EXPERIMENT TECHNICAL DOCUMENTATION

DOT–TSC–NASA–71–3

ASTRONAUT OPERATIONS REQUIREMENTS DOCUMENT

IN-FLIGHT AEROSOL ANALYSIS EXPERIMENT T003

DEPARTMENT OF TRANSPORTATION
TRANSPORTATION SYSTEMS CENTER
CAMBRIDGE, MASSACHUSETTS

ASTRONAUT OPERATIONS REQUIREMENTS DOCUMENT FOR SKYLAB EXPERIMENT T-003

January 8,1971

Revision: 1

ASTRONAUT OPERATIONS REQUIREMENTS DOCUMENT

EXPERIMENT T-003, IN-FLIGHT AEROSOL ANALYSIS

TABLE OF CONTENTS

1. SCOPE 1
   1.1 Purpose 1
   1.2 Scope 1

2. SCIENTIFIC BACKGROUND 1

3. EXPERIMENT DESCRIPTION 2
   3.1 Objectives 2
   3.2 Concept 4

4. EQUIPMENT DESCRIPTION 4
   4.1 Subsystems 4
   4.2 Equipment Hardware Package 5

5. ASTRONAUT TRAINING AND TRAINING EQUIPMENT REQUIRED 6
   5.1 Training Required 6
   5.2 Equipment Required 6

6. FLIGHT OPERATIONS 6
   6.1 General 6
   6.2 In-Flight Aerosol Analyzer Operation Procedure 6
      6.2.1 Significance of Astronaut 6
      6.2.2 Displays and Controls 7
      6.2.3 Measurement Procedure 7
      6.2.4 Prime Obstacles to be Anticipated 8
   6.3 Experiment Constraints 8
   6.4 Spacecraft Measurement Stations 8
   6.5 Deployment 10
   6.6 Deactivation of Instrument 10
   6.7 Task Time Line 11

7. RECOVERY AND POST-MISSION ANALYSIS 14

8. REACTIVATION FOR FLIGHTS SKYLAB 3, 4 14

9. REFERENCES 15

FIGURES

1.1 Aerosol Analyzer 16
2.1 Optical Schematic of Aerosol Analyzer 17
4.1 Pneumatic System 18
4.2 Filter-Impactor System 19
4.3 Experiment Hardware Package 20
6.1 Location of Measurement 21

1. SCOPE

1.1 Purpose - The Astronaut Operations Requirements Document (AORD) is prepared to provide the basis for the development of detailed astronaut training requirements and experiment operation requirements for Experiment T-003, In-flight Aerosol Analysis.

1.2 Scope - This document describes the astronaut requirements associated with Experiment T-003. The AORD presents the scientific background of Experiment T-003 and describes the operation of the instrument (Fig. 1.1) and its major assemblies.

Flight Operations, Section 6, considered the most significant section of this document, defines in-flight sequential procedures.

2. SCIENTIFIC BACKGROUND

A significant amount of information can be ascertained on the size, concentration, material, and morphology of spacecraft airborne particulate matter by the combination in one instrument of real-time analysis for particulate size and concentration and a collection system for post-flight analysis of the particulate matter.

The instrument consists of two analysis systems for particulate evaluation: a filter-impaction system for the collection of particulate matter for post-flight analysis of composition and shape and a light scattering section for real time analysis of particle size and concentration. In the light scattering section, the particle concentration can be measured, while airborne, without resorting to deposition techniques, the measurements are sensitive for low particle concentrations, and the results can be read out immediately after the run. The system will also give a determination of particle size from the intensity of the scattered light.

When light is scattered from a particle, the intensity of the scattered light is dependent on the size of the particle, its index of refraction, shape, and absorption, etc. The theory for light scattering of spherical particles comparable in size to the wave length of the incident light was developed by Gustav Mie in 1908 [1] and the state of the development is reviewed by Green and Lane [2].

Measurement of aerosol particle concentration and size distribution by optical scattering is possible by a variety of systems classifiable by the relationship of the illuminating beam to the scattering angle. Whitley [3] evaluated the merits of various light scattering systems and concluded that the concentric configuration where the scattering angle is concentric with, and outside of, the illuminating beam is preferable for measurement of small particles of unknown index of refraction.

For the T-003 experiment, the instrument illuminating angle is 13.75° and the collector angle is from 30-53 degrees (Fig. 2.1). This geometric configuration was derived from an investigation by Hodkinson [4]. The results of his calculations show the relative independence of scattering cross section coefficient from index of refraction for particles greater than one micron, the lower particle size measure of the aerosol analyzer. The curve spread, and resulting particle sizing spread, is much greater for other geometries.

A secondary advantage of the concentric system lies in the insensitivity to the effect of irregularities in particle shape which may preferentially scatter the light in some particular direction. Integrating through 360° around the optical axis minimizes this problem.

The filter-impactor section of the instrument collects all the particulate matter that passes through the optical system. Particles equal to or greater than one micron will be impacted onto a polished nickel substrate, which can be turned so impaction can be accomplished at eight different points on the substrate. This impaction point can be correlated to the spacecraft measurement locations. The particles between 0.2 microns and one micron will be collected on the filter segment of the filter-impactor section.

3. EXPERIMENT DESCRIPTION

3.1 Objectives - Future space exploration will involve large, complex space stations with prolonged periods of habitability. In the development of these space stations, it is anticipated that there must be considerable changes in modes of operation and functioning systems from those now known and used; food must be prepared for more conventional eating and palatability, water must be conserved by reclamation and reuse, sanitary facility and means of personal hygiene must be upgraded, and new systems for environmental control devised and instituted.

The systems innovations, the increase habitability periods, the level of activity, and the physical size and configuration of the space stations will demand a more rigorous evaluation of the atmospheric contaminants (both aerosol and gaseous) than has been undertaken previously.

Aerosols are generated in a considerable number of ways in spacecrafts through the routines of human occupancy such as food preparation and consumption, waste management, personal hygiene, clothing, skin scales, experiment performance and breathing. In addition, spacecraft systems will contribute to particulates through flaking, microparticle emission and agglomeration from heated electronic systems and wear and fragmentation from moving or contacted parts.

Generation of aerosols is a continuing function of spacecraft life and in a weightless atmosphere, removal is affected by three primary means: the spacecraft filtering system, the "sticking" of particulates to walls and equipment, and by the respiration of the astronauts.

