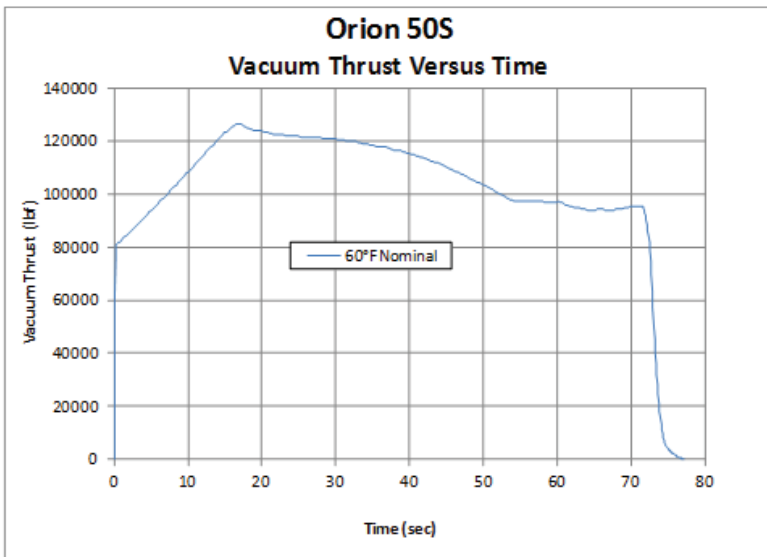
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# ORION 50S



## AIR-IGNITED, FIXED NOZZLE

The Orion 50S was developed as a low-cost, high-performance first stage for the Pegasus launch vehicle. The 50S configuration, shown above incorporating a saddle attachment, has a fixed nozzle and is air ignited after a 5-second freefall drop from approximately 40,000 ft. The Orion 50S has launched Pegasus satellite missions into successful orbit, some of which were Pegsat, Microsat, SCD-1 (Brazil's first data collection satellite), Alexis, and Space Test Experiment Platform (STEP)-2. This motor, with some additional modifications, has also been used as a booster in Hyper-X flights to support scramjet flight-testing.



## MOTOR DIMENSIONS

Motor diameter, in.....50.2  
 Overall motor length (including nozzle), in.....350.1  
 Nozzle exit cone diameter, in.....56.0

## MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec.....74.9  
 Maximum thrust, lbf.....126,641  
 Effective specific impulse, lbf-sec/lbm... 292.25\*  
 Total impulse, lbf-sec.....7,873,000\*  
 Burn time average thrust, lbf.....105,097  
 \* Includes 137 lbm of expended inerts

## WEIGHTS, LBM

Total motor.....29,529  
 Propellant.....26,801  
 Burnout.....2,533

## PROPELLANT DESIGNATION

.....QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... 1.3

RACEWAY..... OPTIONAL

ORDNANCE..... OPTIONAL

TVA..... NO

## TEMPERATURE LIMITS

Operation.....+36°-100°F  
 Storage.....+30°-100°F

## PRODUCTION STATUS

..... FLIGHT PROVEN, INACTIVE PRODUCTION

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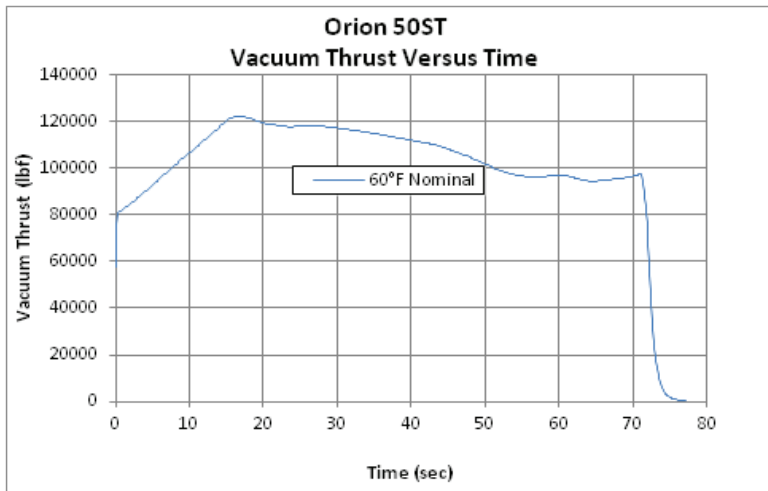


# ORION 50ST



## AIR-IGNITED, VECTORABLE NOZZLE

Another version, Orion 50ST, incorporates a  $\pm 5$ -degree moveable nozzle for the air-ignited Taurus Stage 1. This version has flown on all Taurus missions (both Air Force and commercial versions), such as the Multi-Spectral Thermal Imager (MTI), Orbview-4, Korea Multi-Purpose Satellite (KOMPSAT), etc.



