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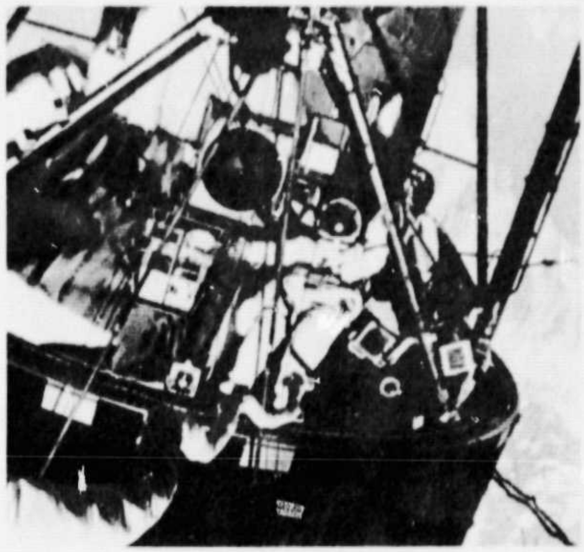
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NASA mission report

The Final Skylab Mission

Man At Home And At Work In Space



Gibson during fourth EVA.

"I'd like people to think of our mission as one where three guys went up . . . and tried to live a normal life in space to show it could be done . . . that man can live a normal existence in space and that he can accomplish a great many things that can't be done on the ground." . . . Gerald P. Carr, commander, Skylab 4, at news conference between the Skylab astronauts in space and reporters on Earth, January 2, 1974.

The record of Skylab 4, the official name for the third and last manned mission to the nation's first space station, clearly demonstrated Carr's words. It indicated that with proper exercise and diet, there may be no limit to how long man can make his home in space.

Records are made to be broken, and the final Skylab manned mission did just that. Its crew, astronauts Carr, Edward G. Gibson, and William R. Pogue established records not only for the longest single manned space mission (84 days, 1 hour, 16 minutes) but also for the longest periods of work in Earth orbit outside of a spacecraft (6 hours 33 minutes on November 22, and 7 hours 1 minute on December 25, 1973).

In doing so, the three astronauts, who had never before been in space, rose from space rookies to space champs, breaking the previous record for the longest individual total flight time in space. This event occurred at 1:45 a.m. EDT, January 25, 1974, when they passed the 69 days, 15 hours, and 45 minutes accumulated by astronaut Alan L. Bean on Apollo 12 and the second Skylab manned mission.

Bean radioed his congratulations and added: "You did it the hard way—all in one shot."

Medical Results Encouraging

The astronauts spent more time on major medical experiments than the first two crews. The information derived from these experiments is contributing to knowledge of the human body as well as to planning for possible future long duration missions in space.

As a result of information acquired in Skylab, many doctors see no medical reasons why men cannot go on such extended missions. Among them is Dr. Charles A. Berry, until recently NASA Director of Life Sciences, who had been medically watching astronauts since 1958. His view: "From what we know today, there is no medical reason to bar a two-year mission to Mars."

Although spending a considerably longer time in space than their predecessors, the Skylab 4 astronauts not only were in better shape upon their return to Earth but also readjusted more quickly to Earth's