To evaluate the efficiency of methods of particulate matter removed by the spacecraft systems and to evaluate the "effective air change," size distribution measurements should be made over on extended period of time at a representative location from the time of initial occupancy of the spacecraft. The trends found will indicate buildup or decrease in particulate matter.

In addition to above measurement routine, the size distribution-count should be determined at specific locations and for certain activities that may be prolific sources of spacecraft particulate contamination or which may give indication of the air distribution throughout the spacecraft.

Sizing the particulates will also indicate that fraction which may be toxic to the astronaut through lung deposition.

Besides the real time readout of particulate size and count, the particle composition should be known for evaluation of its toxicity and as an indicator of the sources within the spacecraft system.

Aerosols also serve as the vehicle for microbial transfer through the atmosphere and aerosol particles can provide sites for bacterial and fungal growth leading to system degradation, food and water spoilage, skin irritation, and infection.

With the above considerations, an initial step to a "complete" particulate system, an aerosol analyzer has been designed for Experiment T-003 which is capable of separating the particulates into three size ranges, accumulate the total particles in the three size intervals and display the results immediately to the astronaut. In addition, the instrument will contain a particulate collection system so that post-flight analysis can be used to ascertain the shape and composition of the individual particles.

An instrument meeting the above requirements allows the objectives of the experiment to be carried out. These objectives are: (1) to evaluate the environmental control system for particle removal by measuring the particulate concentration each 8 hours throughout the flight, (2) to assess the normal activities that should give rise to highest concentrations of particulate generation, i.e. food preparation, waste removal, and clothes by selectively measuring at these areas, (3) to assess the air distribution system by selective measurements at various points within the spacecraft, (4) to evaluate the effect of spacecraft high particulate production activity, etc. by allowing astronaut choice of measurements and (5) evaluate particulate shape and composition and to correlate particle size to electronic sizing through post-flight analysis.

The results of this experiment will be used to establish the limits and parameters necessary for the design of a system to protect from particulate hazards and microbial infection during more extended flights. In addition, findings on Skylab flights may indicate system inadequacies or housekeeping procedures that could be incorporated into subsequent flights.

3.2 Concept - A number of investigations have been made into various optical methods of counting and sizing small aerosol particles having unknown indices of refraction with the conclusion that the type of geometry employed in the present instrument identifies particles essentially by size alone.

The instrument employing an optical geometry (Figure 2.1) can detect and count particles in the size range 1.0 to 100 microns and identify their size. The detector output signal is pulse related in amplitude to particle size. If each signal is directed into one of three registers depending on the pulse amplitude, the accumulated count in each register will indicate the number of counted particles in selected size ranges. With a fixed known rate of air flow through the instrument and a fixed counting time, the accumulated count in each register can be calibrated to give the volumetric concentration of particles of the corresponding size interval in the sampled atmosphere.

When measurements are taken with the aerosol analyzer at a number of selected stations in the spacecraft, at selected time intervals throughout a space flight, invaluable information will be accumulated to assess the generation, circulation, distribution, and filtration of particulate matter in a zero'G closed ecological system and the nature and extent of the problems associated with this matter. Post-flight inspection and analysis of the particles collected by the impactor-filter will give valuable confirmatory information and may permit further identification of the spacecraft particulate contaminants by material and shape.

4. EQUIPMENT DESCRIPTION

4.1 Subsystems - The instrument consists of four subassemblies: (1) the pneumatic subsystem, (2) the optical subsystem, (3) the filter-impactor subsystem, and (4) the electrical/electronic subsystem. Air (see Fig. 4.1) drawn into the instrument by the pump passes first through an illuminated sampling volume (Fig. 2.1). A selected portion of the light scattered by each aerosol particle (30°-53° angle, complete cone around the optical axis) in the air is detected by a photomultiplier tube (PM) causing a PM pulse signal which is related in amplitude to the size of the scattered particle. The electronics system sorts the pulses into three discrete amplitude intervals and accumulates the count in each interval during the sampling time, which commences automatically after an initial purging period. At the end of the display period, the instrument shuts itself off.

The aerosol analyzer is designed to operate without saturation in atmospheres containing several million particles per cubic foot, which is orders of magnitude greater than the anticipated particulate concentration in the spacecraft. There are no inputs other than the air intake. The instrument output is a display identifying the channel indicating particle size range, the number of counts, and the occurence of an overrun if the count exceeds 9999 on a channel.

(1) Pneumatic Subsystem - The pump is a diaphragm type driven by a brushless D.C. motor.

(2) Optics - Optics are as described before in Section 2 and shown on Figure 2.1.

(3) Filter-Impactor System - (Fig. 4.2) The filter impactor system consists of an impactor section which can be rotated to eight different positions so that the particles equal to or greater than one micron can be correlated to the various measurement stations in the spacecraft. This positioning ability will allow correlation to locations and light scattering section readouts. The impactor stage is backed by a 0.2 micron metal filter for collection of the smaller particles not deposited on the impactor plates.

The filter impactor is held in the instrument by O-ring tension and a retaining ring and is removable from the instrument at the OWS deactivation, by turning the knob to the retaining pin release location, grasping the knob, and pulling straight out. CAUTION: Remove slowly to prevent filter rupture. Once the filter is disengaged, it should immediately be stored in its container to prevent contamination entering the filter-impactor system.

(4) Electrical/Electronics System - A detailed description of the electrical/electronics subsystem is in the End Item Specifications.

(5) Battery Pack - The analyzer has a battery pack of sufficient capacity for all three Skylab flights. It consists of 6 Yardney LR-2 silver zinc wet cells potted in a pressure container.

4.2 Experiment Hardware Package (Fig. 4.4) The experiment hardware consists of the following:

(1) Aerosol Analyser - The aerosol analyzer will be stowed ready for operation with the proper filter-impactor unit in the instrument.

(2) Filter-Impactor Units - Three filter-impactor units will be in the stowage container for launch on Skylab I. The turning handle of the filter-impactor is engraved with the number of the flight for which it should be used. Unit 1 will be mounted in the Aerosol Analyzer for launch.

(3) Filter-Impactor Containers - The three filter-impactor containers will contain the space filter impactors for flights 3, 4 and a dummy filter-impactor. The containers are used for maintaining cleanliness and for protection of the used filter-impactor.

(4) Dummy Filter-Impactor - The dummy filter-impactor unit provides a means of maintaining the cleanliness of the interior of the filter-impactor containers. The handle is marked "dummy" and the unit is red anodized to prevent mix-up with operable units.

