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NRL Report 4276
(Supplementary Pages)

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SUPPLEMENTARY MATERIAL

Compiled by
Eleanor C. Pressly
February 1958

TO BE PLACED IN NRL REPORT 4276

U.A.R. REPORT NO. XXI

SUMMARY OF UPPER ATMOSPHERE RESEARCH FIRINGS

Compiled by
Charles P. Smith, Jr.
February 1954

NAVAL RESEARCH LABORATORY
WASHINGTON, D. C. 20375

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NRL Report 4276

UPPER ATMOSPHERE RESEARCH REPORT NO. XXI

SUMMARY OF UPPER ATMOSPHERE ROCKET RESEARCH FIRINGS

Charles P. Smith, Jr.

Rocket Sonde Research Branch
Radio Division I

Supplementary Material
Eleanor C. Pressly

Rocket Sonde Branch
Atmosphere and Astrophysics Division

February 1954
(Supplemented February 1958)

NAVAL RESEARCH LABORATORY
Washington, D.C.

U. S. NAVAL RESEARCH LABORATORY
WASHINGTON 25, D. C.

IN REPLY REFER TO
2000-157:ISR:bw

7 April 1958

From: Director, Naval Research Laboratory
To: Distribution List

Subj: NRL Report 4276; completed data sheets for

1. Enclosed are completed data sheets to replace the simplified entries for Aerobee and V-2 rocket firings. These data sheets are to be inserted in your copy of NRL Report 4276, "UAR Report No. XXI, Summary of Upper Atmosphere Rocket Research Firings," compiled by C. P. Smith, Jr., and issued in February 1954.

2. The V-2 listings are now complete. Additional data sheets for the other types of rockets will be published in the future.

M. E. Jansson
M. E. JANSSON
By direction

NRL Report 4276

UPPER ATMOSPHERE RESEARCH REPORT NO. XXI

SUMMARY OF UPPER ATMOSPHERE ROCKET RESEARCH FIRINGS

Charles P. Smith, Jr.

Rocket Sonde Research Branch
Radio Division I

February 1954

NAVAL RESEARCH LABORATORY
Washington, D.C.

Previous Reports Published in this Series

"Upper Atmosphere Research Report No. I," NRL Report R-2955, October 1946; articles on early V-2 firings in this writing; history, description, experiments on cosmic rays, atmospheric temperatures and pressures, the ionosphere, and solar spectroscopy.

"U.A.R. Report No. II," NRL Report R-3030. December 1946; articles on the second cycle of V-2 firings; emphasis on the 10 October firing, including results of solar-spectroscopy, pressure-temperature, and cosmic-ray experiments.

"U.A.R. Report No. III," NRL Report R-3120, April 1947; articles summarizing accomplishments during first year of upper atmosphere research; discussions of astrophysics and atmospheric composition, cosmic rays, ionosphere, V-2 warhead, physical characteristics of the atmosphere, telemetering from rockets, and radio control.

"U.A.R. Report No. IV," NRL Report R-3171, October 1947; articles on third and fourth cycles of V-2 firings including cosmic-ray research, high altitude spectroscopy and photography, ionosphere investigations, and pressure-temperature studies.

"U.A.R. Report No. V," NRL Report R-3358, June 1948; articles on experimental techniques and apparatus employed for the fifth, sixth, and seventh cycles of V-2 firings; emphasis on solar spectra obtained, results of cosmic-ray research, pressure-temperature studies, and the mathematical analysis of cosmic-ray telescopes.

"U.A.R. Report No. VI, A Detector for the Dobson Ozone Spectrophotometer," H. L. Clark, NRL Report P-3333, August 1948

"U.A.R. Report No. VII, Counting with Geiger Counters," H. E. Newell, Jr. and E. C. Pressly, NRL Report P-3446, April 1949

"U.A.R. Report No. VIII, Prediction and Location of Rocket Impacts at White Sands Proving Ground," H. E. Newell, Jr., NRL Report P-3485, June 1949

"U.A.R. Report No. IX, A Sun-Follower for the V-2 Rockets," H. L. Clark, NRL Report 3522, August 1949

"U.A.R. Report No. X, The Matrix Telemetering System," J. T. Mengel, N. R. Best, D. G. Mazur, and K. M. Uglow, NRL Report 3535, September 1949

"U.A.R. Report No. XI, A Note on the Geometry of Geiger Counter Telescopes," H. E. Newell, Jr., and E. C. Pressly, NRL Report 3715, August 1950

"U.A.R. Report No. XII, Direct Measurements of Solar Extreme Ultraviolet and X-Rays from Rockets by means of a $CaSO_4$: Mn Phosphor," K. Watanabe, J. D. Purcell, and R. Tousey, NRL Report 3733, September 1950

"U.A.R. Report No. XIII, Rocket-Borne Instrumentation for Ionosphere Propagation Experiments," J. E. Jackson, NRL Report 3909, January 1952

"U.A.R. Report No. XIV, Radio-Frequency Mass Spectrometer for Upper Air Research," J. W. Townsend, Jr., NRL Report 3928, January 1952

"U.A.R. Report No. XV, AN/FKR-1 ( ) Telemetering Ground Station Improvement Program," N. R. Best, NRL Report 3992, May 1952

"U.A.R. Report No. XVI, AN/DKT-7 ( ) Fifteen-Channel PTM Telemetering Transmitter," D. G. Mazur, K. M. Uglow, R. Lowell, and N. R. Best, NRL Report 4016, August 1952

"U.A.R. Report No. XVII, A Solar Aspect Indicator for a Rocket," D. M. Packer and R. Tousey, NRL Report 4024, September 1952

"U.A.R. Report No. XVIII, A Method for Determining Density in the Upper Atmosphere During Rocket Flight," R. Horowitz and D. Kleitman, NRL Report 4246, October 1953

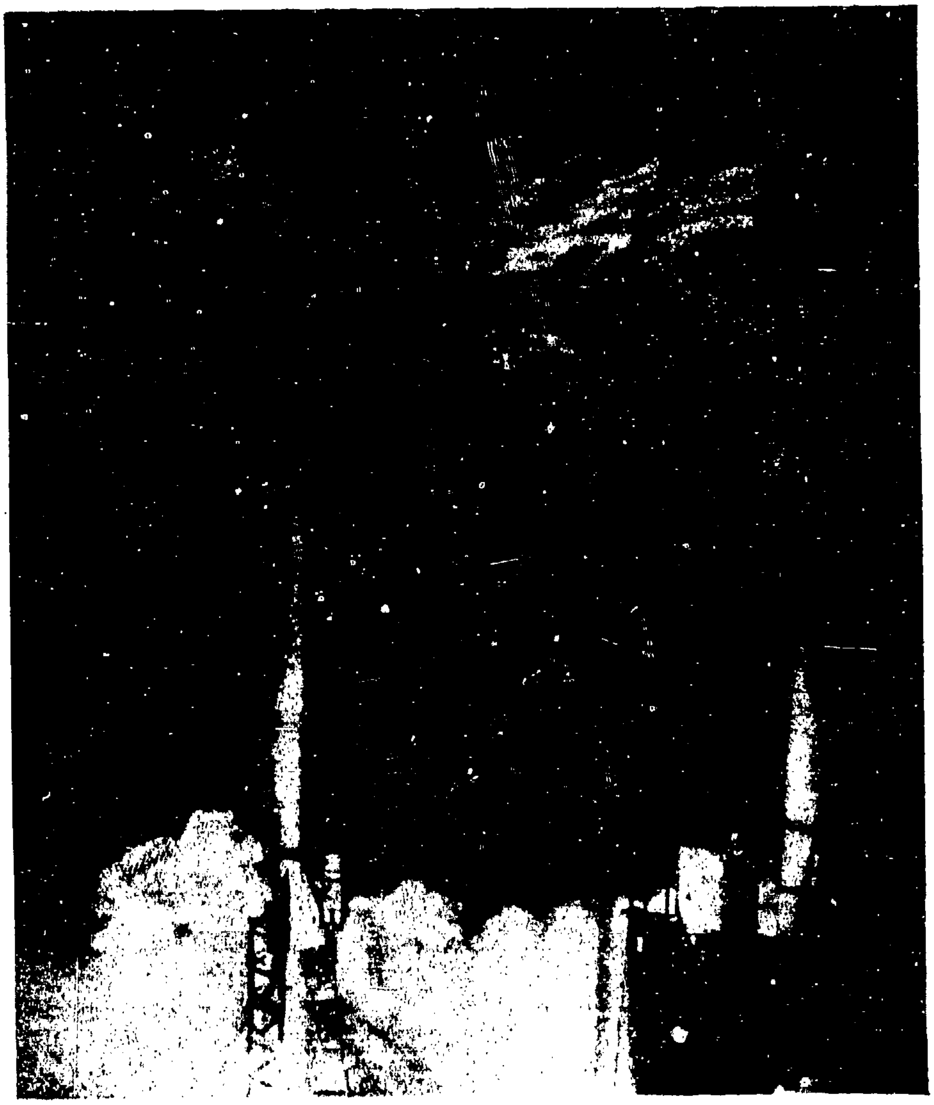
"U.A.R. Report No. XIX, A Geomagnetic Field Angular Orientation Indicator for a Rocket," D. M. Packer, NRL Report 4247, November 1953

"U.A.R. Report No. XX, A Lightweight Azimuth-Correcting Sun Follower," H. L. Clark, NRL Report 4267, December 1953

Contents

Contents (Continued)

1. FOREWORD



Frontispiece - Upper Atmosphere Research Report XXI

SUMMARY OF UPPER ATMOSPHERE ROCKET RESEARCH FIRINGS

1. FOREWORD

The Summary of Upper Atmosphere Rocket Research Firings is a noncritical compendium of information about upper atmosphere research conducted with rocket vehicles. It is a continuing publication that will be revised periodically to expand the information already contained in it and to include the newer rocket firings. The Summary has been prepared by the Naval Research Laboratory* at the invitation of the Upper Atmosphere Rocket Research Panel and with the support of the various agencies and institutions engaged in upper atmosphere rocket research.

The detailed information about each rocket firing is contained on data sheets which have been prepared, for the greater part, by the agency cognizant of the rocket firing. The author's activities in regard to these data sheets have been restricted to the design of the form used, and the abstracting and rearrangement of information wherever the need arose. In some instances additional information was inserted into the rocket entries, but only when the author felt that his sources were superior, or that the original source was lacking in completeness. All of the other material was prepared by the author either out of his experience in this field or from the numerous references listed in the bibliography.

The expandable binder and form of entries have been selected as the most convenient means of maintaining a publication of this type. Thus, newly published material can be directly inserted into the binder and the publication of material as separate reports avoided. All recipients of the Summary will be registered and new material will be forwarded to them as soon as it has been published.

The material has been grouped under eleven headings: the first six sections are mostly narrative and are of general interest, the next four sections contain descriptive material about the different rockets and the rocket data sheets, and the last section contains a bibliography of reports, papers, and articles that have been published. Numerous tables have been included as a convenient method of listing detailed information. Summaries of the various rocket firings have also been included to provide the reader with a ready reference to the general information about each rocket firing.

The rocket entry data sheets are to be found at the end of the sections concerned with the specific types of rockets. They are identified in the upper right-hand corner of the sheet with the rocket name, number, and firing date. All the information concerning a rocket firing appears on one sheet which is imprinted on both sides where necessary. The material is separated under headings which are appropriate to the instruments discussed therein and to the data reported. The last item is a bibliography of material known to have been published concerning the rocket discussed. In those cases where it has not been possible to publish a complete data sheet, because of either a lack of information or of time, simplified entries have been made. These entries will be replaced by the complete data sheets which will be published in the future.

All rocket firings listed are to be assumed as having taken place at the White Sands Proving Ground (32° 24' North latitude and 106° 22' West longitude, geomagnetic latitude 41° North) unless they are identified as having taken place at another location. All times are given in the 24-hour system and are Local Civil Times unless they are identified otherwise. The Local Civil Time at White Sands is Mountain Standard Time (GCT - 7 hours).

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*NRL Problem P06-07, Project No. NR 536-070

The titles in the bibliography have been listed in the title-author form to enable the reader to quickly locate material in which he is interested. The titles are arranged chronologically in an alphabetical listing by agency. Reports have been listed separately from papers and articles.

The author wishes to express his appreciation to Dr. Homer E. Newell, Jr., Head of the Rocket Sonde Research Branch, and to Mr. Milton W. Rosen, Head of the Rocket Development Branch, for their interest in this work and their many valuable suggestions. He also wishes to acknowledge the valuable contributions made by the various agencies in the preparation of their rocket entry data sheets and for providing him with lists of their publications. He also asks that the support given to him in the past will be continued in the future to help keep the Summary abreast of events. Constructive criticism will be welcomed by the author as an aid to the improvement of future revisions.

In the various tables throughout the Summary the following abbreviations will be used.

AFCRC	Air Force Cambridge Research Center, Cambridge, Massachusetts
APL	Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland
ARDC	Air Research and Development Command, Baltimore, Maryland
BRL	Ballistic Research Laboratories, Aberdeen Proving Ground, Aberdeen, Maryland
B. U.	Boston University, Boston, Massachusetts
Col. U.	University of Colorado, Boulder, Colorado
Denv. U.	University of Denver, Denver, Colorado
G. E.	General Electric Co., Schenectady, New York
Harv. U.	Harvard University, Cambridge, Massachusetts
Mich. U.	University of Michigan, Engineering Research Institute, Ann Arbor, Michigan
NIH	National Institutes of Health, Washington, D. C.
NOL	Naval Ordnance Laboratory, White Oak, Maryland
NRL	Naval Research Laboratory, Washington, D. C.
PU	Princeton University, Princeton, New Jersey
R.I. U.	University of Rhode Island, Kingston, Rhode Island
SCEL	Signal Corps Engineering Laboratory, Belmar, New Jersey
UAR	Upper Atmosphere Research
USA	United States Army
Utah U.	University of Utah, Salt Lake City, Utah
WADC	Wright Air Development Center, Dayton, Ohio

2. INTRODUCTION

History of the Upper Atmosphere Rocket Research Firings
The Upper Atmosphere Rocket Research Panel
The Primary Research Agencies

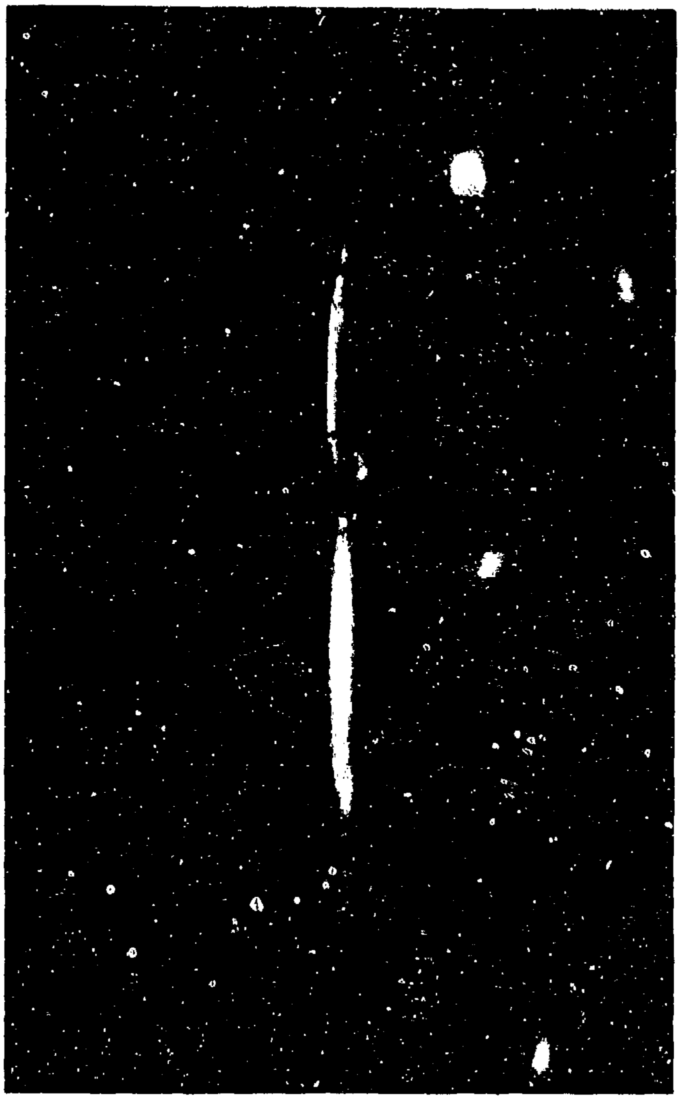

Figure 2.1 - A V-2 Rocket shortly after takeoff

2. INTRODUCTION

History of the Upper Atmosphere Rocket Research Firings

The upper atmosphere rocket research program was implemented when more than 100 unassembled V-2 rockets were captured in Germany and shipped to the United States at the close of World War II. More than sixty of these rockets were assembled, tested, and fired in a program that began early in 1946 and which continued through 1952.

The early fruitful results of the V-2 program demostrated that upper atmosphere research utilizing rocket vehicles had a promising future. It was soon realized that there was a need for a moderate size rocket to complement the V-2, and development work was begun on the Aerobee. It was patterned after the WAC CORPORAL, an earlier meteorological sounding rocket, and the first units were test fired during the latter part of 1947. The Aerobee enjoyed immediate success and has come to be used extensively by the major rocket instrumenting groups, more than 100 having been fired so far. A recently activated program will extend the usefulness of this rocket by increasing its potential altitude.

The Viking development project originated when it became clear that there would be a continuing need for a very high altitude rocket with a large payload capacity. A survey of needs and manufacturing capabilities showed that the V-2 would be prohibitively expensive to reproduce, and that its optimum capabilities could not satisfy the future needs of some phases of upper atmosphere research. Thus, the Viking development program was instituted and the first rocket of this series fired in 1949. Although the Viking propulsion system does not represent any great improvement over that of its predecessor, its structural design is far superior. The improved mass ratio of this rocket has enabled it to outperform the V-2 consistently. The engineering development of this rocket is still in progress.

A considerable boon to upper atmosphere rocket research is the ability to launch rockets from shipboard at diverse geographic locations. This was demonstrated for the first time when a V-2 was fired from the flight deck of an aircraft carrier, the U.S.S. MIDWAY, near Bermuda during 1948. It was confirmed when a series of Aerobee firings were conducted aboard the U.S.S. NORTON SOUND in equatorial waters of the Pacific Ocean during 1949. Another group of Aerobees were fired from this same ship in North Pacific waters in 1951; and a Viking was fired in equatorial waters shortly thereafter.

The shipboard firing techniques were further extended when Deacon rockets were first launched from icebreakers in North American waters in 1952. Although the Deacons' maximum altitude would be about 20 miles when fired from sea level, their optimum altitude can be extended when they are carried aloft by large balloons and then fired. Such firings have attained altitudes in excess of 60 miles during the first trials and again in 1953. Although the Deacon is small and can carry only relatively light instrument loads, it is performing valuable service in the study of cosmic radiation and atmospheric pressure, temperature, and density.

The Upper Atmosphere Rocket Research Panel

Before firing the first V-2 rocket, the U.S. Army Ordnance Department invited the heads of several scientific organizations to instrument these rockets in the interest of upper atmosphere research. A group of representatives from these organizations met shortly thereafter to consider the project and to coordinate their work. This group organized itself into the V-2 Upper Atmosphere Rocket Research Panel, which later became known as the Upper Atmosphere Rocket Research Panel when the Aerobee became available as a research vehicle.

The Panel consists of persons actively engaged in the several phases of the upper atmosphere rocket research program and its present membership represents many years of experience in rocket research and instrumentation. The current membership is as follows:

Dr. L. A. Delsasso	Aberdeen Proving Ground Ballistic Research Laboratories
Prof. W. G. Dow	University of Michigan Engineering Research Institute
*Dr. M. J. Ference	Signal Corps Engineering Laboratories, Meteorological Branch
Dr. C. N. Green	General Electric Company, Aeronautical and Engineering Systems Divisions
Mr. G. K. Megerian (Secretary)	General Electric Company, Aeronautical and Ordnance Systems Divisions
Dr. M. O'Day	Air Research and Development Command, Air Force Cambridge Research Center
Dr. W. H. Pickering	California Institute of Technology, Gugenheim Aeronautical Laboratory
Dr. H. E. Newell, Jr.	Naval Research Laboratory
Dr. J. A. Van Allen (Chairman)	State University of Iowa, Department of Physics (formerly with The Johns Hopkins University Applied Physics Laboratory
Dr. F. L. Whipple	Harvard College Observatory
Dr. P. Wyckoff	Air Research and Development Command, Air Force Cambridge Research Center

The Primary Research Agencies

The upper atmosphere rocket research program has been basically sponsored by the three military services of the United States: the Air Force, the Army, and the Navy. The Air Force's research has been conducted by the Cambridge Research Center and through contracts with a number of universities and scientific organizations. The Army's research has been conducted by the Signal Corps Engineering Laboratories and the University of Michigan Engineering Research Institute. The Navy's program has been conducted by The Johns Hopkins University Applied Physics Laboratory and the Naval Research Laboratory.

*Dr. Ference resigned recently and his successor has not yet been named.

3. ROCKET FIRING FACILITIES

3. ROCKET FIRING FACILITIES

Most of the upper atmosphere rocket research firings have taken place at the White Sands Proving Ground, New Mexico, which is operated by the U.S. Army Ordnance Department. The firing range is about 100 miles in length and has an average width of about 20 miles. It occupies the Tularosa Basin which is situated between the Sacramento and the San Andres mountain ranges north of El Paso, Texas. The U.S. Air Force and the U.S. Navy also operate rocket firing facilities at the White Sands Proving Ground to supplement the services provided by the U.S. Army.

This area is particularly suited for the type of operations in which it is engaged. The basin provides an unobstructed view from the launching points to the terminus of the firing range, and the mountains afford locations for the ballistic instruments. The climate is very favorable and results in a large number of clear and cloudless days throughout the year. This contributes much to the success of the optical instruments used there.

The U.S. Navy maintains a converted Seaplane Tender (AV-11), the U.S.S. NORTON SOUND, which can be used for upper atmosphere rocket firings in all navigable waters throughout the world. This ship has been utilized for one Viking and several Aerobee rocket firings in Pacific and Alaskan waters. It affords a means for studying geographical variations of upper air phenomena.

4. BALLISTIC INSTRUMENTATION

Radio Instruments
Optical Instruments
Time Standards
Range Safety

4. BALLISTIC INSTRUMENTATION

Rockets are tracked by both radio and optical instruments to obtain trajectory and attitude information. The radio instruments, radar and doppler, provide only trajectory data; whereas, the optical instruments, cameras, theodolites, and telescopes, can provide both trajectory and attitude data. Time standards are broadcast throughout the firing range in order to provide a means of synchronizing all events. Range safety is maintained by means of a radio control system that permits emergency rocket fuel cutoff to be effected. The cutoff is operated in conjunction with information obtained from tracking instruments. The characteristics of the ballistic instruments are summarized in Table 4.1.

Radio Instruments

The radars in use at White Sands are basically the same as radars used elsewhere except for slight modifications. The range display system has been altered to accommodate the increased range at which the radars must operate, and two synchronized radars are operated concurrently to insure the receipt of data. Transponding beacons are carried in the rockets because their echo producing surfaces are too small to reflect good tracking signals except at short ranges. The data are recorded in the form of range and azimuth and elevation angles versus time.

The doppler, or DOVAP, system utilizes a transmitter located south of the launching area which broadcasts a continuous signal carefully controlled in frequency, a transponder in the rocket, and four ground station receivers. The transmitter radiation is received by the transponder in the rocket, doubled in frequency, and the signal rebroadcast. The signal frequency is doubled to prevent interference between the transmitters and receivers. This rebroadcast signal is received by the ground receivers and beat against the suitably doubled frequency arriving at the receivers directly from the ground transmitter. The beat difference between the two frequencies is the doppler frequency due to the rocket velocity in the transmitter-rocket-receiver path. The doppler signals are transmitted by wire line to a central location where they are displayed on cathode ray tubes and photographed by a synchronously driven camera.

Integration of the doppler frequency as a function of time from a known location (the launching point at takeoff) gives, when multiplied by wavelength of the doubled signal, the distance in feet from the transmitter to rocket to receiver at any desired time. This known distance defines an ellipsoid of revolution the foci of which are the transmitter and receiver. When similar distances are known for three receivers, three ellipsoids are defined at any instant of time and simultaneous solution of the three equations will give the position of the missile at that instant of time.

Optical Instruments

The rocket is photographed with accurately calibrated optical systems and the photographs used to obtain rocket trajectory and attitude information. The rocket image positions on the photographs are measured with respect to the optical centers of the photographs. These position measurements are converted into rocket angular displacements with respect to the optical axes of these accurately located instruments. Since the directions of the optical axes are accurately determined, the direction of the rocket from the instruments can be determined. Information from two or more of each of the various types of optical instruments, and their positions both with respect to the rocket firing point and each other, uniquely determine the rocket positions with respect to the firing point.

The rocket's attitude is determined from data obtained by two or more similar optical instruments by additional image measurements which are related to the rocket's trajectory. The rocket image projections and longitudinal axis tilts are measured in the photographic plane and are converted into angles expressing the rocket's attitude in the desired planes. Thus, these values may either be expressed in terms of three mutually perpendicular planes established by a tangent to the rocket's trajectory or established by the launching point.

The cameras, Bowen-Knapp and Ballistic, are fixed in direction and are located both to the sides and rear of the expected rocket trajectory. The Bowen-Knapp cameras photograph the rocket at intervals and are aimed to obtain the lower portion of the powered flight. The Ballistic cameras photograph the rocket on a fixed plate and are aimed to obtain the upper portion of the powered flight. The Bowen-Knapp cameras can be used to obtain attitude data as well as trajectory data.

The theodolites, Askania, Mitchell, and Tele-theodolites, photograph the rocket on motion picture film and are located at various stations throughout the firing range. These instruments have restricted fields of view and track the rocket in flight. The elevation and azimuth angles of the instruments are displayed on dials which are photographed concurrently with the rocket. The rocket's final displacement angles, as measured from the photographs, are added to or subtracted from the dial readings as is necessary. The Tele-theodolite records can also be used to obtain attitude data as well as trajectory data.

The telescopes are mainly used to determine rocket attitude data, but are sometimes used to obtain ordinate data at long ranges. They track the rocket in flight, since they have highly restricted fields of view, and photograph it on motion picture film. There are several such instruments located in the firing range at widely separated points.

Time Standards

Standard time signals are generated and broadcast throughout the firing range of radio and also distributed to some points by wire line. The basic time signals are a 100-cycle square wave, a two-cycle signal, and a seven-pulse binary code signal. The 100-cycle signal is initiated by a switch that is actuated as the rocket begins to rise from the launching stand. The two-cycle signal is superimposed on the leading edge of the 100-cycle square wave and begins when the rocket has moved sufficiently (about four inches) to break a wire secured to one of its fins. The time signals are coded, with respect to takeoff (zero time) by suppresing one of the two-cycle pulses at each ten-second interval. The seven-pulse binary code is transmitted only by land lines at each ten-second interval after takeoff. These time signals can be recorded on ballistic and data records to synchronize flight data.

Range Safety

All of the upper air rocket research vehicles being fired at the White Sands Proving Ground are potentially capable of ranges which enable them to fall outside of the firing range boundaries and even in populated areas. They are fired on an almost vertical trajectory which has the twofold effect of attaining the highest possible altitude and restricting the range. There are, however, three possible causes which may affect the trajectory: (a) component failure in the controlled rocket, (b) excessive winds at high altitudes which may tilt the arrow-stabilized rocket into the wind, and (c) a structural failure in either the arrow-stabilized or controlled rocket which can upset its aerodynamic stability.

A control receiver is carried in each of the rockets whereby rocket thrust can be terminated in such an emergency via a ground radio transmitter. This control can take the form of either a command broadcast by the transmitter, or interruption of the transmitter signal. The former method is termed command cutoff, whereas the latter method is termed fail-safe cutoff. Most rockets carry an FM control receiver which is operated by either method through the broadcasting of, or the termination of, audio tones. A second system uses a radar beacon which initiates the fuel cutoff action by changing the radar interrogation rate. This system is usually operated in a fail-safe status. If the rocket dispersion is sufficiently large that thrust termination will not be sufficient to keep it in the firing range, then the explosives normally used for recovery blowup can be detonated. Thus, the rocket's aerodynamic form is destroyed, resulting in large aerodynamic drag forces, and thereby diminishing the horizontal range.

Data used as a basis for determining whether emergency fuel cutoff is needed are obtained from three sources: (a) sky screens, (b) radar, and (c) the impact point computer. The sky screens are essentially theodolites which view the rocket through a pair of crossed rods which are driven closed by an electric motor, beginning at rocket takeoff. If at any time, the rocket crosses these rods it is considered unsafe. Horizontal velocities derived from radar tracking data are plotted; these velocities are compared against the present position of the rocket and the remaining time it will be in flight. The rocket is also tracked with two sets of high-powered binoculars; the angular and elevation positions of these binoculars and the rate of change of their positions are electrically measured and fed into a computer. The computer continously predicts the point of impact of the rocket were its thrust terminated at that instant.

TABLE 4.1

WHITE SANDS PROVING GROUND BALLISTIC INSTRUMENT CHARACTERISTICS

TRAJECTORY DATA

Optical Instruments

Askania Theodolites

Initial data form: Azimuth and elevation angles from stations.
Rate of data: 1. 2, or 4 points per sec.
Instrument range: 40 to 50 miles.
Accuracy: 1/5000.
Stations required: Two or more.
Type of data reduction: Triangulation.
Final data form: X, Y, and Z coordinates vs time.

Tele-Theodolites

Initial data form: Azimuth and elevation angles from stations.
Rate of data: 1, 2, or 4 points per sec.
Instrument range: 75 to 100 miles.
Accuracy: 1/5000.
Stations required: Two or more.
Type of data reduction: Triangulation.
Final data form: X, Y, and Z coordinates vs time.

TABLE 4.1 (Continued)

Mitchell Theodolites
- Initial data form: Azimuth and elevation angles from stations.
- Rate of data: 12 to 16 points per sec.
- Instrument range: 20 miles.
- Accuracy: 1.0 mil.
- Stations required: Two or more.
- Type of data reduction: Triangulation.
- Final data form: X, Y, and Z coordinates vs time.

Ballistic Cameras
- Initial data form: Azimuth and elevation angles from stations.
- Rate of data: 1 or 3 points per sec.
- Instrument range: Upper portion of powered flight trajectory, from about 20,000 ft altitude.
- Accuracy: 2.0 sec of arc.
- Stations required: Two or more.
- Type of data reduction: Triangulation.
- Final data form: X, Y, Z coordinates vs time.

Bowen-Knapp Cameras
- Initial data form: Azimuth and elevation angles from stations.
- Rate of data: 30 points per sec.
- Instrument range: Lower portion of powered flight trajectory. 7 inch lens - 43° vertical, 7° horizontal; 12 inch lens - 25° vertical, 4° horizontal.
- Accuracy: 7 inch lens - 1/5000; 12 inch lens - 1/10,000.
- Stations required: Two or more.
- Type of data reduction: Triangulation.
- Final data form: X, Y, and Z coordinates vs time.

Radio Instruments

Radar
- Initial data form: Azimuth and elevation angles and range from station.
- Rate of data: Continuous.
- Instrument range: Dependent on rocket-borne transponder.
- Accuracy: Angular data - approximately 2.0 mils; Range data - approximately 1/2500.
- Stations required: One.
- Type of data reduction: Vector resolution.
- Final data form: X, Y, and Z coordinates vs time.

Doppler
- Initial data form: Relative velocities to stations.
- Rate of data: Continuous.
- Instrument range: Dependent on rocket-borne transceiver.
- Accuracy: Altitude - 50 ft at 100 miles; Slant range - 25 ft at 100 miles; Velocity - 0.05%; Acceleration - 0.1%.
- Stations required: Three or more.
- Type of data reduction: Triangulation.
- Final data form: X, Y, and Z coordinates; velocity and acceleration vs time.

TABLE 4.1 (Continued)

Beacon Triangulation

Initial data form: Relative ranges to stations.
Rate of data: Continuous.
Instrument range: Dependent on rocket-borne transponder.
Accuracy:
Stations required: Three or more.
Type of data reduction: Triangulation.
Final data form: X, Y, and Z coordinates.

ATTITUDE DATA

Bowen Knapp Cameras

Initial data form: Longitudinal axis deviations in plane of film.
Rate of data: 30 points per sec.
Instrument range: Lower portion of powered flight trajectory.
Accuracy: Approximately 1.0°.
Stations required: Two or more.
Type of data reduction: Vector resolution.
Final data form: Angular displacements in pitch and yaw planes vs time.

Tele-Theodolites

Initial data form: Longitudinal axis deviations in plane of film.
Rate of data: 1, 2, or 4 points per sec.
Instrument range: Powered portion of rocket flight.
Accuracy: Approximately 3°.
Stations required: 2 or more.
Type of data reduction: Vector resolution.
Final data form: Angular displacements in pitch and yaw planes vs time.

Telescopes

Initial data form: Longitudinal axis deviation in plane of film and roll displacements.
Rate of data: 16 readings per sec.
Instrument range:
Accuracy: Pitch and yaw data to approximately 3.0°, roll data to 14 rpm.
Stations required: Two or more.
Type of data reduction: Vector resolution.
Final data form: Angular displacements in pitch and yaw planes and roll vs time.

5. DATA RECOVERY

Radio Telemeter

Physical Recovery

5. DATA RECOVERY

Upper atmosphere data are obtained during rocket flights by means of radio telemeter systems, or by the physical recovery of instruments and records after the flight has been completed. Radio telemeter systems have been the primary data source in most rocket firings because of the many difficulties encountered in attempting physical recovery.

Radio Telemeter

The radio telemeter systems in general use may be classified into the following categories:*

(a) **AM-FM** amplitude modulation - frequency modulation,
(b) **FM-FM** frequency modulation - frequency modulation,
(c) **PAM-FM** pulse amplitude modulation - frequency modulation,
(d) **PWM-PM** pulse width modulation - phase modulation,
(e) **PPM-AM** pulse position modulation - amplitude modulation.

The FM-FM and the PPM-AM systems have been almost exclusively used in the upper atmosphere rocket research program. The characteristics of these two systems are summarized in Table 5.1. Most of the Aerobee rocket firings have utilized the FM-FM system, whereas the PPM-AM system has been the major system employed in the V-2 and Viking firings. However, a miniaturized version of the PPM-AM system has been used in some of the later Aerobee firings.

TABLE 5.1

CHARACTERISTICS OF THE TELEMETERING EQUIPMENT

Designation	Type	Frequency (Mc)	Power Output	Channels	Signal Input	Sample Rate (Sec^{-1})	System Accuracy (%)	Calibration (In Flight)	Equipment Weight Including Batteries (Lb)
PXTA-501	PPM-AM	1025	0.75 Kw†	23	Voltage	180	3	Internal	150
AN/DKT-2(XN-1)	PPM-AM	1025	3.5 Kw†	30	Voltage	312	1	Internal	130
AN/DKT-2(XN-2)*	PPM-AM	1025	3.5 Kw†	30	Voltage	312	1	Internal	130
AN/DKT-7()	PPM-AM	227.5	10 w†	15	Voltage	312	1	External	38
APL FM-FM	FM-FM	225	15 w	6	Voltage	Continuous.	2-5	None	6**

*Repackaged version of (XN-1).
†Peak Pulse Power.
**Equipment weight excluding dynamotor and batteries.

A rocket-borne telemeter system essentially consists of an encoder, a modulator, and a transmitter. The data are presented to the encoder in the form of a signal voltage which is varied according to the intelligence it represents. In the case of the FM-FM

*In this grouping the prefix denotes the data encoding system and the suffix denotes the data transmission system.

system, the signal voltage controls the frequency of an audio subcarrier oscillator, and in the PPM-AM system it controls the duration of a pulse generated by a blocked multi-vibrator. Data are multiplexed into the modulator by virtue of the simultaneous operation of several subcarrier oscillators (at different audio frequencies) in the FM-FM system, and by the sequential sampling of a number of blocked multi-vibrators in the PPM-AM system. In the event that several sources of slowly changing data are available, they may be mechanically commutated into each of the encoders or telemeter channels.

The transmitters, either the amplitude-modulated or frequency-modulated type, are operated at frequencies above 80 Mc. These frequencies provide two advantages for rocket work: (a) they are noncritical with respect to transmission through the ionosphere, and (b) the physical size of antennas are small. The early Aerobee FM-FM system operated at a frequency of about 80 Mc and utilized a probe antenna at the rocket nose; later a notch antenna (in a tail fin) was used and the transmitter frequency shifted to about 225 Mc. The newer Aerobee PPM-AM system also operates at about 225 Mc and utilizes a tail fin notch antenna. The Viking and V-2 PPM-AM systems have always operated at a frequency of 1025 Mc and used a turnstile-type antenna mounted outboard on a tail fin. The higher power radiated by this system makes it necessary to employ a pressurizing plastic dome, enclosing the antenna, to prevent power loss due to corona discharge.

The telemeter ground stations are located along the horizontal path of the rocket in order to provide a more favorable transmission path for the telemeter signals. The received signals are photographically recorded from video display systems, in the case of the PPM-AM system, and a galvanometer-optical arrangement in the case of the FM-FM system. The records are printed by an ozalid process, which provides a satisfactory and inexpensive method for quickly obtaining record copies. The telemeter record is synchronized with the firing operations by also printing the time standard signals on the record. The over-all accuracy of the systems can be determined from known calibration voltages which are introduced into each of the channels at the airborne unit at intervals during flight.

Physical Recovery

In those cases where it is not possible to convert data into a suitable form for telemetering it is necessary to rely on the physical recovery of data bearing media. The two most important problems to overcome in this instance is protection of the data record and then finding it.

A rocket will strike the ground with a velocity in excess of 2000 ft per sec if its aerodynamic form is not destroyed during descent. Severance explosives are employed to separate either the nose (in V-2 and Viking firings) or the tail (Aerobee rocket) at an altitude of about 40 miles. Thus the aerodynamic form is destroyed and the rocket is rendered unstable, which results in the development of large aerodynamic drag forces. Under such conditions a rocket will strike the earth with a velocity under 200 ft per sec. Adequately protected records may then be recovered with relative ease if they remain attached to a findable part of the rocket.

Lower terminal velocities can be realized when parachutes are employed to lower the instruments. Recent parachute recoveries have been remarkably successful and terminal velocities under 100 ft per sec are being realized. In this instance the parachute and instrument container are separated from the rocket with explosives and the parachute deployed when there is sufficient dynamic pressure to inflate it.

The three most serious considerations regarding record protection are brought about by shock, heat, and light. The use of very heavy materials for encasing the records comes close to solving all three of these problems; however, if the record is subject to long exposure to sunlight, the heat damage is most difficult to protect against. In many instances the protecting material is likely to interfere with the experiments, as such is the case when nuclear research emulsions are involved. In some cases it is possible to use less protecting material and to install the object in a portion of the rocket where experience shows the least amount of damage is likely to be sustained.

Rocket impacts are located by means of tracking instruments and ground and air search. If the object to be found contains a radar beacon it is possible to obtain very good information about its probable point of impact. Without such equipment it is necessary to rely on optical 'fixes', sound ranging, or the Impact Point Computer to provide such information. In the early days sound ranging depended upon human listening posts equipped with stop watches; however, this has since been substituted for by the Signal Corps (Geophones) sound ranging set GR-3. The impact point computer provides impact data on the basis of the rocket's position and resolved velocities at burnout. Coordinated ground and air search teams can produce early results if the impact information is sufficiently good to fix the impact within a mile or so, and the rocket has not been torn apart too badly.

6. ROCKET INSTRUMENTATION

Instrument Space
Instrument Weight
Rocket Stability
Acceleration
Vibration
Pressurization
Aerodynamic Effects
Aspect
Equipment Reliability
Contaminants

6. ROCKET INSTRUMENTATION

The major problems associated with the instrumentation of rockets are as follows: space, weight, stability, acceleration, vibration, pressurization, aerodynamic effects, aspect, equipment reliability, data recovery, and trajectory data. The first nine items will be briefly discussed in the succeeding paragraphs and the last two items are discussed in other Sections of the Summary. Reference to Tables 7.1, 8.1, 9.1, and 10.1 will provide the reader with a summary of the characteristics of the Aerobee, Deacon, V-2, and Viking rockets.

Instrument Space

The most limiting factor is that imposed by the relatively small volumes and the space configurations available in the rocket for instruments. Therefore, the instruments must be carefully tailored to meet these conditions. Independent instrument design cannot be tolerated and it is essential that diverse equipments, which have conflicting requirements, must be carefully coordinated into a practical research assembly.

Instrument Weight

Aside from motor efficiency and fuel capacity, the most important contribution that can be made toward attaining the optimum rocket altitude is that of keeping the instrument weights small. This is, of course, directly opposed to the desire to make each rocket carry the maximum instrument load that it is capable of carrying. The solution to this problem can be approached in two ways: all equipment that does not make basic contributions to the data gathering ability of experiments must be eliminated, and the construction materials selected must be as light as strength considerations will permit them to be. Additionally, all equipment should be operated from a common power source whenever possible; i.e., vacuum tube filaments and high voltage dynamotors should be operated from the same battery source. Further, each battery should be taxed to its maximum capacity to avoid carrying useless battery weight.

Rocket Stability

A rocket is statically stable when its center of gravity (C_g) lies between the nose tip and its center of pressure (C_p). It is neutrally stable when the C_g and C_p coincide, and it is statically unstable when the C_g lies between the C_p and the tail end. It is desirable to establish a margin of static stability for each rocket that is greater than an established minimum value (smallest allowable distance between the rocket's C_g and C_p). This margin is usually stated in terms of the maximum allowable aft position for the rocket's C_g, and is essentially determined by the weights of the instruments and their locations.

In the V-2 rocket, the C_p is about 171 inches above the burner base* and the C_g should be placed at about 236 inches; consequently, the minimum acceptable margin of stability is about 67 inches. Since the weight of the uninstrumented V-2 is about 6500 pounds with a C_g at about 160 inches, it is necessary to add about 2500 pounds of weight with a C_g at 434 inches in order to obtain a final rocket C_g of 236 inches. Because of this very large weight requirement, more than one half of the V-2 payload usually consists of nonproductive weight. The practical minimum payload for an Aerobee rocket is about

*The V-2 measurements are always referenced to the burner base, whereas, the Aerobee and Viking measurements are referenced to the nose tip.

120 pounds with a C_g at 64 inches. There is no practical minimum payload specified for the Viking rocket, because it has an acceptable margin of stability with as little as 100 pounds of instruments installed in the nose or instrument sections.

Acceleration

Sustained linear accelerations developed during powered flight can cause the effective weights of objects in the rocket to increase many times. Thus, an object weighing but one pound under static conditions can have an effective weight of 14 pounds in a boosted Aerobee, several times this value in Deacon rockets, and about 7 pounds in V-2's and Vikings. Consequently, rocket structures must be designed to carry many times the apparent instrument weights. This condition must also be considered in the design of the instruments themselves.

During coasting flight all objects in the rocket are weightless because they are freely falling bodies. Although there are no structural or instrument strength difficulties involved, other problems arise. Fluids are not likely to remain at the bottoms of their containers, or, instruments that are dependent upon the existence of a gravitational field will not perform properly. Thus, it may be necessary to create an artificial gravitational field by spinning the instrument or imparting a spin to the rocket.

Vibration

In general, vibration conditions do not appear to be very serious. However, they can be very severe during ignition and burnout of the rocket motor. During these periods, the propellant ratios can become sufficiently unbalanced to cause explosive burning conditions. Vibration becomes insignificant during coasting flight. In most instances, the standard aircraft vibration specifications for equipment appear to be adequate.

Pressurization

The ambient air pressure decreases by one order of magnitude for each ten miles of altitude. Thus, unpressurized equipment must be capable of operating in a near vacuum. During both ascent and descent a critical pressure interval is traversed wherein corona discharge and arcing can take place in unpressurized equipment employing potentials of several hundred volts. Corona discharge can consume a considerable portion of the power available at an antenna and pressurizing may be necessary to insure the uninterrupted receipt of signals radiated by the antenna. Unpressurized fluids may begin to boil under low pressure conditions and have serious consequences, such as causing electrolyte to percolate out of a battery.

Aerodynamic Effects

Instruments protruding into the rocket air stream are subject to aerodynamic heating and drag. The heating is due to air friction and conduction through the air from the boundary layer. The boundary layer temperature can rise to near incandescence at high speeds, which is exemplified by the nominal rule fixing this temperature as being about fifty times the Mach Number squared. The most serious consequences will occur on objects having small heat capacities. It is not sufficient to consider only melting and softening points of materials used in the air stream, but, in the instance of an antenna enclosure, it is also necessary to select a material that will coalesce rather than carbonize. Carbonization would tend to shield an antenna and to short circuit electrical equipment.

The effects of aerodynamic drag are not too serious because they can be evaluated prior to completing the design of the equipment. After this has been taken into consideration, and the equipment designed to have the required strength, the most serious effects are likely to be with respect to upsetting the rocket's stability. Thus, it may be necessary to install a dummy of the equipment on the opposite side of the rocket to balance the drag forces. It is always a good practice, and sometimes necessary, that streamlined fairings be installed around openings in the rocket skin and objects outside the rocket. In the event that an object, such as a whip antenna, must be extended from the rocket, it may be necessary to fold it along the rocket skin during the period of maximum drag.

Aspect

During powered flight, stability is imparted to a rocket by aerodynamic forces and aided by control systems in some cases. When the fuel is spent, the control forces cease and the aerodynamic forces diminish and gradually vanish as the rocket rises through the fast thinning atmosphere. Since all stabilizing influences are removed, the rocket can spin, tumble, and precess. And, since most instruments have directional characteristics, this creates one of the most vexing problems in rocket instrumentation. Post-flight stabilization systems are under development, but they are not yet wholly satisfactory.

This problem has been partially solved for solar spectroscopy by pointing controls that direct the instruments, but this measure is not applicable to all experiments. Thus, it becomes necessary to obtain rocket attitude information in order to evaluate data gathered by these instruments. Gyroscopes have not been satisfactory for this task because uncertainties are introduced by the drift of their axes during sustained accelerations, and little is known of their reliability when they are in a free fall condition. Further, if the rocket is too active with regard to attitude motion, they are likely to tumble and become worthless. Motion pictures of the horizon can be quite helpful, but frequently, it is possible to determine only zenith angles and roll rate rather than roll position. Photoelectric indicators are used which determine the rocket's attitude relative to the sun; however, it is sometimes not possible to determine whether the rocket is coasting with its nose pointing up or down. In addition, the photographic and photoelectric techniques are not useful during night firings. It is possible to obtain rocket zenith angles with respect to the earth's magnetic lines of force with a magnetometer, but this method does not define roll position.

Equipment Reliability

Instruments designed for rocket installation must be highly stable in operation, self calibrating, and simple in design. Stability is required because the opportunity for equipment adjustment ceases many hours before firing time and very critical instruments will probably drift during this interval. The demand for telemeter channels is usually so great that it is not possible to monitor all phases of equipment operation; therefore simple calibration schemes are necessary whereby it can be determined whether the equipment functioned properly during flight. Simplicity is mandatory because it eases the demands on space and weight and considerably improves the equipment reliability relative to the reliability of complex systems.

Contaminants

At very high altitudes the vapor pressures of various contaminants in a rocket, such as propellants, hydraulic oils, and other miscellaneous materials, will exceed the ambient pressure. Thus, foreign gases may be propagated into the openings of pressure gag composition sampling devices, and other instruments. Such events are quite capable obscuring data or even causing false measurements. There are only two methods of combatting this condition; they consist of either sealing the rocket completely or of separating the instrument from the rocket. Both of these solutions are difficult to accomplish and have not yet been successfully used.

7. THE AEROBEE ROCKET

Description

Characteristics - Table

Firings - Tables

Air Research and Development Command Aerobee Firings

Applied Physics Laboratory Aerobee Firings

Naval Research Laboratory Aerobee Firings

Signal Corps Engineering Laboratories Aerobee Firings

Data Sheets

Figure 7.1 - The Aerobee Rocket

7. THE AEROBEE ROCKET

The Aerobee is a vertically launched sounding rocket designed to carry a 150-pound instrument load to an altitude of about 70 miles. It resembles a conically tipped cylinder 19 feet long, with a 15-inch maximum diameter, and has three equally spaced fins at the after end (cf. Figure 7.1). The rocket is directed by a launching tower during its initial stage of flight and is arrow stabilized* thereafter, as it has no movable surfaces or internal controls. Propulsion is in two stages; first by a solid propellant booster rocket that falls away when spent and, then, by a liquid propellant sustaining rocket motor that is spent at an altitude of about 18 miles. The major characteristics of the Aerobee are given in Table 7.1 and the Aerobee firings are summarized in Tables 7.2, 7.3, 7.4, and 7.5.

Instrument Space and Structure

The Aerobee consists of three major sections (cf. Figure 7.2): a nose section, a tank section, and a tail section. All instruments are installed within the pressurizable nose section with the exception of very small objects which must be placed within the tail section. The removable nose cone provides 4.8 cu ft of instrument space within a cone-ogive-cylinder configuration that is 87 inches long and has a maximum diameter of 15 inches. An additional 1.5 cu ft of instrument space can be provided by a 15-inch long cylindrical nose cone extension which is also pressurizable.

The instruments are installed on a structure that fits inside the nose section and which is attached to the rocket body by four mounting pads at the forward end of the tank section. Instruments are mounted on the rocket skin only when they are both light in weight and need access through the skin. Moderate weight instruments can be installed at the nose tip.

The tank section contains the pressurizing gas tank, the oxydizer, and the fuel tanks. The tail section houses the propellants' feed 'burst' diaphragms, the fuel severance fitting, and the rocket motor. Three sockets are provided at the after end of the rocket airframe to receive three plugs fitted on the forward end of the booster which attach the booster to the rocket.

Electrical Wiring and Antennas

Electrical connections and r-f transmission cables are routed from the forward to the after sections via three external shrouds mounted on the rocket's tank section. External circuits from the blockhouse for the control, monitoring, and auxiliary powering of upper air instruments within the rocket are connected through a receptacle in the forward end of the tank section. The connector is disengaged by a device that is operated by upward motion of the rocket in the launching tower. There are no electrical circuits associated with propulsion equipment in the rocket.

Propulsion

Initial propulsion is obtained from a solid propellant rocket booster that is attached to the after end of the rocket. The booster is electrically ignited by a signal originating

*cf. Rocket Stability, Sect. 6.

in the blockhouse. After the booster is spent it falls away under the influence of aerodynamic drag and the rocket continues in flight propelled by its sustaining motor. The booster provides the additional impulse necessary to enable the rocket to attain a velocity sufficient to stabilize it aerodynamically before it emerges from the launching tower.

The regenerative-type rocket motor burns a mixture of red-fuming nitric acid and an analine-furfyrol alcohol solution. The propellants are injected into the combustion chamber by a pressurizing gas where they ignite spontaneously. There are no external controls associated with the propulsion system other than an external trip on the pressurizing gas regulator valve. This mechanical trip is actuated when it engages a projection in the launching tower as the rocket is propelled by the booster. When the regulator has been tripped, gas begins to flow into the propellant tanks and causes the retaining diaphragms in the motor feed lines to rupture. These 'burst' diaphragms keep the propellants from entering the combustion chamber prior to booster firing. Ordinarily the propellants are allowed to burn until one of them has been exhausted. Combustion can be terminated at any time by means of a command via the radio cutoff receiver which stops the flow of fuel to the rocket motor. This is accomplished by severing the fuel feed line with primacord and allowing the fuel to flow into the tail section.

Launching Tower

The launching tower is 143 ft long and is provided with a tripod base. An adjustable jack is mounted under one of the base legs to permit adjustment of the tower tilt, which will compensate for the effect of winds on the rocket's trajectory. Three radially mounted rails, within the tower, engage riding lugs on the rocket skin to direct the rocket during the interval of time that it is moving in the tower. A forked lug on the rocket booster prevents the rocket assembly from rotating in the launching tower.

