National Aeronautics and
Space Administration

ORBITAL CRS-3 MISSION TO THE INTERNATIONAL SPACE STATION

Media Press Kit

October 2014

Version 1

OVERVIEW

Orbital Sciences Corporation's third contracted cargo resupply mission with NASA to the International Space Station will deliver almost 5,000 pounds of science and research, crew supplies, vehicle hardware and spacewalk tools to the orbital complex and its crew. The scientific investigations on the Cygnus will challenge and inspire future scientists and explorers, enable the first space-based observations of meteors entering Earth's atmosphere, help determine how blood flows from the brain to the heart in the absence of gravity and investigate the impact of space travel on both the human immune system and an individual's microbiome, the collection of microbes that live in and on the human body. Cygnus will spend more than a month attached to the space station. In December, the space station crew will detach it from the Harmony module before its release. The spacecraft will dispose of approximately 3,000 pounds of trash during its fiery demise upon reentry into Earth's atmosphere. The International Space Station is the cornerstone of NASA and the nation's strategy for human spaceflight and the exploration of space. The operations and research onboard the space station and the agency's work with U.S. companies to deliver cargo to the orbital complex are indispensable parts of NASA's integrated human exploration strategy to sending astronauts farther into the solar system and enabling them to operate with increasing independence of Earth.

CYGNUS CARGO

TOTAL CARGO:	**4883 pounds/2215 kg**
• *Science Investigations*	*1602.8 pounds/727 kg*
o U.S. Investigations	1254.4 pounds/569 kg
o International Partner Investigations	348.3 pounds/158 kg
• *Crew Supplies*	*1649 pounds/748 kg*
o Flight Crew Equipment	273.4 pounds/124 kg
o Food Supply	1360.3 pounds/617 kg
o Flight Procedures Books	15.4 pounds/7 kg
• *Vehicle Hardware*	*1404.3 pounds/637 kg*
o U.S. Hardware	1338.2 pounds/607 kg
o JAXA Hardware	66.1 pounds/30 kg
• *Spacewalk Equipment*	*145.5 pounds/66 kg*
• *Computer Resources*	*81.6 pounds/37 kg*

RESEARCH HIGHLIGHTS

Pea Shoot Growth in Space

One investigation by students from Duchesne Academy of the Sacred Heart in Houston tests the performance of pea shoot growth in space. Pea shoots grow so quickly on Earth that they can be harvested in two to four weeks. They also contain high amounts of vitamins and minerals, making them a potential source of food on long-duration space missions. Students will identify the best combinations of red and blue LED lights, which are used in the plant growth chamber, by analyzing the plants' mineral content upon return to Earth. The investigation is facilitated by NanoRacks and the Center for the Advancement of Science in Space (CASIS).

Yankee Clipper

A group of 18 student-led investigations, collectively part of the Yankee Clipper suite of research under the Student Spaceflight Experiments Program (SSEP), offers young scientists the opportunity to conceive of, design, implement and analyze scientific research questions in space. The studies investigate a range of topics from a crystal growth study that will enable students to learn more about how fluids act and form into crystals in the absence of gravity to how microgravity affect milk spoilage. Yankee Clipper is the eighth flight opportunity associated with the SSEP, an initiative of the National Center for Earth and Space Science Education in partnership with NanoRacks.

Drain Brain

A human health study called Drain Brain will inform understandings of blood flow in space to possibly aid in the treatment of headaches and other neurological systems reported by crew members living on the space station. The special neck collar, called a strain-gauge plethysmograph, used to measure blood flow from the brain for the Drain Brain study, does not require surgery or special knowledge to operate. This could make the collar a useful tool for monitoring patients on Earth who have heart or brain disorders. Drain Brain also could have implications for development of screening mechanisms for cognitive disorders like Alzheimer's disease.

Meteor

The Meteor Composition Determination, or Meteor, uses high-resolution video and image analysis of the atmosphere to learn about the physical and chemical properties of meteoroid dust, which includes size, density and chemical composition. Investigating the elemental composition of meteors adds to our understanding of how the planets developed. Continuous measurement of meteor interactions with Earth's atmosphere also could spot previously unforeseen meteor showers.

