2024-2025

NASA NATIONAL STUDENT CHALLENGE

ARTEMIS ROADS III

WWW.NWESSP.ORG

OFFICIAL ENGLISH MANUAL

OCT 2024

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About NESSP

Funded by NASA's Science Mission Directorate, the Northwest Earth and Space Sciences Pathways (NESSP) brings NASA science to K-12 students throughout the Pacific Northwest. NESSP's (pronounced "NESPy") goals are to strengthen science, technology, engineering, and math (STEM) education region-wide and to serve as a bridge into other NASA experiences for educators and students.

Contact NESSP

NESSP is headquartered at Central Washington University in Ellensburg, Washington.

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Informational videos, tutorials, and recordings of live-streamed events:
www.youtube.com/nwessp

We also want to see NESSP in action! Share videos or photos of your experience on **Facebook and Instagram** (@nwessp).

Disclaimer statement:
"The material contained in this document is based upon work supported by a National Aeronautics and Space Administration (NASA) grant or cooperative agreement. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of NASA."

About the ROADS Challenge

About ROADS

Our ROADS (Rover Observation and Discoveries in Space) program provides a framework for students to explore STEM concepts through hands-on activities. Inspired by real NASA projects, ROADS guides students through space-related missions. Each year, the program is updated to address new science and engineering challenges and to explore different bodies in the solar system.

The ROADS framework includes Educator Professional Development Workshops, an academic year National Student Challenge, a standards-aligned Companion Course, and summer Mini-Missions. Most students and educators choose to participate in the academic year National Student Challenge, which is described in this manual along with the companion course.

About the ROADS National Student Challenge

For the 2024-2025 Artemis ROADS III National Student Challenge, we have developed eight Mission Objectives (MOs) inspired by NASA's Artemis program. Teams will document their progress in a Mission Development Log (MDL) and submit their materials to NESSP for team recognition.

This is an excellent team-based, hands-on project for students, suitable for in-class group work, school robotics, programming, or other club activities, as well as Scout troops and community organizations. For more information about the Artemis ROADS III Challenge, including support for qualified teams and informational videos, visit the Challenge website at nwessp.org/challenge/artemis-roads-iii.

Mission Advisor and Team Information

The **Mission Advisor** is the adult who will guide the team. This person could be a classroom teacher, the advisor for an extracurricular club, a Scout leader, or any responsible adult from the community. It's the Mission Advisor's responsibility to manage all communications between NESSP and the team, including team registration and submitting results. Teams may have up to two Mission Advisors.

A **National Student Challenge Team** is a group of 3 to 6 students in grades 3–12 who will work together to complete the Challenge. Team members must be enrolled in primary or secondary school or be under the age of 18 at the time of registration to participate. Teams with students from multiple grades should complete the MO "Deliverables" of the highest grade level within the team. Mission Advisors can register and mentor more than one team.

Challenge teams are classified into one of three **divisions** based on the age of their oldest team member at the time of registration.*

Division	Maximum Age
Upper Elementary	11 years old
Middle School	14 years old
High School	18 years old

*If needed, teams can be consolidated during the Challenge. NESSP will reclassify the division of the new consolidated team based on the age of the oldest team member. Only team members in middle or high school and over the age of 11 are eligible to attend the Kennedy Space Center trip.

How to Register a Challenge Team

Artemis ROADS III Challenge teams must register to be eligible for supply loans and the team recognition. Mission Advisors must register as a ROADS educator before they can register one or more Challenge team(s). Mission Advisors register at https://nwessp.org/roads-educator-registration/ and the steps are listed below. **The deadline to register is January 25, 2025!**

Steps to registering an Artemis ROADS III Challenge Team:

1. Register as a ROADS educator by providing information about you and your organization.
2. NESSP sends the Artemis ROADS III Standard Agreement to your organization's Authorized Official Representative (AOR).
3. The AOR signs the agreement and provides proof of insurance. Background check status is checked or verified.
4. Log in to your account to register Challenge teams and request supplies before the January 25th, 2025 deadline.
5. Start working on the Challenge with your student team! Log in to submit your team's results.

Questions? Check out our FAQ, watch this short video describing the process, or email info@nwessp.org

Program Evaluation

Mission Advisors will be asked to have students complete a short before-and-after survey by Horizon Research, Inc. Participation in these surveys helps NESSP improve the quality and outcomes of its programs and enables NESSP to continue receiving support from the NASA Science Activation Program. Mission Advisors can also email the evaluators at NESSPeval@horizon-research.com if they have not received a survey request via email or have additional questions.

How to Complete the Challenge

Once a team is registered for the Challenge, they can begin working on the mission objectives in any order. The Mission Advisor should help guide the team and submit the team's results for each stage by the due dates to ensure their work is recognized.

Please note that Checkpoint 1 is required as it collects the student information needed for recognition. Checkpoint 2 is mandatory for teams attending in-person hub events. While the final submission is strongly encouraged for all teams, recognition will be provided regardless of whether the team completes all eight Mission Objectives.

Stage	Submission	Deadline
Checkpoint 1: Select Your Crew	Upload your student crew info, Mission Patch (MO-2), and signed Risk and Release forms to receive a social media shout-out from NESSP, plus stickers, a participation certificate, and a NASA calendar (while supplies last). This submission is required for all Artemis ROADS III teams.	Feb 12th, 2025
Checkpoint 2: Mission Progress Update	Decide if your team will attend an in-person hub event in Washington, Idaho, Montana, Arizona, or Texas. To qualify, submit a preliminary MDL that includes evidence of progress on completing three additional MOs, beyond MO-1 and MO-2.	Mar 10th, 2025
In-person Hub Events	Teams near an in-person hub event can showcase their results for MO-2, MO-6, MO-7, and one additional MO.	April and May 2025
Final Submission: Complete Your Mission	Mission Advisors submit the final MDL. All team members who complete the final submission receive a certificate. Middle and high school teams completing all eight objectives can win a trip to Kennedy Space Center.	May 30th, 2025

All submissions will be uploaded on Misison Advisors's ROADS educator profile page: nwessp.org/roads-educator-account-page/

