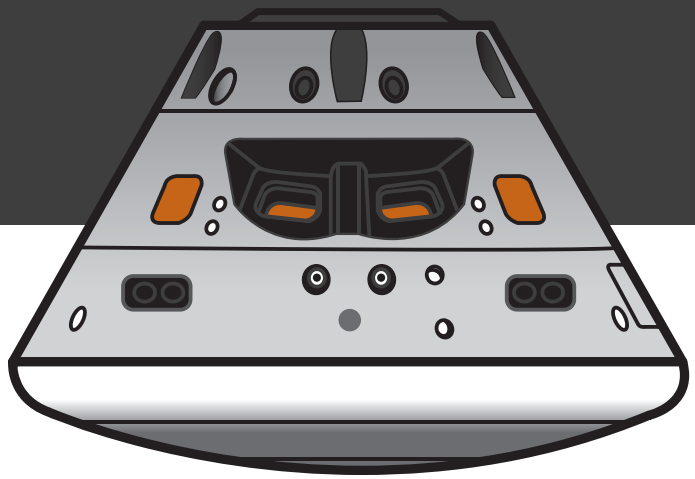
National Aeronautics and Space Administration

America's Next Generation Spacecraft

ORION

A to Z



Orion's First Step to Deep Space:
Exploration Flight Test-1 in 2014

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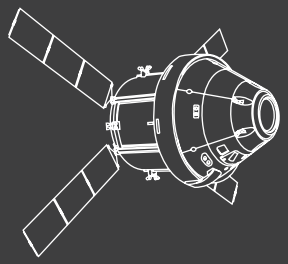
ORION
A to Z

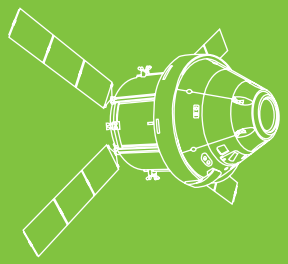


APOGEE

The term apogee refers to the point in an elliptical orbit when a spacecraft is farthest from the Earth.

During Exploration Flight Test-1, Orion's flight path will take it to an apogee of 3,600 miles. Just how high is that? A commercial airliner flies about 8 miles above the Earth's surface, so Orion's flight is 450 times farther than that.

ORION
A to Z



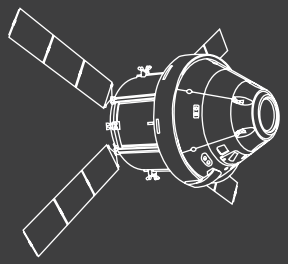
BEO

Beyond Earth Orbit

When a spacecraft travels beyond Earth's orbit, it travels away from the planet, instead of circling around it.

Orion is designed for deep space missions to go beyond Earth's orbit, like going to an asteroid or Mars. The crew module is powered by solar panels and batteries, allowing an unlimited power supply. Orion's life support system recycles water and oxygen for the crew, which allows them to travel through space for months. Orion's heat shield and crew cabin are also designed to shield the crew from the intense radiation encountered during deep space exploration.

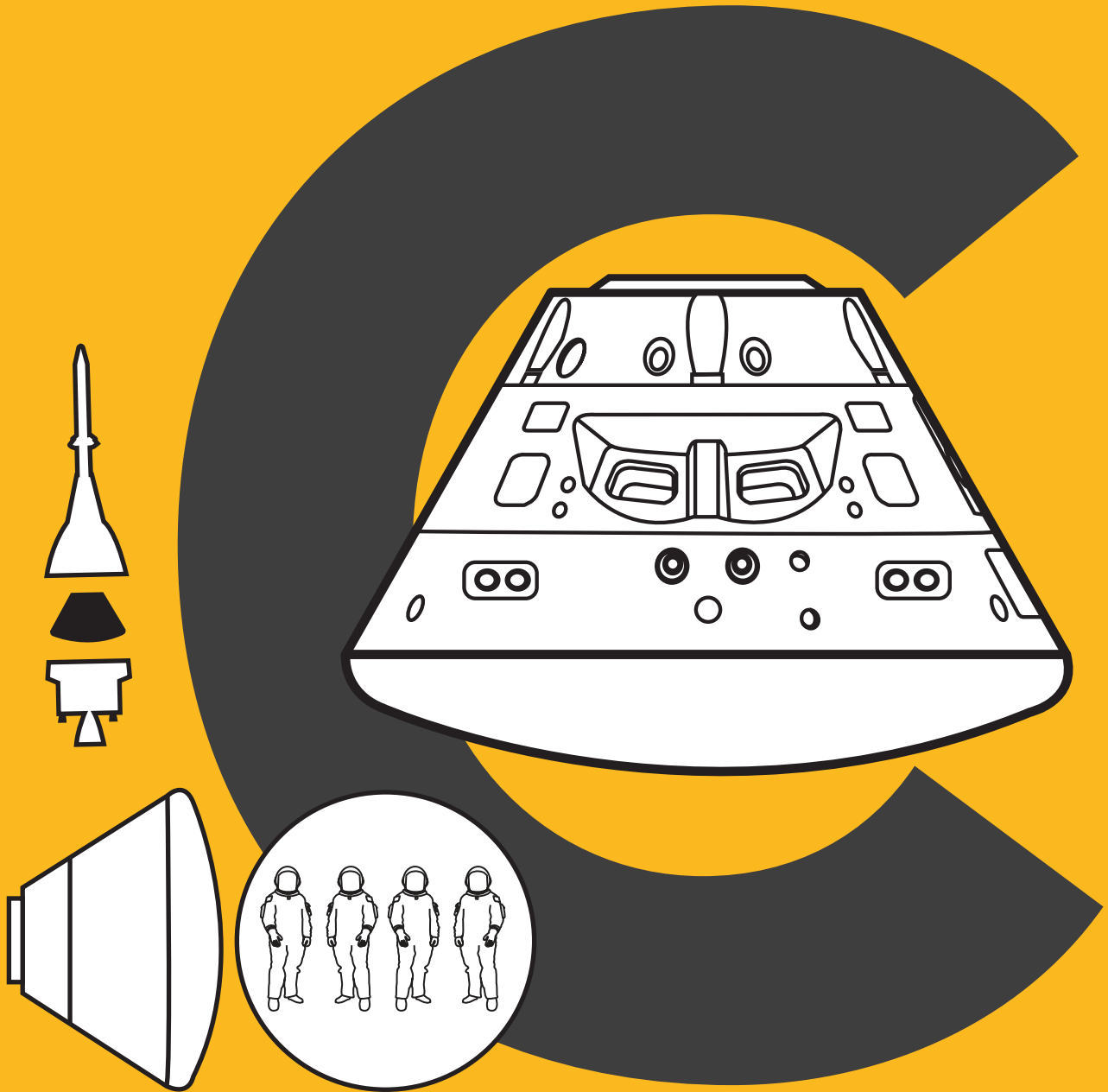
ORION
A to Z



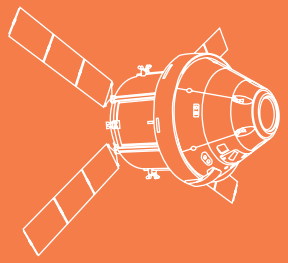
CREW MODULE

The crew module is a transportation capsule that provides a living area for the crew, and storage area for supplies and research instruments.

Orion's crew module will carry astronauts on missions to destinations never before visited by humans and safely return them to Earth. The Exploration Flight Test-1 crew module will be the first Orion test vehicle sent into space.



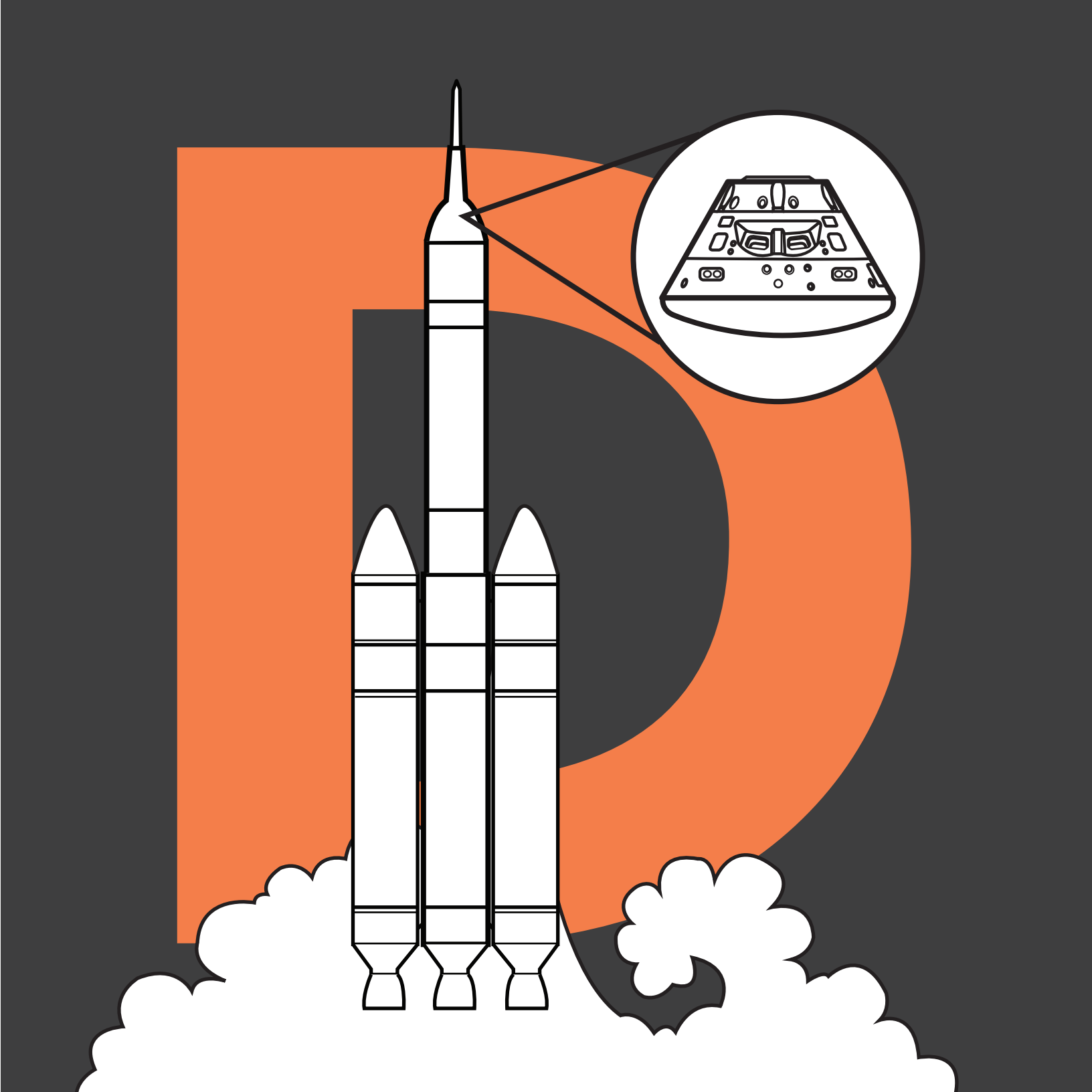
ORION
A to Z



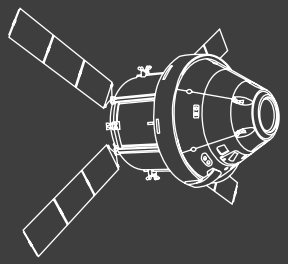
DELTA IV HEAVY

The Delta IV Heavy rocket is the largest launch vehicle available today capable of propelling more than 60,000 pounds of spacecraft and cargo to a high altitude orbit. That's the equivalent of four full-grown elephants or about 13 typical pickup trucks!

The Delta IV Heavy is the rocket that will launch Orion on its first trip to space, Exploration Flight Test-1, in the fall of 2014.



