ARTEMIS I

EXPLORATION GROUND SYSTEMS (EGS)

A Case for Small Business

OFFICE OF **SMALL BUSINESS** PROGRAMS
...where small business makes a **BIG** difference

OSBP

NASA completed the design certification review (DCR) for the Space Launch System Program (SLS) rocket ahead of the Artemis I mission to send the Orion spacecraft to the Moon. This close-up view shows the SLS rocket for Artemis I inside High Bay 3 of the Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center in Florida on September 20, 2021. Inside the VAB, the rocket completed the umbilical retract and release test and the integrated modal test. With the completion of the SLS design, NASA has now certified the SLS and Orion spacecraft designs, as well as the new Launch Control Center at Kennedy for the Artemis I mission.

Credits: NASA/Frank Michaux.

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NASA's Space Launch System (SLS) rocket soars to space in this artist concept depicting the Block 1 crew vehicle configuration launching to space. SLS will be the most powerful and capable rocket ever built for deep space missions. The first SLS mission—Artemis I—launched an uncrewed Orion spacecraft to an orbit beyond the Moon and brought it back to Earth to demonstrate the integrated system performance of the SLS rocket and Orion spacecraft's re-entry and landing prior to a crewed flight.

Image credit: NASA/MSFC

OFFICE OF SMALL BUSINESS PROGRAMS

Mission Statement

MISSION STATEMENT

The mission of the NASA Office of Small Business Programs is to promote and integrate small businesses into the industrial base of contractors and subcontractors that support the future of space exploration, scientific discovery, and aeronautics research.

NASA astronaut Nicole Mann gives a thumbs up from inside the Orion mockup, Wednesday, July 10, 2019 at NASA's Johnson Space Center in Houston, Texas.

Photo Credit: (NASA/Bill Ingalls)

The SLS core stage is the tallest and most powerful rocket stage NASA has ever built. It measures approximately 212 feet tall and 27.6 feet in diameter.

The SLS core stage for the Artemis 1 mission was rotated vertical in January for installation into the B-2 test stand at NASA's Stennis Space Center in southern Mississippi. Credit: NASA/SSC

Small Business Making a BIG Difference!

NASA awarded small business Axiom Space a $228.5M contact to deliver spacesuits for the Artemis III mission.

Navy divers from Explosive Ordnance Disposal (EOD) Expeditionary Support Unit 1, practice recovering a mock Orion capsule during Day 2 of Underway Recovery Test 9 (URT-9) aboard the USS John P. Murtha. During the week-long test, NASA's Landing and Recovery team performed their final mission certification ahead of Artemis I.

Credits: NASA/Frank Michaux.

Top: After four months of rigorous testing in the world's premier space environments simulation facility at NASA's Plum Brook Station, the Orion spacecraft for the Artemis I mission is certified and another step toward being ready for flight.

Bottom: The core stage of the Space Launch System (SLS) rocket for NASA's Artemis I mission has been placed on the mobile launcher in between the twin solid rocket boosters inside the Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center.

OVERVIEW OF THE
Artemis I: EGS Mission

The Exploration Ground Systems Program (EGS) is one of three NASA programs based at NASA's Kennedy Space Center in Florida. EGS was established to develop and operate the systems and facilities necessary to process and launch rockets and spacecraft during assembly, transport, and launch. EGS's mission is to transform the Center from a historically government-only launch complex to a spaceport that can handle several different kinds of spacecraft and rockets—both government and commercial.

Unlike previous work focusing on a single kind of launch vehicle, such as the Saturn V or Space Shuttle, EGS is preparing the infrastructure to support several different kinds of spacecraft and rockets that are in development, including NASA's Space Launch System (SLS) rocket and Orion spacecraft for Artemis I. A key aspect of the program's approach to long-term sustainability and affordability is to make processing and launch infrastructure available to commercial and other government customers, thereby distributing the cost among multiple users and reducing the cost of access to space.