Schedule

ROADS Challenge School Schedule

Team Registration Opens	Late September, 2024
Information Sessions (various dates)	November-December 2024
Registration Closes	**January 25th, 2025**
Mission Advisor Support Session 1	January 29th, 2025
Checkpoint 1 Deadline	**February 12th, 2025**
Meet a NASA Expert	February 24-28th, 2025
Mission Advisor Support Session 2	March 3rd, 2025
Checkpoint 2 Deadline	**March 10th, 2025**
Meet a NASA Expert	March 24-28th, 2025
In-Person Hub Events (MO-8a)	April and May 2025
Mission Advisor Support Session 3	May 7th, 2025
Final Submission Deadline	**May 30th, 2025**
Kennedy Trip Window	August, 2025

In-Person Hub Events

NESSP is offering an in-person hub event in states with a NESSP partner organization. These events give students the opportunity to present their work to NESSP personnel, university experts, and other Challenge teams. Student teams can complete MO-08 either at a regional in-person hub event (MO-08a) or from home (MO-08b). In either case, teams must submit their MDL virtually by May 30th, 2025. All in-person hub events will take place in April or May 2025. Dates, locations, and times for the in-person hub events will be available in early 2025.

About the Companion Course

ROADS Companion Courses are designed to support each Challenge by providing classroom-ready lessons that are aligned with the Mission Objectives (see the table on the following page). Teams are not obligated to complete any part of the Companion Course, but Mission Advisors may find the lessons valuable for extending or supplementing the Mission Objectives activities.

Educators can learn more about the Artemis ROADS III Companion Course at: https://nwessp.org/course/artemis-iii/

Companion Course Classroom Supply Loans

Educators who have participated in a previous ROADS professional development workshops during the past three years can request classroom-sized supply loans for up to 2 months to help them implement the Companion Course lessons in the classroom.

Educators must register for Companion Course supply loans by November 15, 2024, and can receive the kits between October 1, 2024, and February 28, 2025, based on supply and availability. All Companion Course supplies must be returned to NESSP by their due date, which is 2 months after they are received.

To learn more and to request Companion Course classroom supplies, please visit the ROADS educator registration page https://nwessp.org/roads-educator-registration/.

To learn about future professional development opportunities please follow us on social media (@nwessp) or subscribe to our newsletter from our website (www.nwessp.org) to stay up to date on future opportunities.

Alignment of Companion Course and Challenge

The Artemis ROADS III Companion Course centers around the guiding question: 'How can we use experiments, models, and rehearsals on Earth to prepare our astronauts to live and work on the Moon?'

The Companion Course includes eight lessons divided into three units, each following the '5E' instructional model and aligning with middle and high school Next Generation Science Standards (NGSS).

Alignment of Companion Course Lessons and Challenge Mission Objectives

Companion Course Lesson	Unit	Student Challenge Mission Objective
1	Understanding the Mission	MO-1: Documenting Your Mission
2		MO-2: Building a Strong Project Team
3	Living and Working on the Moon	MO-3: Investigating Water on the Earth and the Moon
4		MO-4: Growing Food on the Moon
5		MO-5: ROV-ing Under the Moon
6	Bringing the Mission Home	MO-6: Designing a Human-Rated Rocket
7		MO-7: Envisioning Your Role
8		MO-8: Reflecting on and Presenting Your Mission

A Summary of the Mission Objectives

MO-1: Documenting Your Mission
How does NASA keep complex, long-term projects organized and recognize everyone's efforts? Through documentation! Team members will learn the Artemis ROADS III Mission Objectives (MOs) and identify their unique skills to complete them. Each student will record their work in a Science & Engineering Notebook (SEN). Teams will then choose the required evidence (photos, diagrams, maps, etc.) for each MO to create a single Mission Development Log (MDL).

MO-2: Building a Strong Project Team
A mission patch is an important symbol of any NASA mission, reflecting the team, the object of study, the spacecraft, the mission goals, or a combination! How will you represent your Artemis ROADS mission and crew with imagery?

MO-3: Investigating Water on the Earth and the Moon
All living things are possible because of Earth's giant "life support system." For this MO, teams will focus on one aspect of Earth's systems: water. They will create a placed-based water cycle model and use the water cycle as inspiration to design and test prototype water purification systems for astronauts on the Moon.

MO-4: Growing Food on the Moon
For short-term missions, NASA sends astronauts to space with all of the food that they will need. As missions get longer, it will become more difficult and costly to send all of the food they will need. In this MO, teams will consider the resources (inputs) that will be required for astronauts to create an agriculture plan and grow their own food (output) on the Moon.

MO-5: ROV-ing Under the Moon
Humans aren't the only ones who will be working on the moon--robotic rovers will be there working alongside human crews. In this MO, teams will design a lunar lava tube explorer that can autonomously navigate a lunar tunnel and take measurements along the way.

MO-6: Designing a Human-Rated Rocket
Rocket science gets real when NASA crews are on board. In this MO, teams will design a rocket and a crew capsule that is safe and reliable enough to deliver their astronauts to the Moon and then safely return them home.

MO-7: Envisioning Your Role
Teamwork makes the dream work, and this is especially true at NASA. While astronauts get a lot of attention, it takes hundreds of other roles all working together to complete a successful NASA Mission. In this MO, each team member will tell us about their dream role at NASA.

MO-8: Reflecting on and Presenting Your Mission
What went great, and what could have been better? Reflect on your work and summarize it in your MDL. While all teams will submit their final MDL electronically, there are two options for completing this MO:

1. **MO-8a: For Teams Attending an In Person In-Person Hub:** IT'S GO TIME! Your team has modeled and tested its mission, and now it's time to launch. Teams who attend an in-person hub event will complete MO-5 and MO-6 and present a tri-fold board on another MO of their choice.
2. **MO-8b: For Teams NOT Attending an In-Person Hub:** Teams who cannot attend a in-person hub event will complete their final mission on their own printed or homemade courses and submit their MDL and short videos of MO-5 and MO-6.

Documenting Your Mission

Summary

When NASA has a lot of people working on a complex project over a long period of time, how do they keep it all organized and honor everyone's efforts? Documentation! All team members will learn about the Artemis ROADS III Mission Objectives (MOs) and identify their individual funds of knowledge that will help them complete these objectives. Throughout the Challenge, each student will document their work in a Science & Engineering Notebook (SEN). Then, students will work in teams to select the evidence (e.g. photos, diagrams, maps, typing, writing) required for each MO to create one Mission Development Log (MDL) for the team.