Design, Development, and Firing Services

The Aerobee rocket was jointly developed by the Douglas Aircraft Corporation and the Aerojet-General Corporation under the sponsorship of the U.S. Navy Bureau of Ordnance and Office of Naval Research. The project was under the scientific direction of The Johns Hopkins University Applied Physics Laboratory. The rocket is prepared and fired by personnel of the U.S. Naval Ordnance Missile Test Facility for the Naval Research Laboratory and the Signal Corps Engineering Laboratory. This facility also provided the same services to the Applied Physics Laboratory during the time it was active in this program. The Aerobees fired for the Air Research and Development Command are handled by a crew of the Holloman Air Force Base. Supporting services are provided by the White Sands Proving Ground.

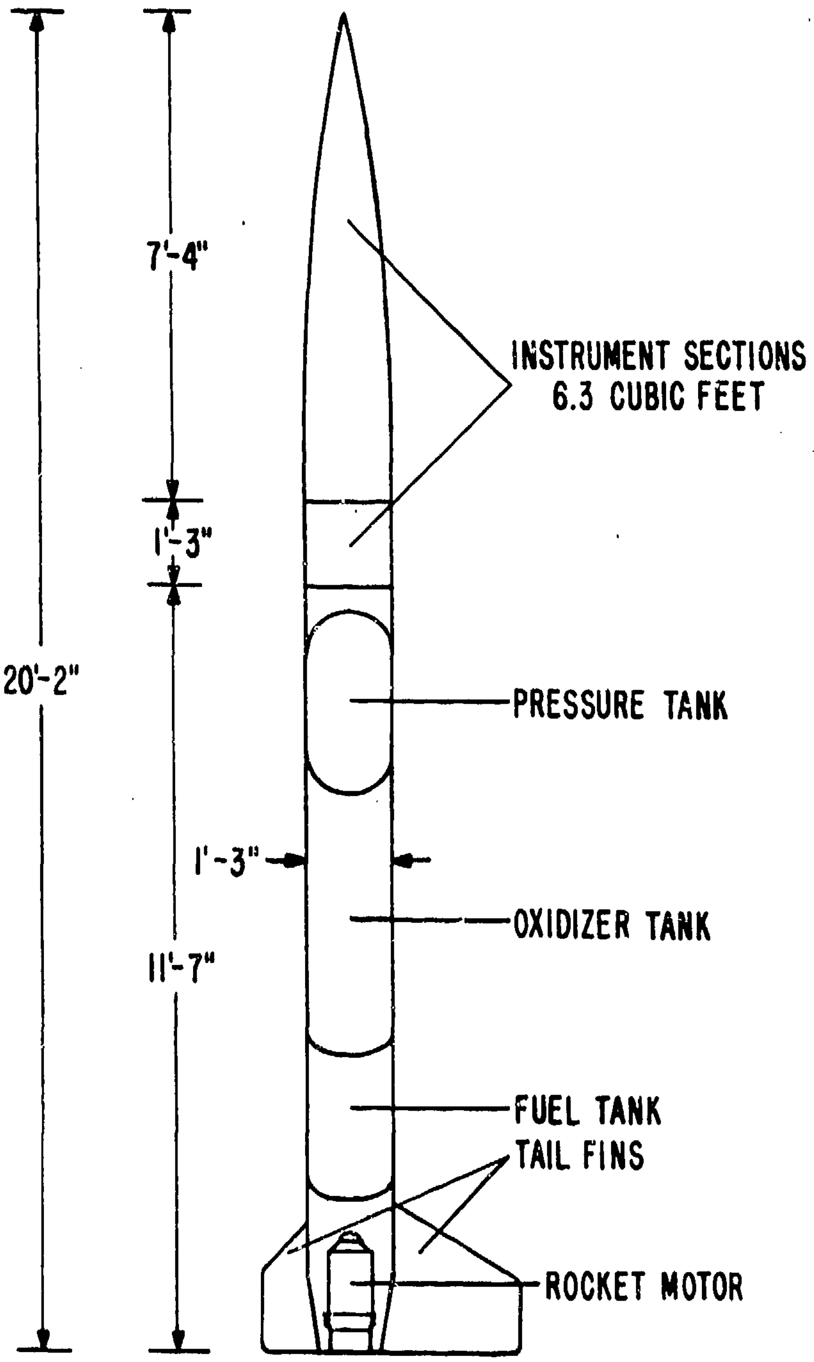

Figure 7.2 - The Aerobee Rocket, cross-sectional view

TABLE 7.1

CHARACTERISTICS OF THE AEROBEE SOUNDING ROCKET

DIMENSIONS	
Total Length	242 in. (less booster)
Booster Length	75 in.
Diameter	15 in.
Fin Span	62 in.
WEIGHTS	
Airframe	295 lb*
Propellants	623 lb (helium pressurized)
Payload	150 lb (nominal payload)
Gross at Launching	1068 lb
Booster Airframe	315 lb
Propellant	260 lb
Booster Gross	575 lb
INSTRUMENT SPACE	
Nose Section	Generally pressurized, cylinder topped with approximately conical shape, detachable
Apex angle	20 deg
Height	88 in.
Maximum diameter	15 in.
Volume	4.8 cu ft
Static load	350 lb (maximum allowable)
Material	0.04 in. spun aluminum
Nose Extension	Generally pressurized, cylinder, detachable
Height	15 in.
Diameter	15 in.
Volume	1.5 cu ft
Static load	350 lb (maximum including nose payload)
Material	0.04 in. aluminum
Other	Very small unpressurized volumes in motor section
ANTENNAS	
Used	One notch in each of three fins. Slots on midbody. Wires from each of three fins to regulator section. Probe and folded dipole at nose tip. Slots in nose section.
Others Possible	Whips on body.
PERFORMANCE	
Maximum Altitude	70 mi (150 lb payload).
Time to Zenith	173 sec
Flight Duration	350 sec
Time Above 18.6 mi	252 sec

TABLE 7.1 (Continued)

FLIGHT CHARACTERISTICS

Acceleration	14 g during boost (120 lb payload). 2 g after boost to 5.8 g at burnout.
Duration of Acceleration	2.5 sec (duration of boost). 45 sec (duration of sustaining motor).
Maximum Velocity	4500 ft per sec
Maximum Dynamic Pressure	11 lb per sq in.
Skin Temperature Rise	165° C on nose cone (estimated).
Vibration Characteristics	Not measured. Some severe cases reported.
Aspect Behavior	No control system. Arrow stabilized by fins. Spin rates up to 2 rps possible. Angle of attack up to 15° during powered flight, larger later. Tumbling possible.

*Includes weight of the propulsion unit.

TABLE 7.2

AIR RESEARCH AND DEVELOPMENT COMMAND AEROBEE FIRINGS

AEROBEE ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
USAF-1	2 Dec 49	1520	59.7	Solar radiation, temperature, photography
USAF-2	15 Dec 49	1010	0.2	Solar radiation, pressure, temperature, photography
USAF-3	14 Mar 50	1343	2.0	Solar radiation (R.I.U.); solar radiation, sky brightness (AFCRC)
USAF-4	26 May 50	1243	42.0	Solar radiation (R.I.U.)
USAF-5	2 Jun 50	1007	15.4	Sky brightness (AFCRC)
USAF-6	20 Jun 50	0838	57.5	Temperature, pressure (Mich. U.)
USAF-7	12 Oct 50	1236	56.7	Photography (WADC)
USAF-8	2 Nov 50	0929	57.0	Airglow (Col. U. & Denv U.)
USAF-9	12 Dec 50	1126	66.0	Pressure, temperature (Mich. U.)
USAF-10	28 Mar 51	1614	41.0	Airglow (AFCRC)
USAF-11	12 Apr 51	1026	18.0	Solar radiation (Col. U.)
USAF-12	18 Apr 51	1139	38.0	Biological (Aero-Med. Lab. WADC)
USAF-13	29 May 51	1246	2.3	Ionosphere (B. U.)
USAF-14	7 Jun 51	1711	55.0	Solar radiation, airglow (AFCRC)
USAF-15	25 Jul 51	0926	44.3	Sky brightness, photography
USAF-16	7 Aug 51	0936	51.9	Ionosphere (B. U.)
USAF-17	30 Aug 51	1540	47.0	No UAR experiments
USAF-18	13 Sep 51	0437	47.0	Pressure, temperature (Mich. U.)
USAF-19	20 Sep 51	0931	44.0	Biological (Aero-Med. Lab. WADC)
USAF-20	17 Oct 51		71.0	Ionosphere (B. U.)
USAF-21	30 Jan 52	1345	0	Ionosphere (Utah U.)
USAF-22	19 Feb 52		0	Sky brightness (AFCRC)
USAF-23	29 Feb 52		55.5	Sky brightness (AFCRC)
USAF-24	22 Apr 52	1028	70.0	Ionosphere (B. U.)
USAF-25	1 May 52	0842	57.0	Solar radiation (Col. U.)
USAF-26	31 May 52	0815	16.2	Biological (Aero-Med. Lab. WADC)
USAF-27	18 Jun 52	1050	62.0	Solar radiation (Denv. U.)
USAF-28	30 Jun 52	0732	63.0	Sky brightness (AFCRC)
USAF-29	26 Aug 52	1153		Ionosphere (Utah U.)

TABLE 7.2 (Continued)

AEROBEE ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
USAF-30	10 Oct 52	0724	38.0	Solar radiation (Denv. U.)
USAF-31	22 Oct 52	0735	62.0	Pressure, temperature (Mich. U.)
USAF-32	6 Nov 52	0856	47.0	Sky brightness (AFCRC)
USAF-33	12 Dec 52	1238	55.0	Solar radiation (Col. U.)

TABLE 7.3

APPLIED PHYSICS LABORATORY AEROBEE FIRINGS

AEROBEE ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
A-1,2,3	-	-	-	Dummy firings, no UAR experiments
A-4	24 Nov 47	1020	34.7	Cosmic radiation
A-5	5 Mar 48	1551	73.0	Cosmic radiation
A-6	13 Apr 48	1441	71.0	Magnetic field
A-7	26 Jul 48	0947	70.0	Photography
A-8	1 Nov 48	1715	56.5	Cosmic radiation; solar radiation (NRL)
A-9	1 Mar 49	-	-	Dummy firing, no UAR experiment
A-10	17 Mar 49	-	65.0	Cosmic radiation; magnetic field (NOL) (lat. 11° S, long. 88° W)
A-11	22 Mar 49	1730 (GCT)	65.0	Cosmic radiation; magnetic field (NOL, APL) (lat. 11° S, long. 88° W)
A-12	24 Mar 49	1514 (GCT)	3.7	Cosmic radiation; magnetic field (NOL) (lat. 11°16' S, long. 82°08' W)
A-13	17 Jun 49	0450	55.0	No UAR experiments
A-14	23 Jun 49	1621	55.0	Cosmic radiation, solar radiation
A-15	15 Jan 50	2345 (GCT)	45.0	Cosmic radiation (Geomag. lat. 58° N)
A-16	18 Jan 50	2317 (GCT)	50.0	Cosmic radiation (Geomag. lat. 50° N)
A-17	12 May 50	0530	54.7	Cosmic radiation
A-18	17 Aug 50	0845	63.0	Composition
A-19	22 Jan 51	1555	55.0	Composition
A-20	25 Jan 51	0800	56.0	Solar radiation
A-21	6 Feb 51	1020	61.0	Photography

TABLE 7.4

NAVAL RESEARCH LABORATORY AEROBEE FIRINGS

AEROBEE ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
NRL-1	5 Aug 48	1337	60.0	Solar radiation, pressure, temperature
NRL-2	28 Jan 49	2317	60.0	Cosmic radiation, solar radiation, pressure, temperature, ionosphere
NRL-3	1 Feb 49	1138	0	Solar radiation
NRL-4	14 Feb 50	1614	54.4	Cosmic radiation, pressure, temperature
NRL-5	14 Jun 49	1903	68.0	Solar radiation
NRL-6	3 Aug 50	1652	3.7	Solar radiation

TABLE 7.2.1

AIR RESEARCH AND DEVELOPMENT COMMAND AEROBEE FIRINGS

AEROBEE ROCKETS	MODEL	DATE	TIME	PLACE	ALTITUDE ABOVE SEA LEVEL	EXPERIMENT
USAF-34	RTV-A-1a	18 Feb 53	1042	Holloman	73 mi	Rocket performance
USAF-35	"	14 Apr 53	0847	"	76 mi	No UAR experiments
USAF-36	"	20 May 53	0704	"	71 mi	Sky brightness; day airglow
USAF-37	"	21 May 53	0857	"	71 mi	Sky brightness; day airglow
USAF-38	"	26 June 53	1210	"	84 mi	Ionosphere
USAF-39	"	1 July 53	1052	"	86 mi	Ionosphere
USAF-40	"	14 July 53	0830	"	64 mi	Solar radiation
USAF-41	"	22 July 53	0247	"	59.4 mi	Atmospheric composition
USAF-42	"	15 Sept 53	0802	"	20 mi	Sky brightness
USAF-43	"	7 Oct 53	1000	"	62 mi	Solar radiation
USAF-44	"	2 Nov 53	1132	"	75 mi	Ionosphere
USAF-45	"	3 Nov 53	1115	"	75.5 mi	Ionosphere
USAF-46	"	11 May 54	0800	"	61 mi	No UAR experiment
USAF-47	"	2 June 54	0910	"	58 mi	No UAR experiment
USAF-48	"	14 July 54	0655	"	57 mi	Temperature aspect
USAF-49	"	11 Aug 54	1025	"	57 mi	Ionosphere
USAF-50	"	17 Sept 54	0731	"	58.8 mi	Solar radiation
USAF-51	"	21 Jan 55	1754	"	58.9 mi	Airglow (sodium flight)
USAF-52	"	7 Feb 55	1151	"	74.8 mi	Ionosphere
USAF-53	"	10 Feb 55	1538	"	47.3 mi	Ionosphere
USAF-54	"	29 Mar 55	0947	"	70 mi	Solar radiation
USAF-55	AJ11-6	21 Apr 55	0858	"	119 mi	Rocket performance
USAF-56	AJ10-27	15 June 55	1811	"	126 mi	Special classified flight
USAF-57	AJ11-6	23 June 55	0547	"	38 mi	Rocket performance
USAF-58	AJ10-27	14 Sept 55	0630	"	59 mi	Rocket aerodynamics
USAF-59	AJ10-27	30 Sept 55	0850	"	46 mi	Solar limb darkening
USAF-60	RTV-A-1a	12 Oct 55	1800	"	63 mi	Sodium studies
USAF-61	AJ10-27	13 Dec 55	1058	"	86 mi	Lyman α, solar limb darkening
USAF-62	RTV-A-1a	12 Mar 56	1415	"	59 mi	Nitric oxide attempt to produce sporadic E

TABLE 7.2.1 (Continued)

AEROBEE ROCKETS	MODEL	DATE	TIME	PLACE	ALTITUDE ABOVE SEA LEVEL	EXPERIMENT
USAF-63	RTV-A-1a	14 Mar 56	0145	Holloman	66 mi	Nitric oxide attempt to re-combine atomic O
USAF-64	RTV-A-1a	11 Apr 56	1305	"	66 mi	Sodium cloud - ionization
USAF-65	AJ10-34	8 May 55	0754	"	89 mi	Solar radiation
USAF-66	AJ11-6	16 May 56	0840	"	105 mi	Rocket performance
USAF-67	AJ10-34	13 June 56	1351	"	85.6 mi	Ionosphere
USAF-68	AJ10-34	18 June 56	1342	"	85 mi	Ionosphere
USAF-69	AJ10-34	21 June 56	1148	"	91 mi	Ionosphere
USAF-70	AJ10-34	26 June 56	1126	"	69 mi	Ionosphere
USAF-71	AJ10-34	30 July 56	1756	"	80 mi	Day airglow
USAF-72	RTV-A-1a	3 Aug 56	0556	"	1.5 mi	Solar spectrum and at-mospheric composition
USAF-73	AJ10-34	1 Nov 56		"	(223,000 ft)	
USAF-74		1 Nov 56		"		
USAF-75		13 Dec 56		"		
USAF-76		2 Feb 57		"		
USAF-77		9 Apr 57		"	(200,000 ft)	Micrometeorites
USAF-78	AJ11-6	18 June 57		"	(107 mi)	Ionosphere
USAF-79	AJ11-6	25 June 57		"	(126 mi)	Ionosphere
USAF-80	RTV-A-1a	16 July 57		"	(80 mi)	Micrometeorites
USAF-81		18 July 57		"	No sustainer	Micrometeorites
USAF-82		6 Aug 57		"	(93 mi)	Sunfollower
USAF-83		19 Aug 57		"	(111 mi)	Sodium studies
USAF-84		21 Aug 57		"	(95 mi)	Nitric oxide studies

Altitudes in ( ) are approximate

TABLE 7.4 (Continued)

AEROBEE ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
NRL-7	19 Feb 52	1000	50.5	Cosmic radiation, solar radiation
NRL-8	30 Apr 52	0630	79.4	Solar radiation; cosmic radiation (NIH)
NRL-9	1 May 52	0759	78.3	Solar radiation
NRL-10	5 May 52	0644	78.9	Solar radiation; cosmic radiation (NIH)
NRL-11	3 Sep 52	0749	61.5	Solar radiation
NRL-12	10 Feb 53	1409	85.1	Composition, cosmic radiation
NRL-13	12 Feb 53	0009	85.3	Composition, cosmic radiation

TABLE 7.5

SIGNAL CORPS ENGINEERING LABORATORIES AEROBEE FIRINGS

AEROBEE ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
SC-1	9 Dec 48	1538	56.9	Composition (Mich. U.)
SC-2	2 Jun 49	0610	48.7	Composition (Mich. U.)
SC-3	6 Dec 49	1132	40.3	Composition (Mich. U.)
SC-4	21 Jul 49	0901	47.3	Composition (Mich. U.); solar radiation (NRL)
SC-5	20 Sep 49	1003	36.4	Composition (Mich. U.); solar radiation (NRL)
SC-6	3 Mar 50	1736	45.0	Temperature
SC-7	6 Dec 49	1716	37.3	Composition (Mich. U.)
SC-8	14 Jul 50	0139	43.0	Temperature
SC-9	21 Feb 50	1754	30.5	Composition (Mich. U.); solar radiation (NRL)
SC-10	16 Oct 50	2100	50.0	Temperature
SC-11	25 Apr 50	1811	61.8	Composition (Mich. U.)
SC-12	17 Oct 50	2130	53.2	Temperature
SC-13	27 Oct 50	0630	49.8	Composition (Mich. U.)
SC-14	11 Dec 50	2106	52.1	Temperature
SC-15	11 Dec 50	1004	0	Temperature (Mich. U.)
SC-16	12 Dec 50	0210	48.3	Temperature
SC-17	19 Dec 50	1152	50.9	Composition (Mich. U.)
SC-18	8 Jun 51	2311	41.5	Temperature
SC-19	7 Jun 51	1818	4.0	Temperature (Mich. U.)
SC-20	1 Nov 51	0245	41.0	Temperature
SC-21	26 Sep 51	1706	42.8	Composition (Mich. U.)
SC-22	2 Nov 51	1735	51.0	Temperature
SC-23	14 May 52	1815	47.3	Density (Mich. U.)
SC-24	19 May 52	1907	56.0	Temperature
SC-25	24 Sep 52	2050	73.0	Temperature
SC-26	20 Oct 52	2045	69.0	Temperature
SC-27	17 Feb 53	2350	66.0	Temperature
SC-28	24 Apr 53	0319	-	Temperature
SC-29	11 Dec 52	1647	65.0	Temperature, density (Mich. U.)
SC-30	24 Apr 53	1230	69.0	Density (Mich. U.)

TABLE 7.5 (Continued)

AEROBEE ROCKETS	MODEL	DATE	TIME (MST)	PLACE	ALTITUDE ABOVE SEA LEVEL (mi)	(Km)	EXPERIMENTS
SC-31	RTV-A-1a	29 Sep 53	1350	WSPG	36	58	Temperature and density (Mich. U.)
SC-32	XASR-SC-2	31 Aug 53	2210	WSPG	66.7	107.4	Temperature, winds (Mich. U.)
SC-33	XASR-SC-1	4 Sep 53	2235	WSPG	71	114	Temperature, winds (Mich. U.)
SC-34	XASR-SC-1	9 Aug 56	0853	WSPG	53.1	85.5	Composition (Mich. U.)
SC-35	XASR-SC-1	10 Aug 56	0022	WSPG	53.4	85.9	Composition (Mich. U.)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-1

2 December 1949

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1520 MST
Altitude: 59.7 miles.

UPPER AIR INSTRUMENTS

Solar Radiation: Soft X-Ray detectors using photographic emulsions and metal foil filters. (Air Force Cambridge Research Center.)
Pressure-Temperature: Boundry layer temperature studies using temperature sensing elements on tail cone, forward fuel tank skirt, and nose cone. (Boston University.)
Other: Earth photography with color film. (W.P.A.F.B. Equipment Laboratory.)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, 6 channel PPM-AM system.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering with parachute. Test of parachute operation observed with tensiometer and cameras mounted on rocket.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Seven Askanias at HAFB
Cameras: Two radar bore sight cameras.
Telescopes:
Radar: Two x-band stations and one SCR-584 with beacon triangulation stations.
Doppler: None
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon
Doppler: None
Radio-cutoff: AFCRC multipurpose beacon for fail-safe fuel cutoff.
Aspect: Modified GSAP cameras for horizon photographs.

ROCKET PERFORMANCE

Firing Angle:
Time of booster separation: 2.4 sec.
Altitude of booster separation: 967 ft.
Velocity at booster separation: 1016 ft. per sec.
Time to burnout: 44 sec.
Altitude at burnout: 14.2 miles
Velocity at burnout: 3400 ft. per sec.
Time to zenith: 165 sec.
Altitude at zenith: 59.7 miles
Time to blowoff: Near zenith
Altitude at blowoff: Near zenith
Flight duration:
Impact coordinates: 21.3 miles north
Payload weight: 159 lbs.
Unfueled rocket weight: 465 lbs.
Unfueled rocket C.G.: 132.9 inches
Gross weight at takeoff: 1085 lbs.

BALLISTIC DATA

Theodolites: Data from four HAFB Askanias to about 50 sec.
Radar: Beacon operative to 127 sec. with 33% of data valid.

DATA RECOVERY

Telemeter: Good telemeter data from beacon system to 127 sec.
Physical Recovery: Parachute recovery failed, nose cone not located until July 1950.

EXPERIMENTAL DATA

Solar radiation: No data, X-Ray detector foils ruptured.
Pressure-Temperature:
Aspect Cameras: No data, film damaged beyond use.

COMMENTS

Rocket performance: In general, the rocket performance was good and the flight stable.
Parachute performance: The parachute was found to have been shredded.

REPORTS AND PAPERS

Boston University Upper Atmosphere Research Laboratory, Contract W28-099-ac-305, Progress Report No. 11
Baird Associates Inc., Contract W19-122ac-23, Interim Report No. 3.
Holloman Air Force Base Report No. MHTh-133, 16 December 1951.
"Panel Report No. 23," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 Feb. 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-2

15 December 1949

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1010 MST
Altitude: 0.2 miles.

UPPER AIR INSTRUMENTS

Pressure-Temperature: Four thermionic ionization gauges and two alphatron type gauges with automatic range seeking circuits. (University of Michigan.)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, 6 channel PPM-AM system.
Physical recovery: Ground command separation of nose cone from rocket body by prima cord and lowering by 10 ft. diameter ribbon parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Seven HAFB stations.
- Cameras: Two HAFB ribbon frame cameras, and two radar bore sight cameras.
- Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
- Impact Location: AFCRC beacon triangulation system.

Airborne
- Beacon: AFCRC multipurpose beacon.
- Radio cutoff: AFCRC multipurpose beacon for fail-safe fuel cutoff.
- Aspect: One Sperry attitude gyro and one modified GSAP camera. (University of Michigan.)

ROCKET PERFORMANCE

Firing angle:
Time of booster separation: 2.72 sec.
Altitude of booster separation: 1276 ft.
Velocity at booster separation: 979 ft. per sec.
Time to burnout: 2.72 sec.
Altitude at burnout: 1276 ft.
Velocity at burnout: 980 ft. per sec.
Time to zenith:
Altitude at zenith: 2 miles
Time to blowoff: 3.44 sec.
Altitude at blowoff: 1970 ft.
Flight duration:
Impact coordinates: Nose cone - about 1000 ft. from launching tower.
Payload weight: 149 lbs.
Unfueled rocket weight: 454 lbs.
Unfueled rocket C.G.: 133 in.
Gross weight at takeoff: 1076 lbs.

BALLISTIC DATA

Theodolites: Position coordinates 1.98 to 2.98 sec.
Cameras:
Radar: Radar bore sight camera used for visual observation. Beacon reply normal during the short flight.

DATA RECOVERY

Telemeter: Operation normal.
Physical recovery: Parachute failed to operate.

EXPERIMENTAL DATA

Pressure-Temperature: No useful data obtained.

COMMENTS

Rocket exploded shortly after leaving tower.
Special nose cone used: 96 in. total length - 58 in ogive and 38 in cone.

REPORTS AND PAPERS

Progress Report No. A6, by W. G. Dow and N. W. Spencer, 10 Jan. 1950. University of Michigan, Contract AF19(122)55.
Holloman Air Force Base Report No. MTHT-133, 10 Dec. 1951.
"Panel Report No. 23," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 Feb. 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-3

IDENTIFICATION

14 March 1950

Agency: Air Research and Development Command
Time: 1343 MST
Altitude: 2.0 miles.

UPPER AIR INSTRUMENTS

Solar radiation: Solar insolation - radiation sensing elements (thermistors) with fixed angle of view. (Rhode Island University.)
Photographic X-Ray film detectors on nose cone and tail section. (Air Force Cambridge Research Center.)
Sky brightness: Photomultiplier tubes with light filters. (Air Force Cambridge Research Center.)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, 6 channel PPM-AM system.
Physical recovery: Nose cone separation from main body and lowering with parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Seven HAFB Askania stations.
Cameras: Two ribbon frame, one 16 mm., one 35 mm., and two radar bore sight cameras, one still camera.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail-safe fuel cutoff.

ROCKET PERFORMANCE

Firing Angle:
Time of booster separation: 2.4 sec.
Altitude at booster separation: 1134 ft.
Velocity at booster separation: 924 ft. per sec.
Time to burnout: 4.75 sec.
Altitude at burnout: 3460 ft.
Velocity at burnout: 1040 ft. per sec.
Time to zenith:
Altitude at zenith: 2.0 miles
Time to blowoff: 4.2 sec.
Altitude at blowoff: 2892 ft.
Flight duration: Nose impact at 45.6 sec.
Impact coordinates: About 1000 ft. from tower.
Payload weight: 228 lbs.
Unfueled rocket weight: 527 lbs.
Unfueled rocket C.G.: 119.5 in.
Gross weight at takeoff: 1145 lbs.

BALLISTIC DATA

Theodolites: Velocity from 0.6 sec. to 7.6 sec.
Cameras: Yaw from radar boresight camera 1.0 sec. to 7.6 sec.
Impact location:

DATA RECOVERY

Telemeter: Approximately 50% of data recorded during flight.
Physical recovery:

EXPERIMENTAL DATA

Solar insolation: Satisfactory instrument operation, no data due to low altitude.
Sky brightness: No significant data.
Soft X-Rays: No significant data.

COMMENTS

Rocket performance: Low altitude due to premature fuel cutoff.
Experiments: All equipment operation satisfactory, low altitude prevented any significant measurements.

REPORTS AND PAPERS

Quarterly Report No. 8, Rhode Island State College, (Contract W28-099 ac-377), 30 Jan. 1950.
*Quarterly Report No. 9, Rhode Island State College, (Contract W28-099 ac-377), 30 April 1950.
*Preliminary Report on AMC Aerobee Round 2, Air Force Cambridge Research Laboratory, 25 April 1950.
Holloman Air Force Base Report MTHT-133, 10 Dec. 1951.
*Panel Report No. 24," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 20 April 1950.

*In these two reports USAF Aerobee 3 is designated as AMC Aerobee Round 2.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-4

26 May 1950

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1243 MST
Altitude: 42 miles.

UPPER AIR INSTRUMENTS

Solar Radiation: Solar insolation, radiation sensing thermistors with fixed viewing angles and bolometers with lithium flouride windows. (Rhode Island University.)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, 6 channel PPM-AM system. Hughes Aircraft Co. telemetering equipment.
Airborne Recorder: Tufts College 10 channel data recorder.
Physical Recovery: Ground command separation of nose cone from main body and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five HAFB Askania stations.
- Telescopes: Two stations.
- Cameras: Two radar bore sight cameras.
- Radar: Two X-band stations with one SCR-584 and beacon triangulation stations.
- Other: One K-24, one 16 mm. color motion picture, one 35 mm. motion picture, and one still camera.
- Impact Location: AFCRC multipurpose beacon triangulation system.

Airborne
- Beacon: AFCRC multipurpose radar beacon.
- Radio cutoff: AN/DRW-4 FM control receiver.

ROCKET PERFORMANCE

Firing Angle:
Time of booster separation: 2.57 sec.
Altitude of booster separation: 1275 ft.
Velocity at booster separation: 930 ft. per sec.
Time to burnout: 45 sec. (approximately)
Altitude at burnout: 15.9 miles
Velocity at burnout: 3000 ft. per sec.
Time to zenith: 136 sec.
Altitude at zenith: 42 miles.
Time to blowoff: Circuit failed.
Altitude at blowoff:
Flight duration: 380 sec.
Impact coordinates: 14 miles North and 10 miles West of the launching tower.
Payload weight: 256 lbs.
Unfueled rocket weight: 556 lbs.
Unfueled rocket C.G.: 134.6 in.
Gross weight at takeoff: 1156 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 33.77 sec.
Telescopes: Data 0 to 8 sec.
Radar: Trajectory data 0 to 380 sec.

DATA RECOVERY

Telemeter: AFCRC multipurpose beacon and Hughes Aircraft Co. telemeter operation normal.
Physical Recovery: Nose separation-parachute system failed to operate, recovery effected by tail cone separation system.
Airborne Recorder: Recorder recovered, good recording during time it operated.

EXPERIMENTAL DATA

Solar Insolation: Tentative value of 2 gram calories per square centimeter per minute obtained.

COMMENTS

Physical Recovery: At the time the separation signal was given only the tail cone explosives detonated, consequently the parachute was not deployed.
Rocket Structure: Two extensions used on nose cone.

REPORTS AND PAPERS

"Report on the Launching of USAF Aerobee 4," Holloman Air Force Base, N.M., 10 July 1950.
Quarterly Reports Nos. 1 - 9 Rhode Island University (Contract W28-099 ac-377).
Holloman Air Force Base Report MTHT-133, 10 December 1951.
"Panel Report No. 25," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 13 and 14 June 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-5

2 June 1950

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1007 MST
Altitude: 15.4 miles.

UPPER AIR INSTRUMENTS

Sky brightness: Photoelectric multipliers and narrow band filters.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Airborne recorder: 10 channel data recorder (Tufts College).
Physical recovery: Separation of nose cone from rocket body with prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Five Askania stations.
Cameras: Two K-24, one 16 mm. color motion picture, one 35 mm. motion picture, two still, six Mitchell 35 mm. motion picture, three Fairchild 35mm. motion picture, and two radar bore sight cameras.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AN/DRW-4 FM control receiver.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.4 sec.
Altitude at booster separation: 924 ft.
Time to zenith: 98 sec.
Altitude at zenith: 15.4 miles
Flight duration: 34.5 sec. (nose), 200 sec. (rocket).
Payload weight: 256 lbs.
Unfueled rocket weight: 552 lbs.
Unfueled rocket C.G.: 110 in.
Gross weight at takeoff: 1174 lbs.

BALLISTIC DATA

Theodolites: WSPG Askania tracked rocket 0 to 122 sec., HAFB tracked nose 0 to 3.9 sec.
Cameras: No information furnished.
Telescopes: One station tracked 0 to 180 sec., other 0 to 130 sec.
Radar: Good beacon signals to nose impact.

DATA RECOVERY

Telemeter: Good operation while nose was aloft.
Physical recovery: Nose damaged, parachute not deployed.
Airborne recorder: Satisfactory operation.

COMMENTS

Experiment: Equipment operated staisfactorally, no data due short duration flight.
Rocket performance: Rocket guide lug became disengaged from rail in tower and rocket rotated 15 degrees as evidenced by rail markings on nose cone. Nose cone failed structurally in extension section and it broke off by 2.8 sec., the rocket continued in flight without the nose. The nose cone reached a maximum altitude of about 2 miles 20 sec. after takeoff.

REPORTS AND PAPERS

"Report on the Launching of USAF Aerobee Round No. 5," Holloman Air Force Base, 27 July 1950.
Report No. MTHT-133, Holloman Air Force Base, December 1951.
"Panel Report No. 25," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 31 and 14 June 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-6

20 June 1950

IDENTIFICATION

Agency: Air Research and Development Command
Time: 0838 MST
Altitude: 57.5 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Two alphatron gauges to measure ambient conditions (University of Michigan).

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, 6 channel PPM-AM system.
Airborne recorder: Ten channel data recorder (Tufts College). Modified camera to photograph gyro (University of Michigan).
Physical recovery: Separation of nose cone from rocket body and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Five Askania stations
Cameras: Two K-24's, one 16 mm. motion picture, one 35 mm. motion picture, two still, six 35 mm. Mitchell, and three 35 mm. Fairchild stations.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AN/DRW-4 FM control receiver.
Aspect: Sperry attitude gyroscope (University of Michigan).

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 45.8 sec.
Altitude at burnout: 16.3 miles
Velocity at burnout: 3680 ft. per sec.
Time to zenith: 160 sec.
Altitude at zenith: 57.5 miles
Time to blowoff: 160 sec.
Altitude at blowoff:
Flight duration: 700 sec. (nose cone).
Impact coordinates: 15.5 miles down and 4.5 miles West of line of firing.
Payload weight: 231 lbs.
Unfueled rocket weight: 497 lbs.
Unfueled rocket C. G.: 129 in.
Gross weight at takeoff: 1096.5 lbs.

BALLISTIC DATA
Theodolites: Trajectory data 0 to 48 sec.
Cameras: No information furnished.
Telescopes: Tracked 0 to 527 sec.
Radar: Approx. 75% coverage, trajectory data.

DATA RECOVERY

Telemeter: Good operation until zenith, no data thereafter.
Physical recovery: Nose instruments in good condition, rocket body also recovered in comparatively good condition.
Airborne recorder: Satisfactory operation.

EXPERIMENTAL DATA

Pressure-temperature: Temperatures computed from pressure data up to 43.5 miles with a probable error of plus or minus 15 degrees. Values generally lower than NACA standard.

REPORTS AND PAPERS

University of Michigan Report No. A-9, Contract AF19(122)-55, October 1951.
Report No. MTHT-133, Holloman Air Force Base, December 1951.
"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-7

12 October 1950

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 1236 MST.
Altitude: 56.7 miles.

UPPER AIR INSTRUMENTS

Temperature: Seven clusters of sensing elements distributed on rocket skin (Boston University).
Photography: Two Jerome type B-2 cameras to photograph the earth to zenith, and one K-15 A camera to photograph the earth during parachute descent (Photo. Lab., WADC).

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket body with prima cord and lowering by parachute. Strain to be measured in parachute swivel (Boston University).

BALLISTIC DATA

Firing Range
- Theodolites: Five Askania stations.
- Cameras: Two K-24's, one 16 mm. motion picture, one 35 mm. motion picture, two still, seven 35 mm. Mitchell, and four 35 mm. Fairchild.
- Telescopes: Two stations.
- Radar: Two X-band and one SCR-584 with beacon triangulation stations.
- Impact location: AFCRC beacon triangulation system.

Airborne
- Beacon: AFCRC multipurpose beacon.
- Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 3.0 sec.
Altitude at booster separation: 1563 ft.
Velocity at booster separation: 972 ft. per sec.
Time to burnout: 45.8 sec.
Altitude at burnout: 16.1 miles.
Velocity at burnout: 3850 ft. per sec.
Time to zenith: 162 sec.
Altitude at zenith: 56.7 miles.
Time to blowoff: 182 sec.
Altitude at blowoff: 55.9 miles.
Flight duration: 738 sec. (nose cone).
Impact coordinates: 24 miles down and 4 miles West of line of firing.
Payload weight: 179 lbs.
Unfueled rocket weight: 478 lbs.
Unfueled rocket C. G.: 125.8 in.
Gross weight at takeoff: 1096 lbs.

BALLISTIC DATA

Theodolites: No information. furnished.
Cameras: No information furnished.
Telescopes: One telescope tracked 0 to 95 sec., other tracked after burnout.
Radar: Trajectory data for complete trajectory, beacon intermittent during nose cone separation.

DATA RECOVERY

Telemeter: Excellent operation except for short period during nose cone separation.
Physical recovery: Nose cone in very good condition, one parachute shroud line severed at ejection, cameras in good condition.

EXPERIMENTAL DATA

Temperature: Good results obtained.
Photography: No information furnished.

COMMENTS

Rocket modifications: Forward 21 in. of nose severed by prima cord at time nose cone severed to expose camera lens.

REPORTS AND PAPERS

"Report on Launching of USAF Aerobee Round No. 7," Holloman Air Force Base Serial EHOOA 319.1/8, 27 December 1950.
Report No. MTHT-133, Holloman Air Force Base, December 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-8
2 November 1950

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 0929 MST.
Altitude: 57 miles.

UPPER AIR INSTRUMENTS

Sky brightness: Quartz spectrograph and pointing control to study sky light emission spectrum (University of Denver and University of Colorado).

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and five Askania stations.
Cameras: Two ribbon frame, two K-24's, one 16 mm. motion picture, one 35 mm. motion picture, six 35 mm. Mitchell, three 35 mm. Fairchild, one still, and two radar bore sight stations.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.85 sec.
Altitude at booster separation: 1660 ft.
Velocity at booster separation: 970 ft. per sec.
Time to burnout: 45.5 sec.
Altitude at burnout: 16.7 miles.
Velocity at burnout: 3700 ft. per sec.
Time to zenith: 160 sec.
Altitude at zenith: 57 miles.
Time to blowoff: 178 sec.
Altitude at blowoff: Near zenith.
Flight duration:
Impact coordinates: 50 miles range (nose cone).
Payload weight: 175 lbs.
Unfueled rocket weight: 476 lbs.
Unfueled rocket C. G.: 127.5 in.
Gross weight at takeoff: 1094 lbs.

BALLISTIC DATA

Theodolites: No information furnished.
Cameras: No information furnished.
Telescopes: No information furnished.
Radar: Trajectory data 0 to 182 sec., system operation intermittent thereafter.

DATA RECOVERY

Telemeter: Good data until nose separation, intermittent thereafter.
Physical recovery: Spectrograph film cassette intact, sepctrography and nose cone not badly damaged. Parachute only partially effective due to failure of many cross members. Rocket main body not located.

EXPERIMENTAL DATA

Sky brightness: Equipment operated satisfactorily, but no spectral data obtained.

COMMENTS

Rocket performance: Roll rate 1 RPS, large precession angles and erratic motions, horizontal at zenith.
Experiments: Erratic angular motions of rocket resulted in unsatisfactory spectrograph exposures. Pointing control unable to operate properly under such flight conditions.

REPORTS AND PAPERS

Quarterly Report No. 11, University of Denver, Contract No. W19-122 ac-16, 31 January 1951.
Upper Air Report No. CL-4, University of Colorado, Contract No. W19-122 ac-9, 1 March 1951.
"Pointing Control Design, Vol. 1, Uniaxial," Upper Air Laboratory, University of Colorado, Contract No. W19-122 ac-9, Special Report No. 1, 30 November 1949.
Progress Report No. 10, Upper Air Laboratory, University of Colorado, Contract No. W19-122 ac-9, 31 October 1950.
Report No. MTHT-133, Holloman Air Force Base, December 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-9

12 December 1950

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 1126 MST.
Altitude: 66 miles.

UPPER AIR INSTRUMENTS

Pressure-temperature: Five thermionic ionization gauges and two alphatron pressure gauges (University of Michigan).

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Airborne recorder: 16 mm. motion picture camera photographing meter panel.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and five Askania stations.
Cameras: Two ribbon frame and two radar bore sight stations.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.
Aspect: Sperry F4A gyroscope and roll photocell (University of Michigan).

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 3.0 sec.
Altitude at booster separation: 1000 ft.
Velocity at booster separation: 1520 ft. per sec.
Time to burnout: 46.3 sec.
Altitude at burnout: 17.8 miles.
Velocity at burnout: 4150 ft. per sec.
Time to zenith: 185 sec.
Altitude at zenith: 66 miles.
Time to blowoff: 187.5 sec.
Altitude at blowoff: Near zenith.
Flight duration: 513 sec. (nose cone).
Impact coordinates: 42.5 miles down and 5.3 miles west of line of firing (nose cone).
Payload weight: 184 lbs.
Unfueled rocket weight: 455 lbs.
Unfueled rocket C. G.: 135 in.
Gross weight at takeoff: 1106 lbs.

BALLISTIC DATA

Theodolites: No information furnished.
Cameras: No information furnished.
Telescopes: Coverage by one station 0 to 72 sec., roll reported 15 to 46 sec.
Radar: Trajectory 0 to 513 sec.; good data to zenith, intermittent thereafter.

DATA RECOVERY

Telemeter: Good data to nose separation, intermittent thereafter.
Physical revovery: Nose severly damaged, parachute did not function properly. Recorder film recovered.
Airborne recorder: Excellent operation.

EXPERIMENTAL DATA

Pressure-temperature: Data questionable because of poor rocket aspect, complete analysis not attempted.

COMMENTS

Rocket performance: Unstable after burnout, excessive yaw.

REPORTS AND PAPERS

University of Michigan Progress Report No. A6-A7, by N. W. Spencer and W. C. Dow, University of Michigan Contract No. AF19(122)55, March 1951.
Report No. MTHT-133, Holloman Air Force Base, December 1951.
"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 31 January 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-10

28 March 1951

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 1614 MST.
Altitude: 41 miles.

UPPER AIR INSTRUMENTS

Sodium chloride experiment: Dispersal of finely divided NaCl into the atmosphere at an altitude of 100 Km.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket body and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites; Two Mitchell stations.
Cameras: No information.
Telescopes: One station.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: Beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.5 sec.
Altitude at booster separation: 1152 ft.
Velocity at booster separation: 920 ft. per sec.
Time to burnout: 41.5 sec.
Altitude at burnout: 14.2 miles.
Velocity at burnout: 3145 ft. per sec.
Time to zenith: 142 sec.
Altitude at zenith: 41 miles.
Time to blowoff: 221 sec.
Altitude at blowoff: 21.6 miles.
Flight duration: 680 sec. (nose cone).
Impact coordinates: 24 miles range.
Payload weight: 202 lbs.
Unfueled rocket weight: 481 lbs.
Unfueled rocket C.G.: 115 in.
Gross weight at takeoff: 1102 lbs.

BALLISTIC DATA

Theodolites: No information furnished.
Cameras: No information.
Telescopes: No information furnished.
Radar: No trajectory data - poor film record. Signal good on upward leg, weak through zenith, and intermittent after nose cone separation.

DATA RECOVERY

Telemeter: Good signals on upleg of trajectory, weak through zenith, intermittent for a time after spearation, and then good to impact.
Physical recovery: Good recovery, parachute operation normal.

EXPERIMENTAL DATA

Sodium chloride experiment: NaCl not ejected due to failure in detonator circuit.

COMMENTS

Rocket performance: Early motor burnout.
Rocket modifications: Motor operation delayed by 2 sec. with special trip mechanism.
Launching operations: 40 ft. extension added to tower and used for first time. Total tower length - 150 ft.

REPORTS AND PAPERS

"Preliminary Report on USAF Aerobee 10 (GRD-2)," Air Force Cambridge Research Center, 11 February 1952.
Report No. MHTH-133, Holloman Air Force Base, December 1951.
"Panel Report No. 28," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-11

12 April 1951

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 1026 MST.
Altitude: 18 miles.

UPPER AIR INSTRUMENTS

Solar radiation: Solar ultra violet spectrograph and monochromatic camera directed with a bi-axial pointing control.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical Recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and four Askania stations.
- Cameras: Two ribbon frame, two K-24's, one 16 mm. motion picture, one 35 mm. motion picture, six 35 mm. Mitchell, three 35 mm. Fairchild, and two radar bore sight stations.
- Telescopes: Two stations.
- Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
- Impact location: AFCRC beacon triangulation system.

Airborne
- Beacon: AFCRC multipurpose beacon.
- Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.6 sec.
Altitude at booster separation: 1000 ft.
Velocity at booster separation: 1000 ft. per sec.
Time to burnout: 30.6 sec.
Altitude at burnout: 7.8 miles.
Velocity at burnout: 2025 ft. per sec.
Time to zenith: 96 sec.
Altitude at zenith: 18 miles.
Time to blowoff: 150 sec.
Altitude at blowoff: 7.0 miles.
Flight duration: 270 sec.
Impact coordinates: 8 miles range (nose cone), 10 miles range (rocket body).
Payload weight: 254 lbs.
Unfueled rocket weight: 550 lbs.
Unfueled rocket C. G.: 110 in.
Gross weight at takeoff: 1171 lbs.

BALLISTIC DATA

Theodolites: Coverage by two stations 0 to 84 sec.
Cameras: No information furnished.
Telescopes: Coverage by one station 0 to 172 sec.
Radar: Trajectory data 0 to 270 sec. Good signal to separation, intermittent thereafter.

DATA RECOVERY

Telemeter: Good signal to separation, intermittent thereafter.
Physical recovery: Nose cone in relatively good condition. Parachute badly damaged by excessive opening shock. Rocket body disintegrated.

EXPERIMENTAL DATA

Solar radiation: No data due to low zenith altitude, information on pointing control operation poor due to failure of telemeter commutator.

COMMENTS

Rocket performance: Premature termination of propulsion due to either failure of pressurizing system or premature fuel line severance.

REPORTS AND PAPERS

Report No. EHO-24, Holloman Air Force Base, 31 May 1951.

"A Monochromatic Solar Camera for Rocket Installation," Upper Air Laboratory, University of Colorado, Contract No. W19-122 ac-9, Report CL-1, 30 June 1950.

Progress Report No. 11, Upper Air Laboratory, University of Colorado, Contract W19-122 ac-9, 31 January 1951.

Progress Report No. 12, Upper Air Laboratory, University of Colorado, Contract W19-122 ac-9, 30 April 1951.

Report MHTH-133, Holloman Air Force Base, December 1951.

"Panel Report No. 28," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-12

18 April 1951

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 1139 MST.
Altitude: 38 miles.

UPPER AIR INSTRUMENTS

Biological: Experiment by Aero-Medical Labotatory, WADC.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five stations.
- Cameras: No information.
- Telescopes: One station.
- Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
- Impact location: AFCRC beacon triangulation system.

Airborne
- Beacon: Oklahoma C of A & MA beacon.
- Radio cutoff: AN/DRW-4 FM control receiver.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.4 sec.
Altitude at booster separation: 1423 ft.
Velocity at booster separation: 938 ft. per sec.
Time to burnout: 45.2 sec.
Altitude at burnout: 14.4 miles.
Velocity at burnout: 2880 ft. per sec.
Time to zenith: 135 sec.
Altitude at zenith: 38 miles.
Time to blowoff: 140 sec.
Altitude at blowoff: 35 miles.
Flight duration: 425 sec. (nose cone).
Impact coordinates: 40 miles range (nose cone).
Payload weight: 256 lbs.
Unfueled rocket weight: 556 lbs.
Unfueled rocket C. G.: 106 in.
Gross weight at takeoff: 1178 lbs.

BALLISTIC DATA

Theodolites: Coverage by two Askania stations 0 to 49 sec.
Cameras: No information.
Telescopes: Coverage 0 to 80 sec.
Radar: Trajectory data 0 to 94 sec. at sec. intervals, and 230 to 415 sec. at 5 sec. intervals.

DATA RECOVERY

Telemeter: No information furnished.
Physical recovery: No comments on nose cone furnished. Parachute badly torn.

EXPERIMENTAL DATA

Biological: Significant data obtained.

COMMENTS

Rocket performance: Spurts in rocket exhaust noted between 43.6 and 44.2 sec.
Rocket modifications: Special telemeter di-pole antenna mounted on nose tip. Extra nose cone extension used to accommodate a 34 ft. canopy type parachute.

REPORTS AND PAPERS

Report No. MHTH-133, Holloman Air Force Base, December 1951.
"Panel Report No. 28," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-13

29 May 1951

IDENTIFICATION

Agency: Air Research and Development Command.
Time: 1246 MST.
Altitude: 2.3 miles.

UPPER AIR INSTRUMENTS

Ionosphere: Oblique incidence propagation experiment. (Boston Univ.)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute. Shock forces in the parachuted swivel bolt to be measured by strain gauge (Boston Univ. and Equipment lab., WAPFB).

BALLISTIC DATA

Firing Range
Theodolites: Two Mitchell and eight Askania stations.
Cameras: Two ribbon frame, two K-24's, one 16 mm. motion picture, one 35 mm. motion picture, six 35 mm. Mitchell, three 35 mm. Fairchild, and two radar bore sight stations.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.
Other: Rocket propulsion performance instruments.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.3 sec.
Altitude at booster separation: 1170 ft.
Velocity at booster separation: 936 ft. per sec.
Time to burnout: Premature cutoff at 2.3 sec.
Time to zenith: 20 sec.
Altitude at zenith: 2.3 miles.
Flight duration: 51 sec.
Payload weight: 147 lbs.
Unfueled rocket weight: 443 lbs.
Unfueled rocket C. G.: 147 in.
Gross weight at takeoff: 1065 lbs.

BALLASTIC DATA

Theodolites: Position and velocity data from Askanias 0 to 5.9 sec.
Cameras: No information furnished.
Telescopes: Intermittent coverage by one station 2 to 43 sec.
Radar: No information furnished.

DATA RECOVERY

Telemeter: Good records during flight.
Physical recovery: Instrumentation and nose recovered.

EXPERIMENTAL DATA

Ionosphere: No data were obtained due to rocket failure.

COMMENTS

Rocket performance: Abnormally short flight result of fuel line severance due to failure in radio cutoff system. Propulsion instrumentation functioning properly, no useful data obtained due to short burning time. Rocket nose cone broke off by 4.6 sec. subsequent to severe yaw. Angle of attack 90 degrees by 6.0 sec. and tail section broke away from rocket body.

Rocket modifications: Circumferential dielectric section inserted in nose cone extension to allow nose cone to be used as a 13.56 MC. antenna, nose broke away at this point.

REPORTS AND PAPERS

"Preliminary Field Test Report. Project MX-1011, USAF Aerobee 13," Holloman Air Force Base Report No. EHO-37, 12 July 1951.

Boston University Progress Report No. 8, Contract AF19(122)-36.

Technical Note No. 11, Boston University Upper Atmosphere Research Labotatory, Contract AF33(038)12942.

Report No. MHTH-133, Holloman Air Force Base, December 1951.

"Panel Report No. 29," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 and 15 August 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-14

7 June 1951

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1711 MST
Altitude: 55 miles

UPPER AIR INSTRUMENTS

Solar radiation: X-ray photographic detectors with metallic foil filters (AFCRC).
Sodium chloride experiment: Ejection of finely divided NaCl at high altitudes and ground based phototube detectors with filters to make comparative observations on nights prior to and subsequent to ejection.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations.
Cameras: Two X-24, one 16 mm. motion picture, one 35 mm. motion picture, six 35 mm. Mitchell, three 35 mm. Fairchild, and two radar bore sight stations.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff and command nose severance.
Rocket performance: Rocket propulsion system performance measuring instruments.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.43 sec.
Altitude at booster separation: 1242 ft.
Velocity at booster separation: 996 ft. per sec.
Time to burnout: 44.6 sec.
Altitude at burnout: 16.1 miles
Velocity at burnout: 3675 ft. per sec.
Time to zenith: 157 sec.
Altitude at zenith: 55 miles
Time to blowoff: 173 sec.
Altitude at blowoff:
Flight duration: 1040 sec. (nose cone)
Impact coordinates: 22.5 miles down and 16.5 miles West of line of firing (nose cone)
Payload weight: 155 lbs.
Unfueled rocket weight: 460 lbs.
Unfueled rocket C.G.: 127 in.
Gross weight at takeoff: 1082 lbs.

