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India's Lunar-Night Endurance — Surviving the 14-Day Lunar Night

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CURATED & WRITTEN BY

Bharat Choudhary

UPSC Educator & Content Creator

linkedin.com/in/epicbharat

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WHY IN NEWS

> *The Indian Space Research Organisation, working with the Department of Atomic Energy, is developing artificial heating technology to keep landers and rovers alive through the roughly 14-Earth-day lunar night, when temperatures near the poles fall to about minus 180 degrees Celsius. The target is a mission life (https://ujiyari.com/terms/mission-life/) of 100 to 200 days, far beyond Chandrayaan-3's single lunar daylight period.*

The effort is a foundational step toward India's more ambitious lunar plans, including a sample-return mission and an eventual space station.

WHY THE LUNAR NIGHT IS SO HARD

The Moon rotates slowly, so a single lunar day and a single lunar night each last about 14 Earth days. During the long night there is no sunlight to power solar panels and no solar warmth, and temperatures plunge to extreme lows. Electronics, batteries and mechanical parts that are not kept warm can freeze and fail, often permanently.

What Chandrayaan-3 did

Chandrayaan-3 landed near the lunar south pole in 2023 at a site named Shiv Shakti Point. Its Vikram lander and Pragyan rover were designed to operate through one lunar day. They completed their primary objectives and were put into sleep mode at nightfall, with the hope of reawakening at the next sunrise. They did not revive, which is the expected outcome for a solar-powered craft without internal heating. The new technology aims to overcome exactly this limitation.

THE SURVIVAL TECHNOLOGY

CHALLENGE	LUNAR-NIGHT CONDITION	ENGINEERING RESPONSE
No sunlight	About 14 Earth days of darkness	Stored power and non-solar heat
Extreme cold	Around minus 180 degrees Celsius near poles	Artificial heating to keep systems warm
Power for electronics	Solar panels idle at night	Radioisotope-based heat and power options

The involvement of the Department of Atomic Energy points to radioisotope heating, in which the heat from the natural decay of a radioactive source keeps critical components above their survival temperature through the night. This is the same class of technology that has allowed deep-space and lunar craft of other nations to survive long, cold, sunless periods. Keeping a lander alive across multiple lunar days, a target of 100 to 200 days, would multiply the scientific return from each mission.

WHERE IT FITS IN INDIA'S ROADMAP

This capability feeds directly into the next phase of India's lunar programme. Chandrayaan-4 is planned as a sample-return mission, which requires hardware that can operate reliably over an extended period on the surface. The technology also supports the long-term vision of the Bharatiya Antariksha Station, India's planned space station, and human-rated lunar ambitions, all of which demand systems that endure harsh thermal cycles.

ANALYSIS

Lunar-night survival is a force multiplier. A craft that lasts only one lunar day yields a short burst of data; one that survives many nights returns far more science for the same launch cost. The choice of radioisotope heating reflects a hard physical reality: solar power alone cannot bridge a 14-day night near the poles. By developing this indigenously with the DAE, ISRO reduces dependence on foreign technology for a capability that is essential to any serious, sustained presence on the Moon.

WAY FORWARD

The technology will need rigorous qualification through extreme thermal-vacuum testing on the ground before it flies. Safe handling, transport and launch protocols for radioisotope sources must be established. Demonstrating the capability on a lander, then scaling it for the heavier hardware of a sample-return mission, is the logical sequence. Success here positions India to participate credibly in the next era of lunar exploration and resource prospecting near the south pole.

UPSC RELEVANCE

For GS Paper 3, this connects to developments in space technology, indigenisation (https://ujiyari.com/vocab/indigenisation/) of critical capabilities, and India's achievements in science and technology. Examiners may ask why the lunar night is a problem, how radioisotope heating addresses it, and how this capability links Chandrayaan-3 to Chandrayaan-4 and the Bharatiya Antariksha Station.

FACTS CORNER

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Lunar night: About 14 Earth days; temperatures near poles around minus 180 degrees Celsius.

Partners: ISRO with the Department of Atomic Energy.

Target life: 100 to 200 days, versus Chandrayaan-3's single lunar daylight period.

Chandrayaan-3: Landed near the lunar south pole in 2023 at Shiv Shakti Point.

Feeds into: Chandrayaan-4 sample-return mission and the Bharatiya Antariksha Station.

Method: Artificial heating, pointing to radioisotope-based heat sources.

Sources: ISRO (https://www.isro.gov.in), The Hindu (https://www.thehindu.com)

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