Materials Needed	Resources from Companion Course Lesson 1:
• Science and Engineering Notebook (any notebook or binder should work) • Digital access to the Mission Development Log (MDL) Template	• Engage Section: An activity to learn about NASA's missions to the Moon by reading the First Woman graphic novel. • Explore Section: A fun Lotería card game in English and Spanish to help teams learn more about NASA's Artemis missions. • Explain Section: A guided activity to introduce the Challenge's MOs and identify the student's relevant funds of knowledge. • Elaborate Section: Guided activities to teach students about the Science & Engineering Notebooks (SEN) and an introduction to the Challenge Mission Development Log (MDL).
	Additional Resources:
	• Artemis ROADS III Schedule Flier • Mission Development Log (MDL) Template • Funds of Knowledge Worksheet • "First Woman" graphic novels: https://www.nasa.gov/calliefirst/

Getting up to Speed

Astronauts have to keep track of everything they do during their training and missions so scientists and engineers can learn from their experiences. They write in mission logs and journals about their daily activities and experiments, take lots of photos and videos, and record their conversations with mission control. They also follow checklists to make sure they do everything correctly and keep detailed records of their health. After the mission, they write reports and talk about what happened so future missions can be even better. How will you keep track of what you did and learned as an Artemis ROADS III Challenge team?

To learn more about NASA's Artemis missions and how scientists, engineers, and astronauts document their work, check out the resources in the Getting up to Speed with Artemis document.

Mission Guidance

For this MO, teams should begin by learning about NASA's Artemis Mission to the Moon. You can do this by browsing NASA's Artemis websites, watching Artemis YouTube videos, reading the First Woman graphic novel series, and even playing a game of Lotería.

Team members should document their work, including what they have learned about NASA's Artemis mission, in their own Science & Engineering Notebook (SEN). The SEN will also be used to keep records of scientific investigations, initial and final engineering designs, successes, and failures—anything the team needs to record as they complete their mission! Documentation and evidence of their work can take many forms. This may include written work (in the language they feel most comfortable using), storytelling (audio and video recordings), art (sketches, paintings, models), diagrams, data tables, and more.

Teams will not submit all of the documentation recorded in their SENs to NESSP. Instead, team members will work together to select the most relevant information from their SENs and tailor it to tell the story of their mission in a team Mission Development Log (MDL). In other words, they will demonstrate how they met the mission objective deliverables. An MDL Google Slides template is provided, along with instructions on modifying the template in multiple formats. Teams can assign a lead to document the team's work for each MO in the MDL. However, all team members should contribute to compiling the MDL and take turns being the lead documentarian.

Local and Cultural Relevance

A fun way to have students learn about the Challenge is through an Artemis-themed game of Lotería, a well-known game from Mexico similar to Bingo. Download the game and learn how to play in the Companion Course Lesson 1 Explore Section.

Students and their families possess a wealth of knowledge, skills, and resources from their homes and cultural activities. We refer to these as 'funds of knowledge.' Team members are strongly encouraged to utilize their funds of knowledge during the Challenge and to document them in their MDL. For assistance in identifying each team member's funds of knowledge, refer to the Elaborate section in the associated Companion Course lesson.

Deliverables

At the end of the Challenge, teams will only send a Mission Development Log (MDL) to NESSP which summarizes what they did for each MO. The end of each MO lists the "Deliverables" that must be included in the MDL. For MO-1, the 'Deliverables' list explains what each team needs to know to start their MDL.

MO-1: What must be in your Mission Development Log (MDL)?

Every MDL must:
• Use the MDL template
• Include title slide/page with:
    ◦ team name (in the team's preferred language),
    ◦ team number (provided by NESSP during registration),
    ◦ team member's names,
• Include a short team member biography and a completed 'Funds of Knowledge' table.
• Describe every division-appropriate deliverables for each mission objective completed
• Be 50 slides or less (including 9 blue MO directions slides, see template for details)
• (optional) A team photo and completed NASA Media Release Forms

Building a Strong Project Team

Summary

A mission patch is an important symbol of any NASA mission, reflecting the team, the object of study, the spacecraft, the mission goals, or a combination! How will you represent your Artemis ROADS mission and crew with imagery?

Materials Needed	Resources from Companion Course Lesson 2:
• Art supplies if creating the mission patch by hand. • OR a computer and art or graphic design software if creating the patch digitally.	• Engage Section: Prompts to help students explore the shapes and images that are significant to them. • Explore Section: Slides and links with examples and explanations of mission patches from NASA and NESSP to inspire students. **Additional Resources:** • Local and Cultural Art Forms to Inspire Your Mission Patch (MO-2)

Getting up to Speed

Since 1965, NASA teams have been working together to design patches for their missions. These patches usually show the mission's name and number, the names of the crew members, and pictures that represent something important about the mission or the team. Creating these patches helps the team feel united and gives them something to remember their mission by forever.

To learn more about NASA mission patches, check out the resources in the Getting up to Speed with Artemis document.

Mission Guidance

Teams are encouraged to get creative and design a mission patch representing themselves, their community, and their mission in the Artemis ROADS III Challenge. The Companion Course has resources that can help teams identify and incorporate images and text that are relevant to both the mission and to themselves and their community. Use the format (drawing, computer graphic, hand-crafted) that works best for you.

Local and Cultural Relevance

Looking for inspiration based on your local culture or traditions? Check out this Padlet of local and traditional art forms!
https://padlet.com/parrar2/inspiringart

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

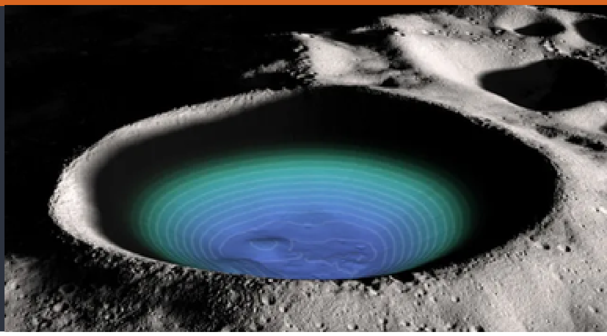
MO-2 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- An image of the patch
  - Please submit a clear photograph of hand-drawn or other hand-crafted mission patch in jpg or png format.
  - Computer-generated mission patches should be no smaller than 500 x 500 pixels.
- At least one paragraph describing the mission patch, addressing the following questions:
  - What is your team's name and why did you choose it?
  - Why did you choose the images and words that you chose?
  - How does the design represent the mission?
  - How does the design represent the team and/or the team's community?

