**Skylab**

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*For other uses, see Skylab (disambiguation).*

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| ***Skylab*** | | |
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| A view of Skylab from the departing Skylab 4 mission | | |
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| **Station statistics** | | |
| **NSSDC ID:** | 1973-027A |  |
| **Call sign:** | Skylab |  |
| **Crew:** | 3 |  |
| **Launch:** | 1973-05-14 17:30:00 UTC |  |
| **Launch pad:** | LC-39A, Kennedy Space Center |  |
| **Reentry:** | 1979-07-11 16:37:00 UTC near Perth, Australia |  |
| **Mass:** | 77,088 kg (169,950 lb.) |  |
| **Living volume:** | 10,000 cu ft (283.17 m3) |  |
| **Perigee:** | 269.7 mi (434.0 km) |  |
| **Apogee:** | 274.6 mi (441.9 km) |  |
| **Orbit inclination:** | 50° |  |
| **Orbital period:** | 93.4 min |  |
| **Orbits per day:** | 15.4 |  |
| **Days in orbit:** | 2,249 days |  |
| **Days occupied:** | 171 days |  |
| **Number of orbits:** | 34,981 |  |
| **Distance travelled:** | ~890,000,000 mi (1.43×109 km) |  |
| Statistics as of deorbit on 1979-07-11 | | |
| **Configuration** | | |
|  | | |
| Skylab configuration with docked Apollo Command/Service Module | | |

**Skylab** was the United States' first space station, and the second space station visited by a human crew. It was also the only space station NASA launched alone. The 100-ton space station was in Earth's orbit from 1973 to 1979 and it was visited by crews three times in 1973 and 1974.

**Background**

The exact origin of the project is difficult to pinpoint because a number of different but related proposals were floated by various NASA centers before Skylab itself was launched.

**Early studies**

A key event took place in 1959, when Werner von Braun submitted his final Project Horizon plans to the U.S. Army. The overall goal of Horizon was to place a human on the Moon, a mission that would soon be taken over by the rapidly-forming NASA. Although concentrating on the Moon missions, von Braun also detailed an orbiting laboratory built out of a Horizon upper stage. This basic concept of re-using existing boosters would lead directly to a number of follow-on designs and eventually the Skylab that actually flew.

In 1963, the U.S. Air Force started development of the Manned Orbital Laboratory (MOL), a small space station primarily intended for photo reconnaissance using large telescopes directed by a two-man crew. The station was the same diameter as a Titan II upper stage. The stations were to be launched with the crew riding atop in a modified Gemini capsule with a hatch cut into the heat shield on the bottom of the capsule.

A number of NASA centers saw the MOL as something of a threat and started back-room studies on various space station designs of their own. Most of these were simply "back of a napkin" type designs with no official backing. Studies generally looked at platforms launched by the Saturn V, followed up by crews launched on Saturn IB using an Apollo Command and Service Module (CSM), or alternately Gemini capsule on a Titan II-C, the latter being much less expensive in the case where cargo was not needed.

But at the same time NASA was also looking for proposals for a major post-Apollo follow-on mission, including studies of a very large 24-man station with an operating lifetime of about five years. Lockheed was involved in this project and proposed a station that they felt would be a natural follow-on to the Moon missions. One requirement for a permanent station would be periodic resupply and for this role Lockheed suggested both Apollo-derived cargo rocket and a new lifting body craft. After a lengthy and circuitous history, the new supply rocket would emerge as the Space Shuttle and its space station proposal as the Space Station Freedom.

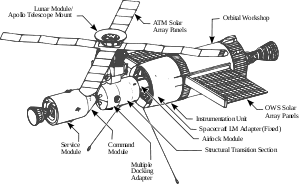
**Apollo Applications Program**

In June 1964, NASA headquarters in Washington set up the **Apollo Logistic Support System Office**, originally intended to study various ways to modify the Apollo hardware for scientific missions. The office initially proposed a number of projects for direct scientific study, including an extended-stay lunar mission which required two Saturn V launchers, a "lunar truck" based on the Lunar Module (LEM), a large manned solar telescope using an LEM as its crew quarters and small space stations using a variety of LEM or CSM-based hardware. Although it didn't look at the space station specifically, over the next two years the office would become increasingly dedicated to this role. In 1965 the office was renamed, becoming the **Apollo Applications Program** (AAP).