ORION
A to Z



ECLSS

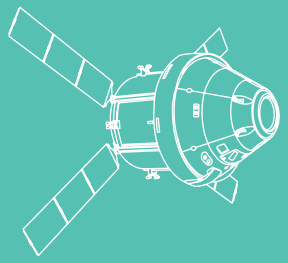
Environmental Control and Life Support System

The ECLSS is a life support system that controls atmospheric pressure, fire detection and suppression, oxygen levels, waste management and water recycling.

Orion's ECLSS will support a crew for missions to deep space and will carry crews farther from Earth than ever before. The ECLSS for Orion consists of technology previously tested on the International Space Station. It will have to support the crew with the essentials like breathable air and drinkable water for 21 days all while fitting in a space smaller than a standard office cubicle!


O2

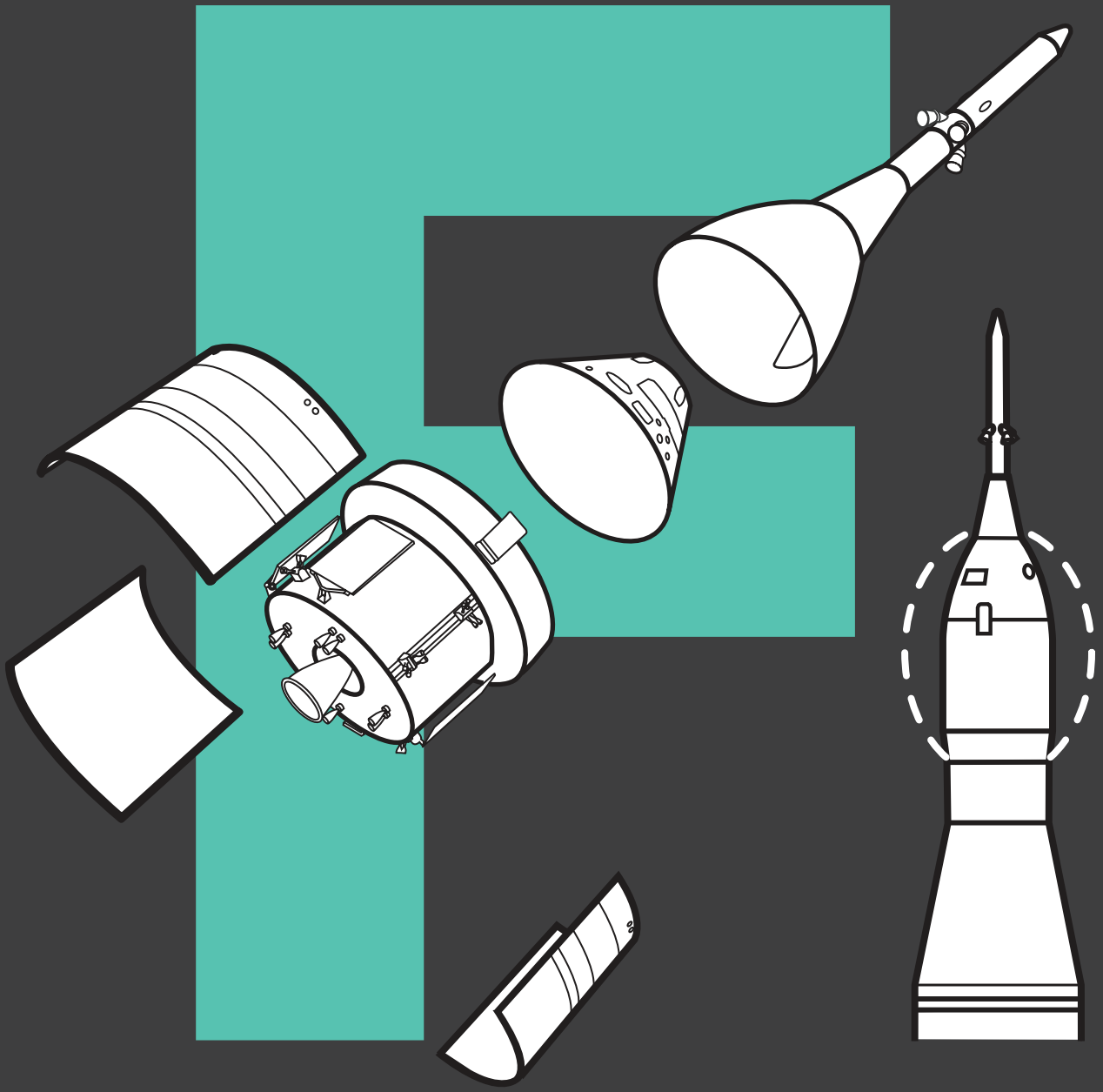
ORION
A to Z



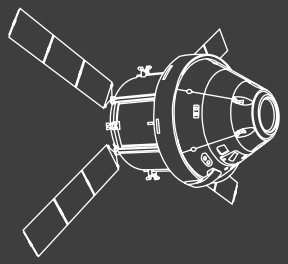
FRANGIBLE JOINTS AND FAIRINGS

Frangible joints are breakable joints used to connect the spacecraft's protective panels, called fairings, to the rocket. The fairings protect the spacecraft from the changing pressures, temperatures and vibrations of the atmosphere surrounding the rocket during ascent.

During ascent, about seven minutes into flight, the Orion spacecraft and launch vehicle will reach 135 miles in altitude. At this point, pyrotechnics will be used to break the frangible joints and separate the fairings, exposing the spacecraft to space.



ORION
A to Z

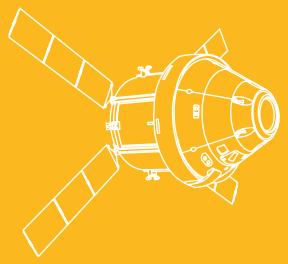


GUPPY

The Super Guppy is a special airplane capable of transporting up to 26 tons in its cargo compartment measuring 25 feet tall, 25 feet wide, and 111 feet long.

The Guppy transported Orion's heat shield from the Boston area to Kennedy Space Center. In order to prevent the heat shield from cracking, it was shipped in a climate controlled container. The world's largest whale, the blue whale, would fit inside the Super Guppy!

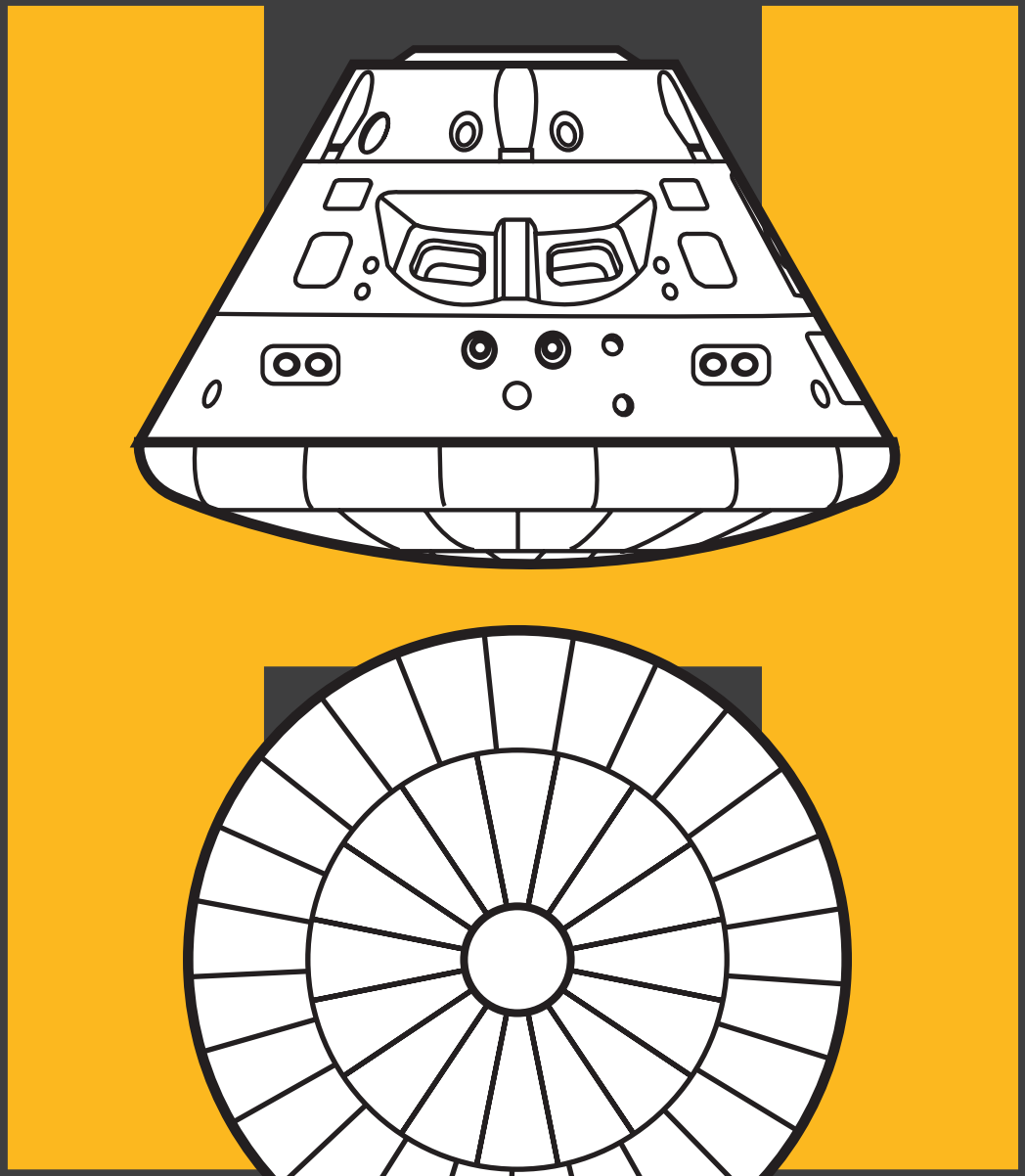
ORION
A to Z



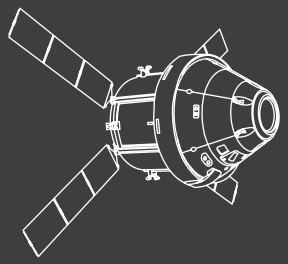
HEAT SHIELD

A heat shield is a protective layer added to the crew module designed to shield the crew and spacecraft from the heat experienced during reentry into Earth's atmosphere.

One of the primary goals of the Exploration Flight Test-1 mission is to validate Orion's heat shield and collect data on its performance as it experiences temperatures near 4,000°F. Orion's heat shield is the largest heat shield ever constructed at more than 15 feet 5 inches in diameter.