NOTE: Mission patches submitted to NESSP and/or social media cannot include copyrighted materials or likenesses of individuals without their consent. The use of copyrighted images may prevent NESSP from posting the team's mission patch on social media or other material.

Investigating Water on Earth and The Moon



Summary

All living things are possible because of Earth's giant "life support system." For this MO, teams will focus on one aspect of Earth's systems: water. They will create a placed-based water cycle model and use the water cycle as inspiration to design and test prototype water purification systems for astronauts on the Moon.

Materials Needed

- Water!
- Supplies for building water purification devices which could include:
  - cups/beakers
  - plastic wrap
  - salt
  - food coloring
  - potting soil
  - filtration media like coffee filters
  - cotton balls
  - sand etc.

Resources from Companion Course Lesson 3:

- Engage Section: An activity to help teams learn where the water at school, at home, and in their community comes from.
- Explore Section: A game to help students understand the water cycle and experiments that demonstrate portions of the water cycle.
- Explain Section: Examples of place-based water cycle models.
- Elaborate Section: Guidance to support students in creating their water purification prototypes.

Additional Resources:

- Video: Water Experiment Video

Getting up to Speed

When NASA sends people to space, they have to replicate all of the "life support systems" that are present here on Earth, including food, water, air, and temperature control. Making sure that these systems work well all the time is truly a matter of life and death! For example, NASA must find ways for the Artemis astronauts to clean, conserve, and reuse any water collected on the Moon.

To learn more about life support systems on upcoming NASA Missions, check out the resources in the Getting up to Speed with Artemis document.

Mission Guidance

The Earth purifies water for humans every day, but we often don't think about it. In this MO, teams will learn about how the water cycle purifies their water on Earth and use what they learned as inspiration to design a water purification device for astronauts on the Moon.

To learn about the water cycle on Earth, teams will create a visual model of their local water cycle like an annotated map, flow chart, infographic, or any other labeled visual. (See the Explain section of the Companion Course lesson for examples.) Teams must focus on what purifies and recycles water in their area, rather than including every detail of the Earth's water cycle.

Teams should start by deciding the area their model will represent. They will need to find out where their school's or home's drinking water comes from. Next, teams should identify the "reservoirs" in this area that store water, such as lakes, rivers, or groundwater aquifers. They can even include clouds and oceans. Then, teams should learn about the processes in the area's water cycle, both visible and invisible, that move water from one reservoir to another like evaporation, runoff, and groundwater flow.

Finally, teams should consider possible sources of contamination in their area, such as pollution or waste. It's unlikely the water at school or home is unsafe to drink, so teams should also investigate the processes that purify water and remove these contaminants. The team's model should include both the sources of contamination and the purification processes, and where they happen. The model must also include symbols or colors to show where the water is safe to drink and where it might be contaminated.

When they have completed their water cycle model, teams should use what they've learned to design, build, and test a water purification device based on how the water cycle cleans water. Teams can choose the methods and materials to use for their device. They should also determine methods to test and evaluate how well their device works. See the Elaborate section in the associated Companion Course lesson additional support.

Teams should be exploring and learning from the water cycle in their community, including where their drinking water comes from. The Engage section in Companion Course Lesson 3 can help uncover what they know and investigate what they need to find out and the Explain section can help them develop their model.

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge, teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

MO-3 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- A picture or drawing of the team's local water cycle model. Including:
  - An explanation of the area shown and why it was chosen.
  - Represent and label all reservoirs (lakes, rivers, clouds, etc) and water cycle processes (evaporation, runoff, etc.).
  - Represent and label the sources of contamination and purification.
  - Represent and label the source of your drinking water at school or community organization.
  - Symbols or colors that indicate where the water is safe or is not safe to drink.
- A description of their prototype purifying water including:
  - At least 3 photos of the prototype being set-up or tested.
  - A description of the part or parts of the purification device that was inspired by the water cycle on Earth.
  - A description of how the prototype was tested, including what the team observed or measured, and the results. Teams should also estimate the rate that their device can clean water. (How much per minute, hour, or day?)
  - A conclusion statement that describes whether or not the prototype worked. Is the water safe to drink?

Middle and high school team's MDL must include:

- Qualitative data that was used to check how well the team's water purification device worked.

Mission Objective 4

Growing Food on The Moon

Summary

For short-term missions, NASA sends astronauts to space with all of the food that they will need. As missions get longer, it will become more difficult and costly to send all of the food they will need. In this MO, teams will consider the resources (inputs) that will be required for astronauts to create an agriculture plan and grow their own food (output) on the Moon.

Materials Needed	Resources from Companion Course Lesson 4:
• Various materials for plant investigation: • Digital scale • Rulers • Camera • Grow light • Seeds and/or dried beans • Soil • Fertilizer • Cups, baggies, or grow trays	• Engage Section: An activity where students think about why we eat and and slides with locally and culturally important foods of the Pacific Northwest. • Explore Section: Scaffolding tips and a template to help students plan and carry out their own investigations, as well as ideas for locally and culturally important seeds to use. • Elaborate Section: Guidance, examples, and a template to help students describe their agricultural plan. • Extend Section: Activities to help students learn about local crops and food.

Getting up to Speed

Astronauts will need lots of food to stay energized - and alive - while living and working on the Moon. To prepare, scientists at Kennedy Space Center in Florida and astronauts on the International Space Station have been doing many experiments to learn which plants grow best, how to grow plants in zero or low gravity, and how to provide plants with light, energy, and water like they get on Earth. They even get to taste the produce they grow.

To learn more about how NASA is preparing to feed humans on the Moon, check out the resources in the Getting up to Speed with Artemis document.

Mission Guidance

In this MO, teams will use both research and their own experiments to create an evidence-based agricultural plan for growing food for astronauts on the Moon.

First, teams will create and run experiments to see how different factors (like water, time, fertilizer, light, number of seeds, and type of seeds) affect the number of calories they can grow from an edible plant. To do this, teams should design an experiment around a question like, "How does (independent variable) affect the (measurable quantity/dependent variable) of my (type) plant?"

