

2027 CDR Requirements/Testing

Design and Prototype

Multi-purpose Packing Box:

1. Close to 18cm x 10.4cm x 15.3cm box
2. Hold a plastic bag with 1kg of water
3. Drop test on flat side from a height of 50cm
4. Drop test on corner from a height of 50cm
5. Using CAD drawings of your box, show other structures that can be made with the box parts

Food Bite Dispenser:

1. Cannot attach to visor of helmet
2. Dispenses 5 to 7 rectangular or spherical or other shaped pellets around the size of 2.5cm x 2cm x 1.5cm
3. Must be accessible to astronauts' mouth, but not interfere with vision or communications
4. Food bite must not break apart, crumble.
5. Only release into astronauts' mouth.

Pneumatic tool on Mars:

1. Tool with rotating motor – Drive 4"x1/2" class 2A thread bolt into Nyloc nut mounted on a stand. Count rotations in 20 seconds.
2. Tool with reciprocating cutter with 18 teeth/inch blade – Cut a 2"x2"x1/8" piece of aluminum angle. Measure how deep you can cut in 20 sec.

Nose Scratcher:

1. Cannot attach to visor of helmet
2. Must be accessible to entire face and forehead
3. Cannot interfere with vision or communications
4. Cannot scratch the visor or allow the dust on the visor to scratch it.

Lunar Habitat Shoes:

1. Describe the flooring material you recommend. Must be integrated into inflatable dome material.
2. Place your shoe on the appropriate flooring sample.
3. Install a shoe spreader that has a heel.
4. Place 1 kg of weight on the ankle of the shoe spreader.
5. Use some kind of force measuring tool (spring scale, digital scale,...) to measure horizontal force of friction while shoe is being pulled across the flooring material.
6. How much force does it take to start the shoe moving? Static friction.
7. How much force does it take to pull the shoe once it is moving? Kinetic friction.
8. Provide subjective data on how shoe is put on (zipper, Velcro, laces), appearance, temperature regulation, comfort

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HUNCH Washing Machine:

1. Use a maximum of 1L of room temperature water (about 71F). Water only, no soap or detergent
2. Use a polo shirt soiled with--sweat and salt crystals, 2 small smudges (¼” dots) of siracha sauce and 2 small smudges of mustard
3. Able to contain the water in a zero-g environment
 - a. Team must be able to explain water behavior in zero-g—page 10
4. Returns a shirt that is damp—not dripping wet
5. If you have controls - Can be hooked up to a laptop for diagnosis if there is a problem
6. Can be hand cranked if you don't have strong enough motors for your prototype. Must be able to show how the team will integrate a motor and controls.
7. Is able to fit inside a box the size of an ISS Single Locker (similar dimensions)

Lunar Ag Science and Food Lab:

1. Design and build a scaled model of an agriculture grow lab for the moon that will begin as an experiment growth lab with some food production but will eventually become solely for food production.
2. Depict in your model at least 3 different types of plants that could be grown in this growth lab and how it would be done.
3. The plants should be grown in at least 2 or 3 styles, such as; In ground planting, hydroponics, aeroponics, hydroculture.
4. Grow at least one type of plant using the plant growth style(s) your team plans to depict in the model. Be prepared to explain why you chose this plant.
5. The growth area on the moon will be 20ft diameter spherical dome with a 2ft cylindrical base. This allows for a 12ft high apex of the dome. Use the volume efficiently.
6. Your model cannot be larger than 2 feet by 2 feet. It must demonstrate; Watering and recycling systems, lighting systems, air circulation, storage for experiment equipment and tools for plant growth, worktable/area, ability to change and reconfigure as the facility proceeds from experimentation to food production. **Your model does not need to be fully functional, but you must have accurate blueprints/schematics, that include all requirements.** (not all parts need to be 3D printed but should be nicely made)
7. Describe the amount of power needed for growing the plants as well as needs for the crew that are working in the facility; i.e. lighting, fans for air circulation, water pumping and recycling.

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Mars Sample Retriever:

1. Pick up two 21mm x 142mm sample tubes within a 30cm circle from the front of the rover.
2. Your Sample Retriever can not weigh more the 2kg not including the battery
3. Deposit the sample tube into launch container. Make a 3-D printable launch container
4. The demonstration will be done with a 30cm diameter paper plate containing sand and pea gravel covering the paper. The Sample Tube will be dropped randomly onto the plate with the sand and gravel. The team's robot arm driver will pick up the sample tube and place it into the Launch Container at the back of the rover. This must be done using the cameras on the rover and robot arm without directly seeing the robot arm and sample tube or cues from other team members watching (we are simulating this being on Mars). After one sample is deposited into the Launch Container, a second sample tube will be dropped in a different random location on the plate and the robot arm driver (same or different team member) will retrieve the sample tube and place it into the Launch Container.