Reentry Breakup Recorder-W (REBR)

REBR uses the flight-verified REBR data collection and transmission system to record data during the reentry and breakup of a vehicle from wireless sensors placed throughout the host vehicle, and return the data for analysis to validate reentry hazard prediction models.

Orbital Orb-3 Mission Overview

Under the Commercial Resupply Services (CRS) contract with NASA, Orbital will deliver approximately 20 metric tons of cargo to the International Space Station (ISS) during the course of eight missions. Orbital CRS-3 is the third of these missions and builds on the successful Orbital CRS-2 mission conducted from July 13 to Aug. 17, 2014.

The launch phase of the mission will take about nine-and-a-half minutes from Antares liftoff through separation of Cygnus at its initial orbit. Cygnus will remain in orbit for several days before embarking on a series of thruster burns to maneuver the spacecraft into close proximity to the space station before it is grappled by the station's robotic arm, which NASA crew members Reid Wiseman and Barry Wilmore will be operating. Cygnus will carry 4,883 pounds (2,215 kg) of cargo, which includes crew provisions, research hardware, emergency equipment, spacewalk supplies and packing materials. It is scheduled to remain berthed at the station for approximately one month prior to unberthing and departure from the space station and eventual reentry into Earth's atmosphere.

Mission Highlights

Flight Day 1 (Launch): Antares will launch Cygnus into orbit in a nine and half minute ascent from Pad 0A at Wallops Island. After separation from Antares, Cygnus will deploy its solar arrays and prepare its propulsion system for maneuvers. As Cygnus orbits Earth, it will increase its altitude, moving closer to the space station. The Cygnus team will conduct a series of tests to ensure the spacecraft's readiness for rendezvous and berthing with the space station.

Flight Day 2 to Nov. 1, 2014: Cygnus will continue its ascent toward the orbital laboratory, eventually loitering at the same altitude as the space station, 1,000 to 2,000 kilometers behind it.

Nov. 2, 2014: NASA will provide a "go" for Cygnus to berth with the station. Cygnus will approach to within 39.4 feet (12 meters) and autonomously stop below the space station. Cygnus will be commanded to "free drift" by the astronauts aboard the station, then will be captured by the robotic arm and subsequently attached to the station. This will require extreme precision as both Cygnus and station will be orbiting the Earth every 90 minutes, traveling in formation at approximately 17,500 mph.

Nov. 3 to Dec. 2, 2014: Astronauts will open Cygnus' hatch, unload the payloads and cargo and fill Cygnus with disposal cargo.

Dec. 3, 2014: After it has completed its mission at the space station, Cygnus will be unberthed and depart from the station. The Cygnus will continue flying after departure to evaluate additional spacecraft capabilities for Orbital engineers. After this additional period of autonomous flight, Cygnus will be guided to a safe destructive reentry over the South Pacific Ocean.