BALLISTIC DATA

Theodolites: Position and velocity 0 to 49 sec.
Cameras: No information furnished.
Telescopes: One station tracked to burnout.
Radar: No information furnished.

DATA RECOVERY

Telemeter: No information furnished.
Physical recovery: Nose cone and X-ray detectors recovered in good condition.

EXPERIMENTAL DATA

Solar radiation: No evidence of X-rays shown by detectors.
Sodium chloride: Inconclusive evidence of increase of sodium activity in the night sky.

COMMENTS

Rocket performance: Normal propulsion operation indicated by performance instruments. Momentary closure of beacon command relay at booster ignition and again at 1.0 sec.

REPORTS AND PAPERS

"Preliminary Field Test Report, Project MX-1011, USAF Aerobee 14," Holloman Air Force Base Report No. EHO-40, 19 July 1951.
Report No. MHTH-133, Holloman Air Force Base, December 1951.
"Panel Report No. 29," Minute of Meeting of the Upper Atmosphere Rocket Research Panel on 14 and 15 August 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-15

25 July 1951

IDENTIFICATION

Agency: Air Research and Development Command
Time: 0926 MST
Altitude: 44.3 miles

UPPER AIR INSTRUMENTS

Sky brightness: Photomultiplier tubes with narrow band interference filters and two GSAP 16 mm. motion picture cameras (AFCRC).

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipur se beacon six channel PPM-AM system.
Physical recovery: Separation of nose cone from rocket body by prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Two Mitchell and seven Askania stations.
Cameras: Two K-24, one 16 mm. motion picture, one 35 mm. motion picture, six 35 mm. Mitchell, three 35 mm. Fairchild, and two radar bore sight stations.
Telescopes: Three stations.
Radar: Two X-band stations and one SCR-584 with beacon triangulation stations.
Impact location: AFCRC beacon triangulation system.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff and command nose severance.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.42 sec.
Altitude at booster separation: 1629 ft.
Velocity at booster separation: 1016 ft. per sec.
Time to burnout: 41.4 sec.
Altitude at burnout: 14.0 miles
Velocity at burnout: 3285 ft. per sec.
Time to zenith: 139 sec.
Altitude at zenith: 44.3 miles
Time to blowoff: 194 sec.
Altitude at blowoff: 35.3 miles
Flight duration: 703 sec. (nose cone).
Impact coordinates: 10 miles range (nose), 11 miles range (rocket body).
Payload weight: 190.5 lbs.
Unfueled rocket weight: 487 lbs.
Unfueled rocket C.G.: 122 in.
Gross weight at takeoff: 1108.5 lbs.

BALLISTIC DATA

Theodolites: Askania position and velocity data 0 to 59.4 sec., aspect data 0.6 to 10 sec., roll data 0.95 to 4.7 sec.
Cameras: No information furnished.
Telescopes: Coverage by one station 0 to 554 sec., another 0 to 272 sec., and the remaining 0 to 124 sec.
Radar: Complete trajectory data. Signals good to separation and intermittent thereafter.

DATA RECOVERY

Telemeter: Good record throughout flight.

DATA RECOVERY (Continued)

Physical recovery: Nose instrumentation in very good condition, parachute operated well. Rocket body badly damaged.

EXPERIMENTAL DATA

Sky brightness: Unexpected large and constant light intensities at altitudes 18.65 to 43.5 miles were again encountered. For 20 Angstrom bandwidths at L 6360 A, the intensity is 7 milliwatts/cm.$^{-2}$; at L 6150A milliwatts, and at L 5910 3 milliwatts. Minimum values were obtained for the following: L 5590 2 milliwatts; L5390 1 milliwatt; L 4895 2 milliwatts; L 4615 1.5 milliwatts; L 4290 1 milliwatt. Photographic evidence obtained at 43 miles indicates the existence of luminescent clouds at higher altitudes.

COMMENTS

Rocket performance: Poor propulsion performance, zenith altitude 15 miles less than predicted.

REPORTS AND PAPERS

"Preliminary Field Test Report, Project MX-1011, Missile No. 15," Holloman Air Force Base Report No. EHO-66, 29 August 1951.

"Day Sky Brightness Measured by Rocketborne Photoelectric Photometers," H. A. Miley, et al., Amer. Geophys. Union Transactions, (in press).

Report No. MTHT-133, Holloman Air Force Base, December 1951.

"Panel Report No. 29," Minutes of the Upper Atmosphere Rocket Research Panel on 14 and 15 August 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-16

7 August 1951

IDENTIFICATION

Agency: Air Research and Development Command
Time: 0936 MST
Altitude: 51.9 miles

UPPER AIR INSTRUMENTS

Ionosphere: Transponder in rocket retransmitting ground originated signal.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket body and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and six Askania stations.
- Cameras: Two K-24; six Mitchell, three Fairchild, one standard 35 mm. motion picture.
- Telescopes: Three stations.
- Radar: Two X-band stations and one SCR-584 station with beacon triangulation stations.
- Impact location: AFCRC multipurpose beacon triangulation system.

Airborne
- Beacon: AFCRC multipurpose beacon.
- Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.
- Parachute performance: Measurement of shock forces appearing on swivel of nose cone parachute (WPAFB and Boston Univ.).

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.3 sec.
Altitude at booster separation: 1178 ft.
Velocity at booster separation: 939 ft. per sec.
Time to burnout: 43.7 sec.
Altitude at burnout: 15.1 miles
Velocity at burnout: 3566 ft. per sec.
Time to zenith: 156 sec.
Altitude at zenith: 51.9 miles.
Time to blowoff: 210 sec.
Altitude at blowoff: 43 miles
Flight duration: 782 sec (nose cone).
Impact coordinates: 15 miles range (nose cone and rocket body).
Payload weight: 153.5 lbs.
Unfueled rocket weight: 456 lbs.
Unfueled rocket C.G.: 145 inches
Gross weight at takeoff: 1077 lbs.

BALLISTIC DATA

Theodolites: Position and velocity data 0 to 55 sec.; aspect data 0.7 to 10.7 sec.; roll data 0.9 to 10.9 sec.
Telescopes: One station tracked 0 to 662 sec., another 0 to 71 sec.
Radar: Trajectory data obtained.

DATA RECOVERY

Telemeter: Good operation.
Physical recovery: Nose cone instruments in excellent condition; rocket body badly damaged.

EXPERIMENTAL DATA

Ionosphere: Altitude insufficient to penetrate E-layer some analysis possible on long distance propagation modes.

COMMENTS

Rocket performance: Zenith altitude 20 miles short of prediction.
Parachute performance: Some data obtained on shock, circuits failed during drop.
Rocket modifications: Two nose cone extensions used. Two second delay introduced in motor ignition.

REPORTS AND PAPERS

"Preliminary Field Test Report, Project MX-1011, USAF Aerobee 16," Holloman Air Force Base Report No. EHO-70, September 1951.
Progress Report No. 9, Boston University Upper Atmosphere Research Laboratory, Contract No. AF19(122)-36.
Report No. MTHT-133, Holloman Air Force Base, New Mexico, December 1951.
"Panel Report No. 29," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 and 15 August 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-17

30 August 1951

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1540 MST
Altitude: 47 miles

UPPER AIR INSTRUMENTS

Comments: No upper air research instruments, test of rocket.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Physical recovery: Separation of nose cone from rocket with prima cord and both sections lowered by parachutes.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Five Mitchell and six Askania stations.
Radar: Two X-band stations and one SCR-584 station with beacon triangulation stations.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.
Rocket performance: Propulsion system pressure measurements, and fuel tank temperature.
Parachute performance: Temperature measurements on ribbon of 50 in. nose cone drag parachute, free stream temperature in region of parachute swivel (Boston University).

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.5 sec.
Altitude at booster separation: 1210 ft.
Velocity at booster separation: 933 ft. per sec.
Time to burnout: 47.2 sec.
Altitude at burnout: 15.8 miles
Velocity at burnout: 3402 ft. per sec.
Time to zenith: 158 sec.
Altitude at zenith: 47 miles
Time to blowoff: 158 sec.
Altitude at blowoff: 47 miles
Flight duration: 530 sec.
Impact coordinates: 17 miles range.
Payload weight: 174.5 lbs.
Unfueled rocket weight: 452 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1136 lbs.

BALLISTIC DATA

Theodolites: Aspect data 1 to 10.8 sec., position data 1 to 272 sec., velocity data 1.4 to 270 sec.
Radar: Roll data from bore sight cameras 1.5 to 9.7 sec.

DATA RECOVERY

Telemeter: Satisfactory operation.
Physical recovery: Parachute recovery failed.

COMMENTS

Rocket performance: Chemical pressurization system functioned satisfactorily.
Parachute performance: Nose cone drag parachute deployed and became separated at swivel, eight ft. nose cone parachute did not deploy. Both main body parachutes deployed, the ten ft. diameter parachute shredded and entangled in rocket tail fins. The main parachute

COMMENTS (Continued)

deployed and functioned satisfactorily until a hole appeared in the canopy and enlarged until the parachute collapsed.

Rocket modifications: Normal pressurizing gas storage tank replaced by a chemically activated gas generator system.

REPORTS AND PAPERS

"Preliminary Field Test Report, Aerobee No. 17, Project No. MX-1011," Holloman Air Force Base Report No. MTHT-92, November 1951.

Report No. MTHT-133, Holloman Air Force Base, New Mexico, December 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-18

13 September 1951

IDENTIFICATION

Agency: Air Research and Development Command
Time: 0437 MST
Altitude: 47 miles

UPPER AIR INSTRUMENTS

Temperature-pressure: One alphatron ionization gauge to measure ram pressure at nose tip. Two alphatron ionization gages to measure cone wall pressure. One electrode assembly to determine air density by means of Paschen's law. (University of Michigan.)
Other: Boundary layer velocity indicator.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon.
Airborne recorder: 16 mm. motion picture camera. (Univ. of Mich.)
Physical recovery: Separation of nose from rocket with prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and five Askania stations.
- Radar: Two X-band stations and one SCR-584 station with beacon triangulation stations.
- Impact location: AFCRC multipurpose beacon triangulation system.

Airborne
- Beacon: AFCRC multipurpose beacon.
- Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.
- Aspect: Gyroscope (University of Michigan).

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.2 sec.
Altitude at booster separation: 1115 ft.
Velocity at booster separation: 942 ft. per sec.
Time to burnout: 42 sec.
Altitude at burnout: 14.2 miles
Velocity at burnout: 3400 ft. per sec.
Time to zenith: 147 sec.
Altitude at zenith: 47 miles
Time to blowoff: 157 sec.
Altitude at blowoff: 46.6 miles
Flight duration: 685 sec. (nose cone)
Impact coordinates: 20 miles range (nose cone)
Payload weight: 196 lbs.
Unfueled rocket weight: 494 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1116 lbs.

BALLISTIC DATA

Theodolites: Position data 0.6 to 33.4 sec., velocity data 1.0 to 33 sec.
Radar: Good flight signals, trajectory possible.
Aspect: Satisfactory gyroscope data.

DATA RECOVERY

Telemeter: Good records.
Physical recovery: Satisfactory parachute operation, nose found in good condition eighty min. after firing. Rocket body not found.
Airborne recorder: Excellent results.

EXPERIMENTAL DATA

Pressure temperature: Temperatures computed from pressure data between 18.6 and 44.7 miles lower than NACA standard.

Density: Paschen's law results inconclusive because boundary layer air characteristics information insufficient.

Boundary layer velocity indicator: Some data from 0 to 30 sec.

COMMENTS

Rocket performance: Propulsion duration shorter than normal.

REPORTS AND PAPERS

"Preliminary Field Test Report, Project MX-1011 (X-8), USAF Aerobee 18," Holloman Air Force Base Report No. MTHT-122, November 1951.

Progress Report No. A9, by N. W. Spencer and W. C. Dow, University of Michigan AFCRC Contract No. AF19(122)55, October 1951.

Report No. MTHT-133, Holloman Air Force Base, New Mexico, December 1951.

"Panel Report No. 30," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 24 October 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-19

IDENTIFICATION

20 September 1951

Agency: Air Research and Development Command
Time: 0931 MST
Altitude: 44 miles

UPPER AIR INSTRUMENTS

Biological: Experiment by Aero-Medical Laboratory, Wright Air Development Center.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Nose cone separation with prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations.
Cameras: Two Clark Ribbon Frame stations.
Telescopes: Two stations.
Radar: Two X-band stations and one SCR-584 station with beacon triangulation stations.
Impact location: Beacon triangulation.

Airborne
Beacon: AFCRC multipurpose beacon.
Radio cutoff: AFCRC multipurpose beacon for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.41 sec.
Altitude at booster separation: 1174 ft.
Velocity at booster separation: 935 ft. per sec.
Time to burnout: 45.5 sec.
Altitude at burnout: 15 miles
Velocity at burnout: 3200 ft. per sec.
Time to zenith: 146 sec.
Altitude at zenith: 44 miles
Time to blowoff: 153 sec.
Altitude at blowoff: 43 miles
Flight duration: 636 sec. (nose cone)
Impact coordinates: 16 miles range (nose cone)
Payload weight: 219 lbs.
Unfueled rocket weight: 518 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1140 lbs.

BALLISTIC DATA

Theodolites: Askania aspect data 0.8 to 36.6 sec.
Cameras: No information furnished.
Telescopes: Coverage by both stations 0 to 117 sec.
Radar: Trajectory data from triangulation system to impact

DATA RECOVERY

Telemeter: No information furnished.
Physical recovery: Successful parachute operation.

EXPERIMENTAL DATA

Biological: Significant data obtained.

COMMENTS

Rocket modifications: Two nose cone extensions on rocket. Folded dipole antenna at nose tip.

REPORTS AND PAPERS

Report No. MTHT-133, Holloman Air Force Base, New Mexico, December 1951.
"Panel Report No. 30," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 24 October 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-20

17 October 1951

Agency: Air Research and Development Command (Boston University).
Time: 1117 MST.
Altitude: 71.0 miles.

Experiments: Ionosphere.

AEROBEE
USAF-21

30 January 1952

Agency: Air Research and Development Command (Utah University).
Time: 1445 MST.
Altitude: 0 miles.

Experiments: Ionosphere.

AEROBEE
USAF-22

19 February 1952

Agency: Air Research and Development Command (AFCRC*).
Time: 0749 MST.
Altitude: 0 miles.

Experiments: Sky brightness

*Air Force Cambridge Research Center.

AEROBEE
USAF-23

29 February 1952

Agency: Air Research and Development Command (AFCRC*).
Time: 0740 MST.
Altitude: 55 miles.

Experiments: Sky brightness

*Air Force Cambridge Research Command.

AEROBEE
USAF-24

24 April 1952

Agency: Air Research and Development Command (Boston University).
Time: 1028 MST.
Altitude: 70.0 miles.

Experiments: Ionosphere.

IDENTIFICATION

30 January 1952

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1445 MST
Agency: Air Force Cambridge Research Center, University of Utah

FLIGHT OBJECTIVES

Ionosphere: Vertical incidence, to measure the time delay of radio waves near the critical frequency through the ionosphere for determination of ion densities

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon

BALLISTIC INSTRUMENTS

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 152 lb
Unfueled rocket C.G.: 122 in. from nose tip

ROCKET PERFORMANCE

Peak altitude: 0 degrees

COMMENTS

Rocket performance: Missile exploded in tower

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

19 February 1952

Rocket type: RTV-A-1a unboosted
Place of firing: Holloman Air Development Center
Time of firing: 0749 MST
Agency: Air Force Cambridge Research Center, University of Utah

FLIGHT OBJECTIVES

To study OH airglow in the day sky

UPPER AIR INSTRUMENTS

Photoelectric radiometer

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Cameras: Aspect

BALLISTIC INSTRUMENTS

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

FLIGHT INFORMATION

Peak altitude: 0 degrees

ROCKET INFORMATION

Payload weight: 189 lb
Unfueled rocket C.G.: 135 in. from nose tip

COMMENTS

Rocket modifications: This was the first non-boosted Aerobee rocket
Rocket performance: There was a thrust chamber explosion in the tower. Payload instrumentation was recovered intact and subsequently flown on USAF-25.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-23

IDENTIFICATION

29 February 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0740 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 55 miles

FLIGHT OBJECTIVES

To study OH airglow in the day sky (See USAF-22)

UPPER AIR INSTRUMENTS

Photoelectric radiometer

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Five Mitchell and five Askania stations
Cameras: Two Mitchell and three hand panned ballistic cameras

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 178 lb
Unfueled rocket C.G.: 125 in. from nose tip
Gross weight at takeoff: 1102 lb

ROCKET PERFORMANCE

Time to burnout: 45.3 sec
Velocity at burnout: 3520 ft/sec
Altitude at zenith: 55 miles

BALLISTIC DATA

Theodolites and Cameras: Optical data through 49.49 sec, Mitchell bold rate through 4.40 sec

DATA RECOVERY

Telemeter: Beacon worked well at low altitudes, spotty or nonexistent at higher altitudes
Physical recovery: Nose cone recovered in fairly good condition

EXPERIMENTAL DATA

No data, due to intermittent telemeter

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-24

IDENTIFICATION

24 April 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 1028 MST
Agency: Air Force Cambridge Research Center, Boston University
Altitude: 72 miles

FLIGHT OBJECTIVES

Ionospheric propagation (See USAF-16 and -20)

DATA RECOVERY INSTRUMENTS

Physical recovery: A new ribbon type (50 in.) parachute constructed of silicone-rubber-impregnated Fiberglass by Aerojet was used

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations
Cameras: Two ballistic camera stations

ROCKET INFORMATION

Payload weight: 145 lb
Unfueled rocket C.G.: 125 in. from nose tip
Gross weight at takeoff: 1061 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 45.3 sec
Velocity at burnout: 4260 ft/sec
Time to booster burnout: 2.71 sec
Velocity at booster burnout: 1008 ft/sec
Altitude at booster burnout: 1428 ft
Time to zenith: 156 sec
Altitude at zenith: 72 miles

BALLISTIC DATA

Theodolites and Cameras: Optical data through 40.64 sec. Roll data (optical) through 2.95 sec.

Beacon Triangulation system: Data from 3.84 to 550.84 sec with one skip of 65 sec around peak and one skip of 40 sec later

DATA RECOVERY

Physical recovery: Instrumentation not materially damaged due to rugged construction

EXPERIMENTAL DATA

Good mode data obtained

COMMENTS

Rocket modifications: This was the first rocket to use the starting slug of 70% furfuryl alcohol and 30% aniline

Rocket performance: The rocket made a smoother start and the flight was normal

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-25

IDENTIFICATION

1 May 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0842 MST
Agency: Air Force Cambridge Research Center, Rhode Island University
Altitude: 50 miles

FLIGHT OBJECTIVES

To determine intensity of solar radiation at the limit of the atmosphere

UPPER AIR INSTRUMENTS

Radiation measured by thermistor bolometers, with bias potential to limit sensitivity to range 1.6 to 2.1 gm cal cm^{-2} min^{-1}. Radiation device mounted in Colorado biaxial pointing control.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Mitchell and five Askania stations
- Cameras: Two ballistic camera stations
- Radar: Two radars

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 240 lb
Unfueled rocket C.G.: 121 in. from nose tip

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 46.60 sec
Velocity at burnout: 3709 ft/sec
Altitude at burnout: 84,380 ft
Time to booster burnout: 2.45 sec
Velocity at booster burnout: 947 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at booster burnout: 1210 ft
Time to zenith: 155 sec
Altitude at zenith: 50 miles
Time to nose cone separation: 215 sec
Flight duration: 548 sec

DATA RECOVERY

Telemeter: Good to 185 sec. Intermittent due to antenna nulls.
Physical recovery: Nose separation did not occur. Large chute remained in canister. Extensive damage to GRD instrumentation. Beacon destroyed.

EXPERIMENTAL DATA

The elevation arm of the biaxial pointing control did not function, hence no data were obtained

COMMENTS

Rocket performance: As predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-26

IDENTIFICATION

21 May 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0815 MST
Agency: Air Force Cambridge Research Center and Aero Medical Laboratory, Wright Air Development Center
Altitude: 38 miles

FLIGHT OBJECTIVES

Biological

DATA RECOVERY INSTRUMENTS

Telemeter: Holloman range facilities
Physical recovery: Parachute system of lowering nose cone. Dual parachute system (24 ft diameter solid canopy main parachute and ten ft diameter ribbon drag parachute).

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Mitchell and eight Askania stations
- Cameras: Two ballistic cameras
- Radar: Four radar
- Beacon Triangulation system: MIRAN

Airborne
- Radio cutoff: DRW-4

ROCKET INFORMATION

Payload weight: 287 lb
Unfueled rocket C.G.: 126 in. from nose tip
Unfueled rocket weight: 526 lb
Gross weight at takeoff: 1209 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, one degree east
Time to burnout: 40.8 sec
Velocity at burnout: 2831 ft/sec
Altitude at burnout: 63629 ft
Time to booster burnout: 2.62 sec
Velocity at booster burnout: 950 ft/sec
Altitude at booster burnout: 1255 ft
Time to zenith: 130 sec
Altitude at zenith: 38 miles
Time to nose cone separation: 560 sec
Altitude at nose cone separation: 148,148 ft
Flight duration: 958 sec

ROCKET PERFORMANCE (Continued)

Impact coordinates: Main Body - 12 mi. south, 29 mi. west from launcher
Parachute - one mi. north, seven mi. west from launcher

BALLISTIC DATA

Theodolites and cameras: Optical data to 54.16 sec. Askania nose cone data from 2 min 34.76 sec to 3 min 22.76 sec. Roll data to 5.08 sec.

DATA RECOVERY

Telemeter: Unusually good. One channel lost on takeoff.
Physical recovery: Successful

COMMENTS

Rocket performance: Normal flight - as predicted

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

18 June 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 1050 MST
Agency: Air Force Cambridge Research Center, Denver University
Altitude: 65.0 miles

FLIGHT OBJECTIVES

Daylight luminescence (day airglow) in the ranges 3000A to 4500A and 6000A to 8000A

UPPER AIR INSTRUMENTS

Spectrographs in the ranges 6000A to 8000A and 3000A to 4500A

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone lowered by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Seven Mitchell and seven Askania stations
- Cameras: Two ballistic cameras
- Radar: Two radars
- Beacon triangulation system: MIRAN

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon - tail safe for fuel severance

ROCKET INFORMATION

Payload weight: 202 lb
Unfueled rocket weight: 467 lb
Unfueled rocket C.G.: 157 in. from nose tip
Gross weight at takeoff: 1089 lb

ROCKET PERFORMANCE

Time to burnout: 44.79 sec
Velocity at burnout: 4035 ft/sec
Altitude at burnout: 85,760 ft
Time to booster burnout: 2.48 sec (visual)

ROCKET PERFORMANCE (Continued)

Velocity at booster burnout: 1008 ft/sec
Altitude at booster burnout: 1272 ft
Time to zenith: 170.6 sec
Altitude at zenith: 65.0 miles
Time to nose cone separation: 170.6 sec (planned for zenith separation)
Altitude at nose cone separation: 65 miles
Flight duration: 1164 sec

BALLISTIC DATA

Theodolites: Flight data (optical) to 49.59 sec. Nose cone data (optical) from 15 min. 52.59 sec to 18 min. 40.59 sec.
Cameras: Through 4.40 sec

DATA RECOVERY

Telemeter: Good for entire trajectory
Physical recovery: Excellent, equipment unharmed and operating at recovery

EXPERIMENTAL DATA

No useful data obtained, because the attitude of the rocket allowed film to be exposed to ground radiation

COMMENTS

Rocket modifications: Three 15-in. extensions were flown for the first time. This was successful.
Rocket performance: Normal flight - as predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-28

IDENTIFICATION

30 June 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0732 MST
Agency: Air Force Cambridge Research Center
Altitude: 63.0 miles

FLIGHT OBJECTIVES

Sky brightness: Day airglow in the range 4500A to 6500A

UPPER AIR INSTRUMENTS

Photoelectric photometers and interference filters, 4500A to 6500A

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone lowered by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Mitchell and six Askania stations
- Cameras: Two ballistic cameras
- Radar: Three radars
- Beacon triangulation system: MIRAN

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 211 lb
Unfueled rocket weight: 476 lb
Unfueled rocket C.G.: 126.5 in. from nose tip
Gross weight at takeoff: 1098 lb

ROCKET PERFORMANCE

Time to burnout: 44.1 sec
Velocity at burnout: 3875 ft/sec
Altitude at burnout: 84,900 ft
Time to booster burnout: 2.41 sec
Velocity at booster burnout: 1002 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at booster burnout: 1248 ft
Time to zenith: 170 sec
Altitude at zenith: 63.0 miles
Impact coordinates: Nose - 23 mi. at 343 degrees true from launcher
Body - 7.7 mi. north, 11.3 mi. west from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data to 51.86 sec. Roll data to 3.51 sec.
Beacon triangulation system: Worked during entire flight

DATA RECOVERY

Telemeter: Fairly good
Physical recovery: Partial chute failure, severe nose cone damage

EXPERIMENTAL DATA

Poor aspect data and only fair telemetering made data reduction difficult. Data indicated a diurnal variation in day airglow when it was compared with previous measurements.

COMMENTS

Rocket performance: Normal flight

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-29

IDENTIFICATION

26 August 1952

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1153 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 20 miles

FLIGHT OBJECTIVES

Ionosphere studies (See USAF-21)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: No physical recovery instrumentation

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell stations and eight Askania stations
Cameras: Two ballistic cameras
Radars: Three radars
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 140 lb
Unfueled rocket weight: 449 lb
Unfueled rocket C.G.: 132 in. from nose tip
Gross weight at takeoff: 1132 lb

ROCKET PERFORMANCE

Time to burnout: 33.61 sec
Velocity at burnout: 4686 ft/sec
Altitude at burnout: 75,860 ft
Time to booster burnout: 2.24 sec
Velocity at booster burnout: 930 ft/sec
Altitude at booster burnout: 1145 ft
Altitude at zenith: 20 miles
Flight duration: Estimated 405 sec

BALLISTIC DATA

Theodolites: Roll data from 0.96 sec to 3.06 sec
Cameras: From 0.867 sec to 1.963 sec. No other tracking data reported.

DATA RECOVERY

Telemeter: Beacon failed after 33 sec

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-25
1 May 1952

Agency: Air Research and Development Command (Colorado University).
Time: 0842 MST.
Altitude: 57.0 miles.

Experiments: Solar radiation. .

AEROBEE
USAF-26
21 May 1952

Agency: Air Research and Development Command (WADC*).
Time: 0815 MST.
Altitude: 16.2 miles.

Experiments: Biological

*Aero Medical Laboratory, Wright Air Development Center

AEROBEE
USAF-27
18 June 1952

Agency: Air Research and Development Command (Denver University).
Time: 1050 MST.
Altitude: 62.0 miles.

Experiments: Solar radiation.

AEROBEE
USAF-28
30 June 1952

Agency: Air Research and Development Command (AFCRC*).
Time: 0732 MST.
Altitude: 63.0 miles.

Experiments: Sky brightness

*Air Force Cambridge Research Center.

AEROBEE
USAF-29
26 August 1952

Agency: Air Research and Development Command (Utah University).
Time: 1153 MST.
Altitude:

Experiments: Ionosphere.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-30

IDENTIFICATION

10 October 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0730 MST
Agency: Air Force Cambridge Research Center, Denver University
Altitude: 63.0 miles

FLIGHT OBJECTIVES

Daylight luminescence (See USAF-27)

UPPER AIR INSTRUMENTS

See USAF-27

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone lowering by parachute. New modified chute system used.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Five Mitchell and six Askania stations
Cameras: Two ribbon frame ballistic cameras
Radar: Two radars
Beacon triangulation system: MIRAN

Airbonre
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon (fail safe)

ROCKET INFORMATION

Payload weight: 170 lb
Unfueled rocket weight: 472 lb
Unfueled rocket C.G.: 147 in. from nose tip
Gross weight at takeoff: 1094 lb

ROCKET PERFORMANCE

Time to burnout: 45.15 sec
Velocity at burnout: 4175 ft/sec
Altitude at burnout: 89,090 ft
Time to booster burnout: 2.51 sec

ROCKET PERFORMANCE (Continued)

Time to zenith: 175.5 sec
Altitude at zenith: 63.0 miles
Time at nose cone separation: Approximately 480 sec
Altitude at nose cone separation: 20,000 ft
Time of tail blowoff: 250 sec
Altitude at tail blowoff: 200,000 ft
Impact coordinates: 6.42 mi. north, 11.5 mi. west; chute - 1.85 mi. north, 1.50 mi. west

BALLISTIC DATA

Theodolites and Cameras: Optical data to 24.55 sec
Beacon triangulation system: Effective 95%. Used for recovery.

DATA RECOVERY

Telemeter: Good during entire trajectory
Physical recovery: Parachute system worked very well, instrumentation working when recovered

EXPERIMENTAL DATA

No data recorded. Equipment still working on recovery. Assumption is that day airglow too weak to be recorded on film without increase in spectrograph speed and film sensitivity.

COMMENTS

Rocket performance: Normal flight - as predicted

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

22 October 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0721 MST
Agency: Air Force Cambridge Research Center, University of Michigan
Altitude: 62.0 miles

FLIGHT OBJECTIVES

To obtain ambient pressures and temperatures of earth's atmosphere

UPPER AIR INSTRUMENTS

Alphatron pressure gages to measure ram pressure and nose cone surface pressure yielding local Mach number. This, together with trajectory velocity and rocket aspect, yields ambient temperature and pressure by means of the Taylor-Maccoll theory.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Mitchell stations and nine Askania stations
- Cameras: Two ballistic ribbon frame cameras
- Radar: Two radars
- Beacon triangulation system: MIRAN

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon (fail safe for fuel cutoff)

ROCKET INFORMATION

Payload weight: 200 lb
Unfueled rocket weight: 500 lb
Unfueled rocket C.G.: 132 in. from nose tip
Gross weight at takeoff: 1122 lb

ROCKET PERFORMANCE

Time to burnout: 42.9 sec
Velocity at burnout: 3975 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 82,930 ft
Time to zenith: 167.8 sec
Altitude at zenith: 62.0 miles

BALLISTIC DATA

Theodolites and cameras: Optical through 48.42 sec. Roll data through 3.85 sec.
Beacon triangulation system: Impact location pinpointed

DATA RECOVERY

Telemeter: 95% good
Physical recovery: Partial parachute failure, but instruments recovered in excellent condition

EXPERIMENTAL DATA

Ambient pressure and temperature derived from data recorded over the interval of 45 to 90 km

COMMENTS

Rocket performance: As predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-32

IDENTIFICATION

6 November 1952

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 0856 MST
Agency: Air Force Cambridge Research Center
Altitude: 47.0 miles

FLIGHT OBJECTIVES

Sky brightness (See USAF-28)

UPPER AIR INSTRUMENTS

See USAF-28

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Lowering nose cone

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two ribbon frame cameras
Radars: Two radars
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 185 lb
Unfueled rocket weight: 485 lb
Unfueled rocket C.G.: 128 in. from nose tip
Gross weight at takeoff: 1107 lb

ROCKET PERFORMANCE

Time to burnout: 43.28 sec
Velocity at burnout: 4000 ft/sec
Altitude at burnout: 84,730 ft
Time to booster burnout: 2.62 sec
Time to zenith: 146 sec

ROCKET PERFORMANCE (Continued)

Altitude to zenith: 47.0 miles
Time to tail blowoff: 109.1 sec

BALLISTIC DATA

Theodolites and cameras: Optical data to 48.12 sec. Roll data to 4.05 sec.
Beacon triangulation system: Very good throughout flight

DATA RECOVERY

Telemeter: Good
Physical recovery: Excellent

EXPERIMENTAL DATA

Experimental equipment functioned properly. Data could not be realistically interpreted because of excessive pitch and roll of the missile, as shown from film from telescope.

COMMENTS

Rocket performance: Poor performance, reason unknown

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-33

IDENTIFICATION

12 December 1956

Rocket type: RTV-A-1
Place of firing: Holloman Air Development Center
Time of firing: 1239 MST
Agency: Air Force Cambridge Research Center, University of Colorado
Altitude: 55 miles

FLIGHT OBJECTIVES

Solar radiation

UPPER AIR INSTRUMENTS

Grazing incidence spectrograph mounted in a biaxial pointing control

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two ballistic ribbon frame cameras
Radar: Two radars

ROCKET INFORMATION

Payload weight: 225 lb
Unfueled rocket weight: 525 lb
Unfueled rocket C.G.: 124 in. from nose tip
Gross weight at takeoff: 1147 lb

ROCKET PERFORMANCE

Time to burnout: 46.25 sec
Velocity at burnout: 3600 ft/sec
Altitude at burnout: 85,000 ft
Time to booster burnout: 2.9 sec
Velocity at booster burnout: 925 ft/sec
Altitude at booster burnout: 1320 ft
Time to zenith: 149 sec
Altitude at zenith: 55 miles

BALLISTIC DATA

Theodolites and cameras: Optical data to 52.12 sec. Attitude azimuth data to 6.35 sec.

EXPERIMENTAL DATA

A picture of Lyman-α was obtained from a 28-sec exposure

COMMENTS

Rocket performance: Normal flight

REPORTS AND PAPERS

"Lyman Alpha-Line Photographed in the Sun's Spectrum," W. B. Pietenpol, W. A. Rense, F. C. Walz, D. S. Stacey, and J. M. Jackson, Phys. Rev. 90:156 (1953)

"Intensity of Lyman Alpha-Line in the Solar Spectrum," W. A. Rense, Phys. Rev. 91:299 (1953)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-30
10 October 1952

Agency: Air Research and Development Command (Denver University).
Time: 0724 MST.
Altitude: 68.0 miles.

Experiments: Solar radiation.

AEROBEE
USAF-31
22 October 1952

Agency: Air Research and Development Command (University of Michigan).
Time: 0735 MST.
Altitude: 62.0 miles.

Experiments: Pressure, Temperature.

AEROBEE
USAF-32
6 November 1952

Agency: Air Research and Development Command (AFCRC*).
Time: 0856 MST.
Altitude: 47.0 miles.

Experiments: Sky brightness

*Air Force Cambridge Research Center.

AEROBEE
USAF-33
12 December 1952

Agency: Air Research and Development Command (University of Colorado).
Time: 1238 MST.
Altitude: 55 miles.

Experiments: Solar radiation.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-34

IDENTIFICATION

18 February 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1042 MST
Agency: Air Force Cambridge Research Center
Altitude: 73 miles

FLIGHT OBJECTIVES

Rocket performance. This was the first of two test flights to determine and correct the cause of failure of the type experienced by USAF-29.

ROCKET PERFORMANCE INSTRUMENTS

An aspect system was flown; also accelerometers, pressure pickups, and instruments to measure the temperatures of nose cone and fins. There was a Fiberglass covering on the nose cone and fins to reduce skin heating.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon

BALLISTIC INSTRUMENTS

Firing Range
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon. S-band beacon to track tail cone.
Radio cutoff: AFCRC multipurpose beacon (fail safe)

ROCKET INFORMATION

Payload weight: 160 lb

ROCKET PERFORMANCE

Time to burnout: 32.2 sec
Time to zenith: 173 sec
Altitude at zenith: 73 miles
Time of tail blowoff: 228 sec
Flight duration: 545 sec
Impact coordinates: 12 mi. south, 18 mi. west of launcher

BALLISTIC DATA

Radar: S-band beacon successful. Operators lost signal at 41 sec, but beacon was operating.

DATA RECOVERY

Telemeter: Beacon operated successfully throughout flight
Physical recovery: Cameras and other vital instrumentation in good condition

COMMENTS

Rocket performance: All equipment worked well. Rocket performance was as predicted and the Fiberglas peeled off fins because of poor bond at high temperatures. This produced excessive roll (greater than 5 rps), but the flight was successful in spite of the roll.

UPPER AIR ROCKET SUMMARY

14 April 1953

IDENTIFICATION

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0837 MST
Agency: Air Force Cambridge Research Center
Altitude: 76 miles

FLIGHT OBJECTIVES

Rocket performance

ROCKET PERFORMANCE INSTRUMENTS

Camera to photograph fin, antenna, and motor flame. NRL photographic system modified by AFCRC. Two accelerometers. Steel cuffs on fins - Fiberglas on nose.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Mitchell, Askania
Cameras: Ballistic cameras
Telescopes: Four telescope stations
Radars: Two X-band radars
AFCRC triangulation system: In use

Airborne
Beacon: AFCRC multipurpose beacon, S-band beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 159 lb
Unfueled rocket weight: 467 lb
Unfueled rocket C.G.: 130 in. from nose tip
Gross weight at takeoff: 1150 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, one degree east
Time to burnout: 33.78 sec
Velocity at burnout: 4690 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 75,135 ft
Time to booster burnout: 2.69 sec
Velocity at booster burnout: 995 ft/sec
Altitude at booster burnout: 1100 ft
Time to zenith: 167.8 sec
Altitude at zenith: 76 miles
Altitude at tail blowoff: 220 sec
Impact coordinates: 47 mi. at 327 degrees true from launcher

BALLISTIC DATA

Theodolites: Data from 0.73 sec to 39.33 sec. Roll from Mitchell from 0.93 sec to 3.93 sec.
Beacon triangulation system: Position data from 1.93 sec to 175.93 sec

DATA RECOVERY

Telemeter: Satisfactory to 90 sec, then signal intermittent
Physical recovery: Nose and body recovered

COMMENTS

Rocket performance: Satisfactory

REPORTS AND PAPERS

"Aerodynamic Heating and Thermal Protection of the Aerobee Sounding Rocket," Aerojet General Corporation Report 744, 25 Feb 1954

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-36

IDENTIFICATION

20 May 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0704 MST
Agency: Air Force Cambridge Research Center
Altitude: 71 miles

FLIGHT OBJECTIVES

Sky brightness - (See USAF-28 and -32)

UPPER AIR INSTRUMENTS

Photoelectric photometers and interference filters, 4500A degrees to 6500A. Aspect camera.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone parachute

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Mitchell and Askania
Cameras: Ballistic
Telescopes: One station
Radar: Two X-band radars
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 189 lb
Unfueled rocket weight: 497 lb
Unfueled rocket C.G.: 128 in. from nose tip
Gross weight at takeoff: 1180 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 33 sec
Velocity to burnout: 4480 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 71,385 ft
Time to booster burnout: 2.51 sec
Velocity at booster burnout: 975 ft/sec
Altitude at booster burnout: 1030 ft
Time to zenith: 173 sec
Altitude at zenith: 71 miles
Time to blowoff: 264 sec
Time to nose separation: 489 sec
Flight duration: 1430 sec
Impact coordinates: 25 mi. at 325 degrees true from launcher

BALLISTIC DATA

Theodolites: Position and velocity data from 1.06 to 36.06 sec; attitude, azimuth, and elevation from 1.46 to 12.86 sec
Cameras: Position, velocity, and acceleration from 1.008 to 2.273 sec
AFCRC beacon triangulation: Position data from 7 to 525 sec

DATA RECOVERY

Telemeter: Good
Physical recovery: Nose and body recovered in excellent condition

EXPERIMENTAL DATA

The Fiberglas coating on the nose cone became detached and partially covered the receiving angles of the photometers. Approximately one half of possible data were obtained. Results of eight interference filters in the visible region showed that day airglow values from this flight (0704 hours) were an order of magnitude lower than those obtained previously at times from 0900 to 1030 hours.

COMMENTS

Rocket modifications: A 0.030-in. layer of Fiberglas was bonded to the nose skin
Rocket performance: As predicted

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

21 May 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0857 MST
Agency: Air Force Cambridge Research Center
Altitude: 71 miles

FLIGHT OBJECTIVES

Sky brightness (See USAF-28, -32, and -38)

UPPER AIR INSTRUMENTS

See USAF-28

ROCKET PERFORMANCE INSTRUMENTS

Aspect camera

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Mitchell and Askania stations
- Cameras: Two ballistic cameras
- Telescopes: One station
- Radar: Two X-band radars
- Beacon triangulation system: MIRAN

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 189 lb
Unfueled rocket weight: 495 lb
Unfueled rocket C.G.: 128 in. from nose tip
Gross weight at takeoff: 1178 lb

ROCKET PERFORMANCE

Firing angle: 3 degrees north
Time to burnout: 33.78 sec
Velocity at burnout: 4490 ft/sec
Altitude at burnout: 72,800 ft
Time to booster burnout: 2.48 sec
Velocity at booster burnout: 980 ft/sec
Altitude at booster burnout: 1000 ft
Time to zenith: 173 sec
Altitude at zenith: 71 miles
Time to tail blowoff: 217 sec
Impact coordinates: 25 mi. at 295 degrees true from launcher

DATA RECOVERY

Telemeter: Generally fair, spotty near and after zenith

BALLISTIC DATA

Theodolites and Cameras: Optical data from 0.88 sec to 37.68 sec

EXPERIMENTAL DATA

The Fiberglas coating on the nose became detached and covered all receiving angles of the photometers, so that no meaningful data were obtained

COMMENTS

Rocket modification: A 0.030-in. Fiberglas layer was bonded to the exterior nose skin
Rocket performance: Essentially as predicted

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

26 June 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1210 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 84 miles

FLIGHT OBJECTIVES

Ionosphere studies (See USAF-21 and -29)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Tail cone primer cord

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: One Mitchell and six Askania stations
- Cameras: Two ballistic Clark ribbon frame cameras and one K-24 camera
- Telescopes: One
- Radars: Two X-band radars
- Beacon triangulation system: MIRAN

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 153.5 lb
Unfueled rocket weight: 462 lb
Unfueled rocket C.G.: 131 in. from nose tip
Gross weight at takeoff: 1145 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, 10 mils east
Time to burnout: 34 sec
Velocity to burnout: 4703 ft/sec
Altitude at burnout: 87,800 ft
Time to booster burnout: 2.48 sec
Velocity at booster burnout: 1050 ft/sec
Altitude at booster burnout: 1000 ft
Time to zenith: 189 sec
Altitude at zenith: 84 miles

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 290 sec
Altitude at tail blowoff: 200,000 ft
Flight duration: 584 sec
Impact coordinates: 25 mi. at 325 degrees true from launcher

BALLISTIC DATA

Beacon triangulation system: Signal lost at 120 sec

DATA RECOVERY

Telemeters: Excellent

EXPERIMENTAL DATA

Good data were obtained on the 4-5 Mc upward transmission delays. No signals obtained from the 6-Mc transmitter in rocket. A plot of electron density vs altitude from 95 km to 135 km was obtained.

COMMENTS

Rocket modifications: A 0.030-in. layer of Fiberglas bonded to entire external surface of nose skin. Rocket fins leading edges had stainless steel cuffs. Three outboard antennas consisting of three wires which extended from the nose cone to the outer corner of each of the rocket fins.
Rocket performance: Zenith above that predicted

REPORTS AND PAPERS

"Bifurcation of the E Region," J. R. Lien, R. J. Marcou, J. C. Ulwick, D. R. McMorrow, D. B. Linsford, and O. C. Haycock, Phys. Rev. 92:508 (1953)
"Ionosphere Research with Rocket-Borne Instruments," J. R. Lien, R. J. Marcou, J. C. Ulwick, J. Aarons, and D. R. McMorrow, in "Rocket Exploration of the Upper Atmosphere," edited by R. L. F. Boyd, and M. J. Seaton, London: Pergamon Press, 1954, pp. 223-239
"Further Remarks on Bifurcation in the E-Layer," W. Pfister, J. C. Ulwick, and R. J. Marcou, Phys. Rev. 97:1183 (1955)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-39

1 July 1953

IDENTIFICATION

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1052 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 86 miles

FLIGHT OBJECTIVES

Ionosphere studies (See USAF-21, -29, and -38)

DATA RECOVERY INSTRUMENTS

Telemetering: AFCRC multipurpose beacon

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: One Mitchell and six Askania stations.
Cameras: Two Clark ribbon frame ballistic cameras
Telescopes: One
Radars: Two X-band radars
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon (fuel severance)

ROCKET INFORMATION

Payload weight: 148.5 lb
Unfueled rocket weight: 455.5 lb
Unfueled rocket C.G.: 130.3 in. from nose tip
Gross weight at takeoff: 1138.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 34 sec
Velocity at burnout: 4827 ft/sec
Altitude at burnout: 79,000 ft
Time to booster burnout: 2.34 sec
Velocity at booster burnout: 1015 ft/sec
Altitude at booster burnout: 1239 ft
Time to zenith: 184 sec
Altitude at zenith: 86 miles
Time to tail blowoff: 283 sec
Altitude at tail blowoff: 200,000 ft

ROCKET PERFORMANCE (Continued)

Flight duration: 573 sec
Impact coordinates: 22 mi. at 306 degrees true from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data from 0.857 sec to 36.14 sec
Beacon triangulation system: Data from 7.34 sec to 69.34 sec

DATA RECOVERY

Telemeter: Excellent at most beacon stations. Two buttes lost signal at 69 sec.
Physical recovery: Nose cone, tail cone, and body recovered

EXPERIMENTAL DATA

6-Mc and 4-5 Mc signals obtained, but somewhat erratic. Electron density vs altitude curves obtained from the recorded data.

COMMENTS

Rocket modifications: See USAF-38
Rocket performance: The 86 miles zenith was ten miles higher than prediction

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

14 July 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0830 MST
Agency: Air Force Cambridge Research Center, Rhode Island University
Altitude: 64 miles

FLIGHT OBJECTIVES

Solar radiation (See USAF-25)

UPPER AIR INSTRUMENTS

See USAF-25

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone blown by aneroid and primer cord, lowered by parachute. Tail cone blown by fail safe

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and five Askania stations
- Cameras: Two Clark ribbon frame ballistic cameras
- Telescopes: Two
- Radars: Two X-band radars

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 249 lb
Unfueled rocket weight: 554 lb
Unfueled rocket C.G.: 122.3 in. from nose tip
Gross weight at takeoff: 1237 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, 57.5 mils west
Time to burnout: 33.63 sec
Velocity at burnout: 4190 ft/sec
Altitude at burnout: 72,000 ft

ROCKET PERFORMANCE (Continued)

Time to booster burnout: 2.34 sec
Velocity at booster burnout: 935 ft/sec
Altitude at booster burnout: 1066 ft
Time to zenith: 160 sec
Altitude at zenith: 64 miles
Time to tail blowoff: 280 sec
Flight duration: 527 sec
Impact coordinates: 25 mi. at 321 degrees true from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data to 37.53 sec
Beacon triangulation system: Trajectory data from 7.13 sec to 280.13 sec

DATA RECOVERY

Telemeter: Satisfactory for 250 sec
Physical recovery: Nose cone did not separate, parachute did not deploy

EXPERIMENTAL DATA

No data. There was no evidence of malfunction of radiation sensing equipment. But, because of optical accident to the biaxial pointing control, no data were obtained.

The azimuth eyes of the biaxial pointing control were blinded by paint transported from the nose, presumably as a consequence of higher skin temperatures and abrasive action of air caused by greater velocity achieved by the use of the newer RTV-A-1a rocket motor with booster. As a result of the blinded eyes, the rotation of the azimuth platform did not counteract the roll of the rocket.

The elevation control did function, and 42 bolometer indications were obtained. However, the maximum reading was only 85% of the solar constant. Apparently the sensing equipment did not have time to come to full response.

COMMENTS

Rocket performance: As predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-41

IDENTIFICATION

22 July 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0247 MST
Agency: Air Force Cambridge Research Center
Altitude: 59.4 miles

FLIGHT OBJECTIVES

To investigate atmospheric composition by means of a spectrograph which photographed emission from an electrodeless discharge through the air. In particular, the presence or absence of Na at particular altitudes was sought.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Nose cone separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and five Askania stations
- Cameras: Two Clark ribbon frame ballistic cameras
- Telescopes: In use
- Radars: Two X-band radars
- AFCRC triangulation system: In use

ROCKET INFORMATION

Payload weight: 239 lb
Unfueled rocket weight: 546.5 lb
Unfueled rocket C.G.: 119.2 in. from nose tip
Gross weight at takeoff: 1229.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 32.5 sec
Velocity at burnout: 3890 ft/sec
Altitude at burnout: 65,184 ft
Time to booster burnout: 1.95 sec
Velocity at booster burnout: 940 ft/sec
Altitude at booster burnout: 950 ft
Time to zenith: 150.1 sec
Altitude at zenith: 59.4 miles
Time to nose cone separation: 380 sec
Altitude at nose cone separation: 20,000 ft

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 256 sec
Altitude at tail blowoff: 200,000 ft
Flight duration: 1015 sec
Impact coordinates: 22 mi. at 333 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data from 0.9 to 32.5 sec
Beacon triangulation system: Position data intermittently from 12.10 sec to 860.10 sec

DATA RECOVERY

Telemeter: Generally good data - intermittent near zenith
Physical recovery: Excellent parachute recovery

EXPERIMENTAL DATA

No data. High voltage breakdown inside missile due to loss of pressurization at or near burnout.

COMMENTS

Rocket modifications: Two scoops roughly 1-1/2 in. in diameter and 6-8 in. long mounted like horns on the sides of the Aerobee. A 0.030-in. Fiberglas layer bonded to the nose skin.
Rocket performance: Normal flight

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

15 September 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0802 MST
Agency: Air Force Cambridge Research Center
Altitude: 20 miles

FLIGHT OBJECTIVES

Sky brightness (See USAF-28, -32, -36, and -37)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Cameras: Two specially modified 16-mm cameras
Physical recovery: Nose cone separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and six Askania stations
- Cameras: Two Clark ribbon frame ballistic cameras
- Telescopes: Two
- Radar: Three X-band radars

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 215.5 lb
Unfueled rocket weight: 524 lb
Unfueled rocket C.G.: 124.2 in. from nose tip
Gross weight at takeoff: 1207 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 35 sec
Velocity at burnout: 1910 ft/sec
Altitude at burnout: 49,200 ft
Time to booster burnout: 2.27 sec
Velocity at booster burnout: 968 ft/sec
Altitude at booster burnout: 1050 sec
Time to zenith: 91 sec
Altitude to zenith: 20 miles

ROCKET PERFORMANCE (Continued)

Flight duration: 180 sec
Impact coordinates: 6.6 mi. at 355 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data from 1.03 sec to 179.63 sec. Mitchell roll data from 0.89 sec to 3.49 sec.

DATA RECOVERY

Telemeter: Good
Physical recovery: Nose cone did not separate. Rocket came in stable and was completely demolished.