As part of their general work, in August 1964 MSC presented studies on an expendable lab known as **Apollo "X"**, short for *Apollo Extension System*. "Apollo X" would have replaced the LEM carried on the top of the S-IVB stage with a small space station slightly larger than the CSM's service area, containing supplies and experiments for missions between 15 and 45 days' duration. Using this study as a baseline, a number of different mission profiles were looked at over the next six months.

Von Braun proposed a more ambitious plan to build a much larger station. His design replaced the S-IVB stage of a complete Saturn V with an aeroshell, primarily as an adapter for the CSM on top. Inside the shell was a cylindrical equipment section slightly smaller in diameter than the CSM. On reaching orbit, the S-II booster would be vented to remove any remaining hydrogen fuel, then the equipment section would be slid into it via a large inspection hatch. The station filled the entire interior of the S-II stage's hydrogen tank, with the equipment section forming a "spine" and living quarters between it and the walls of the booster. This would have resulted in a very large 33-by-45-foot (10.1 by 13.7 m) living area. Power was to be provided by solar cells lining the outside of the S-II stage.

One problem with this proposal was that it required a dedicated Saturn V launch to fly the station. Engineers could not "piggyback" the station's launch on a lunar mission, which required a working S-IVB stage. At the time the design was being proposed, all of the then-contracted Saturn V's were already earmarked for Moon launches. Further work led to the idea of launching a smaller station based on the S-IVB instead, launching it on a surplus Saturn IB. Several planned Earth-orbit test missions for the LEM and CSM had been canceled, leaving a number of Saturn IB's free for use.



An early "wet workshop" version of Skylab.

Since the Saturn I had a much lower throw weight capability, the S-IV stage could not be left empty; its thrust would be needed for the mission. This limitation led to the development of the wet workshop concept, which led naturally out of von Braun's idea of using an existing stage after its fuel had burned off. However, in this case the station was to be built out of the S-IVB stage itself, as opposed to the S-II below it. A number of S-IVB-based stations were studied at MSC, but even the earliest, from mid-1965, had much in common with the Skylab design that actually flew. An airlock was placed in the equipment area immediately below where the LEM sat on a Moon mission and a minimum amount of equipment was installed in the tank itself in order to avoid taking up too much fuel volume. After launch, a follow-up mission launched by a Saturn IB would carry up additional equipment in place of its LEM, including solar panels, an equipment section and docking adaptor, and various experiments. Douglas Aircraft, builder of the S-IVB stage, was asked to prepare proposals along these lines.

On 1 April 1966, MSC sent out contracts to Douglas, Grumman, and McDonnell for conversion of a S-IVB spent stage under the name **Saturn S-IVB spent-stage experiment support module** (SSESM). In May the Apollo astronauts voiced concern over purging the stage's hydrogen tank in space. Nevertheless, in late July it was announced that the Orbital Workshop would be launched as a part of Apollo mission AS-209, originally one of the Earth-orbit CSM test launches, followed by two Saturn I/CSM crew launches, AAP-1 and AAP-2.

Design work continued over the next two years, in an era of shrinking budgets. In August 1967 NASA announced that the lunar mapping and base construction missions examined by the AAP were being canceled. Only the Earth-orbiting missions remained, namely the Orbital Workshop and Apollo Telescope Mount solar observatory. Later several Moon missions were canceled as well, originally to be Apollo missions 18 through 20. The cancellation of these missions freed up three Saturn V boosters for the AAP program. Although this would have allowed them to develop von Braun's original S-II based mission, by this time so much work had been done on the S-IV based design that work continued on this baseline. With the extra power available, the wet workshop was no longer needed; the S-IC and S-II lower stages could launch a "dry workshop" directly into orbit.

**Skylab history**

On 8 August 1969, the McDonnell Douglas Corporation received a contract for the conversion of two existing S-IVB stages to the Orbital Workshop configuration. One of the S-IV test stages was shipped to McDonnell Douglas for the construction of a mock-up in January 1970. The Orbital Workshop was renamed "Skylab" as a result of a NASA contest. The actual stage that flew was the upper stage of the AS-212 rocket (the S-IVB stage). The mission computer used aboard Skylab was the IBM System/4Pi TC-1, a relative of the AP-101 Space Shuttle computers.