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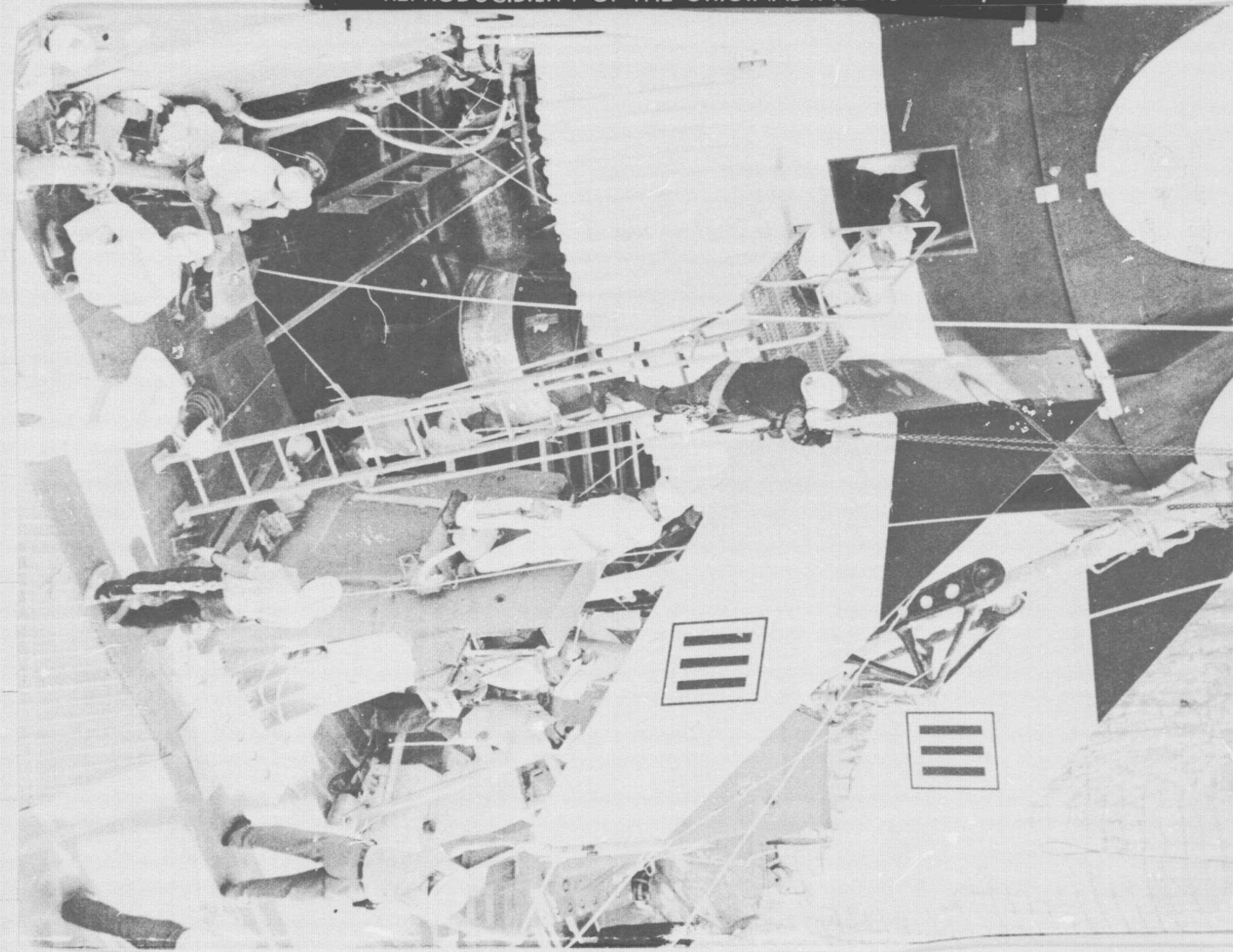


gravity. This may have been due to the greater amount of exercise they performed using a portable treadmill (which they brought into space with them) and the stationary bicycle that already was aboard Skylab).

Measured for the first time on Skylab 4 was another phenomenon of weightlessness: the astronauts actually grew taller, by an inch or more, and trimmer. The changes are believed to result from stretching of the vertebrae of the spinal column and shifting of body fluids from the lower to the upper extremities. (Some doctors attribute space motion sickness to this shift of body fluids.) The situation is reversed by gravity upon return to Earth, causing the men to shrink back to their normal heights.

Nutritionists have prided themselves on the meals they had developed for Skylab. These meals were a far cry from the tube-type feedings of early space flights and were described as almost like home-cooked meals. But the Skylab astronauts complained about the blandness of their diet, even about dishes that they had eaten with relish on Earth.

Although the foods were well seasoned, they lacked flavor for the space-borne astronauts and were literally inundated with onion, garlic, and pepper. Scientists cannot yet explain this decrease in ability to taste.

