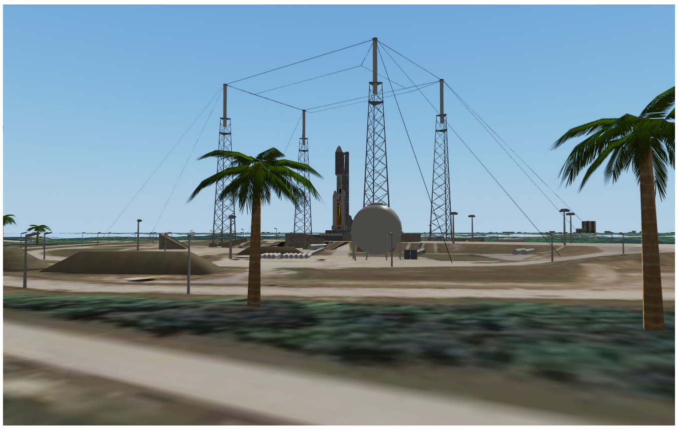
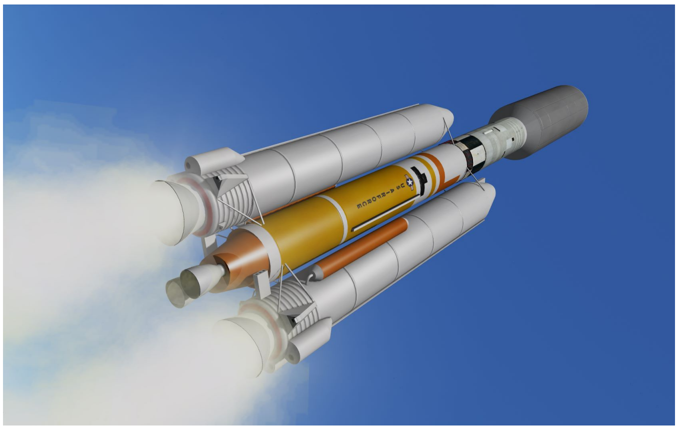
NASA VIKING PROGRAM
Add-On for Orbiter 2024/2016





NASA Viking Program V1.0

Credits:
BrianJ
Buck Rogers
NASA archives, documents
Martin Schweiger & Orbiter Forum members

REQUIREMENTS:

"VesselBuilder for Orbiter2016" add-on (included in this package)
http://www.intech-srl.eu/fred/VesselBuilder1_PreRelease.zip

Orbiter2016 D3D9 Graphics Client (only required for Orbiter2016)
https://www.orbiter-forum.com/resources/d3d9-for-orbiter-2016.5493/

Activate "Enable absolute animation handling" in the Video/Advanced tab.

Mars/Earth Hi-res Textures
http://orbit.medphys.ucl.ac.uk/mirrors/orbiter_radio/tex_mirror.html
This addon has been optimised for use with hi-res textures, it will work without but with some possible graphic glitches; inaccurate ground contact, floating rocks.

REQUIRED FOR LAUNCH AND TMI SCENARIOS:
"Multistage2015 for Orbiter2016"
https://www.orbiter-forum.com/resources/multistage2015-for-orbiter-2016.398/
NOTE: "Multistage2015 for Orbiter2016" is currently not working in Orbiter2024- TMI still funtions correctly but launch (boosters) will fail and CTD.

Multistage titans
https://www.orbiter-forum.com/resources/multistage-titans.919/

Reccomended:
"Interplanetary MFD 5.7"
https://www.orbiter-forum.com/resources/interplanetary-mfd.5500/

INSTALLATION

Extract all files to the root of your Orbiter program directory, preserving the directory structure. This should NOT overwrite anything in the standard Orbiter package.