(5) Log Book - The log book for the experiment will consist of approximately nine 3" x 5" cards per flight and their binding clip. The cards will be returned with the expended filter-impactor unit in their command module after each habitation.

(6) Filter-Impactor Rack - The two spare filter-impactors and the dummy with their containers are stored in a rack.

(7) Storage Container - To protect the instrument against the launch environment and to provide for convenient stowage of log cards and revisit materials, a foam-lined hinged door container with items 1 - 6 will be mounted on the OWS wardroom wall.

(8) Revisit Experiment Location Decals - Self-adhesive metallic foil plates with new measurement locations for flights 3, 4 may be furnished for transport in the command modules taking crews to Skylab. These plates will be affixed to the back of the aerosol analyzer.

5. ASTRONAUT TRAINING AND TRAINING EQUIPMENT REQUIRED

5.1 Training Required - Astronaut training is necessary for understanding the nature of the experiment and for instrument operation. Estimated training time is one-half day.

5.2 Equipment Required - A working instrument is provided for training purposes.

6. FLIGHT OPERATIONS

6.1 General - This section describes the experiment as it affects the crew during flight. The experiment operation, deployment, and data retrieval are discussed in terms of procedures and constraints.

6.2 In-Flight Aerosol Analyzer Operation Procedure

6.2.1 Significance of Astronaut - With the astronaut making the measurement, a single light weight instrument suffices for measurement at all locations. There are no special interface or telemetry requirements and the log card is attached to the instrument. Measurement times can be selected to avoid high humidity (above 95%) or other conditions that would compromise the experiment or the significance of the data. Concurrent activities and any other conditions pertaining to the experiment can be simply entered on the log card. When both sides of the card have been used, the card is unclipped from the instrument, placed in the stowage container and a new card from the stowage container clipped to the instrument. Stowage problems are minimized. The entire experiment can be conducted by one crew member.

6.2.2 Displays and Controls - (Fig. 1.1) The displays and controls sequence for the instrument is as follows: The astronaut sets the filter-impactor number to the station number (Section 6.4) being measured and presses the start button. During the 70 seconds of purge and data accumulation, the pilot light should be on. The instrument shuts its collection cycle off and displays the accumulated counts. These are presented along with the channel number on four tubes. Should the accumulated count in any channel exceed 9999, the pilot light will come on indicating an overflow. After the readout, the instrument shuts itself off.

6.2.3 Measurement Procedure - A measurement operation consists of the following:

(1) Carry instrument to measurement location.

(2) When the instrument is hand-held, its motion should be kept to a minimum during sampling period; there should be no interference with the air intake and exhaust.

(3) Set filter-impactor to measurement station number noted on decal on instrument or to "8" if astronaut selected measurement. Filter can be rotated clockwise or counterclockwise (Fig. 1.1).

(4) Press "initiated cycle" button.

Warm up and purge cycle last 10 seconds.

Measurement cycle lasts 60 seconds.

Readout cycle lasts 24 seconds (8 seconds per channel).

Instrument shuts itself off.

(5) During readout cycle, record instrument readings on the log card.

(6) At the end of the measurement cycle, record time and other pertinent peripheral data (maneuvers in progress or during past 15 minutes, concurrent crew activities, meals, other experiments, etc.); any other special circumstances which related to the production or distribution of aerosols or to any other parameters that may affect the experiment.

(7) For post-flight analysis, relative humidity and temperature from telemetered information will be correlated to time.

(8) If applicable, proceed to next measurement station. (See paragraph 6.5.)

6.2.4 Prime Obstacles to be Anticipated - Malfunctioning of the instrument can lead only to failure of the experiment. Malfunctioning of one or two data channels will be evident from examination of the data, so that single channel failure should not terminate the experiment measurement program. With failure of the data channel readout, there will be significant information on the filter-impactor, so that a readout failure should not terminate the experiment.

Unusually low readings lead to poor statistical accuracy but provide an upper bound for particle concentrations. Very high concentrations can cause counts in excess of 9999 on the channels which record the smallest particles. This event will be noted by an overflow indicator light on the display panel. If there is a high proportion of unusual shaped particles in the spacecraft atmosphere, the instrument may give erroneous size readings, but filter examination will reveal this circumstance and provide a means of correcting for it through correlation with known particle effects on the instrument sizing.

6.3 Experiment Constraints - The astronaut should be cognizant of the following: (1) that he and his clothing are sources of particulate matter and he should be careful that he does not overly contribute to readings at the experiment spacecraft locations; (2) that it is important for the evaluation of buildup or decrease of particulate matter with time, that the time of measurement be correlated with activity within the spacecraft and the spatial relation of the activity to the measurement site be noted; (3) to prevent water condensation on the optics, the instrument should not be operated when the relative humidity is greater than 95 percent or visible fogging is observed; (4) that although the measurements program is routinely scheduled, there may be activities where the astronaut feels that an unusual amount or kind of particulate matter may be generated and that there is set aside in the experimental program a number of runs (20) that he may use at his discretion (See Measurement Station 8 under 6.4) during Skylab flights 1, 3. The number of runs on flight 4 may be from 10 to battery failure.

Particular Experiments

6.4 Spacecraft Measurement Stations (Fig. 6.1) - The Aerosol Analyzer will be furnished with a mounting plate that will clip into the universal camera mounts in the spacecraft. The following measurement station descriptions note hand held operation, but the astronaut may choose either method. hand held or mounted, for the performance of the experiment.

Measurement Station 1 (Crew Station 11) - Adjacent to the aerosol analyzer launch container which is located in experiment compartment on wardroom wall. To be held as close to ceiling as practical over open lattice.

Station 1 is the primary measurement station for the determination of long-term buildup or decrease of particulate contamination. The instrument is held at this position with the air inlet pointing perpendicular to the spacecraft axis (See Fig. 6.2 for locations).

This location was selected as the prime measurement location as it is convenient to other measurement areas, and is in an area of routine astronaut activity.

At the following measurement stations, except Station 3, the Aerosol Analyzer air inlet should be perpendicular to the spacecraft axis and the instrument hand-held or mounted on a camera mount.

Measurement Station 2 (Crew Station 10) - At the center of the hatch between the Air Lock Module and the Orbiting Workshop in forward dome area.

Measurement Station 3 (Crew Station 1) - Command Module at center astronaut couch. Hand-held with air inlet pointing away from couch pad.

Measurement Station 4 (Crew Station 11) - At VSC (air diffuser) in floor of crew experiment area, adhacent to trash disposal in Experiment Compartment.