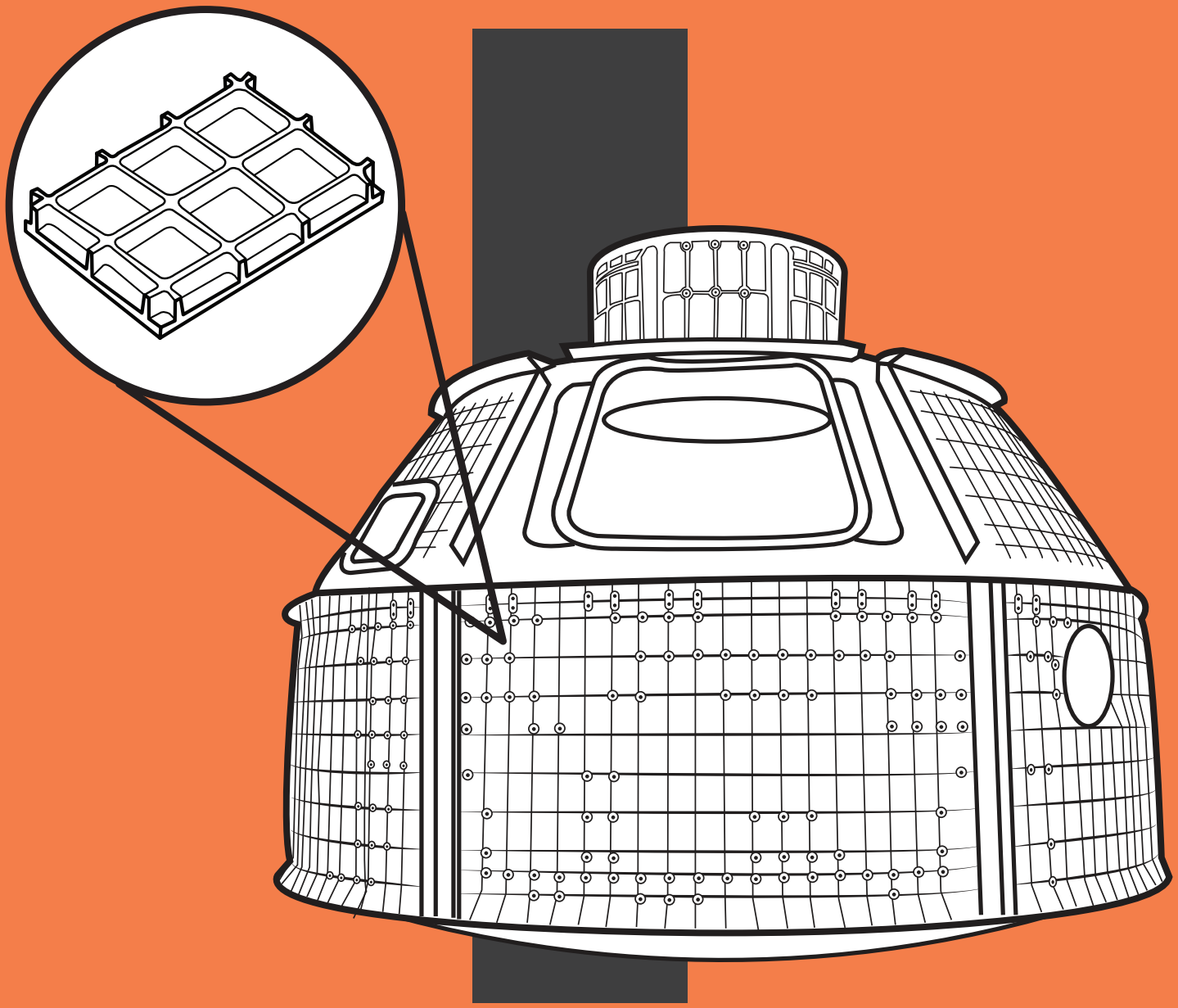
ORION
A to Z



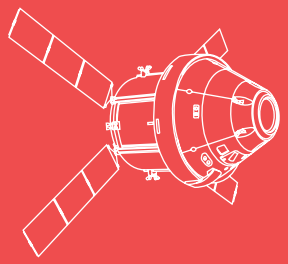
ISOGRID

Isogrid structure is created by removing material from a metal sheet, and retaining the stiffening ribs. This maintains the structural strength of the material while greatly reducing weight. By reducing the weight of the spacecraft structure, we can carry more supplies into space.

The pressure vessel used in Orion's crew module was assembled from multiple isogrid pieces welded together. Orion's isogrid was machined from solid pieces of an aluminum-lithium alloy. The barrel portion of the pressure vessel was machined from a single aluminum donut 139 inches in diameter.



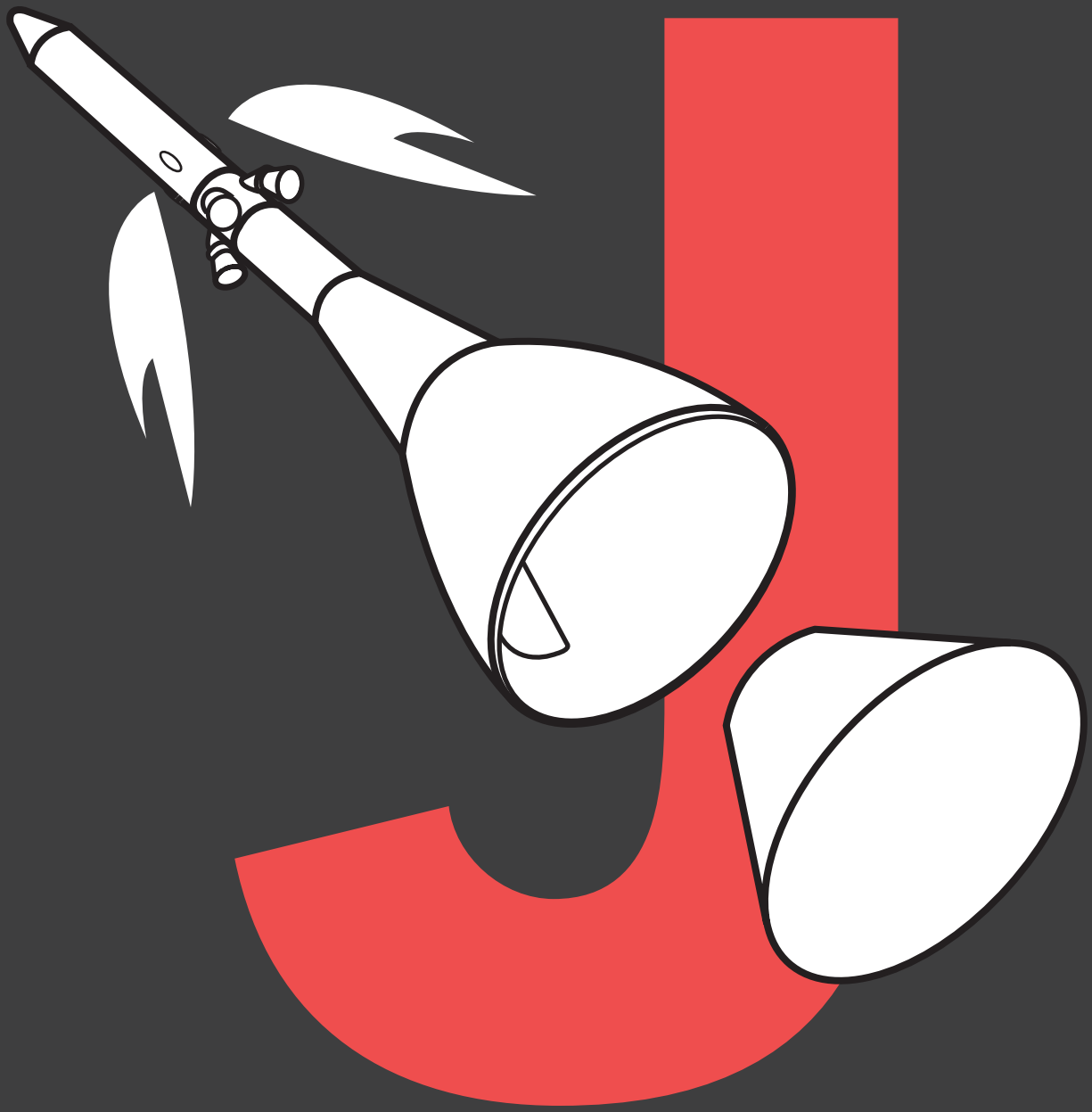
ORION
A to Z



JETTISON

Once Orion reaches orbit, its Launch Abort System is jettisoned or discarded, releasing the spacecraft into space. Prior to re-entry, the service module is also jettisoned.

For Exploration Flight Test 1 (EFT-1), you start out with the rocket's port, starboard, and core boosters, the service module's protective fairings, the launch abort system, the second stage/service module, and the forward bay covers...all of this is jettisoned so that only the crew module re-enters the Earth's atmosphere and splashes down!



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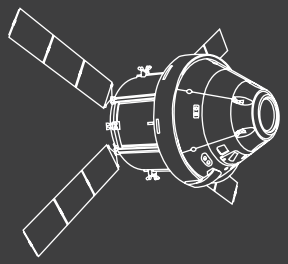
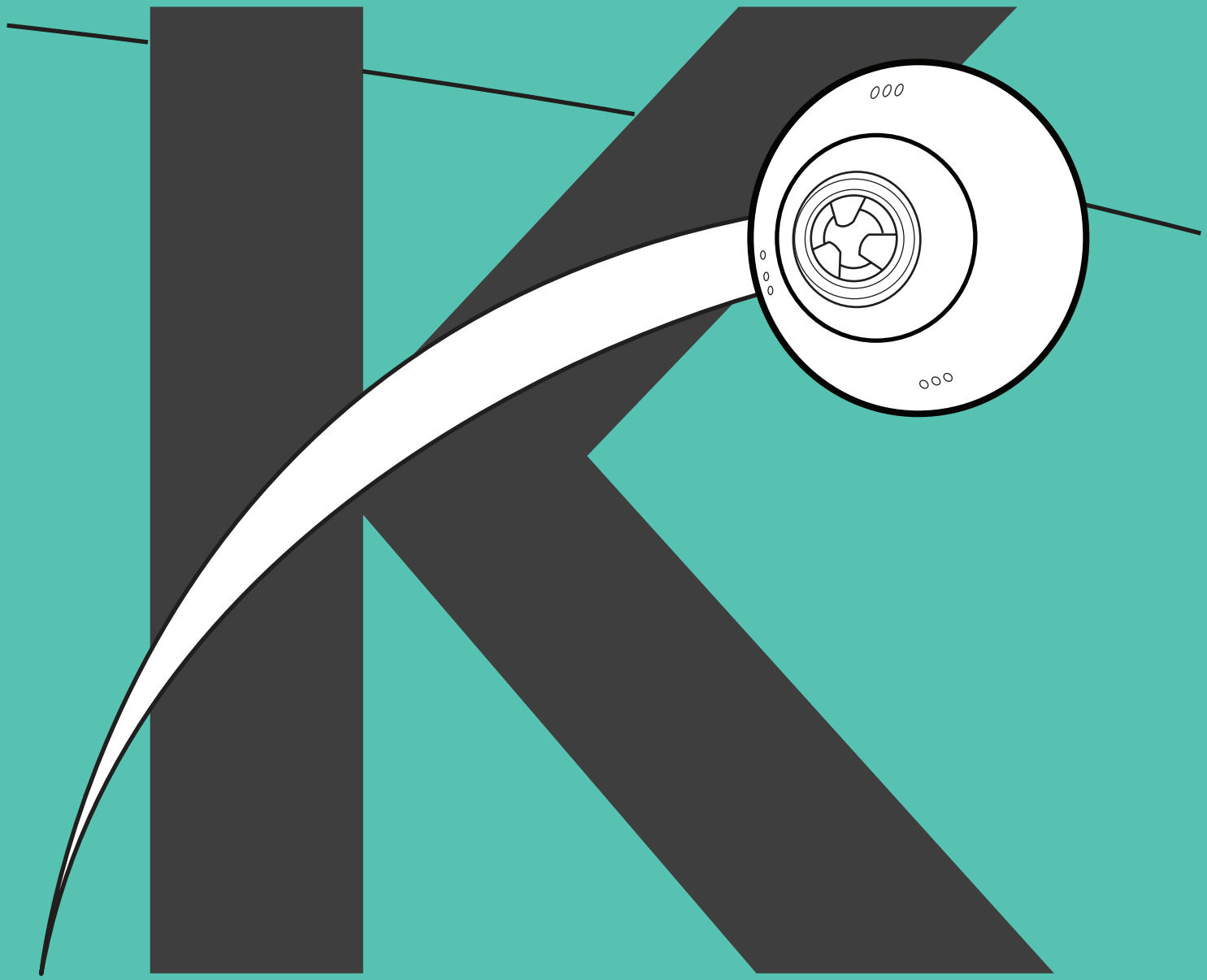
A to Z



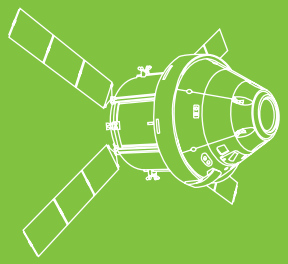
KINETIC ENERGY

Kinetic energy is the energy of an object that is moving. The amount of that energy is relative to the mass of the object and the square of its velocity.

