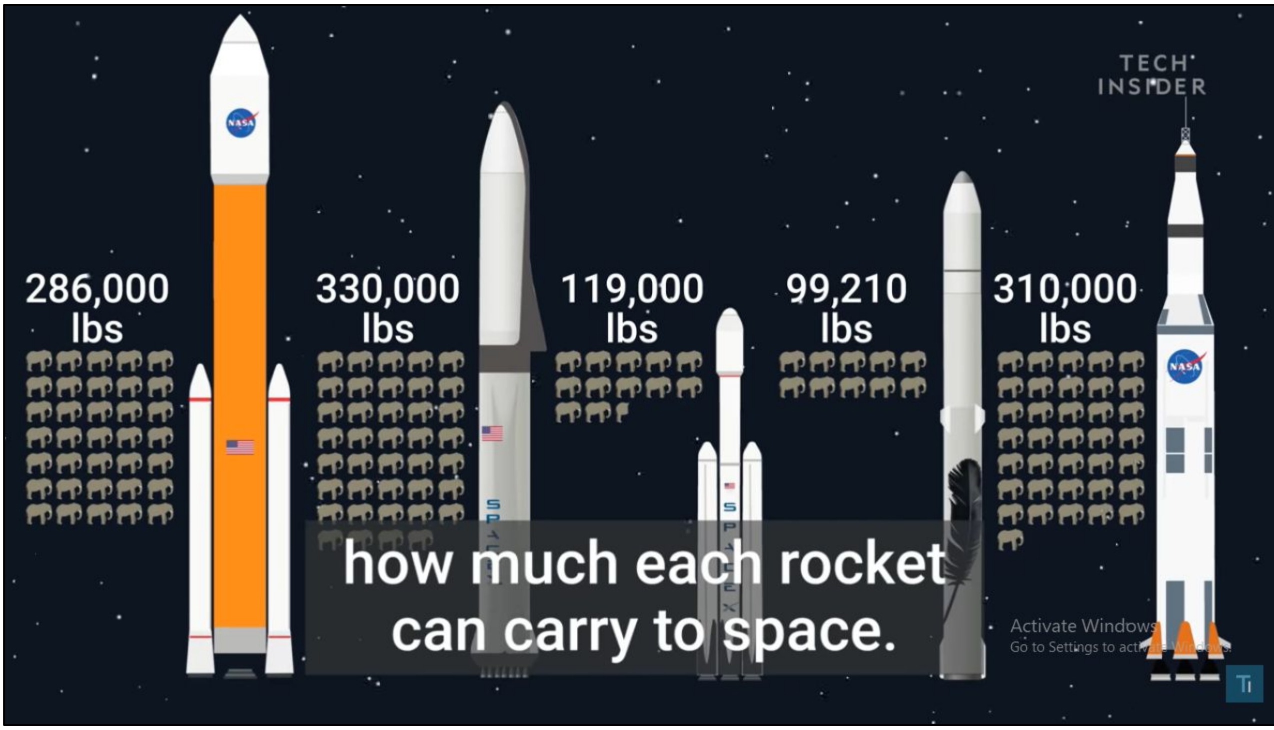


Payload to LEO: https://www.youtube.com/watch?v=mD1_UdW4qqQ


A request from the world to US industry

Saturn-V

Saturn-V

| | |
|---|---|
| | July 16, 1969 |
| **Function** | Apollo lunar program launcher<br>Launch of Skylab |
| **Manufacturer** | Boeing (S-IC)<br>North American (S-II)<br>Douglas (S-IVB) |
| **Country of origin** | United States |
| **Project cost** | $6.417 billion in 1964–1973 dollars[1] (~$42 billion in 2018 dollars) |
| **Cost per launch** | $185 million in 1969–1971 dollars[2] ($1.16 billion in 2016 value), of which $110 million was for vehicle.[3] |
| **Size** | |
| **Height** | 363.0 ft (110.6 m) |
| **Diameter** | 33.0 ft (10.1 m) |
| **Mass** | 6,540,000 lb (2,970,000 kg)[4] |
| **Stages** | 2–3 |
| **Capacity** | |
| **Payload to LEO (90 nmi (170 km), 30° inclination)** | 310,000 lb (140,000 kg)[5][6][note 1] |
| **Payload to TLI** | 107,100 lb (48,600 kg)[4] |

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**SpaceX Starship**

| | |
|---|---|
| **Manufacturer** | SpaceX |
| **Designer** | Elon Musk (lead designer)[1][2][3]<br>Tom Mueller (engine designer)[4][5][6][7] |
| **Country of origin** | United States |
| **Specifications** | |
| **Spacecraft type** | fully reusable, cargo (crewed option later) |
| **Launch mass** | 1,335,000 kg (2,943,000 lb) |
| **Dry mass** | 120,000 kg (260,000 lb)(target)[8] |
| **Payload capacity** | 100,000 kg (220,000 lb)(initally[8]; target is 150000 kg)[9] |
| **Dimensions** | |
| **Length** | 50 m (160 ft)[10] |
| **Diameter** | 9 m (30 ft) |
| **Production** | |
| **Status** | In development |
| **Built** | 3 test articles |
| **Engines** | 3 Raptor (sea-level nozzle) + 3 Raptor vacuum[11] |
| **Thrust** | 12,000 kN; 2,600,000 lbf (1,200 tf) |
| **Specific impulse** | vacuum engine: 380 s<br>sea-level engine: 330 s (at sea level)<br>355 s (in vacuum)[8] |
| **Fuel** | Subcooled $CH_4$ / LOX |



Saturn-V

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| SpaceX Starship | Saturn-V | Space Launch System |
|---|---|---|

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### Space Launch System

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## Space Launch System

| | |
|---|---|
| **Function** | Super heavy-lift launch vehicle |
| **Country of origin** | United States |
| **Project cost** | US$7 billion (2014–18, 2014 estimate),[1] to $35 billion (until 2025, 2011 est.)[2][3][*better source needed*] |
| **Size** | |
| **Height** | 111.25 m (365 ft 0 in), Block 2 Cargo |
| **Diameter** | 8.4 m (27 ft 7 in), Core Stage |
| **Stages** | 2 |
| **Capacity** | |
| **Payload to LEO** | **Block 1**: 95 t (209,000 lb)[4]<br>**Block 2**: 130 t (290,000 lb)[5] |
| **Payload to Moon** | **Block 1**: > 26,000 kg (57,000 lb)[6]<br>**Block 1B Crew**: 34,000–37,000 kg (75,000–82,000 lb)[6]<br>**Block 1B Cargo**: 37,000–40,000 kg (82,000–88,000 lb)[6]<br>**Block 2**: > 45,000 kg (99,000 lb)[6] |
| **Launch history** | |
| **Status** | Under development |
| **Launch sites** | LC-39B, Kennedy Space Center |
| **First flight** | Artemis 1 |
| **Notable payloads** | Orion MPCV, *Europa Clipper*, LOP-G |


Activate Windows
Go to Settings to activate Windows.