Measurement Station 5 (Crew Station 15) - In wardroom above table.

Measurement Station 6 (Crew Station 16) - In Head adjacent to intercom on wardroom wall.

Measurement Station 7 (Crew Station 12) - Crew quarters in area where astronaut is changing clothes, i.e., before and after or during clothing change.

Measurement Station 8 - Astronaut Selection - Astronaut may select the area to be measured.

These measurements should be selected for those activities that may be high particulate producers and/or which cause perturbations to the air flow patterns within the workshop. In particular it is suggested that those experiments and routines where the astronauts exercise or have a workload involving high physical labor are probable particulate producers both from equipment and the astronauts' clothing.

Experiment T-003's primary measurement location is adjacent to Experiment M507, the Gravity Substitute Workbench, and although it is not desirable that the primary measurement series be performed when this experiment is operating, it is suggested that M507 is a possibly interesting source of particulates when operated in both the ionization mode and the air flow mode. Measurements of this experiment should be taken before astronaut work involvement to separate his contribution to particulates from the experiment's contribution.

T020 - Foot Controlled Maneuver Unit Experiment, M509 - Astronaut Maneuvering Equipment Experiment, and before and after ingress from extravehicular activities are other probable activities of measurement.

Measurement of several areas will primarily be valuable from readout counts rather than post flight analysis of the impactor pad number 8.

It is not mandatory for this experiment that the astronaut perform all 20 measurements allocated to him.

6.5 Deployment - The aerosol analyzer is stored in its container in the OWS at launch. As soon as feasible after occupancy of the Saturn 1 workshop (OWS) is complete, the instrument is removed from its shock-mounting container and a measurement taken as soon as possible to establish a base line reading. The aerosol analyzer should be mounted on a camera mount at measurement station 1 and stored in this location.

After the recording of this measurement, the measurements fall into three routines:

(1) After the first reading, a measurement will be made at Measurement Station 1 every 8 hours ±2 hours for the duration of the flight.

(2) Beginning as soon as possible and not later than the eighth day and at 10-day intervals on the flight, the aerosol analyzer will be removed from storage position at Measurement Station 1, and Measurement Stations 1, 2, 3, 4 will be measured in sequence.

During these days, measurements will also be made at Measurement Stations 5, 6.

The measurements (two) at Measurement Station 5 will be made immediately before food preparation and after eating.

The measurements (two) at Measurement Station 6 will be made immediately before and after use of the sanitary facilities when specimen mass measurement has been completed (Experiment M074).

The measurement at Measurement Station 7 will be made immediately after scheduled or normal change and/or donning clothing three times during flight.

6.6 Deactivation of the Aerosol Analyzer - During OWS deactivation the filter-impactor will be removed from the instrument by turning the insert to the keyed position and pulling straight out. This should be done slowly to allow air pressure across the filter to equalize and prevent filter rupture. The dummy insert will be removed from its container in the launch container and the used filter-impactor inserted in the container. (Caution! Insert slowly to prevent filter rupture.) The dummy will be inserted in the aerosol analyzer.

The used filter-impactor and its container will be stowed in the Command Module along with the log book for return to earth.

The aerosol analyzer will be stowed in its container in the OWS.

The cards that constitute the log for the mission will be clipped together to form the logbook for the flight.

6.7 Task Time Line (See Section 6.5 for description of measurement procedure.)

CREW TASK	APPROX. TIME (min)
1.0 PERFORM EXPERIMENT AT CREW STATION 11 EVERY 8 ±2 HOURS 1.1 Translate to experiment stowage area at measurement station 1. 1.2 Rotate Filter-Impactor to 1, press INITIATE CYCLE button, read and record time, channel number, accumulated counts, activities in progress.	 .5 2.3
TIME	2.8 x 72 performances = 201.6 min. (Based on 24 experiment days)
2.0 PERFORM EXPERIMENT AT CREW STATION 11, 10, and 1 EVERY 10 DAYS 2.1 Translate to measurement station. 2.2 Rotate Filter-Impactor to number corresponding to measurement station; press INITIATE button, read and record time, channel number, accumulated counts, and activities in progress. 2.3 At end of measurement cycle return AA to stowage location on camera mount.	13.0
TIME	13.0 x 3 performances = 39.0 min.

CREW TASK	APPROX. TIME (min)
3.0 PERFORM EXPERIMENT AT CREW STATION 15 EVERY 10 DAYS 3.1 Before use of head, translate to experiment stowage area. 3.2 Remove AA from camera mount. 3.3 Translate to head and mount AA on camera mount. 3.4 Rotate filter-impactor to station 15; press INITIATE CYCLE button, read and record time, channel number, accumulated counts. 3.5 After use of head and completion of M074 experiment repeat procedure 3.4.	7.7
TIME	7.7 x 3 performances = 23.1 min.
4.0 PERFORM EXPERIMENT AT CREW STATION 14 EVERY 10 DAYS 4.1 Before food preparation, translate to experiment stowage area. 4.2 Remove AA from camera mount. 4.3 Translate to wardroom and mount AA on camera mount. 4.4 Rotate filter-impactor to number corresponding to station 14; holding the AA above wardroom table, press INITIATE cycle button, read and record time, channel number, accumulated counts. 4.5 After food preparation and eating, repeat step 4.4.	
TIME	7.7 x 3 performances = 12.3 min.

CREW TASK	APPROX. TIME (min)
5.0 PERFORM EXPERIMENT AT CREW STATION 13 EVERY 10 DAYS 5.1 Before a clothing change, translate to experiment stowage area. 5.2 Remove AA from camera mount. 5.3 Translate to sleep compartment and mount AA on camera mount. 5.4 Rotate filter-impactor to station 13, press INITIATE button, read and record time, channel number, accumulated counts. 5.5 After changing/donning clothes, repeat step 5.4.	4.1
TIME	4.1 x 3 performances = 12.3 min.
6.0 PERFORM EXPERIMENT AT ASTRONAUT SELECT LOCATIONS	6.4
TIME	6.4 x 20 performances = 128.0 min.
TOTAL EXPERIMENT OPERATION	= 427.1 min.

6.7.1 <u>Post-Operations Tasks</u> - Upon completion of the experiment, the Filter-Impactor Unit will be removed, placed in its container and transferred to the CM for return to earth along with the log book.