During Exploration Flight Test-1, Orion will be gathering more kinetic energy than any spacecraft has gathered in more than 40 years and must get rid of this energy during reentry for a safe landing. The Orion spacecraft sheds its kinetic energy by interacting with the atmosphere and deploying the parachutes. When Orion reaches the upper layers of the atmosphere, it will be traveling 20,000 mph. The interaction between the heat shield and the atmosphere will slow the spacecraft to about 300 mph before parachutes are deployed to further slow the vehicle to about 20 mph.



ORION
A to Z

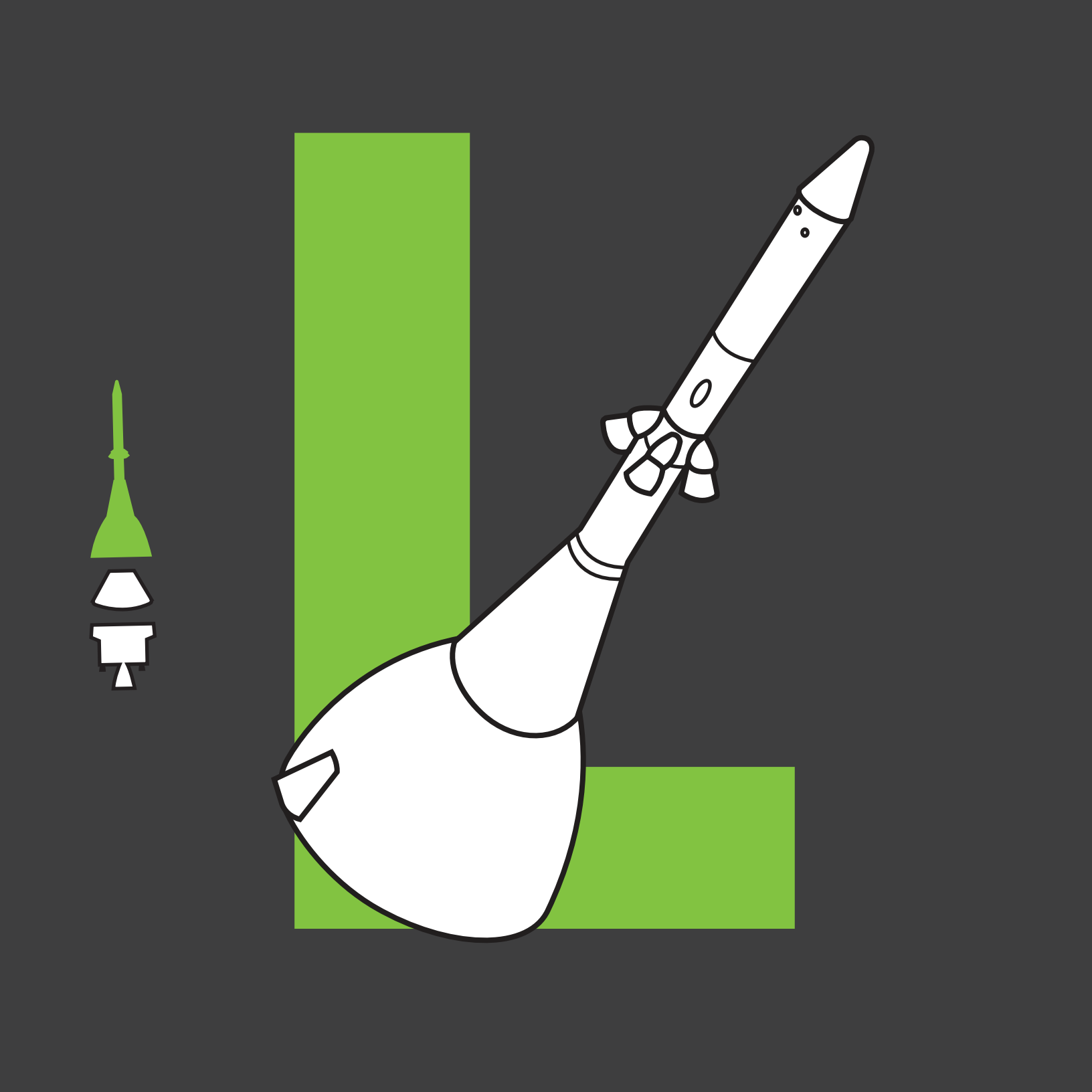


LAS

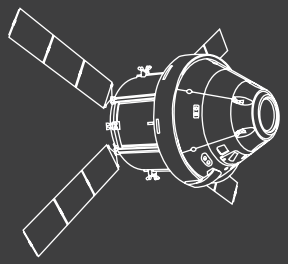
Launch Abort System

Orion's Launch Abort System (LAS) is designed to propel the crew module away from an emergency on the launch pad or during initial takeoff, moving the crew away from danger.

Orion's LAS has three new innovative motors designed to automatically pull the crew to safety, accelerating from 0 to 500 mph in less than 2 seconds. This is nearly 6 times faster than the average roller coaster!



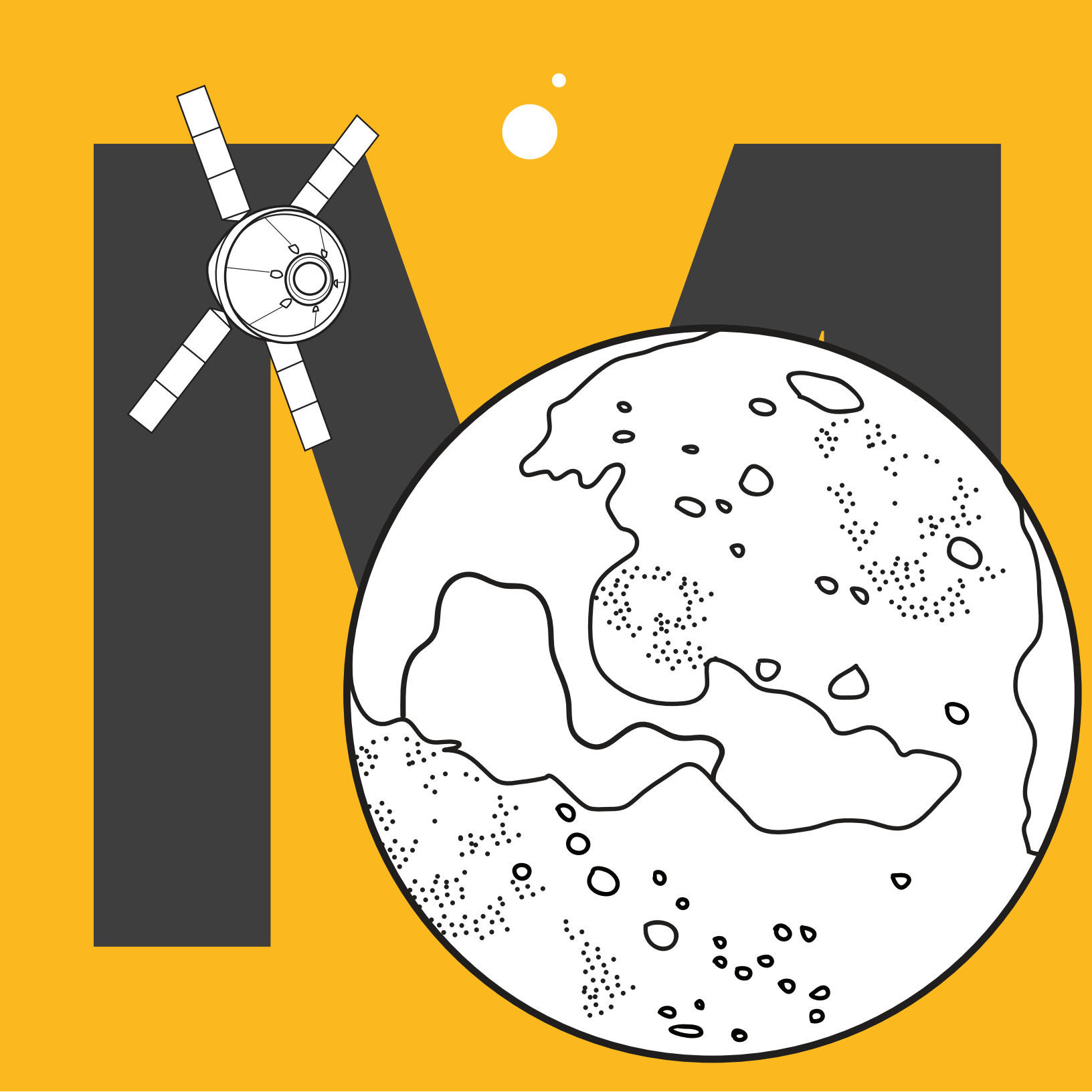
ORION
A to Z



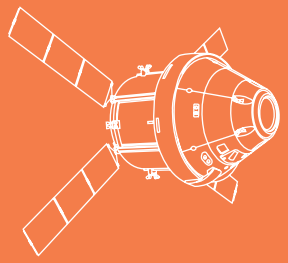
MARS

The fourth planet from the Sun, Mars is a terrestrial planet which is also within our Sun's habitable zone. It orbits the Sun at a distance of about 142 million miles, or 1.5 times as far as Earth. A day on Mars is a little longer than 24 hours. It completes an orbit around the Sun in 687 Earth days. The atmosphere of Mars is made mostly of carbon dioxide (CO_2), and it has two moons, Phobos and Deimos.

In the near-term, Orion will complete missions closer to the Earth-Moon system which will act as stepping stones, so that one day, it will take humans to Mars. Orion is being built with this ultimate destination in mind. More than 40 uncrewed spacecraft have been launched to Mars, including flybys, orbiters, landers, and rovers, but Orion may be the first spacecraft to take humans there.



ORION
A to Z

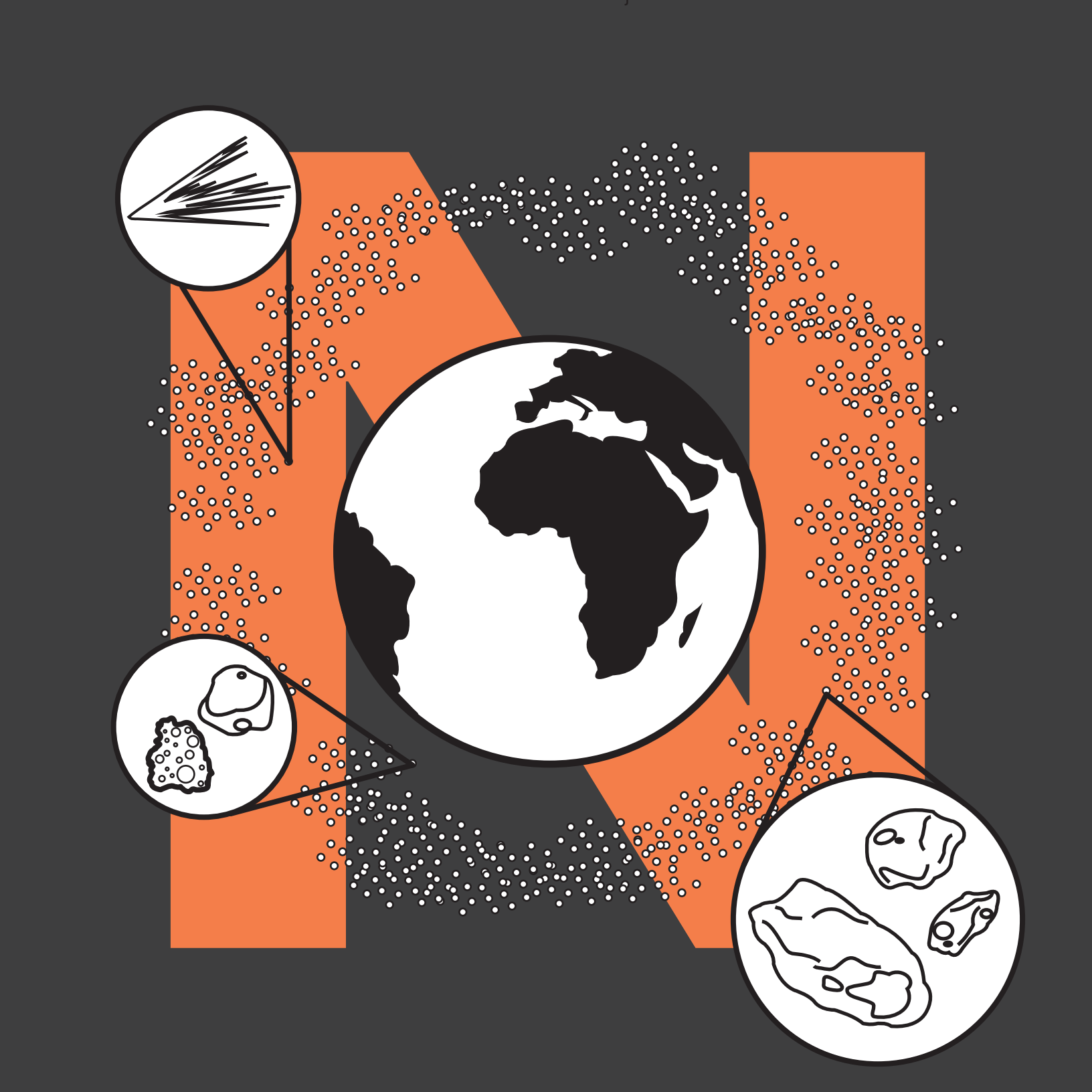


NEO

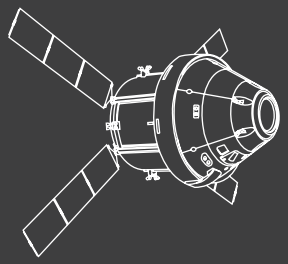
Near Earth Objects

Near-Earth Objects include asteroids, comets and meteoroids whose orbits bring them close to Earth. As of December 2013, more than 10,000 near-Earth asteroids had been discovered, of which 27 have been identified as destinations that are human spaceflight accessible.