The experiments completed by teams should only change one factor at a time (independent variable) while keeping all other factors the same (controlled variables). They should also carefully record the results. The Explore section of the associated Companion Course lesson has a template that can help students develop their experiment.

Next, teams will use what they learned from their experiments to design an agricultural plan for growing food for four astronauts living on the South Pole of the Moon. The plan should explain how many calories they need to grow to support the astronauts and include details about the time, number of plants, greenhouse size, and the amount of water, soil, fertilizer, or grow lights needed to produce those calories. (See the Elaborate section the Companion Course lesson for examples.)

Teams should support their agricultural plan using the Claims-Evidence-Reasoning model:

CLAIM - Make a specific statement that describes how much of a resource is needed to produce a certain amount food or - even better - calories per day.

EVIDENCE - Describe data from their experiments or other investigations they have learned about to support each of the claims above.

REASONING - Explain why the evidence supports the original claim. This should include a description of:

- **CALCULATIONS**: Any calculations the team made to figure out the calories grown in their experiments and how that would scale in the plan.

- **ASSUMPTIONS**: Any assumptions the team made to scale up their experimental results or how they think what they observed on Earth might be different on the Moon. Of course, teams can't test every variable on the Moon! Team members can use their own knowledge, do research, and make reasonable assumptions to fill in the gaps. But remember, every claim should be supported by evidence and reasoning.

Teams are encouraged to use locally and culturally important seeds in their plant investigations. They can also research and explore crops produced in their area and exported elsewhere or investigate how far the food at their local grocery store traveled. See the Companion Course Engage portion for examples of locally and culturally important foods of the Pacific Northwest, the Explore portion for examples of local seeds, and the Extend portion for activities to help students make local connections to food.

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

MO-4 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- A description of the team's experiment(s) that includes:
  - A drawing or picture of the experiment with the independent, dependent, and controlled variables labeled.
  - Information on the frequency of measurements and when measurements were taken.
  - At least three photographs of their experiment in progress that are dated with a description or caption.
  - The experimental data in table or graphical form.
- A description of the team's agricultural plan that includes :
  - A list of claims that describe the number of calories they need to produce, the time, the number of plants, greenhouse size, and the amount of water, soil, fertilizer, or grow lights needed.
  - Evidence and reasoning to support each of the listed claims, including:
    - A description of any calculations the teams did to scale up the measurements from their experiment.
    - Teams should describe any and all assumptions made when designing their agricultural plan. For example, teams might need to assume that NASA won't be able to grow plants in pure Earth soil.

Middle and high school team's MDL must include:

- Citations for external references used as evidence in your agricultural plan, including at least one reference from the "Getting up to Speed with Artemis" document OR other NASA publications.

ROV-ing Under The Moon

Summary

Humans aren't the only ones who will be working on the Moon--robotic rovers will be there before us and working alongside human crews. How will your rover assist the astronauts? Your team will design a lunar lava tube explorer that can autonomously navigate a lunar lava tube and take measurements along the way.

Materials Needed	Resources from Companion Course Lesson 5:
• Lego SPIKE Robot or Lego Mindstorm Robot • A compatible laptop or computer • Foam board, cardboard, or card stock to make lava tubes • A printed or homemade Artemis ROADS III Challenge Map • (High school and middle school) Printable color blocks or a challenge map with a colored grid	• Engage Section: An introduction to how nature inspires the design of NASA robots. • Explore Section: Slides, activities, and worksheets to learn how to build and program their rover to drive a simple path. • Elaborate Section: Slides and activities on how to use ultrasonic sensor help the robot make decisions. • Extend Section: Slides on color mixing and the RGB scale and the Lego "Line Graph and More Sensors Extension." **Additional Resources:** • Description and options for printing a practice Challenge map • Printable color squares for Challenge map • Video guide: Lego SPIKE Quick Start • Video guide: Using the Lego SPIKE Distance Sensor • Video guide: Plotting RGB color data with the Lego SPIKE

Getting up to Speed

Lava tubes on the Moon and Mars formed billions of years ago when lava moved under the surface and then drained away, leaving empty lava tubes. Lava tubes might be useful for Artemis crews because they may contain resources like water and could provide natural protection from extreme temperatures, radiation, and micrometeorite impacts. NASA is supporting the development of lava tube exploration robots that can roll, walk, hop, and crawl through the challenging lava tube terrain. Many of these robots have features inspired by animals and insects on Earth. Can your team design a lava tube exploration rover inspired by nature?

To learn more about how NASA is preparing to explore lava tubes, caves, and skylights on the Moon, check out the resources in the Getting up to Speed with Artemis document.

Mission Guidance

In this mission, your team will design a rover to help astronauts explore lunar lava tubes. Because we don't know much about the lava tube your rover will explore, it needs to use ultrasonic sensors to find its way through the twists and turns. It will also use a color sensor to figure out the color of the lunar surface. The goal is to collect enough information to help astronauts make a map of the lava tube.

Before you start building your rover, download the software you need and get to know the robot, sensors, and how to program them. If you're new to robotics, you can find useful tips in the Explore section of Companion Course Lesson 5.

This year's Challenge map is a 100 cm x 150 cm course with a 20 cm wide lava tube that your rover needs to navigate all by itself. The rover should use its distance sensors to find walls and open spaces. For example, if it runs into a wall, it should stop and look for an opening to the sides. When it finds an opening, it should turn and go through it. Remember, your rover must be programmed to move and make decisions on its own—no remote control allowed. The lava tube's layout will be a surprise during the final mission (check MO-8 for more details), and your rover should be ready to handle up to eight 90-degree turns as it moves through the tube.

High school and middle school teams should also use the rover's color sensor to measure the color of the surface. Use the "Line Graph and More Sensors" extension for Lego robots to show and plot the red, green, and blue (RGB) light intensities. If your rover can't plot RGB data, you can use audio signals to share the color information.

Since you won't know exactly what the final lava tube will be like, test and improve your rover by creating practice courses with different turns and surface colors. Check the Challenge map for ideas on building your practice tube. Good luck!"