EXPERIMENTAL DATA

Altitude insufficient to obtain useful data

COMMENTS

Rocket modifications: A 0.030-in. Fiberglas layer bonded to external surface of the nose cone
Rocket performance: Vehicle failure - propulsion system

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-43

IDENTIFICATION

7 October 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1000 MST
Agency: Air Force Cambridge Research Center, University of Colorado
Altitude: 62 miles

FLIGHT OBJECTIVES

Solar spectrum, Lyman-α

UPPER AIR INSTRUMENTS

Grating incidence spectrograph oriented by means of a biaxial pointing control. Range of spectrograph was from center of image to 7000A.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Parachute recovery system

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two Clark ribbon frame cameras, one K-24 camera

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 226.5 lb
Unfueled rocket weight: 533.5 lb
Payload C.G.: 66.6 in. from nose tip
Gross weight at takeoff: 1216.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 32.15 sec
Velocity at burnout: 4145 ft/sec
Altitude at burnout: 66,700 ft
Time to booster burnout: 2.16 sec
Velocity at booster burnout: 930 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at booster burnout: 1100 ft
Time to zenith: 163 sec
Altitude at zenith: 62 miles
Time to tail blowoff: 235 sec
Altitude at tail blowoff: 200,000 ft
Flight duration: 540 sec
Impact coordinates: 15 mi. at 336 degrees true from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data to 38.70 sec
Beacon triangulation system: Position data from 15.10 to 510.10 sec

DATA RECOVERY

Telemeter: Beacon operated normally
Physical recovery: Recovery system failed to operate

EXPERIMENTAL DATA

University of Colorado spectrograph and pointing control equipment operated only partially

COMMENTS

Rocket performance: Flight normal and altitude essentially that predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-44

IDENTIFICATION

2 November 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1132 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 75 miles

FLIGHT OBJECTIVES

Ionosphere studies (See USAF-21, -29, -38, and -39)

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Tail cone separation primer cord

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Mitchell and Askania
Cameras: Ballistic stations
Telescopes: Three telescopes
Beacon triangulation system: In use

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 148.5 lb
Unfueled rocket weight: 455.5 lb
Unfueled rocket C.G.: 130.8 in. from nose tip
Gross weight at takeoff: 1138.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, ten mils east
Time to burnout: 33.8 sec
Velocity at burnout: 4700 ft/sec
Altitude at burnout: 74,400 ft
Time to booster burnout: 2.63 sec
Velocity at booster burnout: 1010 ft/sec
Altitude at booster burnout: 1400 ft (approximate)
Altitude at zenith: 75 miles
Time to tail blowoff: 328 sec
Altitude at tail blowoff: 120,000 ft (approximate)
Impact coordinates: 34 mi. at 346 degrees true from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data to 37.13 sec

DATA RECOVERY

Telemeter: Beacon operated to 29 sec, and then was intermittent

EXPERIMENTAL DATA

No data recorded because of equipment failure

COMMENTS

Rocket modifications: A 0.030 in. Fiberglas layer bonded to nose cone surface.
Three outboard antennas from nose cone to tail fins.
Rocket performance: Normal flight

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-45

IDENTIFICATION

3 November 1953

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1115 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 75.5 miles

FLIGHT OBJECTIVES

Ionosphere studies (See USAF-21, -29, -38, -39, and -44)

DATA RECOVERY INSTRUMENTS

Telemeter: New modified AFCRC multipurpose beacon flown for first time

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Mitchell and Askania stations
- Cameras: Ballistic cameras
- Telescopes: In use
- AFCRC triangulation system: In use

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 161 lb
Unfueled rocket weight: 470.5 lb
Unfueled rocket C.G.: 137.4 in. from nose tip
Gross weight at takeoff: 1152.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 34 sec
Velocity at burnout: 4580 ft/sec
Altitude at burnout: 73,000 ft
Time to booster burnout: 2.59 sec
Velocity at booster burnout: 985 ft/sec
Altitude at booster burnout: 850 ft
Time to zenith: 181.5 sec
Altitude at zenith: 75.5 miles
Time to tail blowoff: 325 sec
Impact coordinates: 30 mi. at 335 degrees true from launcher

BALLISTIC DATA

Theodolites: Spotty data
Cameras: Good records
Telescopes: Spotty data
Beacon triangulation system: Tracking good from 11.54 sec to 241.54 sec

DATA RECOVERY

Telemeter: Excellent records on one channel
Physical recovery: Body and beacon assembly recovered in good condition

EXPERIMENTAL DATA

No upward transmission data, but downward 6-Mc data were obtained. These data will give an electron density vs altitude plot.

COMMENTS

Rocket modifications: A 0.030-in. layer of Fiberglas bonded to the nose cone surface. Three outboard antennas were connected from the nose cone to the tail fins.
Rocket performance: Normal flight
Experiments: New modified beacon performed satisfactorily

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

11 May 1954

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0800 MST
Agency: Air Force Cambridge Research Center
Altitude: 61 miles

FLIGHT OBJECTIVES

Primary purpose: To test operation under flight conditions of the AFCRC multipurpose beacon system modified for use with the MIRAN system of triangulation
Secondary purpose: Other instrumentation and rocket tests; especially a new design notch antenna and a new design nose cone flown without a Fiberglas protective covering

UPPER AIR INSTRUMENTS

Vibrator power supply was test flown
New design beacon modulator circuit was test flown
New notch antenna mounted on fin-coaxial switch to regular slot antenna after tail cone blowoff
Nose cone of higher strength material

ROCKET PERFORMANCE INSTRUMENTS

Oxidizer shut-off valve actively connected to combustion pressure switch
Combustion chamber pressure gage
Accelerometers mounted to obtain lateral accelerations in nose

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon system (6-channel telemeter)
Camera: Aspect camera. Camera mounted to provide record of parachute recovery system.
Physical recovery: Parachute recovery

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and six Askania stations
- Cameras: Two Clark ribbon frame cameras; K-24 camera
- Telescopes: Three
- Beacon triangulation system: MIRAN

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 192 lb
Unfueled rocket weight: 500 lb
Unfueled rocket C.G.: 157.8 miles from nose tip
Gross weight at takeoff: 1183 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 31.58 sec
Velocity at burnout: 4240 ft/sec
Altitude at burnout: 65,497 ft
Time to booster burnout: 2.50 sec
Velocity at booster burnout: 970 ft/sec
Altitude at booster burnout: 1147 ft
Time to zenith: 159 sec
Altitude at zenith: 61 miles
Time at nose cone separation: 460 sec
Altitude at nose cone separation: 20,000 ft
Time to tail blowoff: 209 sec
Altitude at tail blowoff: 282,000 ft
Flight duration: 1240 sec
Impact coordinates: 39 mi. north, 13.6 mi. west of launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data available to 39.92 sec
Beacon triangulation system: MIRAN position data intermittent from 17.92 to 348.92 sec

DATA RECOVERY

Physical recovery: Nose cone recovered in excellent condition

EXPERIMENTAL DATA

Successful flight, AFCRC multipurpose beacon system and MIRAN triangulation systems operated together satisfactorily. Other instrumentation and rocket tests were successful.

COMMENTS

Rocket performance: Early burnout, possibly due to oxidizer shutoff valve actuation too soon, caused low zenith. Except for this the flight was normal.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-47

IDENTIFICATION

2 June 1954

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0910 MST
Agency: Air Force Cambridge Research Center, University of Colorado
Altitude: 58 miles

FLIGHT OBJECTIVES

Solar ultraviolet spectrum

UPPER AIR INSTRUMENTS

Solar spectrograph oriented to look continuously at the sun by means of a biaxial pointing control

ROCKET PERFORMANCE INSTRUMENTS

Rocket aspect equipment associated with biaxial pointing control
Combustion chamber pressure

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Parachute recovery system

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two Clark ribbon frame cameras, one K-24 camera
Radars: One
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 239.5 lb
Unfueled rocket weight: 548.5 lb
Unfueled rocket C.G.: 125.1 in. from nose tip
Gross weight at takeoff: 1231.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, ten mils west
Time to burnout: 34.32 sec
Velocity at burnout: 3980 ft/sec
Altitude at burnout: 70,000 ft
Time to booster burnout: 2.31 sec
Velocity at booster burnout: 960 ft/sec
Altitude at booster burnout: 1060 ft
Time to zenith: 158 sec
Altitude at zenith: 58 miles
Time to tail blowoff: 240 sec
Altitude at tail blowoff: 152,000 ft
Flight duration: 560 sec
Impact coordinates: 39 mi. at 336 degrees true from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data to 40.48 sec
Beacon triangulation system: Data from 11.68 to 380.68 sec

DATA RECOVERY

Telemeter: Beacon operated throughout flight; however, no signal received from 70-240 sec due to malfunction of coaxial feed to antenna
Physical recovery: Parachute recovery failed and nose separation failed. Nose section was badly damaged - no salvagable instrumentation.

COMMENTS

Rocket performance: Flight normal - zenith 1.5 miles short of prediction

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-48

IDENTIFICATION

14 July 1954

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0655 MST
Agency: Air Force Cambridge Research Center, University of Michigan
Altitude: 57 miles

FLIGHT OBJECTIVES

To determine vehicle aspect. To determine feasibility of a stream velocity indicator. Ambient temperature.

UPPER AIR INSTRUMENTS

University of Michigan gyroscope, photographic "sun-horizon" system. Velocity of air stream instrumentation consisted of an ion source generator and detector. Wind vanes.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Cameras: 16-mm modified rocket camera
Physical recovery: 16- and 35-mm film record of gyroscopes. Nose and tail separation by primer cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two Clark ribbon frame cameras
Beacon triangulation system: MIRAN

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 280.5 lb
Unfueled rocket weight: 589.5 lb
Unfueled rocket C.G.: 127 in. from nose tip
Gross weight at takeoff: 1272.5 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, 17 mils west
Time to burnout: 34.11 sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 66,304 ft
Time to booster burnout: 2.42 sec
Velocity at booster burnout: 922 ft/sec
Altitude at booster burnout: 1066 ft
Altitude at zenith: 57 miles
Time to tail blowoff: 185 sec
Impact coordinates: 17 mi. at 305 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania to 34.84 sec
Beacon triangulation system: Data from 10.84 to 40.84 sec

DATA RECOVERY

Telemeter: Beacon intermittent
Physical recovery: Nose and tail sections recovered

EXPERIMENTAL DATA

Data were obtained, evaluation not complete

COMMENTS

Rocket performance: Normal flight

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-49

IDENTIFICATION

11 August 1954

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1025 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 57 miles

FLIGHT OBJECTIVES

Electron density of D layer to measure electromagnetic energy absorption of the ionosphere

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Parachute recovery system

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations
Cameras: Two ballistic cameras

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 196 lb
Unfueled rocket weight: 505 lb
Unfueled rocket C.G.: 136 in. from nose tip
Gross weight at takeoff: 1188 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north
Time to burnout: 30.96 sec
Velocity at burnout: 3975 ft/sec
Altitude at burnout: 62,948 ft
Time to booster burnout: 2.14 sec
Velocity at booster burnout: 970 ft/sec
Altitude at booster burnout: 1089 ft
Time to zenith: 151.09 sec
Altitude at zenith: 57 miles
Impact coordinates: 15 mi. at 300 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania to 44.69 sec
Beacon triangulation system: Position data from 11.09 to 219.09 sec

DATA RECOVERY

Telemeter: Good
Physical recovery: Parachute system failed, stable impact

COMMENTS

Low zenith due to early burnout. Believed caused by excessive spin rate which forced fuel to slosh in tanks.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-50

IDENTIFICATION

17 September 1954

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0731 MST
Agency: Air Force Cambridge Research Center, Rhode Island University
Altitude: 58.8 miles

FLIGHT OBJECTIVES

Solar radiation (see USAF-25 and -40)

UPPER AIR INSTRUMENTS

University of Colorado biaxial pointing control was used to orient equipment

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two ballistic cameras

ROCKET INFORMATION

Payload weight: 250 lb
Unfueled rocket weight: 558 lb
Unfueled rocket C.G.: 128.5 in. from nose tip
Gross weight at takeoff: 1241 lb

ROCKET PERFORMANCE

Firing angle: Three degrees north, 12 mils east
Time to burnout: 34.22 sec
Velocity at burnout: 4030 ft/sec
Altitude at burnout: 67,982 ft
Time to booster burnout: 2.6 sec
Velocity at booster burnout: 945 ft/sec
Altitude at booster burnout: 1161 ft
Time to zenith: 160 sec
Altitude at zenith: 58.8 mi
Impact coordinates: 23 mi. at 336 degrees true from launcher

BALLISTIC DATA

Theodolites and Cameras: Optical data to 42.38 sec

DATA RECOVERY

Physical recovery: Tail separation failed to operate. Nose separation successful - rocket recovered. Nose cone and instrumentation were scattered over about one square mile.

EXPERIMENTAL DATA

No data. Elevation arm of University of Colorado sunseeker didn't function properly.

COMMENTS

Rocket performance: Essentially as predicted

21 January 1955

IDENTIFICATION

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1754 MST
Agency: Air Force Cambridge Research Center
Altitude: 58.9 miles

FLIGHT OBJECTIVES

An attempt to produce an artificial sodium airglow by the temporary, local enrichment of the atmosphere with sodium vapor

UPPER AIR INSTRUMENTS

Three vaporizers containing a two-pound mixture of thermite and metallic sodium.
Spectrograph, an interference-filter photocell instrument, and a skanning night sky photometer with interference filter peaked for the sodium doublet, were operated at Sacramento Peak.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and six Askania stations
Cameras: Two ribbon frame cameras
Beacon triangulation system: MIRAN, six stations

Airborne
Beacon: AFCRC multipurpose beacon
Radio cutoff: AFCRC multipurpose beacon, fail safe fuel cutoff

ROCKET INFORMATION

Payload weight: 262 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 254 in.
Unfueled rocket weight: 569 lb
Unfueled rocket C.G.: 128.6 in. from nose tip
Gross weight at takeoff: 1252 lb
Calculated $C_{m\alpha}$ at burnout: 0.345
Calculated M_α at burnout: 722 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 34 sec
Velocity at burnout: 3900 ft/sec
Altitude at burnout: 70,000 ft
Time to booster burnout: 2.61 sec
Velocity at booster burnout: 900 ft/sec
Altitude at booster burnout: 1100 ft
Time to zenith: 155 sec
Altitude at zenith: 58.9 miles
Time of nose cone separation: 414 sec.
Altitude at nose cone separation: 20,000 ft
Time of tail blowoff: 238 sec
Flight duration: 1014 sec
Impact coordinates: 21.5 naut mi at 323 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data to 32 sec
Beacon triangulation system: MIRAN beacon data not reduced because of intermittent signal

DATA RECOVERY

Telemeter: Intermittent, 90% effective
Physical recovery: Body and nose recovered

EXPERIMENTAL DATA

The first vaporizer was successfully fired at 35 to 45 miles and ejected a cloud of atomic sodium vapor. The remaining vaporizer was to be fired at about 56 miles. However, the firing of the first burned off the firing circuit to the other and it did not fire.

The spectrograph recorded an intense continuum in the visible from the cloud during the first 5 minutes after vaporization.

As the cloud drifted over the interference filter instrument, there was a considerable decrease in intensity of the sodium doublet. This observation showed that some of the sodium at least had dispersed into atomic form, and is perhaps the most significant single observation.

COMMENTS

Rocket performance: Normal

REPORTS AND PAPERS

"Emission from a Sodium Cloud Artificially Produced by Means of a Rocket," H. D. Edwards, J. F. Bedinger, E. R. Manring, and C. D. Cooper, in "The Airglow and the Aurorae," edited by E. B. Armstrong and A. Dalgarno, London:Pergamon Press, 1956, pp. 122-134

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

7 February 1955

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1151 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 74.8 miles

FLIGHT OBJECTIVES

Electron density measurements in the ionosphere. Spatial inhomogeneities in the ionosphere. Absorption coefficients of the D layer.

UPPER AIR INSTRUMENTS

4-Mc receivers

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, 6-channel telemeter

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and six Askania stations
- Cameras: Two Clark ribbon frame cameras
- Telescopes: In use
- Beacon triangulation system: MIRAN

ROCKET INFORMATION

Payload weight: 178 lb
Total extension length: 25 in.
Total rocket length (nose tip to base of tail section): 252 in.
Unfueled rocket weight: 460 lb
Unfueled rocket C.G.: 138.9 in. from nose tip
Gross weight at takeoff: 1142 lb
Calculated $C_{m\alpha}$ at burnout: -0.202
Calculated M_α at burnout: 474 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 34.3 sec
Velocity at burnout: 4500 ft/sec
Altitude at burnout: 74,000 ft
Time to booster burnout: 2.8 sec

ROCKET PERFORMANCE (Continued)

Velocity at booster burnout: 985 ft/sec
Altitude at booster burnout: 1000 ft
Time to zenith: 175.7 sec
Altitude at zenith: 74.8 miles
Time to tail blowoff: 290 sec
Altitude at tail blowoff: 210,000 ft
Impact coordinates: 45 mi. at 353 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania through burnout
Beacon triangulation system: No MIRAN data reducible

DATA RECOVERY

Telemeter: Failure during the important parts of flight

EXPERIMENTAL DATA

No scientific data were obtained due to the telemetering failure

COMMENTS

Rocket performance: Burnout velocity and altitude slightly below that predicted. Actual, 4500 ft/sec at 74,000 ft; predicted, 4700 ft/sec at 73,000 ft.

UPPER AIR ROCKET SUMMARY

10 February 1955

IDENTIFICATION

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 1538 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 47.3 miles

FLIGHT OBJECTIVES

Electron density measurements in the ionosphere

UPPER AIR INSTRUMENTS

See USAF-52

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon - 6 channels
Delay time measuring equipment

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and six Askania stations
- Cameras: Two Clark ribbon frame cameras
- Telescopes: One
- Beacon triangulation system: MIRAN six stations

Airborne
- Beacon: AFCRC multipurpose beacon
- Radio cutoff: Fuel cutoff - fail safe

ROCKET INFORMATION

Payload weight: 178 lb
Total extension length: 25 in.
Total rocket length (nose tip to base of tail section): 252 in.
Unfueled rocket weight: 467 lb
Unfueled rocket C.G.: 141 in. from nose tip
Gross weight at takeoff: 1150 lb
Calculated $C_{m\alpha}$ at burnout: -0.196
Calculated M_{α} at burnout: 451 ft lb/°

ROCKET PERFORMANCE

Time to burnout: 34.22 sec
Velocity at burnout: 4410 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 73,040 ft
Time to booster burnout: 2.74 sec
Velocity at booster burnout: 970 ft/sec
Altitude at booster burnout: 1327 ft
Time to zenith: 138 sec
Altitude at zenith: 47.3 miles

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 37 sec
Beacon triangulation system: MIRAN, data from 5 to 195 sec

DATA RECOVERY

Telemeter: Worked well

EXPERIMENTAL DATA

The instrumentation worked well; however, no scientific results were obtained due to the low peak altitude of the rocket

COMMENTS

Rocket performance: Rocket performance was poor. Engine sputtering occurred at burnout, as deduced from telescope film. There has been no explanation for the failure.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-54

IDENTIFICATION

29 March 1955

Rocket type: RTV-A-1a
Place of firing: Holloman Air Development Center
Time of firing: 0947 MST
Agency: Air Force Cambridge Research Center, University of Colorado
Altitude: 70 miles

FLIGHT OBJECTIVES

Study of the solar spectrum in the 870-3100A region

UPPER AIR INSTRUMENTS

Grazing incidence, Lyot type solar ultraviolet spectrograph, mounted on a University of Colorado biaxial pointing control

DATA RECOVERY INSTRUMENTS

Cameras: Camera to record sunfollower operation
Physical recovery: Parachute recovery

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and six Askania stations
- Cameras: Two ribbon frame cameras
- Telescopes: Three
- Beacon triangulation system: MIRAN
- Radar: In use

Airborne
- Beacon: AFCRC multipurpose beacon, AN/DDW-19 radar beacon
- Radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 244 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 254 in.
Unfueled rocket weight: 551 lb
Unfueled rocket C.G.: 129.5 in. from nose tip
Gross weight at takeoff: 1234 lb
Calculated $C_{m\alpha}$ at burnout: -0.287
Calculated M_{α} at burnout: 598 ft lb/$^{\circ}$

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 34.2 sec
Velocity at burnout: 4320 ft/sec
Altitude at burnout: 69,500 ft
Time to booster burnout: 2.56 sec
Velocity at booster burnout: 930 ft/sec
Altitude at booster burnout: 1400 ft
Time to zenith: 174 sec
Altitude at zenith: 112.2 km = 70 miles
Time to nose cone separation: 368.5 sec
Time to tail blowoff: 214.8 sec
Flight duration: 1415 sec
Impact coordinates: 26.65 mi. at 325 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 38 sec
Radars: S-band beacon intermittent 37 to 210 sec
Beacon triangulation system: MIRAN data intermittent

DATA RECOVERY

Physical recovery: Parachute recovery was successful, the equipment was undamaged. This is the largest Aerobee payload ever recovered by parachute.

EXPERIMENTAL DATA

Seven spectrograms were obtained in the altitude range 94 to 112 km. They covered the wavelength range 900 to 3000A with a dispersion of 41A/min. A large number of Fraunhofer lines were recorded in the region 2100 to 3000A. Below 2100A, seven emission lines were resolved. Lyman-alpha is present on all seven spectrograms. Lyman-beta was not detected, presumably because of insufficient exposure. The intensity of the continuum cannot be satisfactorily evaluated due to scattered light within the instrument.

COMMENTS

Rocket modifications: Modified nose cone for camera and sunfollower installations.
Rocket performance: Normal

REPORTS AND PAPERS

"Results of a Recent Attempt to Record the Solar Spectrum in the Region of 900-3000A," A. S. Jursa, F. J. LeBlanc, and Y. Tanaka, J. Opt. Soc. America 45:1085 (1955)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-55
AEROBEE-HI NO 1
21 April 1955

IDENTIFICATION

Rocket type: AJ11-6
Place of firing: Holloman Air Development Center
Time of firing: 0858 MST
Agency: Air Force Cambridge Research Center
Altitude: 119 miles

FLIGHT OBJECTIVES

To test rocket vehicle performance

ROCKET PERFORMANCE INSTRUMENTS

Gages for powerplant performance, skin temperature resistance thermometers, accelerometers, and an aspect camera

DATA RECOVERY INSTRUMENTS

Telemeter: AN/DKT-7 15-channel telemeter
Physical recovery: Air Force 2-stage recovery parachute
AFCRC multipurpose beacon: Six channel telemeter

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Five Mitchell and six Askania stations
Cameras: Two Clark ribbon frame cameras
Beacon triangulation system: MIRAN

Airborne
Beacon: AN/DPN-19 S-band beacon, AFCRC multipurpose beacon, command triangulation
Radio cutoff: AFCRC multipurpose beacon, fail safe oxidizer cutoff

ROCKET INFORMATION

Payload weight: 195 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 277.84 in.
Unfueled rocket weight: 471 lb
Unfueled rocket C.G.: 139.9 in. from nose tip
Gross weight at takeoff: 1377 lb
Calculated $C_{m\alpha}$ at burnout: -0.299
Calculated M_α at burnout: 198 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 41.9 sec
Velocity at burnout: 5700 ft/sec
Altitude at burnout: 110,000 ft
Time to booster burnout: 2.9 sec
Velocity at booster burnout: 860 ft/sec
Altitude at booster burnout: 1060 ft
Time to zenith: 220 sec
Altitude at zenith: 119 mi
Time to nose cone separation: 495 sec
Time to tail blowoff: 360 sec
Flight duration: 20 min
Impact coordinates: 35 mi. at 348 degrees true

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 18 sec
Radars: To 650,000 ft
Beacon triangulation system: MIRAN, data from 34 to 100 sec and at 373 sec

DATA RECOVERY

Telemeter: Excellent through 45 sec
Physical recovery: The parachute system was used successfully

COMMENTS

Rocket performance: The rocket was a complete success, in all respects performing essentially as predicted. Maximum nose cone temperatures were 350°C at Station 52, 400°C at Stat:.on 70, and 430°C at Station 34. Two temperature gages in fin 2 (one placed on leading edge 7 in. from the rocket body and the other some 3-1/2 in. into the fin from that point) recorded 445°C maximum.

A lateral accelerometer showed a maximum acceleration of 1.5 g occurring during passage through the tower.

REPORTS AND PAPERS

See USAF-57

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-57
AEROBEE-HI No. 2
23 June 1955

IDENTIFICATION

Rocket type: AJ11-6
Place of firing: Holloman Air Development Center
Time of firing: 0547 MST
Agency: Air Force Cambridge Research Center
Altitude: 38 miles

FLIGHT OBJECTIVES

To test rocket vehicle performance

ROCKET PERFORMANCE INSTRUMENTS

Powerplant gages, accelerometers, skin temperature resistance thermometers

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon, AN/DKT-7 telemeter
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Mitchell and six Askania stations
- Cameras: Two Clark ribbon frame cameras
- Beacon triangulation system: MIRAN

Airborne
- Beacon: S-band beacon; Air Force multipurpose beacon
- Radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 177 lb
Total extension length: 25 in.
Total rocket length (nose tip to base of tail section): 275.84 in.
Unfueled rocket weight: 456 lb
Unfueled rocket C.G.: 143 in. from nose tip
Gross weight at takeoff: 1377 lb
Calculated $C_{m\alpha}$ at burnout: -0.173

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 42 sec
Velocity at burnout: 3900 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 97,500 ft
Time to booster burnout: 2.19 sec
Velocity at booster burnout: 880 ft/sec
Altitude at booster burnout: 927 ft
Altitude at zenith: 38 miles
Time to tail blowoff: 172 sec by command
Impact coordinates: 10.3 mi. at 2 degrees true

BALLISTIC DATA

Theodolites and cameras: Photographic data from 0 to 88 and 320 to 380 sec
Beacon triangulation system: No data

DATA RECOVERY

Telemeter: Good
Physical recovery: good

COMMENTS

Rocket performance: Thrust chamber burnout occurred at 23 sec. The result was reduced performance and a low zenith altitude of only 38 miles

REPORTS AND PAPERS

"Flight Analysis of Two Model AJH-6 Aerobee-Hi Rockets," R. C. Much, and D. Ragusa, Aerojet General Corporation Special Report 1161, Contract AF33(600)-22153

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-56

15 June 1955

IDENTIFICATION

Rocket type: AJ10-27
Place of firing: Holloman Air Development Center
Time of firing: 1811 MST
Agency: Holloman Air Development Center
Altitude: 126 miles

FLIGHT OBJECTIVES

Special classified flight

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Nine Mitchell and six Askania stations
- Cameras: Two Clark ribbon frame cameras
- Beacon triangulation system: MIRAN

ROCKET INFORMATION

Payload weight: 112 lb
Total rocket length (nose tip to base of tail section): 247 in.
Unfueled rocket weight: 420 lb
Unfueled rocket C.G.: 130.25 in. from nose tip
Gross weight at takeoff: 1275 lb
Calculated $C_{m\alpha}$ at burnout: -0.171
Calculated M_{α} at burnout: 168 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 46.3 sec
Velocity at burnout: 5950 ft/sec
Altitude at burnout: 115,514 ft
Time to booster burnout: 2.3 sec
Velocity at booster burnout: 9300 ft/sec
Altitude at booster burnout: 900 ft
Time to zenith: 229 sec
Altitude at zenith: 126 miles
Flight duration: 460 sec
Impact coordinates: 23.2 mi. at 336 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 48 sec
Beacon triangulation system: MIRAN data from 338 to 414 sec intermittently

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-58

IDENTIFICATION

14 September 1955

Rocket type: AJ10-27
Place of firing: Holloman Air Development Center
Time of firing: 0630 MST
Agency: Air Force Cambridge Research Center, University of Michigan
Altitude: 59 miles

FLIGHT OBJECTIVES

To test the feasibility of determining Mach number by means of wind vane measurements. Rocket aspect. Micrometeorite studies.

UPPER AIR INSTRUMENTS

An acoustic micrometeorite detector flush mounted approximately two feet back from the tip of the nose cone

ROCKET PERFORMANCE INSTRUMENTS

A small metal wind vane was installed on the front section of the nose cone. The front section of the nose was canted at 34 sec after launch and the position of the wind vane was photographed by a camera in the nose cone. Aspect was measured by two horizon aspect cameras, by a photographically recorded gyro and by a a Gianinni gyro with an electrical takeoff which was telemetered.

DATA RECOVERY INSTRUMENTS

Telemeter: Bendix FM-FM telemeter for micrometeorite experiment. AFCRC multipurpose beacon.
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Mitchell and Askania stations
- Radars: In use
- Beacon triangulation system: MIRAN

Airborne
- Beacon and radio cutoff: AFCRC multipurpose beacon - oxidizer cutoff

ROCKET INFORMATION

Payload weight: 273 lb
Unfueled rocket C.G.: 117 in. from nose tip

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 42 sec
Velocity at burnout: 4230 ft/sec
Altitude at burnout: 85,411 ft
Time to zenith: 160 sec
Altitude at zenith: 59 miles
Impact coordinates: 20 mi. at 328 degrees true from launcher

DATA RECOVERY

Telemeter: The telemetered gyro aspect data were received well only at Sacramento Peak due to a shift of 2 Mc in the frequency of the telemeter

Physical recovery: Nose cone and tail cone separation did not function; the rocket disintegrated on the way down and portions were found over a quarter mile area

EXPERIMENTAL DATA

The micrometeorite detector recorded many pulses during flight. Only a portion of the pulses have the proper form for particle impact signals. It is hoped to be able to separate the valid pulses from the spurious ones by comparison with laboratory records.

COMMENTS

Rocket performance: Preliminary data show that the rocket started to roll and yaw during powered flight and went into a flat spin after burnout at 42 sec. The nose cone tip section rotated as planned, but no data were obtained from the wind vane camera. The three aspect systems appeared to function properly and gave aspect data in excellent agreement with each other.

REPORTS AND PAPERS

"Scientific Uses of Earth Satellites," J. A. Van Allen, ed., Ann Arbor:University of Michigan Press, 1956

7th International Astronautical Congress, Rome, Italy, 1946 (in press)

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

30 September 1955

Rocket type: AJ10-27
Place of firing: Holloman Air Development Center
Time of firing: 0850 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 46 miles

FLIGHT OBJECTIVES

To study the limb darkening effect on the sun

UPPER AIR INSTRUMENTS

University of Colorado sunfollower and University of Colorado ultraviolet spectrograph covering the range 900A to 2500A. A "jitter camera" was installed on the sunfollower boom to indicate accuracy of the pointing control.

DATA RECOVERY INSTRUMENTS

Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Mitchell and six Askania stations
- Cameras: Two Clark ribbon frames
- Radar: In use
- Beacon triangulation system: MIRAN

ROCKET INFORMATION

Payload weight: 225 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 273 in.
Unfueled rocket weight: 541 lb
Unfueled rocket C.G.: 137.5 in. from nose tip
Gross weight at takeoff: 1416 lb
Calculated $C_{m\alpha}$ at burnout: -0.338
Calculated M_{α} at burnout: 375 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 40.1 sec
Velocity at burnout: 4215 ft/sec
Altitude at burnout: 86,690 ft

ROCKET PERFORMANCE (Continued)

Time to booster burnout: 2.32 sec
Velocity at booster burnout: 832 ft/sec
Altitude at booster burnout: 994 ft
Time to zenith: 135 sec
Altitude at zenith: 46 miles
Time to nose cone separation: 400 sec
Time to tail blowoff: 300 sec by command
Impact coordinates: 28 mi. at 347.5 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data from 0.92 to 43.52 sec
Beacon triangulation system: MIRAN data not reducible

DATA RECOVERY

Physical recovery: The instrumentation was lowered by parachute and recovered without damage

EXPERIMENTAL DATA

Due to the low altitude no film was exposed

COMMENTS

Rocket modifications: Modified nose cone for camera and sunfollower installations

Rocket performance: The low performance was the result of burnout of the thrust chamber in flight. Because of payload and altitude requirements, high performance acid was used (18% NO_2, 1.9% H_2O). A static firing under these conditions was successful. After the flight failure it was discovered that the H_2O content was only 1.6%. This error may have caused the thrust chamber burnout.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-60

IDENTIFICATION

12 October 1955

Rocket type: AJ10-25
Place of firing: Holloman Air Development Center
Time of firing: 1800 MST
Agency: Air Force Cambridge Research Center
Altitude: 63 miles

FLIGHT OBJECTIVES

To increase the amount of sodium present at various altitudes to derive: the heights at which natural sodium emits D-lines; the equilibrium ratio of free to combined sodium; seasonal variations of the natural occurring D-lines; chemical energy available at the various altitudes; diffusion at the various altitudes; winds and turbulence.

UPPER AIR INSTRUMENTS

Two sodium vaporizers, each capable of vaporizing 1 kg of sodium over a 10-sec period of time. A monitor camera was installed looking outward and down to catch any sodium glow, and a photocell telemetered light intensity. A spectograph and night sky recording photometer were installed on Sacramento Peak.

DATA RECOVERY INSTRUMENTS

Physical recovery: Parachute system

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and eight Askania stations
Beacon triangulation system: MIRAN

Airborne
Beacon and radio cutoff: AFCRC multipurpose beacon

ROCKET INFORMATION

Payload weight: 183 lb
Total extension length: 25 in.
Total rocket length (nose tip to base of tail section): 252 in.
Unfueled rocket weight: 489 lb
Unfueled rocket C.G.: 127.3 in. from nose tip
Gross weight at takeoff: 1163 lb
Calculated $C_{m\alpha}$ at burnout: -0.25

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Velocity at burnout: 4390 ft/sec
Time to booster burnout: 2.4 sec
Velocity at booster burnout: 930 ft/sec
Altitude at booster burnout: 1200 ft
Time to zenith: 168.5 sec
Altitude at zenith: 63 miles
Time to tail blowoff: 192 sec
Impact coordinates: 23 mi. at 320 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data from 0.02 to 28.67 sec
Beacon triangulation system: MIRAN data from 6.22 to 519.22 sec

EXPERIMENTAL DATA

All instrumentation worked successfully. The first sodium vaporizer ignited at approximately 70 sec at an altitude of 190,000 ft and the second ignited at 80 sec at an altitude of 220,000 ft. A yellow glow was visible to the eye for 28 minutes, and four spectrographs were taken from Sacramento Peak. The night sky photometer recorded high sodium emission for the rest of the night. The initial bright glow appeared to be resonance excitation, but the possibility of supplementary mechanisms will have to await a study of the photometer data. The glow was observed from Amarillo, Texas, approximately 300 miles away.

COMMENTS

Rocket performance: Normal

REPORTS AND PAPERS

"The Airglow and the Aurorae," edited by E. B. Armstrong and A. Dalgarno, London: Pergamon Press, 1955, pp. 122-134

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-61

IDENTIFICATION

13 December 1955

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 1058 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 86 miles

FLIGHT OBJECTIVES

To obtain an absolute intensity measurement for Lyman-alpha and to measure solar limb darkening

UPPER AIR INSTRUMENTS

University of Colorado sunfollower and spectrograph

DATA RECOVERY INSTRUMENTS

Physical recovery: Photographic film recovered by tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Ten Mitchell and six Askania stations
Cameras: Twelve ribbon frame cameras
Beacon triangulation system: MIRAN

Airborne
Beacon and radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 222 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 273 in.
Unfueled rocket weight: 541 lb
Unfueled rocket C.G.: 138.8 in. from nose tip
Gross weight at takeoff: 1396 lb
Calculated $C_{m\alpha}$ at burnout: -0.258
Calculated M_{α} at burnout: 352 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation 340 degrees true azimuth
Time to burnout: 40.3 sec

ROCKET PERFORMANCE (Continued)

Velocity at burnout: 4820 ft/sec
Altitude at burnout: 88,000 ft
Time to booster burnout: 2.77 sec
Velocity at booster burnout: 830 ft/sec
Altitude at booster burnout: 1289 ft
Time to zenith: 200 sec
Altitude at zenith: 86 miles
Time of nose cone separation: 422 sec
Time to tail blowoff: 241 sec
Impact coordinates: 39.3 mi. 350 degrees

BALLISTIC DATA

Theodolites and cameras: Photographic data from 0.10 to 42.3 sec
Beacon triangulation system: MIRAN data to 240 sec

DATA RECOVERY

Physical recovery: Nose instrumentation recovered in excellent condition

EXPERIMENTAL DATA

The experiment was about 80% successful. The pointing control lost its elevation control at 80 miles on ascent and no data were obtained above that altitude.

The intensity of the solar Lyman-alpha was measured to be 3.0 ergs/cm^2/sec at 122 km and the half width of the line was about 0.8A.

Because of special features of the spectrograph design it was possible to measure solar limb darkening in Lyman-alpha radiation. The averaged results indicated slight limb brightening, possibly because of an appreciable increase of intensity in Lyman-alpha radiation in the solar latitudes which exhibited sunspot activity at the time of the flight.

COMMENTS

Rocket performance: Seven percent predicted altitude
Modifications to rocket: Modified nose ogive for sunseeker

REPORTS AND PAPERS

"Lyman Alpha Intensity and Solar Limb-Darkening from Rocket Spectrograms," Miller, S. C., Jr., Mercure, R., Rense, Wm. A., Astrophys. J. 124:580 (1956)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-62

IDENTIFICATION

12 March 1956

Rocket type: AJ10-25
Place of firing: Holloman Air Development Center
Time of firing: 1415 MST
Agency: Air Force Cambridge Research Center
Altitude: 59 miles

FLIGHT OBJECTIVES

To release a nitric oxide gas cloud at approximately 100 km during daylight to attempt to produce artificial sporadic E regions. Theoretical considerations indicated that a density of 3×10^6 electrons per cm^3 should be obtained in the initial gas cloud.

UPPER AIR INSTRUMENTS

Two Fiberglas spheres containing a total of 18 lb of nitric oxide gas at 3000 psi with suitable solenoid valve and timer to release gas at peak. C-3 ionospheric recorder (Holloman). A 17.38-Mc pulsed radar at Sacramento Peak. Modified C-3 ionosphere recorder in a C-97 aircraft which was flown under the cloud.

DATA RECOVERY INSTRUMENTS

Telemeter: 225-Mc, 2-channel pulse-time telemeter
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and three Askania stations
- Radar: In use
- Beacon triangulation system: MIRAN
- Doppler: Velocimeter

Airborne
- Beacon and radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 244 lb
Total extension length: 42 in.
Total rocket length (nose tip to base of tail section): 269 in.
Unfueled rocket weight: 518 lb
Unfueled rocket C.G.: 147 in. from nose tip
Gross weight at takeoff: 1235 lb
Calculated $C_{m\alpha}$ at burnout: -.0.264 ft/lb
Calculated M_α at burnout: 740 ft lb/$^\circ$

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 32.5 sec
Velocity at burnout: 4030 ft/sec
Altitude at burnout: 65,800 ft
Time to booster burnout: 2.51 sec
Velocity at booster burnout: 873 ft/sec
Altitude at booster burnout: 1200 ft
Time to zenith: 155 sec
Altitude at zenith: 59 miles
Time to nose cone separation: 455.8 sec
Altitude at tail blowoff: 290,000 ft
Flight duration: 1600 sec
Impact coordinates: 10.8 mi. at 225 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data to 41.7 sec
Radars: To 90 sec
Beacon triangulation system: MIRAN data to 411 sec

DATA RECOVERY

Physical recovery: Successful

EXPERIMENTAL DATA

The C-3 ionosphere recorder at Holloman picked up reflections from the cloud 30 sec after gas release and held it for 10 minutes. Returns were very similar to natural sporadic E.

The pulsed-radar at Sacramento Peak also tracked the NO cloud for ten minutes. An initial density of 2.75×10^6 electrons/cm^3 was reported.

The aircraft failed to get any quantitative data.

COMMENTS

Rocket performance: Normal

REPORTS AND PAPERS

"Formation of an Artificial Ion Cloud; Photoionization of NO by Solar Lyman Alpha at 95 km," Frederick F. Marms, Jerome Pressman, Leonard M. Aschenbrand, Adolph Jursa, and Murry Zelikoff, J. Chem. Phys. 25:187 (1956)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-63

IDENTIFICATION

14 March 1956

Rocket type: AJ10-25
Place of firing: Holloman Air Development Center
Time of firing: 0145 MST
Agency: Air Force Cambridge Research Center
Altitude: 66 miles

FLIGHT OBJECTIVES

To attempt to recombine atomic oxygen in the atmosphere at night by means of a gaseous catalyst, NO

UPPER AIR INSTRUMENTS

Two Fiberglas spheres containing a total of 18 lb of NO at 3000 psi. A photomultiplier photometer telemetered relative light intensity and there was a 16-mm movie camera to record intensity.

Special photometers were operated at Sacramento Peak. Super-Schmidt meteor cameras of the Harvard Meteor project at Mayhill and Sacramento Peak.

DATA RECOVERY INSTRUMENTS

Physical recovery: Parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Eight Askania stations
- Beacon triangulation system: MIRAN
- Doppler: Velocimeter

ROCKET INFORMATION

Payload weight: 209 lb
Total extension length: 42 in.
Total rocket length (nose tip to base of tail section): 269 in.
Unfueled rocket weight: 516 lb
Unfueled rocket C.G.: 146.7 in. from nose tip
Gross weight at takeoff: 1198 lb
Calculated $C_{m\alpha}$ at burnout: -0.242
Calculated M_{α} at burnout: 746 ft lb/$^{\circ}$

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 32.8 sec

ROCKET PERFORMANCE (Continued)

Velocity at burnout: 4245 ft/sec
Altitude at burnout: 66,000 ft
Altitude at booster burnout: 1100 ft
Time to zenith: 153 sec
Altitude at zenith: 66 miles
Impact coordinates: 21.2 mi. at 311 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data from 2 to 31.6 sec
Beacon triangulation system: MIRAN data from 6 to 154 sec

DATA RECOVERY

Physical recovery: Parachute did not operate

EXPERIMENTAL DATA

Upon release of the gas, a strong luminous glow appeared immediately at the release point and was estimated to be of an initial intensity of -2 visual magnitude. It gradually grew in size while diminishing in intensity until at ten minutes after release it covered an area equivalent to that of three or four moon diameters and was no longer visible to the naked eye.

This experiment was generally regarded as representing a major forward step in the study of the chemical processes in the atmosphere by direct test with the addition of selected gases.

COMMENTS

Rocket performance: Normal

REPORTS AND PAPERS

"Synthetic Atmosphere Chemiluminescence Caused by the Release of NO at 106 km," Jerome Pressman, Leonard M. Aschenbrand, Frederick F. Marmo, Adolph Jursa, and Murry Zelikoff, J. Chem. Phys. 25:187 (1956)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-64

11 April 1956

IDENTIFICATION

Rocket type: AJ10-25
Place of firing: Holloman Air Development Center
Time of firing: 1905 MST
Agency: Air Force Cambridge Research Center
Altitude: 66 miles

FLIGHT OBJECTIVES

To measure ionization in the sodium cloud and observe 5890A radiation from the trail

UPPER AIR INSTRUMENTS

Two sodium vaporizers, each containing one kilogram of sodium and timer to fire vaporizers sequentially over the region of 50 to 110 km. Stanford 17.35-Mc sporadic E detection radar at Sacramento Peak.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Tail separation, nose separation and parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Eleven Askania stations
- Radar: In use
- Beacon triangulation system: MIRAN
- Doppler: Velocimeter

Airborne
- Beacon and radio cutoff: AFCRC multipurose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 189 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 254 in.
Unfueled rocket weight: 498 lb
Unfueled rocket C.G.: 138.9 in. from nose tip
Gross weight at takeoff: 1176 lb
Calculated $C_{m\alpha}$ at burnout: -0.228
Calculated M_α at burnout: 532 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 32.8 sec
Velocity at burnout: 4300 ft/sec
Altitude at burnout: 72,000 ft
Time to booster burnout: 2.3 sec
Velocity at booster burnout: 980 ft/sec
Altitude at booster burnout: 790 ft
Altitude at zenith: 66 miles
Time to zenith: 166 sec
Impact coordinates: 33 mi. at 310 degrees true from launcher

BALLISTIC DATA

Theodolites: Askania data to 32 sec
Radar: Beacon was disabled by an explosion in the nose at the time the experiment was released. Consequently radar tracking was lost.
Beacon triangulation system: MIRAN data from 8 to 76 sec
Doppler: Velocimeter data from 1.1 to 21.5 sec

EXPERIMENTAL DATA

For some unknown reason both vaporizers fired simultaneously and there was an explosion in the nose. The altitude of sodium release will be obtained from a 3-camera triangulation network which obtained excellent photographs of the cloud. The photographs are also expected to yield excellent results of high altitude winds.

The data are still under study, and it is hoped that further information will be obtained concerning the twilight and night emission of 5890A.

COMMENTS

Rocket performance: Normal

REPORTS AND PAPERS

"A Study of Sodium Vapor Ejected into the Upper Atmosphere," J. F. Bedinger, E. R. Manring and S. N. Ghosh, J. Geophys. Res. (in press)

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

8 May 1956

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 0754 MST
Agency: Air Force Cambridge Research Center, University of Colorado
Altitude: 89 miles

FLIGHT OBJECTIVES

To photograph the solar spectrum in the region 200A to 2500A and to obtain an image of the sun in Lyman-alpha light

UPPER AIR INSTRUMENTS

University of Colorado sunfollower with a University of Colorado spectrograph and a monochromatic camera mounted on the boom

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and nine Askania stations
- Cameras: Two ribbon frame cameras
- Beacon triangulation system: MIRAN
- Dopplers: Velocimeter

Airborne
- Beacon and radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 227 lb
Total extension length: 25 in.
Total rocket length (nose tip to base of tail section): 272 in.
Unfueled rocket weight: 545 lb
Unfueled rocket C.G.: 137.5 in. from nose tip
Gross weight at takeoff: 1395 lb
Calculated $C_{m\alpha}$ at burnout: -0.260
Calculated M_α at burnout: 428 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 41 sec
Velocity at burnout: 4960 ft/sec
Altitude at burnout: 85,000 ft
Time to booster burnout: 2.65 sec
Velocity at booster burnout: 793 ft/sec
Altitude at booster burnout: 1074 ft
Altitude to zenith: 89 miles
Time to zenith: 193 sec

BALLISTIC DATA

Theodolites and cameras: Photographic data from 0.96 to 47.96 sec
Beacon triangulation system: MIRAN data from 4 to 600 sec
Doppler: Velocimeter data from 1.80 to 28.95 sec

DATA RECOVERY

Physical recovery: Spectrograph was undamaged, but the pointing control sustained moderate damage

EXPERIMENTAL DATA

The pointing control, spectrograph, and monochromatic camera all functioned well throughout flight.

Good photographs of the sun's disk in Lyman-alpha radiation were obtained, though oscillations in the elevation servo of the pointing control resulted in a slight blurring. Considerable detail in the sun's disk was obtained.

The spectrograph yielded an excellent profile of the Lyman-alpha line. The width at half height was about 1A and the width at the level of the background was about 6A. No spectra were obtained at wavelengths shorter than 1000A. This may have been due to the diminished reflection coefficient of the grating in this region.

COMMENTS

Rocket performance: Normal

REPORTS AND PAPERS

"The Sun's Disk in Lyman-Alpha Radiation," R. Mercure, S. C. Miller, Jr., W. A. Rense, and F. Stuart, Jour. Geophys. Res. 61:571-57" (1956)

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-66
AEROBEE-HI No.3
16 May 1956

IDENTIFICATION

Rocket type: AJ11-6
Place of firing: Holloman Air Development Center
Time of firing: 0840 MST
Agency: Air Force Cambridge Research Center
Altitude: 105 miles

FLIGHT OBJECTIVES

To test rocket vehicle performance

ROCKET PERFORMANCE INSTRUMENTS

Aerodynamic wind vanes on nose. Skin temperature detectors. Motor monitoring gages.

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon. 565-Mc beacon with nose tip probe antenna. 225-Mc 2-channel pulse-time modulation system.
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Two Clark ribbon frame cameras
- Radar: In use
- Beacon triangulation system: MIRAN
- Doppler: Velocimeter

ROCKET INFORMATION

Payload weight: 169 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 282 in.
Unfueled rocket weight: 428 lb
Unfueled rocket C.G.: 145.5 in. from nose tip
Gross weight at takeoff: 1329 lb
Calculated $C_{m\alpha}$ at burnout: -0.281
Calculated M_{α} at burnout: 275 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 41.4 sec
Velocity at burnout: 5600 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 101,000 ft
Time to booster burnout: 2.7 sec
Velocity at booster burnout: 826 ft/sec
Altitude at booster burnout: 1181 ft
Time to zenith: 225 sec
Altitude at zenith: 105 miles
Impact coordinates: 42 mi. at 320 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data from 0 to 56 sec
Radar: Radar data through zenith
Beacon triangulation system: MIRAN data from 2 to 580 sec

DATA RECOVERY

Telemeter: Good
Physical recovery: Thrust chamber not excessively burned. Tail good and fins found in apparent good condition. No indication of mechanical failure.

EXPERIMENTAL DATA

The wind vanes on the nose survived the flight and appear to be suitable for use in subsequent flights for determining local Mach numbers. Skin temperatures and motor performance were normal.

COMMENTS

Rocket modifications: Cylindrical tail cone, large fins
Rocket performance: The rocket engine operated at nominal thrust for approximately full duration. The rocket started yawing at approximately 25 sec and by burnout had an angle of 45 degrees to 90 degrees from the flight path. The roll rate was less than one revolution per sec. At the same time that yaw was first detected there was a distinct change in the flame - it increased in density by approximately three times.

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-67

IDENTIFICATION

13 June 1956

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 1351 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 85.6 miles

FLIGHT OBJECTIVES

Vertical incidence experiment, non-densities and space variations of same in E layer

UPPER AIR INSTRUMENTS

4.5 Mc receiver

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Two Clark ribbon frame cameras
- Radars: In use
- Beacon triangulation system: MIRAN

Airborne
- Beacon and radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 195 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 274 in.
Unfueled rocket weight: 513 lb
Unfueled rocket C.G.: 146.3 in. from nose tip
Gross weight at takeoff: 1369 lb
Calculated $C_{m\alpha}$ at burnout: -0.227
Calculated M_{α} at burnout: 200 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 39.5 sec

ROCKET PERFORMANCE (Continued)

Velocity at burnout: 4730 ft/sec
Altitude at burnout: 96,000 ft
Time to booster burnout: 2.32 sec
Altitude at booster burnout: 1000 ft
Time to zenith: 190 sec
Altitude at zenith: 85.6 miles

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 45 sec
Radar: To 250,000 ft
Beacon triangulation system: MIRAN data from 14 to 137 sec

DATA RECOVERY

Telemeter: Good
Physical recovery: Parachute recovered extensions only; nose separated at deployment

EXPERIMENTAL DATA

Data reduction underway

COMMENTS

Rocket modifications: Three antennas from nose to outer edge of fins
Rocket performance: Zenith ten percent lower than predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-68

IDENTIFICATION

18 June 1956

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 1342 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 85 miles

FLIGHT OBJECTIVES

Ionosphere (See USAF-67)

UPPER AIR INSTRUMENTS

Six-Mc transmitters

DATA RECOVERY INSTRUMENTS

See USAF-67

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Seven Clark ribbon frame cameras
- Beacon triangulation system: MIRAN

Airborne
- See USAF-67

ROCKET INFORMATION

Payload weight: 194 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 274 in.
Unfueled rocket weight: 512 lb
Unfueled rocket C.G.: 144 in. from nose tip
Gross weight at takeoff: 1376 lb
Calculated $C_{m\alpha}$ at burnout: -0.235
Calculated M_{α} at burnout: 500 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 39.6 sec
Velocity at burnout: 4760 ft/sec
Altitude at burnout: 38,000 ft

ROCKET PERFORMANCE (Continued)

Time to booster burnout: 2.5 sec
Velocity at booster burnout: 816 ft/sec
Altitude at booster burnout: 1080 ft
Time to zenith: 190 sec
Altitude at zenith: 85 miles
Impact coordinates: 27.4 mi. at 323 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 52 sec
Beacon triangulation system: MIRAN data from 2 to 290 sec

DATA RECOVERY

Telemeter: Fair
Physical recovery: Good

EXPERIMENTAL DATA

Reduction in progress

COMMENTS

Rocket modifications: Three antennas from nose cone to fins
Rocket performance: Ten percent below predicted zenith

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

21 June 1956

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 1148 MST
Agency: Air Force Cambridge Research Center, University of Utah
Altitude: 91 miles

FLIGHT OBJECTIVES

Ionosphere (See USAF-67 and -68)

UPPER AIR INSTRUMENTS

See USAF-67

DATA RECOVERY INSTRUMENTS

See USAF-67

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and seven Askania stations
- Cameras: Two Clark ribbon frame cameras
- Beacon triangulation system: MIRAN

Airborne
- See USAF-67

ROCKET INFORMATION

Payload weight: 201 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 274 in.
Unfueled rocket weight: 518 lb
Unfueled rocket C.G.: 144 in. from nose tip
Gross weight at takeoff: 1374 lb
Calculated $C_{m\alpha}$ at burnout: -0.242
Calculated M_{α} at burnout: 216 ft lb/$^{\circ}$

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 41.7 sec
Velocity at burnout: 4910 ft/sec
Altitude at burnout: 92,500 ft

ROCKET PERFORMANCE (Continued)

Time to booster burnout: 2.81 sec
Altitude at booster burnout: 1000 ft
Time to zenith: 200 sec
Altitude at zenith: 91 miles
Altitude at tail blowoff: 320,000 ft
Impact coordinates: 41.5 mi. at 337 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data from 1 to 38 sec
Radar: To 250,000 ft
Beacon triangulation system: MIRAN data from 11 to 279 sec

DATA RECOVERY

Telemeter: Fair
Physical recovery: Nose in excellent condition

EXPERIMENTAL DATA

Reduction in progress

COMMENTS

Rocket modifications: Three antennas from nose cone to fins
Rocket performance: Normal

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-70

IDENTIFICATION

26 June 1956

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 1126 MST
Agency: Air Force Research Development Center, University of Utah
Altitude: 69 miles

FLIGHT OBJECTIVES

Ionosphere (See USAF-67, -68, and -69)

UPPER AIR INSTRUMENTS

See USAF-67

DATA RECOVERY INSTRUMENTS

See USAF-67

BALLISTIC INSTRUMENTS

Firing Range
  Theodolites: Four Mitchell and seven Askania stations
  Cameras: Seven Clark ribbon frame cameras
  Beacon triangulation system: MIRAN

Airborne
  See USAF-67

ROCKET INFORMATION

Payload weight: 210 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 274 in.
Unfueled rocket weight: 526 lb
Unfueled rocket C.G.: 143.8 in. from nose tip
Gross weight at takeoff: 1382 lb
Calculated $C_{m\alpha}$ at burnout: -0.279
Calculated M_α at burnout: 385 ft lb/°

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to burnout: 40.1 sec
Velocity at burnout: 4310 ft/sec
Altitude at burnout: 83,000 ft

ROCKET PERFORMANCE (Continued)

Time to booster burnout: 2.25 sec
Velocity at booster burnout: 779 ft/sec
Altitude at booster burnout: 915 ft
Time to zenith: 172 sec
Altitude at zenith: 69 miles
Impact coordinates: 25 mi. at 335 degrees true from launcher

BALLISTIC DATA

Theodolites and cameras: Photographic data from 0 to 46 sec
Beacon triangulation system: MIRAN

DATA RECOVERY

Telemeter: Fair
Physical recovery: Failure of nose and tail to separate, probably due to external antennas

EXPERIMENTAL DATA

Reduction underway

COMMENTS

Rocket modifications: Three antennas from nose cone to fins
Rocket performance: Zenith was 15% lower than predicted

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-71

30 July 1956

IDENTIFICATION

Rocket type: AJ10-34
Place of firing: Holloman Air Development Center
Time of firing: 1756 MST
Agency: Air Force Cambridge Research Center
Altitude: 80 miles

FLIGHT OBJECTIVES

Day airglow

UPPER AIR INSTRUMENTS

Spectrophotometer

DATA RECOVERY INSTRUMENTS

Telemeter: 225-Mc FM-FM telemeter
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Two Clark ribbon frames
- Radar: In use
- Beacon triangulation system: MIRAN

Airborne
- Beacon and radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 256 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 274 in.
Unfueled rocket weight: 578 lb
Unfueled rocket C.G.: 138.7 in. from nose tip
Gross weight at takeoff: 1423 lb
Calculated $C_{m\alpha}$ at burnout: -0.26

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to zenith: 185 sec
Altitude at zenith: 80 miles
Impact coordinates: 25 mi. at 335 degrees true from launcher

Supplement
February 1958

BALLISTIC DATA

Beacon triangulation system: MIRAN data from 10 to 364 sec

DATA RECOVERY

Telemeter: Good, tape recording
Physical recovery: Tail separation did not occur; parachute tore from nose at deployment. All parts found.