### MOTOR DIMENSIONS

Motor diameter, in.....50.2  
 Overall motor length (including nozzle), in.....335.4  
 Nozzle exit cone diameter, in.....47.6

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time, sec.....74.2  
 Maximum thrust, lbf.....122,099  
 Effective specific impulse, lbf-sec/lbm... 284.97\*  
 Total impulse, lbf-sec.....7,676,500\*  
 Burn time average thrust, lbf.....103,356  
 \* Includes 137 lbm of expended inerts

### WEIGHTS, LBM

Total motor.....29,103  
 Propellant.....26,801  
 Burnout.....2,165

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... 1.3

RACEWAY..... OPTIONAL

ORDNANCE..... OPTIONAL

TVA..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....+36°-100°F  
 Storage.....+30°-100°F

### PRODUCTION STATUS

..... FLIGHT-PROVEN, INACTIVE PRODUCTION

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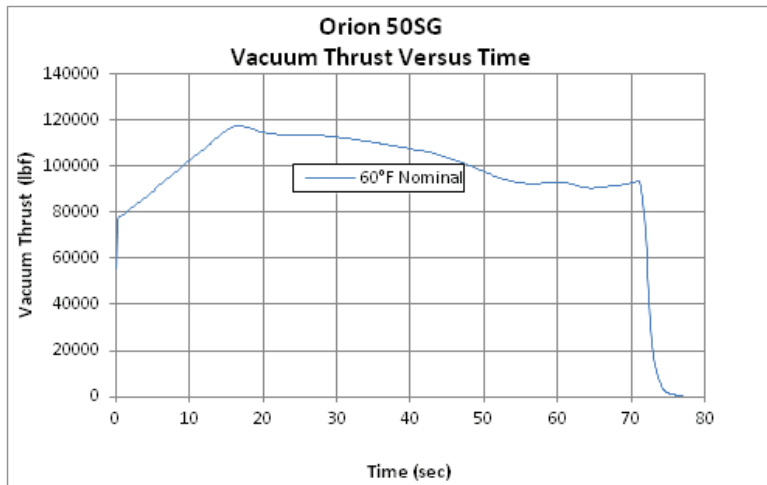
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# ORION 50SG



## GROUND-IGNITED, VECTORABLE NOZZLE

Another version, Orion 50SG, incorporates a  $\pm 3$ -degree moveable nozzle for a ground-ignited Stage 1 configuration. This version is similar to what has flown on the standard Taurus missions, but with a shorter nozzle.



### MOTOR DIMENSIONS

Motor diameter, in.....50.2  
 Overall motor length (including nozzle), in.....318.3  
 Nozzle exit cone diameter, in.....36.0

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time, sec.....74.2  
 Maximum thrust, lbf.....117,358  
 Effective specific impulse, lbf-sec/lbm... ..273.7\*  
 Total impulse, lbf-sec.....7,372,900\*  
 Burn time average thrust, lbf.....99,268

\* Includes 137 lbm of expended inerts

### WEIGHTS, LBM

Total motor.....28,865  
 Propellant.....26,801  
 Burnout.....1,930

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... ..1.3

RACEWAY..... OPTIONAL

ORDNANCE..... OPTIONAL

TVA..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....+36°-100°F  
 Storage.....+30°-100°F