Antares Launch Sequence

Mission Parameters

Orbital Attitude: 207 km x 296 km
Inclination: 51.64°

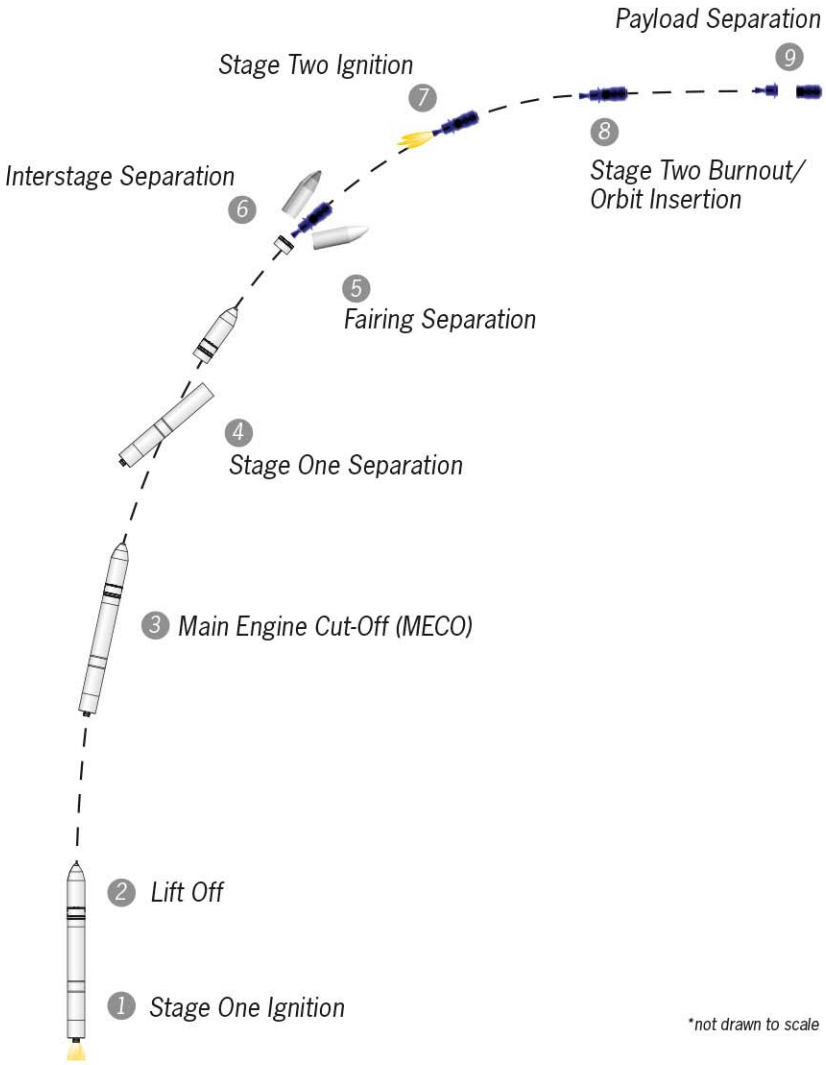
Countdown Highlights

T Minus (HH:MM:SS)	Event
T- 03:50:00	Launch Management Call to Stations
T- 03:05:00	Poll to Initiate Liquid Oxygen Loading System Chilldown
T- 01:30:00	Poll for Readiness to Initiate Propellant Loading
T- 00:15:00	Cygnus switched to Internal Power
T- 00:12:00	Poll for Final Countdown and MES Medium Flow Chilldown
T- 00:11:00	Transporter-Erector-Launcher (TEL) Armed for Rapid Retract
T- 00:05:00	Antares Avionics switched to Internal Power
T- 00:03:00	Auto-Sequence Start (Terminal Count)
T- 00:02:00	Pressurize Propellant Tanks
T- 00:00:00	Main Engine Ignition
T+ 00:00:02	Liftoff of Antares

Note: all times are approximate

Launch Highlights

	Time (Seconds)	Event	Orbit (km)
1	0	Stage One Ignition	0
2	2.2	Lift-off	0
3	234	Main engine Cut-Off (MECO)	100
4	240	Stage One Separation	106
5	269	Fairing Separation	131
6	274	Interstage Separation	135
7	281	Stage Two Ignition	140
8	447	Stage Two Burnout	214
9	567	Payload Separation	214


Payload Separation
9
Stage Two Ignition
7
8
Stage Two Burnout/
Orbit Insertion
Interstage Separation
6
5
Fairing Separation
4
Stage One Separation
3 Main Engine Cut-Off (MECO)
2 Lift Off
1 Stage One Ignition
*not drawn to scale

INTERNATIONAL SPACE STATION OVERVIEW

The International Space Station is an unprecedented achievement in global human endeavors to conceive, plan, build, operate and use a research platform in space.

Almost as soon as the space station was habitable, researchers began using it to study the impact of microgravity and other space effects on several aspects of our daily lives. With approximately 1,500 experiments completed on the station to date, the unique scientific platform continues to enable researchers from all over the world to put their talents to work on innovative experiments that could not be performed anywhere else.

