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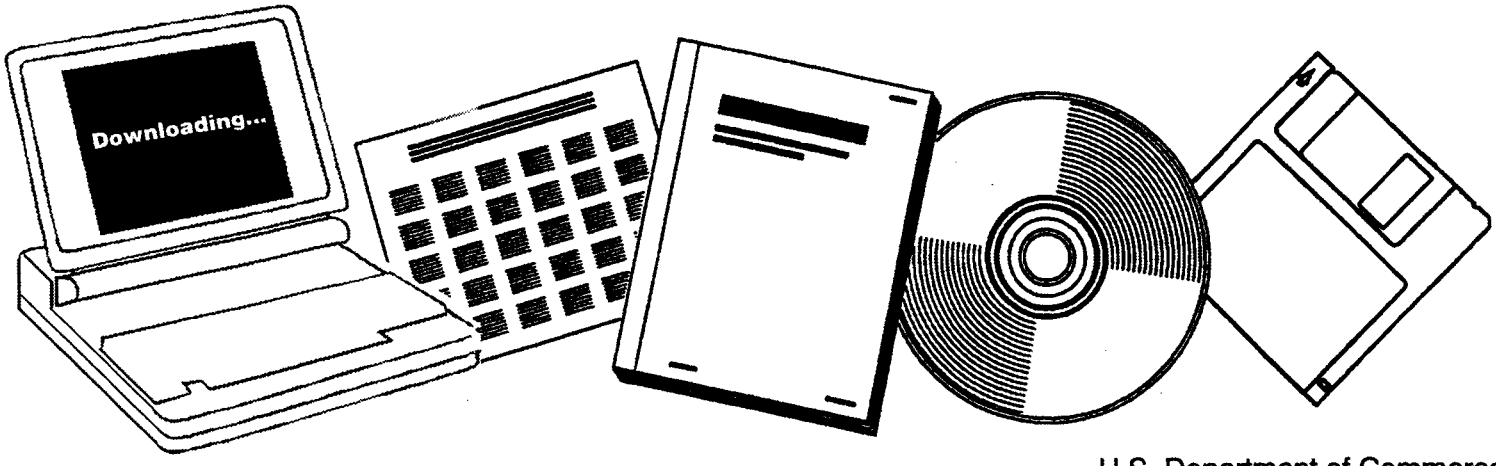
FINAL ENVIRONMENTAL STATEMENT FOR NATIONAL AERONAUTICS AND SPACE ADMINISTRATION SKYLAB PROGRAM

MAY 5, 1972



U.S. Department of Commerce
National Technical Information Service

N7227905

FINAL

ENVIRONMENTAL STATEMENT

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SKYLAB PROGRAM

May 5, 1972

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SUMMARY STATEMENT

Final Environmental Statement
Skylab Program
Office of Manned Space Flight
National Aeronautics and Space Administration

1. Administrative Action.

2. The Skylab Program is an existing flight project of the National Aeronautics and Space Administration. The space vehicles involved will be launched from NASA, John F. Kennedy Space Center in Brevard County, Florida.

3. The impact on the environment will be negligible.

4. This project was initiated prior to enactment of the National Environmental Policy Act. Alternative hardware configurations were considered during the planning phase of the program. Differences in environmental impact would have been minimal.

5. Comments on the draft statement were received from the Environmental Protection Agency and were taken into account in preparing the final statement.

6. The draft statement was made available to the Council on Environmental Quality and the public on 12 March 1971 and 18 March 1971 respectively. The final statement was made available to the Council on Environmental Quality and the public in May 1972.

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SKYLAB ENVIRONMENTAL STATEMENT

1. PROGRAM DESCRIPTION

The Skylab Program, currently planned for an initial launch date of April 1973, is an extension of the Mercury-Gemini-Apollo manned space flight programs and is designed to capitalize on the hardware and technological capabilities evolved and developed by those programs. Basic objectives of the program are: (1) To increase man's knowledge of the sun and its effect on man's earthly environment; (2) To gather data for studies of earth resources related to oceanography, water management, agriculture, geology, air/water pollution and meteorology; and (3) To advance understanding of the effects of long-term space flight on man's performance and the system requirements for future space missions.