EXPERIMENTAL DATA

Data reduction underway

COMMENTS

Rocket performance: Cutoff at 44 sec

UPPER AIR ROCKET SUMMARY

AEROBEE
USAF-72

IDENTIFICATION

3 August 1956

Rocket type: AJ10-25
Place of firing: Holloman Air Development Center
Time of firing: 0556 MST
Agency: Air Force Cambridge Research Center
Altitude: 1.5 miles

FLIGHT OBJECTIVES

Study of solar spectrum and atmospheric composition

UPPER AIR INSTRUMENTS

Biaxial pointing control to aim grating spectrograph toward sun, permitting photographic recording of 1000A to 3000A radiation at 50 to 95 km

DATA RECOVERY INSTRUMENTS

Telemeter: AFCRC multipurpose beacon
Physical recovery: Tail separation, nose separation and lowering by parachute

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Seven Askania stations
Cameras: Two fixed cameras
Beacon triangulation system: MIRAN

Airborne
Beacon and radio cutoff: AFCRC multipurpose beacon, oxidizer cutoff

ROCKET INFORMATION

Payload weight: 228 lb
Total extension length: 27 in.
Total rocket length (nose tip to base of tail section): 254 in.
Unfueled rocket weight: 535 lb
Unfueled rocket C.G.: 130.5 in. from nose tip
Gross weight at takeoff: 1198 lb
Calculated $C_{m\alpha}$ at burnout: -0.28

ROCKET PERFORMANCE

Firing angle: 87 degrees elevation, 340 degrees true
Time to zenith: 20 sec
Altitude at zenith: 1.5 miles
Flight duration: 160 sec

BALLISTIC DATA

Theodolites: Askania to 45 sec

COMMENTS

Rocket performance: Fail safe cutoff at 4.6 sec apparently from tube filament failure

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-1

IDENTIFICATION

9 December 1948

Agency: Signal Corps Engineering Laboratory (University of Michigan).
Time: 1538 MST.
Altitude: 56.9 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air-sampling bottles with timer and pyrotechnic opening and closing devices.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as single channel system.
Physical recovery: Tail section separation with prima cord detonated by beacon or timer command.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Two Askania stations.
Cameras: Two Bowen-Knapp stations.
Telescopes: Two stations.
Radar: Two modified SCR-584 S-band stations.

Airborne
Beacon: AN/APN-55 S-band transponder.
Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time of booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 47 sec.
Altitude at burnout: 16.2 miles.
Velocity at burnout: 3634 ft. per sec.
Time to zenith: 163 sec.
Altitude at zenith: 56.9 miles.
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 188 lbs.
Unfueled rocket weight: 469 lbs.
Unfueled rocket C.G.: 115 in.
Gross weight at takeoff: 1116 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 47.0 sec.
Cameras: Trajectory 0 to 3 sec.
Telescopes: Tracked rocket to shortly after burnout.
Radar: Trajectory data 0 to 94 sec.

DATA RECOVERY

Telemeter: Partial record obtained.
Physical recovery: Sampling bottles found four months after firing in fair condition.

EXPERIMENTAL DATA

Composition: No data obtained; two bottles leaked at pressures gages, and the third failed to operate.

COMMENTS

Rocket: Nose cone modified by installation of three sets of air intake and exhaust scoops lying close to skin.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," by L. M. Jones and H. W. Neill, Final Progress Report, Contract W-36-039 sc-32307. Engineering Research Institute, University of Michigan.

Preliminary Report, Radar Data, SCEL-WSPG, 9 December 1948, Numerical and Graphical Data on Aerobee Round No. SC-1.

Roll Data, Numerical and Graphical, prepared by Ballistic Data Section, BRL, WSPG.

Preliminary Report, Bowen-Knapp Camera Observations of Aerobee SC-1, Numerical and Graphical Data, prepared by BRL-APG.

Preliminary Report, Askania Camera Observations of Aerobee SC-1, Numerical and Graphical Data, prepared by BRL-APG.

"Panel Report No. 19," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 5 January 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-2

2 June 1949

IDENTIFICATION

Agency: Signal Corps Engineering Laboratory (University of Michigan).
Time: 0610 MST.
Altitude: 48.7 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air-sampling bottles with timer and pyrotechnic opening and closing devices.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as a single channel system.
Physical recovery: Tail section separation with prima cord detonated by beacon or timer command.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Two Mitchell and three Askania stations.
Cameras: Two Bowen-Knapp stations.
Telescopes: Four stations.
Radar: One modified SCR-584 S-band station.
Sound ranging: Six pickup microphones.

Airborne
Beacon: AN/APN-55 S-band radar beacon.
Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle:
Time of booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time at burnout: 42.35 sec.
Altitude at burnout: 15 miles.
Velocity at burnout: 3516 ft. per sec.
Time to zenith: 147 sec.
Altitude at zenith: 48.7 miles.
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 208.5 lbs.
Unfueled rocket weight: 490 lbs.
Unfueled rocket C.G.: 114.5 inches.
Gross weight at takeoff: 1137 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 50.1 sec., Mitchell trajectory data 12 to 44 sec.
Cameras: Trajectory data 0 to 3.5 sec.
Telescopes: Attitude data 0 to 44 sec., roll data 3.7 to 18 sec.
Radar: Trajectory data 0 to 67 sec.

DATA RECOVERY

Telemeter: No data received from beacon pulse widening system.
Physical recovery: Two sampling bottles recovered in good condition, third bottle damaged at impact.

EXPERIMENTAL DATA

Composition: Samples obtained in intervals 29.9 miles to 32.3 miles, and 32.2 miles to 34.3 miles. Charcoal adsorption analyses for the ratios He/N_2+A and a/N_2 showed no increase over ground level values.

COMMENTS

Rocket performance: Tail cone blowoff occurred prematurely at 76 sec.
Rocket modifications: Three sets of air intake scoops and exhausts installed on nose cone. Nose cone modified into two sections to improve access to instrumentation, and seals improved to prevent air leakage from contaminating samples.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," by L. M. Jones and H. M. Neill, Final Progress Report, Contract W-36-039 sc32307, Engineering Research Institute, University of Michigan.
Preliminary Radar Data, prepared by SCEL Beacon Radar Unit and BRL, WSPG, Numerical and Graphical Data for Aerobee SC-2.
BRL Technical Note No. 34, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-2.
BRL Technical Note No. 44, APG; Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-2.
BRL Technical Note No. 115, APG; Numerical and Graphical Attitude Data from Telescopes I, II, III, IV Observing Aerobee SC-2.
BRL Technical Note No. 121, APG; Numerical and Graphical Trajectory Data from Mitchell and Askania Observations of Aerobee SC-2.
"Panel Report No. 19," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 5 January 1949.
"Panel Report No. 21," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 3 August 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-3

6 December 1949

IDENTIFICATION

Agency: Signal Corps Engineering Laboratory (University of Michigan).
Time: 1132 MST.
Altitude: 40.3 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air-sampling bottles with timer and pyrotechnic opening and closing devices.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of the radar beacon used as a single channel system.
Physical recovery: Separation of tail section with prima cord; separation of the nose cone section with prima cord and blasting caps. Nose cone lowered by parachute.

BALLISTIC INSTRUMENTS

Firing range
- Theodolites: Three Mitchell and seven Askania stations.
- Cameras: Three Bowen-Knapp stations.
- Telescopes: Four stations.
- Radar: Two modified SCR-584 S-band stations.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55 S-band transponder.
- Radio cutoff: AN/DRW-3 FM radio control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 3.9 degrees North, 2 degrees East.
Time of booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.4 sec.
Altitude at burnout: 14.3 miles.
Velocity at burnout: 2954 ft. per sec.
Time to zenith: 137 sec.
Altitude at zenith: 40.3 miles.
Time to blowoff: 147.8 sec.
Altitude at blowoff: 40 miles.
Flight duration:
Impact coordinates: 17.1 miles North and 8.3 miles West.
Payload weight: 207 lbs.
Unfueled rocket weight: 493 lbs.
Unfueled rocket C.G.: 127.5 in.
Gross weight at takeoff: 1141 lbs.

BALLISTIC DATA

Theodolites: Trajectory data from 0.75 to 61.4 sec., roll data from 3.0 to 43.9 sec.
Cameras: Trajectory data from 0.2 to 3.8 sec.
Telescopes: Attitude and yaw data 0 to 142 sec.
Radar: Trajectory data from 0 to 147.5 sec.

DATA RECOVERY

Telemeter: Good record obtained of pulse widening.
Physical recovery: Sample bottles recovered by parachute in excellent condition.

EXPERIMENTAL DATA

Composition: One sample obtained in altitude interval 31.3 miles to 33.2 miles. Charcoal adsorption analysis for the ratios He/N_2-A and A/N_2 showed no increase over ground level values. Negligible contamination from nose cone gas was obtained.

COMMENTS

Rocket performance: Zenith altitude was 18.6 miles below predicted altitude for payload carried, although burning time was apparently normal. Some of this loss may be ascribed to increased drag caused by the air intake and exhaust scoops on the nose cone.

Experiments: Nose cone sealing was improved and filled with radioactive CO_2 at an altitude of 18.9 miles to check for contamination of air samples by leakage of gas from the nose cone.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes", by L. M. Jones and H. W. Neill, Final Progress Report, Contract W-36-039-sc-32307, Engineering Research Institute, University of Michigan.

BRL Technical Note 100, Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-3.

Roll Data, Numerical and Graphical, prepared by BRL, WSPG.

Preliminary Radar Data, Numerical and Graphical, prepared by SCEL Ballistic Radar Unit, WSPG.

BRL Technical Note 154, APG; Numerical and Graphical Trajectory Data from Mitchell Observations of Aerobee SC-3.

BRL Technical Note 163, APG; Numerical and Graphical Trajectory Data from Askania Observations of SC-3.

First Report of Test of Aerobee SC-3 and SC-7, L. M. Blanchett, Aerobee Project Officer.

"Panel Report No. 23," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 February 1950.

Weather Data, prepared by Air Weather Detachment, WSPG.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-4

21 July 1949

IDENTIFICATION

Agency: Signal Corps Engineering Laboratory (University of Michigan).
Time: 0901 MST.
Altitude: 47.3 miles.

UPPER AIR INSTRUMENTS

Solar radiation: Two X-ray photographic film detectors with metal foil filters.
Composition: Three evacuated air sampling bottles with timer and pyrotechnic opening and closing devices.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as one channel system.
Physical recovery: Separation of tail section with prima cord, and separation of the nose section with prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Two Mitchell and two Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified S-band stations.
Impact location: Impact Point Predictor.

Airborne
Beacon: AN/APN-55 (XE-3) S-band transponder.
Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 4.0 degrees North and 2.4 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 46.0 sec.
Altitude at burnout: 15.9 miles.
Velocity at burnout: 3230 ft. per sec.
Time to zenith: 145 sec.
Altitude at zenith: 47.3 miles.
Time to blowoff: 172 sec.
Altitude at blowoff: 45.2 miles.
Flight duration:
Impact coordinates: 35 miles North and 7.6 miles East.
Payload weight: 247 lbs.
Unfueled rocket weight: 538 lbs.
Unfueled rocket C.G.: 121.2 inches.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 50 sec.
Cameras: Trajectory data 0 to 4 sec.
Telescopes: Attitude data 18 to 42 sec.
Radar: No data, beacon failed.

DATA RECOVERY

Telemeter: No data due to beacon failure.
Physical recovery: Nose cone separation and parachute ejection did not occur, two samples bottles recovered in good condition, third damaged; X-ray detectors recovered.

EXPERIMENTAL DATA

Composition: Air samples obtained in altitude interval 31.9 miles to 36.5 miles. Charcoal adsorption analyses for the ratios He/N_2-A and A/N_2 showed no increase over ground levels.

Solar radiation: No data.

COMMENTS

Rocket performance: Zenith altitude 1.2 miles less than predicted.

Rocket modifications: Air intake and exhaust scoops on nose cone; parachute contained in nose cone extension.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," by L. M. Jones and H. W. Neill, Final Progress Report, Contract No. W-36-039-sc-32307, Engineering Research Institute, 31 October 1950.

First Report on Test of Aerobee SC-4, L. M. Blanchett, Aerobee Project Officer.

BRL Technical Note 48, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-4.

BRL Technical Note 66, APG; Numerical and Graphical Trajectory Data from Mitchell Observations of Aerobee SC-4.

BRL Technical Note 79, APG; Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-4.

BRL Technical Note 118, APG; Numerical and Graphical Attitude Data from Telescope Observations of Aerobee SC-4.

"Panel Report No. 21," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 3 August 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-5

20 September 1949

IDENTIFICATION

Agency: Signal Corps Engineering Laboratory (University of Michigan).
Time: 1003 MST.
Altitude: 36.4 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air sampling bottles with timer and pyrotechnic opening and closing devices.
Solar radiation: Two X-ray photographic detectors with metal foil filters. (NRL)

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as single channel system.
Physical recovery: Separation of tail section with prima cord; separation of nose section with prima cord and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing range
- Theodolites: Two Mitchell and eight Askania stations.
- Cameras: Two Bowen-Knapp stations.
- Telescopes: Two stations.
- Radar: Two modified SCR-584 S-band stations.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55 S-band transponder.
- Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 2.8 degrees North and 0.1 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 40.2 sec.
Altitude at burnout: 12.9 miles.
Velocity at burnout: 2810 ft. per sec.
Time to zenith: 120 sec.
Altitude at zenith: 36.4 miles.
Time to blowoff: 148.5 sec.
Altitude at blowoff: 24.7 miles.
Flight duration:
Impact coordinates: Main body-14.5 miles North and 0.3 miles West; parachute 13.8 miles North and 0.46 miles West.
Payload weight: 242 lbs.
Unfueled rocket weight: 532 lbs.
Unfueled rocket C.G.: 122.7 inches.
Gross weight at takeoff: 1180.5 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 4.2 to 88.5 sec., attitude data 0 to 86.5 sec.
Cameras: Trajectory data 0.46 to 4 sec.
Telescopes: Attitude data 0 to 109 sec.
Radar: Trajectory data 5 to 123 sec.

DATA RECOVERY

Telemeter: Satisfactory results.
Physical recovery: X-ray detectors recovered, three air sample bottles recovered in excellent condition, one bottle had an imperfect seal.

EXPERIMENTAL DATA

Composition: Air samples obtained in intervals 26 to 27.8 miles and 27.8 to 29.6 miles. Charcoal adsorption analysis for the ratios He/N_2-A and A/N_2 showed no increase over ground level values.

Solar radiation: No data.

COMMENTS

Rocket performance: Burning ended 4.8 sec. early; zenith altitude 13.6 miles lower than predicted.

Rocket modifications: Nose cone extension used and three sets of air scoops and exhausts installed on nose cone.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes" by L. M. Jones and H. W. Neill, Final Progress Report, Contract No. W-36-039-sc-32307, Engineering Research Institute, University of Michigan.

Preliminary Radar Data, Numerical and Graphical, prepared by SCEL Ballistic Radar Unit and BRL-WSPG for Aerobee SC-5.

First Report on Test of Aerobee SC-5, L. M. Blanchett, Aerobee Project Officer.

BRL Technical Note 81, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-5.

BRL Technical Note No. 82, APG; Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-5.

Roll Data from Aerobee SC-5, prepared by BRL-WSPG.

Ballistic Wind Data for Aerobee SC-5, prepared by 19th Weather Squadron, 2103rd Air Weather Group, WSPG.

"Panel Report No. 22," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 26 October 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-6

3 March 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories.
Time: 1736 MST.
Altitude: 45 miles.

UPPER AIR INSTRUMENTS

Pressure-Temperature: Nine grenades with four lb. charges. Four photocells to detect explosion. Grenades to be ejected and exploded at four sec. intervals. Temperature determination by determining velocity of sound.

DATA RECOVERY INSTRUMENTS

Telemeter: Four channel Melpar FM-FM system.
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing range
- Theodolites: Three Mitchell and seven Askania stations.
- Cameras: Three Bowen-Knapp stations.
- Telescopes: Three stations.
- Radar: Two modified SCR-584 S-band stations.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55(XE-3) S-band transponder.
- Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 2.7 degrees North and 0.2 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 45.2 sec.
Velocity at burnout: 3100 ft. per sec.
Altitude at burnout: 14.7 miles.
Time to zenith: 145 sec.
Altitude at zenith: 45 miles.
Time to blowoff: 167.8 sec.
Altitude at blowoff: 43.4 miles.
Flight duration: 500 sec.
Impact coordinates: 29.6 miles North and 5.4 miles East.
Payload weight: 232 lbs.
Unfueled rocket weight: 523 lbs.
Unfueled rocket C.G.: 122.3 inches.
Gross weight at takeoff: 1171 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 194.9 sec.
Cameras: Records from three cameras.
Telescopes: Attitude data 0 to 111 sec.
Radar: Trajectory data 0 to 81 sec.

DATA RECOVERY

Telemeter: Good record 0 to 167.8 sec.
Physical recovery: Rocket recovered in damaged condition, five grenades not ejected were exploded.

EXPERIMENTAL DATA

Pressure-Temperature: No data obtained.

COMMENTS

Rocket performance: Roll rate about 21 rpm from 1.5 sec. to 20 sec., increasing to 48 rpm at 45 sec., decreasing to 36 rpm at 95 sec.

Experiments: Inaccuracies of radar and Askania positions too great to permit worthwhile temperature determinations.

REPORTS AND PAPERS

"Preliminary Report, Radar Data, Aerobee Missile Round No. SC-6," SCEL Field Station No. 1.

"First Report on Signal Corps Aerobee, Round No. SC-6, and Seventh Report under Parent Project Signal Corps," Ordnance Department, WSPG, 3 May 1950.

Letter of Installation for Aerobee SC-6, DA Project No. 3-36-07-051, SigC Project 745A-1, 12 Jan. 1950, SCEL, Ft. Monmouth, N. J.

"Panel Report No. 24," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 20 April 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-7

IDENTIFICATION

6 December 1949

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1716 MST.
Altitude: 37.3 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air sample bottles with timer and pyrotechnic opening and closing devices. $C^{14}O_2$ contaminator technique employed.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as a one channel system.
Physical recovery: Separation of tail section with prima cord; separation of nose section with pyrotechnic pistons, nose cone lowered by parachute.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Three Mitchell and seven Askania stations.
Cameras: Two Ballistic and three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified SCR-584 S-band stations.
Impact location: Impact Point Computer.

Airborne
Beacon: AN/APN-55 S-band transponder.
Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 4.2 degrees North and 2.4 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 43.5 sec.
Altitude at burnout: 13.9 miles.
Velocity at burnout: 2930 ft. per sec.
Time to zenith: 133 sec.
Altitude at zenith: 37.3 miles.
Time to blowoff: 146.8 sec.
Altitude at blowoff: 37.3 miles.
Flight duration:
Impact coordinates: 12.2 miles North and 3.8 miles East.
Payload weight: 220 lbs.
Unfueled rocket weight: 508 lbs.
Unfueled rocket C.G.: 125.7 inches.
Gross weight at takeoff: 1156 lbs.

BALLISTIC DATA

Theodolites: Trajectory data from 1.2 to 37 sec. and 72.5 to 161.5 sec.
Cameras:
Telescopes: Attitude data 91 to 148 sec.
Radar: Trajectory data 0 to 146 sec.

DATA RECOVERY

Telemeter: Good record from beacon:
Physical recovery: Sample bottles recovered in excellent condition.

EXPERIMENTAL DATA

Composition: Air samples obtained in the intervals 26.4 miles to 27.9 miles, and 29.9 miles to 31.6 miles. Charcoal adsorption analyses of the samples for ratios He/N_2-A and A/N_2

EXPERIMENTAL DATA (continued)

showed no increase over ground level values. Radioactive carbon dioxide contamination test did not operate.

COMMENTS

Rocket performance: Zenith altitude 11.6 miles lower than predicted, loss may be ascribed to shortened burning time and drag from airscoops.
Rocket modifications: Three sets of air intake and exhaust scoops installed on nose cone.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," by L. M. Jones and H. W. Neill; Final Progress Report, Contract No. W-36-039-sc-32307, Engineering Research Institute, University of Michigan.
BRL Technical Note 200, APG; Numerical and Graphical Data of Trajectory Observations, by Mitchell of Aerobee SC-7.
BRL Technical Note 198, APG; Numerical and Graphical Attitude Data from Telescope Observations of Aerobee SC-7.
BRL Technical Note 165, APG; Numerical and Graphical Trajectory Data from Askania observations of Aerobee SC-7.
Preliminary Radar Data, Numerical and Graphical, prepared by SCEL Ballistic Radar Unit, WSPG.
First Report of Test of Aerobee SC-3 and SC-7, L. M. Blanchett, Aerobee Project Officer.
Weather Data, prepared by Air Weather Detachment, WSPG.
"Panel Report No. 23," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 February 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE SC-8

14 July 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories.
Time: 0139 MST.
Altitude: 43 miles.

UPPER AIR INSTRUMENTS

Pressure-Temperature: Temperature determination by measuring the velocity of sound. Rocket carried nine grenades containing four pound high explosive charges and eight photoelectric cells to detect the explosion of grenades after ejection. Grenades ejected at eight second intervals.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Tail section separation with prima cord.

BALLISTIC INSTRUMENTS

Firing range
- Theodolites: Three Mitchell and three Askania stations.
- Cameras: Three Ballistic and three Bowen-Knapp stations.
- Telescopes: Three stations.
- Radar: Two modified SCR-584 S-band stations.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55(XE-3) S-band transponder.
- Radio cutoff: AN/DRW-3(XE-1) FM control receiver for fail safe fuel cutoff.
- Other: SCEL miniature FM control receiver, AN/DRW-3(XE-2) for flight test.

Other Instruments
- Three wide view cameras used as check on Ballistic cameras. Sound ranging set GR3-C employed to record explosion sound wave arrival on ground. Flash detector employed at Station C to determine exact time of grenade bursts.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 43 sec.
Altitude at burnout: 14.7 miles.
Velocity at burnout: 3300 ft. per sec.
Time to zenith: 140.5 sec.
Altitude at zenith: 43.0 miles.
Time to blowoff: 166.7 sec.
Altitude at blowoff: 40 miles.
Flight duration:
Impact coordinates: 11.98 miles North and 2.84 miles East.
Payload weight: 272 lbs.
Unfueled rocket weight: 563 lbs.
Unfueled rocket C.G.: 122.7 inches.
Gross weight at takeoff:

BALLISTIC DATA

Theodolites: Trajectory data 0 to 29 sec.
Cameras: Operated satisfactorily, no data reduced.
Telescopes: Images to 31 sec., no data reduced.
Radar: Trajectory data 0 to 165 sec.
Other: One wide angle camera produced excellent data.

DATA RECOVERY

Telemeter: Good record 0 to 166 sec.
Physical recovery: Rocket body and nose cone fell in same area, nose badly damaged. Four grenades remained in nose, destroyed with explosives when found.

EXPERIMENTAL DATA

Temperature-pressure: Mean temperature of four layers between 19 miles and 38 miles obtained.

COMMENTS

Experiments: Not all grenades ejected although squib firing voltages applied. Good sound ranging data, but no useful results from flash detector.
Cutoff: Miniature cutoff receiver operation satisfactory.

REPORTS AND PAPERS

"Aerobee Missile Round No. SC-8," Radar Operations Report, SCEL Field Station No. 1, White Sands Proving Ground, undated.
"Preliminary Report, Upper Air Atmosphere Experiments, Aerobee SC-8"; SCEL Field Station No. 1, White Sands Proving Ground, undated.
Grenade Coordinates, Aerobee SC-8, Based on Ballistic Camera Flashes, prepared by Ballistic Research Laboratories, Aberdeen Proving Ground, Md., dated 16 October 1950.
Letter of Installations for Aerobee SC-8, DA Project No. 3-36-07-051, SigC Project 745A-1, dated 12 June 1950.
"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-9

21 February 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1754.5 MST.
Altitude: 30.5 miles.

UPPER AIR INSTRUMENTS

Solar radiation: Three soft X-ray photographic detectors with metal foil filters.
Composition: Three evacuated air sampling bottles with timer and pyrotechnic opening and closing devices. $C^{14}O_2$ contaminator technique used.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as single channel system.
Physical recovery: Separation of tail section with prima cord; separation of nose section with pyrotechnic piston charges and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing range
- Theodolites: Three Mitchell and nine Askania stations.
- Cameras: Three Bowen-Knapp stations.
- Telescopes: Four stations.
- Radar: Two modified SCR-584 S-band radars.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55 S-band transponder.
- Radio cutoff: AN/DRW-3 FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 4.1 degrees North and 2.3 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 40.5 sec.
Altitude at burnout: 12.2 miles.
Velocity at burnout: 2530 ft. per sec.
Time to zenith: 119.3 sec.
Altitude at zenith: 30.5 miles.
Time to blowoff: 166.6 sec.
Altitude at blowoff: 22.9 miles.
Flight duration:
Impact coordinates: 14 miles North and 2.1 miles West.
Payload weight: 196 lbs.
Unfueled rocket weight: 487 lbs.
Unfueled rocket C.G.: 128.5 inches.
Gross weight at takeoff: 1135 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 251.6 sec.
Cameras:
Telescopes: Attitude data 12 to 165.5 sec.; roll data 10 to 130 sec.
Radar: Trajectory data 0 to 165.5 sec.

DATA RECOVERY

Telemeter: Record from 0 to 99.4 sec.
Physical recovery: All three sample bottles recovered in excellent condition.

EXPERIMENTAL DATA

Composition: No data, two of the bottles did not operate and the third developed a leak. Contaminator failed to operate.

COMMENTS

Rocket performance: Burning period 5 sec. short and zenith altitude 29.5 miles less than predicted.
Ballistic data: Mitchell theodolites tracked parachute 173 to 185 sec.; and telescopes tracked parachute 190 to 330 sec.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitude," by L. M. Jones and H. W. Neill; Final Progress Report, Contract No. W-36-039-sc-32307, Engineering Research Institute, University of Michigan.
BRL Technical Note 226, APG; Numerical and Graphical Trajectory Data from Mitchell Observations of Aerobee SC-9.
BRL Technical Note 261, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-9.
First Report on Test of Aerobee SC-9, L. M. Blanchett, Aerobee Project Officer.
Weather Data, prepared by Air Weather Detachment, WSPG.
Preliminary Ballistic Instrumentation Report on Aerobee SC-9, by L. G. Smith, Major, Deputy Chief, Ord. Dept.
Roll Data, Numerical and Graphical, prepared by Ballistic Data Unit, WSPG.
Preliminary Radar Data, Numerical and Graphical, prepared by SCEL Ballistic Radar Unit, WSPG. Trajectory Data on Aerobee SC-9.
Parachute Numerical Data from Mitchell (C and E) and Telescope (II and III) Observations of Aerobee SC-9.
"Panel Report No. 24," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 20 April 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-10

10 October 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories.
Time: 2100 MST.
Altitude: 50 miles.

UPPER AIR INSTRUMENTS

Temperature: Temperature determination by measuring the velocity of sound. Seven grenades containing 4 lbs. high explosive charges and eight photoelectric cells to detect the explosion of grenades after ejection. Grenades ejected at equal time intervals.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Tail section separation with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Askania stations.
Cameras: Four Ballistic and two Bowen-Knapp stations.
Telescopes: None.
Radar: Two modified SCR-584 S-band radars.
Impact location: Impact Point Computer.

Airborne
Beacon: None.
Radio cutoff: AN/DRW-3(XE-1) FM control receiver for fail safe fuel cut off.

Other:
Cameras: Five wide view stations to supplement the Ballistic cameras for photographing grenade flashes.
Sound ranging: Set GR3-C to record arrival time of grenade bursts.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 41 sec.
Altitude at burnout:
Velocity at burnout: about 3285 ft. per sec.
Time to zenith:
Altitude at zenith: 50 miles.
Time to blowoff: 187.5 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates: 17.5 miles North and 1.5 East.
Payload weight: 215 lbs.
Unfueled rocket weight: 504 lbs.
Unfueled rocket C. G.: 128.5 inches.
Gross weight at takeoff: 1127 lbs.

BALLISTIC DATA

Theodolites: Images recorded to 38.4 sec.
Cameras: Images recorded for 5.2 sec. by Bowen-Knapp, good images and all grenade bursts recorded by Ballistic cameras.
Radar: Rocket tracked from skin reflection for 30 to 40 sec.
Other: Good records obtained from three cameras and sound ranging set.

DATA RECOVERY

Telemeter: Good record.
Physical recovery: All parts recovered except tail section; nose and tank sections severely damaged at impact.

EXPERIMENTAL DATA

Temperature: Mean temperatures of six layers between 27.7 and 50.4 miles obtained.

COMMENTS

Rocket performance: Good performance although jet images not visible after forty sec. Fuel tank pierced by fragments from grenades.
Experiment: All grenades ejected and detonated at altitudes within 10% of preset program.

REPORTS AND PAPERS

"First Report on Test of Signal Corps Aerobees, Rounds No. SC-10 and SC-12 and Tenth Report under Parent Project Signal Corps," Ordnance Corps, White Sands Proving Ground, 29 Jan. 1951.
Grenade Coordinates, Aerobee SC-10, Based on Ballistic Camera Flashes, Prepared by Ballistic Research Laboratories, Aberdeen Proving Ground.
"Radar Operations Report, Aerobee Missile Round No. SC-10," SCEL Field Station No. 1, White Sands Proving Ground, undated.
Letter of Installation for SC-10 and SC-12, DA Project No. 3-36-07-051, Signal Corps Project 745A-O, 7 Sept. 1950.
"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.
"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 31 January 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-11
25 April 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1811 MST.
Altitude: 61.8 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air sampling bottles with timer and pyrotechnic opening and sealing devices.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as a one channel system.
Physical recovery: Tail section separation by prima cord; nose cone separation by pyrotechnic piston charges and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Three Mitchell and eight Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Three stations.
Radar: Two modified SCR-584 S-band radars.
Impact location: Impact Point Computer.

Airborne
Beacon: AN/APN-55 S-band transponder.
Radio cutoff: AN/DRW-3 FM control receiver in fail safe status.

ROCKET PERFORMANCE

Firing angle: 4.2 degrees North and 2.5 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 42.8 sec.
Altitude at burnout: 16.8 miles.
Velocity at burnout: 3832 ft. per sec.
Time to zenith: 166 sec.
Altitude at zenith: 61.8 miles.
Time to blowoff: 166.5 sec.
Altitude at blowoff: 61.8 miles.
Flight duration:
Impact coordinates: Main body - 18.1 miles North and 4.5 miles East; nose cone - 18.8 miles North and 5.9 miles East.
Payload weight: 141 lbs.
Unfueled rocket weight: 432 lbs.
Unfueled rocket C.G.: 135.2 inches.
Gross weight at takeoff: 1080 lbs.

BALLISTIC DATA

Theodolites: Mitchell trajectory data 0 to 47 sec., Askania trajectory data 31.8 to 62.3 sec.
Cameras: Bowen-Knapp trajectory data 0 to 3.5 sec.
Telescopes: Attitude and yaw data 5.5 to 58.5 sec.
Radar: Trajectory data 0 to 147 sec.

DATA RECOVERY

Telemeter: Partial record, pulse widening signals incomplete.
Physical recovery: Parachute functioned improperly, sample bottles badly bent at impact although had no visible punctures.

EXPERIMENTAL DATA

Composition: No samples obtained because openers and sealers failed.

COMMENTS

Rocket performance: 3.5 miles loss in altitude from predicted seems to be typical Aerobee performance. Predicted value of 65.3 miles based on drag due to nose modification as equivalent to 10 lbs. additional payload.

Rocket modifications: Aerobee nose cone used with extension and truncated 45 inches above its base. An air tight brass cone with ejectable tip (12 in. length) was mounted in place of the truncated section with four 4-in. standoff tubes. Three of the tubes were ported and fitted with spring loaded sleeves. The four-inch gap allowed air to flush through the tubes before sampling began.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Progress Report No. 17, Contract No. W-36-039-sc-32307, Engineering Research Institute, University of Michigan.
"Atmospheric Phenomena at High Altitudes," by L. M. Jones and H. W. Neill; Final Progress Report, Contract No. W-36-039-sc-32307.
First Report on Test of Aerobee SC-11, L. M. Blanchett, Aerobee Project Officer.
Weather Data, prepared by Air Weather Detachment, WSPG.
BRL Technical Note 271, APG; Numerical and Graphical Attitude and Yaw Data from Telescope Observations of Aerobee SC-11.
BRL Technical Note 270, APG; Numerical and Graphical Trajectory Data from Mitchell Observations of Aerobee SC-11.
BRL Technical Note 246, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-11.
Preliminary Ballistics Instrumentation Report on Aerobee SC-11, BRL, WSPG.
BRL Technical Note 180, APG; Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-11.
Preliminary Radar Data; Numerical and Graphical, prepared by SCEL Ballistic Radar Unit, WSPG.
"Panel Report No. 25," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 13 and 14 June 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-12

17 October 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories
Time: 2130 MST
Altitude: 53.2 miles

UPPER AIR INSTRUMENTS

Temperature: Temperature determination by measuring velocity of sound. Seven grenades with four pound high explosive charges to be ejected and exploded, with eight photocells to detect explosions.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Tail section separation with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Askania stations.
Cameras: Four Ballistic and two Bowen-Knapp stations.
Radar: Two modified SCR-584 S-band radars.
Impact location: Impact Point Computer.

Airborne
Radio cutoff: AN/DRW-3 (XE-1) FM control receiver in fail safe status.

Other
Cameras: Five wide view stations to supplement the Ballistic cameras in photographing grenade flashes.
Sound ranging: Set GR3-C to record arrival time of grenade bursts.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout:
Altitude at burnout:
Velocity at burnout:
Time to zenith:
Altitude at zenith: 53.2 miles.
Time to blowoff: 179.1 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates: 11 miles North and 1.5 miles East
Payload weight: 215 lbs.
Unfueled rocket weight: 505 lbs.
Unfueled rocket C. G.: 129 inches.
Gross weight at takeoff: 1128 lbs.

BALLISTIC DATA

Theodolites: Askania images recorded to about 35 sec.
Cameras: No Bowen-Knapp images after 4.9 sec.; good records from four Ballistic stations.
Radar: Intermittent reflected signal received for about 35 sec.
Other: Good results from three wide angle cameras, no data from sound ranging recorder.

DATA RECOVERY

Telemeter: Good records obtained.
Physical recovery: Nose cone recovered.

EXPERIMENTAL DATA

Temperature: No data obtained due to sound ranging failure, all grenades fired.

REPORTS AND PAPERS

"First Report on Test of Signal Corps Aerobees, Rounds No. SC-10 and SC-12 and Tenth Report under Parent Project Signal Corps," Ordnance Corps, WSPG, 29 January 1951.

"Radar Operations Report, Aerobee Missile Round No. SC-12", SCEL Field Station No. 1, WSPG, undated.

Letter of Installation for SC-10 and SC-12, DA Project No. 3-36-07-051, Signal Corps Project 745A-0, 7 September 1950.

"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.

"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-13

27 October 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 0630 MST.
Altitude: 49.8 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air sampling bottles with timer and mechanical openers and pyrotechnic sealers. Radioactive carbon dioxide contaminator technique used.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as a single channel system.
Physical recovery: Separation of tail section with prima cord and separation of nose cone with pyrotechnic pistons and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and eight Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Five stations.
Radar: Modified SCR-584 S-band stations.

Airborne
Beacon: AN/APN-55 S-band transponder.
Radio cutoff: AN/DRW-3 FM control receiver.

ROCKET PERFORMANCE

Firing angle: 3.2 degrees North and 1.0 degree East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 42.7 sec.
Altitude at burnout: 15.4 miles
Velocity at burnout: 3323 ft. per sec.
Time to zenith: 151 sec.
Altitude at zenith: 49.8 miles.
Time to blowoff: 164.5 sec.
Altitude at blowoff: 47.9 miles
Flight duration:
Impact coordinates: Main body - 24.6 miles North and 0.4 miles East; Nose cone - 25.3 miles North and 3.4 miles East.
Payload weight: 156 lbs.
Unfueled rocket weight: 450 lbs.
Unfueled rocket C. G.: 133.7 inches.
Gross weight at takeoff: 1098 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 77.2 sec.
Cameras: Bowen-Knapp trajectory data 0.5 to 3.3 sec.
Telescopes: Attitude data 8 to 27.5 sec., 35.5 to 37.5 sec., and 63 to 75 sec.; Attitude and yaw data 7.7 to 76.2 sec.; roll data 0 to 164.5 sec.
Radar: Trajectory data 0 to 164.5 sec.

DATA RECOVERY

Telemeter: Good record.
Physical recovery: Sample bottles recovered in fair condition.

EXPERIMENTAL DATA

Composition: No data - bottle sealers and contaminator failed.

COMMENTS

Rocket performance: Zenith altitude 12.7 miles less than predicted.
Rocket modifications: Lower nose same as SC-11. The one-piece upper cone separated by a T-31-0.9-ES-800 Jato which exposed the sample bottle intake scoops.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Progress Report No. 19, Contract No. W-36-039-sc-32307, Engineering Research Institute, University of Michigan.
"Atmospheric Phenomena at High Altitudes," Progress Report No. 1, Contract No. DA-36-039-sc-125.
First Report on Test of Aerobee SC-13, L. M. Blanchett, Aerobee Project Officer.
Weather Data, Prepared by Air Weather Detachment, WSPG.
BRL Technical Note 321, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-13.
BRL Technical Note 368, APG; Numerical and Graphical Attitude and Yaw Data from Telescope and Askania Observations of Aerobee SC-13.
BRL Technical Note 335, APG; Numerical and Graphical Trajectory Data of Bowen-Knapp Observations of Aerobee SC-13.
Preliminary Radar Data, Numerical and Graphical, Prepared by SCEL Ballistic Radar Unit, WSPG.
Roll Data, Numerical and Graphical, Prepared by BRL Data Reduction Section, WSPG.
"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-14

11 December 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories.
Time: 2106 MST.
Altitude: 52.1 miles.

UPPER AIR INSTRUMENTS

Temperature: Temperature determination by measuring the velocity of sound. Seven grenades containing four pound high explosive charges to be ejected and exploded at preset intervals. Eight photocells to detect flashes.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Tail section separation by prima cord.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Askania stations.
- Cameras: Four Ballistic and three Bowen-Knapp stations.
- Radar: One modified SCR-584 S-band station and one SCR-584 X-band station.
- Impact location: Impact Point Computer.

Airborne
- Beacon: None
- Radio cutoff: AN/DRW-3(XE-1) FM control receiver in fail safe status.
- Other: Combustion chamber pressure gauge.

Other
- Cameras: Four wide view stations to supplement the Ballistic cameras in photographing grenade bursts.
- Sound ranging: Set GR3-C to record arrival time of grenade explosions.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 45-50 sec.
Altitude at burnout:
Velocity at burnout: 3400 ft. per sec.
Time to zenith:
Altitude at zenith: 52.1 miles.
Time to blowoff: About 174 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 219.5 lbs.
Unfueled rocket weight: 510 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 1132 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 33 sec.
Cameras: All grenade bursts recorded by Ballistic stations; trajectory data 0 to 4 sec. from Bowen-Knapp.
Radar: Trajectory data 0 to 48 sec. from reflection tracking.
Other: Good record from wide view cameras and sound ranging set.

DATA RECOVERY

Telemeter: System failed after recording first three bursts.
Physical recovery: Rocket recovered.

EXPERIMENTAL DATA

Temperature: Mean temperatures of six layers between 18.9 and 41.7 miles obtained with lower order of accuracy because of telemeter failure. Burst times obtained by an observer.

COMMENTS

This firing part of a group of coordinated firings to measure upper air temperatures during "T" day experiments.

REPORTS AND PAPERS

"Radar Operations Report, Aerobee Missile Round No. SC-14," SCEL Field Station No. 1, WSPG, undated.

"Preliminary Ballistic Instrumentation Report on Aerobee SC-14," BRL-WSPG, 20 December 1950.

Letter of Installation for SC-14 and SC-16, DA Project No. 3-36-07-051, Signal Corps Project 745A-O, 14 November 1950.

"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.

"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-15

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories (University of Michigan). 11 December 1950
Time: 1004 MST.
Altitude: Less than 1000 ft.

UPPER AIR INSTRUMENTS

Temperature: Temperature determination in the region 18.9 to 47.3 miles by measuring angle of shock wave formed by rocket nose tip.

DATA RECOVERY INSTRUMENTS

Telemeter: Dovap transceiver used as a single channel system.
Airborne recorder: Univ. of Mich. 13 channel magnetic tape recorder.
Physical recovery: Separation of tail section by prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four stations.
Radar:
Doppler: Six stations.
Impact location: Impact Point Computer.

Airborne
Beacon:
Doppler: Dovap transceiver T-4 unit.
Radio cutoff: AN/DRW-3 FM control receiver in a fail safe status.

COMMENTS

Rocket performance: Rocket sustaining motor malfunctioned. Rocket began to pitch and yaw shortly after leaving the tower, nose cone became detached and booster separated at 3 sec. Propellants exploded at impact after short flight with a zenith altitude of about 1000 ft.

Experiment and rocket modification: A 3 ft. cylindrical section, containing electronics and a drive motor, with three piece detachable skin was attached to the forward part of the rocket. Ten equally spaced pirani gage probe rods were mounted on the capping plate of this section, which extended through openings in a right circular cone. The cone was periodically driven through a 12 in. excursion by means of a double thread reversing screw. During powered flight the probe cone and exposed rods were covered with an ejectable false cone. This cone was fitted with a Jato unit, flame deflection cone, and flame ports. Shortly after burnout the Jato was to have been ignited to remove the false nose and expose the probe cone and gages. The probe motor would then start and drive the probe cone through its periodic excursions.

The pressure discontinuity of the shock wave formed by the probe cone is detected by the pirani gages and recorded as a function of time. The shock wave angle is found from the geometry of the system and is reduced by Mach number by aerodynamic theory. This is used to calculate the local velocity of sound, in conjunction with the Dovap velocity data, and hence the temperature is determined.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Progress Report No. 1, Contract No. DA-36-039-sc-125, Engineering Research Institute, University of Michigan.
First Report of Test of Aerobee SC-15, L. M. Blanchett, Aerobee Project Officer.
Preliminary Ballistic Instrumentation Report, BRL, WSPG.
"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.
"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-16

12 December 1950

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories.
Time: 0210 MST.
Altitude: 48.3 miles.

UPPER AIR INSTRUMENTS

Temperature: Temperature determination by measuring the velocity of sound. Seven grenades containing four pound high explosive charges to be ejected and exploded at preset intervals. Eight photoelectric cells to detect flashes.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel Bendix FM-FM system.
Physical recovery: Tail section separation with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Askania stations.
Cameras: Four Ballistic and three Bowen-Knapp stations.
Radar: One modified SCR-584 S-band and one modified SCR-584 X-band.
Impact location: Impact Point Computer.

Airborne
Radio cutoff: AN/DRW-3(XE-1) FM control receiver in fail safe status.

Other
Cameras: Four wide view stations to supplement Ballistic cameras in photographing grenade flashes.
Sound ranging: Set GR3-C to determine arrival time of grenade explosions.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 45 sec.
Altitude at burnout:
Velocity at burnout: 3240 ft. per sec.
Time to zenith:
Altitude at zenith: 48.3 miles.
Time to blowoff: 174 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 214 lbs.
Unfueled rocket weight: 504 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 1127 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 30 sec.
Cameras: Five grenade bursts recorded by Ballistic stations; trajectory data 0 to 4 sec. from Bowen-Knapp.
Radar: Reflection signal tracking to about 45 sec.
Other: Good plates from wide view cameras and sound ranging set of grenade explosions.

DATA RECOVERY

Telemeter: Good record showing seven ejections and four bursts.
Physical recovery: Rocket recovered showing all grenades ejected.

EXPERIMENTAL DATA

Temperature: Mean temperature of four layers between 17 and 37.9 miles were obtained.

COMMENTS

Rocket performance: Slightly less than predicted.
Experiments: Two grenades were ejected and did not detonate, a third one was ejected and detonated, but photocells failed to record it.
Other: This experiment part of a group of coordinated firings to measure upper air temperatures during "T" day experiments.

REPORTS AND PAPERS

Letter of Installation for SC-14 and SC-16, DA Project No. 3-36-07-051, Signal Corps Project 745A-O, 14 November 1950.
"Radar Operations Report, Aerobee Missile Round No. SC-16," SCEL Field Station No. 1, WSPG, undated.
"Preliminary Ballistic Instrumentation Report, Aerobee Missile Round No. SC-16," BRL, WSPG, 20 December 1950.
"Panel Report No. 26," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.
"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-17

IDENTIFICATION

19 December 1950

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1152 MST.
Altitude: 50.9 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air sampling bottles with timer and mechanical openers and pyrotechnic sealers. Radioactive carbon dioxide contaminator technique used.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as a one channel system.
Physical recovery: Tail section separation by prima cord, and nose bottle container ejected by pyrotechnic piston charges and lowered by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and six Askania stations.
- Cameras: Three Bowen-Knapp stations.
- Telescopes: Four stations.
- Radar: Two modified SCR-584 S-band stations.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55 S-band transponder.
- Radio cutoff: AN/DRW-3 FM control receiver in fail safe status.

ROCKET PERFORMANCE

Firing angle: 3.1 degrees North and 0.8 degrees East.
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 46.0 sec.
Altitude at burnout: 16.6 miles.
Velocity at burnout: 3418 ft. per sec.
Time to zenith: 153.7 sec.
Altitude at zenith: 50.9 miles.
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: Main body - 34.2 miles North and 2.7 miles East; Nose section - 36.5 miles North and 4.3 miles East.
Payload weight: 161 lbs.
Unfueled rocket weight: 455 lbs.
Unfueled rocket C G.: 137.4 inches.
Gross weight at takeoff: 1103 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 1 to 51.5 sec.
Cameras:
Telescopes: Attitude and yaw data 6 to 47 sec., roll data 11.6 to 45.8 sec.
Radar: Trajectory data 0 to 32.2 sec.

DATA RECOVERY

Telemeter:
Physical recovery: Three air sampling bottles recovered in good condition.

EXPERIMENTAL DATA

Composition: Samples obtained in the altitude intervals 39.9 to 41.9 miles, 41.9 to 43.5 miles, 43.5 to 45 miles. Charcoal adsorption analyses show definite increase in the ratios of He/N_2 and Ne/N_2 and a definite decrease in the ratio of A/N_2 over ground level values. Radio-active carbon dioxide contaminator did not operate.

COMMENTS

Rocket performance: Zenith altitude 10.6 miles less than predicted.
Rocket modifications: See comments SC-15 on false cone ejection; ejection occurred at 85 sec. after takeoff.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Progress Report Numbers 1, 2, and 3, Contract No. DA-36-039-sc-125, Engineering Research Institute, University of Michigan.
BRL Technical Note 405, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-17.
BRL Technical Note 397, APG; Numerical and Graphical Attitude and Yaw Data from Telescope Observations of SC-17.
Roll Data; Numerical and Graphical, Prepared by BRL Data Reduction Section, WSPG.
Radar Data, Numerical and Graphical, Prepared by SCEL Ballistic Radar Unit WSPG.
First Report on Test of Aerobee SC-13 and SC-17, L. M. Blanchett, Aerobee Project Officer.
Weather Data, Prepared by Air Weather Detachment, WSPG.
"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 25 April 1951.
"Panel Report No. 29," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 and 15 August 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-18

8 June 1951

Agency: Signal Corps Engineering Laboratories.
Time: 2311 MST.
Altitude: 41.5 miles.

Experiments: Upper air temperature.

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

8 June 1951

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 2311 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 41.5 mi
Peak time: 139 sec
Burnout velocity: 3040 ft/sec
Burnout altitude: 76,500 ft
Burnout time: 45 sec
Time of blowoff: 166 sec
Impact location: 22.5 mi north, 9.4 mi west of Navy blockhouse

ROCKET INFORMATION

Modifications to rocket: Nose structure modified to mount nine 4-lb grenades rather than the usual seven. Orifices in nose cone covered with 0.006-in. aluminum foil.

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Nine grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Five-channel FM-FM system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/APN-55(XE-3) S-band transponder; flight test of an omnidirectional array of flush-mounted linearly polarized antennas, used with beacon
Cutoff: AN/DRW-3(XE-1) FM control receiver for fail-safe fuel cutoff

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide view cameras, Bowen-Knapp cameras, S-band radar, impact point computer

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment field test. This equipment was developed by SCEL to detect times of grenade flashes from the ground.

Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Data recovery

Telemeter: Good record, except for one channel until blowoff. Nine grenade ejections and seven detonations recorded.

Tracking: Optical data to 35 sec when jet faded. Radar to 110.5 sec. Radar beacon signal failure at time of last grenade detonation. Omnidirectional array of slot antennas, installed in forward section for beacon, gave good results.

Upper air experimental data: The sound ranging set recorded eight sound signals and the flash detector similarly recorded eight flash signals. One grenade did not function, but all others burst within 0.5 sec of expected times. Seven temperature intervals and wind observations were obtained between 100,000 and 200,000 ft. The ground flash detector equipment, which was used for the first time, operated satisfactorily.