Local and Cultural Relevance

Explore caves near you or in an area you are curious about. How has life adapted to live and move in those caves? Do you think any of these biological feature would be helpful to include in a robot designed to explore the same environments? Explain how your robot was inspired by creatures that sense and move in the darkness! See the Engage portion of the associated Companion Course lesson for more information about how NASA's robot are inspired by nature.

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

Heads up! This MO is part of the team's final mission! If your team plans to attend a NESSP in-person hub event (MO-8a), your rover will navigate a lunar tunnel at the event as described in MO-8a. If your team does NOT plan to attend a NESSP in-person hub event, you will submit a video of your rover in action (maximum of 5 minutes) as described in MO-8b.

MO-5 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- At least one example of how nature (sensing capabilities or the body of insects or animals) has inspired the design of a NASA rover or a robot of the students own imagination or creation.
- A picture or drawing of the rover, labeling important components like the motors and sensors that allow the rover to correctly navigate the lava tube.
- Pictures of the teams practice lava tubes, corners, or map; that allowed them to correctly navigate their tube.
- An image of the team's Word Block or Python code or a flow chart diagram describing the logic of the code.
- A summary of the challenges the team faced and how the team overcame them.

High school and middle school MLD's must also include:

- A graph of the RGB color intensity measured by the rover as it navigated a lava tube.
- A map of the surface color of the lava tube constructed based on the RGB color intensity graph or data. Teams can use the Lava Tube Color Detection Worksheet to draw a map of their tunnel.

Designing a Human-Rated Rocket

Summary

Rocket science gets real when NASA crews are on board. In this MO, teams will design a rocket and a crew capsule that is safe and reliable enough to deliver their astronauts to the Moon and then safely return them home.

Materials Needed	Resources from Companion Course Lesson 6:
Building Materials: • Empty and clean 2-liter soda or water bottles • Pringles chips • Variety of additional craft and construction materials such as: duct or packing tape, glue, cardboard or balsa wood, popsicle sticks, plastic bags, tissue paper, string scissors and/or box cutters, rulers Launching Materials: • Bicycle pump with pressure gauge • Grease or lubricant • Aquapod Launchers (or similar) • Estes Altitude Trackers	• Engage Section: An activity to introduce how NASA prepares SLS for human flight and the test dummy Commander Moonikin Campos • Explore Section: Slides and hands-on activities to teach concepts related to rocket stability • Explain and Elaborate Sections: Guidance and worksheets to help students use the Engineering Design Process to construct and test their rocket and capsule • Extend Section: An additional crew exploration vehicle activity and a guide on how to simulate their rocket's flight. **Additional Resources:** • Video guide: NESSP AquaPod Rocket Tutorial

Getting up to Speed

The Artemis mission's Space Launch Systems Rocket (SLS) is the most powerful rocket in the world and NASA's only human-rated rocket, meaning it can safely take astronauts to the Moon and back. To achieve a human rating the SLS and the Orion Crew Capsule had to pass strict tests to ensure they can provide a safe and habitable environment for its human crew. Is your team ready to take on the challenge of building a safe and reliable rocket and capsule?

To learn more about how NASA designs and test rockets and crew capsules for human space flight, check out the resources in the Getting up to Speed with Artemis document.

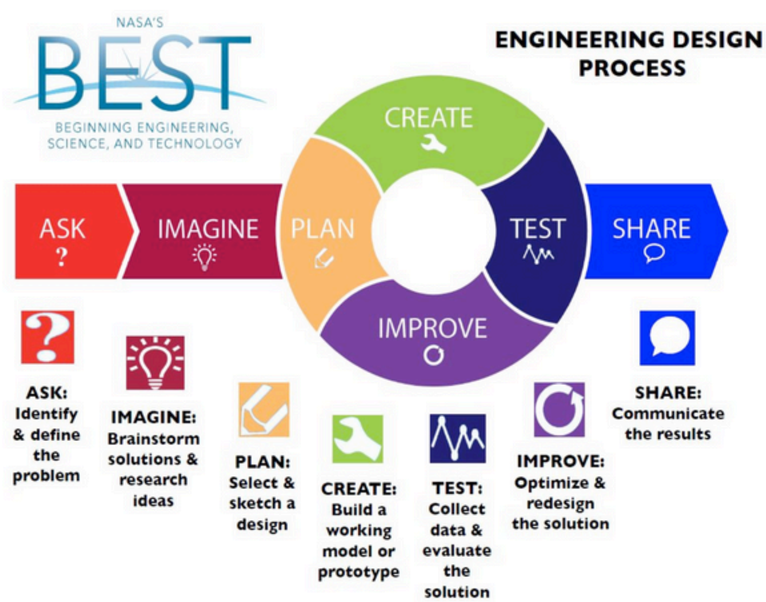
Mission Guidance

In this MO, teams will design a water bottle rocket that can launch a test dummy chip-stronaut (Pringles chip) at least 50 feet into the air and bring them back safely to Earth. Teams should start by designing, building, and testing their rocket, trying different designs for the rocket's body length, width, nose cone, and fins to make sure it flies smoothly. Teams should also choose strong materials and build their rocket in a way that allows it to be flown multiple times without damage.

Next, teams will design a crew exploration vehicle that fits inside the nose cone of their rocket and is big enough to hold a test dummy 'chip-stronaut' (a Pringles chip). The capsule must have a hatch that can be easily opened so ground crews can insert and remove the chip-stronauts and take clear photos of it before and after the flight. The capsule can stay in the rocket during the flight or be ejected and land with a parachute - it's up to you!

Teams must follow the Engineering Design Process when designing their rocket and crew exploration vehicle.

The goal is to build a rocket and crew exploration vehicle that can be launched more than 50 feet in the air three times in a row without damaging the rocket or the chip-stronaut.



Local and Cultural Relevance

Teams should learn about the inspiration behind the name of the famous Artemis I test dummy by watching "Arturo Campos: The Man Behind the Artemis Moonikin" or reading "The Adventures of Commander Moonikin Campos and Friends" and name their astronaut test dummy after someone who motivates them.

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

Heads up! This MO is part of the team's final mission! If your team plans to attend a NESSP in-person hub event (MO-8a), you will launch your rocket at the event as described in MO-8a. If your team does NOT plan to attend a NESSP in-person hub event, you will submit a video of your rocket launching (maximum of 5 minutes) as described in MO-8b.