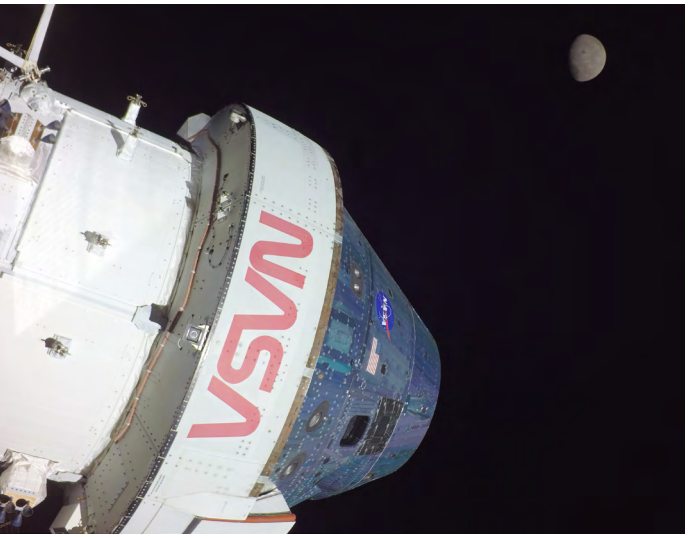
To meet this challenge, EGS is upgrading Launch Pad 39B, the crawler-transporters, the Vehicle Assembly Building (VAB), the Launch Control Center's Young-Crippen Firing Room 1 and mobile launcher (ML), and other facilities.

Returning from the Moon, Orion's round heat shield reached temperatures of nearly 5,000°F when the spacecraft entered Earth's atmosphere!

SMALL BUSINESS CONTRIBUTIONS
to the Artemis Mission

As NASA began to take its next steps toward revisiting the Moon with the Artemis I test mission, we want to take a moment to recognize the incredible efforts made by small businesses that helped get us to this point. Small businesses have permeated every component of Artemis I, covering the Space Launch System (SLS), Orion Capsule, and Exploration Ground Systems (EGS). The goal of landing on another celestial body doesn't come easy, and it cannot be done without the partnership between NASA and American small businesses. Let's take a trip down each component and learn how small businesses have contributed to it.

Building one of the largest rockets in the world requires all hands on deck, and our small businesses have gone above and beyond to make SLS a reality. For example, SLS's core stage will be using a mix of refurbished and newly built RS-25 engines, which are engines that propelled the Space Shuttle. Small businesses have helped with retooling of equipment, manufacturing, and processing to ensure the engines meet a high degree of operability for flight on Artemis I. This also applies to the two solid rocket boosters and abort system thrusters, as small businesses served as important subcontractors on the project.



On November 20, 2022, the fifth day of the 25.5-day Artemis I mission, a camera mounted on the tip of one of Orion's solar array wings captured this footage of the spacecraft and the Moon as Orion continued to fly nearer to our lunar neighbor.

The Orion capsule, which on Artemis I performed a practice flyby of the Moon, is also heavily supported by small businesses. Many aspects of the capsule, from module integration and testing, quality analysis, supply chain planning, project proposal phase, and ground systems data configuration have been successfully completed by many small business contractors and subcontractors. This list could go on for much longer, as these businesses touched virtually all parts of Orion in some way.

To get SLS and Orion off the ground, NASA had to place large investments into facilities and structures to better accommodate an increasing launch cadence and various types of government and commercial launch vehicles. The Exploration and Ground Systems (EGS) program has allowed more infrastructure to be built at NASA's Kennedy Space Center and has opened the door for small businesses to contribute to these systems. Data tracking, communication systems, and even the Mobile Launcher 2 (ML2), the launch platform for SLS Block 1B and Block 2 configurations, have small business written all over it.

It's evident that small business has a far reach at NASA. They can perform just about any task that is presented to them and produce high quality results while doing it. As we look ahead toward future launches of Artemis II and Artemis III, we can be sure small business will remain a cornerstone of progress for America's return to the Moon! Next, we will take a detailed look at some of the businesses that contributed to Artemis I.

Top: NASA's Pegasus Barge arrives at the Launch Complex 39 turn basin wharf at Kennedy Space Center in Florida to make its first delivery to Kennedy in support of the Agency's Artemis missions.