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-19

7 June 1951

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1818 MST.
Altitude: 4.0 miles.

UPPER AIR INSTRUMENTS

Temperature: Temperature determination in the region 18.9 to 47.3 miles by measuring angle of shock wave formed by rocket nose cone.

DATA RECOVERY INSTRUMENTS

Telemeter: Dovap transceiver used as a single channel system.
Airborne recorder: Univ. of Mich. 13 channel magnetic tape recorder.
Physical recovery: Separation of tail section by prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and five Askania stations.
Cameras: Two Bowen-Knapp stations.
Telescopes: Five stations.
Radar: Two modified SCR-584 3-band stations.
Doppler: Unknown number of stations.
Impact location: Impact Point Computer.

Airborne
Doppler: Dovap T-4 transceiver unit.
Radio cutoff: AN/DRW-3 FM control receiver in fail safe status.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 49.2 sec.
Altitude at burnout: 3.5 miles.
Velocity at burnout: 376 ft. per sec.
Time to zenith: 38.6 sec.
Zenith altitude: 4.0 miles.
Blowoff time:
Blowoff altitude:
Flight duration:
Impact coordinates:
Payload weight: 176 lbs.
Unfueled rocket weight: 465.5 lbs.
Unfueled rocket C. G.: 131.3 inches.
Gross weight at takeoff: 1089 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 71.6 sec.
Cameras: Bowen-Knapp trajectory data 0 to 3.4 sec.
Telescopes: Attitude data 2 to 62.6 sec., roll data 9.3 to 67.8 sec.
Radar:
Doppler:

DATA RECOVERY

Telemeter:
Airborne recorder: 51 sec. of flight record recovered.
Physical recovery:

EXPERIMENTAL DATA

Temperature: No data due to rocket failure.

COMMENTS

Rocket performance: Intermittent burning, thrust considerably below normal. Failure in propellant feed system not due to premature cutoff.
Rocket modifications: See comments SC-15 on false cone ejection and experiment; false cone ejection at 56.5 sec.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," by L. M. Jones and H. W. Neill, Final Progress Report, Contract No. W-36-039-sc-32307, Engineering Research Institute, University of Michigan.
"Atmospheric Phenomena at High Altitudes," by L. M. Jones, Progress Report No. 1, Contract No. DA-36-039-sc-125, Engineering Research Institute, University of Michigan.
BRL Technical Note 521, APG; Numerical and Graphical Attitude Data from Telescope Observations of Aerobee SC-19.
BRL Technical Note 534, APG; Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-19.
BRL Technical Note 528, APG; Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-19.
Roll Data, Numerical and Graphical, Prepared by BRL, WSPG.
Final Report of Test of Aerobee SC-19, J. C. Pile, WSPG Project Officer.
"Panel Report No. 29," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 14 and 15 August 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-20

IDENTIFICATION

1 November 1951

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 0246 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 41.2 mi
Peak time: 136 sec
Burnout velocity: 3180 ft/sec
Burnout time: 33 sec (jet fadeout)

ROCKET INFORMATION

Payload weight: 254.55 lb
Total unfueled rocket weight: 542 lb
Gross weight at takeoff: 1150 lb
C. G. total unfueled rocket: 122 in. from nose tip
Modifications to rocket: Nose structure modified to mount nine 4-lb grenades rather than the usual seven. Orifices in nose cone covered with 0.006-in. aluminum foil.

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Nine grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Five-channel Bendix FM-FM system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/APN-55(XE-3) transponder
Cutoff: AN/DRW-3 FM control receiver for fuel cutoff

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, Bowen-Knapp cameras, tracking telescope, S-band radar

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment. This equipment was developed by SCEL to detect times of grenade flashes from the ground.

Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: Normal

Data Recovery

- Telemeter: Satisfactory
- Tracking: Optical data to jet fadeout, radar to impact
- Upper air experimental data: Six of the grenades exploded, five temperature intervals and wind observations were obtained

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-20

1 November 1951

Agency: Signal Corps Engineering Laboratories.
Time: 0245 MST.
Altitude: 41.0 miles.

Experiments: Upper air temperature.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-21

26 September 1951

IDENTIFICATION

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1706 MST.
Altitude: 42.8 miles.

UPPER AIR INSTRUMENTS

Composition: Three evacuated air sampling bottles with timer and pyrotechnic opening and sealing devices.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse widening feature of radar beacon used as a one channel system.
Physical recovery: Tail section separation with prima cord; nose cone separation with pyrotechnic piston charges and lowering by parachute.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and six Askania stations.
- Cameras: Three Bowen-Knapp stations.
- Telescopes: Five stations.
- Radar: Two modified SCR-584 S-band stations.
- Impact location: Impact Point Computer.

Airborne
- Beacon: AN/APN-55 S-band transponder.
- Radio cutoff: AN/DRW-3 FM control receiver in fail safe status.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.5 sec.
Altitude at burnout: 14.1 miles.
Velocity at burnout: 3068 ft. per sec.
Time to zenith: 134.2 sec.
Altitude at zenith: 42.8 miles.
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 18.1 miles North and 4.5 miles East.
Payload weight:
Empty rocket weight:
Empty rocket C. G.:
Gross weight at takeoff:

BALLISTIC DATA

Theodolites:
Cameras:
Telescopes:
Radar:

DATA RECOVERY

Telemeter: Satisfactory records.
Physical recovery: Three air sampling bottles recovered in good condition.

EXPERIMENTAL DATA

Composition: Samples obtained by two bottles in the altitude intervals 34.9 to 36.5 miles and 36.5 to 37.7 miles. Charcoal adsorption analyses showed gravitational separation confirming results from SC-17. Radio active carbon dioxide contaminator operated, but no results obtained.

COMMENTS

Rocket configuration same as SC-13 and SC-17.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Progress Report No. 5, Contract No. DA 36-039-sc-125, Engineering Research Institute, University of Michigan.

BRL Technical Note 659.

BRL Technical Note 642, Numerical and Graphical Trajectory Data from Askania Observations of Aerobee SC-21.

BRL Technical Note No. 635, Numerical and Graphical Trajectory Data from Bowen-Knapp Observations of Aerobee SC-21.

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

2 November 1951

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 1735 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 51 mi
Burnout velocity: 3271 ft/sec
Burnout time: 44 sec
Time of booster burnout: 2.5 sec (approx.)
Firing angle: N 53 mils, E 10 mils
Impact location: 21 mi north, 2-1/2 mi east of Navy blockhouse

ROCKET INFORMATION

Payload weight: 173 lb
Total unfueled rocket weight: 461 lb
Gross weight at takeoff: 1090 lb
C. G. total unfueled rocket: 121 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells

Data recovery instrumentation
Telemeter: Four-channel Bendix FM-FM system
Physical Recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/DPN-19(XE-2) transponder
Radio cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, Bowen-Knapp cameras, tracking telescopes, S-band SCR-584 radars, X-band SCR-584 radar, impact point computer

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment
Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: Satisfactory
Tracking: Askania data to 33 sec, tracking telescopes to about 200 sec, radar to 40 sec
Upper air experimental data: Four of the seven grenades exploded. The late afternoon firing required filters on the ballistic camera lens, which caused considerable distortion. As a result the data were not within tolerable accuracy limits. Temperature data were obtained. Wind direction and velocity at four altitudes were obtained from the BRL ballistic cameras. The ground flash detector failed to detect the grenade flashes. However, the flashes were detected by the photocells mounted in the skin of the rocket. Grenade firing in the daylight was not satisfactory. However, it was decided to attempt another late afternoon firing.

REPORTS

See Aerobee SC-33

IDENTIFICATION

14 May 1952

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 1816 MST
Instrumenting agency: Signal Corps Engineering Laboratories, University of Michigan

BRIEF OF FLIGHT OBJECTIVES

To determine upper atmosphere densities and temperatures by the falling-sphere method

FLIGHT INFORMATION

Peak altitude: 46.2 mi (sphere)
Peak time: 141.48 sec
Burnout velocity: 3408 ft/sec
Burnout altitude: 70,287 ft
Burnout time: 36.73 sec
Time of booster burnout: 2.04 sec (approx.)
Maximum acceleration: +149 ft/sec^2

ROCKET INFORMATION

Payload weight: 127 lb
Total unfueled rocket weight: 414.30 lb
Gross weight at takeoff: 1040.0 lb (approx.)
Total rocket length (nose tip to base of tail section): 259 in.
C. G. total unfueled rocket: 148.8 in. from nose tip
Modifications to rocket: Front end (forward of tank section) was a cylinder plus a 46-inch secant ogive fabricated out of laminated plywood

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Sphere of 54-in. diameter containing DOVAP transponder and weighing 48.5 lb

Data recovery instrumentation
Telemeter: DOVAP single channel system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
DOVAP: T7-3-8 transponder
Radio cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Bowen-Knapp cameras, Askania cinetheodolites, tracking telescopes, impact point computer, DOVAP, radar

RESULTS

Rocket performance: Normal. Short burning time, high spin rate.

Data recovery
Telemeter: Satisfactory operation throughout flight
Physical recovery: Sphere recovered
Tracking: Bowen Knapp, Askania, and DOVAP trajectory data, attitude data from tracking telescopes, roll data from DOVAP
Upper air experimental data: Temperature data in the altitude range 165,000 to 170,000 ft, density data in the altitude range 165,000 to 215,000 ft

REPORTS

1. Bartman, F. L., et al., "Falling Sphere Method for Upper Air Density and Temperature," in "Rocket Exploration of the Upper Atmosphere," Boyd, R.I.F. and Seaton, M. J., eds., London:Pergamon, 1954, pp. 98-107

2. Bartman, F. L. and Jones, L. M., "Density and Temperature of the Upper Atmosphere as Measured by the Falling-Sphere Method," Univ. of Mich. Eng. Res. Ins. Report #2299-1-F, September 1955

3. Bartman, F. L., Chaney, L. W., Jones, L. M., and Liu, V. C., "Upper-Air Density and Temperature by the Falling-Sphere Method," J. Appl. Phys. 27:706-712 (July 1956)

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

19 May 1952

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 1907 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 55.6 mi
Peak time: 155 sec
Burnout velocity: 3780 ft/sec
Burnout altitude: 83,680 ft
Burnout time: 40.1 sec
Velocity at booster burnout: 1043 ft/sec
Altitude at booster burnout: 5872 ft
Time of booster burnout: 2.5 sec (approx.)
Time of blowoff: 192 sec
Flight duration: 520 sec
Firing angle: N 50 mils, E 9 mils

ROCKET INFORMATION

Payload weight: 155.5 lb
Total unfueled rocket weight: 444 lb
Gross weight at takeoff: 1062 lb
C. G. total unfueled rocket: 119 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells

Data recovery instrumentation
Telemeter: Four-channel Bendix FM-FM system
Physical recovery: Primer cord for tail cone separation

Ballistic instrumentation
Beacon: AN/DPN-19(XE-2) transponder
Radio cutoff: AN/DRW-3(XE-1) FM control fail-safe radio cutoff system

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, radar

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment
Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: The burning period was 5 sec short and there was a resulting altitude loss of 13 mi

Data recovery
- Telemeter: Failed after third grenade detonation when shrapnel severed the antenna cable
- Tracking: Optical data to 30 sec, radar data to 271 sec
- Upper air experimental data: Overexposure and failure to photograph stars made the plates of the BRL ballistic cameras and the SCEL wide-view camera useless. As a result of this failure and that of SC-22, daylight grenade firings were abandoned. Grenade puffs were tracked by Mitchell and Askania cinetheodolites.

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-26

IDENTIFICATION

22 October 1952

Rocket type: XASR-SC-2
Place of firing: White Sands Proving Ground
Time of firing: 2043 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 69.6 mi
Peak time: 175 sec
Burnout velocity: 4200 ft/sec
Burnout time: 430 sec
Flight duration: 577 sec
Impact location: North 20 mi, east 11 mi from Navy blockhouse

ROCKET INFORMATION

Payload weight: 140.5 lb
Total unfueled rocket weight: 487.0 lb
Gross weight at takeoff: 1105.0 lb
C. G. total unfueled rocket: 124 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Four-channel Bendix FM-FM system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/DPN-19(XE-2) transponder
Radio cutoff: AN/DRW-3 radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, Bowen-Knapp cameras, radar, impact point computer

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment
Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: Satisfactory

Data recovery
- Physical recovery: Normal impact, all parts were in same area
- Tracking: Radar tracked to impact
- Upper air experimental data: Five of the grenades exploded and four temperature intervals and wind measurements were obtained. The experiment was considered successful. This flight was performed as part of a "T" day operation.

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-22
2 November 1951

Agency: Signal Corps Engineering Laboratories.
Time: 1735 MST.
Altitude: 51.0 miles.

Experiments: Upper air temperature.

AEROBEE
SC-23
14 May 1952

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1815 MST.
Altitude: 47.3 miles.

Experiments: Air density.

AEROBEE
SC-24
19 May 1952

Agency: Signal Corps Engineering Laboratories.
Time: 1907 MST.
Altitude: 56.0 miles.

Experiments: Upper air temperature.

AEROBEE
SC-25
24 September 1952

Agency: Signal Corps Engineering Laboratories.
Time: 2050 MST.
Altitude: 73.0 miles.

Experiments: Upper air temperature.

AEROBEE
SC-26
20 October 1952

Agency: Signal Corps Engineering Laboratories.
Time: 2045 MST.
Altitude: 69.0 miles.

Experiments: Upper air temperature.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-27

17 February 1953

IDENTIFICATION

Rocket type: XASR-SC-2
Place of firing: White Sands Proving Ground
Time of firing: 2350 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 67.5 mi
Peak time: 173.6 sec
Burnout velocity: 3925 ft/sec
Burnout time: 45 sec
Flight duration: 540 sec
Impact location: North 41 mi, west 3 mi from Navy blockhouse

ROCKET INFORMATION

Payload weight: 155.5 lb
Total unfueled rocket weight: 354.25 lb
C. G. total unfueled rocket: 123.5 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Four-channel Bendix FM-FM system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/DPN-19(XE-2) transponder
Radio Cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, Bowen-Knapp cameras, radar

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide angle photoelectric flash-detector equipment
Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: Satisfactory

Data recovery
Telemeter: Performance satisfactory
Physical recovery: Not required but was made
Tracking: Radar to impact
Upper air experimental data: Five of the grenades exploded, four temperature intervals and four wind measurements were obtained. The experiment was successful.

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-28

IDENTIFICATION

24 April 1953

Rocket type: XASR-SC-2
Place of firing: White Sands Proving Ground
Time of firing: 0319 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 67 mi
Burnout velocity: 4076 ft/sec
Burnout time: 46 sec
Time of booster burnout: 1.87 sec

ROCKET INFORMATION

Payload weight: 156 lb
Total unfueled rocket weight: 447.5 lb
C. G. total unfueled rocket: 121.4 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Three-channel Bendix FM-FM system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/DPN-19(XE-3) transponder
Radio cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, radar, impact point computer, sound ranging

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment
Sound ranging equipment: Used to detect time of arrival of grenade bursts

RESULTS

Rocket performance: Satisfactory

Data recovery
Telemeter: Performance satisfactory
Tracking: Radar to 130 sec when beacon failed

Upper air experimental data: Five of the grenades exploded, four temperatures and four wind observations were obtained. The experiment was a success.

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-29

IDENTIFICATION

11 December 1952

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 1647 MST
Instrumenting agency: Signal Corps Engineering Laboratories, University of Michigan

BRIEF OF FLIGHT OBJECTIVES

To determine upper atmosphere densities and temperatures by the falling-sphere method. Cosmic radiation plates in nose cone for National Institutes of Health.

FLIGHT INFORMATION

Peak altitude: 65.3 mi
Peak time: 170.95 sec
Burnout velocity: 4003 ft/sec
Burnout altitude: 93,738 ft
Burnout time: 44.3 sec
Time of booster separation: 2.53 sec
Maximum acceleration: +149 ft/sec^2

ROCKET INFORMATION

Payload weight: 127 lb
Total unfueled rocket weight: 417 lb
Gross weight at takeoff: 1045 lb
Total rocket length (nose tip to base of tail section): 252 in.
C. G. total unfueled rocket: 143.3 in. from nose tip
Modifications to rocket: Front end, forward of tank section was a cylinder plus a 46-in. secant ogive fabricated out of laminated plywood

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Sphere of 46-in. diameter containing DOVAP transponder and weighing 41.4 lb

Data recovery instrumentation
Telemeter: DOVAP single-channel system
Physical recovery: Primer cord for tail cone severance

Ballistic instrumentation
DOVAP: Modified T7-3-8 transponder
Radio cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Bowen-Knapp cameras, Askania cinetheodolites, Mitchell cinetheodolites, impact point computer, radar, and DOVAP

RESULTS

Rocket performance: Normal

Data recovery

Telemeter: Satisfactory operation throughout flight

Physical recovery: Sphere and cosmic radiation plates recovered

Tracking: Optical data to 47.3 sec, radar to 60.6 sec, DOVAP data from 157 to 723 sec

Upper air experimental data: Temperature data in the altitude range 115,000 to 195,000 feet. Density data in the altitude range 115,000 to 243,000 feet.

REPORTS

See Aerobee SC-23

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-30

IDENTIFICATION

23 April 1953

Rocket type: XASR-SC-2
Place of firing: White Sands Proving Ground
Time of firing: 1233 MST
Instrumenting agency: Signal Corps Engineering Laboratories, University of Michigan

BRIEF OF FLIGHT OBJECTIVES

To determine upper atmosphere densities and temperatures by the falling-sphere method

FLIGHT INFORMATION

Peak altitude: 76.6 mi
Peak time: 186.1 sec
Burnout velocity: 4383 ft/sec
Burnout altitude: 97,989 ft
Burnout time: 45.6 sec
Time of booster separation: 2.76 sec

ROCKET INFORMATION

Payload weight: 124 lb
Total unfueled rocket weight: 413.5 lb
Total rocket length (nose tip to base of tail section): 248.5 in.
C. G. total unfueled rocket: 142.25 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Sphere of 48-in. diameter containing DOVAP transponder and weighing 49.2 lb

Data recovery instrumentation
Telemeter: DOVAP single-channel system

Ballistic instrumentation
DOVAP: transponder
Radio cutoff: AN/DRW-3 radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Bowen-Knapp cameras, DOVAP

RESULTS

Rocket performance: Normal

Data recovery
Telemeter: Data obtained
Tracking: Bowen-Knapp and DOVAP trajectory data, roll data from DOVAP

Upper air experimental data: Temperature data in the altitude range 120,000 to 213,000 ft, density data in the altitude range 120,000 to 268,000 ft

REPORTS

See Aerobee SC-23

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-27
17 February 1953

Agency: Signal Corps Engineering Laboratories.
Time: 2350 MST.
Altitude: 66.0 miles.

Experiments: Upper air temperature.

AEROBEE
SC-28
24 April 1953

Agency: Signal Corps Engineering Laboratories.
Time: 0319 MST.
Altitude:

Experiments: Upper air temperature.

AEROBEE
SC-29
11 December 1952

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1647 MST.
Altitude: 65.0 miles.

Experiments: Temperature, Density.

AEROBEE
SC-30
24 April 1953

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1230 MST.
Altitude: 69.0 miles.

Experiments: Density.

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-31

IDENTIFICATION

29 September 1953

Rocket type: RTV-A-1a
Place of firing: White Sands Proving Ground
Time of firing: 1350 MST
Instrumenting agency: Signal Corps Engineering Laboratories, University of Michigan

BRIEF OF FLIGHT OBJECTIVES

To determine upper atmosphere densities and temperatures by the falling-sphere method

FLIGHT INFORMATION

Peak altitude: 36 mi
Peak time: 99.5 sec
Burnout velocity: 4651 ft/sec
Burnout altitude: 80,340 ft
Burnout time: 34.0 sec
Time of booster separation: 2.40 sec
Maximum acceleration: 234 ft/sec^2

ROCKET INFORMATION

Payload weight: 140 lb
Total unfueled rocket weight: 448.5 lb
Total rocket length (nose tip to base of tail section): 246 in.
C. G. total unfueled rocket: 130.7 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Sphere of 48-in. diameter containing DOVAP transponder and weighing 19.9 lb

Data recovery instrumentation
Telemeter: DOVAP single-channel system

Ballistic instrumentation
DOVAP: Transponder
Radio cutoff: AN/DRW-3 radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Askania cinetheodolites, Bowen-Kanpp cameras, DOVAP, radar.

RESULTS

Rocket performance: Performance was apparently normal through burnout. At burnout the angle of attack began to increase, approaching 90 degrees in a few seconds. Thus, performance was decidedly subnormal. Sphere was ejected prematurely at this time.

Data recovery
Telemeter: Data obtained
Tracking: Askania, DOVAP, radar, and Bowen-Knapp trajectory data, attitude data from IGOR and Askania

Upper air experimental data: Temperature data in the altitude range 106,000 to 125,000 ft, density data in the altitude range 106,000 to 174,000 ft

REPORTS

See Aerobee SC-23

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-32

IDENTIFICATION

31 August 1953

Rocket Type: XASR-SC-2
Place of firing: White Sands Proving Ground
Time of firing: 2210 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 66.7 mi
Peak time: 180 sec
Burnout velocity: 3621 ft/sec
Burnout time: 46.5 sec
Impact location: North 8.1 mi, east 6.5 mi from Navy blockhouse

ROCKET INFORMATION

Payload weight: 161 lb
Total unfueled rocket weight: 453.5 lb
C. G. total unfueled rocket: 122.4 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Three-channel FM-FM system
Physical Recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/DPN-19(XE-2) transponder
Radio cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, BRL ballistic cameras, SCEL wide view cameras, Bowen-Knapp cameras, radar, impact point computer

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment
Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: Satisfactory

Data recovery
Tracking: Good beacon signal to burnout, skip-triggering until 208 seconds, BRL cameras satisfactory

Upper air experimental data: Five of the seven grenades exploded, four temperatures and four wind observations were obtained. The experiment was successful.

REPORTS

See Aerobee SC-33

UPPER AIR ROCKET SUMMARY

4 September 1953

IDENTIFICATION

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 2235 MST
Instrumenting agency: Signal Corps Engineering Laboratories

BRIEF OF FLIGHT OBJECTIVES

Determination of temperatures and winds in the upper atmosphere by the grenade method

FLIGHT INFORMATION

Peak altitude: 71 mi
Peak time: 46 sec
Burnout velocity: 4054 ft/sec
Burnout altitude: 89,976 ft
Time of blowoff: 190 sec

ROCKET INFORMATION

Payload weight: 162.0 lb
Total unfueled rocket weight: 453.5 lb
C. G. total unfueled rocket: 121.8 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Seven grenades containing 4-lb high-explosive charges, eight photoelectric cells located in the skin of the mounting ring between the extension and the tank forward skirt

Data recovery instrumentation
Telemeter: Three-channel Bendix FM-FM system
Physical Recovery: Primer cord for tail cone severance

Ballistic instrumentation
Beacon: AN/DPN-19 transponder
Radio cutoff: AN/DRW-3(XE-2) radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Mitchell cinetheodolites, Askania cinetheodolites, BRL ballistic cameras, SCEL wide-view cameras, Bowen-Knapp cameras, radar

GROUND-BASED DATA RECOVERY EQUIPMENT

Ground flash detectors: Wide-angle photoelectric flash-detector equipment
Sound ranging equipment: Sound ranging set GR3-C for arrival time and angle of grenade-burst sound waves at the ground

RESULTS

Rocket performance: Satisfactory

Data recovery
Telemeter: Performance satisfactory
Tracking: Radar to 102.5 sec, time of last grenade when beacon failed

Upper air experimental data: Five of the grenades exploded, four temperatures and four wind observations were obtained. The experiment was successful.

REPORTS

1. Stroud, W. G., "The Reduction of Data from the Rocket-Grenade Experiment," Technical Memorandum 1570, Army Signal Engineering Laboratory, 1954

2. Walsh, J. R., Terhune, E. J., Weiland, S., and Venner, J. H., "Description of the Instrumentation and Procedures for the Velocity of Sound (Grenade) Experiment," Engineering Report E-1140, Army Signal Engineering Laboratory, 1954

3. Newell, H. E., Jr., "High Altitude Rocket Research," Academic Press:New York, 1953, pp. 133-142

4. Stroud, W. G., Terhune, E. A., Venner, J. H., Walsh, J. R., and Weiland, S., "Instrumentation of the Rocket-Grenade Experiment for Measuring Atmospheric Temperatures and Winds," Rev. of Sci. Instr. 26:427-432 (1955)

5. Stroud, W. G., Nordberg, W., and Walsh, J. R., "Atmospheric Temperatures and Winds Between 30 and 80 Km," J. Geophys. Research 61:45-56 (1956)

6. Ference, M., Jr., Stroud, W. G., Walsh, J. R., and Weisner, A. G., "Measurement of Temperatures at Elevations of 30 to 80 Kilometers by the Rocket-Grenade Experiment," J. Meteorol. 13:5-12 (1956)

7. Weisner, A. G., "Measurement of Winds at Elevations of 30 to 80 Kilometers by the Rocket-Grenade Experiment," J. Meteorol. 13:30-39 (1956)

8. Nordberg, W., "A Method of Analysis for the Rocket-Grenade Experiment," Technical Memorandum M-1856, Army Signal Engineering Laboratory, 1957

IDENTIFICATION

9 August 1956

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 0853 MST
Instrumenting agency: Signal Corps Engineering Laboratories, University of Michigan

BRIEF OF FLIGHT OBJECTIVES

To collect and recover upper air samples for later analysis in the laboratory

FLIGHT INFORMATION

Peak altitude: 53.1 mi
Peak time: 149.5 sec
Burnout velocity: 3511 ft/sec
Burnout altitude: 86,300 ft
Burnout time: 46.46 sec
Time of booster burnout: 2.31 sec
Impact location: 0° 50' 22" azimuth, 28.05 mi from launcher (sample canister and parachute)

ROCKET INFORMATION

Payload weight: 221.25 lb
Total unfueled rocket weight: 488.25 lb
Gross weight at takeoff: 1169.5 lb
Total rocket length (nose tip to base of tail section): 247 in.
C. G. total unfueled rocket: 124 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Three sampling bottles, each having a volume of 500 cu in.

Data recovery instrumentation
Physical recovery: Parachute for canister containing three sampling bottles and radar beacon

Ballistic instrumentation
Beacon: AN/DPN-19 transponder contained in canister
Radio cutoff: AN/DRW-3 radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Radar, AN/TPS-5, Bowen-Knapp cameras, Askania cinetheodolites, SOTIM (sound ranging)

RESULTS

Rocket performance: Normal

Data recovery:
- Telemeter: Data recovery complete
- Physical recovery: Parachuted canister containing three sampling bottles and AN/DPN-19 beacon recovered virtually intact
- Tracking: Complete radar tracking of parachuted canister to impact

Upper air experimental data: Two bottles leaked and had to be rejected, one bottle was good and contents are being analyzed (bottle was opened at 85.3 km and closed at 85.5 km)

UPPER AIR ROCKET SUMMARY

AEROBEE
SC-35

IDENTIFICATION

10 August 1956

Rocket type: XASR-SC-1
Place of firing: White Sands Proving Ground
Time of firing: 0822 MST
Instrumenting agency: Signal Corps Engineering Laboratories, University of Michigan

BRIEF OF FLIGHT OBJECTIVES

To collect and recover upper air samples for later analysis in the laboratory

FLIGHT INFORMATION

Peak altitude: 53.4 mi
Peak time: 159.0 sec
Burnout velocity: 3452 ft/sec
Burnout altitude: 90,124 ft
Burnout time: 46.76 sec
Impact location: 09° 54' 04", 16.530 mi from launcher (sample canister and parachute)

ROCKET INFORMATION

Payload weight: 240 lb
Gross weight at takeoff: 1179 lb
Total rocket length (nose tip to base of tail section): 247 in.
C. G. total unfueled rocket: 122.3 in. from nose tip

ROCKETBORNE EQUIPMENT

Upper atmosphere instrumentation: Three sampling bottles, each having a volume of 500 cu in.

Data recovery instrumentation
Physical recovery of parachuted canister containing three sampling bottles and radar beacon

Ballistic instrumentation
Beacon: AN/DPN-19 transponder contained in canister
Radio cutoff: AN/DRW-3 radio cutoff receiver

FIRING RANGE GROUND-BASED TRACKING EQUIPMENT UTILIZED

Radar, AN/TPS-5, Bowen-Knapp cameras, Askania cinetheodolites, SOTIM (sound ranging)

RESULTS

Rocket performance: Normal

Data recovery
- Telemeter: Data recovery complete
- Physical recovery: Parachuted canister containing three sampling bottles and AN/DPN-19 beacon recovered virtually intact
- Tracking: Complete radar tracking of parachuted canister to impact

Upper air experimental data: All three bottles were good and contents are being analyzed (bottles were opened at 85.6 km and closed at 85.9 km)

UPPER AIR ROCKET SUMMARY

AEROBEE
A-1
25 September 1947

Agency: Applied Physics Laboratory

Comment: First dummy firing to evaluate initial flight ballistics of the Aerobee. Boosted airframe, no upper air instruments.

Results: Satisfactory performance.

AEROBEE
A-2
2 October 1947

Agency: Applied Physics Laboratory

Comment: Second dummy firing to evaluate initial flight ballistics of the Aerobee. Boosted airframe, no upper air instruments.

Results: Satisfactory performance.

AEROBEE
A-3
31 October 1947

Agency: Applied Physics Laboratory

Comment: Third dummy firing to evaluate initial flight ballistics of the Aerobee. Boosted airframe, no upper air experiments.

Results: Satisfactory performance.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-4
24 November 1947

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1020 MST
Altitude: 34.7 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Single geiger counter to measure primary cosmic ray flux.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system.
Physical recovery:

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and two Askania stations
Cameras: Two Ballistic and three Bowen-Knapp stations
Telescopes: Two stations
Radar: One modified SCR-584 S-Band and one modified SCR-584 X-band station

Airborne
Radio cutoff: NMCA&MA-APL FM control receiver for fail-safe fuel cutoff
Aspect: Three attitude gyros
Other: Propulsion performance instruments.

ROCKET PERFORMANCE

Firing angle: 3.9 degrees North and 2.3 degrees East
Time to booster separation: 2.9 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 34.7 sec.
Altitude at burnout: 11 miles
Velocity at burnout: 3100 ft. per sec.
Time to zenith:
Altitude at zenith: 34.7 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 240 sec.
Impact coordinates: 25 miles North and 13 miles East
Payload weight: 146 lbs.
Empty rocket weight: 425 lbs.
Unfueled rocket C.G.: 119.5 in.
Gross weight at takeoff: 1073 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 44.9 sec., Mitchell trajectory data 0 to 33.5 sec.
Cameras: Bowen-Knapp yaw data 0 to 4.1 sec.
Telescopes:
Radar: S-band trajectory data 0 to 50 sec., X-band data 0 to 35 sec.

DATA RECOVERY

Telemeter: More than 90% of flight recorded.
Physical recovery:

EXPERIMENTAL DATA

Cosmic radiation: No data, equipment failed.

COMMENTS

Rocket performance: Propulsion satisfactory; initial yaw required radio fuel cutoff
Instrumentation: Aspect gyros did not uncage, no data.

REPORTS AND PAPERS

APL Bumblebee Series Report No. 95, by L. W. Fraser, December 1948
"The Aerobee Rocket - A New Vehicle for Research in the Upper Atmosphere," Science 108:746, 1948.
"V-2 Report No. 14." Minutes of Meeting of the V-2 Upper Atmosphere Research Panel of 28 January 1948.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-5
5 March 1948

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1551 MST
Altitude: 73.0 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Single geiger counter and a geiger counter telescope to measure the average directional intensity.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system
Physical recovery:

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Two Ballistic and three Bowen-Knapp stations
Telescopes: Two stations
Radar: One modified SCR-584 S-band station.

Airborne
Radio cutoff: NMCA&MA-APL FM control receiver for fail-safe fuel cutoff
Aspect: Three sets of attitude photocells
Other: Rocket propulsion performance instruments.

ROCKET PERFORMANCE

Firing angle: 4.2 degrees North and 2.6 degrees East
Time to booster separation: 2.7 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 48.0 sec.
Altitude at burnout: 17.8 miles
Velocity at burnout: 4050 ft. per sec.
Time to zenith:
Altitude at zenith: 73 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 335 sec.
Impact coordinates: 35 miles North and 8.1 miles East
Payload weight: 155 lbs.
Unfueled rocket weight: 431 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1077 lbs.

BALLISTIC DATA

Theodolites: Trajectory data to about 48 sec.
Cameras: Bowen-Knapp trajectory data to 3.9 sec.
Telescopes:
Radar: Intermittent data 0 to 53 sec.

DATA RECOVERY

Telemeter: Total of 8 sec. lost out of 326 sec.

EXPERIMENTAL DATA

Cosmic radiation: Upper limit of primary intensity established for geomagnetic lattitude 41 degrees North.

COMMENTS

Rocket performance: Good performance. Zenith angle 10 degrees and roll period 1.13 sec. at burnout. Precession period about 60 sec. with a cone half angle of about 15 degrees until 260 sec. At 290 sec. the rocket axis was parallel to trajectory with nose down.

REPORTS AND PAPERS

APL Bumblebee Series Report No. 95, by L. W. Fraser, December 1948.

"The Cosmic Ray Intensity Above the Atmosphere," by A. V. Gangnes, J. F. Jenkins, Jr., and J. A. VanAllen, Phys. Rev. 75:57, 1949.

"An Improved Upper Limit to the Primary Cosmic Ray Intensity at Geomagnetic Lattitude 41 North," by J. A. VanAllen, Proceedings of the Echo Lake Cosmic Ray Symposium June 23-28, 1949, pp. 95-102, Published by ONR Nov. 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-6
13 April 1948

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1441 MST
Altitude: 71.0 miles.

UPPER AIR INSTRUMENTS

Magnetic field: Magnetometer to detect existence of circulating current sheets in the upper atmosphere (APL and Naval Ordnance Laboratory).

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Two stations
Radar: One modified SCR-584 S-band and one modified SCR-584 X-band station
Impact location: Sound ranging. Red flare smoke candle to be ignited at 240 sec.

Airborne
Radio cutoff: NMCA&MA-APL FM control receiver for fail safe fuel cutoff.
Aspect: Sixteen attitude photocells
Other: Propulsion performance instruments.

ROCKET PERFORMANCE

Firing angle: 3.7 degrees North and 1.7 degrees East
Time to booster separation: 2.5 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.8 sec.
Altitude at burnout: 17.7 miles
Velocity at burnout: 4125 ft. per sec.
Time to zenith:
Altitude at zenith: 71.0 miles
Time to blowoff: Breakup at 326 sec.
Altitude at blowoff:
Flight duration: 349 sec.
Impact coordinates: 17.7 miles North and 1.7 miles East
Payload weight: 153 lbs.
Unfueled rocket weight: 427 lbs.
Unfueled rocket D.G.:
Gross weight at takeoff: 1073 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data to about 55 sec.
Cameras: Bowen-Knapp trajectory data to 2.5 sec., yaw data 0 to 3.6 sec.
Telescopes: Attitude data 6 to 38 sec., roll rate 6.5 to 30 sec.
Radar: X-band trajectory data 0 to 18.5 sec.
Impact location: Impact 0.3 mile from sound ranging prediction.
Other: Smoke flare failed to operate.

DATA RECOVERY

Telemeter: Good record for 326 sec.

EXPERIMENTAL DATA

Magnetic field: Decrease of earth's field with altitude measured; discontinuity caused by current sheet too small to be detected with equipment.

COMMENTS

Rocket performance: Thrust normal to 38.7 sec. and fell off to 60% by 40.3 sec. and came back to normal by 41.7 sec., then thrust was erratic until burnout. Roll increased during burning to a period of 1.75 sec.

REPORTS AND PAPERS

APL Bumblebee Series Report No. 95, by L. W. Fraser, The Johns Hopkins University Applied Physics Laboratory, Dec. 1948.

"Measurement of the Earth's Magnetic Field at High Altitudes at White Sands, New Mexico," by S. F. Singer, E. Maple, and W. A. Bowen, J. of Geophys. Res., 55:115, 1950.

"V-2 Report No. 16," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel of April 28, 1948.

AEROBEE
A-7
26 July 1948

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 0947 MST
Altitude: 70.0 miles.

UPPER AIR INSTRUMENTS

Earth photography: Two K-25 aerial cameras and two 16 mm. GSAP motion picture cameras.

DATA RECOVERY INSTRUMENTS

Telemeter: None
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: One modified SCR-584 S-band and one SCR-584 X-band station
- Impact location: Seven sound ranging stations.

Airborne
- Radio cutoff: NMCA&MA - APL FM control receiver for fail safe fuel cutoff and recovery separation blowoff.

Other
- Nose tip: Special nose tip formed of four plastic dielectric materials for temperature test.

ROCKET PERFORMANCE

Firing angle: 2.8 degrees North and 0.1 degree East
Time to booster separation: 2.5 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.5 sec.
Altitude at burnout:
Velocity at burnout: 4068 ft. per sec.
Time to zenith: 175 sec.
Altitude at zenith: 70.0 miles
Time to blowoff: 265 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates: 25.5 miles North and 9.3 miles East
Payload weight: 176 lbs.
Unfueled rocket weight: 450 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1096 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 45 sec.
Cameras: Bowen-Knapp trajectory data 0 to 3.5 sec.
Telescopes: Good record from one telescope 0 to 150 sec.
Radar: S-band radar trajectory 0 to 37 sec.
Impact location: Ground and air search.

DATA RECOVERY

Physical recovery: Nose and tank section recovered after 19 days search.

EXPERIMENTAL DATA

Earth photography: Aerographic kodacolor film in one K-25 showed loss of color balance, Super XX in other K-25 yielded excellent results. The Kodachrome and Super XX film in the GSAP cameras completely fogged.

Temperature studies: Results of plastic dielectric materials on special nose cone as follows:
- Melamine-fiberglass laminate: Good thermal resistance
- Silicone-fiberglass laminate: Good thermal resistance, slight tendency to delaminate
- Teflon: Erosion and flow
- Kel F: Erosion and flow.

COMMENTS

Rocket modifications: Two uncovered 6 sq. inch ports cut in nose cone as apertures for cameras.

REPORTS AND PAPERS

APL Bumblebee Series, Report No. 95, by L. W. Fraser, the Johns Hopkins University Applied Physics Laboratory, 1948.

"Preliminary Report on High Altitude Photography," by C. T. Holliday, Photogr. Engr. 1:16, 1950.

"Panel Report No. 18," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 29 September 1948.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-8

1 November 1948

IDENTIFICATION

Agency: Applied Physics Laboratory
me: 1715 MST
.citude: 56.5 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Three geiger counters in a triangular array (housed in a lead cylinder 5 mm. thick) to supplement similar measurements in V-2 40 of the transition effects of the primary cosmic radiation in lead.
Solar radiation: Soft X-ray film detectors (Naval Research Laboratory).

DATA RECOVERY INSTRUMENTS

Telemeter: DOV^P airborne transceiver used as a single channel system.
Physical recovei,. Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Four stations
- Doppler: Four stations
- Impact location: Sound ranging.

Airborne
- Doppler: DOVAP transceiver unit
- Radio cutoff: NMCA&MA - APL FM control receiver for fail safe fuel cutoff.
- Aspect: GSAP 16 mm. motion picture camera.

ROCKET PERFORMANCE

Firing angle: 2.9 degrees North and 0.4 degrees East
Time to booster separation: 2.4 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 40.5 sec.
Altitude at burnout: 15.5 miles
Velocity at burnout: 3623 ft. per sec.
Time to zenith: 162 sec.
Altitude at zenith: 56 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 33.5 miles North and 8.4 miles West
Payload weight: 182 lbs.
Unfueled rocket weight: 456 lbs.
Unfueled rocket C.G.: 126.7 inches
Gross weight at takeoff: 1102 lbs.

BALLISTIC DATA

Theodolites: All Askanias tracked beyond peak, five tracked to near impact; two Mitchells tracked for 100 sec.
Cameras: Insufficient light to obtain images on all film
Telescopes: Images to 140 sec.
Doppler: Velocity, position, and acceleration data; vector velocity, and vector acceleration with magnitude, zenith angle, and azimuthal plane. Roll period.

DATA RECOVERY

Telemeter: Generally good record with some nulls due to roll
Physical recovery: X-ray detectors not recovered, parts of nose scattered over a 4 sq. mile area.

EXPERIMENTAL DATA

Cosmic Radiation: Transition effects of primary cosmic radiation in 5 mm of lead measured.
Solar radiation: No data

COMMENTS

Rocket performance: Propulsion normal until 40.5 sec. when burning ceased, resulting in subnormal altitude.
Rocket modification: Wooden nose cone replaced usual aluminum cone.

REPORTS AND PAPERS

Bumblebee Series Report No. 95, by L. W. Fraser, Applied Physics Laboratory, The Johns Hopkins University, December 1948.

"The Transition Effects of the Primary Cosmic Radiation in Lead, Aluminum, and the Atmosphere," by J. A. VanAllen, Proceedings of the Echo Lake Cosmic Ray Symposium, June 23-28, 1949, published by the Office of Naval Research, November 1949.

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

"Panel Report No. 19," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 5 January 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-9

1 March 1949

IDENTIFICATION

Agency: Applied Physics Laboratory

UPPER AIR INSTRUMENTS

No upper air instruments

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system with test oscillator
Physical recovery: None

BALLISTIC INSTRUMENTS

Firing and Support Ships
Cameras: 35 mm. Mitchell (17 in. focal length) mounted on Mk 25 radar antenna of Mk 37 gun directors on firing and two support ships.
Optical: 20 x 120 binoculars mounted on Mk 51 gun director.
Radar: SP radar with stabilized SM antenna, and Mk 25 automatic tracking radar mounted on Mk 37 gun director.
Other: 35 mm. Mitchell camera in Command Operations Center to photograph data dial box giving ship's course, relative target bearing, target elevation, range, level, and cross level angles for Mk 25 and SP radar systems.

Airborne: None

ROCKET PERFORMANCE

Comments: Dummy firing to evaluate shipboard launching procedures and shortened tower.
Results: Satisfactory

UPPER AIR ROCKET SUMMARY

AEROBEE
A-10

17 March 1949

IDENTIFICATION

Agency: Applied Physics Laboratory
Location: Longitude, 88 degrees West; Latitude, 11 degrees South
Time:
Altitude: 65 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Pair of crossed wide angle geiger counter telescopes with axes inclined 45 degrees to rocket axis to measure total intensity at zenith angle 45 degrees and azimuthal distribution.
Pair of geiger counter telescopes with axes mutually perpendicular with one axis parallel to rocket axis. To measure total vertical and horizontal intensity.
Single unshielded geiger counter to measure average total cosmic ray intensity.

Magnetic field: Magnetometer to measure change in magnetic field, particularly in search of discontinuity caused by current sheets.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system.
Physical recovery: None

BALLISTIC INSTRUMENTS

Firing and Support Ships
Cameras: 35 mm. Mitchell, 17 in. focal length, mounted on Mk 25 radar antenna of Mk 37 gun director on firing ship and two support ships.
Optical: Mk 51 gun director equipped with 20 x 120 binoculars.
Radar: SP radar with stabilized SM antenna, and Mk 25 automatic tracking radar mounted on Mk 36 gun director.
Other: 35 mm. Mitchell camera in command operation center to photograph data dial box giving ships course, relative target bearing, target elevation, range, level, and cross level angles for Mk 25 and SP radar systems.

Airborne
Aspect: Magnetometer and photocell orientors.
Radio cutoff: None.

ROCKET PERFORMANCE

Comment: No information reduced to determine performance details.
Altitude at zenith: 65 miles
Payload weight: 157 lbs.

BALLISTIC DATA

Cameras: Optical tracking of Mk 37 very good with data past burnout.
Optical: Binocular-gun director combination superior to camera system.
Radar: SP radar provided range data and Mk 37 radar provided elevation and bearing data to 39.7 miles slant range, which was independent of that obtained by triangulating supporting ship data.
Aspect: Record of angles between rocket longitudinal axis and solar vector, and angles between rocket axis and local terrestrial magnetic field. These provided a unique solution which described the rocket angular motion.

DATA RECOVERY

Telemeter: Good record
Physical recovery: None attempted.

EXPERIMENTAL DATA

Cosmic radiation: Vertical intensity of charged particles above the atmosphere at magnetic equator is 0.028 particles per sec. per cm^2. per stearadian. Measured asymmetry can be consistent with belief that most ordinary primaries are positively charged protons.

Magnetic field: Field between 12.4 and 65.3 miles altitude decreased in accordance with simple dipole field theory. Solar daily variation minimum at time of firing and no field discontinuity was detected.

COMMENTS

Rocket performance: This first of a group of live firings from shipboard (USS NORTON SOUND, AV-11) with a shortened tower proved the feasibility of this type of operation.

REPORTS AND PAPERS

"The Cosmic Ray Intensity Above the Atmosphere at the Geomagnetic Equator", by J. A. Van-Allen and A. V. Gangnes, Phys. Rev. 79:51, 1950.

"On the Azimuthal Asymmetry of Cosmic Ray Intensity Above the Atmosphere at the Geomagnetic Equator," by J. A. VanAllen and A. V. Gangnes, Phys. Rev. 79:51, 1950.

"Evidence for Ionosphere Currents from Rocket Experiments Near the Geomagnetic Equator," by S. F. Singer, E. Maple, and W. A. Bowen, J. of Geophs. Res., 56:265, 1951.

"Panel Report #20," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 21 April 1949.

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-11

22 March 1949

IDENTIFICATION

Agency: Applied Physics Laboratory
Location: Longitude, 88 degrees West; latitude, 11 degrees South
Time: 1730 GCT
Altitude: 65 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Low pressure hydrogen filled geiger counters to measure high specific ionization in conjunction with data from Aerobee A-10, also to measure production of narrow angle cosmic ray showers. Four-fold geiger counter telescope to measure average specific ionization, total intensity, and azimuthal distribution of radiation. Counter telescope identical to above but shielded with 2 cm. lead, to study narrow showers.
Magnetic field: Magnetometer to measure altitude dependence of terrestrial magnetic field.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system
Physical recovery: None.

BALLISTIC INSTRUMENTS

Firing and Support Ships
- Cameras: 35mm. Mitchell (17 in. focal length) mounted on Mk 25 radar antenna of Mk 37 gun directors on firing and two support ships.
- Optical: 20 x 120 binoculars mounted on Mk 51 gun director.
- Radar: SP radar with stabilized SM antenna, and Mk 25 automatic tracking radar mounted on Mk 37 gun director.
- Other: 35 mm. Mitchell camera in Command Operations Center to photograph data dial box giving ship's course, relative target bearing, target elevation, range, level, and cross level angles for Mk 25 and SP radar systems.

Airborne
- Aspect: Magnetometer and photocell orientors
- Radio cutoff: None.

ROCKET PERFORMANCE

Comment: No information reduced to determine performance details.
Altitude at zenith: 65 miles
Payload weight: 157 lbs.

BALLISTIC DATA

Comments: No information given concerning ballistic data result.

DATA RECOVERY

Telemeter: Record for 317 sec.
Physical recovery: No physical recovery attempted.

EXPERIMENTAL DATA

Cosmic radiation: The bulk of the ionizing radiation above the atmosphere at the geomagnetic equator carries a simple charge and has a primary specific ionization close to minimum value. These results consistent with existence of a primary radiation composed mainly of positively charged protons. The directional intensity, corresponding to an average telescope zenith angle of 45 degrees and averaged over all azimuths, was found to be 0.040 particle per sec. per cm^2. per stearadian at geomagnetic latitude 0.0 degrees, of which not more than 65% can be attributed to primaries, the remainder being due to albedo, i.e., secondary particles originating in the earth's atmosphere whose directional dependence bears no simple relationship to the primaries that caused them.

EXPERIMENTAL DATA (Continued)

Magnetic field: A discontinuity of about 4 milligauss was observed at an altitude of about 62 miles; which indicates the existence of a current layer in the E region of the ionosphere, but is insufficient to draw detailed conclusions.

COMMENTS

Rocket performance: This is second of a group of live firings from shipboard (USS NORTON SOUND, AV-11) with a shortened tower.

REPORTS AND PAPERS

"The Primary Specific Ionization and Intensity of the Cosmic Radiation Above the Atmosphere at the Geomagnetic Equator," S. F. Singer, Phys. Rev. 80:47, 1950.

"Evidence for Ionosphere Currents from Rocket Experiments Near the Geomagnetic Equator," by S. F. Singer, E. Maple, and W. A. Bowen, J. of Geophys. Res. 56:265, 1951.

"Panel Report No. 20," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 21 April 1949.

"High Altitude Research at the Applied Physics Laboratory," by S. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory of the Johns Hopkins University, May 1951.

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

24 March 1949

Agency: Applied Physics Laboratory
Time: 1514 GCT
Location: Latitude, 11 degrees 16 min. South; Longitude, 82 degrees 08 min. West
Altitude: 3.7 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Pair of crossed wide angle geiger counter telescopes with axes inclined 45 degrees to rocket axis to measure total intensity at zenith angle 45 degrees and azimuthal distribution. Pair of geiger counter telescopes with axes mutually perpendicular with one axis parallel to rocket axis to measure total vertical and horizontal intensity. Single unshielded geiger counter to measure average total cosmic ray intensity.

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system
Physical recovery: None

BALLISTIC INSTRUMENTS

Firing and Support Ships

Cameras: 35 mm. Mitchell, 17 inch focal length, mounted on Mk 25 radar antenna of Mk 37 Gun Director on firing ship and two support ships.

Optical: Mk 51 Gun Director equipped with 20 x 120 binoculars.

Radar: SP radar with stabilized SM antenna, and Mk 25 automatic tracking radar mounted on Mk 37 Gun Director.

Other: 35 mm. Mitchell camera in Command Operation Center to photograph data dial box displaying ship's course, relative target bearing, target elevation, range level, and cross level angles for Mk 25 and SP radar systems.

ROCKET PERFORMANCE

Comments: Leak in gas pressurizing regulator resulted in unboosted takeoff.

EXPERIMENTAL DATA

Comments: No data obtained.

REPORTS AND PAPERS

"Panel Report No. 20," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 21 April 1949, dated 2 May 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-13

IDENTIFICATION

17 June 1949

Agency: Applied Physics Laboratory
Time: 0450 MST
Altitude: 55 miles.

UPPER AIR INSTRUMENTS

Comments: No upper air experiments.

ROCKET PERFORMANCE

Comments: Configuration of nose materially altered for an aerodynamics experiment, therefore the performance data are not typical.

REPORTS AND PAPERS

Naval Ordnance Laboratory Memorandum 10124, Naval Ordnance Laboratory, Washington, D.C.
"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, the Johns Hopkins University, May 1951.
"Panel Report No. 21," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 3 August 1949, dated 1 September 1949.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-14

23 June 1949

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1621 MST
Altitude: 55 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Four-fold geiger counter telescope to measure average specific ionization of charged cosmic rays and their total intensity and azimuthal distribution.
Solar radiation: Quartz optics ozone spectrograph with automatic azimuthal positioning of pickup mirror with a photoelectric sun follower. Soft X-ray film detectors (Naval Research Laboratory).

DATA RECOVERY INSTRUMENTS

Telemeter: Six channel APL FM-FM system.
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and six Askania stations.
- Cameras: Two Ballistic and three Bowen-Knapp stations.
- Telescopes: Three stations
- Impact location: Three observers and SCEL GR3-C sound ranging set, and Impact Point Predictor.

Airborne
- Radio cutoff: NMCA&MA - APL FM control receiver for fail safe fuel cutoff.

ROCKET PERFORMANCE

Firing Angle:
Time to booster separation: 2.7 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 42 sec.
Altitude at burnout: 14.3 miles
Velocity at burnout: 3445 ft. per sec.
Time to zenith:
Altitude at zenith: 55 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 23 miles North and 5 miles West
Payload weight: 191 lbs.
Unfueled rocket weight:
Unfueled rocket C.G.: 463 lbs.
Gross weight at takeoff: 1109 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 51 sec., roll data; Mitchell trajectory data 0 to 20 sec.
Cameras: Good data from Bowen-Knapp.
Telescopes: Attitude data 0 to 25 sec.
Impact location: Prediction from both sound ranging systems.