CREW TASK	APPROX. TIME (min)
1.0 SECURE 1.1 Remove FILTER-IMPACTOR UNIT from AA, place in its container, translate with FILTER-IMPACTOR UNIT CONTAINER and log book to CM.	5.9
TIME	5.9 x 1 performance = 5.9 min.

7. RECOVERY AND POST- MISSION ANALYSIS

The following equipment should be returned to the Principal Investigator for evaluation of the T-003 Experiment:

(1) the instrument filter-impactor unit in its container;

(2) three copies of the data pertinent to the experiment from the experiment logbook;

(3) three copies of peripheral data, i.e., temperature and relative humidity, time related to logbook;

(4) three copies of pertinent debriefing information.

8. REACTIVATION FOR FLIGHTS AAP-3, AAP-4

The storage container in which the aerosol analyzer was launched on Skylab-1 will contain the necessary supplies for reactivation of the instrument for Skylab flights 3, 4 with the exception of the decals for measurement stations for these flights.

To reactivate the instrument:

1. (a) Remove dummy from instrument.

   (b) Replace with filter-impactor from container marked with flight number.

   CAUTION! Removal and insertion of filter-impactor units in the instrument and containers should be done slowly to prevent the vacuum/pressure from removal/insertion from rupturing the filter.

   (c) Put dummy in container position of removed filter-impactor to keep container clean.

2. Affix new decal to instruments for new measurement locations. Measurement locations will be chosen by analysis of results from preceding mission. The measurement routine will be the same as on Skylab-1, i.e., there will be a primary measurement location. There will be 20 runs allocated to astronaut selection and six locations with the same measurement protocol as on Skylab-1.

   The new decal for the flight will be in the resupply provisions on the Command Module.

9. REFERENCES

1. Mie, G. Ann Phys. Lpz 25, 375 (1908).

2. Green, H. L. and Lane, W. R. "Particulate Clouds" E and FN Spon Ltd., London (1946).

3. Whitby, K. T. "Evaluation of Optical Particle Counters" Progress Report USPHS Grant No. AP 00284-1, May 1965, Univ. of Minesota Particle Laboratory Publication 86.

4. Hodkinson, J. R. and Greenfield, J. P. "Response Calcluations for Light Scattering Aerosol Counters and Photometers" App. Opt. 4 (11) Nov. 1965.