Acknowlegments and notes

This addon started many years ago, the inspiration was to update the iconic historic addons of the original Orbiter, this still remains an aspiration but with the 50th anniversary coming up here at least is the Viking mission. In honour of all those who have inspired with their creativity in Orbiter, especially Dr Martin Schweiger, and thank you to all who helped along the way. And a very special thanks to BrianJ, without whom this would not be possible- autopilot, aerodynamics, flight plans, launch pad, technical assistance and...
It is possible to fly the entire mission in a single flight.
The Viking2 landing site is 10km! lower than officially specified (with hi-res, interestingly the default textures are more accurate!), this is due to the missing oblateness in Orbiter planetery modeling (perfect sphere).
EDL autopilot uses radar altitude and should be able to land almost anywhere (Olympus Mons should always be avoided!).
A note on accuracy/realism: Every effort has been made to make this addon as close to the original as possible, all data and dates are taken from original NASA documents. The only differences are a minimal increase in ISP for the aeroshell and EDL timing is a few hours off, the entire mission was almost completly flown in a single flight. BrianJ's original flight notes attached.

Viking 1, 2

The Viking project consisted of launches of two separate spacecraft to Mars, Viking 1, launched on 20 August 1975, and Viking 2, launched on 9 September 1975. Each spacecraft consisted of an orbiter and a lander. After orbiting Mars and returning images used for landing site selection, the orbiter and lander detached and the lander entered the martian atmosphere and soft-landed at the selected site. The orbiters continued imaging and other scientific operations from orbit while the landers deployed instruments on the surface. (Wiki)
The two Viking orbiters returned 52,663 images of Mars and mapped about 97 percent of the surface at a resolution of 300 meters. The landers returned 4,500 photos of the two landing sites.

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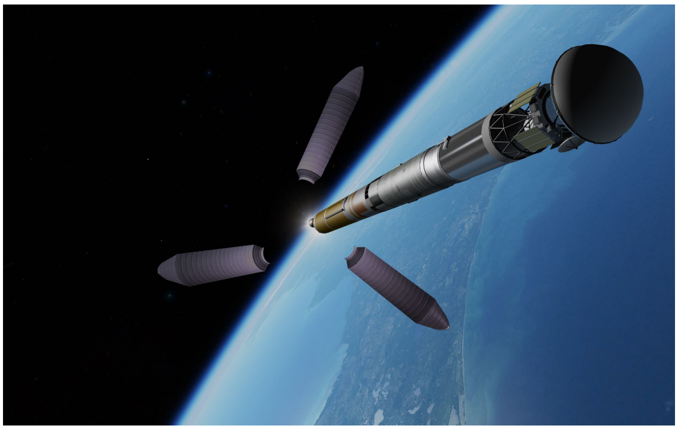