The space station represents the culmination of more than two decades of dedicated effort by a multinational team of agencies spanning Canada, Europe, Japan, Russia and the United States. It provides the first laboratory complex where gravity, a fundamental force on Earth, is virtually eliminated for extended periods. This ability to control the variable of gravity in experiments opens up unimaginable research possibilities. As a research outpost, the station is a test bed for future technologies and a laboratory for new, advanced industrial materials, communications technology, medical research, and more.

In the areas of human health, telemedicine, education and observations from space, the station already has provided numerous benefits to human life on Earth. Vaccine development research, station-generated images that assist with disaster relief and farming, and education programs that inspire future scientists, engineers and space explorers are just some examples of research benefits, which are strengthening economies and enhancing the quality of life on Earth.

Clearly visible with the naked eye in the night sky, the expansive International Space Station is a working laboratory orbiting approximately 260 miles above the Earth traveling at 17,500 miles per hour and is home to an international crew. Assembly in space began in November 1998 with the launch of its first module, Zarya, and was completed with the departure of the Space Shuttle Atlantis on the program's final flight in July 2011. The station is as large as a five-bedroom home with two bathrooms, a gymnasium and a 360-degree bay window, and provides crew members with more than 33,000 cubic feet (935 cubic meters) of habitable volume. The station weighs nearly 1 million pounds (419,600 kilograms) and measures 361 feet (110.03 meters) end to end, which is equivalent to a U.S. football field including the end zones. The station's solar panels exceed the wingspan of a Boeing 777 jetliner and harness enough energy from the sun to provide electrical power to all station components and scientific experiments.

The station's first resident crew, Expedition 1, marked the beginning of a permanent international human presence in space, arriving at the station in a Russian Soyuz capsule in November 2000. For more than 13 years, station crews have provided a continuous human presence in space, with crews averaging six months at a time through the current 41st expedition.

Earlier this year, the Obama Administration approved an extension of the International Space Station until at least 2024. The decision will allow NASA to maximize its potential, deliver critical benefits to our nation and the world and maintain American leadership in space. This extension will give the agency and its private sector partners sufficient time to fully transition low-Earth orbit cargo transportation, research experiments and crew to the commercial space industry so that NASA can continue to focus on developing the next generation heavy-lift rocket and crew capsule necessary for deep space exploration.

Extending the life of the space station another decade will allow NASA to complete necessary technological and human research activities aboard the orbital laboratory that are associated with planned long-duration human missions beyond low-Earth orbit, including a planned human mission to an asteroid in the mid-2020s and to Mars in the 2030s.

With the assembly of the space station at its completion and the support of a full-time crew of six, a new era of utilization for research is beginning. During the space station assembly phase, the potential benefits of space-based research and development were demonstrated, including the advancement of scientific knowledge based on experiments conducted in space, development and testing of new technologies, and derivation of Earth applications from new understanding.

The space station also is a vital precursor for future human exploration, where humans are learning how to combat the psychological and physiological effects of being in space for long periods, conducting both fundamental and applied research, testing technologies and decision-making processes.

The 2005 NASA Authorization Act designated the U.S. segment of the space station as a national laboratory. As the nation's only national laboratory on-orbit, the space station national lab fosters relationships among NASA, other federal entities, and the private sector, and advances science, technology, engineering and mathematics education through utilization of the space station's unique capabilities as a permanent microgravity platform with exposure to the space environment. NASA's research goals for the space station are driven by the NASA Authorization Act of 2010 and are focused on the following four areas: human health and exploration, technology testing for enabling future exploration, research in basic life and physical sciences, and Earth and space science.

The International Space Station Program’s greatest accomplishment is as much a human achievement as it is a technological one—how best to plan, coordinate, and monitor the varied activities of the program’s many organizations. The program brings together international flight crews; multiple launch vehicles; globally distributed launch, operations, training, engineering, and development facilities; communications networks; and the international scientific research community.