One of Orion's early missions is to rendezvous with an asteroid that will be placed in lunar orbit, marking the first time humans have visited an asteroid. Once Orion arrives at the asteroid, the astronauts on board will conduct a spacewalk to retrieve a sample of the rock to be brought back to Earth.



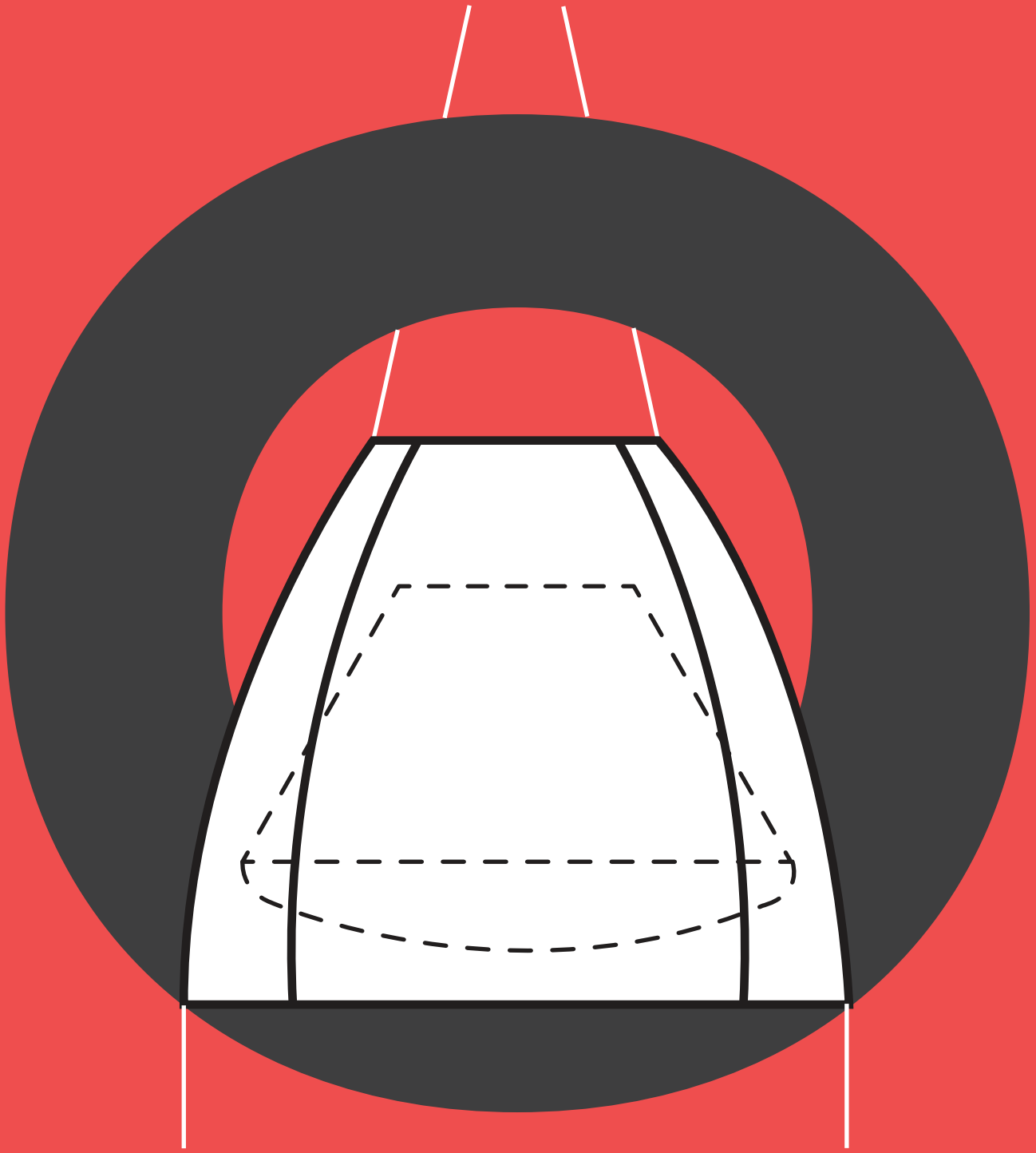
ORION
A to Z



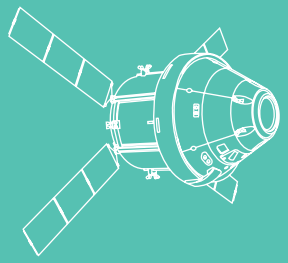
OGIVE

Ogive refers to a surface that has a pointed, curved arch shape. The front tip of a bullet has an ogive shape. Another example of an ogive shape is the top of the space shuttle's external tank.

The bottom portion of Orion's Launch Abort System (LAS) surrounds the crew module with ogive-shaped fairings and protects the module from sound and vibration in the event of its activation at the launch pad or during ascent.



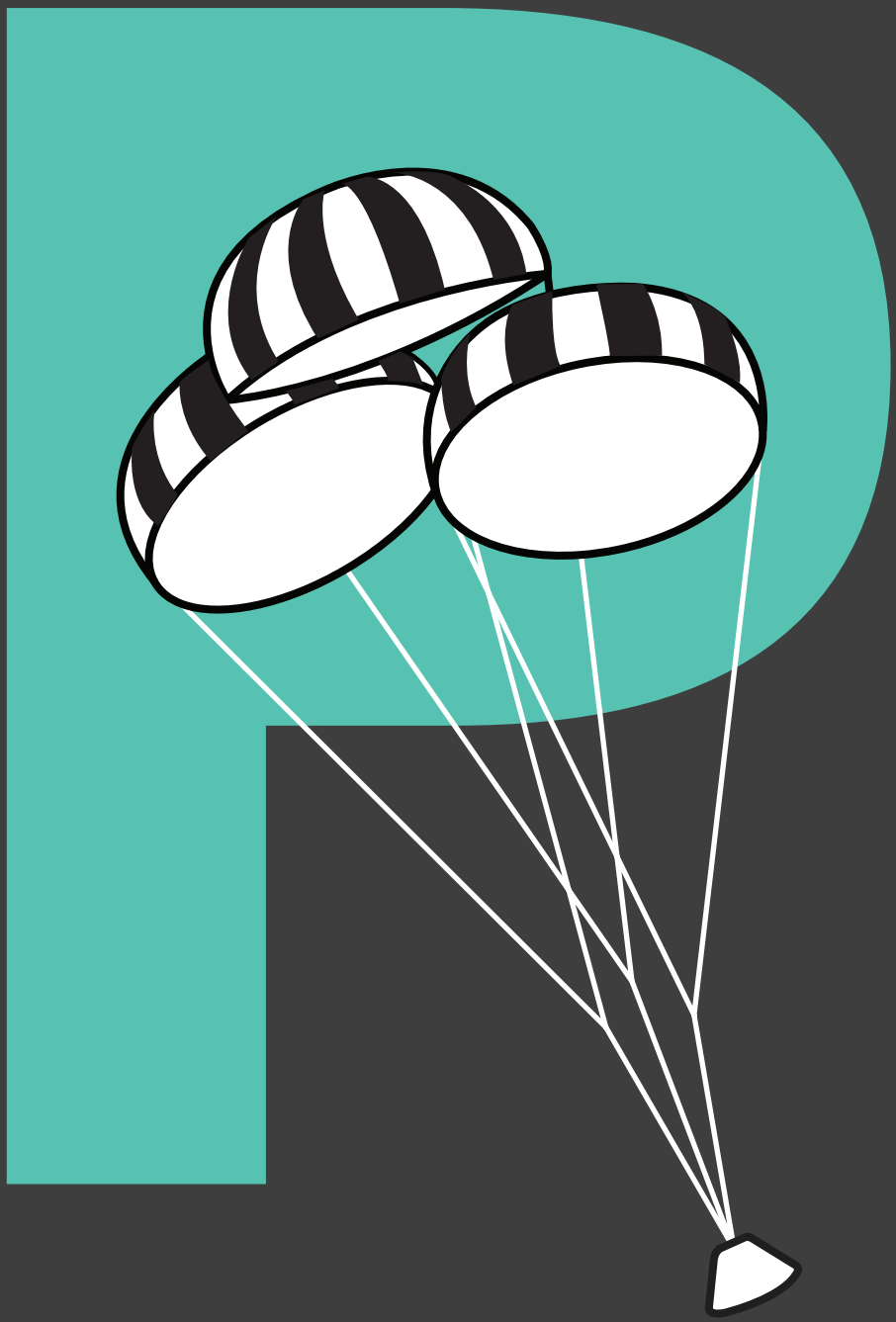
ORION
A to Z



PARACHUTES

Parachutes are used to slow the motion of the capsule through the atmosphere by creating drag.

The Orion spacecraft will use 11 parachutes during re-entry – 3 parachutes to remove a cover which protects the other parachutes during re-entry and 8 parachutes to slow the spacecraft down for a safe landing in the Pacific Ocean. The Orion spacecraft will be travelling at close to 20,000 mph when the heat shield begins to interact with the atmosphere and slow the spacecraft through aerobraking. Once the spacecraft is slowed to about 300 mph at 25,000 ft. altitude, the protective cover is removed using pyrotechnics, thrusters and the first three parachutes. The next two parachutes will then deploy and open. Once the spacecraft slows to around 100 mph, the three main parachutes will then deploy using three pilot parachutes and slow the spacecraft to around 20 mph for splashdown in the Pacific Ocean. When fully deployed, the canopies of three main parachutes for Orion could together cover almost an entire football field.