The Light That Failed

A passing comet got more than passing interest from Skylab. The Comet Kohoutek, named for its Czech-born discoverer Lubos Kohoutek, was first observed far out in space in March 1973. The first observation was some 9½ months before the comet would sweep into the inner solar system, giving scientists an unprecedented opportunity to prepare observing instruments for its arrival. Skylab was drafted into Operation Kohoutek, the worldwide many-faceted study of the comet.

Some calculations indicated this would be the comet of the century, lighting up the sky for the Christmas–New Year 1973-1974 season. Scientists and the public waited with anticipation for this celestial marvel to come from the outer reaches of the solar system beyond Pluto.

On December 13, 1973, the Skylab 4 astronauts sighted Kohoutek and trained their Apollo Telescope Mount and hand-held cameras on it. They continued to incorporate Kohoutek observations into their program until the comet was obscured by the Sun. On December 30, as Kohoutek swept out from behind the Sun, it was sighted by Carr and Gibson while on EVA. Carr remarked: "It looks yellow and orange, just like a flame." "Mostly yellow," said Gibson. Both filmed the comet with hand-held cameras.

Kohoutek's unexpected dimness to Earth viewers did not lessen its scientific importance. Scientists are gathering significant information from the observations of Kohoutek by Skylab 4, NASA unmanned spacecraft such as Mariner 10 and the Orbiting Astronomical Observatory 3 (Copernicus), sounding rockets, high altitude aircraft, balloons, and ground telescopes.

Viewing the Blue Planet

The viewer from space could characterize Earth as the Blue Planet because blue is its predominant color. Skylab's purpose in viewing Earth was to define the best instruments for and determine man's usefulness in Earth surveys from space. However, Skylab has also provided a wealth of data about the Earth and its resources and about such scourges as pollution, infestation, and drought.

Skylab's data are applicable to research in agriculture, forestry, ecology, geology, geography, meteorology, hydrology, and oceanography. The Skylab 4 astronauts took about 20,000 pictures of Earth and gathered additional data about our planet on some 30 kilometers (19 miles) of magnetic tape. Some observations:

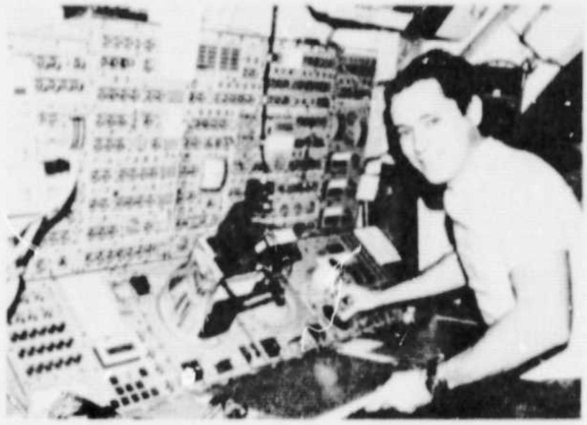
- Swirling pools, believed to be cold water, occur in the warm Gulf Stream that runs from the Caribbean, along the southeast United States coast, and then eastward to Europe. This has important implications for weather forecasting.
- Effects of strip mining in Illinois, Indiana, and Kentucky.
- Newly revealed subterranean hot springs and gases that could contribute to meeting Earth's energy requirements.
- Swirling cloud patterns that seem to be generated by islands.

Studying Our Nearest Star

The approximately 75,000 telescopic images that the Skylab 4 astronauts made of the Sun will add to the storehouse of knowledge about our most important celestrial body. The images were taken in the X-ray, ultraviolet, and visible portions of the spectrum.

New stabilizing fin for first stage of Saturn 1B is hoisted into position. It replaces fin in which corrosion cracks were discovered.

Pogue and Carr, in home-like chore of putting out trash, pass bags through Skylab trash airlock.



Gibson at ATM solar observatory console.

Cloud wakes over Campbell Island, 400 miles south of New Zealand, photographed by Skylab 4 astronauts.

X-ray and ultraviolet images, which can tell much about the Sun, cannot be obtained by ground observatories because of the Earth's atmosphere. The pictures strengthen the evidence that the solar corona is more dynamic and complex than previously believed.