Launch of the modified Saturn V rocket carrying the Skylab space station

Skylab was launched 14 May 1973 by a Saturn INT-21 (a two-stage version of the Saturn V rocket) into a 235 nautical mile (435 km) orbit. The launch is sometimes referred to as Skylab 1, or SL-1. Severe damage was sustained during launch, including the loss of the station's micrometeoroid shield/sun shade and one of its main solar panels. Debris from the lost micrometeoroid shield further complicated matters by pinning the remaining solar panel to the side of the station, preventing its deployment and thus leaving the station with a huge power deficit. The station underwent extensive repair during a spacewalk by the first crew, which launched on 25 May 1973 (the SL-2 mission) atop a Saturn IB. If the crew had failed to repair Skylab in time, the plastic insulation inside the station would have melted, releasing poisonous gas and making Skylab completely uninhabitable. They stayed in orbit with Skylab for 28 days. Two additional missions followed with the launch dates of 28 July 1973 (SL-3) and 16 November 1973 (SL-4) with mission durations of 59 and 84 days, respectively. The last Skylab crew returned to the Earth on 8 February 1974.



View of Skylab space station cluster in Earth orbit from the departing Skylab 4 command module.

**Operations in orbit**

Skylab orbited Earth 2,476 times during the 171 days and 13 hours of its occupation during the three manned Skylab missions. Astronauts performed ten spacewalks totaling 42 hours 16 minutes. Skylab logged about 2,000 hours of scientific and medical experiments, including eight solar experiments. The Sun's coronal holes were discovered because of these efforts. Many of the experiments conducted investigated the astronauts' adaptation to extended periods of microgravity. Each Skylab mission set a record for the amount of time astronauts spent in space.

**Abandonment and re-entry**

Skylab was abandoned after the SL-4 mission in February 1974. At that time there was only one Saturn IB rocket left in the inventory while all other Saturn IB and Saturn V rocket parts had been donated to museums. The lone remaining Saturn IB was used to send the Apollo mission into orbit to rendezvous with a Soviet Soyuz space capsule in orbit, a mission that was called the Apollo-Soyuz Test Project (ASTP). The next manned mission to be launched into space by NASA did not occur until the first Space Shuttle mission (STS-1) was launched on April 12, 1981. Between 1975 and 1981 there was no launching rocket available to send another mission to the Skylab.



*Vanguard* (T-AGM-19) seen here as a NASA Skylab tracking ship. Note the tracking radar and telemetry antennas.

Skylab was left in a parking orbit that was expected to last at least eight years. The Space Shuttle was intended to dock with the Skylab and to boost this space station to a higher safe altitude in 1979. However, the Space Shuttle was not ready to fly until mid-1981. Increased solar activity heated the outer layers of the Earth's atmosphere and thereby increased drag on Skylab, leading to an early re-entry. In the previous weeks before re-entry, ground controllers had re-established contact with the six-year-old space station and were able to adjust its orientation for ideal re-entry dynamics. Skylab's re-entry occurred at approximately 16:37 UTC 11 July 1979. The footprint for its re-entry into the Earth's atmosphere was a narrow band (about four degrees of latitude wide) beginning at about 48°S 87°E﻿ / ﻿48°S 87°E﻿ / -48; 87 and ending at about 12°S 144°E﻿ / ﻿12°S 144°E﻿ / -12; 144, an area covering portions of the Indian Ocean and Western Australia.



Debris was found between Esperance, Western Australia, and Rawlinna, Western Australia, from 31° to 34°S and 122° to 126°E. The Shire of Esperance fined the United States $400 for littering, a fine which remained unpaid for 30 years. The fine was paid in April 2009, when radio show host Scott Barley of Highway Radio raised the funds from his morning show listeners and paid the fine on behalf of NASA.



The largest fragment of Skylab recovered after its re-entry through Earth's atmosphere. It is on display at the United States Space & Rocket Center.

Skylab's demise was an international media event, with merchandising, wagering on time and place of re-entry and nightly news reports. The *San Francisco Examiner* offered a $10,000 prize for the first piece of Skylab to be delivered to their offices. Seventeen-year-old Stan Thornton scooped a few pieces of Skylab off the roof of his home in Esperance, W.A., and then caught the first flight to San Francisco, where he collected his prize. In a coincidence for the organizers, the annual Miss Universe pageant was scheduled to be held a few days later, on 20 July 1979 in nearby Perth, Western Australia. A large piece of Skylab debris was displayed on the stage.