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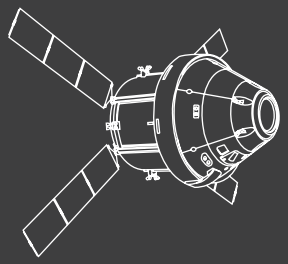
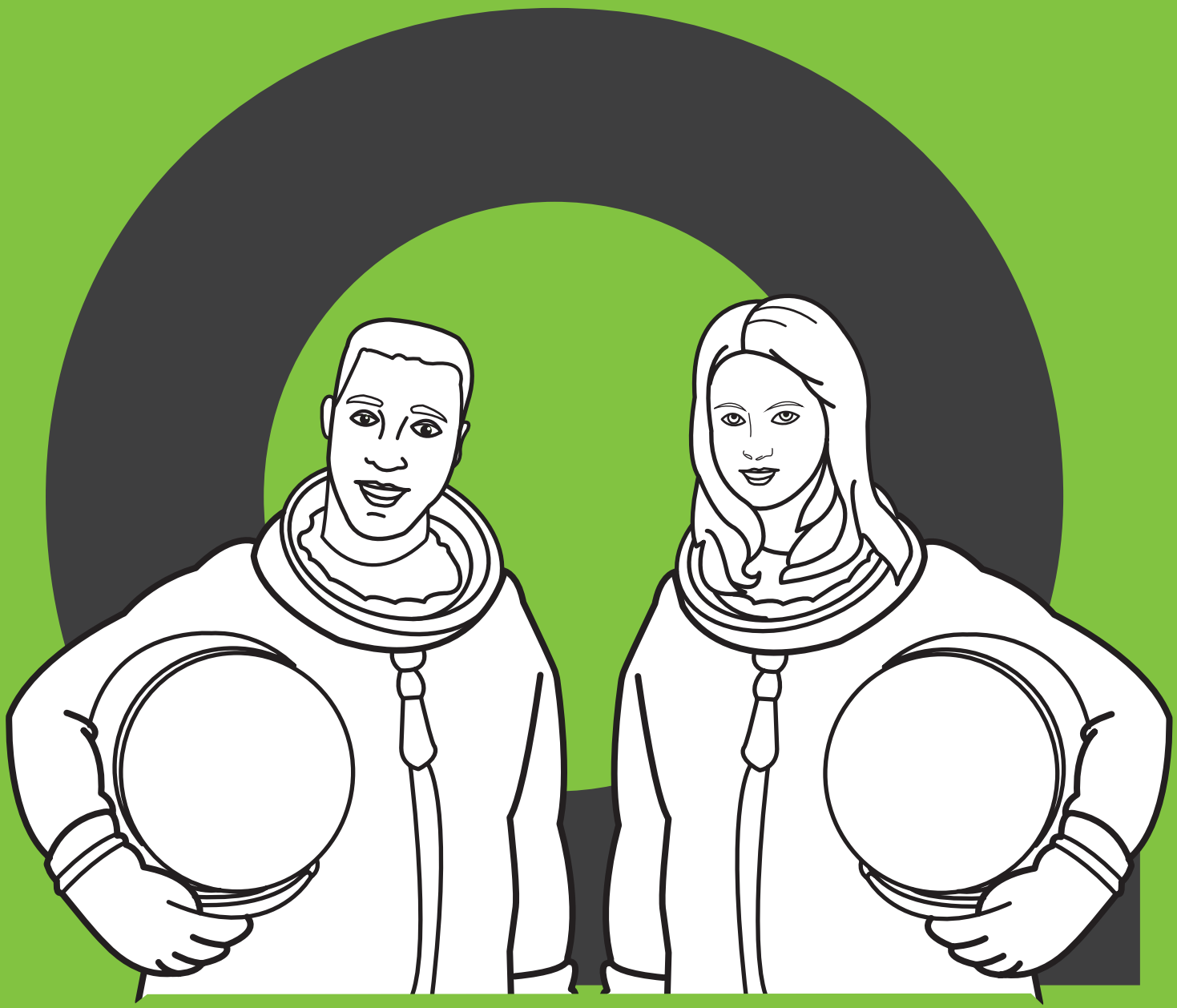
A to Z



QUALITY

At NASA, "Quality" means freedom from deficiencies or errors that require work to be re-done or that result in failures.

The Orion spacecraft must be designed and built with extremely strict quality standards so that it can accomplish its mission within the harsh and dangerous environment of space. When Orion is transporting her most precious cargo – her crew – a failure could be fatal. So, during the design, assembly and testing phase, no shortcuts can be taken.



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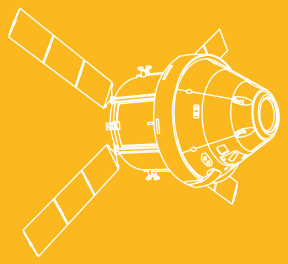
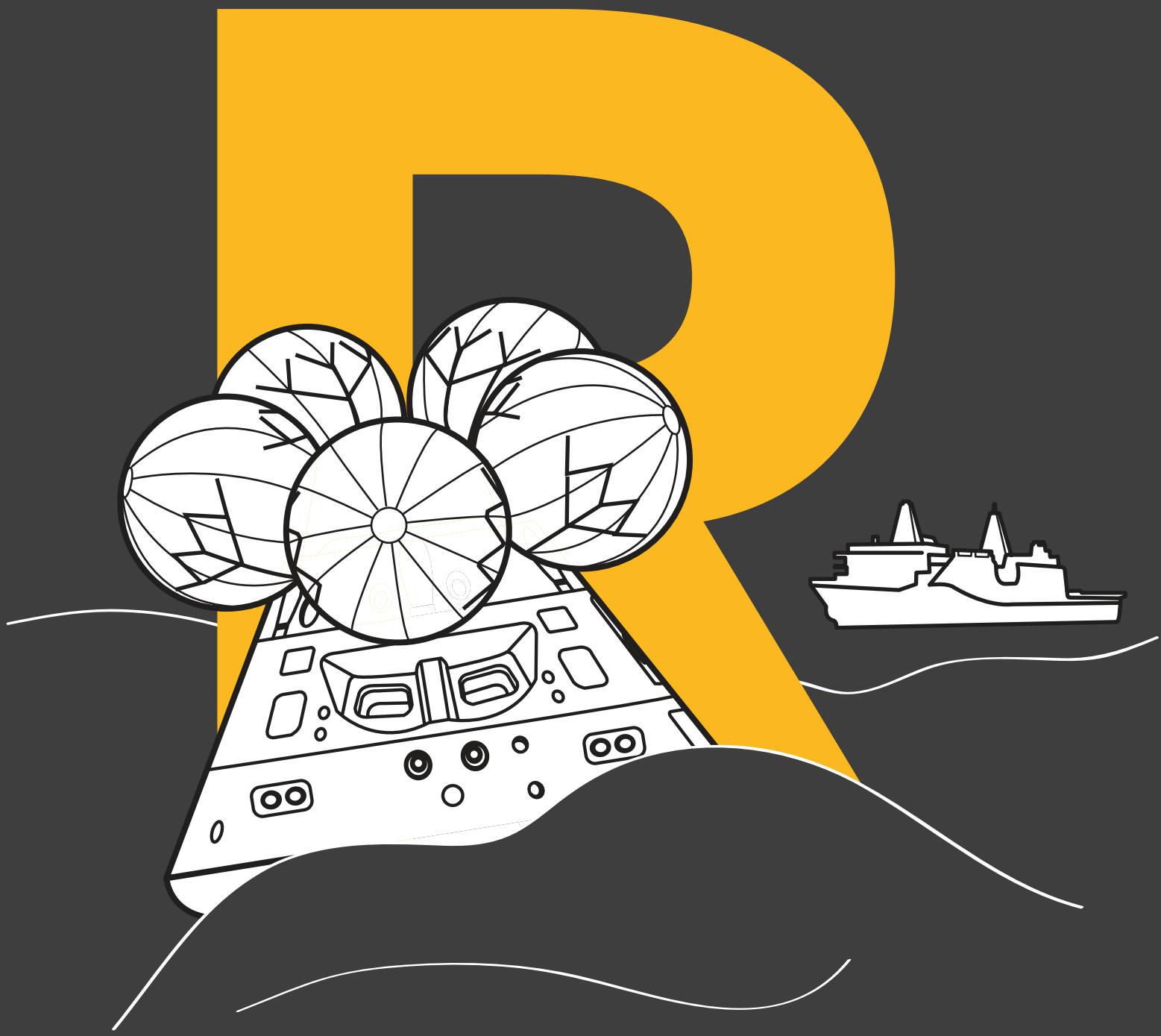
A to Z



RECOVERY

The Orion Spacecraft lands in the ocean and must be retrieved, or recovered, by boats and divers, and brought back to land.

After traveling almost 3,600 miles above the Earth, Orion will re-enter and aim for a specific, 10-mile across target landing area in the Pacific Ocean, off the coast of California. Once the Orion spacecraft splashes down it will be recovered by a Navy well deck ship and returned to land.



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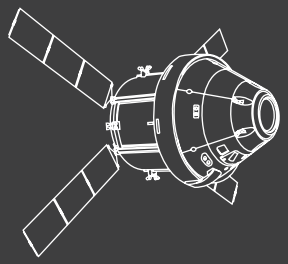
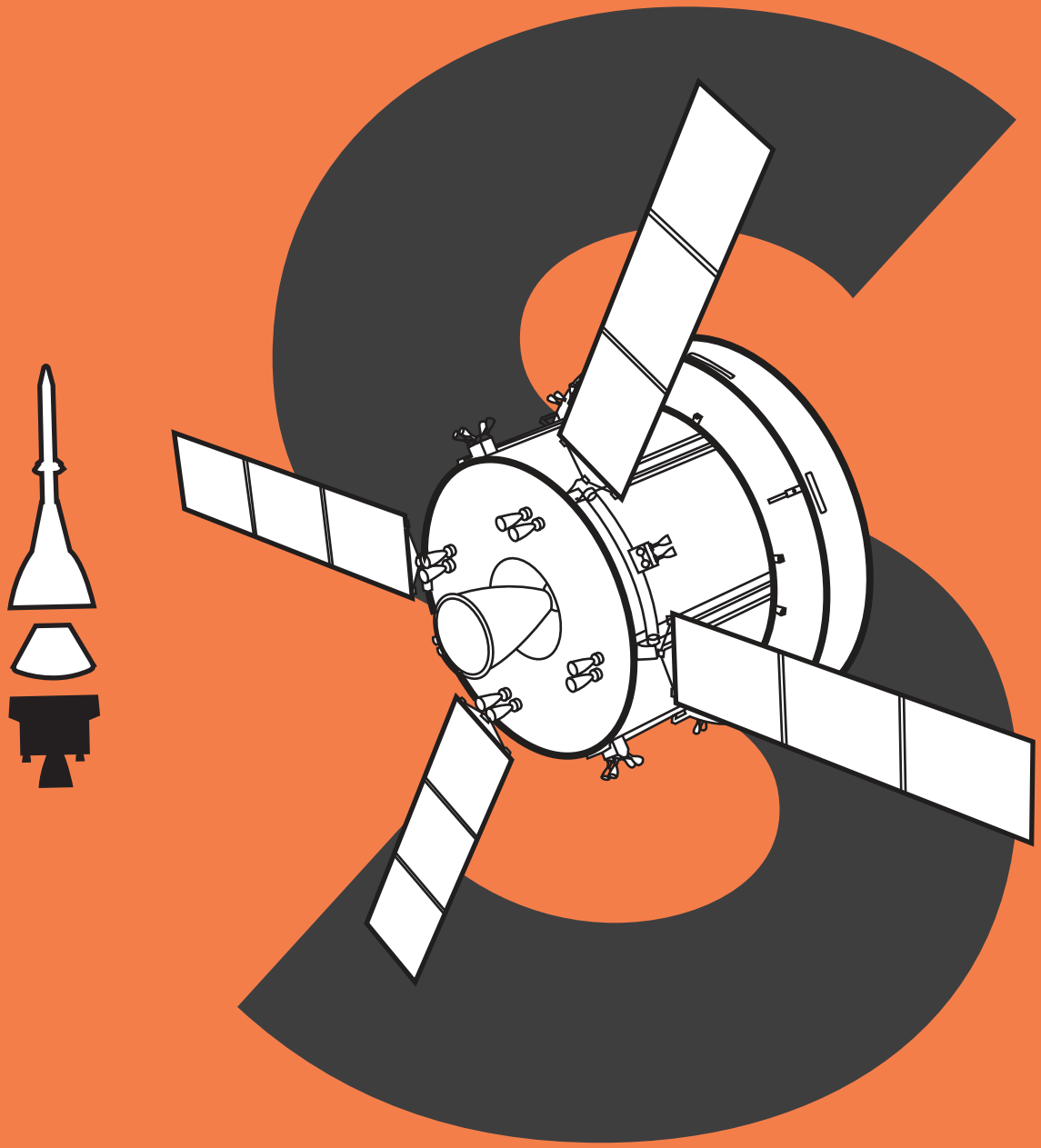
A to Z



SERVICE MODULE

A service module attaches to a crew module and is the powerhouse that fuels and propels the spacecraft, providing electricity via solar panels and batteries. It remains connected to the crew module until just before the capsule returns to the Earth.