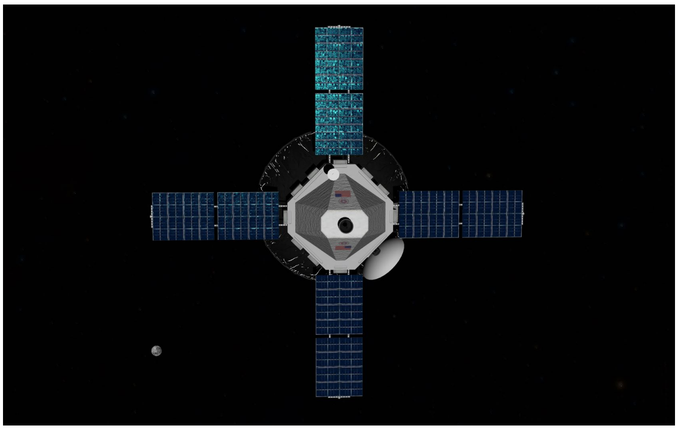

SPACECRAFT SPECS and CONTROLS

Nation: United States of America (USA)
Objective(s): Mars Landing and Orbit
Spacecraft: Viking-B
Spacecraft Mass: 7,776 pounds (3,527 kilograms)
Spacecraft Power: Each lander carried two SNAP 19 Radioisotope Thermoelectric Generators RTGs). Orbiters were solar powered
Mission Design and Management: NASA / Langley Research Center (LaRC) / Jet PropulsionLaboratory (JPL)
Launch Vehicle: Titan IIIE-Centaur (TC-4 / Titan no. E-4 / Centaur D-1T)
Launch Site: Cape Canaveral, Fla. / Launch Complex 41
Scientific Instruments: Orbiters:
1. Imaging System (2 Vidicon Cameras) (VIS)
2. infrared Spectrometer for Water Vapor Mapping (MAWD)
3. Infrared Radiometer for Thermal Mapping (IRTM)
Landers:
1. Imaging System (2 facsimile cameras)
2. Gas Chromatograph Mass Spectrometer (GCMS)
3. Seismometer
4. X-Ray Fluorescence Spectrometer
5. Biological Laboratory
6. Weather Instrument Package (Temperature, Pressure, Wind Velocity)
7. Remote Sampler Arm
Aeroshells:
1. Retarding Potential Analyzer
2. Upper-Atmosphere Mass Spectrometer
3. Pressure, Temperature, and Density Sensors

Orbiter

The orbiter, based on the earlier Mariner 9 spacecraft, was an octagon approximately 2.5 m across.
The total launch mass was 2328 kg, of which 1445 kg were propellant and attitude control gas.
The overall height was 3.29m.
Power was provided by eight 1.57 × 1.23 m solar panels.

Total Dv: 1520 m/s (Payload attached + RCS seperate tank)

Orbiter keys:
Ctrl+Shft+K = Deploy Solar Panels
Shft+K = Stow Solar Panels
G = Jettison Bioshield cover
J = Unlatch aeroshell and lander

Aeroshell

The aeroshell was an aerodynamic heat shield made of aluminum alloy. It was 3.5meters (11.5 feet) in diameter.
The interior of the aeroshell contained twelve small reaction control engines, in four clusters of three around the aeroshell's edge.

Total Dv: 160 m/s

Aeroshell keys:
Fully automated descent and landing autopilot
K = Manual Parachute Deploy (Automatic at 6km alt.)
G = Manual Heatshield Jettison (Automatic at 5km alt.)
J = Manual Lander Jettison (Automatic at 1.49km alt.)

Lander

The lander consisted of a 6-sided aluminum base with alternate 1.09 m and 0.56 m long sides.
Power was provided by two radioisotope thermal generator (RTG) units containing plutonium 238 affixed to opposite sides of the lander base and covered by wind screens. Each generator was 28 cm tall, 58 cm in diameter, had a mass of 13.6 kg and provided 30 W continuous power at 4.4 volts.
Propulsion was provided for deorbit by a monopropellant hydrazine (N2H4) rocket with 12 nozzles arranged in four clusters of three that provided 32 N thrust.

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Total Dv: 180 m/s

Lander keys:
Ctrl+G = Manual gear deploy
C = Camera, cam positions simulate original first photos
Ctrl+K = Meteorology Mast
Ctrl+J = HGA
Ctrl+U = Sampling Arm

IMFD tips:
IMFD only updates in cockpit MFD mode, i.e. Engine start/cutoff etc. will not be executed in external camera mode.
Autoburn attitude control starts at T-180s.

Scenerios

01-Viking 1-Launch
Launch Viking 1 at 21:22 UTC on August 20,1975 (Arrival June 19,1976 MJD 42948)
Automatic launch T-22min

Multistage:
Disengage Autopilot "P"
Complex Flight on
Failure prob. 1%

02-Viking 1-TMI
MFD is set for TMI. T-5min to real-time burn point. At T-200s manually activate the main thrusters (Cntrl+ Numpad "+"), at ~T-5s deactivate the main thrusters (Numpad "*")and then press AB on the right MFD for Auto Burn, the Autopilot will then complete the TMI.
After the burn detach orbiter (J), deploy Solar Panels "Cntl+Shft+K", jettison Bio Shield "G".
NOTE: RCS cannot be used until the panels are deployed.

