In early robotic missions, and later in outpost missions, permanently shadowed regions of the Lunar surface (e.g.,
the bottoms of craters in the polar regions). These areas appear to remain at temperatures of 50°K to 80°K
(-223°C to -193°C). Current surface exploration hardware has demonstrated capability to operate in the range of
158K to 273K (-115°C to 0°C) on Mars. However, the technical challenges of developing and demonstrating
hardware that can operate over 100°C colder than current capabilities are significant. The major technology drivers
of the low temperature mechanism technology development are to significantly enhance operation of mechanized
parts by (1) lowering the operating temperature for the life of the component and (2) improving mechanism
performance (e.g., torque output, actuation performance, lubrication state) at the lunar environment conditions of
cold and vacuum. The targeted application of the technology is to provide for operation of motors and drive
systems, lubricated mechanisms, and actuators of lunar rovers and mobility systems, ISRU machinery, robotic
systems mechanisms, and surface operations machinery (i.e. cranes, deployment systems, airlocks), lunar sortie
and the lunar outpost missions. This topic area is responsible for mid-level technology research, development, and
testing through experimental and/or analytical validation.

Subtopics

X5.01 Motors and Drive Systems for Cryogenic Environments

Lead Center: GSFC
Participating Center(s): GRC, JPL, JSC, LaRC

This subtopic focuses on the development of selected hardware and support technologies for motors, drive
systems and related mechanisms that will operate in cryogenic temperature environments such as permanently
shaded craters on the Moon, and/or on the lunar surface exposed to the day/night cycle. In the former situation
such mechanisms may be exposed to, and will need to operate in, sink temperatures as low as approximately 25K.
In the latter situation they will need to operate over a temperature sink range of approximately 83K to 146K
(-190°C to +127°C). Actual operational temperatures may be somewhat different. The component technologies
developed in this effort will be utilized for rovers, operational equipment, instruments, drills, crushers, and other
such facilities. The nearer term focus for this effort is for lunar missions, but these technologies should ideally be
translatable to applications on Mars. These components must operate in a hard vacuum and/or planetary
environment, with partial gravity, and full solar radiation exposure. Additional requirements include high reliability,
ease of maintenance, low-system volume, low mass, and minimal power requirements. Low out-gassing is
desirable, as are modular design characteristics, fail-safe operation, and reliability for handling fluids, slurries,
biomass, particulates, and solids. While dust mitigation is not specifically included in this subtopic, proposed
concepts should be cognizant of the need for such technologies.
Specific areas of interest include gear boxes, suspension systems, material components (i.e., wiring, harnesses, insulating materials, and jackets/covers) that are flexible in cryogenic environments; advanced lubricants and lubrication technology; and an accelerated means of life testing for cold temperatures.