NASAfacts

# Lunar Electric Rover Concept

## Background:

If you want to get anywhere, you've got to have wheels – even on the moon. With that in mind, NASA is now testing concepts for a new generation of rovers at sites around the country. These lunar rover concepts will help future astronauts explore more of the moon than ever before, build a long-term lunar presence and conduct a wealth of science experiments.

Rovers proved invaluable during the Apollo missions, enabling astronauts to complete almost 20 trips across the surface of the moon. With each successive mission, NASA improved the rovers' capacities, increasing the number and duration of exploration missions astronauts could complete on the lunar surface.

NASA is still building on the lessons learned during the Apollo missions, and is also incorporating the experiences of operating unmanned rovers on Mars. One pressurized rover concept is the Lunar Electric Rover, or LER. The chassis, which serves as the base for the LER, was unveiled in 2007. One cabin prototype was then built and integrated with the chassis in 2008, and another, upgraded version was completed in 2009.

# The Lunar Electric Rover:

NASA plans to conduct human lunar missions with stays as long as 180 days, providing the technology that astronauts will entrust with their lives as they explore the moon, Mars and other planetary bodies in our solar system.

Astronauts will need surface mobility to explore multiple sites across the lunar surface. The LER concept enables a mobile form of exploration that can provide the astronauts' main mode of transportation, and – unlike the unpressurized Apollo lunar rover – also allow them to work on long excursions without the restrictions imposed by spacesuits. The pressurized cabin has a suitport that allows the crew to get into their spacesuits and out of the vehicle faster than before, enabling multiple, short moonwalks, as an alternative to one, long moonwalk.

The adaptable vehicle features pivoting wheels that enable "crab style" sideways movement to help the rover maneuver over difficult terrain. Its tilt-able cockpit provides the drivers the best possible view of the terrain ahead. Early concepts also call for an exercise bike that allows crew to exercise while charging the vehicle's batteries.

Each rover consists of a mobility chassis and a small, pressurized cabin module. These two components could be delivered to the lunar surface pre-integrated or as separate elements. Astronauts can drive the mobility chassis without the pressurized cabin, by riding in rotating turrets while wearing spacesuits; the chassis can also be used to carry cargo. The modular design allows various tools – winches, cable reels, backhoes, cranes and bulldozer blades – to be attached for special missions. And the chassis can pick up and reposition solar-powered charging stations, communication relays and scientific packages.


**Functional Requirements:**

- The LER must be able to hold a crew of two, but can support a crew of four in an emergency
- It can travel at about 10 kilometers per hour
- The mobility chassis wheels are able to pivot 360 degrees, allowing it to drive in any direction

**LER Specifications:**

**Weight:** 3000 kg
**Payload:** 1000 kg
**Length:** 4.5 m
**Wheelbase:** 4 m
**Height:** 3 m
**Wheels:** 12x99 cm in diameter, 30.5 cm wide

**Chassis Specifications:**

**Weight:** 1000 kg
**Payload:** 3000 kg
**Length:** 4.5 m
**Wheelbase:** 4 m
**Height:** 1.3 m
**Wheels:** 12x99 cm in diameter, 30.5 cm wide

One of the goals for testing prototypes on Earth is to identify the features that are going to be the most useful on the moon. Of the features currently being tested, not all will end up on the lunar surface, but here is what is being considered in the latest rover designs.

## Range of Exploration

On the surface of the moon, travel range is limited primarily by how quickly astronauts can get back to a safe, pressurized environment in the case of an emergency. During the Apollo program, exploration was confined to the distance astronauts could expect to walk back in their spacesuits if their rovers broke down – that worked out to about six miles. The presence of two or more LERs on the lunar surface would extend that potential range to more than 150 miles in any direction, greatly increasing the scientific opportunities during lunar missions. Even in the midst of challenging terrain, emergency shelter and support can be less than an hour away.

## Astronaut Protection

The greatest risk to explorers on the lunar surface is that posed by unanticipated solar particle events. With a heavily shielded cabin, the Lunar Electric Rover doubles as a storm shelter. The rapidly accessible, pressurized, radiation-hard safe haven can sustain and protect exploring crew members for up to 72 hours against solar particle events, acute suit malfunctions and other medical emergencies. The radiation shielding in the LER cabin provides protection that the Apollo crew did not have on their unpressurized rover (or even in their Lander).

## Rapid Ingress/Egress

The LER system's suitport concept allows astronauts to go out for a moonwalk at almost a moment's notice. The suitport will allow the crew to enter and exit their spacesuits without bringing the suit inside, keeping the internal space mostly free of dust and reducing wear-and-tear on the suits. It also minimizes the loss of air inside the cabin when it is depressurized for moonwalks, extending sortie durations by helping the LER to make the most of its resources.