MO-6 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- A profile of their chip-stronaut, including a picture or drawing, a name, and a description of the motivational figure it is named after.
- A summary of the Engineering Design Process taken by the team including:
  - A clear statement of the problem.
  - Labeled drawings or images of at least two initial designs of the rocket and the crew capsule.
  - Results of at least two tests of the rocket and crew exploration vehicle, including:
    - before and after images of the rocket body and crew.
    - a written description of what happened to the rocket and crew exploration vehicle.
    - a quantitative description of the size and number of pieces of chip-stronaut.
    - how the team decided to improve the rocket after each test.
- An image and quantitative description of the final rocket and crew exploration vehicle design, including the height, width, and mass.
- A description whether the final design achieved the goal of being launched above 50 feet three times in a row without damaging the rocket or the chip-stronauts.
- A statement describing what the team would do to continue testing and improving their rocket and crew capsule design if they had more time.

Envisioning Your Role

Summary

Teamwork makes the dream work, and this is especially true at NASA. While astronauts get a lot of attention, it takes hundreds of other roles all working together to complete a successful NASA Mission. In this MO, each team member will tell us about their dream role at NASA.

Materials Needed	Resources from Companion Course Lesson 7:
Access to a computer If making graphic novels: • Art supplies (or graphic software) • Templates (optional) If doing a video interview: • Video recording devices	• Engage: An activity where students match NASA roles to the Artemis ROADS III Mission Objectives • Explain: Resources and templates to help students understand how to write a graphic novel • Elaborate: Resources to help students identify and map community needs to their envisioned careers • Extend: A video planning worksheet **Additional Resources:** • Career Catalog

Mission Description

Have you ever wondered what it's like to work for NASA? In this mission, your team will explore different careers related to the Artemis ROADS III Mission Objectives, imagining yourself in one of these roles in the future.

Start by exploring career options using the Career Catalog from Lesson 7 of the Companion Course. You can also use other resources to learn about more NASA careers. Each team member should pick one career that matches their interests and values—one they'd like to explore further.

For the chosen career, investigate:

- What the daily tasks are like.
- The type of education needed.
- Other skills or knowledge you could bring from your community, family, hobbies, or interests.
- Salary and benefits, such as whether people in this job get to travel to interesting places.

Once you understand the role, imagine yourself in that career in the future. Think about:

- Where you went to school.
- How old you were when you got the job.
- Where you live and work now.
- What missions or projects you've worked on at NASA.

After envisioning your future role, your team can work together or individually to tell your story. You can do this through a graphic novel, a role-play video interview, or both. Use resources from Lesson 7, like templates and planning worksheets, to help create your story and understand how to build a plot with a dramatic arc (see novel & interview requirements).

Students should come up with examples of how their community could benefit from the career skills of their future role. For example, in a video interview a future engineer might have the following be part of their story, “As a communications engineer, I learned how NASA uses antennas to connect and communicate with satellites. I used these skills to set up a dish network, providing faster and more reliable internet at my community’s public library.” You can see more examples in the Elaborate section of the Lesson 7 in the Companion Course.

Deliverables

As they work, teams should keep track of their results in their Science and Engineering Notebooks (SEN). At the end of the Challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see MO-1 for guidelines on the format and length of the MDL.

MO-7 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- Either graphic novel pages or video interviews (see the details below) to describe each team member's future role at NASA. The team should decide together whether to make a graphic novel or video interviews.
- If the team chooses to create a graphic novel, they can either write one story that includes all the career roles, or each team member can create their own separate graphic novel.
- Each team member must include at least one example of how they were able to help their community using the skills they gained in their future role. Alternatively, they can describe how they employed a skill learned from their community in their future career.

Graphic Novel Page

Create part of a graphic novel that shows "future you" working at your dream job at NASA. If you decide to do this as a team, show how the various roles you choose will work together.

Be sure to include:

- Job title(s)
- The characters using their job skills to identify and/or solve a problem for NASA

Inspiration: "First Woman" graphic novels https://www.nasa.gov/calliefirst/

Length requirements:

- Individual team member novels: 1 page
- Combined team novels: Minimum 1 page, maximum 3 pages

Video Interview

Pretend that you are working in your dream NASA career. Record a video where someone interviews you about your job at NASA.

Be sure to include:

- Job title
- What a typical day looks like and what skills they use
- Steps they took to get a job a NASA

Inspiration:

- Career Highlight: Planetary Scientist
- Meet Martha | NIRCam Instrument Scientist Behind NASA's James Webb Space Telescope
- NASA Test Pilot: Day in the Life

Length requirements:

- Individual team member interviews: 2:30 minutes max
- Combined teams interviews: 5 minutes max

Reflecting on and Presenting Your Mission

Summary

What went great, and what could have been better? Reflect on your work and summarize it in your MDL. While all teams will submit their final MDL electronically, there are two options for completing this MO: **MO-8a is for teams that attend an in-person hub event** and MO-8b is for teams that cannot attend.

Materials Needed	Resources from Companion Course Lesson 8:
• Team's rover from MO-5 • The team's rocket and crew exploration vehicle from MO-6 • Electronic access to MDL • Tri-fold board and supplies for teams attending in-person hub events	• Engage, Explore, and Elaborate Sections: Guidance to help team members reflect on their work and summarize the MOs in the team's MDL. • Evaluate: Guidance to help students evaluate their own work and the work of their peers with a Mission Review Rubric. **Additional Resources:** • Description and options for producing a practice Challenge map • Printable color squares for Challenge map • Mission Development Log (MDL) Template

Mission Guidance

IT'S GO TIME! Your team has modeled and tested its mission, and now it's time to launch. Teams who attend an in-person hub event will complete MO-5 and MO-6 on the Final Challenge Course and present a tri-fold board on another MO of their choice.

In-person hub events will be held across the Northwest and beyond. Find dates and details on the Challenge website. Teams should complete MO-2, MO-5, MO-6, and at least one other MO (MO-3, MO-4, or MO-7) before attending, so they are prepared to complete the following activities.