Photo credit: NASA/Mike Downs

Left: A model of NASA's Orion spacecraft glides to a successful touchdown during a test of its parachute system. Orion's three main parachutes, which slow it gradually down for landing, weigh 300 pounds each and can cover almost an entire football field.

NASA's Space Launch System (SLS) rocket with the Orion spacecraft aboard is seen atop the mobile launcher at Launch Pad 39B, Tuesday, August 30, 2022, at NASA's Kennedy Space Center in Florida.

Credits: NASA/Joel Kowsky

The SLS core stage is designed to operate for the roughly eight-minute Artemis I launch and ascent to Earth orbit, reaching speeds of faster than 17,500 mph, or nearly 23 times the speed of sound (Mach 23), and more than 530,000 feet in altitude before it separates from the ICPS, Orion stage adapter, and Orion spacecraft.

ARTEMIS I INDUSTRY PARTNERS

AVATAR TECHNOLOGIES, INC.

Avatar Technologies, Inc. (Avatar), an Economically Disadvantaged Woman-Owned Small Business (EDWOSB) and Small Disadvantaged Business (SDB) headquartered in Greenbelt, Maryland, has continuously supported the NASA Kennedy Space Center's Exploration Ground Systems mission since 2009. Mainly focused on complex systems engineering, program management, technology integration, and software development, Avatar is currently a subcontractor to Jacobs Technology on Test and Operations Support Contract (TOSC). Avatar systems engineers support mechanical and electrical implementation of ground systems capabilities, flight hardware processing, and launch operations for Artemis and commercial crew missions. Moreover, Avatar IT PMs support the Launch Control Center's (LCC) software modification, design, development, integration, debugging and near operational simulation testing, including the recent Artemis I joint countdown simulation.

Prior to joining the TOSC team, Avatar was a subcontractor on both the KSC Exploration Ground Systems (EGS) Program Office (LX) Support Services [KLXS] I and II contracts. Company engineers performed concept of operations development, requirements management, ground systems integration, validation and verification testing, integrated schedule analysis, configuration management, and budget planning for KSC's new and legacy ground systems and facilities. Avatar participated in integrated systems development cycles to prepare the LCC, Vertical Assembly Building (VAB), Multi-Payload Processing Facility (MPPF), Launch Pad 39B, Mobile Launcher (ML) and other critical ground support infrastructure to help realize the Center Director's "multi-user spaceport" vision. For example, the Avatar team helped develop the early end-to-end operational concept for ground systems interfacing with SLS, Orion and commercial customers to develop robust user-based requirements and ultimately share infrastructure and maintenance costs.

CIMARRON SOFTWARE SERVICES, INC.

Working closely with Bechtel NS&E, Cimarron has developed a strong and productive relationship on the Mobile Launcher 2 (ML2) project. Significant contributions have been in the areas of IT (Windchill Development and Administration), Systems Engineering, CREO/Design Engineering, Quality, and Civil Structure engineering. Cimarron personnel provide key inputs to critical sub-systems on ML2 and have led design reviews for the project and NASA customer. Over the past three years Cimarron's scope has doubled, which demonstrates the company's ability to garner skilled support to Bechtel and NASA.

Cimarron's support and contributions in Systems Engineering/Human Factors Engineering has been critical to the success of the design reviews and completion of all subsystems that will support the ML2 and Artemis SLS vehicle for launch. The design engineering team brought expertise in pipe, panel, structures, and cryogenic systems used on NASA spaceflight hardware for successful completion of designs and will prepare ML2 for assembly, testing, and commissioning of the mobile launcher.

Cimarron's significant contribution was gathering requirements and installation of the Windchill PTC system from the start-up of the project and integration with the various project IT systems. Cimarron was chosen for

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this critical position due to its expertise in this area and that the company was the architect of the KDDMS System for NASA at KSC. The Windchill PTC system houses all critical documentation for the design, build, and commissioning of the mobile launcher through projects lifecycle. This system also allows project and NASA personnel quick access for reviews and inquiries quickly and efficiently.