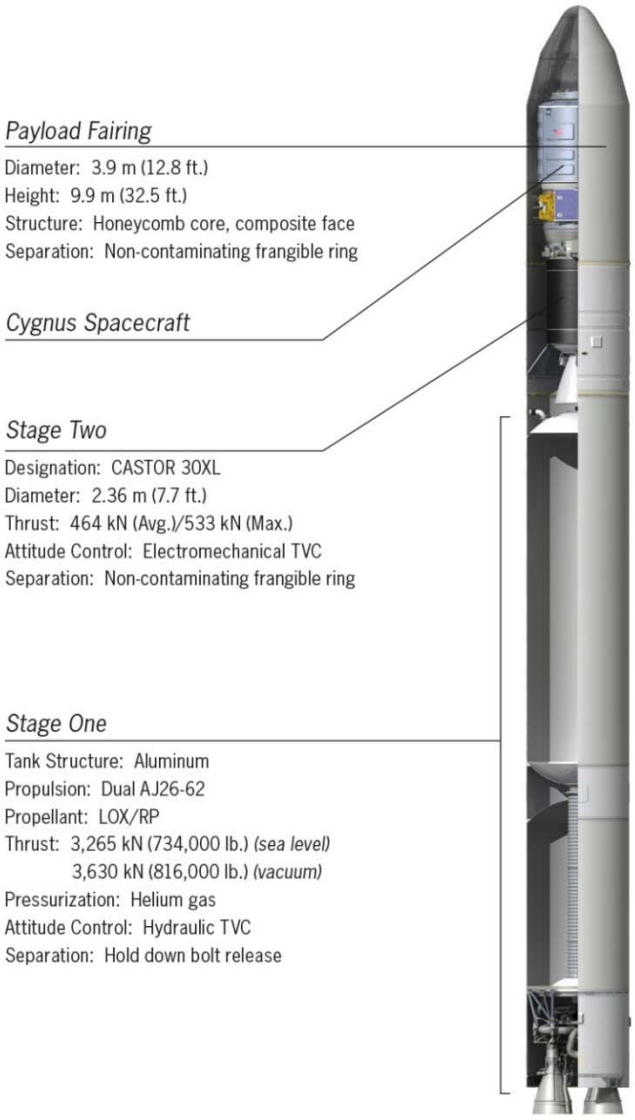
Elements launched from different countries and continents are not mated together until they reach orbit, and some elements that have been launched later in the assembly sequence were not yet built when the first elements were placed in orbit.

Construction, assembly and operation of the International Space Station requires the support of facilities on the Earth managed by all of the international partner agencies and countries involved in the program. These include construction facilities, launch support and processing facilities, mission operations support facilities, research and technology development facilities and communications facilities.

Operating the space station is even more complicated than other space flight endeavors because it is an international program. Each partner has the primary responsibility to manage and run the hardware it provides. The addition of commercial partners as providers of resupply and, in the future, crew transportation services, adds a new dimension to this complexity.

ANTARES

Antares is a two-stage launch vehicle consisting of a liquid-fueled liquid Oxygen/refined kerosene first stage powered by two Aerojet Rocketdyne AJ26 engines. The second stage is an ATK CASTOR 30XL solid motor. Antares employs a 32.5 ft. (9.9 meter) fairing to protect Cygnus from atmospheric heating as it accelerates through Earth's atmosphere.



From its launch site at Wallops Island, Virginia, Antares is capable of supporting mid-inclination and polar orbiting spacecraft weighing up to approximately 13,500 lb. (6123 kg) and 5,500 lb. (2495 kg), respectively.

The Antares program successfully conducted its inaugural test launch on April 21, 2013, and the Orb-D1 demonstration mission on Sept. 18, 2013, both of which were conducted under the Commercial Orbital Transportation System (COTS) agreement with NASA. The first Commercial Resupply Services (CRS) program launch was conducted Jan. 9, 2014, and the second mission was conducted on July 13, 2014. For the CRS program, there are currently five more launches on the Antares manifest after the Orbital CRS-3 mission.