Mission Objective In-Person Hub (MO-2/MO-7, MO-3, or MO-4)

The in-person hub gives each team the opportunity to highlight an area of the challenge where they did well. Teams should prepare a tri-fold (maximum size 36” by 48”) to present on one or more of the MOs:

- MO-2 (Building a Strong Project Team) and MO-7 (Envisioning Your Role)
- MO-3 (Investigating Water on Earth and the Moon
- MO-4 (Growing Food on the Moon)

Regardless of which option your team chooses, the tri-fold board should contain:

- The team name, team members’ names, and mission patch
- The number and title of the MO or MOs featured on the board
- Include text, photos, drawings, data, artifacts (like plants or prototypes), and other information to summarize the team's work. Use the MO Deliverables as a guide for the board's content.

During the in-person hub event, teams will present their tri-fold boards to NESSP Reviewers and other teams. All team members should be prepared to answer questions about the MO or MOs on their board.

Demonstration of ROV-ing Under the Moon (MO-5)

Teams will demonstrate that their rover can navigate the lava tube course on the Artemis ROADS III Challenge Map. Teams won’t know what turns will await their rover, so it must be able to autonomously sense walls and corners with an ultrasonic sensor. High school and middle school teams should also be prepared to make measurements of the color of the surface of the course an use the graphical data provided by their rover to reconstruct the tunnel on a Lava Tube Surface Navigation Color Detection Worksheet.

Demonstration of Designing a Human-Rated Rocket (MO-6)

Teams will launch their most successful water bottle rocket and crew exploration vehicle. The rocket will be evaluated based on the following criteria:

- Its ability to reach the target altitude (50 ft).
- Whether it has a smooth stable flight.
- Whether it was reliable enough to be launched multiple times.
- The damage to the crew exploration vehicle and twist-tie crew.
- If it had a creative design.

Surprise Teamwork Challenge

Artemis astronauts need to collaborate, develop new strategies, and master new skills for their Moon missions. In-person hub events will include surprise challenges to test each teams teamwork and engineering abilities.

Deliverables

This is your final MO! It's time to wrap up your mission by summarizing your work on all Mission Objectives into a complete and final Mission Development Log (MDL) that will be submitted to NESSP. Remember, the MDL must address the "Deliverables" in each MO. Teams are not required to complete every MO, but only teams that satisfactorily addressed every Deliverable in every MO will be eligible to win the trip to a NASA center (only middle school and high school teams are eligible). Good work and good luck!

What must be in your Mission Development Log (MDL)?

The MDL must:

- Have a title slide with team name, team number, team members's names, and the mission patch
- Include a completed Table of Contents slide
- Include the deliverables for each Mission Objective that the team completed
- Be 50 slides or less (including 9 green Mission Objective direction slides, see Template in MO-1)
- Include a completed copy of the "Mission Review Rubric" in the MDL template
- Be submitted electronically by May 30th, 2025

Reflecting on and Presenting Your Mission

Summary

What went great, and what could have been better? Reflect on your work and summarize it in your MDL. While all teams will submit their final MDL electronically, there are two options for completing this MO: MO-8a is for teams that attend an in-person hub event and **MO-8b is for teams that cannot attend.**

Materials Needed

- Team's rover from MO-5
- The team's rocket and crew exploration vehicle from MO-6
- Electronic access to MDL
- Tri-fold board and supplies for teams attending in-person hub events

Resources from Companion Course Lesson 8:

- Engage, Explore, and Elaborate Sections: Guidance to help team members reflect on their work and summarize the MOs in the team's MDL.
- Evaluate: Guidance to help students evaluate their own work and the work of their peers with a Mission Review Rubric.

Additional Resources:

- Description and options for producing a practice Challenge map
- Printable color squares for Challenge map
- Mission Development Log (MDL) Template

Mission Guidance

IT'S GO TIME! Your team has modeled and tested its mission, and now it's time to launch. Teams not attending an in-person hub event will demonstrate their “final mission” by including two videos to highlight MO-5 (ROV-ing) and MO-6 (Rockets) at the same time they submit their final Mission Development Log (MDL) electronically.

Video Demonstration of ROV-ing Under the Moon (MO-5)
Teams must record a video that shows that their rover can autonomously navigate a lava tube course that is the same as or similar to the Artemis ROADS III Challenge Map. Team Mission Advisors should configure this course for the teams in advance. Next students should align their robot at the start of the course and hit START! Teams can get as many tries as they need to navigate the lava tube, just make sure to edit the video to show us your best stuff. Videos must be 5 minutes in length or less.
Video Demonstration of Designing a Human-Rated Rocket (MO-6)
Teams must record a video that shows that their rocket and crew exploration video can be successfully and reliably launched above 50 ft 3 times in a row without significant damage to the twist-tie dummy crew. The video should show the condition of the rocket and the crew before and after each launch, in addition to the launch. Please edit the video so it is 5 minutes or less.
(Optional) Explore ways to showcase additional MOs in your region
Teams can explore other options for showcasing their work in this Challenge in their region. For example, if there are several Challenge teams in your area, teams can work together to create your own mini in-person hub event. Reach out to info@nwessp.org for support! Teams can also showcase your project at a local science or engineering fair. Explore the list below to find one near you: ◦ Top 10 Science Fairs for High School ◦ ISEF Science Fairs ◦ Science Fair Directory ◦ National American Indian Science & Engineering Fair Teams can also present their work at a family STEM night, Parent/Teacher Conferences, or other school gatherings. They can even share their Challenge work with younger students at school.

Deliverables

This is your final MO! It's time to wrap up your mission by summarizing your work on all Mission Objectives into a complete and final Mission Development Log (MDL) that will be submitted to NESSP. Remember, the MDL must address the "Deliverables" in each MO. Teams are not required to complete every MO, but only teams that satisfactorily addressed every Deliverable in every MO will be eligible to win the trip to a NASA center. Good work and good luck!

What must be in your Mission Development Log (MDL)?
The MDL must: • Have a title slide with team name, team number, team members's names, and the mission patch • Include a completed Table of Contents slide • Include the deliverables for each Mission Objective that the team completed • Be 50 slides or less (including 9 green Mission Objective direction slides, see Template in MO-1) • Include a completed copy of the "Mission Review Rubric" in the MDL template. • Be submitted electronically by May 30th, 2025 Teams must also upload or provide a link to their MO-5 and MO-6 videos at the same time they submit their final MDL. The uploaded videos must: • Be two files or a links to YouTube videos (one for each MO) • Be less than 5 minutes long each • Only show the faces of students who have complete the NASA Media Release Form (see MDL template)

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