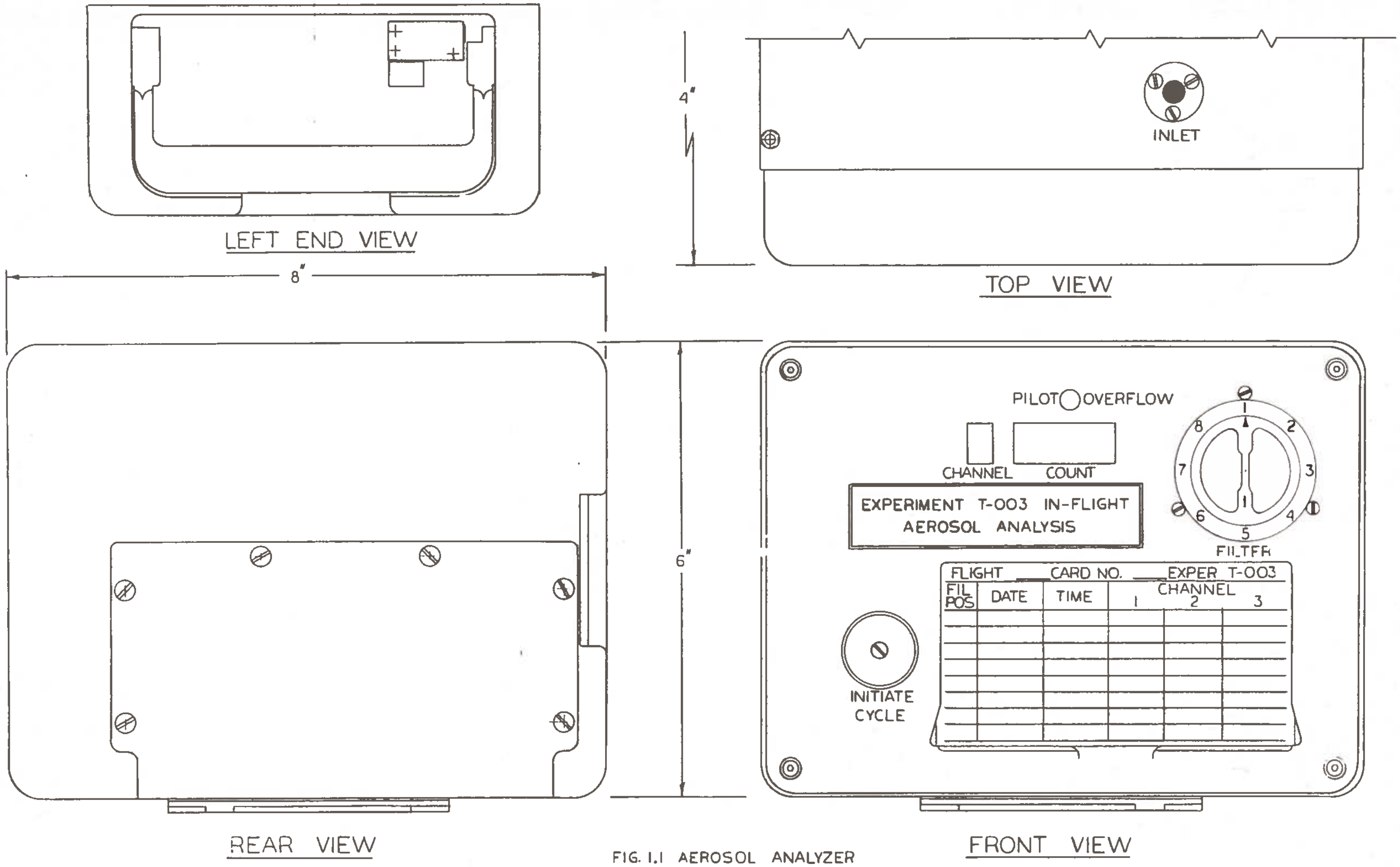

FIG. 1.1 AEROSOL ANALYZER

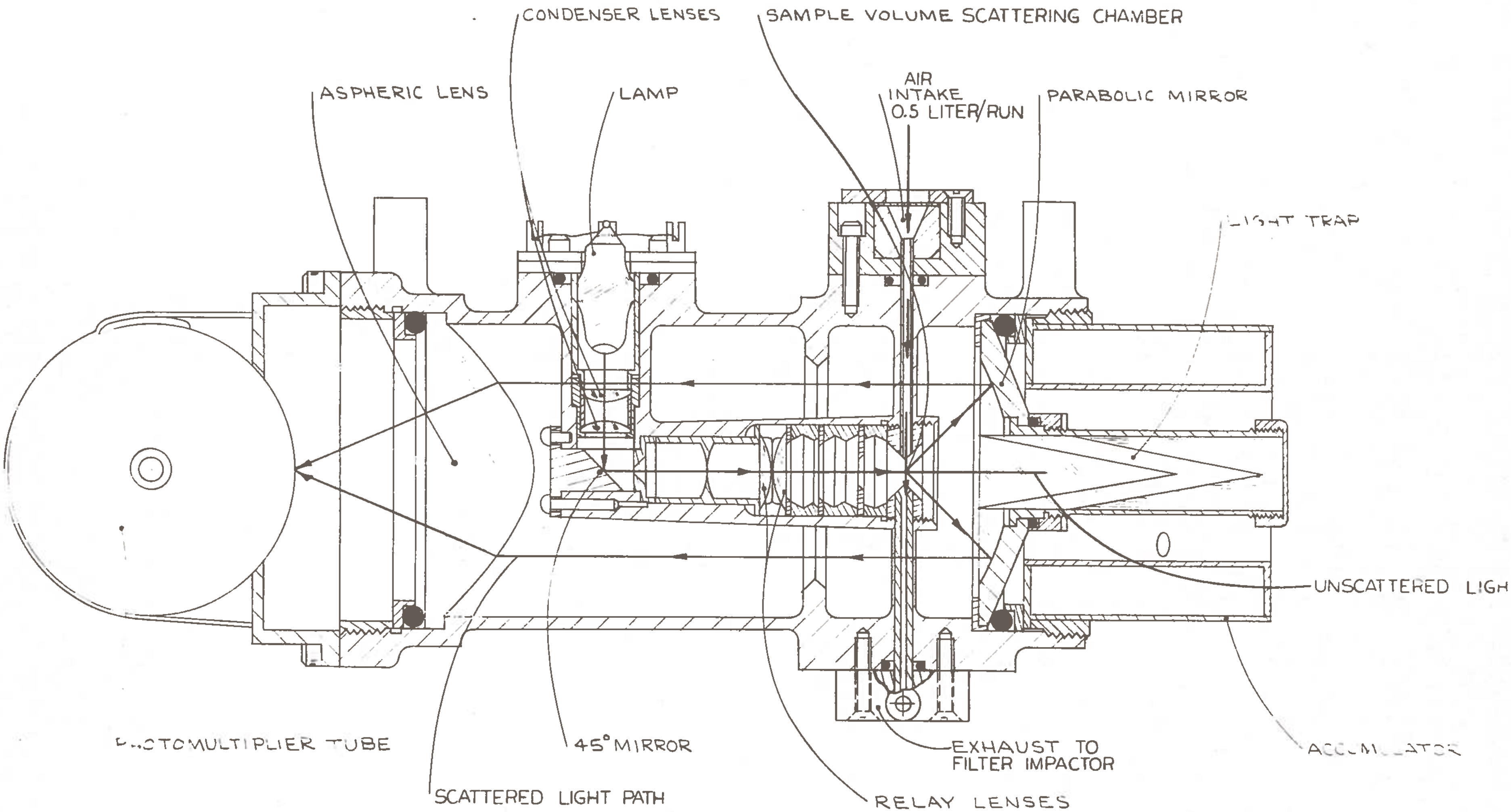

Fig. 2.1 Optical Schematic