CRAIG TECHNOLOGIES

Craig Technologies engineers and technicians provided Exploration Ground Systems (EGS) support to the following efforts: Hardware and network engineers responsible for Launch Control Center (LCC) rebuild, ground wiring harness fabrication (5K+), design and testing support for 13 umbilical systems, software developers responsible for linking the LCC firing room to the launch pad.

Craig delivered fabricated and build components in support of the Electrical Ground Support Equipment (EGSE), Hazardous Gas Leak Detection System (HGLDS), Orion Service Module Umbilical (OSMU), and Mass Spectrometer Leak Detection System (MSLDS) subsystems.

Craig supported the design and installation of the Vehicle Motion Simulator, Hazardous Gas Detection and Flame Detection Systems, Cryogenic Liquid Flow System, Ground Support Equipment Integration Test Bed, and Fluid Component Water Flow Test System.

Craig provided Ground Coolant System design engineering expertise, including design, acquisition, fabrication, testing, installation, and verification & validation. Tasks include designing Ground Coolant System Ground Support Equipment for the SLS Orion service module.

Craig provided QC Inspectors, configuration management, and environmental and safety support across all programs/projects. This support occurred using both government and company facilities.

Craig Technologies also provided support to Mobil Launcher 1 to include wire harness fabrication, fluid systems design and support (cryogenic and hypergolic), and power/programmable Logic controllers/fluids enclosures (cabinets) design and build

Craig engineers designed the crew access arm on the Mobile Launcher used to access the Orion spacecraft atop the Space Launch System (SLS) rocket.

INSIGHT GLOBAL

Insight Global is an Engineering Services company that provides unique talent solutions through staff augmentation, professional and managed services, direct-hire, and surge support both pre- and post-award. Insight Global began support of the EGS mission in December 2017 when they were brought on to help with a large surge need for NASA. The team had been struggling with design engineering efforts for the launch pad

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and Mobile Launcher supporting the Artemis mission. Insight Global was able to build a "program- specific" solution comprised of the most qualified senior recruiters from around the country to help fill hundreds of open positions for the prime. Insight Global handled all screening, final interviews, and onboarding, which alleviated hours of hiring managers' time. Insight Global's initial surge efforts resulted in successfully onboarding more than 200 resources within a three-month window; hitting every single deadline given by the prime. They provided skillsets such as Build Engineers, Electrical and Mechanical Design, Fluids Design, System Test, Structural Engineers, and more. As a subcontractor, Insight Global worked closely with the prime on a daily basis to truly understand the skillsets, mission, and culture. They were able to understand the program's pain points and be flexible with their solutions-based approach. By March 2018, Insight Global's total surge efforts resulted in onboarding 426 contract employees and 25 direct hire employees. As a result, Insight Global's engineering staff directly contributed to the realignment of the Mobile Launcher and launch pad design schedule and greater Artemis mission lifecycle, leading to future mission success.

PROXOPS, LCC

ProXopS supports multiple functional areas that include the command and control group, configuration management of the ground support equipment, and IT Shared Services.

SUMMIT TECHNOLOGIES & SOLUTIONS, INC.

Summit provides support in troubleshooting electrical and control systems, including Programmable Logic Controllers (PLC's), human machine Interfaces (HMI) Panel View displays, and software development as well as RXLogix 5000 and/or Studio 5000 Logix Designer and Factory Talk View ME/SE. Summit provides logistics support, including analysis of designs for parts needed to perform maintenance; manages assigned systems from a logistics supportability perspective to ensure proper spares are on hand when needed during operations; works with Project Management to ensure on-time delivery of materials in support of projects; and defines requirements for materials to be purchased. In addition, Summit provides IT Programming support with specific duties that include the following: system administration, system architecture development, application development, IT security technical aspects, and IT Specialist functions; assists with writing, reviewing, and modifying computer software; assists with encoding, testing, debugging, and documenting programs; and analyzes designs for parts needed to perform maintenance. Summit provides engineering support to the VAB as well as other subsystems bringing their product to the level required to meet certification for transfer over to operations.

