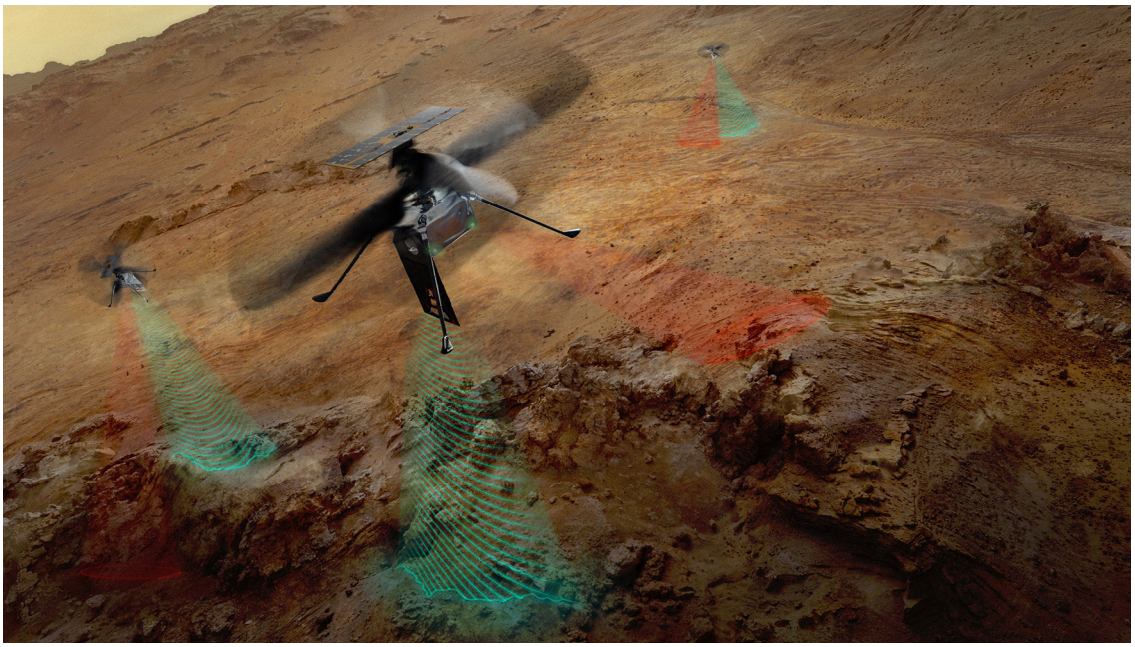
NASAfacts

SkyFall

Humanity's first aircraft equipped with scientific tools to explore another planet



Credit: NASA/JPL-Caltech

NASA's SkyFall mission will deliver three solar-powered helicopters to Mars in a midair deployment, releasing them during descent to fly to the surface on their own. Carrying cameras, ground-penetrating radar, and environmental sensors, the helicopters will investigate the planet's geology, map the shallow subsurface, and search for ice deposits, provide meteorological data, and monitor surface radiation. Their data will provide clues to Mars' history and scout resources and terrain as a demonstration for preparing human missions to Mars.

SkyFall will be the first Mars mission to fly a trio of instrument-carrying helicopters, which together are expected to make flights every other day during a prime surface mission of at least 180 Martian days, or sols (a Martian day is 24 hours, 39 minutes).

Mars has a rarefied atmosphere — just about 1% of the density of our atmosphere on Earth — so a rotorcraft there must spin its blades far faster than one on Earth to generate lift. SkyFall builds on NASA's Ingenuity Mars Helicopter design, which proved that powered, controlled flight on the Red Planet is possible. Ingenuity made the first such flight on April 19, 2021, and went on to complete 72 flights over about two and a half years. The SkyFall helicopters use ultra-lightweight carbon-composite structures and two counter-rotating rotors with blade tips that can reach supersonic speeds.

Radio signals take too long to travel between Earth and Mars for real-time piloting, so Earth-bound operators send scripted commands for the helicopters to fly autonomously using visual odometry, an inertial measurement unit, and a laser altimeter that measures height above the ground.