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Biomedical Engineering and Health Science

6-Lead Kardiamobile Holster:

1. Thigh-strap secures hardware to mid-to-lower thigh with a stable position during movement or medical procedures.
2. Posterior aperture (opening) on the holster allows the KardiaMobile rear electrode continuous direct contact with bare skin for 6-lead acquisition.
3. Dedicated mechanical holders secure the patient's thumbs against the top electrodes, compensating for lack of muscle tone.
4. All materials shall be non-irritating to skin and compatible with medical-grade disinfection for multiuse cycles over a 900+ day mission.
5. A single caregiver must be able to fully deploy the device AND position the patient's limbs in under 60 seconds during an emergency response — no 60s instructions booklet allowed.
6. The design should include intuitive visual alignment markers so the caregiver can position the holster correctly on the thigh for optimal electrode contact — even under stress.
7. The holster materials shall NOT block or interfere with the Bluetooth wireless transmission of ECG data to the receiving device.
8. Device placement shall not block access for AED defibrillator pads, blood pressure cuffs, or other critical emergency hardware applied simultaneously.
9. The design must allow the patient to be safely moved through the spacecraft habitat without the ECG device dislodging or causing pressure injuries.
10. Summary - Secure device on thigh without caregiver holding it.
Allow rear electrode contact with bare skin .
Hold thumbs in electrode contact passively.
Deployable in under 60 seconds.
Skin-safe & disinfects materials Allow AED pad access to the chest

Lunar Splint Design Challenge:

1. Immobilize the assigned injury adequately for the lunar environment
2. Printable with ABS, PLA or other 3D print material. Although your prototype can be printed in common material, explain what kind of 3D print material you would use for flight.
3. Accounts for long-term habitat wear
4. Incorporates at least one lunar-specific novel innovation (A– E)
5. Justifies material choice against thermal and radiation requirements
6. Mass budget: calculate filament mass and justify against ~\$1M/kg launch cost

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ARED Exercise Protocol for Commercial Crew:

1. Your mission: Learn how the ARED works, understand what bones and muscles need to stay healthy, and design a 1 to 3-month exercise plan for commercial crew astronauts that could actually be monitored in real time.

IV Fluid Administration:

1. Your Mission Design a compact, easy to set up, with disposable IV lines (including in-line filters) that is a crew operable IV fluid delivery system that works without gravity.
2. Your system must:
3. Full system Prime in less than 90 seconds.
4. Deliver an emergency bolus flow rate of 1 L in 15 minutes. Use a pressure infuser to do this.
5. Deliver fluid at a controlled rate without relying on gravity to drive flow
6. Eliminate air bubbles from the line before and during delivery
7. Be set up and operated entirely by one crew member without ground support
8. Meet basic safety standards for spaceflight medical equipment
9. **DO NOT** worry about bubbles in the IV bag. Only focus on the line from IV bag to the patient

ARES Lunar Dust Project:

1. Research Paper:
 - Identify and accurately describe the physical and chemical properties of lunar regolith that make it biologically hazardous
 - Explain how exposure affects at least four distinct human physiological systems at the cellular, tissue, and organ levels
 - Connect exposure mechanisms to real clinical outcomes observed or predicted for astronauts
 - Evaluate the effectiveness of current and proposed remediation and protective strategies
 - Synthesize information from peer-reviewed scientific literature, NASA technical reports, and primary research
 - Communicate complex scientific content at a college-level standard using APA citation format
2. Lab Protocol:
 - Test chamber built from PVC
 - Minimum 6 filter types tested
 - Tier 2 OR Tier 3 measurement
 - 3 replicate trials for top 2 filters
 - Bar chart of efficiency by filter
 - Cost-vs-efficiency scatter plot
 - Completed student data sheet
 - Group lab report or presentation

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Mars Transit Habitat Food Storage:

1. Design a food storage module that will dock permanently to the Transit Habitat.
2. Solid module, or inflatable is up to you.
3. Cylindrical shape allows for large surface area to achieve heat transfer.
4. Attach module to end of TH to minimize need for enter/egress.
5. Space modules are complex systems that are beyond the scope of this project. **Your prototype should primarily focus on the issue of refrigeration/freezing.**
6. Your prototype must be scaled and no larger than 2 cubic foot.
7. You must have diagrams that illustrate the compartmentalization for food storage versus biological samples.
8. You must include an inventory system
9. Recommendations for specific materials used in flight hardware are required.