SUPPORTING SMALL BUSINESSES
at a Glance

4D Technology	Tucson, AZ
ACDA InterCorp	Deerfield Beach FL
Acute Technological Services, inc.	Houston, TX
ADNET Systems, inc.	Bethesda, MD
Advocate in Manpower Management, Inc.	Palm City, FL
Aero-Space Tooling and Machining	Salt Lake City, UT
Aerofit, LLC	Fullerton, CA
Agilent Technology, inc.	Santa Clara, CA
Air Mobility Command	Scott Air Force Base, IL
Alliance Spacesystems, LLC	Los Alamitos, CA
Appli-Tec, inc.	Salem, NH
Arconic	Torrance, CA
Arizona State University	Tempe, AZ
ASRC Federal	Beltsville, MD
ASRC Federal Inuteq	Beltsville, MD
ASRC HQ	Barrow, AK
ATA Engineering, inc.	San Diego, CA
BAE Systems, inc.	Manassas, VA
Ball Aerospace	Boulder, CO
Belcan Government Services	Albuquerque, NM
Blue Line Engineering	Colorado Springs, CO
Cobham Semiconductor Solutions	Colorado Springs, CO
Cobham Semiconductor Solutions	Plainview, NY
Coherent, inc.	Richmond, CA
Composite Technology Development, inc.	Lafayette, CO
Conceptual Analytics, LLC	Glenn Dale, MD
Data Device Corporation	Bohemia, NY
Data Device Corporation	Poway, CA
Dow-Key Microwave Corp.	Ventura, CA
DXC Technology	Tysons, VA
Dynavac	Hingham, MA
Ellsworth Adhesive	Germantown, WI
Emerson Electric	St. Louis, MO
EnerSys - ABSL	Longmont, CO
Epner Technology	Brooklyn, NY
General Dynamics	Cullman, AL
Genesis Engineering Solutions, Inc.	Lanham, MD
Geodetics Systems, inc.	Melbourne, FL
Geologics Corporation	Alexandria, VA
Glenair, inc.	Glendale, CA
Global Science & Technology, inc.	Greenbelt, MD
Global Scientific Technology, inc.	Honolulu, HI
Hexcel	Salt Lake City, UT
Hextek Corporation	Tucson, AZ
Honeywell	Phoenix, AZ
Indium Corporation	Utica, NY
ION Corp.	Eden Prairie, MN
Jackson & Tull	Greenbelt, MD
Janis Research Company, LLC	Woburn, MA
Jar Machine & Fabrication	Azusa, CA
Johns Hopkins University	Baltimore, MD
JPW Structural Contracting, Inc.	Syracuse, NY
KBRWyle	Greenbelt, MD
Keithley Instruments, A Tektronix Company	Cleveland, OH
Kepco Inc.	Flushing Queens, NY
L3Harris Technologies	Rochester, NY
LA Gauge Company	Sun Valley, CA
Lake Shore Cryotronics, inc.	Westerville, Ohio
Leonardo S.P.A.	Arlington, VA
Lester R. Summers, Inc.	Ephrata, PA
Linde Gas	La Porte, TX
Lockheed Martin	Palo Alto, CA
Lorr Company	Beltsville, MD
Magna Tool Inc.	Cypress, CA
ManTech Nexolve Corporation	Huntsville, AL
Materion Corporation	Elmore, OH
Materion Corporation Mining Site	Topaz-Spor Mountains, UT
MEI Technologies, inc.	Houston, TX
Micro Instruments Corp	Rochester, NY
Microchip Technology Inc.	Chandler, AZ
Microsemi Corporation	Aliso Viejo, CA
Microtel LLC	Greenbelt, MD
Minco Products, inc.	Minneapolis, MN
Minus K Technology	Inglewood, CA
MOOG INC.	Chatsworth, CA
MOOG INC.	East Aurora, NY
Multek – Sheldahl Brand Material	Northfield, MN
NASA IV & V Facility	Fairmont, WV

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SUPPORTING SMALL BUSINESSES
at a Glance