DATA RECOVERY

Telemeter: Good records for 293 sec. with 3 sec. lost.
Physical recovery: Nose section not recovered, body located quickly.

EXPERIMENTAL DATA

Cosmic radiation: No comments furnished.
Solar radiation: Intensity of sunlight at 3708, 3002, 3204, and 2646 Angstroms obtained as a function of altitude.

COMMENTS

Rocket Performance: Roll CCW from tail: 9.4 RPM at 5.7 sec., 14.0 RPM at 11.0 sec., 16.2 RPM at 15.1 sec., and 18.4 RPM at 18.4 sec.

REPORTS AND PAPERS

"The Specific Ionization of the Cosmic Radiation Near the Pfotzer Maximum at L 41° N," by S. F. Singer, Phys. Rev. 77:730, 1950.

"Panel Report No. 21," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel, on 3 August 1949, dated 1 Sept. 1949.

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, The Applied Physics Laboratory of the Johns Hopkins University, May 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-15

15 January 1950

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 2345 GCT
Location: Geomagnetic latitude 58° N (Gulf of Alaska).
Altitude: 45 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Two triangular arrays of geiger counters surrounding brass block to measure burst production cross section, angular distribution, and multiplicity of bursts produced in brass. Vertical telescope of six geiger counter trays to measure the intensity and specific ionization of the radiation in a vertical direction. Horizontal telescope of five geiger counter trays to measure horizontal intensity.

DATA RECOVERY INSTRUMENTS

Telemeter: Two six channel APL FM-FM systems
Physical recovery: None attempted.

BALLISTIC INSTRUMENTS

Firing Ship
Optical: Two Mk 51 gun directors equipped with 20 x 120 binoculars to aid visual tracking.
Radar: SP radar with photographic recording of data dial box and range scope.
Cameras: 35mm. Mitchell on Mk 25 antenna of Mk 37 gun director.

Airborne
Radio cutoff: None
Aspect: NOL Magnetometer orientor and photoelectric cell orientor.

Other
Cameras: Motion picture and still cameras to record launching and early portion of flight.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout:
Altitude at burnout:
Velocity at burnout:
Time to zenith:
Altitude at zenith: 45 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 162 lbs.
Empty rocket weight: 446 lbs.
Empty rocket C.G.:
Gross weight at launching: 1068 lbs.

BALLISTIC DATA

Comments: No comments furnished by instrumenting agency.

DATA RECOVERY

Telemeter: Complete record for 253 sec. with one sec. lost time.

EXPERIMENTAL DATA

Cosmic radiation: Absolute directional intensity of charged particles above the atmosphere and the primary cosmic ray spectrum obtained.

COMMENTS

Rocket modification: Helium pressurization used. Normal nose cone replaced with a cylinder surmounted with a 13 degree (half angle) cone.

REPORTS AND PAPERS

"On the Primary Cosmic Ray Spectrum," by J. A. VanAllen and S. F. Singer, Phys. Rev. 78:819, 1950

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

"Panel Report No. 23, "Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 15 Feb. 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-16

18 January 1950

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 2317 GCT
Location: Geomagnetic latitude 50° N (Off coast of Southern Washington).
Altitude: 50 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Two triangular arrays of geiger counters surrounding brass block to measure burst production cross section, angular distribution, and multiplicity of bursts produced in brass. Vertical telescope of six geiger counter trays to measure the intensity and specific ionization of the radiation in a vertical direction. Horizontal telescope of five geiger counter trays to measure horizontal intensity.

DATA RECOVERY INSTRUMENTS

Telemeter: Two six channel APL FM-FM systems.
Physical recovery: None attempted.

BALLISTIC INSTRUMENTS

Firing Ship
Cameras: 35 mm. Mitchell on Mk 25 antenna of Mk 37 gun director
Optical: Two Mk 51 gun directors equipped with 20 x 120 binoculars to aid visual tracking.
Radar: CP radar with photographic recording of data dial box and range scope.

Airborne
Radio cutoff: None
Aspect: NOL magnetometer orientor and photocell orientor.

Other
Cameras: Motion picture and still cameras to record launching and early portion of flight.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude to booster separation:
Velocity at booster separation:
Time to burnout:
Altitude at burnout:
Velocity at burnout:
Time to zenith:
Altitude at zenith: 50 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 162 lbs.
Empty rocket weight: 442 lbs.
Empty rocket C.G.:
Gross weight at launching: 1068 lbs.

BALLISTIC DATA

Comments: No data furnished by instrumenting agency.

DATA RECOVERY

Telemeter: One transmitter operated satisfactorily for 268 sec., modulator of other transmitter failed at takeoff

EXPERIMENTAL DATA

Cosmic radiation: Data on absolute directional intensity of charged particles above the atmosphere and the primary cosmic ray spectrum obtained.

COMMENTS

Rocket modification: Helium pressurization used. Normal nose cone replaced with a cylinder surmounted with a 13 degree (half angle) cone.

REPORTS AND PAPERS

"On the Primary Cosmic Ray Spectrum," by J. A. VanAllen and S. F. Singer, Phys. Rev. 78:819, 1950.

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

"Panel Report No. 23, "Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 15 Feb. 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-17

12 May 1950

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 0530 MST
Altitude: 54.7 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Two triangular arrays of geiger counters surrounding brass block to measure burst production cross section, angular distribution, and multiplicity of bursts produced in brass. Vertical telescope of six geiger counter trays to measure the intensity and specific ionization of the radiation in a vertical direction. Horizontal telescope of five geiger counter trays to measure horizontal intensity.

DATA RECOVERY INSTRUMENTS

Telemeter: Two six channel APL FM-FM systems
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations
Cameras: Two Bowen-Knapp stations
Telescopes: Two stations
Radar: One modified SCR-584 S-band station
Impact location: Three sound ranging stations, SCEL GR3-C sound ranging set, and Impact Point Computer.

Airborne
Radio cutoff: ARW-37 FM control receiver for command fuel cutoff.
Aspect: NOL magnetometer orientor and photocell orientor.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation: 2.6 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.1 sec.
Altitude at burnout: 15.4 miles
Velocity at burnout: 3550 ft. per sec.
Time to zenith: 163 sec.
Altitude at zenith: 54.7 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 14.6 miles North and 5 miles East
Payload weight: 153 lbs.
Unfueled rocket weight: 452 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1074 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 94 sec., Mitchell trajectory data 0 to 54 sec.
Cameras: Trajectory data 0 to 3.9 sec.
Telescopes: Attitude and roll data for entire flight.
Radar: Trajectory data 0 to 35 sec.
Impact location: No comments furnished by instrumenting agency.
Aspect: No comments furnished.

DATA RECOVERY

Telemeter: Good signals 0 to 130 sec., then signals failed
Physical recovery: Telescoped instruments found 1/2 mile South of main body impact.

EXPERIMENTAL DATA

Cosmic radiation: Data on absolute directional intensity of charged particles above the atmosphere and the primary cosmic ray spectrum was obtained.

COMMENTS

Rocket performance: Roll rate 10 RPM
Rocket modifications: Helium pressurization used. Normal nose cone replaced with a cylinder surmounted with a 13 degree (half angle) cone.

REPORTS AND PAPERS

"On the Primary Cosmic Ray Spectrum," by J. A. VanAllen and S. F. Singer, Phys. Rev. 78:819, 1950.
"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.
"Panel Report No. 25," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 13 and 14 June.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-18
17 August 1950

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 0845 MST
Altitude: 63 miles.

UPPER AIR INSTRUMENTS

Composition: Radio frequency mass spectrometer to measure the abundance ratio of Oxygen and Nitrogen.

DATA RECOVERY INSTRUMENTS

Telemeter: Two six channel APL FM-FM systems
Airborne recorder: Magnetic tape
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Five stations
Impact location: Impact Point Computer.

Airborne
Radio cutoff: NMCA&MA-APL FM co[illegible] receiver for fail-safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 2.7 degrees North and 0.2 degrees East
Time to booster separation: 2.4 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 42 sec.
Altitude at burnout: 16.0 miles
Velocity at burnout: 2960 ft. per sec.
Time to zenith: 170-175 sec.
Altitude at zenith: 63 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 182 lbs.
Unfueled rocket weight: 467 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1089 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 53 - 58 sec., Mitchell trajectory data 0 to 60 sec.
Cameras: Bowen-Knapp trajectory data 0 to 3.1 sec.
Telescopes: Two station images to near peak, one station to 150 sec., one station to 180 sec.
Impact location: No comments furnished.

DATA RECOVERY

Telemeter: Good records for 310 sec.
Physical recovery: No recovery.

EXPERIMENTAL DATA

Composition: No data.

COMMENTS

Rocket performance: Roll rate increased from 7 RPM at 9.7 sec. to 10 RPM at 39.7 sec.
Experiment: Mass spectrograph failed.

REPORTS AND PAPERS

"A Report of Aerobee A-18," by A. V. Gangnes and J. W. B. Barghausen, CF 1565, Applied Physics Laboratory, The Johns Hopkins University, Dec. 1950.
"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.
"Panel Report No. 28," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-19

22 January 1951

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1555 MST
Altitude: 55 miles.

UPPER AIR INSTRUMENTS

Composition: Radio frequency mass spectrometer to measure the abundance ratio of Oxygen and Nitrogen.

DATA RECOVERY INSTRUMENTS

Telemeter: Two six channel APL FM-FM systems
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Three stations
Radar: Two modified SCR-584 S-band stations
Impact location: Impact Point Computer.

Airborne
Radio cutoff: NMCA&MA-APL FM control receiver for fuel cutoff.

ROCKET PERFORMANCE

Firing Angle: 3.0 degrees North and o.6 degrees East
Time to booster separation: 2.3 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 41.6 sec.
Altitude at burnout: 15.2 miles
Velocity at burnout: 3690 ft. per sec.
Time to zenith: 157 sec.
Altitude at zenith: 55 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 27.1 miles North and 3.0 miles East
Payload weight: 172 lbs.
Unfueled rocket weight 463.5 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1085.5 lbs.

BALLISTIC DATA

Theodolites: Mitchell obtained images 0 to 90 sec.; Askanias tracked less than 109 sec.
Cameras: No information provided
Telescopes: Attitude data 0 to 52 sec. and 233 sec. to impact
Radar: Trajectory data 0 to 56 sec.; intermittent thereafter
Impact Point Computer: Position and velocity data 0 to 88 sec., tracking until breakup, good impact prediction.

DATA RECOVERY

Telemeter: Continuous record to breakup
Physical recovery: Rocket recovered.

EXPERIMENTAL DATA

Composition: No data, mass spectrometer failed.

COMMENTS

Rocket performance: Booster and rocket burning times shorter than normal. Rocket rolled through 600 degrees CCW from 1.2 to 17.1 sec., and then rolled 60 degrees CW from 17.1 to 25.5 sec., no rotation observed thereafter.

Rocket modifications: Helium pressurization used.

REPORTS AND PAPERS

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

"Panel Report No. 28," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 7 and 8 September 1950.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-20

IDENTIFICATION

25 January 1951

Agency: Applied Physics Laboratory
Time: 0800 MST
Altitude: 56 miles.

UPPER AIR INSTRUMENTS

Composition: Quartz optics spectrometer to measure the vertical distribution of ozone.

DATA RECOVERY INSTRUMENTS

Telemeter: Two six channel APL FM-FM systems
Physical recovery: Separation of tail section with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and six Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Four stations
Radar: Two modified SCR-584 S-band stations
Impact location: Impact Point Computer.

Airborne
Radio cutoff: NMCA&MA-APL FM control receiver for fail-safe fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 2.7 degrees North and 0.2 degrees East
Time to booster separation: 2.5 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.5 sec.
Altitude at burnout: 16.9 miles
Velocity at burnout: 3720 ft. per sec.
Time to zenith: 159 sec.
Altitude at zenith: 56 miles
Time to blowoff: Breakup at 309.2 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates:
Payload weight: 132.5 lbs.
Unfueled rocket weight: 425 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1047 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 60 sec., Mitchell - 0 to 50 sec.
Cameras: Trajectory data 0 to 4 sec.
Telescopes: Attitude data to breakup
Radar: Trajectory data from one station to peak.
Impact location:

DATA RECOVERY

Telemeter: Good record from takeoff to breakup
Physical recovery: Not recovered.

EXPERIMENTAL DATA

Composition: Vertical distribution of ozone measured.

COMMENTS

Rocket performance: Zenith altitude considerably less than expected for the payload carried. Rocket rotated CCW through 240 degrees between 1 and 3.6 sec., 60 degrees CW between 3.6 and 6.6 sec., and then began to roll CCW.

REPORTS AND PAPERS

"High Altitude Distribution of Atmospheric Ozone," J. A. VanAllen and J. J. Hopfield, to be published.

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 31 January 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
A-21

6 February 1951

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1020 MST
Altitude: 61 miles.

UPPER AIR INSTRUMENTS

High altitude photography: (Classified).

DATA RECOVERY INSTRUMENTS

Telemeter: Two two channel APL FM-FM systems
Physical recovery: Tail section separation with prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and six Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Four stations
Impact location: Impact Point Computer.

Airborne
Radio cutoff: NMCA&MA-APL FM control receiver for fail-safe fuel cutoff and recovery separation.

ROCKET PERFORMANCE

Firing angle: 3.0 degrees North and 0.6 degrees East
Time to booster separation: 2.51 sec.
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 42.3 sec.
Altitude at burnout: 14.2 miles
Velocity at burnout: 3500 ft. per sec.
Time to zenith:
Altitude at zenith: 61 miles
Time to blowoff: 250.7 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates: 38.4 miles North and 8.9 miles West
Payload weight: 204 lbs.
Unfueled rocket weight: 492 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1114 lbs.

BALLISTIC DATA

Theodolites: No Askania data, trajectory data 0 to about 42 sec.
Cameras: Trajectory data 0 to about 4 sec.
Telescopes: Attitude data 0 to 60 sec.
Radar: Trajectory data 0 to 50 sec.
Impact location: Good prediction.

DATA RECOVERY

Telemeter: Good record to 350 sec
Physical recovery: Camera film recovered in good condition.

COMMENTS

Experiments: Good results obtained from cameras
Rocket performance: Burning time slightly short, performance good, Rocket rotated 120 degrees CCW from 1.9 to 4.0 sec.; 30 degrees CW from 4.0 sec. to 8.2 sec.; began to roll CCW after 8.2 sec.
Rocket modification: Helium pressurization used.

REPORTS AND PAPERS

"High Altitude Research at the Applied Physics Laboratory," by L. W. Fraser, Bumblebee Series Report No. 153, Applied Physics Laboratory, The Johns Hopkins University, May 1951.

"Panel Report No. 27," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel Meeting on 31 June 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-1

5 August 1948

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1837 MST
Altitude: 60 miles

UPPER-AIR INSTRUMENTS

Solar radiation: Ozone spectrograph
Pressure-temperature: Pirani and bellows gages at nose tip for ram pressure, and pirani gages ahead of fins for ambient pressure.

DATA-RECOVERY INSTRUMENTS

Telemeter: APL six channel FM-FM system
Physical recovery: Separation of single fin with primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Four stations
Radar: One modified SCR-584 S band station, and one modified SCR-584 X band station
Doppler: None
Impact location: None

Airborne
Radio cutoff: APL-NMCA&MA FM control receiver

ROCKET PERFORMANCE

Firing angle:
Time to booster separation
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44.9 sec.
Altitude at burnout: 16.1 miles
Velocity at burnout: 3820 ft. per sec.
Time to zenith:
Altitude at zenith: 60.2 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 16.8 miles North and 1.0 miles East
Payload weight: 207 lbs.
Unfueled rocket weight:
Unfueled rocket C. G.: 119 inches
Gross weight at takeoff: 1120 lbs.

BALLISTIC DATA

Theodolites: One Askania obtained record 0 to 80 sec.
Cameras:
Telescopes: 10 in. telescope obtained record 0 to 100 sec.
Radar:
Impact location: Two visual fixes obtained, sound ranging within 1/4 mile of actual impact.

DATA RECOVERY

Telemeter: No record from one ground station, record 0 to 200 sec. obtained from other.
Physical recovery: Single fin blowoff inadequate. Spectrograph cassette recovered in good condition, rocket badly damaged.

EXPERIMENTAL DATA

Solar radiation: No useable data, film jammed in flight.
Pressure-temperature: Tabulated data in reasonable agreement with previous data.

REPORTS AND PAPERS

Aerobee Progress Report No. 6, WSPG serial NP(WSPG)S78-1(2m)/MHS: dp (18) -(052), dated 17 August 1948.

Askania Graphical and Numerical Data, Venus No. 1, BRL-WSPG.

"Pressures and Temperatures in the Earth's Upper Atmosphere," R. Havens, R. Koll, and H. LaGow, Naval Research Laboratory Reprint, March 1950.

"The Pressure, Density, and Temperature of the Earth's Atmosphere to 160 Kilometers," by R. Havens, R. Koll, and H. LaGow, J. of Geophys. Res., 57:59-72, March 1952.

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-2

28 January 1949

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 2317 MST
Altitude: 60 miles

UPPER-AIR INSTRUMENTS

Cosmic radiation: Soft Gamma Ray Geiger counter bundle.
Pressure-temperature: Ram pressure gage at nose tip, ambient pressure gages at base of nose section and ahead of fins.
Ionosphere: Electrostatic field voltmeter on nose.
Solar radiation: X-ray film plate detectors with foil filters.

DATA-RECOVERY INSTRUMENTS

Telemeter: APL 6 channel FM-FM system.
Physical recovery: Separation of tail section with primacord actuated by air pressure switch.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations.
Cameras: Two Ballistic and three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: None
Doppler: None
Impact location: Sound ranging stations.

Airborne
Radio cutoff: APL - NMCA&MA FM control receiver for fail-safe fuel cutoff.

Other
Spectrographic camera.

ROCKET PERFORMACE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 44 sec.
Altitude at burnout:
Velocity at burnout: 4000 ft. per sec.
Time to zenith:
Altitude at zenith: 60 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 49.4 miles North and 10.6 miles East.
Payload weight:
Unfueled rocket weight:
Unfueled rocket C. G.: 114.2 in.
Gross weight at takeoff: 1089.5 lbs.

BALLISTIC DATA

Theodolites: Askania images 0 to 29 sec., Mitchell images 0 to 9 sec.
Cameras:
Telescopes: Three stations tracked 0 to 44 sec., had images 0 to 5 sec., remaining station obscured by clouds.
Impact location: Insufficient data to obtain location.

DATA RECOVERY

Telemeter: Signals erratic after 42 sec., two channels unreadable after 51.7 sec., signals intermittent after 56.6 sec., weak sporadic RF signals after 71.7 sec., some data recorded at 236.8 sec.
Physical recovery: Rocket body recovered in fair condtion six months after firing, tail section not found. X-ray detectors damaged by long exposure.

EXPERIMENTAL DATA

Cosmic radiation: Gamma ray intensity measured up to 16.7 miles.
Pressure-temperature: No data obtained due to low altitude telemeter failure.
Solar radiation: No data, film damaged.

COMMENTS

Folded dipole antenna substituted at nose tip for standard probe antenna, Telemeter signal failure attributed to internal causes.
Unsatisfactory weather conditions delayed firing from 17 Jan. Second attempt on 21 Jan., after fueling and pressurizing a regulator valve leak ruptured oxidyzer burst diaphragm and fuel leak appeared at fuel filling boss. Mixture ignited at edge of burner and an emergency attempt at firing failed. Rocket repaired and a third firing attempt failed due to high winds and rocket fired during fourth attempt.

REPORTS AND PAPERS

NRL Serial 3420-521/48dlj (3423CPS), Aerobee Venus 2, Request for Firing.

WSPG Serial NP(WSPG)S78-1(13-11)MHS:dp(18)-(204), Aerobee Progress Report No. 8, Conduct of Firing of Aerobee Venus 2.

WSPG Serial NP(WSPG)S78-1(2-5) JAP:jb(18)-(823), Supplement to Aerobee Progress Report No. 8, Conduct of Firing of Aerobee Venus No. 2.

NMCA&MA, BRL-APG, Venus 2, January 28, 1949, Bowen Knapp Graphical and Numerical Data
NMCA&MA, BRL-APG, Venus 2, January 28, 1949, Askania Graphical and Numerical Data.

AEROBEE
NRL-3

UPPER AIR ROCKET SUMMARY

1 February 1949

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1138 MST
Altitude: 0 miles

UPPER-AIR INSTRUMENTS

Solar radiation: Sunfollower-spectrograph (1600 to 4000 Angstroms) and a fixed angle spectrograph (1000-3000 Angstroms). Film transporting X-ray detector with foil filters.

DATA-RECOVERY INSTRUMENTS

Telemeter: None
Physical recovery: Tail section separation with primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations.
Camera: Two Ballistic and three Bowen Knapp stations.
Telescopes: Four stations.
Radar: None
Doppler: None
Impact location: Sound ranging stations.

Airborne
Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff.

Other
Spectro camera: One station.

ROCKET PERFORMANCE

Comments: Booster exploded at ignition and severely damaged rocket which moved out of launching tower and immediately fell to ground where it exploded. Booster failure due to fractured propellant grain.

Payload weight: 137.7 lbs.
Unfueled rocket weight: 421.5 lbs.
Unfueled rocket C. G.: 114.2 in.
Gross weight at takeoff: 1062.5 lbs.

EXPERIMENTAL DATA

Comments: Instrumentation a total loss due to rocket failure, no data.

REPORTS AND PAPERS

Request for Firing of Venus 3, NRL serial 3420-498/48 (3423CPS).

Aerobee Progress Report No. 9, Conduct of Firing of Aerobee Venus 3, WSPG-NUWS.

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-4

14 February 1950

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1614 MST
Altitude: 54.4 miles

UPPER-AIR INSTRUMENTS

Cosmic radiation: Wilson cloud chamber, and a soft Gamma Ray Geiger counter bundle.
Pressure-temperature: Ambient pressure gages ahead of tail fins.

DATA-RECOVERY INSTRUMENTS

Telemeter: APL 6 channel FM-FM system.
Physical recovery. Tail section separation with primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and nine Askania stations.
Cameras: Two Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified SCR-584 S band stations.
Doppler: None
Impact location: Impact Point Computer; twelve sound ranging stations, and one Signal Corps GR-3 sound ranging set.

Airborne
Beacon: None, reflection tracking used.
Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff and recovery blowoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 42 sec.
Altitude at burnout: 14.8 miles
Velocity at burnout: 3500 ft. per sec.
Time to zenith: 157 sec.
Altitude at zenith: 54.4 miles
Time to blowoff: 263.4 sec.
Altitude at blowoff:
Flight duration: 500 sec.
Impact coordinates: 24 miles North and 7.9 miles East.
Payload weight: 176.3 lbs.
Unfueled rocket weight:
Unfueled rocket C. G.:
Gross weight at takeoff: 1104.8 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 211 sec., Mitchell trajectory data 0 to 41.4 sec.
Cameras: Bowen Knapp trajectory data 0 to 2.5 sec.
Telescopes: Orientation and yaw angles 0 to 79 sec., elevation and azimuth angles 0 to 79 sec.
Radar: Tracked to burnout on sporadic signals.
Impact location: Sound ranging error 1/2 mile. Geophone error 1.9 mile.

DATA RECOVERY

Telemeter: Overall quality of record good.
Physical recovery: Cloud chamber film in good condition. Nose section of rocket located within one hour of impact.

EXPERIMENTAL DATA

Cosmic radiation: Film badly overexposed after first two frames. Pictures showed excessive amount of background fog attributed to over expansion of cloud chamber. Excessive expansion ratio attributed to loss of gas during launching from motion of chamber face plate. Gamma radiation intensities obtained up to 49.7 miles.
Pressure-temperature: No significant data obtained due to erratic rocket aspect.

COMMENTS

Rocket performance: Propulsion performance sub normal, burner blow-back at burnout. Roll 20 rpm at booster separation, and rose to 50 rpm by burnout. Pitching and yawing with 2 sec perion by burnout.

REPORTS AND PAPERS

Request for Firing of Aerobee Venus 4, NRL serial 3420-123/49dlj (3423CPS)

Progress Report No. 12, Conduct of Firing of Aerobee NRL-4, WSPG serial NP(WSPG)S78-1(13-v) JAP:afw(18)(1513).

Attitude and Yaw Data from Tracking Telescope Observations of Aerobee NRL-4, Launched 14 February 1950, BRL Technical Note 221.

Trajectory Data from Askania Camera Observations of NRL Aerobee 4, Launched 14 February 1950, BRL Technical Note No. 189.

Trajectory Data from Mitchell Theodolite Observations of Aerobee NRL-4, Launched 14 February 1950, BRL Technical Note No. 212.

"A Search for Primary Cosmic Gamma Radiation. II. Low Energy Radiation Above and Within the Atmosphere," by G. J. Perlow and C. W. Kissinger, Phys. Rev. 84:572-580, 1 November 1951.

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-5

14 June 1949

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1903 MST
Altitude: 68 miles

UPPER-AIR INSTRUMENTS

Solar radiation: One fixed angle, lithium flouride aperture, ozone spectrograph, and one fixed angle, slit aperture, ozone spectrograph.
Six X-radiation film plate detectors with foil filters.

DATA-RECOVERY INSTRUMENTS

Telemeter: None
Physical recovery: Tail section separation with primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations.
Cameras: Two Ballistic and three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: None
Doppler: None
Impact location: Impact Point Computer and nine sound ranging stations.

Airborne
Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff and recovery blowoff.

ROCKET PERFORMANCE

Firing angle:
Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 45.6 sec.
Altitude at burnout: 16.8 miles
Velocity at bourout: 4185 ft. per sec.
Time to zenith:
Altitude at zenith: 68 miles
Time to blowoff:
Flight duration:
Impact coordinates: 34.8 miles North and 3.4 miles West.
Payload weight: 142.8 lbs.
Unfueled rocket weight: 279.6 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 1060.2 lbs.

BALLISTIC DATA

Theodolites: Mitchell trajectory data 0 to 46 sec., Askania trajectory data 0 to 38 sec.
Cameras: Ballistic- no data; Bowen-Knapp trajectory data 0 to 24 sec.
Telescopes:
Impact location: Incomplete sound ranging data- no prediction. Geophone data 1 mile South and 1 mile West of actual impact.

DATA RECOVERY

Physical revovery: Very good recovery, four of six X-ray detectors and spectrograph film cassettes in excellent condition, in spite of two days exposure to the elements.

EXPERIMENTAL DATA

Solar radiation: Solar intensity distribution obtained down to 2100 Angstroms and the ozone distribution calculated up to 43.5 miles.

REPORTS AND PAPERS

Request for Firing of Aerobee Venus 5, NRL Serial 3420-117/49 dlj (3423CPS).

Report on Firing of Aerobee NRL-5, WSPG Serial NP(WSPG)S78-1(13-V)JAP:dp(18)-(711)

Trajectory Data from Mitchell Theodolite Observations of Aerobee Venus 5, BRL Technical Note No. 111

Trajectory Data from Bowen-Knapp Camera Observations of Venus Round 5, BRL Technical Note No. 43.

Trajectory Data from Askania Cameria Observations of Venus Round 5, BRL Technical Note No. 38.

Ballistic Wind Data at 1903 MST on 14 June 1949, WSPG Air Weather Detachment.

"Measurements of the Vertical Distribution of Atmospheric Ozone from Rockets," by F. Johnson, J. Purcell and R. Tousey, J. Geophys. Res., 56:583-594, December 1951.

"Direct Measurements of the Vertical Distribution of Ozone to 70 Kilometers Altitude," by F. Johnson, J. Purcell, R. Tousey, and K. Watanabe, J. Geophys. Res., 57:157-176, June 1952.

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-6

IDENTIFICATION

3 August 1950

Agency: Naval Research Laboratory
Time: 1652 MST
Altitude: 3.7 miles

UPPER-AIR INSTRUMENTS

Solar radiation: Sunfollower- spectrograph. Three X-radiation film detectors with metal foil filters.

DATA-RECOVERY INSTRUMENTS

Telemeter: None
Physical recovery: Tail section separation with primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and seven Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: None
Doppler: None
Impact location: Impact Point Computer, and Geophone set GR-3 for sound ranging.

Airborne
Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff and recovery blowup.

ROCKET PERFORMANCE

Velocity at burnout: 900 ft. per sec.
Time to zenith: 35 sec.
Altitude at zenith: 3.7 miles
Flight duration: 72 sec.
Payload weight: 174 lbs.
Unfueled rocket weight: 285 lbs.
Unfueled rocket C.G.:
Gross weight at takeoff: 1078 lbs.

COMMENTS

Physical recovery: Instruments and rocket severly damaged by explosion and fire at impact.
Experimental data: No results due to complete rocket failure.
Rocket performance: Booster performance normal. No useful thrust developed by propulsion unit apparently result of fuel line rupture at takeoff. Blowup explosives not cause.

REPORTS AND PAPERS

Request for Firing of Aerobee NRL-6, NRL Serial 3420-260a/50 dlj(3423CPS)

Aerobee Progress Report No. 14, Conduct of Firing of Venus Round 6, WSPG Serial NP(WSPG)S78-1(3) ECS:lhf(18)-(734).

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-7

19 February 1952

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1000 MST
Altitude: 50.5 miles

UPPER-AIR INSTRUMENTS

Cosmic radiation: Cosmic ray emulsions (National Institutes of Health)
Cosmic Ray emulsions (NRL).
Solar radiation: One axis sunfollower spectrograph. X-radiation film detectors with foil filters.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-7 () 15 channel PPM-AM system.
Physical recovery: Tail section separation with primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Six Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four tracking and two Igor stations.
Radar: Two modified SCR-584 S band stations and two X band stations.
Doppler: None
Impact location: Impact Point Computers (optical and radar), and GR-3 Geophone sound ranging set.

Airborne
Radio cutoff: AN/ARW-37 FM control reveiver for command fuel cutoff and recovery blowoff.
Aspect: NRL photocell aspect indicator.

Other
Bureau of Standards Ionosphere Height Finding station.

ROCKET PERFORMANCE

Time to booster separation:
Altitude at booster separation:
Velocity at booster separation:
Time to burnout: 43.5 sec.
Altitude at burnout: 13.1 miles
Velocity at burnout: 3400 ft. per sec.
Time to zenith:
Altitude at zenith: 50.5 miles
Time to blowoff: 173.4 sec.
Altitude at blowoff: 47 miles
Flight duration: 173.4 sec. (useful flight).
Impact coordinates:
Payload weight: 247 lbs.
Unfueled rocket weight:
Unfueled rocket C. G.:
Gross weight at takeoff: 1163 lbs.

BALLISTIC DATA

Theodolites:
Cameras:
Telescopes:
Radar:
Impact location:
Aspect: Photocell indicators produced complete record of aspect relative to sun and roll rate.

DATA RECOVERY

Telemeter: First flight of new telemeter completely successful, good record 0 to 174 sec.
Physical recovery: Main body recovered on 20 February. X-ray detectors damaged and cosmic ray emulsions pulverized.

EXPERIMENTAL DATA

Solar radiation: No data, sunfollower tracked sun throughout flight.
Cosmic radiation: No data.

COMMENTS

Rocket performance: Exceptionally good propulsion performance. Roll rate varied from 2.4 rpm at 11.6 sec. to 11.1 at 35 sec, and 8.8 rpm at 40 sec. to 10.9 at 50 sec. Stabilized at 9 rpm by 90 sec. Varying roll rates due to reaction to sunfollowing mechanism.
Experiments: Although the sunfollowing mechanism successfully tracked the sun, the spectrograph was misaligned or the scanning mechanism introduced an error of 5 degrees.

REPORTS AND PAPERS

Project Directive for Aerobee NRL-7, NRL Serial 3420-8/52(3423VFG)

"A Solar Aspect Indicator for a Rocket," by D. Packer and R. Tousey, Upper Atmosphere Research Report No. XVII, NRL Report 4024, Naval Research Laboratory, 5 September 1952.

"The AN/DKT-7( ) 15 Channel PPM Telemetering Transmitter," by N. Best, R. Lowell, D. Mazur, and K. Uglow, Upper Atmosphere Research Report No. XVI, NRL Report 4016, Naval Research Laboratory, 22 August 1952.

UPPER AIR ROCKET SUMMARY

AEROBEE
NRL-8
30 April 1952

Agency: Naval Research Laboratory
Time: 0659 MST
Altitude: 79.4 miles

Experiments: Cosmic radiation, Solar radiation.

AEROBEE
NRL-9
1 May 1952

Agency: Naval Research Laboratory
Time: 0759 MST
Altitude: 78.3 miles

Experiments: Solar radiation, Cosmic radiation.

AEROBEE
NRL-10
5 May 1952

Agency: Naval Research Laboratory
Time: 0644 MST
Altitude: 78.9 miles

Experiments: Solar radiation, Cosmic radiation.

AEROBEE
NRL-11
3 September 1952

Agency: Naval Research Laboratory
Time: 0740 MST
Altitude: 61.5 miles

Experiments: Solar radiation.

AEROBEE
NRL-12
10 February 1953

Agency: Naval Research Laboratory
Time: 1409 MST
Altitude: 85.1 miles

Experiments: Composition, Cosmic radiation

AEROBEE
NRL-13
12 February 1953

Agency: Naval Research Laboratory
Time: 0009 MST
Altitude: 85.3 miles

Experiments: Composition, Cosmic radiation

8. THE DEACON ROCKET

Description

Characteristics - Table

Firings - Tables

Naval Research Laboratory Deacon Rocket Firings

State University of Iowa Deacon Rocket Firings

Data Sheets

Figure 8.1 - The Deacon Rocket with a 55-foot plastic skyhook launching balloon in the foreground

8. THE DEACON ROCKET

The Deacon is a vertically launched sounding rocket designed to carry a 50-pound instrument load to an altitude of about 20 miles. It has no internal controls or movable surfaces and is arrow stabilized* by fins at the after end of the rocket. Propulsion is furnished by a solid propellant rocket motor. Characteristics of the Deacon Rocket are given in Table 8.1, and summaries of firings are given in Tables 8.2 and 8.3.

The Deacon is capable of attaining altitudes in excess of 60 miles when launched from an altitude of about 70,000 ft. The rockets are carried to launching altitude by a plastic balloon and then fired either by a timing circuit or by a pressure sensing device. This arrangement is particularly applicable for launching small instrument assemblies in various parts of the world. So far the launchings have been confined to active auroral regions in the vicinity of the north magnetic pole and to cosmic radiation and pressure-temperature measurements.

TABLE 8.1

CHARACTERISTICS OF THE DEACON ROCKET

DIMENSIONS	
Total length	12.3 ft
Diameter	6.5 in.
Fin Span	38.9 in.
WEIGHTS	
Payload (nominal)	50 lb
INSTRUMENT SPACE	
Nose Section	Generally pressurized, approximately conical in shape, detachable.
Apex angle	Ogive (24 in. radius).
Height	37.8 in.
Maximum diameter	6.5 in.
Volume	About 2.5 cu ft
ANTENNA CAPACITY	
Used	Probe at nose tip.
Others Possible	Slots in nose tip.
PERFORMANCE	
Maximum altitude	About 65 miles when launched at 70,000 ft.
Time of zenith	
Flight duration	
Time above 18.7 miles	
FLIGHT CHARACTERISTICS	
Acceleration	About 75 g maximum.
Duration	About 3 sec.
Maximum velocity	About 4000 ft per sec.

*cf. Rocket Stability, Sect. 6.

TABLE 8.2

NAVAL RESEARCH LABORATORY DEACON ROCKET FIRINGS

DEACON ROCKET	DATE	TIME (GCT)	LOCATION	ALTITUDE (MILES)	EXPERIMENTS
NRL-1	5 Aug 53	2317	62° 04' N 63° 55' W	49.2	Pressure, density, temperature
NRL-2	8 Aug 53	1701	73° 37' N 61° 37' W	****	Pressure, density, temperature
NRL-3	9 Aug 53	1115	74° 29' N 73° 31' W	23.7	Pressure, density, temperature
NRL-4	11 Aug 53	1828	74° 34' N 94° 29' W	50.2	Pressure, density, temperature
NRL-5	3 Sep 53	0513	43° 10' N 52° 30' W	41.7	Pressure, density, temperature
NRL-6	4 Sep 53	1551*	43° 00' N 62° 30' W	8.5**	Pressure, density, temperature

*Balloon release time.
**Balloon altitude, rocket did not fire.
****Zenith altitude of rocket uncertain.

TABLE 8.3

STATE UNIVERSITY OF IOWA DEACON ROCKET FIRINGS

DEACON ROCKET	DATE	TIME	LOCATION	ALTITUDE (MILES)	EXPERIMENTS
SUI-1	21 Aug 52	0125 EST*	80° 06' N 68° 28' W	13.3**	Cosmic radiation
SUI-2	23 Aug 52	2234 EST*	77° 31' N 73° 30' W	13.3**	Cosmic radiation
SUI-3	28 Aug 52	2021 EST	77° 33' N 73° 30' W	37.9	Cosmic radiation
SUI-4	29 Aug 52	0330 EST	77° 32' N 73° 29.5' W	36.9	Cosmic radiation
SUI-5	29 Aug 52	1417 EST	77° 21' N 73° 29' W	47.3	Cosmic radiation
SUI-6	31 Aug 52	1855 EST	77° 20' N 72° 50' W	39.8	Cosmic radiation
SUI-7	4 Sep 52	0511 EST	77° 11' N 71° 13' W	39.8	Cosmic radiation

TABLE 8.3 (Continued)

DEACON ROCKET	DATE	TIME	LOCATION	ALTITUDE (MILES)	EXPERIMENTS
SUI-8	18 Jul 53	1727 EST*	42° 26.2' N 70° 22' W	13.7**	Cosmic radiation
SUI-9	19 Jul 53	0530 EST*	43° 04' N 65° 07' W	13.8**	Cosmic radiation
SUI-10	19 Jul 53	1053 EST*	43° 41' N 63° 28.5' W	13.8**	Cosmic radiation
SUI-11	19 Jul 53	1657 EST*	44° 16' N 62° 09.5' W	14.4**	Cosmic radiation
SUI-12	24 Jul 53	1640 GCT*	58° 32.5' N 61° 55' W	***	Cosmic radiation
SUI-13	28 Jul 53	1104 GCT	62° 30.5' N 66° 15' W	54.9	Cosmic radiation
SUI-14	3 Aug 53	1948 GCT	62° 45' N 66° 15' W	****	Cosmic radiation
SUI-15	6 Aug 53	1651 GCT	64° 20' N 59° 06' W	40.7	Cosmic radiation
SUI-16	6 Aug 53	1845 GCT	65° 13' N 58° 35' W	****	Cosmic radiation
SUI-17	9 Aug 53	0601 GCT	74° 23' N 71° 56' W	61.6	Cosmic radiation
SUI-18	30 Aug 53	1400 GCT*	53° 06' N 55° 05' W	8.3**	Cosmic radiation
SUI-19	30 Aug 53	1620 GCT*	52° 47' N 55° 24' W	11.9**	Cosmic radiation
SUI-20	30 Aug 53	2156 GCT	53° 08' N 54° 45' W	64.4	Cosmic radiation
SUI-21	3 Sep 53	1051 GCT	44° 50' N 57° 13' W	****	Cosmic radiation
SUI-22	3 Sep 53	1247 GCT	44° 45' N 57° 10' W	64.4	Cosmic radiation
SUI-23	3 Sep 53	1510 GCT	44° 33' N 57° 03' W	61.6	Cosmic radiation

*Balloon release time.
**Balloon altitude, rocket did not fire.
***Balloon cut down, rocket did not fire.
****Zenith altitude of rocket uncertain.

UPPER AIR ROCKET SUMMARY

DEACON
NRL-1
5 August 1953

Agency: Naval Research Laboratory.
Location: 62° 04' North, 63° 55' West.
Time: 2317 GCT.
Launching altitude: 15.7 miles.
Zenith altitude: 49.2 miles.

Experiments: Pressure, temperature, and density.

DEACON
NRL-2
8 August 1953

Agency: Naval Research Laboratory.
Location: 73° 37' North, 61° 37' West.
Time: 1701 GCT.
Launching altitude: 15.8 miles.
Zenith altitude: Uncertain.

Experiments: Pressure, temperature, and density.

DEACON
NRL-3
9 August 1953

Agency: Naval Research Laboratory.
Location: 74° 29' North, 73° 31' West.
Time: 1115 GCT.
Launching altitude: 5.5 miles.
Zenith altitude: 23.7 miles.

Experiments: Pressure, temperature, and density.

DEACON
NRL-4
11 August 1953

Agency: Naval Research Laboratory.
Location: 74° 34' North, 94° 29' West.
Time: 1828 GCT.
Launching altitude: 14.2 miles.
Zenith altitude: 50.2 miles.

Experiments: Pressure, temperature, and density.

DEACON
NRL-5
3 September 1953

Agency: Naval Research Laboratory.
Location: 43° 10' North, 52° 30' West.
Time: 0513 GCT.
Launching altitude: 14.0 miles (estimated).
Zenith altitude: 41.7 miles.

Experiments: Pressure, temperature, and density.

DEACON
NRL-6
4 September 1953

Agency: Naval Research Laboratory.
Location: 43° 00' North, 62° 30' West.
Time: 1551 GCT (balloon release).
Launching altitude: 8.5 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Pressure, temperature, and density.

UPPER AIR ROCKET SUMMARY

DEACON
SUI-1
21 August 1952

Agency: State University of Iowa.
Location: 80° 06' North, 68° 28' West.
Time: 0125 EST (balloon release).
Launching altitude: 13.3 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation altitude dependence.

DEACON
SUI-2
23 August 1952

Agency: State University of Iowa.
Location: 77° 31' North, 73° 30' West.
Time: 2234 EST (balloon release).
Launching altitude: 13.3 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation altitude dependence.

DEACON
SUI-3
28 August 1952

Agency: State University of Iowa.
Location: 77° 33' North, 73° 30' West.
Time: 2021 EST.
Launching altitude: 7.2 miles.
Zenith altitude: 37.9 miles.

Experiments: Cosmic radiation.

DEACON
SUI-4
29 August 1952

Agency: State University of Iowa.
Location: 77° 32' North, 73° 29.5' West.
Time: 0330 EST.
Launching altitude: 6.6 miles.
Zenith altitude: 36.9 miles.

Experiments: Cosmic radiation.

DEACON
SUI-5
29 August 1952

Agency: Iowa State University.
Location: 77° 21' North, 73° 29' West.
Time: 1417 EST.
Launching altitude: 9.7 miles.
Zenith altitude: 47.3 miles.

Experiments: Cosmic radiation.

UPPER AIR ROCKET SUMMARY

DEACON
SUI-6
31 August 1952

Agency: State University of Iowa.
Location: 77° 20' North, 72° 50' West.
Time: 1655 EST.
Launching altitude: 7.8 miles.
Zenith altitude: 39.8 miles.

Experiments: Cosmic radiation.

DEACON
SUI-7
4 September 1952

Agency: Iowa State University.
Location: 77° 11' North, 71° 13' West.
Time: 0511 EST.
Launching altitude: 8.1 miles.
Zenith altitude: 39.8 miles.

Experiments: Cosmic radiation.

DEACON
SUI-8
18 July 1953

Agency: Iowa State University.
Location: 42° 26.2' North, 70° 22' West.
Time: 1727 EST (balloon release).
Launching altitude: 13.7 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

DEACON
SUI-9
19 July 1953

Agency: Iowa State University.
Location: 43° 04' North, 65° 07' West.
Time: 0530 EST (balloon release).
Launching altitude: 13.8 miles (balloon release).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

DEACON
SUI-10
19 July 1953

Agency: State University of Iowa.
Location: 43° 41' North, 63° 28.5' West.
Time: 1053 EST (balloon release).
Launching altitude: 13.8 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

UPPER AIR ROCKET SUMMARY

DEACON
SUI-11
19 July 1953

Agency: State University of Iowa.
Location: 44° 16' North, 62° 09.5' West.
Time: 1657 EST (balloon release).
Launching altitude: 14.4 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

DEACON
SUI-12
24 July 1953

Agency: Iowa State University.
Location: 58° 32.5' North, 61° 55' West.
Time: 1640 GCT (balloon release).
Launching altitude: Balloon cut down.
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

DEACON
SUI-13
28 July 1953

Agency: Iowa State University.
Location: 62° 30.5' North, 64° 13.5' West.
Time: 1104 GCT.
Launching altitude: 10.8 miles.
Zenith altitude: 54.9 miles.

Experiments: Cosmic radiation.

DEACON
SUI-14
3 August 1953

Agency: Iowa State University.
Location: 62° 45' North, 66° 15' West.
Time: 1948 GCT.
Launching altitude: 8.0 miles.
Zenith altitude: Uncertain.

Experiments: Cosmic radiation.

DEACON
SUI-15
6 August 1953

Agency: Iowa State University.
Location: 64° 20' North, 59° 06' West.
Time: 1651 GCT.
Launching altitude: 6.5 miles.
Zenith altitude: 40.7 miles.

Experiments: Cosmic radiation.

UPPER AIR ROCKET SUMMARY

DEACON
SUI-16
6 August 1953

Agency: Iowa State University.
Location: 65° 13' North, 58° 35' West.
Time: 1845 GCT.
Launching altitude: Uncertain, above 6.0 miles.
Zenith altitude: Uncertain.

Experiments: Cosmic radiation.

DEACON
SUI-17
9 August 1953

Agency: Iowa State University.
Location: 74° 23' North, 71° 56' West.
Time: 0601 GCT.
Launching altitude: 12.9 miles.
Zenith altitude: 61.6 miles.

Experiments: Cosmic radiation.

DEACON
SUI-18
30 August 1953

Agency: Iowa State University.
Location: 53° 06' North, 55° 05' West.
Time: 1400 GCT (balloon release).
Launching altitude: 8.3 miles.
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

DEACON
SUI-19
30 August 1953

Agency: State University of Iowa.
Location: 52° 47' North, 55° 24' West.
Time: 1620 GCT (balloon release).
Launching altitude: 11.9 miles (balloon altitude).
Zenith altitude: Rocket did not fire.

Experiments: Cosmic radiation.

DEACON
SUI-20
30 August 1953

Agency: Iowa State University.
Location: 53° 08' North, 54° 45' West.
Time: 2156 GCT.
Launching altitude: 13.3 miles.
Zenith altitude: 64.4 miles.

Experiments: Cosmic radiation.

UPPER AIR ROCKET SUMMARY

DEACON
SUI-21
3 September 1953

Agency: Iowa State University.
Location: 44° 50' North, 57° 13' West.
Time: 1051 GCT.
Launching altitude: 12.7 miles.
Zenith altitude: Uncertain.

Experiments: Cosmic radiation.

DEACON
SUI-22
3 September 1953

Agency: Iowa State University.
Location: 44° 45' North, 57° 10' West.
Time: 1247 GCT.
Launching altitude: 12.7 miles (approximately).
Zenith altitude: 64.4 miles.

Experiments: Cosmic radiation.

DEACON
SUI-23
3 September 1953

Agency: Iowa State University.
Location: 44° 33' North, 57° 03' West.
Time: 1510 GCT.
Launching altitude: 12.2 miles (approximately).
Zenith altitude: 61.6 miles.

Experiments: Cosmic radiation.

9. THE V-2 ROCKET

Description

Characteristics - Table

Firings - Table
V-2 Rocket Firings of All Agencies

Data Sheets

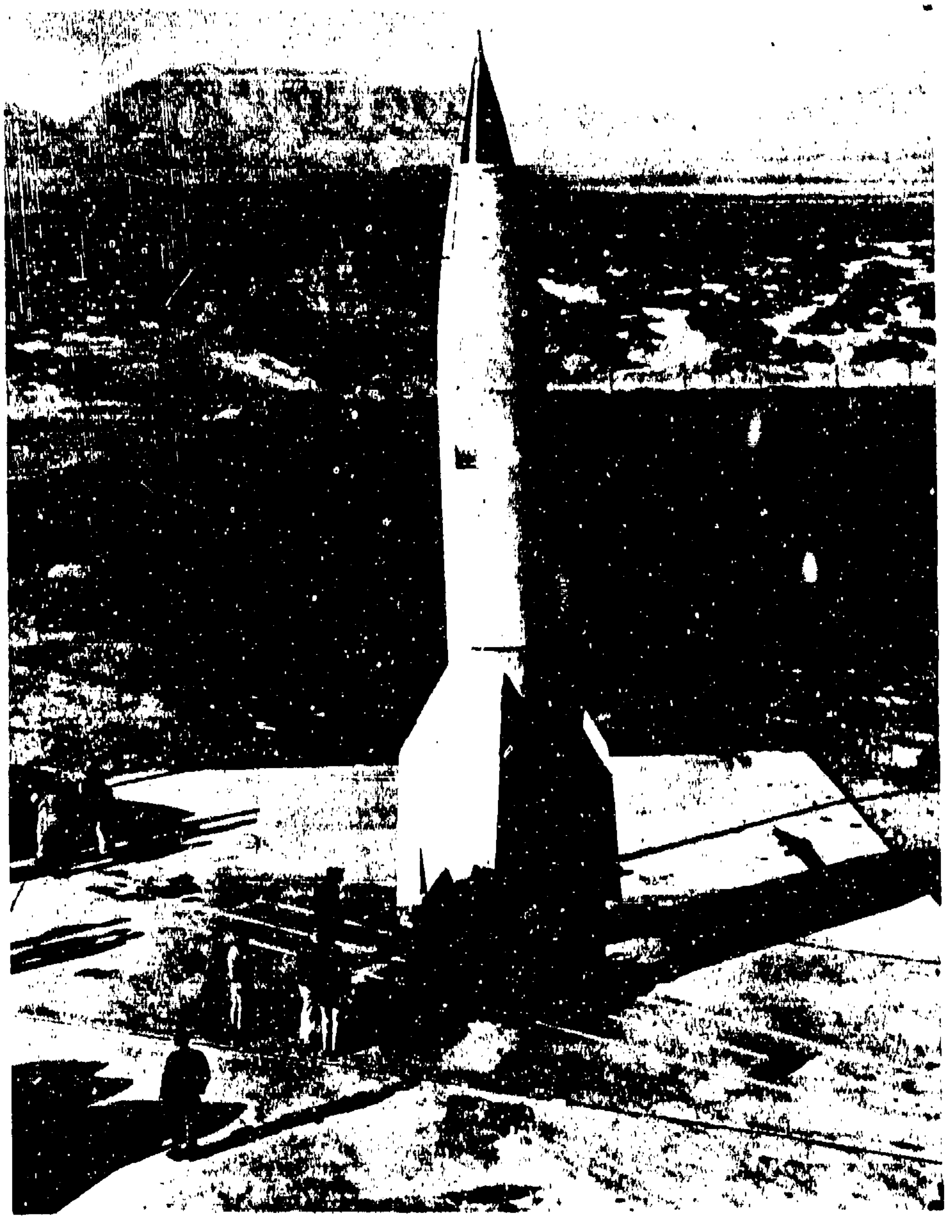

Figure 9.1 - The V-2 Rocket

9. THE V-2 ROCKET

The V-2 is a vertically launched rocket capable of carrying a 2200-pound instrument load to an altitude of about 100 miles. It resembles a conically tipped cylinder with a pronounced boat tail and has a length of 46.5 ft and a maximum diameter of 65 inches; there are four equally spaced fins at the after end (cf. Fig. 8.1). Propulsive force is obtained from a liquid propellant rocket motor that is spent at an altitude of about 20 miles. It is stabilized in flight and controlled in trajectory by an internal control system. The major characteristics of the V-2 are given in Table 8.1 and the firings are summarized in Table 8.2.

Instrumentation and Structure

The rocket consists of four major sections (cf. Fig. 8.2): a nose section, a control chamber, a mid-section, and a tail section. Upper air instrument space is contained in the nose section, control chamber, and tail section. The removable nose section is separated into a pressurizable nose cone, which provides 4 cu ft of instrument space, and a warhead base section, which provides 14 cu ft of instrument space. The unpressurized control chamber is removable and is divided into quadrants, two of which are available for upper air instruments. The total volume of the control chamber is 52 cu ft. Relatively large and unpressurized volumes are available within the tail section for instruments, and in some cases small objects have been installed in the tail fins. An unpressurized region between the propellant tanks can also be utilized, but with extremely limited access.