Orion's service module for Exploration Mission-1 mission will be provided by the European Space Agency under a partnership agreement. The service module will provide storage for oxygen tanks as well as other important life support system components. The solar arrays attached to the service module collect and transport energy to charge the batteries on the crew module.



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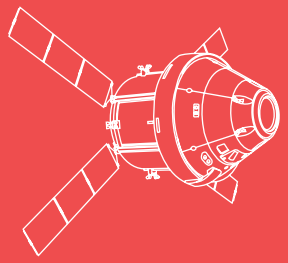
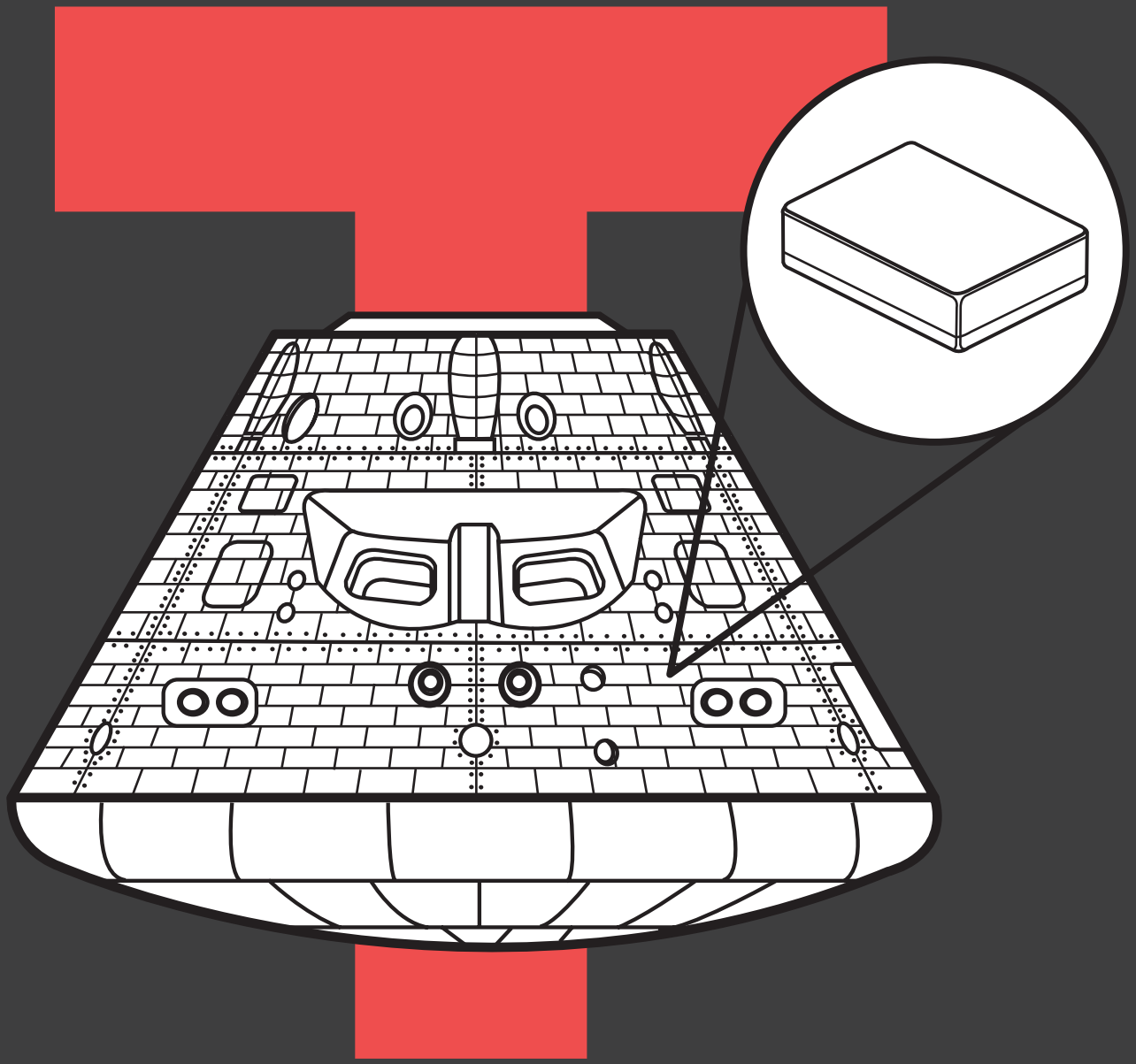
A to Z



TILES

Tiles are insulating blocks placed around the outside of the spacecraft to help protect it from the immense amounts of heat experienced during reentry into Earth's atmosphere.

Orion will have about 1,300 tiles. Unlike the space shuttles, Orion will feature a solid, ablative heat shield below the spacecraft, and thermal protection tiles on the backshell of the spacecraft that are more standard in size and shape, making them easier to manufacture.



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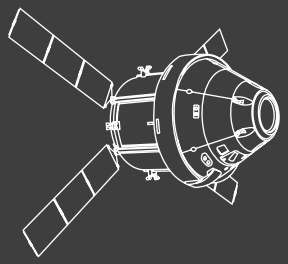
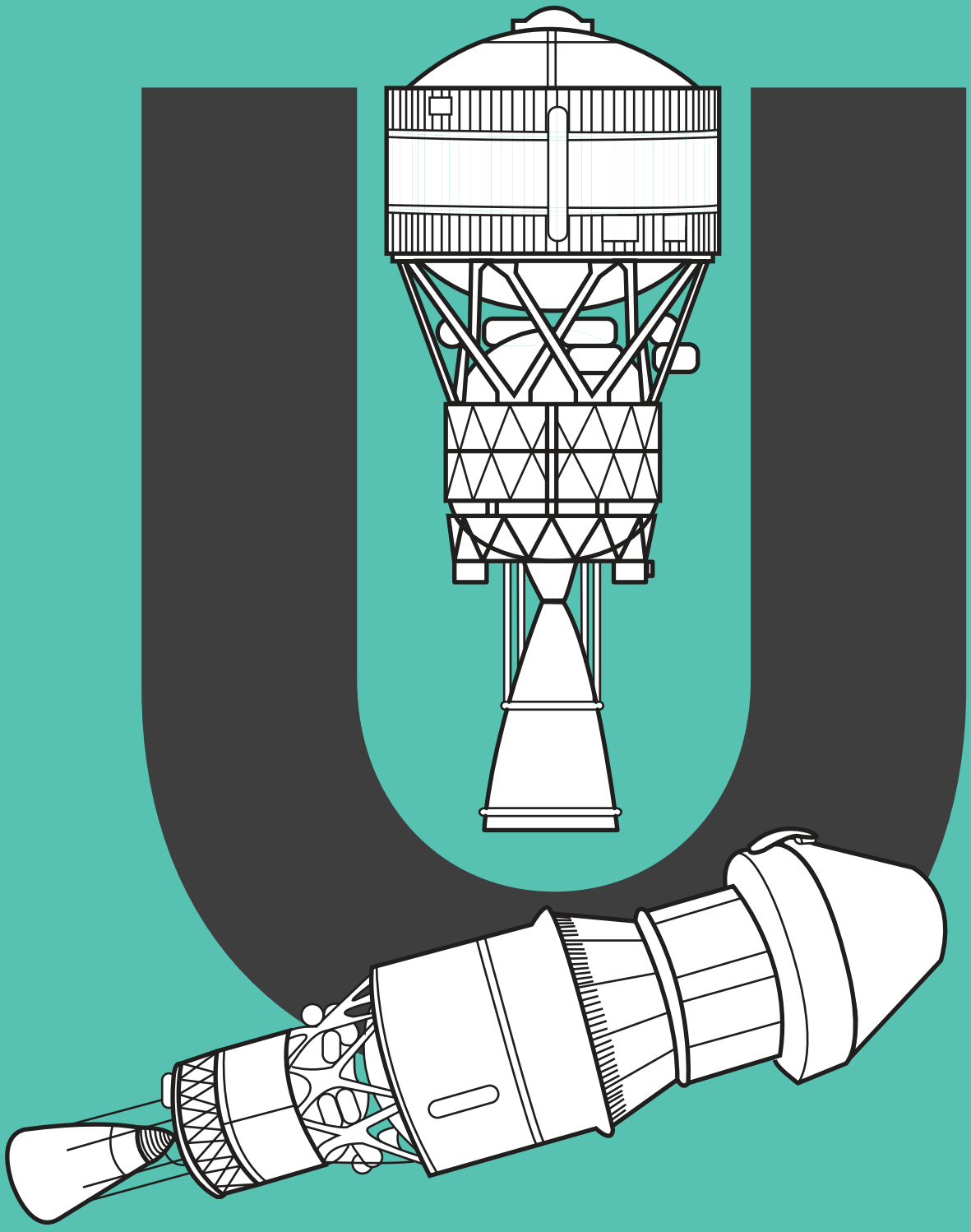
A to Z



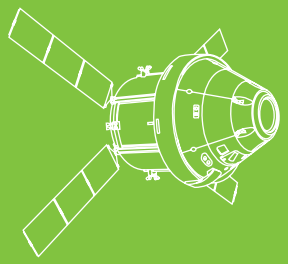
UPPER STAGE

The upper stage is the top segment of a rocket. It usually delivers the final energy, or boost, to help a spacecraft reach its intended orbit.

The upper stage will boost Orion into a highly elliptical orbit during Exploration Flight Test-1. It will also be used to propel Orion to a lunar orbit on Exploration Mission-1.



ORION
A to Z

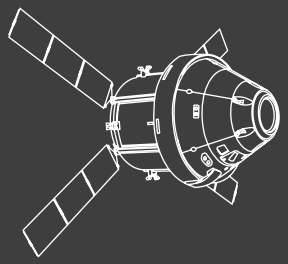


VAN ALLEN RADIATION BELTS

The Van Allen Belts are belts of plasma trapped by the Earth's magnetic field that shield the surface of the Earth from much of the radiation in space.

During Exploration Flight Test-1, Orion will pass within the Van Allen Radiation Belts and will spend more time in the belts than on a typical mission, allowing for extended testing of the radiation-exposed equipment. The spacecraft itself must protect the electronic devices on board from high-radiation environments. Without the protection of the spacecraft, common electronic devices, such as cell phones, would not be able to withstand this high level of radiation encountered in the Van Allen Belts.