## SpaceX Starship

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| Diameter | 33.0 ft (10.1 m) |
| Mass | 6,540,000 lb (2,970,000 kg)[4] |
| Stages | 2–3 |
| **Capacity** | |
| Payload to LEO (90 nmi (170 km), 30° inclination) | 310,000 lb (140,000 kg)[5][6][note 1] |
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| **Launch history** | |
| Status | Under development |

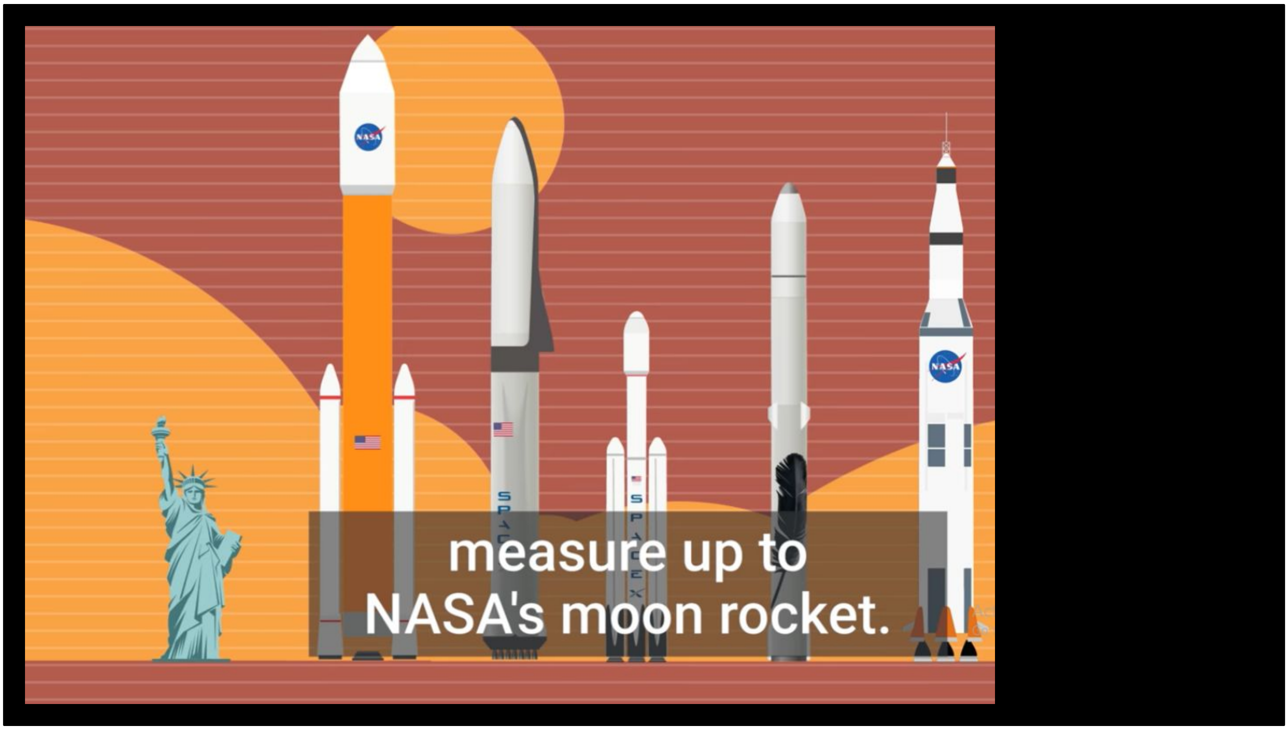
| SLS variant | Payload mass to ... | |
|---|---|---|
| | low Earth orbit (LEO) | trans-lunar injection (TLI) |
| Block 1 | 95 t (209,439 lb)[4] | 26 t (57,000 lb)[4] |
| Block 1B | 105 t (231,000 lb)[41] | 37 t (88,000 lb)[4] |
| Block 2 | 130 t (290,000 lb)[5] | |

# SLS, Saturn-V, Starship

| Parameter | **Space Launch System** | **Saturn-V** | **Starship** |
|---|---|---|---|
| Manufacturer | NASA | Boeing (S-IC)<br>North American (S-II)<br>Douglas (S-IVB) | SpaceX |
| Height, Diameter, Mass and Stages | 365 ft (111.25m), 27.7 ft (8.4m), 2,90,000 lb (105 t) maximum and 2<br>(Different payloads have SLS mass variation) | 363.00 ft (110.6m), 33.00 ft (10.1m), 6,540,000 lb (2,970,000kg) and 2-3 | 387 ft (118m), 30 ft (9m), 11,000,000 lb (5,000,000kg) and 2 |
| Built in the year of | 2019 (in the process of completion) | 1967 | Under development |
| Launch | 2020-21 (Planned) | Total 13, first on November 9, 1967 | 2020 (Planned) |
| Function: | Super Heavy Lift Launch Vehicle | Apollo Lunar Program Launcher | Mars colonization, Earth-Lunar Transport, Multiplanetary, Interplanetary transport, Orbiter Launcher, Space Tourism |

This is from “Extreme Machines: Rockets”. THE iconic video depicting the Saturn-V (atleast to me). The operal choir music is EPIC.

(Video file also attached)




Height comparisons, Vox video

J-1

‘Nuff said.

https://www.youtube.com/watch?v=DKtVpvzUF1Y

“Engineers can do just about anything.” - :)

