

Long Duration Experiment on Mars

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Future human missions to Mars will depend on equipment and structures that can survive the planet's harsh surface conditions for long periods of time. For example, this includes aspects like habitats, airlocks, rovers, and tools, which will use various metal materials such as aluminum, titanium, and stainless steel. Over time, there is a high possibility of these materials weakening when they are exposed to Martian dust, radiation, extreme temperature changes, and possible microbial contamination that is carried by the astronauts themselves. Due to this, it is critical to understand how these environmental factors might affect metal surfaces in order to ensure future mission safety. This experiment relates to MEPAG goal IV in relation to the preparation for human exploration, which focuses on identifying hazards on the Martian surface and improving the consistency and reliability of the systems that astronauts use. This report describes a long-duration experiment conducted on the Martian surface and explains aspects of it, including the experimental design, differences between Mars and Earth conditions, required materials, power needs, astronaut time requirements, and predicted results.

Experimental Design

This experiment would be conducted directly on the Martian surface near the astronaut habitat. Metal samples that are made from aluminum alloys, titanium alloys, and stainless steel would be mounted on an external testing platform outside the habitat. During normal surface activities, astronauts would intentionally expose some of the metal samples to microorganisms carried on their spacesuits and equipment. Other metal samples would remain untouched to act as control samples. All samples would be exposed to the natural Martian environment, including dust, ultraviolet radiation, temperature changes, and the thin Martian atmosphere. Cameras and surface sensors on the testing platform would monitor changes in the metal

samples over time. Astronauts would periodically inspect the samples during surface operations and collect small material samples for closer analysis inside the habitat laboratory. By comparing samples exposed to microbes with samples exposed only to the Martian environment, scientists can determine whether microbial corrosion occurs on the Martian surface (Piatek & Fisher, 2023).

Long-Duration Design Differences

Designing this experiment for Mars is different from conducting it on Earth because the Martian environment is extremely harsh. Mars has much lower gravity than Earth, which may affect how dust settles on metal surfaces. The thin Martian atmosphere also provides very little protection from ultraviolet radiation, which could influence microbial survival and corrosion processes. Large temperature changes between day and night may also cause metal materials to expand and contract, which could potentially affect the rate of corrosion. A short experiment would not work because corrosion develops slowly and takes months to become noticeable. Since the process of corrosion occurs slowly, the experiment must operate for many months to observe any meaningful changes. The equipment must also be designed to survive exposure to Martian dust storms, radiation, and extreme temperatures (Malin et al., 2026).

Materials

In order to conduct this experiment, there are several specialized materials that are required. Metal test samples made from aluminum, titanium, and stainless steel would be prepared before the mission. An external testing platform would hold the samples from the Martian surface near the habitat. Surface cameras would record changes in the metal samples over time, while chemical sensors would detect any early signs of corrosion. Dust sensors would measure the amount of Martian dust settling on the metal surfaces. Furthermore,

astronauts would use small sampling tools to collect pieces of the metal samples for detailed analysis inside the habitat laboratory. Lastly, protective containers would store these samples so they can be safely studied without contamination (Ryan, 2026).

Power Requirements

The experiment requires electrical power in order to operate cameras, environmental sensors, and corrosion monitoring equipment on the surface testing platform. These instruments would need to be able to continuously record environmental conditions that include temperature, radiation levels, and the accumulation of dust. Because the equipment is located outside the habitat, it would likely be powered by small solar panels mounted on the testing platform. These panels would provide electricity during daylight hours (Sia, 2020). Data from the sensors and cameras would also be transmitted to the habitat for analysis. The power requirements would be relatively small because the system mainly uses sensors and monitoring devices instead of large mechanical equipment.

Time Factors

Most of the experiment would operate automatically using remote monitoring systems. Astronauts would only need to spend a small amount of time maintaining the actual experiment. During regular surface activities, astronauts would check the metal samples and collect small material samples for analysis. This would likely require about two to three hours per month of astronaut time (Piatek & Fisher, 2023). Some preparation of the metal samples could begin during the transit to Mars so that the experiment is ready immediately after landing is finished. Once the testing platform is installed on the surface of Mars, the experiment will continue running for up to one year to observe long-term corrosion effects.

Predicted Results

Three Months

After three months, scientists may observe dust accumulation and early chemical changes on some metal surfaces. Metal samples exposed to microbes from astronaut equipment may begin showing small signs of microbial growth. Sensors might also start to detect minor oxidation reactions as metal surfaces interact with dust and oxygen compounds.

Six Months

After six months, sensors may detect early corrosion patterns on certain metal materials, particularly those exposed to both microbes and Martian dust. Differences between the metal materials may become more noticeable at this stage. There is a chance that some metals might start to show corrosion rates that are a bit faster because of dust abrasion and temperature changes.

Twelve Months

After twelve months, the experiment may reveal clear patterns showing which metals are most resistant to corrosion on the Martian surface (Britannica Editors, 2026). The results may also show whether microbial contamination from astronaut equipment accelerates corrosion. Visible surface damage might begin to appear on some samples, which would provide clearer data on long-term corrosion.

Conclusion

Metal structures will play an important role in supporting long-duration human missions on Mars. However, exposure to Martian dust, radiation, and microorganisms carried by astronauts may gradually weaken these materials. This experiment studies how corrosion develops when metal samples are exposed directly to the Martian surface environment in relation to the rate at which it develops and which metals resist it best. By identifying which

metals are the most resistant to corrosion, engineers can design stronger habitats, vehicles, and equipment for future missions. Understanding these processes will help to make sure that infrastructure remains reliable during long-term exploration of Mars.

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