TESTING and VALIDATION

10. Dry ice in a Styrofoam container with adequate ventilation can provide a cold environment for several hours.
11. Cool your prototype as much as possible before testing so that your internal compartment is as close to freezing as possible.
12. Place packages of frozen food inside the prototype.
13. Temperature measurements at point closest/furthest from access door are required.
14. Take multiple temperature measurements at various locations inside your prototype
15. Measure power consumption throughout the test period.

SFT 2025-26-27 Medical Diagnostic System with Machine Learning & Artificial Intelligence (From a non-Medical Persons Perspective):

1. Design a functional prototype of an onboard, autonomous medical decision support systems—intelligent enough to interpret symptoms, analyze physiological data, and provide step-by-step guidance, yet resource-efficient and robust enough for space deployment.
2. The system must operate without external support for up to two weeks.
3. Must withstand the harsh space environment (radiation, limited power, hardware constraints).
4. Interface and recommendations must be accessible to non-experts under stress.
5. Easy Straight Forward Verbal, Visual, Keyboard and real time entering of health based on information.
6. AI Physiological Monitoring
7. Smart Environment Features
8. Personalized Support and Countermeasures
9. Data Collection and Analysis
10. Medical Data Synthesis
11. Disease Types

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SFT 2026-27 - AI Plant Growth for Space:

1. Build an AI-assisted system that monitors enclosed-habitat plants in real time, automatically adjusts conditions to reduce stress, and actively promotes the growth of each individual plant — factoring in artificial light and reduced (1/6 g) gravity.
2. Deliverable: an automated 'robot greenhouse' concept/prototype that diagnoses issues and adjusts care (water, light height, climate) per plant, a defined list of monitored stressors, and a proposed pollination-automation approach
3. Real-time, 24/7 monitoring with automated feedback control
4. AI stress detection: water, air, temperature, airflow, soil pH (and radiation)
5. Individualized watering — no over- or under-watering
6. Automated growth promotion (e.g., adjustable LED light height)
7. Resource-efficient: minimal water use and crew time
8. Automated pollination method (e.g., air-blast)
9. Contamination control / growth-medium sterilization

SFT 2026-27 - Lunar Sleep-Shift Scheduling Tool:

1. Build an onboard tool that generates personalized, evidence-based sleep/wake schedules and fatigue-mitigation advice for astronauts, running offline and improving through feedback.
2. Objective: produce recommendations for sleep, wake, naps, caffeine, and sleep-aid timing autonomously.
3. Deliverables: end-user requirements with access protocols; hardware/software technical specs; high-level mission requirements and challenges; a requirements document; a student presentation; a project video; and a posting on nasahunch.com.
4. Daily sleep-onset / wake recommendations per crewmember
5. Nap, caffeine, and sleep-aid (e.g., melatonin) timing
6. Gradual shifting rules (≤ 2 hr per sleep period; ~ 24 hr to adjust per 1 hr shift)
7. A fatigue score (e.g., 0-100) rating how fatiguing a schedule is
8. Light / exercise guidance; runs offline on a laptop or tablet
9. A feedback loop that learns from adherence and alertness

SFT 2025-26-27 Lunar Smart Adaptive Habitat Design with AI Psychological Monitoring for Crew Adaptive Positive Mental Health:

1. Create a lunar habitat that uses psychological research and AI to monitor and support astronaut mental health, while integrating smart building systems for life support and power.
2. **The habitat integrates state-of-the-art AI systems that continuously monitor crew psychological health using natural language processing (NLP), biometric data, and environmental sensors. These systems adapt lighting, sound, and environmental cues to individual circadian rhythms and mood, and provide virtual companions and real-time feedback to support mental well-being.**

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3. The internal layout is optimized using AI-powered generative design tools, ensuring functional zoning (crew quarters, galley, hygiene, workstations, medical, storage, ECLSS, airlock) and adjacency priorities that enhance workflow, privacy, and dust mitigation. The design is scalable and allows for future expansion.
4. A scale model demonstrating adaptive features and psychological support systems.
5. Final prototype must include:
 - 2 ft by 2ft scaled model of habitat
 - User interface on smartphone or laptop
 - Evidence of research to justify design