https://www.youtube.com/watch?v=TKbDd2SbJeo
14:18 - 43:51

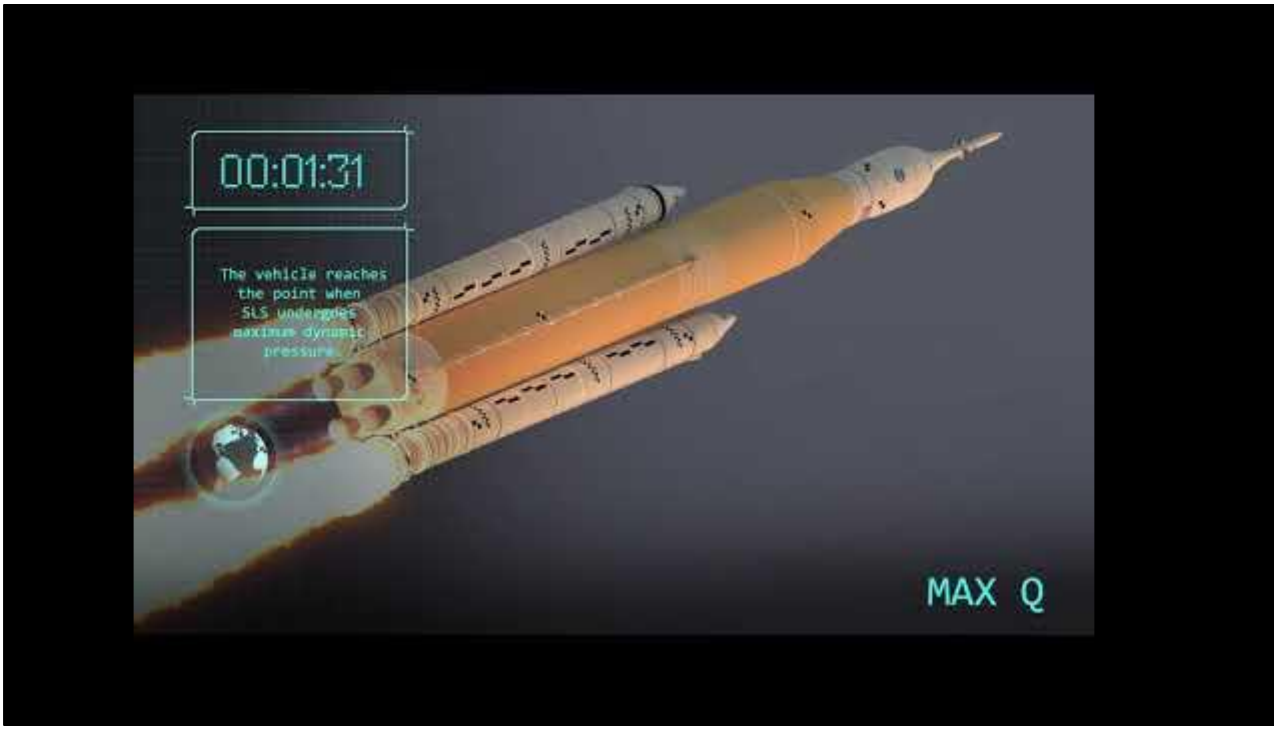

When the rocket ‘talks’ to you. #RocketWhisperer #JimLovell
This is on here because I think it conveys a visceral understanding of the launch.
(Creaking sounds, humidity, smells, jolts...)

https://www.youtube.com/watch?v=1-JdqHxqkHA

Vibrations!

https://www.youtube.com/watch?v=TKbDd2SbJeo
25:52 - 27:15

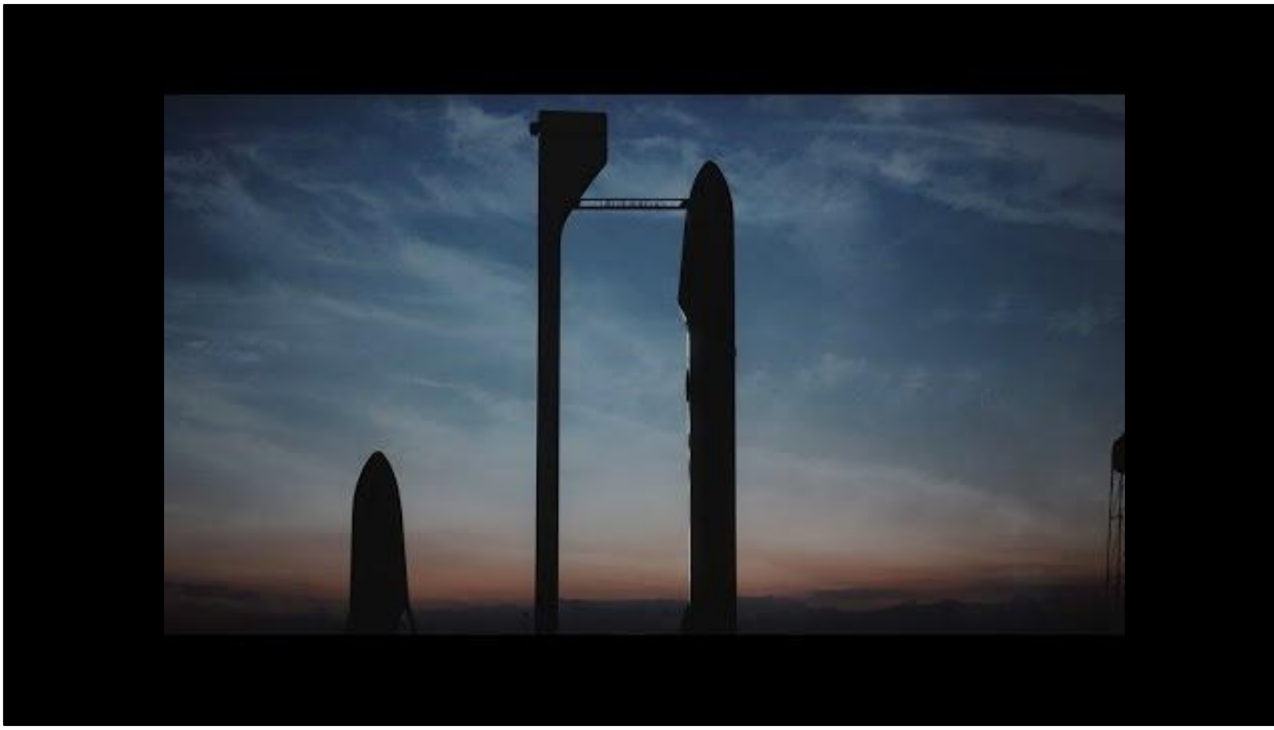
https://www.youtube.com/watch?v=LVzwf0nS-eE