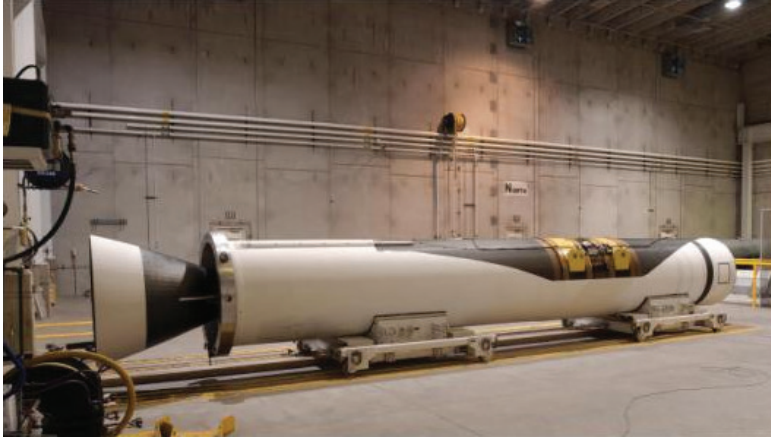
### PRODUCTION STATUS

..... QUALIFIED, INACTIVE PRODUCTION

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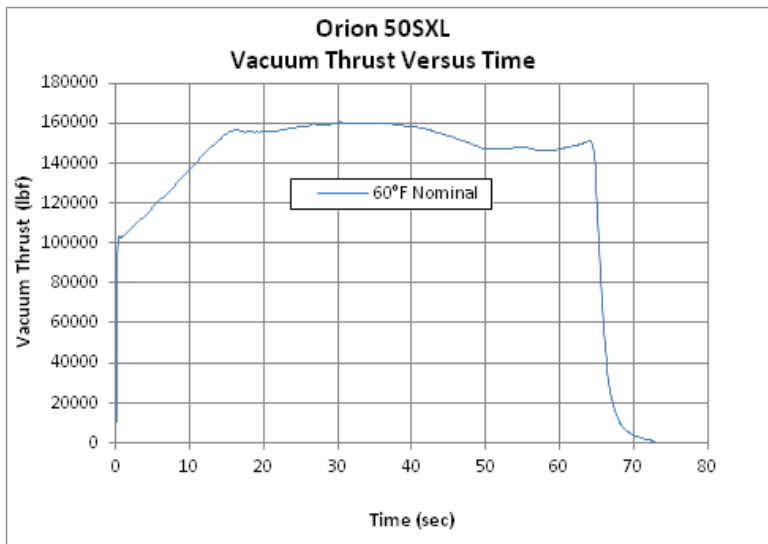
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# ORION 50S XL



## AIR-IGNITED, FIXED NOZZLE

A performance upgrade of the Orion 50S, the Orion 50S XL is 55.4 inches longer and contains 6,500 lbm more propellant. This fixed-nozzle XL version has performed successfully on all Pegasus XL launch vehicle missions, such as the Solar Radiation and Climate Experiment (SORCE), Fast Auroral Snapshot (FAST), High Energy Solar Spectroscopic Imager (HESSI), Orbview-3, and Transition Region and Coronal Explorer (TRACE).



### MOTOR DIMENSIONS

Motor diameter, in.....	50.2
Overall motor length (including nozzle), in.....	404.3
Nozzle exit cone diameter, in.....	56.0

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec.....	69.7
Maximum thrust, lbf.....	160,404
Effective specific impulse, lbf-sec/lbm.....	292.78*
Total impulse, lbf-sec.....	9,744,300*
Burn time average thrust, lbf.....	139,726

\* Includes 137 lbm of expended inerts

### WEIGHTS, LBM

Total motor.....	36,153
Propellant.....	33,145
Burnout.....	2,837

### PROPELLANT DESIGNATION

.....QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... 1.3

RACEWAY ..... OPTIONAL

ORDNANCE ..... OPTIONAL

TVA ..... NO

### TEMPERATURE LIMITS

Operation.....	+36°-100°F
Storage.....	+30°-100°F

### PRODUCTION STATUS

..... FLIGHT-PROVEN, PRODUCTION

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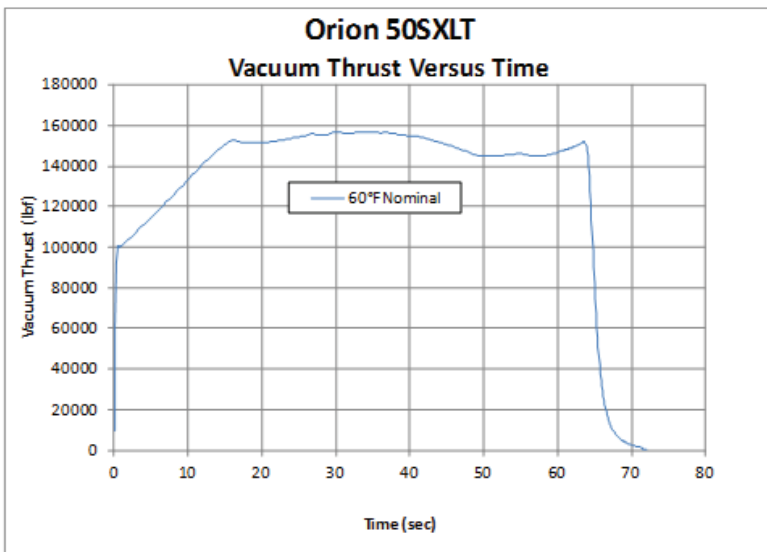
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# ORION 50S XLT



## AIR-IGNITED, VECTORABLE NOZZLE

Vectorable nozzle configurations of the Orion 50S XL have also been added to support versatility and new applications. One such configuration, Orion 50S XLT, has been used as a second-stage motor on the enhanced Taurus XL vehicle, which first launched in May 2004. This version incorporates a  $\pm 5$ -degree vectorable nozzle and thicker skirts.