03 V1 Enroute V2 Launch
Launch Viking 2 at 18:39 UTC on 09 Sept.1975 (Arrival 07 Aug.1976 MJD 42997)
Automatic launch T-9min

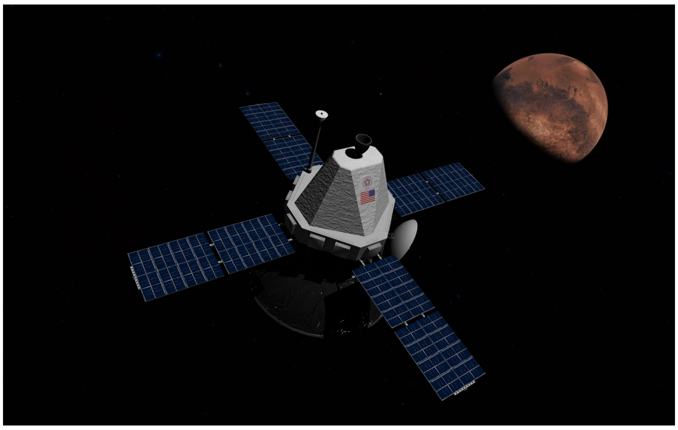
Multistage:
Disengage Autopilot "P"
Complex Flight on
Failure prob. 1%

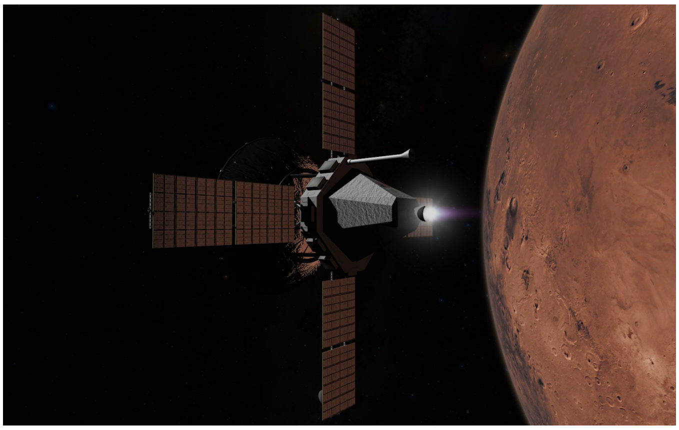
04 V1 Enroute V2 TMI
MFD is set for TMI. T-5min to real-time burn point. At T-200s manually activate the main thrusters (Cntrl+ Numpad "+"), at ~T-5s deactivate the main thrusters (Numpad "*")and then press AB on the right MFD for Auto Burn, the Autopilot will then complete the TMI.
After the burn detach orbiter (J), deploy Solar Panels "Cntl+Shft+K", jettison Bio Shield "G".
NOTE: RCS cannot be used until the panels are deployed.

05 V1 Enroute V2 MCC1
T-0s Viking2-MCC1 BT=89s
Activate Autoburn in the left MFD

06 V1 MCC1 V2 Enroute
T-0s Viking1-MCC1 BT=50s
Activate Autoburn in the left MFD
Historically three course corrections were made: Aug. 27, 1975, June 10, 1976, and June 15, 1976.