Solar physicists awaited with anticipation the Skylab 4 observations of a medium sized solar flare on January 21 1974. It was the first time a flare had been recorded from beginning to end with powerful spaceborne instruments. There is as yet no way to predict a flare. The processes that take place at its beginning are very important as it is then that the puzzling energy transfer from magnetic field into thermal (heat) energy takes place. Unlocking the secret of this energy transfer may offer a way to obtain inexpensive energy on Earth.

Catching this flare is a tribute to the patience and perseverance of Astronaut Gibson who spent long hours at his ATM solar observing instruments hoping to be on hand when such a transient solar event took place.

Planned Repair Chores

The final Skylab crew, like its two predecessors, was not without its share of repair work. On November 19, 1973, they replenished the cooling fluid in the system that kept Skylab's electronic equipment from overheating. The second Skylab crew had discovered that the coolant was escaping but was unable to locate the leak.

The Skylab 4 crew had brought from Earth a tank with 40 pounds of coolant, which was enough to refill the cooling system with some left over. The refill was sufficient for the duration of the mission.

On November 22, in the first Skylab 4 EVA (Extra-Vehicular Activity), Gibson and Pogue repaired and adjusted an antenna used in Earth surveys. The antenna was in an awkward spot. Gibson and Pogue had to edge around a pipe to reach the antenna, and Gibson had to steady Pogue by the feet to allow Pogue to fix it.

Thus, the third crew, like the others, demonstrated men in space can not only gather otherwise unavailable scientific data but also complete difficult repair or construction jobs. Skylab reemphasized that people are needed in space because of their unique qualities of adaptability and resourcefulness.

Unanticipated Problems

Man's longest and most productive mission into space had a less than auspicious beginning. In October 1973, cracks were discovered in the eight huge tail fins that stabilized the Saturn 1B launch vehicle of Skylab 4. These could have caused the rocket to break up in flight. Replacement of each of the 192-kilogram (423-pound) fins delayed the launch for five days. The nearly microscopic cracks were blamed on stresses on the rocket during fueling tests and on corrosion due to the Atlantic Ocean's salt-laden winds.

An oversight caused two Saturn fuel tanks to buckle. A plastic cover over the tanks' vent to protect it during a rainstorm prevented air from being drawn into them as their kerosene fuel was drained. The resulting vacuum caused the tops of the tanks to collapse. However, fueling the tanks under pressure forced the domes back into position. Metallurgists ruled the tanks were safe for launch.

During another check, cracks were discovered in seven of eight support beams in the circular band that connects Saturn's first and second stages. This was solved by splinting the supports with heavy aluminum strips. Residual tension from manufacturing might have caused these cracks.

Finally, the Skylab 4—Saturn 1B vehicle was pronounced fit for launch. At 9:01 a.m. EDT, November 16, 1973, the vehicle roared from the launch pad. "Smooth ride," radioed Astronaut Carr as the vehicle trailed a bright orange plume of flame across the

Atlantic. His opinion was confirmed by Mission Control, Houston, Texas with: "Everything's looking real good."

At the time, Skylab Program Director William C. Schneider cautiously called Skylab 4 "a planned 60-day open-ended mission with enough consumables on board to last as long as 84 days." He emphasized that beginning on the mission's 56th day, decisions would be made weekly on whether to prolong the mission. The decisions would be based on crew health, work to be done, remaining food and supplies, and condition of equipment.

During their first day in space, the crew did not report to Mission Control that Pogue had had some motion sickness. Later, a transcript of the onboard tape revealed this to the ground. Alan B. Shepard, Jr., chief of the Astronaut Office, chided the crew and reminded them: "We are down here to help you, so let us know if you have any problems as you go along."

To which Skylab 4 commander Carr responded: "Okay. I agree with you. It was a dumb decision."

The Skylab 4 crew actually fared better than the previous crew which was hampered severely by motion sickness during its first few days in space. Carr and Gibson took the drug scopolamine/d/amphetamine, while Pogue took ephedrine and promethazine. The former drug is stronger, but its effects are not as lasting.