### MOTOR DIMENSIONS

Motor diameter, in.....	50.2
Overall motor length (including nozzle), in. ....	390.8
Nozzle exit cone diameter, in.....	47.6

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec.....	69.0
Maximum thrust, lbf.....	156,823
Effective specific impulse, lbf-sec/lbm.....	284.61*
Total impulse, lbf-sec.....	9,472,400*
Burn time average thrust, lbf.....	137,192

\* Includes 137 lbm of expended inerts

### WEIGHTS, LBM

Total motor.....	35,763
Propellant.....	33,145
Burnout.....	2,472

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... .. 1.3

RACEWAY..... OPTIONAL

ORDNANCE..... OPTIONAL

TVA..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....	+36°-100°F
Storage.....	+30°-100°F

### PRODUCTION STATUS

..... FLIGHT-PROVEN, PRODUCTION

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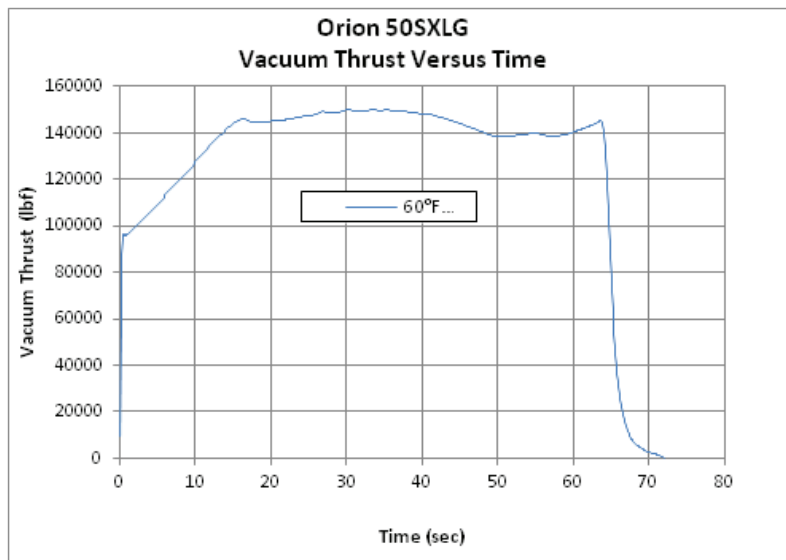
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# ORION 50S XLG



## GROUND-IGNITED, VECTORABLE NOZZLE

A ground-ignited, vectorable nozzle configuration with  $\pm 5$ -degree vector capability has also been developed, designated Orion 50S XLG. This motor was first flown on the Taurus Lite vehicle, February 2003, as the ground-ignited first stage. It is also used on the Orbital Boost Vehicle (OBV) for the Missile Defense Agency (MDA) Ground-based Midcourse Defense (GMD) and as an Intermediate Range Ballistic Missile (IRBM) target for MDA.



### MOTOR DIMENSIONS

Motor diameter, in.....50.2  
 Overall motor length (including nozzle), in. ....344.0  
 Nozzle exit cone diameter, in.....36.0

### MOTOR PERFORMANCE (60°F NOMINAL, VACUUM)

Burn time to 30 psia, sec.....69.0  
 Maximum thrust, lbf.....150,010  
 Effective specific impulse, lbf-sec/lbm ..... 272.26\*  
 Total impulse, lbf-sec..... 9,061,400\*  
 Burn time average thrust, lbf .....131,200  
 \* Includes 137 lbm of expended inerts

### WEIGHTS, LBM

Total motor.....35,525  
 Propellant .....33,145  
 Burnout.....2,237

### PROPELLANT DESIGNATION

..... QDL-1, HTPB POLYMER, 19% ALUMINUM

HAZARDS CLASSIFICATION... ..... 1.3

RACEWAY ..... OPTIONAL

ORDNANCE ..... OPTIONAL

TVA ..... OPTIONAL

### TEMPERATURE LIMITS

Operation.....+36°-100°F  
 Storage.....+30°-100°F

### PRODUCTION STATUS

.....FLIGHT-PROVEN, PRODUCTION

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