CYGNUS SPACECRAFT

Cygnus is a free-flying spacecraft developed under NASA's Commercial Orbital Transportation program. The spacecraft consists of a Pressurized Cargo Module (PCM) and a Service Module (SM). The PCM carries pressurized cargo and experiments to the space station and pressurized disposal cargo away from the station for destructive reentry at the end of the mission. The SM provides power, propulsion, guidance, computation, and communications for Cygnus.

Pressurized Cargo Module

Developed by Thales Alenia of Turin, Italy, the PCM shares its heritage with numerous space station modules, including the Multipurpose Logistics Module, the Autonomous Transfer Vehicle, and Nodes 2 and 3. The Cargo Module is designed with two configurations. The standard configuration carries up to 4,409 lbs. (2,000 kg) of cargo while the enhanced variant will carry up to 5,952 lbs. (2,700 kg). The Orbital CRS-3 mission will use the standard configuration.

Service Module

Propulsion
Dual-mode N2H4/MON-3 or N2H4, IHI Delta V engine generating 100 pounds of force (thrust), and 32 Rocket Engine Assemblies (REAs) which provide 6 pounds of force (thrust), each.

Power
Two solar array wings on the service module, six panels total, generating 3.5 kilowatts of power.

Communications
Communication between Cygnus and the ISS is provided by the Japan Aerospace Exploration Agency's (JAXA) proximity communications (PROX) system. The space station crew commands Cygnus using the Hardware Control Panel. Cygnus can also communicate on S-band via either the Tracking and Data Relay Satellite System (TDRSS) or ground stations.

Environmental Control System
Astronauts will enter Cygnus to remove cargo. Cygnus provides a habitable cabin with air circulation, fire detection, lighting, pressure and temperature monitoring.

Safety

Cygnus meets NASA's high standards for human-rating to permit rendezvous and berthing to the space station. Cygnus successfully completed NASA's 3 Phase safety certification program, proving that Orbital-engineered designs will ensure safe and successful missions for NASA and its crews. In addition, Cygnus met all 425 requirements necessary to approach and berth with the space station, imposed by the station to Visiting Vehicle Office specifications.

Power Video Grapple Fixture
The Cygnus Service Module includes a Power Video Grapple Fixture (PVGF) developed by MacDonald, Dettwiler and Associates, providing a mechanical and electrical interface between Cygnus and the Space Station Robotic Arm (SSRMS). The PVGF allows Cygnus to obtain 120V power from the SSRMS once captured, reducing the time sensitivity of berthing Cygnus after it is grappled by the robotic arm.

Avionics System
The Avionics System provides a two fault tolerance for all critical computational and commanding systems, ensuring that Cygnus will safely and successfully complete its resupply mission to the space station. Cygnus includes a four computer real time voting architecture that is designed to continually monitor the health of the spacecraft and react to anomalies while still maintaining the stringent safety requirements imposed on Cygnus by NASA.

Guidance and Navigation
Guidance and Navigation systems include specialized sensors and software to provide guidance from Antares separation to the capture location 12 meters below the ISS. The navigation sensors include redundant Space Integrated Global Positioning System/Inertial Navigation System (SIGI) and redundant LIDARs to provide far and near field rendezvous guidance, respectively. SIGI and LIDAR have extensive flight heritage, increasing the chances for mission success. Navigation software includes Orbital proprietary software and software provided from Draper Laboratory, the company responsible for successfully guiding the Apollo capsule to the moon and return, and providing rendezvous software for the space shuttle.

New Systems on Orbital CRS-3 Mission
The Orbital CRS-3 Cygnus spacecraft includes a major updates for this mission. One of the LIDARs will be replaced with TriDAR (Triangulation LIDAR), a model-based laser navigation sensor. While LIDAR relies on retro-reflectors located on the space station for navigation, TriDAR compares its readings with a computer-aided design model of the station to determine Cygnus' relative position and attitude. TriDAR has a proven heritage having flown on three space shuttle missions. Cygnus will employ two TriDAR units for the Orbital CRS-3 mission. Future missions will incorporate two TriDARs and one LIDAR. Cygnus will also employ the same Quasonix radio configuration used on the Orbital CRS-2 mission for telemetry and commanding of the spacecraft. The Quasonix S-band radio will be paired with the heritage Thales-Espanã radio used on previous Cygnus missions.