07 V1 MCC2 V2 Enroute
T-0s Viking2-MCC2 BT=2.3s
Activate Autoburn in the left MFD





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08 V1 Enroute V2 MCC2
T-0s Viking2-MCC2 BT=2.5s
Activate Autoburn in the left MFD

09 V1 MCC3 V2 Enroute
T-0s Viking1-MCC3 BT=12.3s
Activate Autoburn in the left MFD
June 14 1976 (3 days earlier) First global images of Mars sent from the orbiter

10 V1 MOI V2 Enroute
T-10.5min Mars Orbit Insertion BT=42.6min
Activate Autoburn in the left MFD
June 19 1976, Viking1 arrives at Mars

11 V1 OC1 V2 Enroute
T-5 min to Orbit Correction maneuver BT=2.8s
Activate Autoburn in the left MFD

12 V1 OC2 V2 Enroute
T-5 min to Orbit Correction maneuver BT=1.2s
Activate Autoburn in the left MFD

13 V1 OC3 V2 Enroute
T-5 min to Orbit Correction maneuver BT=0.9s
Activate Autoburn in the left MFD

14 V1 OC4 V2 Enroute
T-5 min to Orbit Correction maneuver BT=125s
Activate Autoburn in the left MFD
Final base alignment

15 V1 Aero sep V2 Enroute
T-20m to Entry burn. sep. aeroshell (J)

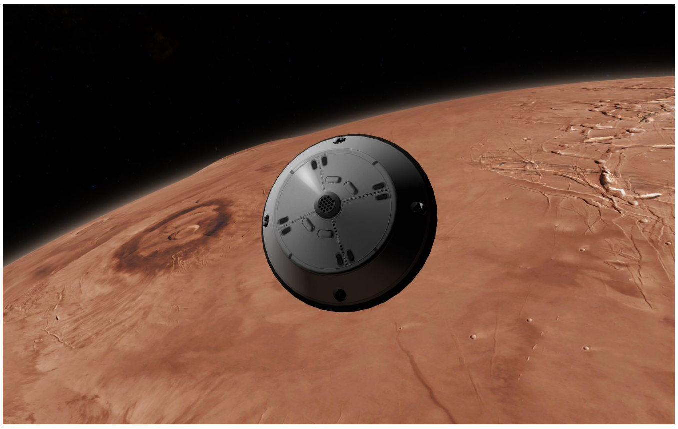
15b V1 Aero EI Burn V2 Enroute
T-4.5m to deorbit burn BT=21min
Activate AB in the left at T-180s, after the autopilot has aligned turn OFF the autopilot, wait till T-0 and manually burn or input Dv/time into BurntimeMFD and auto burn (BurntimeMFD doesn't save/load .scn data, so you have to do it manually), and the Aeroshell uses RCS also as the main thrusters which is not compatible with IMFD

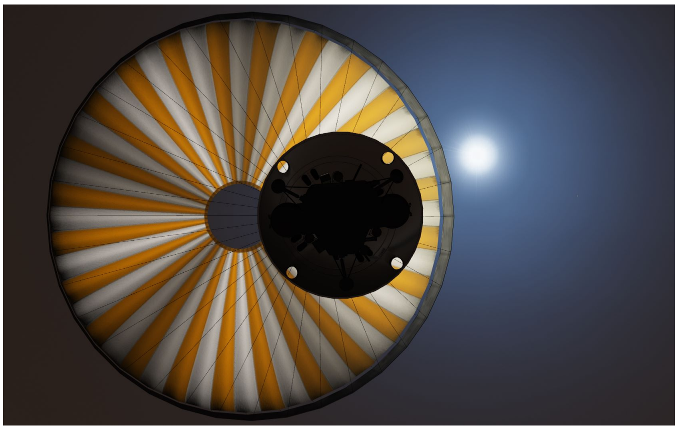
16 V1 Aero EI Trim V2 Enroute
T-0s Viking1-deorbit burn correction BT=3s
Activate Autoburn in the left MFD (same procedure as above)

17 V1 Aero EDL V2 Enroute
Mars Atmospheric entry
T-5m Atmospheric contact.
Fully automated descent:
At 6km radar altitude (~250m/s) the 16m parachutes are deployed.
At 5km the heatshield is jettisoned.
The 3 lander legs are extended.
At 1.5km the lander detaches, performs a collision avoidance maneuver and touches down at about 2.4 m/s.
The Viking1 Lander touched down in western Chryse Planitia.