The motion sickness episode proved but a prelude to other difficulties. Struggling to keep up with a heavy workload, the crew made errors on several experiments, including neglecting to install filters on an Earth study instrument composed of six cameras. The information was recouped later during another sweep of Earth.

The crew mentioned lack of training for some of their medical experiments "which we had never seen before." This slowed them down, they said. And a delay anywhere causes time-programmed tasks to bunch up and the schedule to be wrecked. The crew also asked for more time to relax.

All this raised questions in some quarters. For example, can prolonged isolation and weightlessness be depressing, tiring, and cause mistakes?

After some frank exchanges, the men in Skylab and those on the ground held an operational discussion. As it turned out, the crux of the problem appeared to be that the crew of Skylab 4 started at the work pace that the previous crew had reached after several weeks in space. This proved too much for them to handle while they were adapting to their new environment.

As a result of the frank air-to-ground exchanges, work schedules were adjusted and the Skylab crew got more time to relax. Subsequently, both the crew's performance and its relationship with Mission Control improved enormously. By the end of the mission, the crew completed more than expected; for example, 39 Earth survey passes were made, although only 30 were planned, and the crew used two complete sets of solar instrument film, although only one set had been planned.

On January 25, 1974, as the Skylab 4 astronauts headed for new records in space, they were lauded by James C. Fletcher, NASA Administrator, and George M. Low, NASA Deputy Administrator, in a message from Mission Control: "Congratulations . . . for the outstanding work you have done and are continuing to do . . . Keep up the good work."

Another threat to the mission occurred in November 1973. One of the three gyroscopes that stabilized Skylab failed and could not be repaired. Its loss posed no problem to normal flight but required special effort by the crew to align the craft for Earth surveys. If another gyroscope had been lost, it would have necessitated that the mission be prematurely ended.

The final ordeal occurred as the astronauts were returning to Earth. The astronauts discovered that their control system would not fire the tiny thrusters (rockets) that would keep the Skylab 4 ferrycraft properly oriented. If not oriented correctly, the spacecraft might have landed far from the targeted area, where recovery ships were waiting to pick it up.

But a procedure was available for just such an emergency. It involved bypassing the computer that controls the spacecraft rocket firings. (Investigation after return to Earth showed the problem was due to accidental opening of four circuit breakers.)

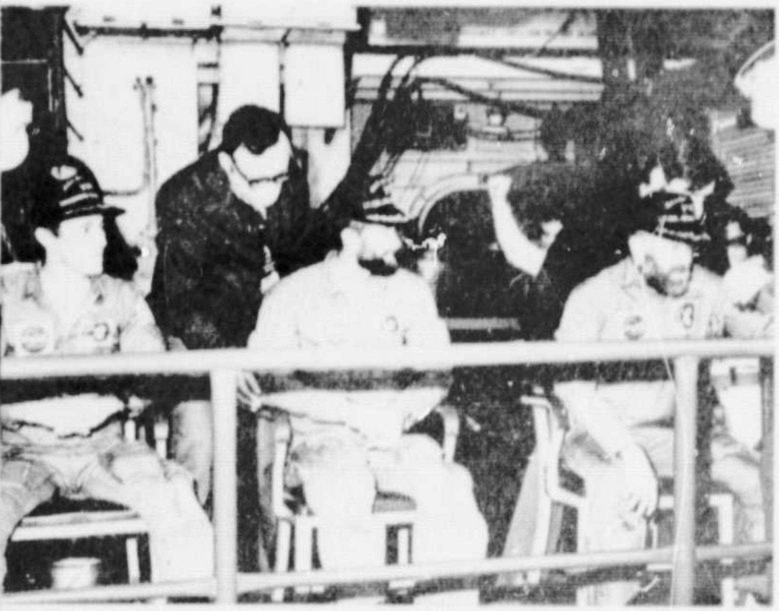
At 11:18 a.m. EDT, February 8, 1974, the Skylab 4 crew landed safely right on target in the Pacific Ocean about 290 kilometers (180 miles) southwest of San Diego, California. In less than an hour, they were aboard the recovery ship, the helicopter carrier USS New Orleans.