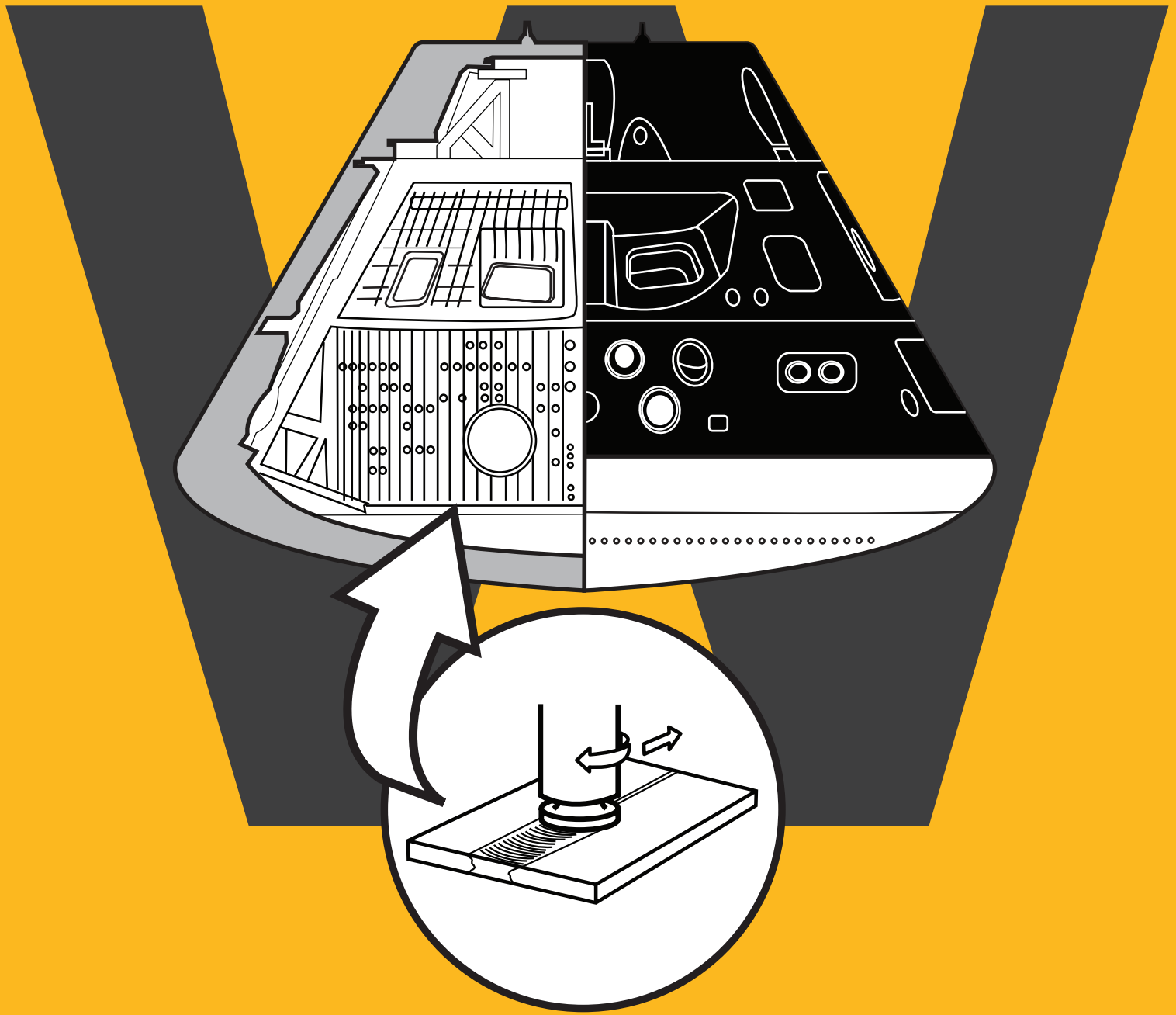
ORION
A to Z



WELDING

Welding is a manufacturing process that joins two separate sections of material together.

There are various welding methods being used to construct the Orion spacecraft, such as friction stir welding, which was used to assemble the crew module pressure vessel, and orbital tube welding, which is used to weld the propellant and life support system lines. Friction stir welding is not the same standard welding that you see on bridges and buildings, but rather looks more like blending the metals.



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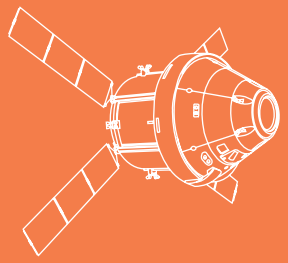
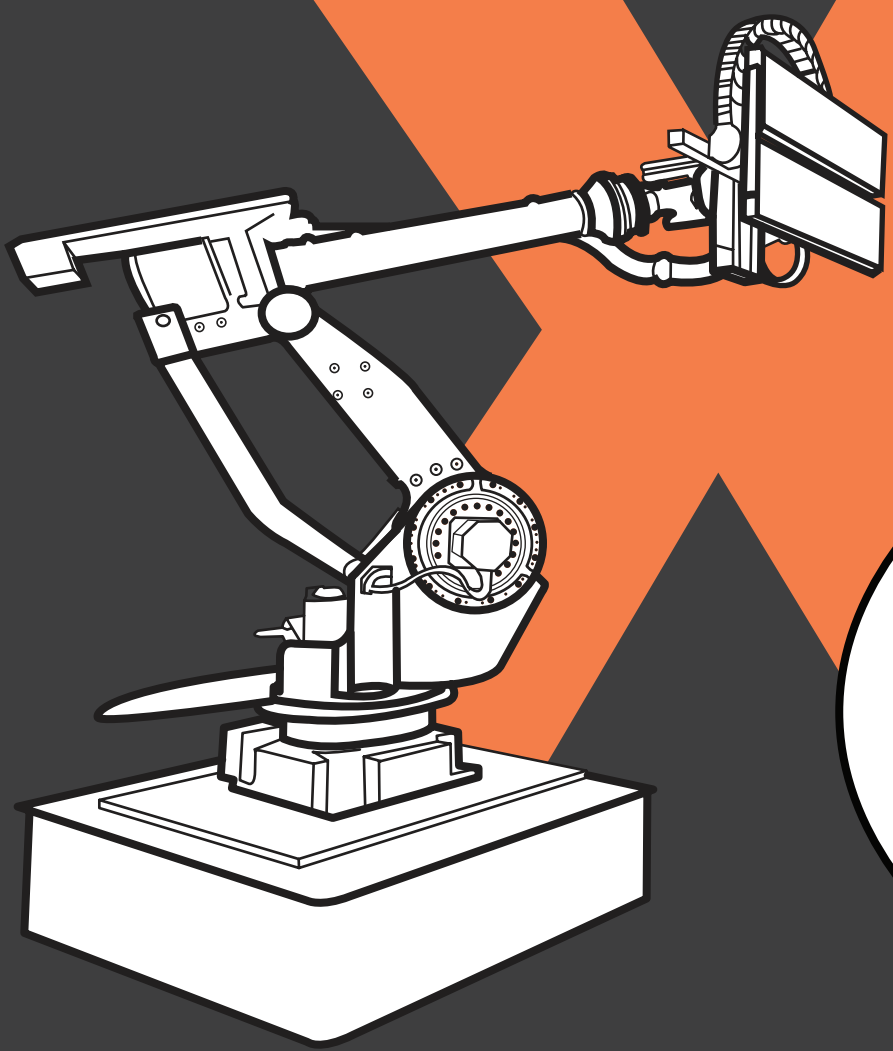


X-RAY TESTING

X-ray machines use a camera that can "see" in the x-ray wavelength, through clothing, flesh, and some metals. This is the same concept that doctors use to check your teeth or look for broken bones.

The Orion engineers use x-ray machines to inspect the spacecraft for imperfections, or cracks, below the surface. Using x-ray machines to inspect a spacecraft is an ideal method, because it does not damage the article being inspected.



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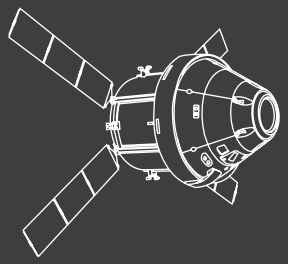
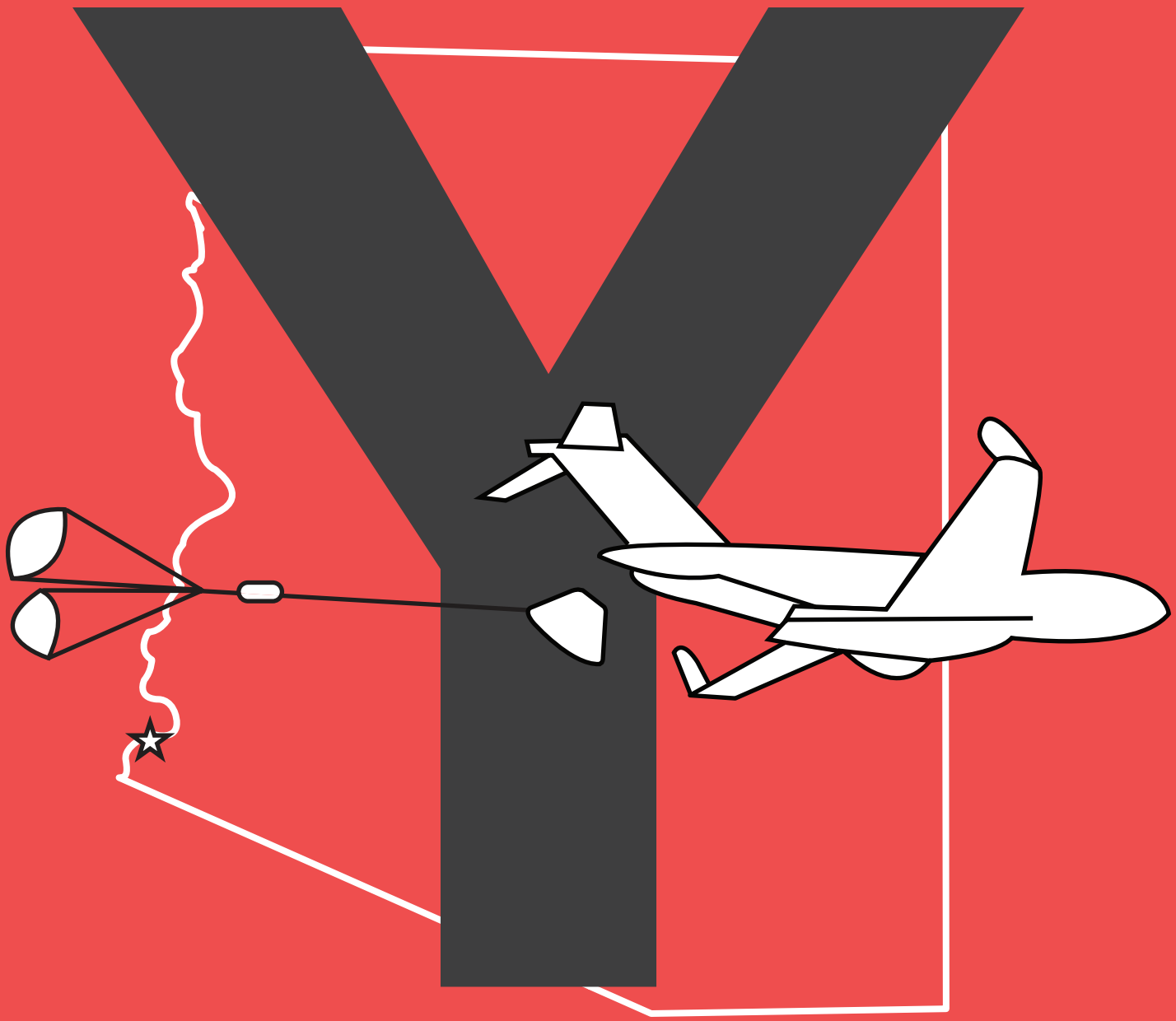


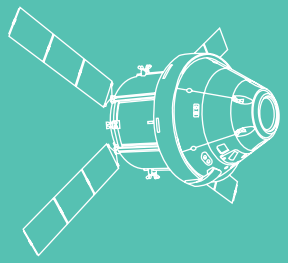
YUMA PROVING GROUNDS

The United States Army Yuma Proving Grounds is a multi-purpose test complex spanning more than 1,300 miles of terrain near Yuma, Arizona. The area has very low rainfall amounts, a high number of sunny days, and dry air that allows the site to be available for testing year-round. General George Patton trained his troops there in 1943!

Orion's parachutes were tested by dropping a mockup of Orion from C-130 and C-17 aircraft to test different parachute failure scenarios in the Yuma Proving Grounds. Prior to Exploration Flight Test-1, approximately 40 drop tests will have been conducted at Yuma to test the system.



ORION
A to Z



ZIF

Zero Insertion Force Connector

A zero insertion force electrical connector uses little or no force for installation in electrical circuits. A lever mechanism is used to secure the connector contacts to the pins of the socket. The advantage of using a connector that requires little force to install, or remove, is that the risk of damaging the circuit boards or bending the pins is minimized.

Zero insertion force electrical connectors are used on Orion in the connection between the crew module and the service module. The connection is severed to de-mate the crew module and the service module prior to reentry.