LAUNCH FACILITIES

Virginia Commercial Space Flight Authority/Mid-Atlantic Regional Spaceport

The Virginia General Assembly created the Virginia Commercial Space Flight Authority (VCSFA) in 1995 to promote the development of the commercial space flight industry, economic development, aerospace research, and science, technology, engineering and math (STEM) education throughout the commonwealth.

In 1997, VCSFA entered into a Reimbursable Space Act Agreement with NASA, which provided for the lease of land at NASA Wallops Island, and applied for and was granted an FAA license to launch to orbit. This led to establishment of the VCSFA Mid-Atlantic Regional Spaceport (MARS), located on the southern portion of Wallops Island. MARS is approved for launch azimuths from 38 to 60 degrees, making it an ideal location from which to launch to the International Space Station. Pad-0B for small-class solid fueled rockets became operational in 1999 and was upgraded with a movable gantry in 2004.

Following the 2008 NASA selection of Orbital to participate in the COTS program and the follow-on CRS contract and subsequent selection of MARS as the launch site, MARS began construction on the all new state-of-the-art Pad 0A.

Since its establishment, 10 successful space launch missions have launched from MARS.

- TacSat-2 (Minotaur I) 2006
- NFIRE (Minotaur I) 2007
- TacSat-3 (Minotaur I) 2009
- ORS-1 (Minotaur I) 2011
- A-ONE (Antares) 2013
- LADEE (Minotaur V) 2013
- Orb-D1 COTS Demonstration (Antares) 2013
- ORS-3 (Minotaur I) 2013
- Orbital CRS-1 (Antares) 2014
- Orbital CRS-2 (Antares) 2014

MARS Pad 0A

MARS Pad 0A is a medium-class launch facility used for Antares missions. The pad consists of:

- Piling-reinforced launch pad
- Ramp
- Liquid fueling facility
- Deluge system for cooling and acoustic suppression
- Launch mount/flame trench
- Hydraulic system for erecting the Antares Transporter/Erector/Launcher
- Environmental control system for payload/launch vehicle
- LO2 subcooler

Gross Lift-off Weight: More than one million pounds (453.6 metric tons); licensed for payloads up to low-Earth orbit: 11,100 lb. (5035 kg).

Pad 0A Specifications

Longitude:	75.49º E
Latitude:	37.83º N
Altitude:	0.03 km
Azimuth:	128.65º

CONTACTS AND ADDITIONAL INFORMATION FOR MEDIA

NASA Public Affairs Contacts

NASA's Johnson Space Center
Dan Huot
281-483-5111
daniel.g.huot@nasa.gov

NASA's Wallops Flight Facility
Keith Koehler
757-824-1579
Keith.a.koehler@nasa.gov

NASA Headquarters
202-358-1100
Rachel Kraft, rachel.h.kraft@nasa.gov
Joshua Buck, jbuck@nasa.gov
Stephanie Schierholz,
stephanie.schierholz@nasa.gov

Orbital Media Contact

Barron Beneski
Vice President, Public and Investor Relations
706-406-5528
Beneski.barron@orbital.com

High Resolution Photos and Video

NASA and Orbital will post pre- and post-launch photos at http://www.nasa.gov/orbital and at http://www.orbital.com and on social media sites. Video highlights of the mission will be posted on NASA's and Orbital's YouTube channel after the launch.

NASA Websites
http://www.nasa.gov
http://www.nasa.gov/orbital
http://www.nasa.gov/station
http://www.nasa.gov/nasatv
http://www.nasa.gov/connect

Orbital Websites
http://www.orbital.com
http://twitter.com/OrbitalSciences
http://youtube.com/OrbitalSci
http://flickr.com/photos/orbitalsciences

Broadcast/Webcast Information

The launch will be broadcast live on NASA Television and webcast at
http://www.nasa.gov/nasatv

Prelaunch coverage will begin approximately one hour prior to launch.