https://www.youtube.com/watch?v=7VvozsSG23w

https://www.youtube.com/watch?v=zqE-uItsWt0

https://www.youtube.com/watch?v=sOpMrVnjYeY
32:27 - 34:15



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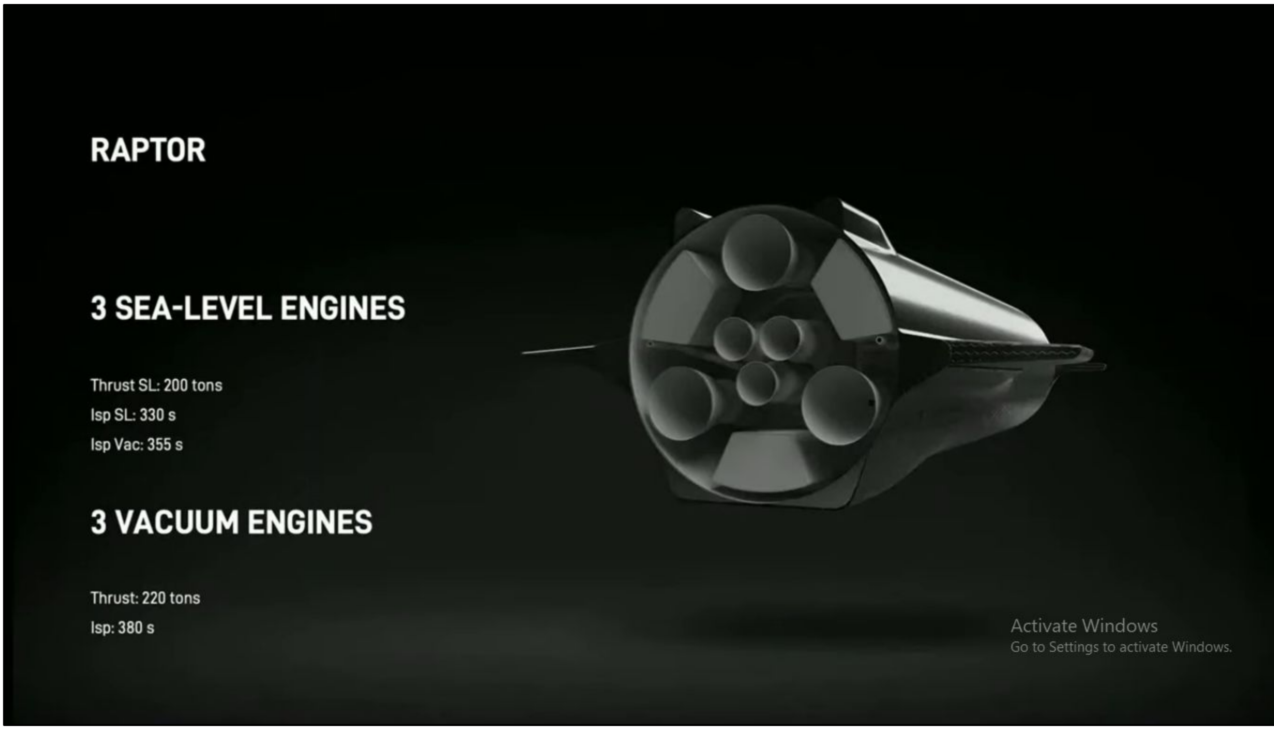
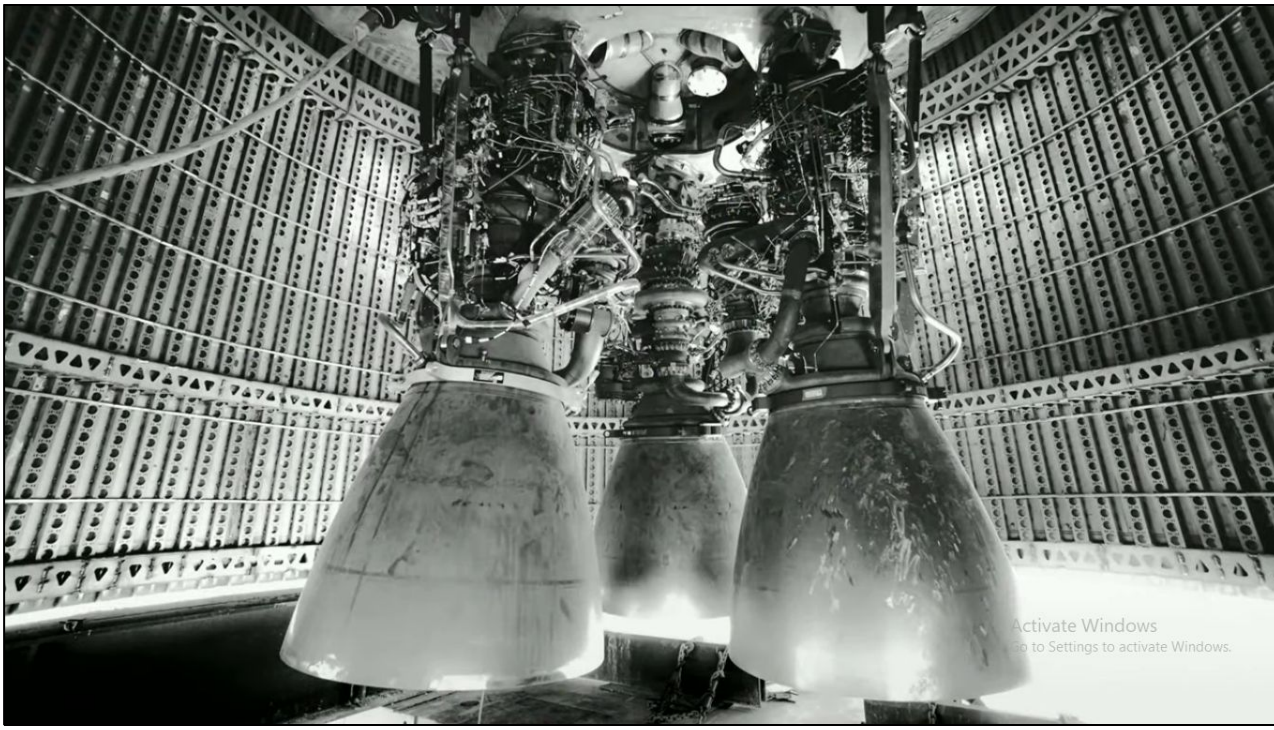


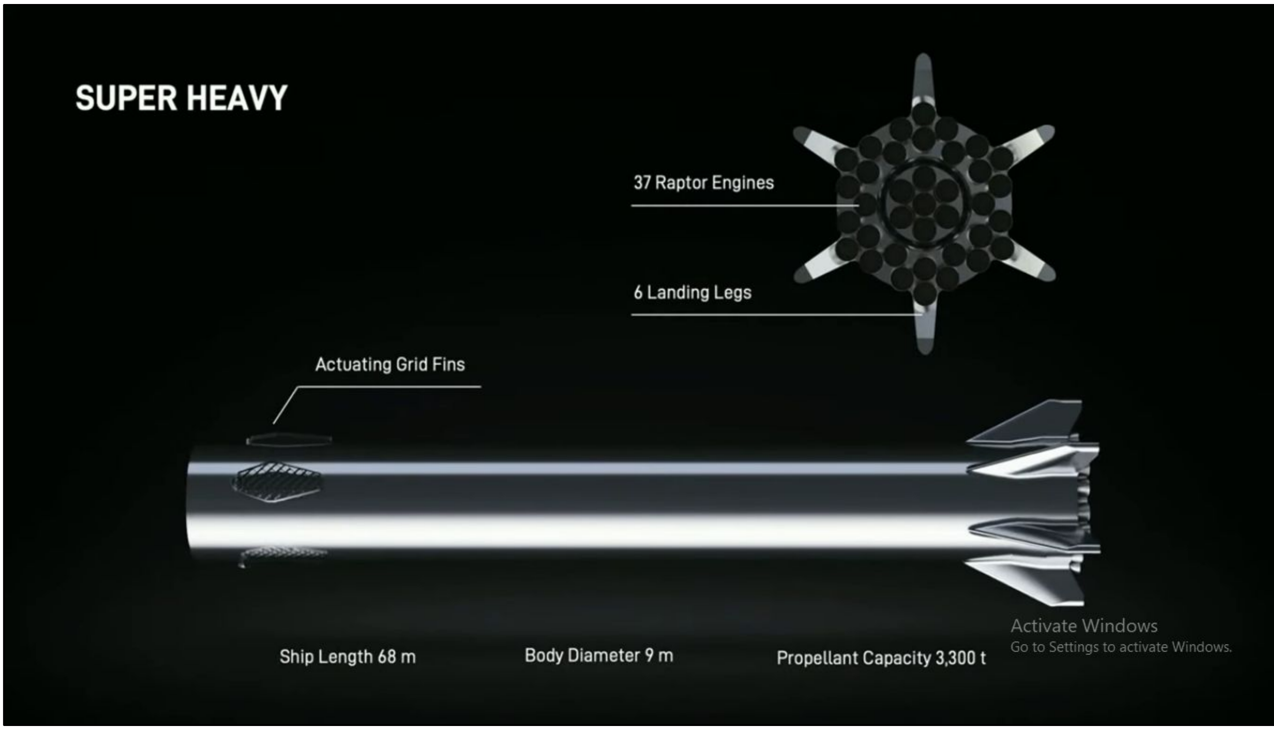

Starship (orbital vehicle) - the Raptor engines are Metholox [Screenshot from the Starship Update video]