18-Viking 1-Landed
Viking Lander 1 set down safely at 22.483 degrees north latitude and 47.94 degrees west longitude at 11:53:06 UT July 20, 1976. It landed about 17 miles (28 kilometers) from its planned target.

Ground camera view simulates the first photograph ever taken on the surface of Mars. It was obtained minutes after the spacecraft landed.





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C: camera views
CTRL+K: Raise Meteorology Mast
CTRL+J: Raise HGA
CTRL+U: Deploy sample boom

19 V1 Orbiting V2 MCC3
T-77s Viking2-MCC3 BT=57.3s
Activate Autoburn in the left MFD

20 V1 Orbiting V2 MOI
T-3m 21s Viking2 Mars Orbit Insertion BT=40.5min
Activate Autoburn in the left MFD
August 7 1976, Viking2 arrives at Mars

21 V1 Orbiting V2 OC1
T-75s to Viking2 Orbit Correction maneuver BT=1s
Activate Autoburn in the left MFD

22 V1 Orbiting V2 OC2
T-2m 15s to Viking2 Orbit Correction maneuver BT=1.7s
Activate Autoburn in the left MFD

23 V1 Orbiting V2 OC3
T-47s to Viking2 Orbit Correction maneuver BT=1.7s
Activate Autoburn in the left MFD

24 V1 Orbiting V2 OC4
T-3.5m to Viking2 Orbit Correction maneuver BT=41.2s
Activate Autoburn in the left MFD

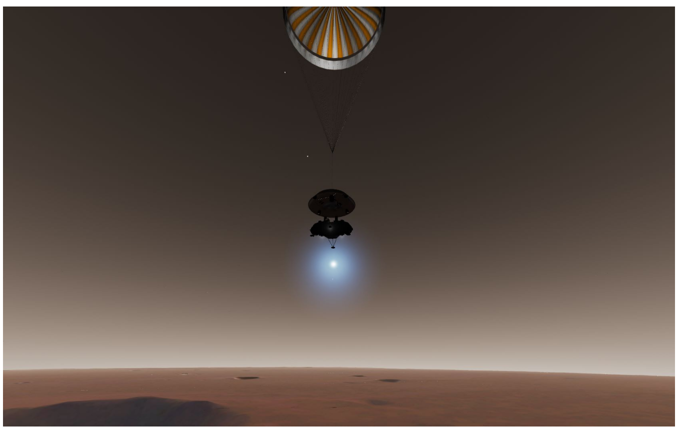
25 V1 Orbiting V2 Aero EI Burn
T-3min to deorbit burn BT=22min
Activate AB in the left at T-180s, after the autopilot has aligned turn OFF the autopilot, wait till T-0 and manually burn or input Dv/time into BurntimeMFD and auto burn (BurntimeMFD doesn't save/load .scn data, so you have to do it manually), and the Aeroshell uses RCS also as the main thrusters which is not compatible with IMFD

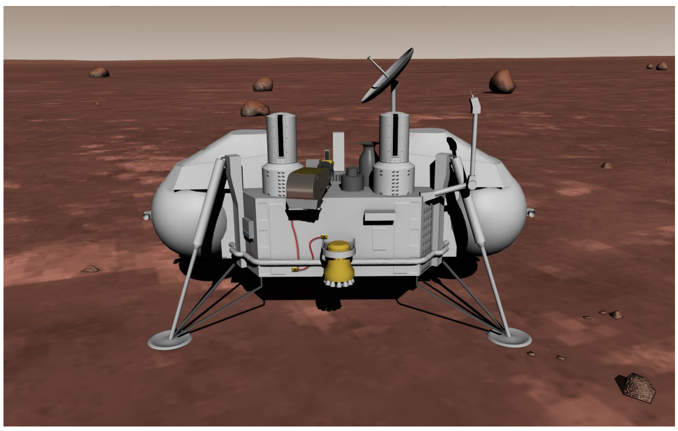
26 V1 Orbiting V2 Aero EI Trim
T-27s Viking1-deorbit burn correction BT=1.3s
Activate Autoburn in the left MFD (same procedure as above)