To achieve these objectives, it is planned to launch and return, over an eight-month period, three separate crews of three men, who will live and work in an earth orbiting Workshop for periods of time up to two months. During these periods the crews will perform experiments and operate instruments and sensors to obtain information which will augment our knowledge of solar astronomy, space medicine, space physics, materials processing and earth resources. The sequence of operations and hardware to be used are as follows:

General Mission Description - The Skylab Program is divided into three phases: SL-1/SL-2; SL-3 and SL-4.

SL-1/SL-2. The initial phase of the Skylab Program consists of two launches on successive days: the first (SL-1), using a two-stage version of the Saturn V launch vehicle to place the Workshop into an orbit 235 nautical miles (435 km) above the earth and at a 50° inclination with respect to the equqtor. Launch will be from Launch Complex 39A at the Kennedy Space Center on a northerly azimuth. To date there have been eleven successful Saturn V vehicles launched in the Apollo Program and, it is anticipated that by April 1973 this number will have been increased to 12 (with the flight of Apollo 17). The two stages of the Skylab Saturn V (S-IC and S-II) will be essentially the same as the first two stages of the three stage Saturn V Apollo launch vehicle. Total weight of the Saturn V and its payload at liftoff will be approximately 6,222,000 pounds. The first stage (S-IC) develops 7.6 million pounds of thrust from five F-1 engines burning a maximum of 3.3 million pounds of liquid oxygen and 1.43 million pounds of RP-1 (kerosene) from liftoff to approximately 90 km altitude, at which time it is approximately 43 n. miles down range over the Atlantic ocean. The second stage (S-II), using five J-2 engines, is then ignited and develops approximately 1.1

million pounds thrust by burning a maximum of 821 thousand pounds of liquid oxygen and 158 thousand pounds of liquid hydrogen during ascent to the 435 km orbital altitude. After the Workshop is in orbit, the S-II stage is separated by retro-rockets, the payload shroud is jettisoned, the solar arrays are deployed and the interior is pressurized to five psia., (3.7 psia oxygen and 1.3 psia nitrogen), making it ready for the flight crew. The internal habitable volume is approximately 13,000 cubic feet and is designed to provide the three-man crew with air, water, food, heat, power, shelter from the environment, and equipment to perform scientific tasks.

SL-2. On the day following the Workshop launch, the three-man crew is launched in a modified Apollo Command and Service Module aboard a Saturn IB launch vehicle, with a total lift-off weight of approximately 1,295,600 pounds from Launch Complex 39B. The Saturn IB has two propulsive stages (S-IB and S-IVB), essentially the same as those used in the five previous launches of similar vehicles in the Apollo Program. The S-IB stage provides 1.6 million pounds of thrust with eight H-1 engines burning a maximum of 631,800 pounds of liquid oxygen and 276,900 pounds of RP-1 from liftoff to 60 km altitude when it is approximately 35 n. miles down range over the Atlantic. The S-IVB stage has one J-2 engine burning a maximum of 225,401 pounds, total, of liquid oxygen and hydrogen between 60 km and 163 km altitude to produce a thrust of 230,000 pounds. The Command Module (CM) is basically the same vehicle used in the Apollo Program with modified attitude control and thermal environment systems and with special provisions for the return of films, magnetic tape and biomedical specimens to earth. The Service Module (SM) is also similar to that used in the Apollo Program. It contains a propulsion system (SPS) (to provide thrust for major velocity changes of the CSM) using Aerozine-50 (50/50 blend of UDMH and Hydrazine) for fuel, and nitrogen tetroxide for oxidizer. This system has approximately 2,727 pounds of usable propellants under helium pressure. Several small jets, located in the CM and SM, each with a nominal thrust of 100 pounds, are part of the Reaction Control System (RCS) to effect rotation and translation of the spacecraft and assist in rendezvous and docking maneuvers. Approximately 2554 pounds of Hydrazine and nitrogen tetroxide under helium pressure are available to power the RCS.

The Saturn IB places the CSM into an 81-by-120 nautical mile (150 x 223 km) phasing orbit and the SPS and RCS are used to complete height, orbit plane phasing and rendezvous/docking maneuvers of the CSM and Workshop. After docking the crew transfers to the Workshop for 28 days to perform experiments and mission tasks. At the end of this time, they will return to the CSM, undock and return to earth. The Workshop is placed in

a semi-active mode to await the visit of the next crew which will be launched on SL-3 approximately 90 days after the SL-2 launch. The SM remains attached to the CM throughout the space flight and is separated from the CM just prior to earth re-entry but is not recovered.