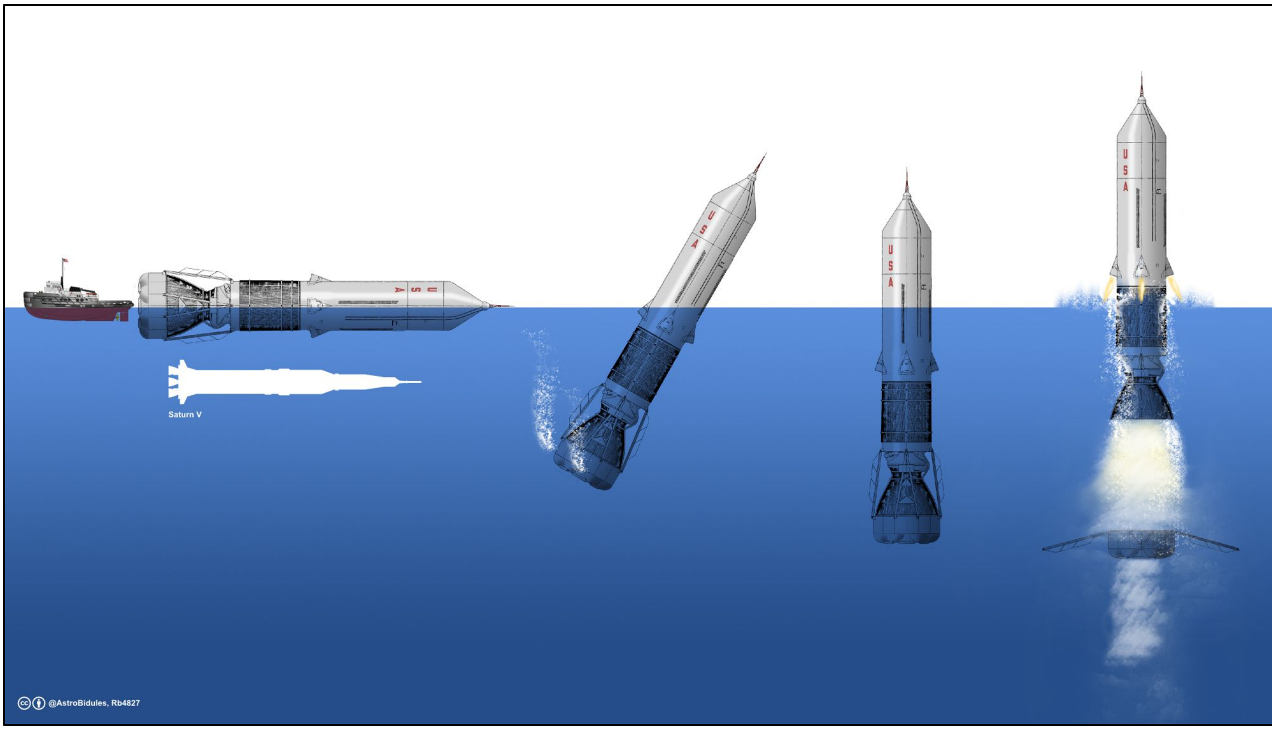

The Raptor Engines - screenshot from the Starship update video


HEAT SHIELD
Stainless steel resists high temperatures
Rugged ceramic tiles for maximum heating areas
Fully reusable, low maintenance
Supports rapid production and installation
Activate Windows
Go to Settings to activate Windows.

Ibid

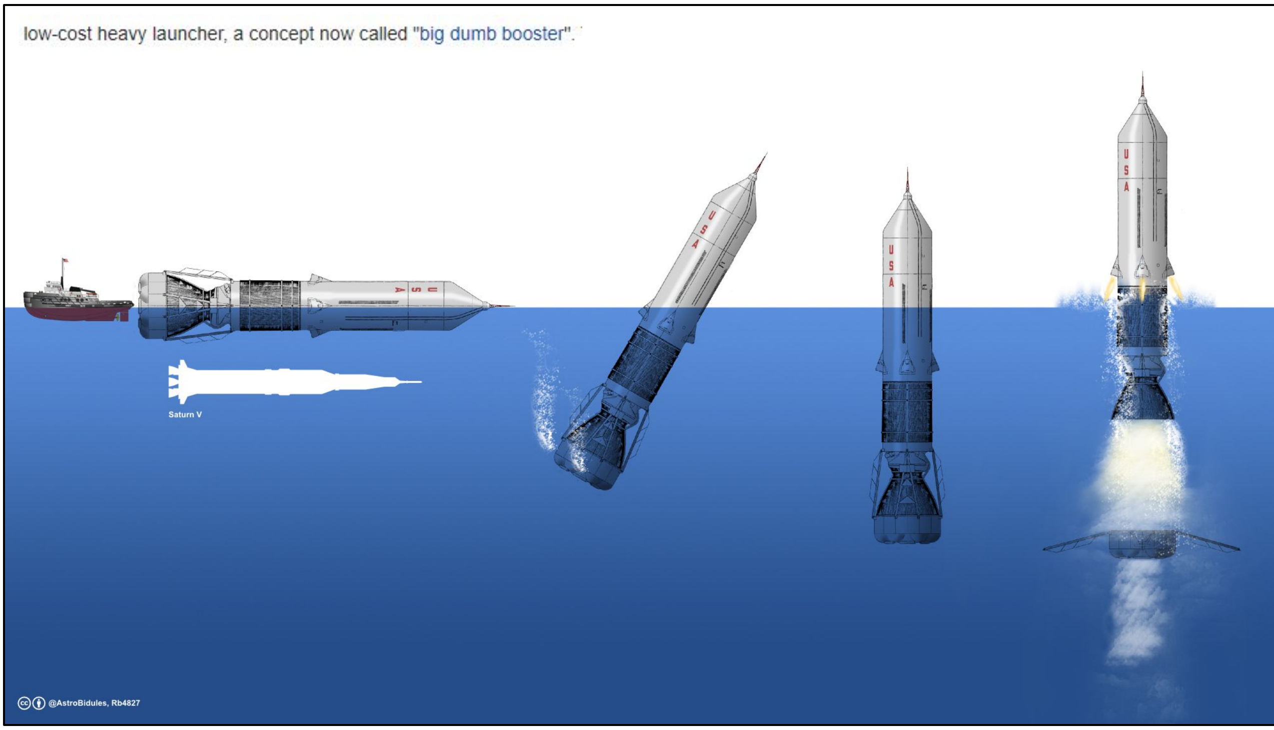



THIRTY SEVEN ENGINES! (Aiming for 2x the thrust of a Saturn-V, at a thrust-to-weight of 1.5), [Ibid.]