A flight-quality back-up Skylab was also built. It is on display at the National Air and Space Museum in Washington, D.C. A full-size training mock-up once used for astronaut training is located at the Lyndon B. Johnson Space Center visitor's center in Houston, Texas. Another full-size training mock-up is now kept in a museum at Huntsville, Alabama, that was made from spare parts. It is currently being restored.

**Unflown planned missions**

**Skylab 5**

Skylab 5 would have been a short 20-day mission to conduct scientific experiments and boost Skylab into a higher orbit. Astronauts Vance Brand (commander), Don Lind (command module pilot), and William B. Lenoir (science pilot) would have been the crew for this mission, with Brand and Lind being the prime crew for the never-flown Skylab Rescue flights.

**Skylab B**

NASA considered use of the existing Apollo/Saturn material for launching a second Skylab B station in May 1973 or later, but rather, NASA decided to donate all of the hardware to museums. Launching another Skylab with another Saturn V rocket would have been very costly, and it was decided to spend this money on the development of the Space Shuttle, instead.

The Skylab B is now in the National Air and Space Museum.

**Planned shuttle missions**

Skylab was in need of a major overhaul, including new gyroscopes, and was low on fuel. Some systems were not designed for maintenance in space; however this type of problem had been overcome before such as when the primary coolant loop was repaired. In 1977, when NASA still believed the shuttle would be ready by 1979, it completed a four-phase plan to reuse Skylab:

1. An early Shuttle flight would boost Skylab to a higher orbit that would add five years of life. The shuttle might have pushed or towed the station, but attaching a booster — the Tele-operated Reboost System (TRS) — to the station was more likely based on astronauts' training for the task. Contracts for the Skylab reboost module were awarded in the late 1970s, and the design of the over 4 metric ton module, included a docking port and nearly 3 tons of propellant.
2. In two shuttle flights, Skylab would be refurbished. In January 1982, the first mission would attach a docking adapter and conduct repairs. In August 1983, a second crew would replace several system components.
3. In March 1984, shuttle crews would attach a solar-powered Power Expansion Module, refurbish scientific equipment, and conduct 30- to 90-day missions using the Apollo Telescope Mount and the earth resources experiments.
4. Over five years Skylab would be expanded to accommodate six to eight astronauts, with a new large docking/interface module, additional logistics modules, Spacelab modules and pallets, and an orbital vehicle space dock using the shuttle's external tank.

The cost (the first three phases would require about $60 million in 1980s dollars, not including launch costs) and Skylab's early demise aborted the plan. Also rejected was a proposal to launch the TRS using one or two unmanned rockets.

**Skylab mission designations**



Robbins Medallions issued for Skylab Missions

The number identification of the manned Skylab missions is the cause of much confusion. Originally, the unmanned launch of Skylab and three manned missions were numbered **SL-1** through **SL-4**. During the preparations for the manned missions, some documentation was created with a different scheme--**SLM-1** through **SLM-3**--for those missions only. William Pogue credits Pete Conrad with asking the Skylab program director which scheme should be used for the mission patches and the astronauts were told to use 1-2-3, not 2-3-4. By the time NASA administrators tried to reverse this decision, it was too late, as all the in-flight clothing had already been manufactured and shipped with the 1-2-3 mission patches.

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| **Mission** | **Patch** | **Commander** | **Pilot** | **Science Pilot** | **Launch date** | **Landing date** | **Duration (days)** |
| **Skylab 1 *SL-1*** |  | ***unmanned launch of space station*** | | | 1973-05-14 17:30:00 UTC | 1979-07-11 16:37:00 UTC | 2248.96 |
| **Skylab 2 *SL-2* (*SLM-1*)** |  | Pete Conrad | Paul Weitz | Joseph Kerwin | 1973-05-25 13:00:00 UTC | 1973-06-22 13:49:48 UTC | 28.03 |
| **Skylab 3 *SL-3* (*SLM-2*)** |  | Alan Bean | Jack Lousma | Owen Garriott | 1973-07-28 11:10:50 UTC | 1973-09-25 22:19:51 UTC | 59.46 |
| **Skylab 4 *SL-4* (*SLM-3*)** |  | Gerald Carr | William Pogue | Edward Gibson | 1973-11-16 14:01:23 UTC | 1974-02-08 15:16:53 UTC | 84.04 |

**Gallery**

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| The waste management facilities in the backup Skylab at the National Air and Space Museum. | An astronaut dines aboard the backup Skylab at the Smithsonian NASM. |

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