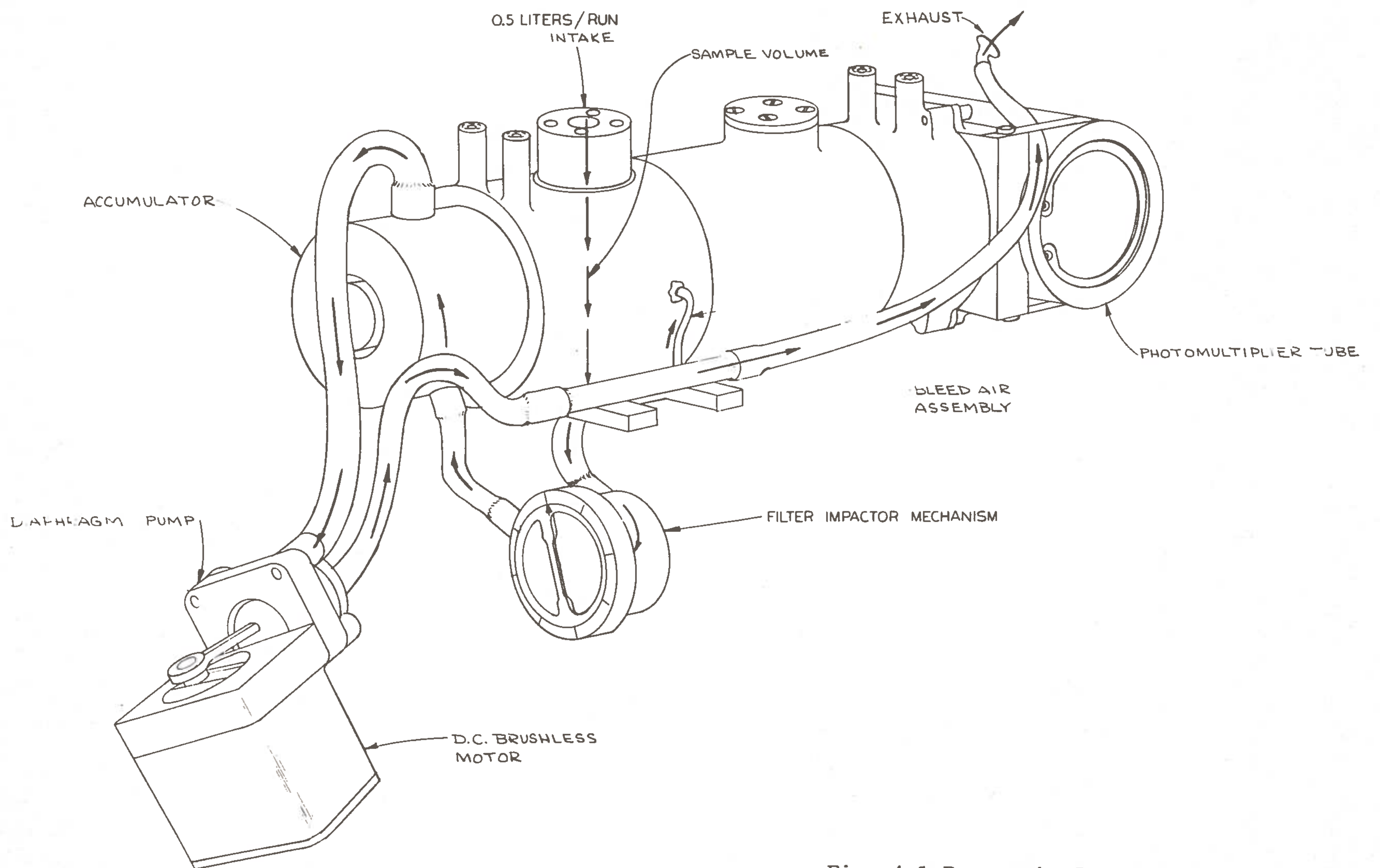

Fig. 4.1 Pneumatic System

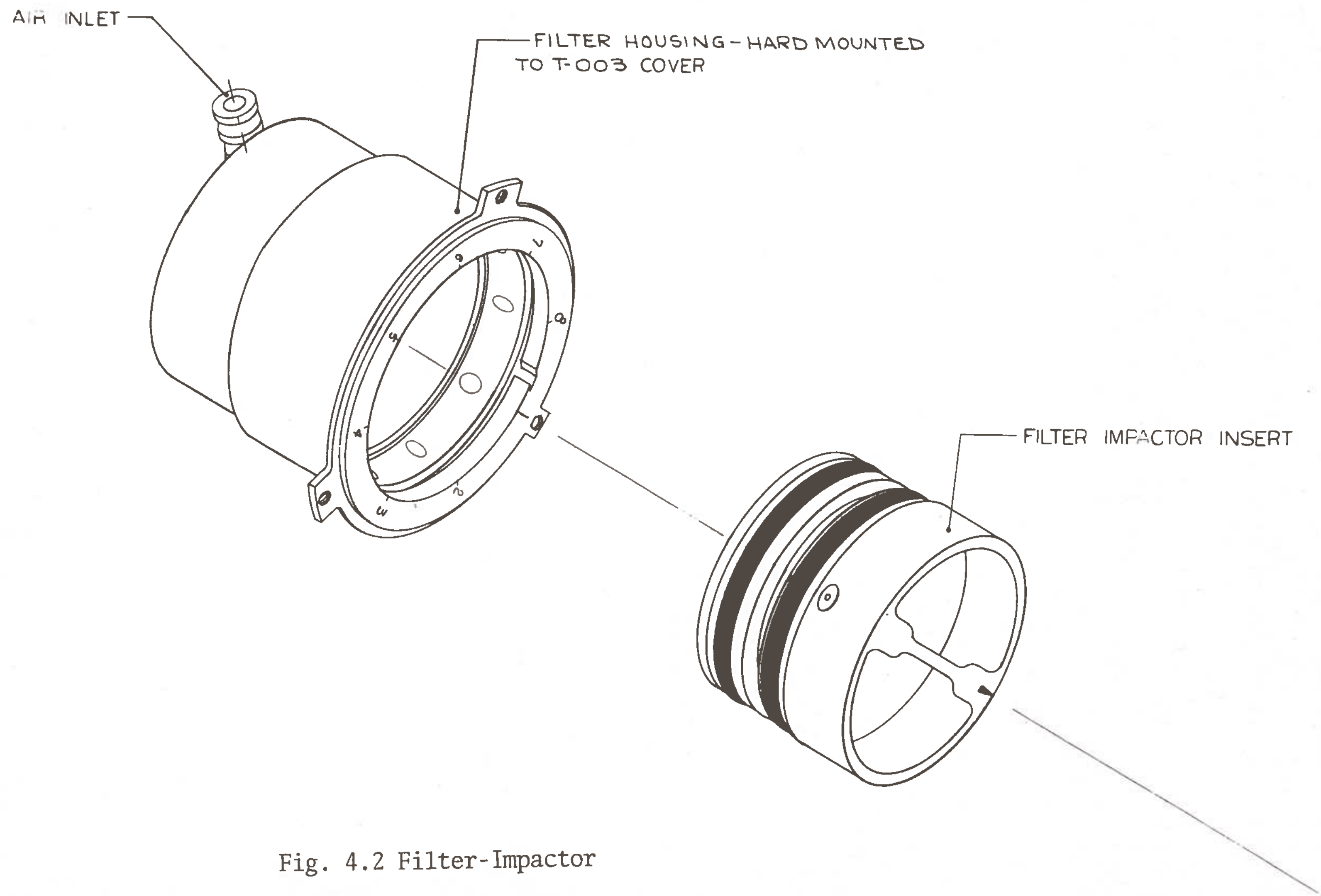

Fig. 4.2 Filter-Impactor

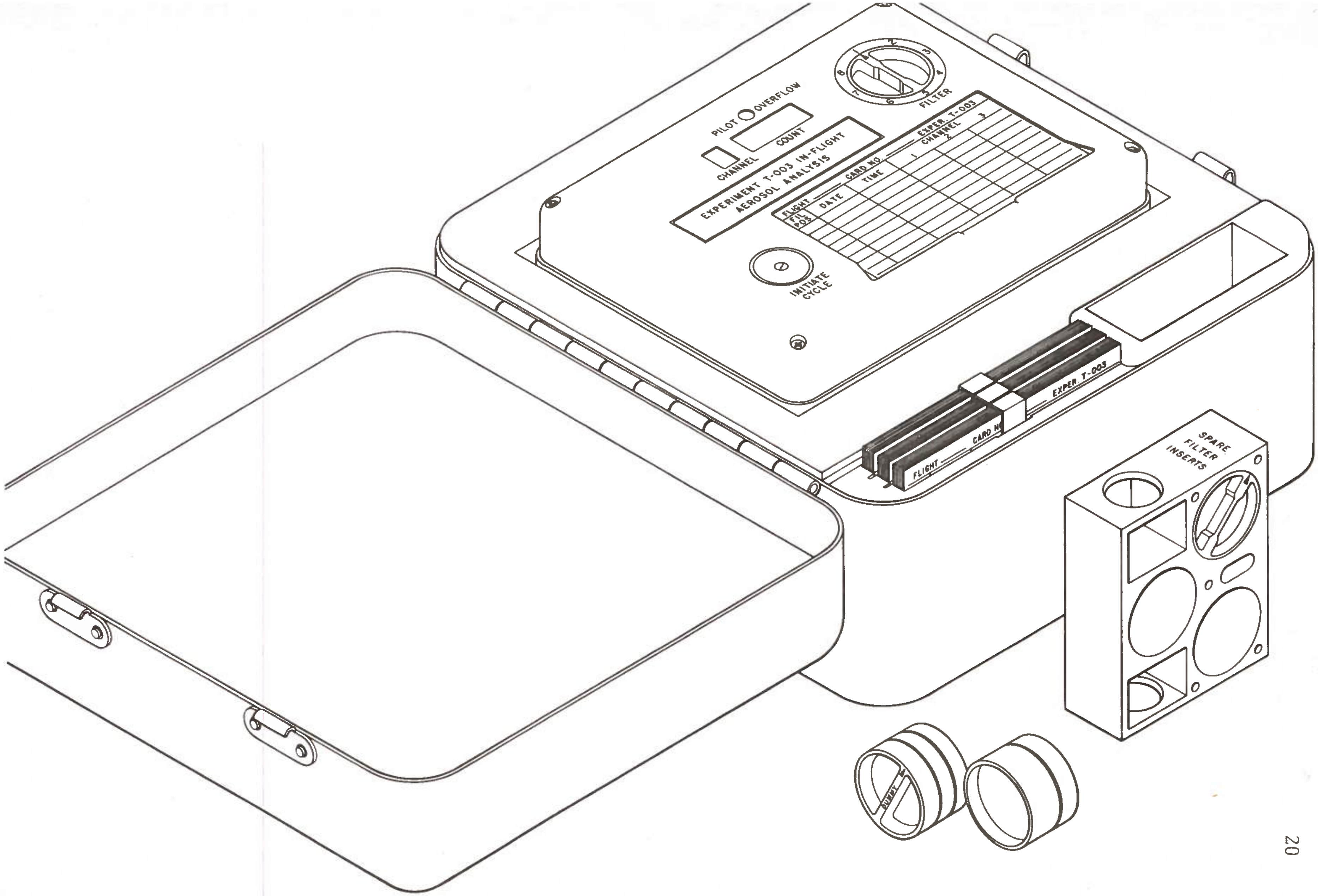