Sea-Dragon - largest rocket ever “fully” conceived (in any detail)

Screenshots from the Wikipedia article for Sea-Dragon

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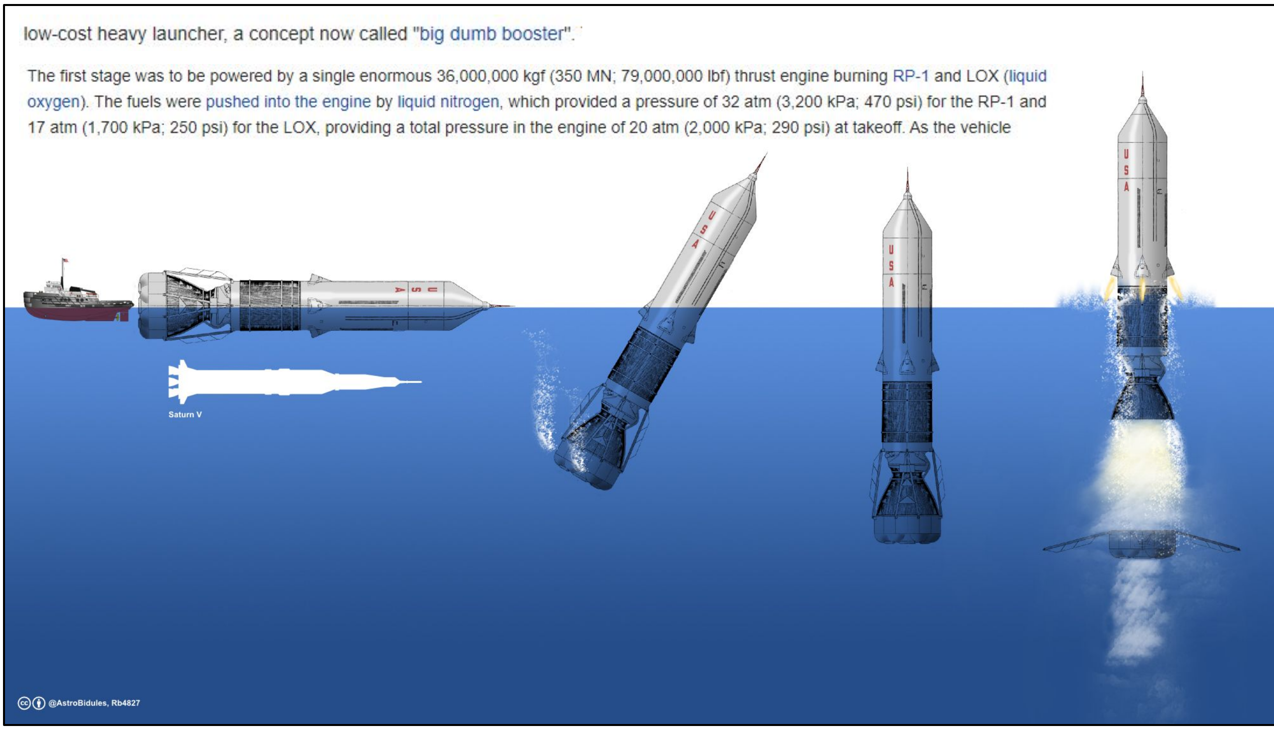
low-cost heavy launcher, a concept now called "big dumb booster".

The first stage was to be powered by a single enormous 36,000,000 kgf (350 MN; 79,000,000 lbf) thrust engine burning RP-1 and LOX (liquid oxygen). The fuels were pushed into the engine by liquid nitrogen, which provided a pressure of 32 atm (3,200 kPa; 470 psi) for the RP-1 and 17 atm (1,700 kPa; 250 psi) for the LOX, providing a total pressure in the engine of 20 atm (2,000 kPa; 290 psi) at takeoff. As the vehicle



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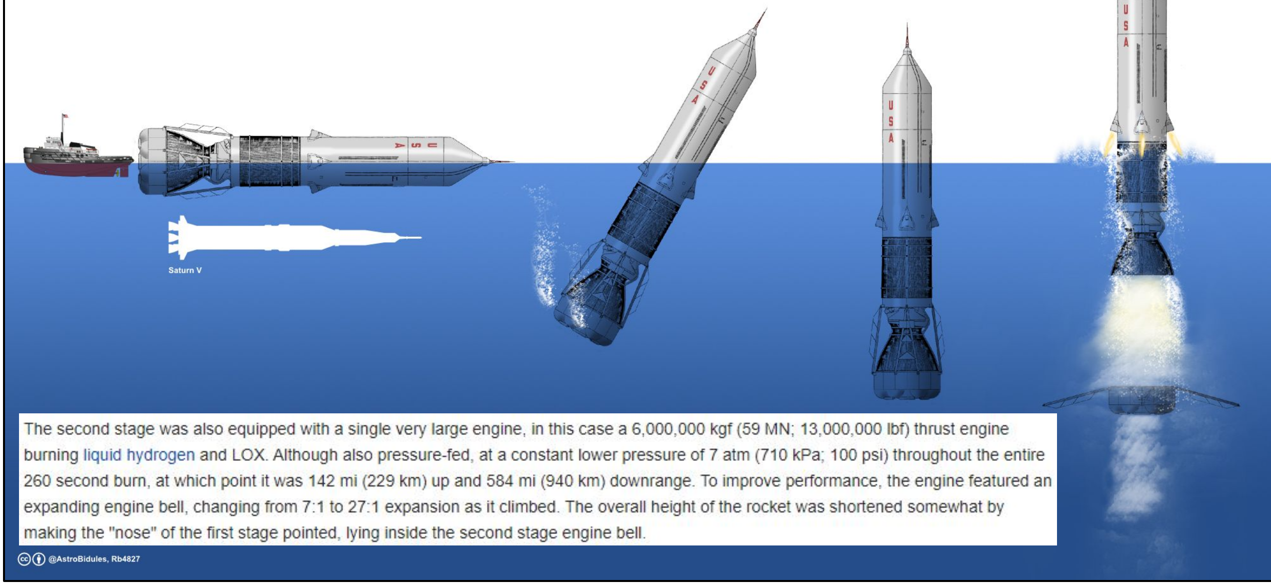


The second stage was also equipped with a single very large engine, in this case a 6,000,000 kgf (59 MN; 13,000,000 lbf) thrust engine burning liquid hydrogen and LOX. Although also pressure-fed, at a constant lower pressure of 7 atm (710 kPa; 100 psi) throughout the entire 260 second burn, at which point it was 142 mi (229 km) up and 584 mi (940 km) downrange. To improve performance, the engine featured an expanding engine bell, changing from 7:1 to 27:1 expansion as it climbed. The overall height of the rocket was shortened somewhat by making the "nose" of the first stage pointed, lying inside the second stage engine bell.