Key Objectives

- Investigate the geology of Mars and demonstrate scouting methods for future human exploration
- Map buried ice deposits and shallow subsurface structures
- Monitor surface radiation and lower atmosphere meteorology

Expected Mission Timeline

- **Launch:** Late 2028, as a hosted payload aboard NASA's nuclear-powered SR-1 Freedom
- **Mars arrival:** Mars flyby in November 2029, followed by atmospheric entry and landing on Sept. 18, 2030

Spacecraft

- **Fleet:** Three identical helicopters, evolved from Ingenuity Mars Helicopter's design
- **Mass:** About 6 pounds (2.7 kilograms) each
- **Height:** About 26.8 inches (68 centimeters)
- **Rotors:** Two counter-rotating rotors, about 4.6 feet (1.4 meters) in diameter
- **Range:** 0.6 to 1.2 miles (1 to 2 kilometers) per flight
- **Flight rate:** Each helicopter flies up to every other sol (prime mission goal of 50 to 100 kilometers cumulative distance per helicopter)
- **Avionics:** Ingenuity-heritage flight computer and field-programmable gate array (FPGA) with an upgraded Qualcomm Snapdragon navigation processor
- **Power:** About 1.6-square-foot (1,500-square-centimeter) solar array using Rocket Lab IMM4 inverted metamorphic multijunction solar cells
- **Communications:** Direct-to-Orbit (DTO) Arke UHF radio sends data directly to Mars orbiter spacecraft that then relay the data to Earth

Science Payloads

- **Color stereo cameras:** Dual 13-megapixel visible RGB cameras (one nadir, one horizon-pointed) build centimeter-scale 3D terrain models
- **Near-infrared cameras:** Dual nadir-pointing near-infrared cameras characterize mineral features, such as hydration, and surface regolith
- **Ground-penetrating radar:** Ultra-compact radar with a deployable antenna maps subsurface ice and layering 10 to 16 feet (3 to 5 meters) deep
- **Dosimeter:** Commercial micro dosimeter measures near-surface radiation flux
- **Temperature sensors and wind:** Four air temperature thermocouples mounted in rotor downwash provide atmospheric temperature. Wind speed and direction are derived from flight data

"SkyFall Maneuver"

SkyFall's helicopters deploy in midair during entry, descent, and landing, avoiding the cost and risk of a dedicated landing craft. After a parachute decelerates the backshell and the heat shield is jettisoned, the three helicopters spin up their rotors to flight speed while attached to the entry vehicle, simultaneously release from the platform they're attached to, pitch nose-down to gain horizontal speed, level out, slow to a hover, and autonomously avoid hazards to land.

SR-1 Freedom

SkyFall will travel to Mars aboard Space Reactor-1 (SR-1) Freedom, targeting launch in late 2028. Demonstrating fission-powered nuclear electric propulsion in deep space, SR-1 Freedom will release SkyFall into an independent trajectory in October 2029 prior to a Mars gravity-assist flyby, setting up SkyFall's arrival for landing in September 2030. SkyFall incorporates a cruise stage and entry vehicle with heritage from the Mars Exploration Rover (Spirit and Opportunity) mission.

Landing Site Selection

SkyFall will target a low-elevation, mid-latitude region with the possibility of ice close to the surface. A final landing-site selection is expected no later than mid-2028.

Mission Partners

NASA's Jet Propulsion Laboratory manages SkyFall for the agency's Science Mission Directorate (SMD). A division of Caltech, JPL leads overall mission management, system engineering, flight software, and integration. AeroVironment is co-designing the helicopters, leading on rotors, airframes, and mechanical structures. Lockheed Martin and Firefly are planned commercial partners for the aeroshell and cruise elements, with solar cell technology provided by Rocket Lab.

Media Resources

- **SkyFall website:** science.nasa.gov/mission/skyfall
- **Mars Exploration blog:** science.nasa.gov/blogs/mars/
- **SR-1 Freedom website:** www.nasa.gov/mission/space-reactor-1-freedom/