NASA's AMES Research Center	Mountain View, CA
NASA's Glenn Research Center	Cleveland, OH
NASA's Jet Propulsion Laboratory	Pasadena, CA
NASA's Johnson Space Center	Houston, TX
NASA's Marshall Space Flight Center	Huntsville, AL
National Institute of Standards and Technology	Gaithersburg, MD
National Instrument Corporation	Austin, TX
NEA Electronics, inc.	Moorpark, CA
Nelson Manufacturing Company	Ottawa, OH
NEO Technology Solutions	Chatsworth, CA
Newark Element14	Chicago, IL
Newport Corporation	Irvine, CA
Next Intent	San Luis Obispo, CA
Nightsky Systems, Inc.	Baltimore, MD
Northrop Grumman	Redondo Beach, CA
Northrop Grumman (formerly Orbital ATK)	Commerce, CA
Northrop Grumman (formerly Orbital ATK)	Magna, UT
Nu-Tek Precision Optical Corp	Aberdeen, MD.
Numerical Precision, LLC	Wheeling, IL
Optical Solutions Inc.	Charlestown, NH
Park Aerospace Corp.	Newton, KS
Parsons	Pasadena, CA
Positronic	Springfield, MO
Precise Tool & Manufacturing Inc.	Rochester, NY
Precision Measurements and Instruments Corporation	Corvallis, OR
Progressive Machine & Design	Victor, NY
Quantum Coating, Inc.	Moorestown, NJ
Quartus Engineering Incorporated	San Diego, CA
Quick Turn Circuit	Salt Lake City, UT
Raytheon Company	Aurora, CO
Raytheon Company	Goleta, CA
Science Application International Corporation	Reston, VA
Science Systems and Application, inc.	Lanham, MD
SEAKR Engineering, inc.	Centennial, CO
Select Fabricators, inc.	Canandaigua, NY
Sierra Lobo, inc.	Greenbelt, MD
Sigmadyne	Rochester, NY
Smiths Interconnect Americans, inc.	Costa Mesa, CA
SolAero Technologies Corp.	Albuquerque, NM
Southern Research	Birmingham, AL
Space Dynamics Laboratory	North Logan, UT
Space Science Institute	Boulder, CO
Space Telescope Science Institute	Baltimore, MD
Stinger Ghaffarian Technologies	Greenbelt, MD
Synopsys, inc.	Mountain View, CA
Tavis Corporation	Mariposa, CA
Tayco Engineering, inc.	Cypress, CA
TE Connectivity	Harrisburg, PA
Teledyne Imaging Sensors	Camarillo, CA
Texas A&M University	College Station, TX
The Bechdon Company, inc.	Upper Marlboro, MD
The Boeing Company	Chicago, IL
The Catholic University of America	Washington D.C.
The Hammers Company, Inc.	Greenbelt, MD
The Timken Company	Keene, NH
The University of Alabama in Huntsville	Huntsville, AL
Titanium Brazing, inc.	Columbus, OH
TRAX International Corporation	Greenbelt, MD
TRAX International Corporation	Las Vegas, NV
Triplex Industries, inc.	Rochester, NY
U.S. Naval Research Laboratory	Washington D.C.
Universities Space Research Association (USRA)	Columbia, MD
University of Arizona	Tucson, AZ
University of California, Davis	Davis, CA
University of Hawaii	Hilo, HI
University of Hawaii	Honolulu, HI
University of Idaho	Moscow, ID
University of Maryland	College Park, MD
University of Rochester	Rochester, NY
UTC Aerospace Systems	Albuquerque, NM
Vacco Industries, Inc.	South El Monte, CA
Valcor Engineering Corporation	Springfield, NJ
ValveTech, inc.	Phelps, NY
Viavi Solution Inc.	Santa Rosa, CA
Viewpoint Systems, inc.	Rochester, NY
W. L. Gore & Associates, Ltd.	Newark, DE
White Sands Missile Range	White Sand, NM
ZYGO Corporation	Middlefield, CT

A view of the entrance to low bay of the Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center in Florida, during sunrise on January 19, 2022, with the Artemis banner above the door. Inside the VAB, NASA's Space Launch System and Orion spacecraft underwent final testing in preparation for the Agency's Artemis I flight test.

Credits: NASA/Cory Huston

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