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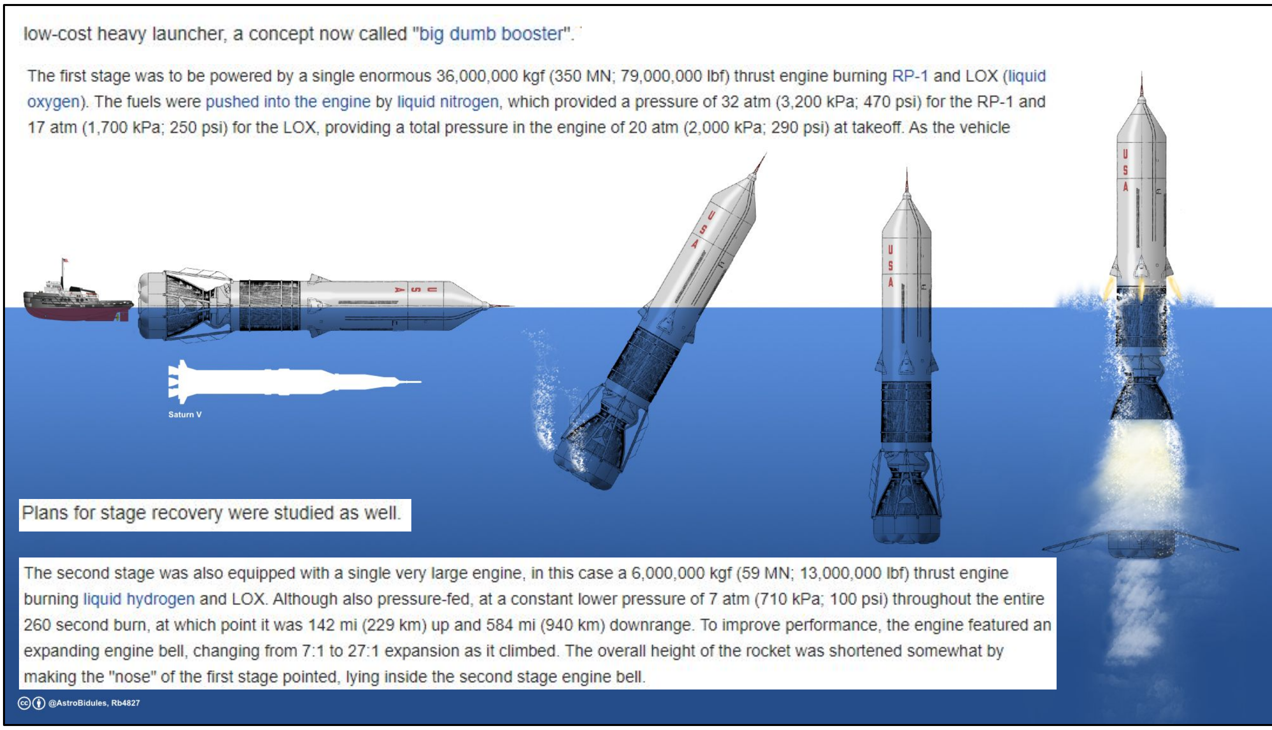

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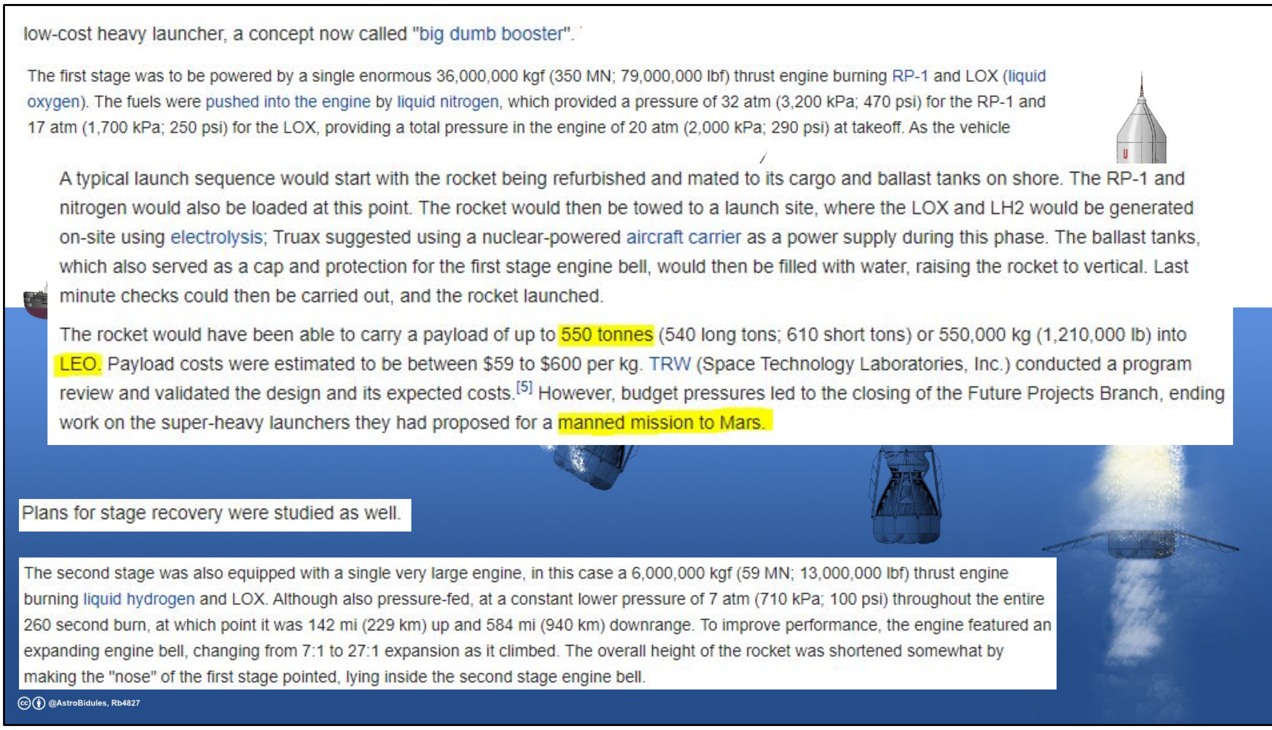

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A typical launch sequence would start with the rocket being refurbished and mated to its cargo and ballast tanks on shore. The RP-1 and nitrogen would also be loaded at this point. The rocket would then be towed to a launch site, where the LOX and LH2 would be generated on-site using electrolysis; Truax suggested using a nuclear-powered aircraft carrier as a power supply during this phase. The ballast tanks, which also served as a cap and protection for the first stage engine bell, would then be filled with water, raising the rocket to vertical. Last minute checks could then be carried out, and the rocket launched.

The rocket would have been able to carry a payload of up to 550 tonnes (540 long tons; 610 short tons) or 550,000 kg (1,210,000 lb) into LEO. Payload costs were estimated to be between $59 to $600 per kg. TRW (Space Technology Laboratories, Inc.) conducted a program review and validated the design and its expected costs.[5] However, budget pressures led to the closing of the Future Projects Branch, ending work on the super-heavy launchers they had proposed for a manned mission to Mars.