## Field Science Capability

By combining a pressurized cabin with a suitport, the LER gives crew members the unprecedented flexibility of being able to easily switch between working in plain clothes or spacesuits. Although astronauts may want to exit the vehicle to take a closer look at something outside, activities requiring fine manipulation and unfettered visual access are best performed without the confines of a bulky gloves and helmets. Being able to sit comfortably in a cabin and look at geologic formations without the continuous exertion of suited walking enables better use of computers, maps and dialogue between crew members. The cabin can also serve as a rolling science lab for studying samples.

## Extended Range on the Moon and Earth

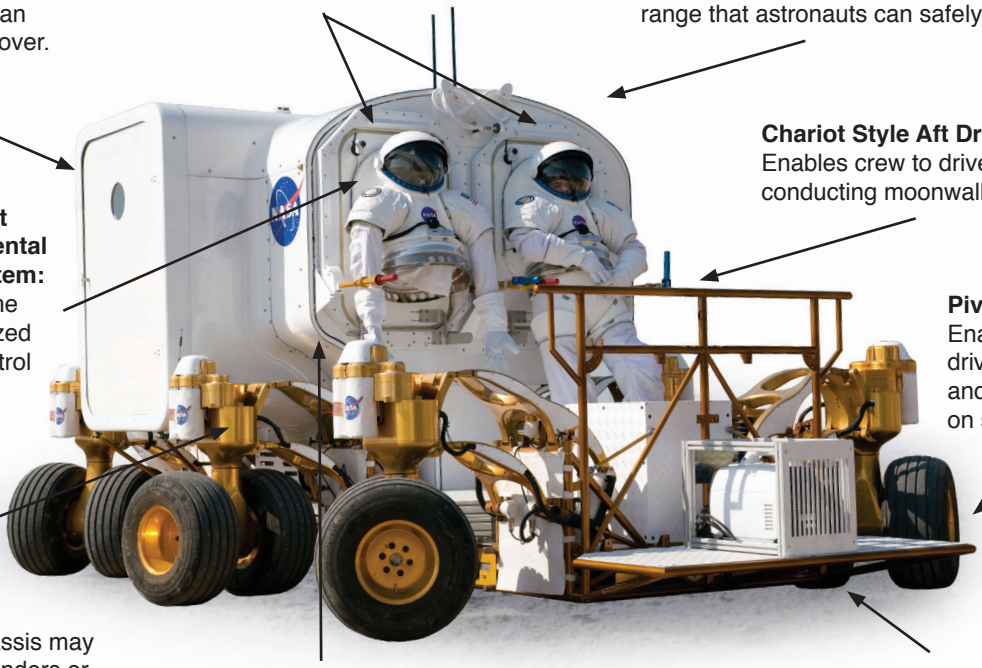
Like electric cars here at home, the Lunar Electric Rover will rely on batteries to travel. NASA is developing batteries that weigh less and provide more power than those currently being used in earthly automobiles. The same technology that will someday allow astronauts to see more of the moon could also lead to better, more efficient transportation for the rest of us, as well. Electric commuter vehicles, electric off-road vehicles, electric transport trucks, and electric construction equipment may one day benefit from NASA's battery innovations.

# The Lunar Electric Rover Concept Characteristics

**Docking Hatch:**
Allows crew members to move from the rover to a habitat, an ascent module or another rover.

**Suitports:**
Allow suit donning and vehicle egress in fewer than 10 minutes with minimal gas loss.

**Pressurized Rover:**
Low-mass, low-volume design makes it possible to have two pressurized vehicles on the lunar surface, greatly extending the range that astronauts can safely explore.



**Chariot Style Aft Driving Station:**
Enables crew to drive rover while conducting moonwalks.

**Suit Portable Life Support System-based Environmental Control Life Support System:**
Reduces mass, cost, volume and complexity of Pressurized Rovers Environmental Control Life Support System.

**Pivoting Wheels:**
Enables crab-style driving for docking and maneuvering on steep terrain.

**Modular Design:**
Pressurized Rover and chassis may be delivered on separate landers or pre-integrated on one lander.

**Ice-shielded Lock / Fusible Heat Sink:**
Lock surrounded by 2.5 cm of frozen water provides radiation protection. Same ice is used as a fusible heat sink, rejecting heat energy by melting ice instead of evaporating water to vacuum.

**Work Package Interface:**
Allows attachment of modular work packages for various duties (e.g. winch, cable, backhoe or crane).

The Lunar Electric Rover Concept will rely on the incorporation of many advanced technologies. Examples include:

**Batteries**
**Wheels**
**Avionics and Software**
**Fuel Cells**
**Light-Weight Structures and Materials**
**Extra-Vehicular Activity (EVA) Suitport**
**Regenerative Brakes**
**Active Suspension**
**Thermal Control Systems**

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