Northwest Wyoming during Skylab 4 mission. Dark area is Yellowstone National Park.

U.S. Manned Spaceflight Record

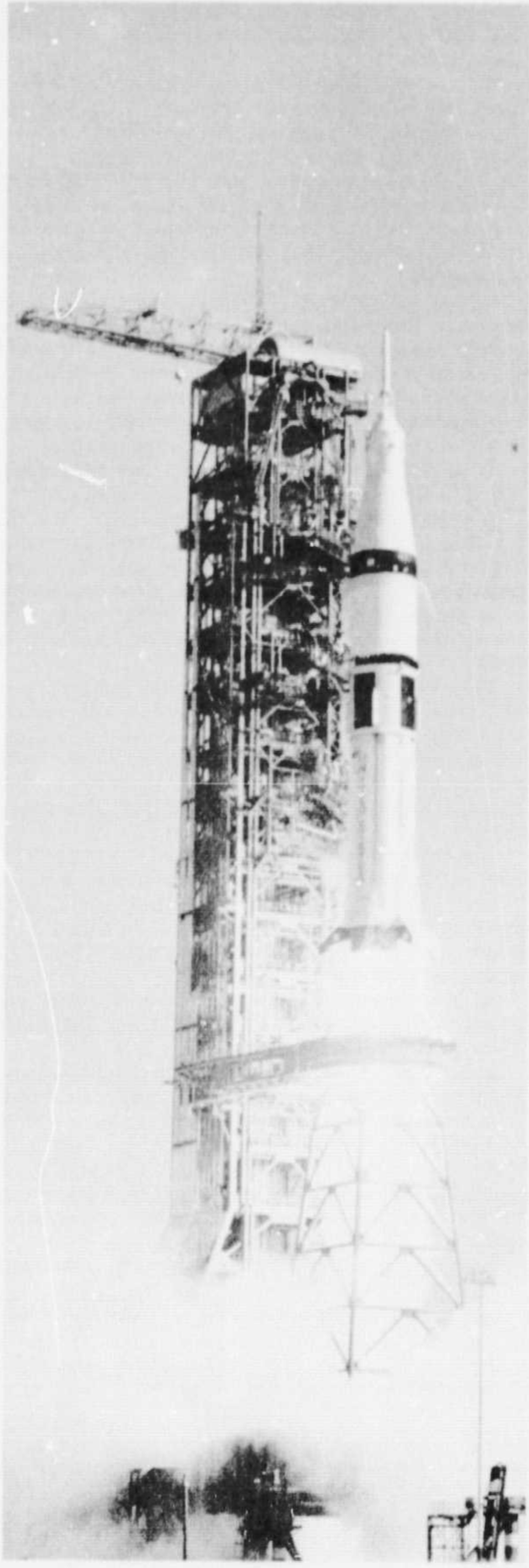
	Flights	Manned Time*
Mercury	6	53:55
Gemini	10	969:52
Apollo	11	2,502:00
Skylab	3	4,117:17
Total	30	7,643:04

*Hours: Minutes



Skylab 4 crew on U. S. S. New Orleans about an hour after splashdown in the Pacific. Left to right; Gibson, Pogue, and Carr.

At right; Skylab 4 launch.



Skylab Epilog

Skylab, the nation's pioneering space station program, proved that man can function effectively for long periods in space. It has clearly demonstrated the usefulness of man. It has also produced an unprecedented wealth of data in such diverse fields as: study of the Sun; surveys of Earth to meet mankind's need for new sources of energy, food, and fresh water and improved utilization of existing resources; understanding of life processes; improved crystals and alloys by producing them in the weightless environment of space; and unique data on the comet Kohoutek. Skylab's impact may not be realized for many years, but it has probably provided bases for important discoveries that could expand significantly man's knowledge and well-being.