Software and Technology

SFT 2025-26-27 HERA Moonscape, Mars scape and Robotics Updated:

6.1 Scaled Model Development

- 2ft × 2ft prototype landscape
- Scale factor: 1:4 of the final design
- Integration with the NASA HUNCH program guidelines
- Student team collaboration framework

6.2 Robot Prototype Development

- Arduino-based control systems
- Scaled robot designs
- Testing and validation protocols
- Documentation requirements

6.2 Outline Mission Scenario Testing

- Day/night operation verification
- Communication system validation
- Emergency procedure testing
- User interface evaluation

LLASO Project 1 - Lunar Logistics Supply Chain (VR Simulation, Game or Math Model):

1. Simulate a cylindrical or box cargo container module (~3 m dia., ~40 ft long)
2. Model CTBs, lockers, and canister cargo types, including unusual shapes
3. Track the location of CTBs, lockers, canisters, packing boxes, etc.
4. Include 1/6 lunar gravity physics on the Moon
5. Support both rack-stacking and free-float packing modes
6. Include loading and unloading sequences
7. Be usable with no prior VR experience, with a display

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LLASO Project 2 - External Cargo Transport Robot (Rocket to Supply Building):

1. Handle a module mass equivalent in 1/6 g (may be scaled for an Earth demo)
2. Navigate unprepared lunar regolith terrain
3. Include a dust-exclusion coupling at the habitat dock (~1-2 m opening)
4. Operate autonomously, with human override capability
5. Use a solar + battery power architecture
6. Require no human EVA for nominal transport operation

LLASO Project 3 - Internal Cargo Unloading Robot (Inside the Module):

1. Operate inside a cylindrical module (~3 m dia.) in a pressurized environment
2. Handle CTBs, equipment racks, and bulk cargo items
3. Adapt to 1/6 g mass handling (items are lighter, but inertia is the same)
4. Communicate item identity and status to a manifest system
5. Work alongside human crew without creating a safety hazard

SFT 2026-27 - LLASO Project 4 - AI Predictive Maintenance for Lunar Robots:

1. Collect motor, joint, wheel, battery, and thermal telemetry streams
2. Detect anomalies and predict failures with configurable thresholds
3. Generate a work order and route the robot to the P5 Repair Garage
4. Track a standby fleet and dispatch replacements automatically
5. Accept a robot self-diagnostic override (the robot can confirm or reject an AI flag)
6. Operate autonomously during uncrewed mission phases

SFT 2026-27 LLASO Project 5 - Semi-Autonomous - Lunar Robots Repair Garage (Shirt-Sleeve Maintenance Facility):

1. A pressurized shirt-sleeve interior (no EVA suit required for normal work)
2. A dust-exclusion airlock or wash-down zone for robots entering from regolith
3. A minimum of 2 service bays plus 1 standby parking area
4. Tool and parts storage integrated into the bay layout
5. A work-order interface that receives dispatch from the P4 AI system
6. A robot return-to-service certification process before redeployment
7. Redundant power and air supply (no single point of failure)

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SFT 2025-26-27 Modified - Moon Base - Defending the Smart Lunar Building: Cyber Security for Control Systems:

1. Develop and simulate a secure, segmented network architecture for both lunar and Earth facilities.
2. Integrate host intrusion detection systems (HIDS), security appliances, and protection for all smart equipment, including Nokia 4G wireless.
3. Provide educational labs for grades 8–10 and a comprehensive, multivendor simulation for professional testing.
4. Deliver detailed network diagrams, traffic analysis, redundancy plans, and documentation for all segments.

SFT 2026-27 - Lunar Base Micrometeorite Inspection Robot(s):

1. Inspect $\geq 110\%$ of the base surface, including habitat and landing pad (SYS-001)
2. Autonomous plus remote-controlled operation (SYS-002)
3. Real / near-real-time data, latency < 2 s (SYS-003, HW-007)
4. Modular sensors: RGB $\geq 1080p$, IR, LiDAR (HW-002)
5. Detect pits ≥ 0.1 mm diameter; measure depth to 0.05 mm (HW-003)
6. Traverse flat, curved, and vertical surfaces to 90 degrees (ME-003/005/006)
7. AI detects and classifies impacts vs. a baseline (SW-003)
8. Assess severity and decompression risk (SW-005); VR/GUI control (SW-001); battery ≥ 120 min (HW-005)