Fig. 4.3 Experiment Hardware Package

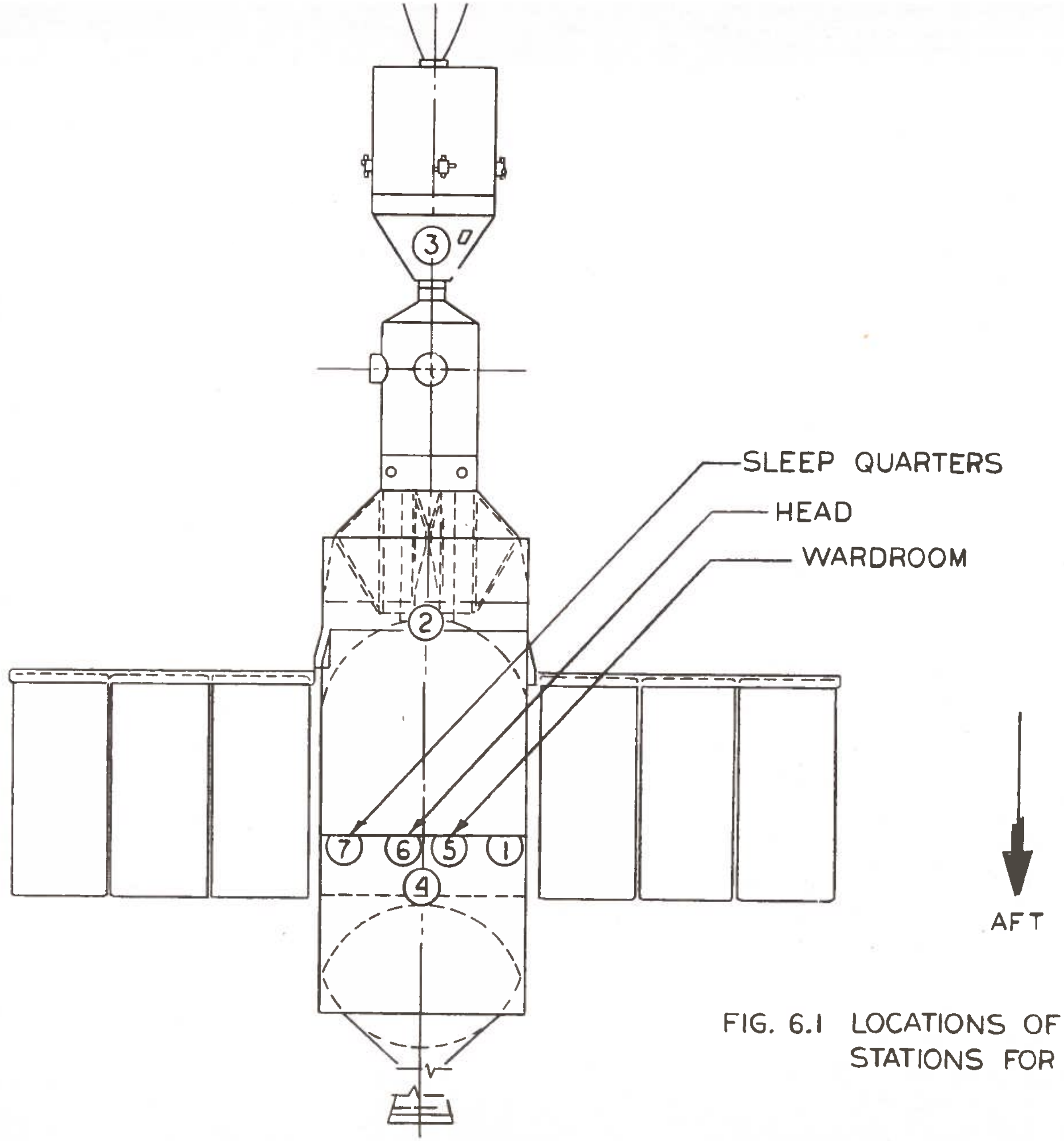

FIG. 6.1 LOCATIONS OF MEASUREMENT STATIONS FOR EXPERIMENT T-003