The second phase of the Skylab Program, the SL-3 mission, will employ essentially the same type hardware used in SL-2 but is planned for a longer orbital duration of approximately 56 days. The Workshop will be reactivated and the crew will perform additional medical, solar astronomy, scientific and earth resources experiments prior to their return to earth.

The SL-4 mission is the third and final utilization of the Workshop. It will be launched approximately 90 days after SL-3 and is also planned for approximately 56 days of manned orbital operations. Upon completion of their tasks in orbit, the SL-4 crew will prepare the Workshop for orbital storage and will then undock the CSM and return to earth.

During the missions described above, the orbit will sweep across all land and sea areas between latitudes 50°N. to 50°S.

SL-1/SL-2, SL-3 and SL-4 missions will complete the presently planned Skylab Program operations.

2. THE PROBABLE ENVIRONMENTAL IMPACT OF THE PROGRAM

The use of proven hardware and techniques, coupled with studies, analysis and experience gained over a decade of space flight, provide the basis in the following assessment of the Skylab Program, indicating that no significant adverse impact on the environment will occur.

Atmosphere: The largest potential impact on the environment is associated with the Saturn V launch vehicle. The magnitude and possible effects of this vehicle on the atmosphere, the ocean and humans are discussed in the Apollo Program Environmental Statement[1] and it is concluded that no detrimental environmental impact will result. This conclusion is supported by the experience from the eleven vehicles of this type already flown in the Apollo Program. The effects from the one Saturn V vehicle used in the Skylab Program will be even less than any of those in the Apollo Program since only two propulsive stages are used in Skylab, while three were used in Apollo.

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1. Apollo Environmental Statement p. 2.

The next largest item of environmental concern--the Saturn IB--is considerably smaller in size and would have less potential effect on the environment than a Saturn V[2]. Three Saturn IB launches are collectively equivalent to approximately 60% of a single Saturn V as regards combustion products. Therefore, no detrimental impact is anticipated from the three vehicles to be flown at three-month intervals in the Skylab Program. This conclusion is supported by flight experience from the five vehicles of this type which have been flown in the Apollo Program.

To achieve the technical objectives of the Skylab Program, a "clean" environment is required. Operating procedures in the program are designed to minimize the quantities of exhaust products and materials vented into space to prevent interference with scientific experiments and observations. Therefore, most liquid waste and trash is stowed in a waste tank in the Workshop. Small quantities of O_2, N_2, H_2, CO_2, water vapor and urine vapor will be vented periodically. Exhaust products such as N_2, H_2, CO_2, OH, O_2, NO, O&H will also be produced by the SM RCS during maneuvers. It is estimated that a total of approximately 100 lbs/day of liquids, gases and exhaust products will be released to the exosphere during manned operations. No detrimental environmental effect on earth is anticipated from these operations since the quantities of material are released at 235 n. miles (435 km) altitude--well above the atmosphere and are infinitesimal in the realm of space. Materials in the Workshop Waste Tank will remain in orbital stowage for approximately six years until the Workshop disintegrates upon reentering the atmosphere and they then vaporize/burn.

Water: Potential effects on water quality which might occur during normal launch, aborted flight and reentry are discussed in detail in the Apollo Environmental Statement[3]. That discussion (with the exception of the section dealing with lunar material) and the conclusion that water quality will not be affected also applies to the Skylab Program.[4]

In the event of an aborted flight and the subsequent discharge of RP-1 (kerosene) to the coastal waters, NASA accepts the responsibility to notify EPA of any large discharge of hazardous material into the ocean or coastal waters. In addition, NASA will document the location and amount of such spills for further investigation by suitable scientists.

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2. Saturn IB uses the same propellants as Saturn V, but in lesser quantities.

3. Apollo Environmental Statement p. 4.

4. See Footnote 2 above.

Radiation: Unlike Apollo, Skylab does not use a Radioisotope Thermoelectric Generator (RTG). Only small amounts of low energy level radioactive materials will be present in Skylab, so that there should be no environmental radioactivity problem associated with the employment of these small radiation sources.[5] Prior to flight, safety reviews will have been made by specialists from NASA, AEC and other agencies to assure that this same situation will prevail at that time.

Orbital Debris: The Skylab Workshop cluster and elements associated with Skylab launches remain in orbit for varying periods of time. Each element will eventually decay and undergo disintegration and reentry. The extent of this hazard has been considered and is small based on worldwide experience to date.

3. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

None of the foregoing environmental impacts are considered to fall within this category.

4. ALTERNATIVES TO THE PROGRAM

The Skylab Program was initiated prior to enactment of the National Environmental Policy Act. Alternative hardware configurations were considered during the planning phase of the program. Differences in environmental impact would have been minimal.

5. RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

It is expected that local short-term use of the environment in this program will contribute to the enhancement of long-term productivity because of the knowledge which will accrue from Skylab Earth Resources Experiments. As indicated in the first section of this Statement, a number of experiments and scientific observations related to earth environment and earth resources are to be conducted. Multispectral photography, IR imaging and spectragraphic techniques will be used to gather data for studies in oceanography, water management, agriculture, geography, geology and ecology. It is anticipated that information obtained from these experiments and observations will contribute materially to knowledge and understanding of our environment and assist in the improvement of its quality. The effect of the Skylab Program on long-term productivity is thus expected to be a beneficial one.

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5. Light sources, switch tips etc. same as used in Apollo spacecraft; most in the millicurie and microcurie range. Docking target of promethium not exceeding 20 curies.

6. IRREVERSIBLE/IRRETRIEVABLE COMMITMENTS OF NATURAL RESOURCES

No depletion of natural resources will result from the Skylab Program.

7. COMMENTS BY OTHER AGENCIES

Comments on the draft Statement were received from the Environmental Protection Agency on 20 October 1971. No objections were raised. However certain specific provisions were recommended for inclusion under Water Pollution. These provisions have been included in this final Statement. (Page 4, under section entitled "Water.")

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 20 1971

OFFICE OF THE ADMINISTRATOR
EPA-76

Mr. Ralph E. Cushman
Special Assistant
Office of Administration
National Aeronautics and Space
Administration
Washington, D.C. 20546

Dear Mr. Cushman:

The Environmental Protection Agency has concluded its review of your draft impact statement on the NASA Skylab Program. We trust the following comments will be of assistance in preparing the final impact statement.

AIR POLLUTION

Toxicity:

The largest contributor to the atmospheric toxicity among the exhaust products is carbon monoxide. The sink for CO is unknown. All the known reactions are slow and it has an estimated residence time of 1-3 years in the lower atmosphere. While the amount put into the atmosphere is large at the injection points along the rocket trajectory, it should disperse sufficiently rapidly to avoid becoming a toxic hazard.

Heat Balance:

The local heat balance could be affected by the massive introduction of CO_2 and water vapor along the rocket trajectory. This concentration of CO_2 and H_2O should disperse rapidly so that any effect would be brief. On a global scale, the input from each launch is insignificant and will have no significant effect on the global climate.

Locally, the input of H_2O into the stratosphere will result in supersaturation and the formation of stratospheric clouds. Additionally, the input of exhaust gases, particularly H_2O, CO and some NO_x will result in local thinning of the ozone layer. No potential global effect is apparent.

Electron Density:

There will be an increase in the electron density in the ionosphere due to the large input of water vapor and a small amount of NO_x along the rocket trajectory. This will have no effect on the global climate and little, if any, on radio wave propagation.

Chemosphere Emissions:

There may be an insignificant increase in airglow activity due to a small amount of N_2 released. This will be of no significance to the global or local climate.

RADIOLOGICAL

The draft statement refers to the fact that safety reviews will be conducted by specialists for applications of radiation. No information concerning source material or source strength is presented in this statement. The safety reviews referred to should consider these matters in detail. If the radiation sources are indeed as small as is indicated, then there should be no environmental radioactivity problem associated with their employment, even in the remote case of a launch or reentry accident.

WATER POLLUTION

Because of the possibility of an aborted flight and the subsequent discharge of RP-1 (kerosene) to the coastal waters, it is recommended that the following provisions be incorporated into the NASA Skylab Program impact statement:

1. EPA be immediately notified of any large discharge of kerosene or other hazardous material.

2. NASA document the exact location of the discharge and amount of spill.

3. NASA, in cooperation with EPA, immediately dispatch an investigation team consisting of an oceanographer, a marine biologist and a chemist to conduct a field investigation and document the impact upon the marine environment.

We appreciate the opportunity to comment on environmental considerations as you develop your plans. If any questions develop in regard to our review, or if we can be of further assistance, please contact Mr. W.C. Holmberg of this office.

Sincerely,

George Marienthal

George Marienthal
Acting Director
Office of Federal Activities

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