Today, Skylab is a ghost ship, destined to circle the Earth dark and vacant for as long as ten years. In time, it will drift down into the denser part of the atmosphere. Eventually, atmospheric friction will heat and cause it to break apart, falling to Earth like a meteor shower in a fiery finale to a brilliant career.

Sometime before this, another group of astronauts may visit Skylab, using the space Shuttle, the vehicle that NASA is developing to ferry men and equipment on a regular basis between Earth and Earth orbit. Their purpose will not be to reopen the space station but to retrieve articles left in a "time-capsule" bag. Examination of these articles would give data on their reaction to long duration space flights.

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Skylab, now a ghost ship, is snapped by the departing Skylab 4 crew.

Some Skylab Statistics

Missions	First	Second	Third	Total
Launch	5/25/73 9:00 a.m. EDT	7/28/73 7:10 a.m. EDT	11/16/73 9:01 a.m. EDT	
Splashdown	6/22/73 9:49 a.m. EDT	9/25/73 6:19 p.m. EDT	2/8/74 11:17 a.m. EDT	
Duration (days: hours: minutes)	28:0:49	59:01:9	84:01:16	171:13:14
Revolutions	404	858	1214	2476
Distance (million miles)	11.5	24.5	34.5	70.5
*SEVA	0:37 (5/25/73)			
**EVA 1 Duration (Hours: minutes and date)	3:30 (6/7/73)	6:29 (8/6/73)	6:33 (11/22/73)	
EVA 2 "	1:44 (6/19/73)	4:30 (8/24/73)	7:01 (12/25/73)	
EVA 3 "		2:45 (9/22/73)	3:28 (12/29/73)	
EVA 4 "			5:19 (2/3/74)	
Totals—EVA (Hours: minutes)	5:41	13:44	22:21	41:46 min.
Apollo Telescope Mount Film Frames	30,242	77,600	75,000	182,842
Earth Survey Film Frames	8,886	14,400	17,000	40,286

*Stand-up (in spacecraft hatch) Extra-Vehicular Activity
**Extra-Vehicular Activity (completely outside of spacecraft)

Reflections On Skylab

Everything that we have done in the Skylab Program has been necessary for future progress in space and the Skylab experience has confirmed that we are really on the right track in proceeding to develop the Space Shuttle and its Spacelab manned module for use in the 1980s and 1990s.

Skylab, in all its aspects, has demonstrated that this nation is capable of conducting broader and more useful beneficial activities in space that directly relate to our own planet Earth. It has served us well as a true orbiting research facility enabling our astronauts to carry out a wide spectrum of scientific, engineering and biomedical studies.

To appreciate the broad capabilities of Skylab we should take note of President Nixon's landmark speech on space exploration which he made on March 7, 1970. In that speech, the President stated that three purposes should guide our space program: exploration, scientific knowledge and practical application. Skylab and the Skylab men have accomplished simultaneously all of these purposes.

It was also said that we must see our space effort not only as an adventure of today, but also as an investment in tomorrow, and that space activities will be a part of our lives for the rest of time.

Skylab has shown the way. In a very real sense, Skylab can be considered a turning point—for while it was still basically an experimental space station, it nevertheless possessed many qualities and ingredients that will characterize operational missions of the future. It has moved the space program from the realm of the spectacular into a new phase that can be characterized possibly as almost businesslike, if not quite routine.

The investment in Skylab has contributed to an orderly transition from the Apollo era of the 1960's to the Shuttle/Spacelab era of the 1980's and has continued U.S. leadership in manned space flight. We have clearly demonstrated that men can perform valuable services in Earth orbit as observers, scientists, engineers and repairmen.

Skylab has given us a wealth of new information about the dynamic processes of the Sun, provided new evidence of the value of Earth observations from space, helped define the feasibility of making new products in zero gravity, and has stimulated interest in international cooperation in space.

These returns from our Skylab investment already are impressive, but I should point out, the returns are not all in. We will be hearing much more in the months ahead. Indeed, we will be living with our Skylab success for a long, long time.

Dr. James C. Fletcher
NASA Administrator
February 15, 1974

GPO 879-976