27 V1 Orbiting V2 Aero EDL
Mars Atmospheric entry
T-4m Atmospheric contact.
Fully automated descent:
At 6km radar altitude (~250m/s) the 16m parachutes are deployed.
At 5km the heatshield is jettisoned.
The 3 lander legs are extended.
At 1.5km the lander detaches, performs a collision avoidance maneuver and touches down at about 2.4 m/s.
The Viking 2 Lander touched down about 200 km west of the crater Mie in Utopia Planitia.

28 V1 Orbiting V2 Landed
Viking Lander2 set down (with one leg on a rock, tilted at 8.2 degrees) at 48.269 deg N latitude and 225.990 deg W longitude at 22:37:50 UT September 3, 1976.

C: camera views
CTRL+K: Raise Meteorology Mast
CTRL+J: Raise HGA
CTRL+U: Deploy sample boom





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29 V1 Phobos Burn V2 Orbiting
T-5m to Viking1 Phobos intercept burn BT=139s
Activate Autoburn in the left MFD

30 V1 Phobos Trim V2 Orbiting
T-71s to Viking1 Phobos intercept trim BT=7.5s
Activate Autoburn in the left MFD

31 V1 Phobos Flyby V2 Orbiting
T-11m to perigee 171km

31b V1 Phobos Flyby V2 Orbiting
An unhistorical but even closer flyby.

32 V1 Orbiting V2 Deimos Burn
T-4.5m to Viking2 Deimos intercept burn BT=261s
Activate Autoburn in the left MFD

33 V1 Orbiting V2 Deimos Trim
T-3.5m to Viking2 Deimos intercept trim BT=7.2s
Activate Autoburn in the left MFD

34 V1 Orbiting V2 Deimos Flyby
T-5m to perigee 17km! - Enjoy the view!

On 7 August 1980 the Viking 1 Orbiter was running low on attitude control gas and its orbit was raised from 357 × 33943 km to 320 × 56000 km to prevent impact with Mars and possible contamination until the year 2019. Operations were terminated on 17 August 1980 after 1485 orbits.
The Viking 1 Lander was named the Thomas Mutch Memorial Station in January 1982 in honor of the leader of the Viking imaging team. It operated until 13 November 1982 when a faulty command sent by ground control resulted in loss of contact.

The Viking 2 orbiter developed a leak in its propulsion system that vented its attitude control gas. It was placed in a 302 × 33176 km orbit and turned off on 25 July 1978 after returning almost 16,000 images in 706 orbits around Mars.
The Viking 2 Lander operated on the surface for 1281 Mars days and was turned off on 11 April 1980 when its batteries failed.

By the time the Viking 1 lander's mission ended in November 1982, its onsurface operational record of 2,307 days would remain unbroken for almost three decades, until finally exceeded by NASA's still-going Opportunity rover in May 2010.
In the meantime, from high above, the Viking 1 orbiter imaged the surface at resolutions of between 500 feet (150 meters) and 1,000 feet (300 meters), revealing immense canyons, volcanoes, lava plains, wind-formed features and evidence of ancient surface water. Despite the emphasis upon searching for ancient Martian biology, nothing was found by either the Viking 1 lander or its twin, the Viking 2 lander, which alighted in the vast impact basin of Utopia Planitia.
However, these remarkable dual missions—and the four spacecraft which accomplished them—would transform our knowledge of the Red Planet, rewrite the textbooks and provide us with our most complete set of data about Mars for the following quarter-century. -AmericaSpace

HAPPY 50th ANNIVERSARY!
-Hail Probe

-Dedicated to my dear mother who sparked my imagination with scifi when I was a child.