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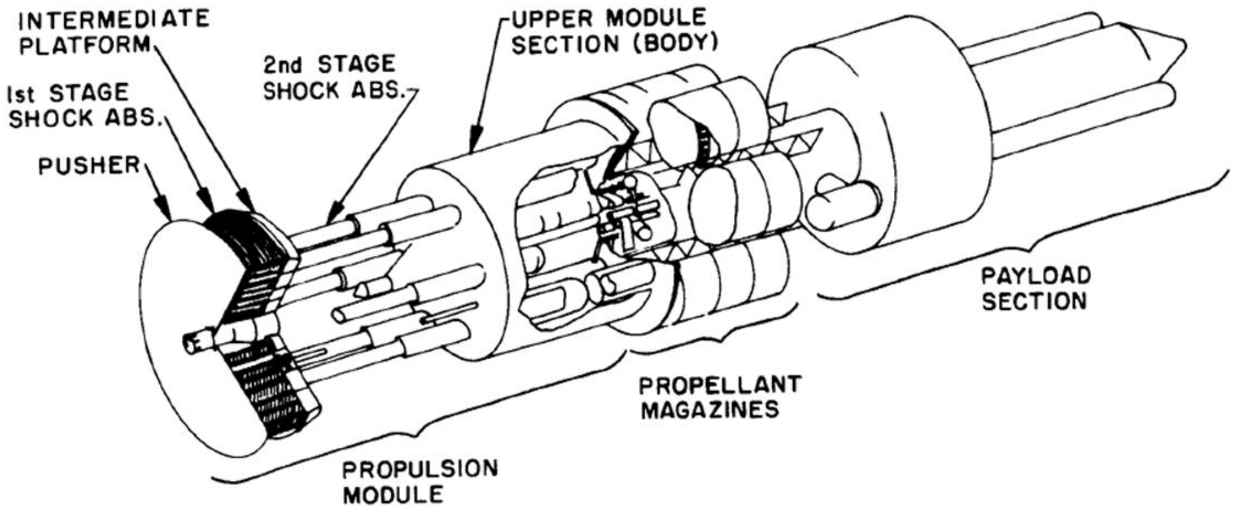
Project Orion (nuclear propulsion… yes, NUCLEAR propulsion. As in blast shockwave propelled...)




Picture from Wikipedia

| | Orbital test | Interplanetary | Advanced interplanetary | Saturn V |
|---|---|---|---|---|
| **Ship mass** | 880 t | 4,000 t | 10,000 t | 3,350 t |
| **Ship diameter** | 25 m | 40 m | 56 m | 10 m |
| **Ship height** | 36 m | 60 m | 85 m | 110 m |
| **Bomb yield (sea level)** | 0.03 kt | 0.14 kt | 0.35 kt | n/a |
| **Bombs (to 300 mi Low Earth Orbit)** | 800 | 800 | 800 | n/a |
| **Payload (to 300 mi LEO)** | 300 t | 1,600 t | 6,100 t | 130 t |
| **Payload (to Moon soft landing)** | 170 t | 1,200 t | 5,700 t | 2 t |
| **Payload (Mars orbit return)** | 80 t | 800 t | 5,300 t | – |
| **Payload (3 yr Saturn return)** | – | – | 1,300 t | – |

Wikipedia screenshots

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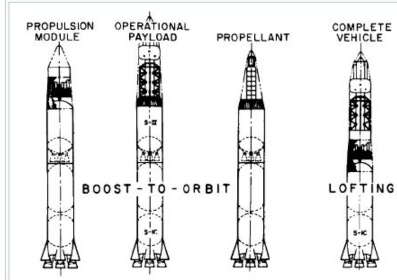


Image of the smallest Orion vehicle extensively studied, which could have had a payload of around 100 tonnes in an 8 crew round trip to Mars.[8] On the left, the 10 meter diameter Saturn V "Boost-to-orbit" variant, requiring in-orbit assembly before the Orion vehicle would be capable of moving under its own propulsion system. On the far right, the fully assembled "lofting" configuration, in which the spacecraft would be lifted high into the atmosphere before pulse propulsion began. As depicted in the 1964 NASA document "Nuclear Pulse Space Vehicle Study Vol III - Conceptual Vehicle Designs and Operational Systems."[9][10]

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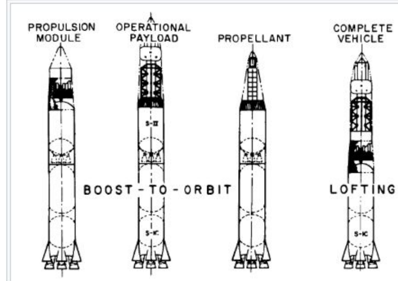


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The Orion nuclear pulse drive combines a very high exhaust velocity, from 19 to 31 km/s (12 to 19 mi/s) in typical interplanetary designs, with meganewtons of thrust.[5] Many spacecraft propulsion drives can achieve one of these or the other, but nuclear pulse rockets are the only proposed technology that could potentially meet the extreme power requirements to deliver both at once (see spacecraft propulsion for more speculative systems).

Wikipedia screenshots

| | "Energy Limited" Orion | "Momentum Limited" Orion |
|---|---|---|
| **Ship diameter (meters)** | 20,000 m | 100 m |
| **Mass of empty ship (tonnes)** | 10,000,000 t (incl.5,000,000 t copper hemisphere) | 100,000 t (incl. 50,000 t structure+payload) |
| **+Number of bombs = total bomb mass (each 1 Mt bomb weighs 1 tonne)** | 30,000,000 | 300,000 |
| **=Departure mass (tonnes)** | 40,000,000 t | 400,000 t |
| **Maximum velocity (kilometers per second)** | 1000 km/s (=0.33% of the speed of light) | 10,000 km/s (=3.3% of the speed of light) |
| **Mean acceleration (Earth gravities)** | 0.00003 g (accelerate for 100 years) | 1 g (accelerate for 10 days) |
| **Time to Alpha Centauri (one way, no slow down)** | 1330 years | 133 years |
| **Estimated cost** | 1 year of U.S. GNP (1968), \$3.67 Trillion | 0.1 year of U.S. GNP \$0.367 Trillion |

Wikipedia screenshots (Project Orion)

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In order to improve on this performance while reducing size and cost, Dyson also considered an alternative *momentum limited* pusher plate design where an ablation coating of the exposed surface is substituted to get rid of the excess heat. The limitation is then set by the capacity of shock absorbers to transfer momentum from the impulsively accelerated pusher plate to the smoothly accelerated vehicle. Dyson calculated that the properties of available materials limited the velocity transferred by each explosion to ~30 meters per second independent of the size and nature of the explosion. If the vehicle is to be accelerated at 1 Earth gravity (9.81 $m/s^2$) with this velocity transfer, then the pulse rate is one

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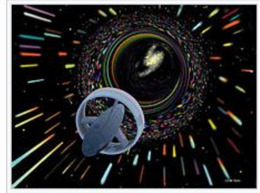
...because the safety was not already an impediment…?

Wikipedia screenshots (Project Orion)

## Speculative methods [ edit ]

A variety of hypothetical propulsion techniques have been considered that require a deeper understanding of the properties of space, particularly inertial frames and the vacuum state. To date, such methods are highly speculative and include:

- Black hole starship
- Differential sail
- Faster-than-light
- Field propulsion
  - RF resonant cavity thruster
- Gravitational shielding
  - Diametric drive
  - Disjunction drive
  - Pitch drive
  - Bias drive
- Photon rocket
- Photonic laser thruster[citation needed]
- Quantum vacuum thruster
- Reactionless drive
  - Abraham—Minkowski drive
  - Alcubierre drive
  - Heim drive
  - Dean drive
  - Gyroscopic Inertial Thruster (GIT)
  - Woodward effect



Artist's conception of a warp drive design

A NASA assessment of its Breakthrough Propulsion Physics Program divides such proposals into those that are non-viable for propulsion purposes, those that are of uncertain potential, and those that are not impossible according to current theories.[43]

https://en.wikipedia.org/wiki/Spacecraft_propulsion#Speculative_methods

...and the reference in Wikipedia:
https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060000022.pdf

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3. https://en.wikipedia.org/wiki/SpaceX_Starship


Some references