No special racks or structures are utilized with the V-2 for mounting instruments and, except in very unusual cases, forward instrument weight causes no concern because it is usually necessary to add counter weights at the base of the nose section in order to establish an acceptable margin of aerodynamic stability.* The V-2 is very heavily constructed to withstand a considerable amount of handling because it was primarily designed as an artillery weapon.

The two remaining control chamber quadrants are devoted to the rocket controls and distribution circuits. The mid-section houses the two propellant tanks, and the tail section houses the fuel pumps, steam plant, control servos, and the rocket motor.

Electrical Wiring and Antennas

Electrical connections and r-f transmission cables are routed from the forward to the after portions of the rocket within the mid-section shells. External circuits from the blockhouse for the control, monitoring, and auxiliary powering of upper air instruments within the rocket are connected through two pull-away receptacles at the base of the rocket. These connectors are disengaged by upward motion of the rocket. Similar circuits for the rocket controls and propulsion systems are connected through two receptacles in the control chamber. These connectors are electrically ejected just prior to the initiation of full rocket thrust.

*cf. Rocket Stability Sect. 6.

Propulsion

The regenerative-type rocket motor burns a mixture of alcohol and liquid oxygen. These two liquids are injected into the combustion chamber by propellant pumps driven by a steam turbine which is powered by the rapid decomposition of concentrated hydrogen peroxide. The propulsion system is semi-automatic in operation and is manually controlled in stages. During preliminary stage the propellants flow into the motor under the influence of gravity and are ignited by a pyro-technic "pinwheel" inserted into the combustion chamber through the nozzle. When a good burning pattern has been observed to develop, the steam plant is placed into operation and full thrust is developed. Fuel cutoff can be accomplished in various ways: the motor can be allowed to burn until one of the propellants has been exhausted; the thrust can be cut back to about 1/3 of its normal value and the motor allowed to burn until propellant exhaustion; the thrust can be cut back and then cut off; or the radio cutoff receiver can be used to cause complete cutoff.

Control and Stabilization

During powered flight the rocket is stabilized in the pitch, yaw, and roll axes by internal controls. Error signals from gyro pickoffs are doubly differentiated, amplified, and fed to selected solenoid control valves by an electronic mixer-computer system. For pitch, yaw, and roll corrections these valves control hydraulic servos which rotate carbon vanes projecting into the rocket jet in the pitch and yaw planes. Two trim tabs at the outboard trailing edges of the fins in the pitch plane are mechanically linked with their counterpart jet vanes. The remaining two trim tabs are independently operated by their own servo mechanisms. The control system also contains a method of introducing any predetermined program angle of trajectory control by an automatically timed system.

Firing Platform

V-2 rockets are not statically fired prior to flight firing and, consequently, do not require the use of a firing pit. A calibration operation takes place prior to rocket assembly in which the steam plant is operated, but without fuel ignition. The firing platform is installed on a concrete apron and a flame deflector at the platform base directs the rocket jet along the ground. The rocket may be directed in azimuth by manually rotating the firing platform prior to firing.

Design, Development, and Firing Services

The V-2 was designed in Germany during World War II. After a number of these rockets were captured and shipped to the United States, the General Electric Company was contracted by the U.S. Army Ordnance Department to assemble, test, and fire the rockets. During the later stages of the firing program, the General Electric Company provided gyros, mixer-computers, wiring, servo motors, and propellant piping to replace those German parts that had deteriorated with age. Supporting services are provided by the White Sands Proving Ground.

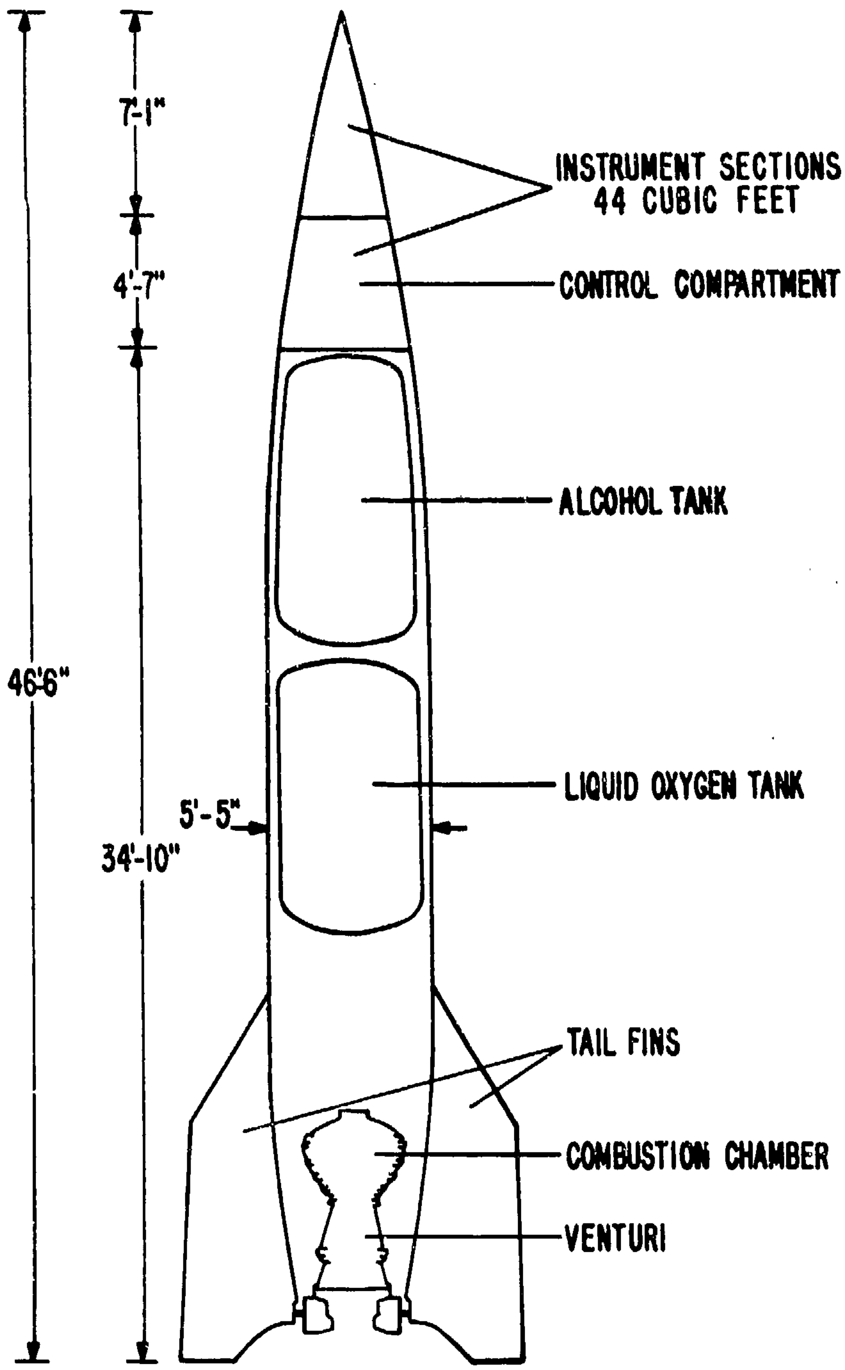

Figure 9.2 - The V-2 Rocket, cross-sectional view

TABLE 9.1

CHARACTERISTICS OF THE V-2 ROCKET

DIMENSIONS		
Total Length (of White Sands V-2 with American built nose)	558 in.	
Maximum Diameter	65 in.	
Fin Span	140 in.	
WEIGHTS		
Airframe (including fuel pumps, turbine, air flasks, propulsion unit, and control equipment)	6,500 lb	
Propellants (average weight at launching)	19,500 lb	
Payload (includes ballistics instruments, telemetering and research equipment)	2,500 lb (nominal).	
Gross at Launching	28,500 lb	
INSTRUMENT SPACE		
Nose Cone		Generally pressurized; conical in shape; detachable.
Apex angle	25 deg.	
Height	50 in.	
Base diameter	24 in.	
Volume	4 cu ft	
Static load	*	
Material	0.125 in. aluminum.	
Warhead Base Section		Generally pressurized; approximately truncated cone in shape; detachable.
Height	33 in.	
Top diameter	24 in.	
Base diameter	38 in.	
Volume	14 cu ft	
Static load	2,200 lb**	
Material	0.250 in. steel	
Control Section		Unpressurized, approximately truncated cone in shape, detachable, divided into four quadrants
Height	55 in.	
Top diameter	38 in.	
Base diameter	54 in.	
Volume (of 2 quadrants†)	26 cu ft	
Static load	500 lb (nominal)	
Material	0.020 in. steel	
Other		Unpressurized region between propellant tanks in mid-section. Relatively large unpressurized volumes distributed in motor section.

TABLE 9.1 (Continued)

ANTENNA CAPACITY	
Used	Outrigger turnstiles on two fins. Outrigger wires between four fins. Trailing rods in two fins. Strips on trailing edge of two fins. Two insulated doors in control section. Wires from body to fins. Slots in special nose section.
Others Possible	Notches in four fins. Slots in body. Whips on body. Probe at nose.
PERFORMANCE	
Maximum Altitude	100 miles (nominal with 2200 lb payload)††
Time to Zenith	220 sec (average)
Flight Duration	425 sec (average)
Time Above 18.6 miles	345 sec
FLIGHT CHARACTERISTICS	
Acceleration	1 g at takeoff to about 6.6 at burnout.
Duration of Acceleration	68 sec (approximately)
Maximum Velocity	1600 meters per sec
Maximum Dynamic Pressure	13 lb per sq in.
Skin Temperature Rise	140° C on nose cone.
Vibration Characteristics	Construction of equipment to aircraft specifications appears to be adequate. Vibration present only during burning period.
Aspect Behavior	
Powered flight	Stabilized in roll, pitch, and yaw by control system.
Coasting flight	Not controlled; normal roll period about 10 sec, precession likely, tumble possible.

*Instrumentation not normally installed on nose cone skin, loads taken by upper bulkhead of warhead base section.

**Static loads greater than this are permissible with structural strengthening of rocket.

†Two of the four control section quadrants are available for research instruments, the remaining two quadrants are employed for rocket control equipment.

††Best probable performance; average performance generally poorer than this. Altitudes up to 132 miles have been achieved.

TABLE 9.2

V-2 ROCKET FIRINGS OF ALL AGENCIES

V-2 ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	AGENCY	EXPERIMENTS
1	15 Mar 46				Static firing; no UAR experiments
2	16 Apr 46	1447	3.4	GE	Cosmic radiation (APL)
3	10 May 46	1415	70.0	GE	Cosmic radiation (APL)
4	29 May 46	1410	69.7	GE	Cosmic radiation (APL)
5	13 Jun 46	1640	73.0	GE	Solar radiation, ionosphere (NRL)
6	28 Jun 46	1203	67.0	NRL	Cosmic radiation, solar radiation, pressure, temperature, ionosphere
7	9 Jul 46	1230	83.5	GE	Cosmic radiation, ionosphere (NRL)
8	19 Jul 46	1211	3.0	GE	Ionosphere (NRL)
9	30 Jul 46	1240	100.4	APL	Cosmic radiation; ionosphere (NRL); biological (Harv. U.)
10	15 Aug 46	1100	4.0	PU	Cosmic radiation
11	22 Aug 46	1015	0	ARDC	Pressure, density, ionosphere, sky brightness
12	10 Oct 46	1102	108.0	NRL	Cosmic radiation, solar radiation, pressure, temperature, ionosphere; biological (Harv. U.)
13	24 Oct 46	1218	65.0	APL	Cosmic radiation, solar radiation, winds, photography
14	7 Nov 46	1331	0.2	PU	Cosmic radiation
15	21 Nov 46	1000	63.0	ARDC	Pressure, temperature, ionosphere, sky brightness
16	5 Dec 46	1308	95.0	NRL	Cosmic radiation, solar radiation, pressure, temperature, photography
17	17 Dec 46	2218	114.0	APL	Cosmic radiation, meteorites; biological (NIH)
18	10 Jan 47	1413	72.2	NRL	Cosmic radiation
19	23 Jan 47	1722	31.0	GE	No UAR experiments
20	20 Feb 47	1116	68.0	ARDC	Pressure, ionosphere, sky brightness, biological, photography
21	7 Mar 47	1123	101.0	NRL	Cosmic radiation, pressure, temperature, solar radiation, ionosphere, photography, biological (Harv. U.)
22	1 Apr 47	1310	80.3	APL	Cosmic radiation, solar radiation, photography
23	8 Apr 47	1713	63.5	APL	Cosmic radiation, solar radiation, photography
24	17 Apr 47	1422	88.5	GE	Pressure, temperature (SCEL)
25	2 Apr 48	0640	89.5	SCEL	Density, pressure, temperature, composition; cosmic radiation, solar radiation (NRL)
26	15 May 47	1604	84.0	NRL	Cosmic radiation, solar radiation, temperature, ionosphere, photography
27	9 Oct 47	1215	97.0	GE	Solar radiation (NRL); pressure, composition (SCEL)

TABLE 9.2 (Continued)

V-2 ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	AGENCY	EXPERIMENTS
28	8 Dec 47	1442	65.0	ARDC	Pressure, temperature, solar radiation, sky brightness, ionosphere, photography
29	10 Jul 47	1218	10.1	NRL	Cosmic radiation, pressure, temperature, ionosphere, biological (Harv. U. & USA)
30	29 Jul 47	0555	99.9	APL	Cosmic radiation, solar radiation, photography
31	8 Dec 49	1214	81.0	ARDC	Composition, ionosphere, meteorites, solar radiation, sky brightness
32	16 Sep 49	1619	2.6	ARDC	Composition, ionosphere, meteorites, solar radiation, sky brightness, cosmic radiation, biological
33	2 Sep 48	1800	93.6	SCEL	Density, pressure, temperature, composition
34	22 Jan 48	1312	99.0	NRL	Cosmic radiation, pressure, temperature, ionosphere
35	27 May 48	0716	86.8	APL	Cosmic radiation, solar radiation, photography; composition (SCEL)
36	6 Feb 48	1015	69.0	GE	No UAR experiments
37	11 Jun 48	0322	38.7	ARDC	Pressure, temperature, composition, ionosphere, sky brightness, solar radiation
38	19 Apr 48	1254	34.8	NRL	Cosmic radiation, solar radiation, pressure, temperature, ionosphere
39	19 Mar 48	1610	3.4	GE	Magnetic field, composition, winds, temperatures (SCEL)
40	26 Jul 48	1103	54.0	APL	Cosmic radiation, photography; pressure, temperature, composition (SCEL)
41	21 Mar 49	2343	83.0	ARDC	Ionosphere, sky brightness, solar radiation, composition, photography
42	9 Dec 48	0908	67.4	SCEL	Winds, pressure, temperature; solar radiation (NRL)
43	5 Aug 48	0507	103.0	NRL	Cosmic radiation, temperature, pressure, ionosphere, solar radiation, photography
44	18 Nov 48	1534	90.3	GE	Biological (Harv. U.); solar radiation (NRL); composition (SCEL)
45	28 Jan 49	1020	37.2	NRL	Cosmic radiation, solar radiation, pressure, temperature, ionosphere, photography
46	5 May 49	0815	5.5	GE	Solar radiation (NRL)
47	14 Jun 49	1535	83.0	ARDC	Cosmic radiation, composition, ionosphere, pressure, temperature, photography, solar radiation
48	17 Feb 49	1000	62.5	APL	Cosmic radiation, photography; solar radiation (NRL); composition (SCEL); biological

TABLE 9.2 (Continued)

V-2 ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES	AGENCY	EXPERIMENTS
49	29 Sep 49	0958	93.7	NRL	Cosmic radiation, solar radiation, ionosphere, meteorites, pressure
50	11 Apr 49	1505	54.2	SCEL	Temperature, composition; solar radiation (NRL); biological
51	31 Aug 50	1009	84.8	ARDC	Ionosphere, meteorites, sky brightness, density, biological
52	28 Jun 51	1443	3.6	ARDC	Solar radiation, ionosphere, sky brightness, air glow
53	17 Feb 50	1101	92.4	NRL	Cosmic radiation, solar radiation, pressure, temperature
54	18 Jan 51	1314	1.0	NRL	Cosmic radiation, solar radiation
55	14 Jun 51	-	0	NRL	Solar radiation; cosmic radiation (NIH)
56	18 Nov 49	0803	77.0	SCEL	Winds, composition, temperature; cosmic radiation (APL); solar radiation (NRL)
57	8 Mar 51	2016	1.9	ARDC	Composition, air glow, sky brightness, ionosphere
58	-	-	-	-	This rocket never fired
59	20 May 52	0906	64.3	SCEL	Composition, photography
60	29 Oct 51	1404	87.6	SCEL	Pressure, temperature
61	26 Oct 50	1602	5.0	NRL	No UAR experiments
TF-1	22 Aug 51	1200	132.6		No UAR experiments
TF-2	-	-	-	-	See V-2 Rocket No. 59
TF-3	22 Aug 52	0033	48.5	NRL	Composition, pressure, magnetic field, solar radiation; cosmic radiation (NIH); sky brightness (ARDC)
TF-4	-	-	-	-	Never fired
TF-5	19 Sep 52	0849	16.8	SCEL	Temperature, composition; cosmic radiation (NIH)
GE Sp.	20 Nov 47	1647	16.6	GE	No UAR experiments

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

15 March 1946

Agency: General Electric Company
Comments: Static firing; satisfactory performance of rocket propulsion for 57.0 sec.

UPPER AIR ROCKET SUMMARY

V-2
NO. 2

16 April 1946

IDENTIFICATION

Agency: None
Time: 1447 MST
Altitude: 3.4 miles.

UPPER AIR INSTRUMENTS

Cosmic Radiation: Single geiger counter with lead shield (APL).

DATA RECOVERY INSTRUMENTS

Telemeter: None
Recorder: Brass tape recorder (APL).

BALLISTIC INSTRUMENTS

Firing Range
Optical Instruments: None recorded
Radar: A modified SCR-584 S-Band station

Airborne
Beacon: S-Band transponder
Radio Cutoff: AN/ARW-17. FM control receiver for command fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: No data
Time to burnout: 19.0 sec.
Altitude at burnout: No data
Velocity at burnout: No data
Time to zenith: No data
Altitude at zenith: 3.4 miles
Time to blowoff: No blowoff installation
Altitude at blowoff:
Flight duration: No data
Impact Coordinates: 0.0 miles north, 6.0 miles east
Payload weight: No data (about 2200 lbs.)
Unfueled rocket weight: 8530 lbs.
Unfueled rocket C. G.: No data
Gross weight at takeoff: No data

BALLISTIC DATA

None recorded.

DATA RECOVERY

Recorder: Did not operate, rocket did not attain sufficient acceleration to actuate "g" switch.
Physical recovery: Rocket demolished

EXPERIMENTAL DATA

None.

COMMENTS

Rocket Performance: Control system failure, broken jet vane, fuel cutoff by radio at 19.5 sec when rocket deviated 90 degrees to east. Structural failure of fin 4 prior to cutoff. Rocket demolished at impact from explosion of unused propellants.

REPORTS AND PAPERS

Project Hermes Report of 21 April 1946.

REPORTS AND PAPERS (Cont'd)

"V-2 Report No. 3," Minutes of V-2 Upper Atmosphere Research Panel.

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Co., September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 3

10 May 1946

IDENTIFICATION

Agency: None
Time: 1415 MST
Altitude: 70.0 miles

UPPER AIR INSTRUMENTS

Cosmic Radiation: Single geiger counter and Cosmic Ray Emulsions. (APL)
Other: Exposed and unexposed film for wreckage study.

DATA RECOVERY INSTRUMENTS

Telemeter: None
Airborne Recorder: Single Channel wire recorder.

BALLISTIC INSTRUMENTS

Firing Range
  Theodolites: Two Mitchell and three Askania stations
  Cameras: Two Bowen-Knapp stations
  Radars: Two SCR-584, one SCR-784, and one AN/MPQ-2 station.

Airborne
  Beacon: APN-55 S-Band transponder
  Radio Cutoff: AN/ARW-17 FM-control receiver for command fuel cutoff.

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: 10.5 degrees
Time to burnout: 59.0 sec.
Altitude at burnout: No data
Velocity at burnout: No data
Time to zenith: No data
Altitude at zenith: 70 miles
Time to blowoff: No blowoff installation
Altitude at blowoff:
Flight duration: 225 sec.
Impact coordinates: Range, 31.0 miles; 2.5 miles west of north
Payload weight: 2200 lbs.
Unfueled rocket weight: 8190 lbs.
Unfueled rocket C. G.: 236 inches
Gross weight at takeoff: 27,850 lbs.

BALLISTIC DATA

Theodolites: Mitchell - fair to good results; Askania trajectory 0 to 74 sec.
Cameras: Trajectory, first 6,800 ft. of flight
Radar: Beacon functioned satisfactorily
Impact location: By air and ground search.

DATA RECOVERY

No data recovered.

EXPERIMENTAL DATA

No experimental data, rocket demolished at impact.

COMMENTS

Rocket Performance: Normal propulsion and control operation, propulsion terminated by rocket integrator.

REPORTS AND PAPERS

WSPG Firing Report of No. 3 A-4 Rocket Fired 10 May 1946
"V-2 Report No. 4," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 3 June 1946.
Project Hermes Report for Month of May 1946
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Co., September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 4

29 May 1946

IDENTIFICATION

Agency: General Electric Company
Time: 1410 MST
Altitude: 69.7 miles

UPPER AIR INSTRUMENTS

Cosmic Radiation: Single Geiger Counter (APL).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 11 channel PPM/AM system.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and three Askania stations
- Cameras: Two Bowen-Knapp Stations
- Radar: Two SCR-584, and two AN/MPQ-2 stations
- Doppler: Four stations.

Airborne
- Beacon: APN-55 S-Band transponder
- Doppler: DOVAP transceiver
- Radio Cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Other: X-Band crossjet attenuation transmitter and receiver (NRL)
  Attitude Gyros
  Longitudinal accelerometer
  Routine rocket performance instruments.

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: 9.9 degrees
Time to burnout: 60.2/63.1 sec
Altitude at burnout: 19.2 miles
Velocity at burnout: 4100 ft. per sec.
Time to zenith: No data
Altitude at zenith: 69.7 miles
Time to blowoff: No blowoff installation
Altitude at blowoff:
Flight duration: 348 sec.
Impact coordinates: 37.6 miles north, 13.5 miles west
Payload weight: 2200 lbs.
Unfueled rocket weight: 8696 lbs.
Unfueled rocket C. G.: Approx. 241 inches
Gross weight at takeoff: 27,800 lbs.

BALLISTIC DATA

Theodolites: Askania, trajectory 0 to 348 sec; Mitchell, trajectory 0 to 348 sec.
Cameras: Bowen-Knapp, trajectory 0 to 348 sec.
Radar: Beacon operation until final part of trajectory
Doppler: Data taken successfully
Impact Location: By Air and ground search
Other: No report of data.

DATA RECOVERY

Telemeter: Total recording time 280 sec., operation sporadic at times
Physical recovery: Rocket struck intact. Recoverable specimens from crater and radius of 100 yards.

EXPERIMENTAL DATA

None recorded.

COMMENTS

Rocket performance: Normal flight, rocket drift 13 miles to west possibly due to high altitude winds. Roll rate 6 rpm. Propulsion terminated in two stages by rocket integrator.
Ballistic instruments: Automatic radar tracking inferior to optical directing.

REPORTS AND PAPERS

Project Hermes Report No. 17, May 1946
WSPG firing Report of No. 4 A-4 Fired 29 May 1946
"V-2 Report No. 4," Minutes of meeting of the V-2 Upper Atmosphere Rocket Research Panel on 3 June 1946

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Co., September 1952.

V-2
NO. 5

13 June 1946

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

Agency: General Electric Company
Time: 1640 MST
Altitude: 73.0 miles.

UPPER AIR INSTRUMENTS

Solar radiation: Solar ultra-violet spectrograph (NRL)
Ionosphere: Ion densities by rf propagation transmitters (NRL).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 18 channel PPM/AM system
Physical recovery: No blowup installation.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and three Askania stations
- Cameras: Two Bowen-Knapp stations
- Radar: SCR-584 with T14E1 plotting board
- Doppler: Four stations.

Airborne
- Beacon: APN-55 S-Band transponder
- Doppler: DOVAP transceiver
- Radio Cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Other: Routine rocket performance instrumentation.

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: 9.3 degrees
Time to burnout: 58.5/61.2 sec.
Altitude at burnout: 19.1 miles
Velocity at burnout: 4220 ft. per sec.
Time to zenith: 193 sec.
Altitude at zenith: 73.0 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 356 sec.
Impact coordinates: 40.0 miles north, 1.5 miles west
Payload weight: 2205 lbs.
Unfueled rocket weight: 9286 lbs.
Unfueled rocket C. G.: 240.2 inches
Gross weight at takeoff: 28,396 lbs.

BALLISTIC DATA

Theodolites: Mitchell and Askania produced satisfactory recudible records
Other: No satisfactory records from other firing range instruments
Impact location: From theodolite fixes and air and ground search.

DATA RECOVERY

Telemeter: Approx. 380 sec recorded data. Intermittent from poor antenna aspect caused by rocket roll
Physical recovery: Rocket struck intact in salt flats adjacent to White Sands, crater filled with water, few fragments found.

EXPERIMENTAL DATA

Solar radiation: No data
Ionosphere: Signal received 70 to 170 sec from one transmitter - no data.

COMMENTS

Rocket performance: Trajectory as calculated. No air burst achieved although alcohol tank pressurized. Propulsion terminated in two stages by rockot integrator.
Experiments: Two of three ionosphere antennas probably torn off during flight, Spectrograph not recovered.

REPORTS AND PAPERS

WSPG Report of No. 5 A-4 Rocket Fired 13 June 1946
Project Hermes Report No. 17, June 1946
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Co., September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 6

28 June 1946

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1203 MST
Altitude: 67.0 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Geiger counter telescope to identify primary radiation
Solar radiation: Ultra-violet spectrograph
Pressure-temperature: Skin temperature gages on nose, midsection, and tail section of rocket. Stagnation pressure at nose tip. Ambient pressure in spectrograph case.
Ionosphere: Three propagation transmitters for ion density studies.

DATA RECOVERY

Telemeter: PXTA-501, 23 channel NRL PPM/AM system
Physical recovery: Nose section separation explosives in control chamber.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Five Askania stations
- Cameras: Two Bowen-Knapp stations
- Telescopes: None
- Radar: Two modified SCR-584 S-band stations
- Doppler: Four stations
- Impact location: None.

Airborne
- Beacon: S-band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Other: Routine rocket propulsion and control performance instruments; pitch rate gyroscope. (General Electric Company.)

ROCKET PERFORMANCE

Firing angle:
Program angle: 11.4 degrees
Time to burnout: 66.8 sec.
Altitude at burnout: 19.4 miles
Velocity at burnout: 4075 ft. per sec.
Time to zenith:
Altitude at zenith 67.0 miles
Time to blowoff: 320 sec.
Altitude at blowoff: 17.4 miles
Flight duration: 353 sec..
Impact coordinates: 41.0 miles north and 0.5 miles east
Payload weight: 2727 lbs.
Unfueled rocket weight: 9807 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 27,850 lbs.

BALLISTIC DATA

Theodolites: Satisfactory records from three stations
Cameras: Satisfactory records from one station
Telescopes: None
Radar: No data, beacon failed at takeoff
Doppler: No data, record incomplete or irreducible
Impact location: Air and ground search.

DATA RECOVERY

Telemeter: Records poor 0 to 89 sec., satisfactory 89 to 232 sec.
Physical recovery: Nose did not separate, rocket destroyed at impact.

EXPERIMENTAL DATA

Cosmic Radiation: Data above 38 miles shows increase in counting rate
Skin Temperature: Temperature rise between 90 to 230 sec. observed
Ionosphere: No data, no signals received from propagation transmitters.

REPORTS AND PAPERS

"Upper Atmosphere Research Report No. 1," M. A. Garstens, H. E. Newell, and J. W. Siry, Editors, Naval Research Laboratory Report No. R-2955, 1 October 1946.

"Review of the Results of the Ballistic Instrumentation Program for V-2 Work," unsigned, Ballistic Research Laboratories, Aberdeen Proving Ground, 1946.

"V-2 Report No. 5," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 9 July 1946, dated 15 July 1946.

"V-2 Report No. 6," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 5 September 1946.

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 7

9 July 1946

IDENTIFICATION

Agency: General Electric Company
Time: 1230 MST
Altitude: 83.5 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Four packages of cosmic ray emulsions
Ionosphere: Indirect ion density measurements with rf propagation transmitters (NRL)
Biological: Selected seeds. (Harvard University).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 22 channel PPM/AM system.
Physical recovery: Ejection mechanism with drag plates (NRL).

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and two Askania stations
- Cameras: Two Bowen-Knapp stations
- Touching Telescopes: One station
- Radar: Modified SCR-584 S-band radar
- Doppler: Four stations.

Airborne
- Beacon: APN-55 (XE-2) S-band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and ejection
- Other: X-band crossjet attenuation transmitter and receiver (NRL)
  Routine rocket performance instruments.

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: 12.4 degrees
Time to burnout: 60.6 sec.
Altitude at burnout: 19.5 miles
Velocity at burnout: 4680 ft. per sec.
Time to zenith: No data
Altitude at zenith: 83.5 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 402 sec
Impact coordinates: 61.0 miles north, 1.0 mile east
Payload weight: 2050 lbs.
Unfueled rocket weight: 8977 lbs.
Unfueled rocket C. G.: 240.9 inches
Gross weight at takeoff: 27,850 lbs.

BALLISTIC DATA

Theodolites: Good results from Mitchell and Askanias
Cameras: Good results from Bowen-Knapp
Telescope: Records incomplete or irreducible
Radar: Trajectory coordinates, 0 to 402 sec.
Doppler: Very poor, weak signal
Impact location: Air and ground search.

DATA RECOVERY

Telemeter: Good signal throughout trajectory
Physical recovery: Fragments of ejection block up to 0.5 mi. from rocket impact. Emulsions, seeds badly damaged, unusable.

EXPERIMENTAL DATA

Cosmic Radiation: No data, emulsions destroyed at impact
Ionosphere: No significant data, last signal received from rocket 70 sec. after takeoff.

COMMENTS

Rocket Performance: Good propulsion, terminated by rocket timer, actual trajectory angle greater than preset program angle.

REPORTS AND PAPERS

WSPG Preliminary Firing Report, A-4 Rocket No. 7, Fired 9 July 1946.
Telemetering Data, DF-71393 G. E. Rocket No. 3, 9 July 1946.
"V-2 Report No. 5," Minutes of meeting of the V-2 Upper Atmosphere Research Panel on 9 July 1946.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 8

19 July 1946

IDENTIFICATION

Agency: General Electric Company
Time: 1211 MST
Altitude: 3.0 miles.

UPPER AIR INSTRUMENTS

Ionosphere: Test of ionosphere propagation transmitters (NRL).

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501, NRL 21 channel PPM-AM system
Physical recovery: Ejected block with drag plates (NRL).

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and two Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: One station
Radar: One modified SCR-584 S-Band station
Doppler: Four stations
Impact location: none.

Airboane
Beacon: AN/APN-55 (XE-2) S-Band transponder
Doppler: DOVAP transceiver
Radio Cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
Other: Instruments to measure rocket propulsion and control performance.

ROCKET PERFORMANCE

Firing Angle: 000 degrees
Program angle: 5.65 degrees
Time to burnout: Exploded at 28.5 sec.
Altitude at burnout:
Velocity at burnout: 1310 ft per sec.
Time to zenith: 28.3 sec.
Altitude at zenith: 3.0 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 0.5 miles North, 0.0 miles East West
Payload weight: 2105 lbs.
Unfueled rocket weight: 9167 lbs.
Unfueled rocket C. G.: 242.8 inches
Gross weight at takeoff: 28,840 lbs.

BALLISTIC DATA

Theodolites: Askania trajectory data 0 to 20 sec.
Cameras:
Telescopes: No data, timing circuit failed
Radar: Trajectory data 0 to 28 sec.
Doppler: Good signals 0 to 30 sec.

DATA RECOVERY

Telemeter: Good signals 0 to 28 sec.
Physical recovery: Tail section scattered over wide area, remainder fell in one piece, ejection device did not operate due to short flight time.

EXPERIMENTAL DATA

Ionosphere: No signals received from transmitters.

COMMENTS

Rocket performance: Overheated oxygen pump bearing caused explosion
Optical tracking: Heavy cloud cover obscured rocket past 20 sec.

REPORTS AND PAPERS

Telemetering Data DF-71395, G. E. Rocket No. 4.
Project Hermes Weekly Report, General Electric Company, 22 July 1946
Preliminary Report of V-2 Firing, WSPG, 19 July 1946
Report No. 695, by H. P. Hitchcock, Ballistics Research Laboratories, Aberdeen Proving Ground, April 1949
Report No. 639, by H. P. Hitchcock and V. M. Reklis, Ballistic Research Laboratories Aberdeen Proving Ground, October 1947
"Upper Atmosphere Research Report No. 1," by M. A. Garstens, H. E. Newell, and J. W. Siry, Editors, Naval Research Laboratory Report No. R-2955, October 1946.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 9

30 July 1946

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1240 MST
Altitude: 100.4 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Two geiger counter telescopes, and Alpha Particle emulsions
Ionosphere: Indirect ion density measurements by means of rf propagation transmitters (NRL).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 23 channel PPM/AM system
Recorder: Two steel drum recorders
Physical Recovery: Warhead separation explosives in Control Chamber.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and six Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: One station
- Radar: One modified SCR-584, S-Band radar or sub-station.
- Doppler: Four stations.

Airborne
- Beacon: AN/APN-55 (XE-2), S-Band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Other: Single roll photocell
  - Routine rocket performance instruments (G. E. Co.)

ROCKET PERFORMANCE

Firing Angle: 0.0 degrees
Program angle: 11.3 degrees
Time to burnout: 68.6 sec.
Altitude at burnout: 25.1 miles
Velocity at burnout: 5130 ft. per sec.
Time to zenith: 233 sec.
Altitude at zenith: 100.4 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 68.0 miles North, 9.3 miles East
Payload weight: 2500 lbs
Unfueled rocket weight: 8562 lbs.
Unfueled rocket C. G.: 244.4 inches
Gross weight at takeoff: 28,600 lbs.

BALLISTIC DATA

Theodolites: Mitchell, record incomplete or irreducible; Askania trajectory data 0 to 88 sec.
Cameras: Satisfactory reducible records
Telescope: Record incomplete or irreducible
Radar: Record incomplete or irreducible
Doppler: Record incomplete or irreducible
Roll photocells: Questionable data.

DATA RECOVERY

Telemeter: Good record to 160 sec.
Recorders: No record, not recovered
Physical recovery: Warhead not recovered, but main body recovered in fair condition.

EXPERIMENTAL DATA

Cosmic radiation: Maximum counting rate at 50 sec was 45 times greater than ground rate - single counter data

Ionosphere: Internal failure of three transmitters between 44 and 75 sec., no experimental conclusions.

COMMENTS

Rocket performance: Very good propulsion performance

Experiments:

REPORTS AND PAPERS

WSPG Preliminary Report of A-4 Rocket No. 9, Fired 30 July 1946

"High Altitude Research Using the V-2 Rocket," March 1946-April 1947, by L. W. Fraser and E. H. Siegler, Bumblebee Series Report No. 81, July 1948

"V-2 Report No. 6," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 5 September 1946

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0520, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 10

15 August 1946

IDENTIFICATION

Agency: Palmer Physics Laboratory, Princeton University
Time: 1100 MST
Altitude: 4.0 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Geiger counter telescope to measure total cosmic ray intensity
Two neutron counters
Shielded ionization chamber
Ionosphere: Propagation transmitters, low frequency system on ground and high frequency transceiver in rocket.

DATA RECOVERY

Telemeter: PXTA-501, 23 channel NRL PPM-AM pulse sequential system
Four channel Lark FM-FM system
Airborne recorder: Brass tape recorder
Physical recovery: Nose separation with TNT and primacord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: One station
Radar: Two modified SCR-584 S-Band stations
Doppler: Four stations
Impact location: None.

Airborne
Beacon: S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff.

ROCKET PERFORMANCE

Time to burnout: 18.5 sec., radio fuel cutoff
Altitude at zenith: 4.0 miles
Comments: Steering control failed shortly after takeoff and rocket began a large deviation from range center. One fin was torn off about the time of fuel cutoff. Unburned propellants exploded at impact.

EXPERIMENTAL DATA

Comments: No data obtained.

REPORTS AND PAPERS

"Review of the Results of the Ballistic Instrumentation Program for V-2 Work," Ballistic Research Laboratories, Aberdeen Proving Ground, 1946
"V-2 Report No. 6." Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 5 September 1946
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 11

23 August 1946

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1015 MST
Altitude: 330 feet.

UPPER AIR INSTRUMENTS

Pressure-temperature: Ion type gage to measure stagnation pressure on head of truncated cone. Four ion type gages to measure pressure on cone surface (Mich. U.)
Ionosphere: Ion density measurements with programmed bi-polar probes (Mich. U.), Incidence ionosphere propagation experiment (AFCRC)
Other: Daylight sky brightness by phototubes with wide-band filters (AFCRC), Atmosphere temperature and density in the ionosphere with ionization gages in nose piece. (Mich. U.).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 23 channel PPM/AM system.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and four Askania stations
Cameras: Three Bowen-Knapp stations
Radar: Modified SCR-584 S-Band station
Doppler: Four stations.

Airborne
Beacon: AN/APN-55 (XE-2), S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
Other: Routine rocket performance instruments (G. E. Co.)

ROCKET PERFORMANCE

Complete failure of control system shortly after takeoff and fuel cutoff by radio command at 6.5 sec. Maximum altitude, 330 ft. Flight duration of 11 sec.

BALLISTIC DATA

Complete record of data from all sources except the telescope.

DATA RECOVERY

Telemeter: Complete records for duration of flight.

EXPERIMENTAL DATA

All equipment apparently functioning normally, no data because of rocket failure.

REPORTS AND PAPERS

WSPG preliminary Firing Report of A-4 Rocket No. 11 fired 22 August 1946.
"V-2 Report No. 6," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 5 September 1946.
"Atmosphere Pressure and Temperature Measurements Between the Altitudes of 40 and 110 Kilometers," Upper Air Research Report No. 2, by Engineering Research Institute, University of Michigan, July 1948.
Air Materiel Command, Cambridge Field Station, "Upper Air Research Program," Report No. 1, September 1947.
University of Michigan, Bi-Polar Probe Experiment: Phy. Rev. 76, p. 987, 1949.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 12

10 October 1946

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1102 MST
Altitude: 108.0 miles.

UPPER AIR INSTRUMENTS

Cosmic Radiation: Geiger counter telescope
Solar radiation: Solar ultra-violet spectrograph
Pressure-temperature: Skin temperature gages on nose tip, nose cone, control chamber, and between fins on tail section.
Pressure gages on tail section ahead of fins
Ionosphere: Indirect ion density measurements by radio propagation experiment
Other: Selected Seeds (Harvard College)
Cross jet attenuation transmitter and receiver.

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 21 channel PPM/AM system
Airborne recorder: NRL 10 channel neon lamp camera recorder
Physical recovery: Warhead separation explosives in control chamber,
NRL spring ejected block with parachute and drag plates,
Daughter recovery device (U. S. Army).

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: One station
Radar: Modified SCR-584, S-Band station
Doppler: Four stations

Airborne
Beacon: AN/APN-55, (XE-2), S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
Other: Routine rock-^ performance instruments (G. E. Co.).

ROCKET PERFORMANCE

Firing Angle: 0.0 degrees
Program angle: 4.7 degrees
Time to burnout: 67.7 sec.
Velocity at burnout: 5350 ft. per sec.
Altitude at burnout: 25 miles (approx.)
Time to zenith: 227 sec.
Altitude at zenith: 108 miles
Time to blowoff: 335 sec.
Altitude at blowoff: 22 miles
Flight duration: 412 sec. (rocket breakup)
Impact coordinates: 12 miles north, 5.0 miles east
Payload weight: 2200 lbs. (approx.)
Unfueled rocket weight: 9,164 lbs.
Unfueled rocket C. G.: 236.2 inches
Gross weight at takeoff: 28,959 lbs.

BALLISTIC DATA

Theodolites: Records incomplete or irreducible
Cameras: Records incomplete or irreducible
Telescopes: Satisfactory reducible record
Radar: Satisfactory reducible record
Doppler: Records incomplete or irreducible
Impact location: Air and ground search

DATA RECOVERY

Telemeter: Station 1 failed at 60 sec. Station 2 record complete but for several short intervals. Probably caused by poor rocket aspect.
Physical recovery: NRL ejection device not recovered. Warhead not recovered.
Daughter recovery device not recovered until 22 Dec. 1947.
Solar spectrograph recovered in excellent condition.
Airborne recorder: Located in ejection block, never recovered.

EXPERIMENTAL DATA

Cosmic radiation: Telescope counting rate in free space (less than 2 mm. Hg pressure) one third of maximum rate. Penetrating component 70% of total radiation. Shower rate high.
Pressure: Pressure measurements to 90 km conform closely with NACA standard and Harvard College Observatory data.
Skin temperature: 600°C rise on 0.3 mm cone at nose tip, 35° rise at bottom of warhead to 60° rise 24 in. behind nose tip (skin 0.8 to 11 mm. thick cone angle 17 degrees). 230°C temperature rise on 0.5 mm control chamber skin, Skin temperature rose to 45°C at 40 sec, and fell to -80°C after 100 sec.
Solar radiation: Solar spectrograms to 88 km down to 2260 Angstroms.
Ionosphere: No data from propagation experiment due to antenna failure.

COMMENTS

Rocket performance: Propulsion and control performance very good.
Unusual rocket modifications: Solar spectrograph house in fairing on a tail fin, duplicate dummy housing on opposite fin.
Ballistic Tracking: Very poor results, altitude of rocket obtained from pressure data.
Physical recovery: Tail section installation of recovery items appears to be optimum location, warhead locations offer least chance.

REPORTS AND PAPERS

WSPG Preliminary Firing Report of A-4 Rocket No. 12, Fired 10 October 1946.
"V-2 Report No. 7," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 4 November 1946.
Review of the Results of the Ballistic Instrumentation Program for V-2 Work, Ballistics Research Laboratory, Aberdeen Proving Ground, March 1946.
"Upper Atmosphere Research Report No. II," by H. E. Newell, Jr. and J. W. Siry, NRL Report R-3030, December 1946 (Cosmic Radiation, Solar Radiation, Pressure-Temperatures, Ionosphere, Telemetering, Theoretical discussions)
"Additional Cosmic Ray Measurements with the V-2 Rocket," by S. E. Golian, E. H. Krause, and G. J. Perlow, Phys. Rev., 70:776-7, 1946.
Solar Ultra-Violet Spectrum to 88 Kilometers, by W. A. Baum, F. S. Johnson, J. J. Oberly, C. C. Rockwood, C. V. Strain, and R. Tousey, Phys. Rev. 70:781-2, 1946.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 13
24 October 1946

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1218 MST
Altitude: 65.0 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Two geiger counter telescopes
Solar radiation: Ultra Violet spectrograph
Winds: High altitude wind studies with smoke puffs
Photography: 35 mm. DeVry motion picture camera.

DATA RECOVERY INSTRUMENTS

Telemeter: PTXA-501, NRL 21 channel PPM-AM system
Airborne recorders: Three brass tape recorders in nose, and three steel drum recorders in control chamber.
Physical recovery: Nose separation with TNT and prima cord; "Daughter" ejection device in midsection.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and three Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: One station
Radar: Two modified SCR-584 S-Band stations
Doppler: Four stations
Impact location: None

Airborne
Beacon: AN/APN-55 (XE-2) S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and recovery blowoff
Gyros: One roll and one yaw
Other: Rocket propulsion and steering performance instruments. (G. E. Co.)

ROCKET PERFORMANCE

Firing angle: 000 degrees
Program angle: 4.7 degrees
Time to burnout: 59.8 sec.
Altitude at burnout: 17.0 miles
Velocity at burnout: 3990 ft. per sec.
Time to zenith: 180 sec.
Altitude at zenith: 65.0 miles
Time to blowoff: 330 sec.
Altitude at blowoff: 5.7 miles
Flight duration:
Impact coordinates: 16.8 miles North and 2.4 miles West
Payload weight:
Unfueled rocket weight: 9070 lbs.
Unfueled rocket C. G.: 231.5 inches
Gross weight at takeoff: 28,277 lbs.

BALLISTIC DATA

Theodolites:
Cameras:
Telescopes: No data
Radar: Trajectory data 0 to 330 sec.
Doppler: Fair data 0 to 100 sec.
Aspect: No data from gyros, angular motion data from camera.

DATA RECOVERY

Telemeter: Fair to good record 0 to 180 sec., then fading and intermittent.
Physical recovery: Steel drum recorder, camera, and spectrograph recovered; rocket remains scattered over wide area
Airborne recorder: No data obtained.

EXPERIMENTAL DATA

Cosmic radiation: No comments furnished
Solar radiation: No data, light leak in film cassette
Winds: No reliable conclusions, due to lack of photographic detail.

COMMENTS

Rocket performance: Propulsion below normal.

REPORTS AND PAPERS

"High Altitude Research Using the V-2 Rocket, March 1946 - August 1947," by L. W. Fraser and E. H. Siegler, Bumblebee Series Report No. 81, Applied Physics Laboratory, The Johns Hopkins University, July 1948.
"Preliminary Report on High Altitude Photography," by C. T. Holliday, Photog. Engr. 1:16, 1950.
Report No. 695, by H. P. Hitchcock, Ballistic Research Laboratories, Aberdeen Proving Ground, April 1949.
Report No. 639, by H. P. Hitchcock and V. M. Reklis, Ballistic Research Laboratories, Aberdeen Proving Ground, October 1947.
"V-2 Report No. 7," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 4 November.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 14

14 November 1946

IDENTIFICATION

Agency: Palmer Physics Laboratory (Princeton Univeristy)
Time: 1331 MST
Altitude: 0.2 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Geiger counter telescope
Two ionization chambers.

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501, 23 channel NRL PPM-AM system. Four channel Lark FM-FM system
Recorder: Brass tape recorder
Physical recovery: None.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and three Askania stations
Cameras: Three Bown-Knapp stations
Telescopes: One station
Radar: Two modified SCR-584 S-Band stations
Doppler: Four stations.

Airborne
Beacon: S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and recovery blowoff
Other: Routine propulsion and control performance instruments. (G. E. Co.).

ROCKET PERFORMANCE

Comments: Rocket deviated to left shortly after takeoff and then corrected to the right and slowly changed its course to the south. It leveled off at 1200 ft. altitude and flew in this position until emergency fuel cutoff was effected at 31 sec.

EXPERIMENTAL DATA

Comments: No data obtained due to rocket failure.

REPORTS AND PAPERS

Preliminary Report of Firing of V-2 No. 14, White Sands Proving Ground, November 1946.
"V-2 Report No. 8," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 28 Januart 1947.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 15

IDENTIFICATION

21 November 1946

Agency: Air Research and Development Command
Time: 1000 MST
Altitude: 63.0 miles.

UPPER AIR INSTRUMENTS

Pressure-temperature: Ram pressure on truncated cone with ion type gage, four ion type pressure gages on side of cone
Ionosphere: Vertical incidence ionosphere measurement comparing two signals, one near critical frequency and other far removed. Ion density with bipolar probe.
Sky-brightness: Sky light intensity measured by photocells
Voltage breakdown: Critical voltage breakdown point between electrodes.

DATA RECOVERY INSTRUMENTS

Telemeter: NRL, 23 channel PPM/AM system.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and seven Askania stations
- Cameras: Two Ballistic and three Bowen-Knapp stations
- Telescopes: Two stations
- Radar: Two modified SCR-584 S-Band stations
- Doppler: Four stations.

Airborne
- Beacon: AN/APN-55 (XE-2) S-Band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Other: Routine rocket performance instruments (G. E. Co.).

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: 3.5 degrees
Time to burnout: 62.5 sec.
Altitude at burnout: 16.5 miles
Velocity at burnout: 3876 ft. per sec.
Time to zenith. 180 sec.
Altitude at zenith: 63 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 340 sec.
Impact coordinates: 12.6 miles north, 1.25 miles east
Payload weight:
Unfueled rocket weight: 8885 lbs.
Unfueled rocket C. G.: 237.4 inches
Gross weight at takeoff: 28,240 lbs.

BALLISTIC DATA

Theodolites: Mitchell - trajectory data 0 to 72 sec., Askania - complete tracking from one station, to 80 degrees elevation from other
Cameras: Bowen-Knapp - complete record, Ballistic - record to burnout
Telescopes: Complete record for 35 sec.
Radar: Both tracked to peak, one near impact
Doppler: Good signals 0 to 306 sec.

DATA RECOVERY

Telemeter: Good telemeter record
Physical recovery: Rocket destroyed at impact.

EXPERIMENTAL DATA

Pressure-temperature: Pressures and temperatures obtained from 67 to 101 km. Temperatures calculated from slope of pressure altitude curve. Barometric equation temperatures higher than NACA mean standard.

Ionosphere: Altitude too low for desired ionosphere data from propagation experiment, good systems test since equipment performed well

Sky birghtness: Initial measurements of scattered sky light to 35 km. Intensity approximately proportaional to atmospheric densities at various altitudes. Ratio of intensity through blue and green wratten filters 3.5. Blue intensity at 10 km. 0.5 watts/cm^2.

Ion Density: Good data record. Proper interpretation indefinite. Good agreement with expected values from preliminary analysis.

Voltage breakdown: Good data to 90 km, data invalid beyond.

COMMENTS

Rocket performance: Normal takeoff. Subnormal propulsion performance.
Telemeter: Improved performance with new circularly polarized antenna.

REPORTS AND PAPERS

WSPG Preliminary Report on A-4 Missile, Round No. 15, fired 31 November 1946.

Preliminary Report on Radar Tracking of the A-4 Missile, Round No. 15, fired at WSPG 31 November 1946, Ballistic Research Laboratories.

Meterological Measurements for 31 November 1946, WSPG Air-Weather Section.

"Atmospheric Temperature and Pressure Measurements Between the Altitudes of 40 and 110 Kilometers," Upper Air Research Program Report No. 2, 1 July 1948. Engineering Research Institute, University of Michigan, Ann Arbor, Michigan.

"Upper Air Research Program, Report No. 1 by the Navigation Laboratory, AMC, Cambridge Field Station, 1 September 1947.

"Dynamic Probe Measurements in the Ionosphere," by A. Reifman and W. G. Dow, Phys. Rev. 76, No. 7, 987, 1949.

"Dynamic Probe Measurements in the Ionosphere," Upper Air Research Program Report No. 3, Engineering Research Institute, University of Michigan, Ann Arbor, Michigan.

"Day Sky Brightness Measured by Rocketborne Photoelectric Photometers," by H. A. Miley et al, Trans., Amer. Geophys U., Program 23rd. Annual Meeting, 321, 1952.

Journal American Optical Society, 37, 994, 1947.

Report No. 639, by H. P. Hotchcock and V. M. Reklis, Ballistic Research Laboratories of the of the Aberdeen Proving Ground, Maryland, October 1947.

Report NO. 695, by H. P. Hithcock, Ballistic Research Laboratories of the Aberdeen Proving Ground, Maryland, April 1947.

"V-2 Report No. 8," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 28 January 1947.

"Final Report, Project Hermes V-2 Missile Program, by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 16

5 December 1946

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1308 MST
Altitude: 95.0 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Geiger counter telescope
Solar radiation: Ultra-violet spectrograph
Pressure-temperature: Ambient pressure gages on nose and tail sections
Skin temperature gages on nose tip.
High altitude photography: Two K-25 cameras in midsection.

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501, 23 channel NRL PPM-AM system
Physical recovery: Nose separation with explosives in control chamber.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Seven Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Two stations
Radar: Two modified SCR-584 S-Band stations
Doppler: Four stations
Impact location: None.

Airborne
Beacon: AN/APN-55 S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and blowoff
Other: Routine rocket propulsion and control performance instruments. (G. E. Co.).

ROCKET PERFORMANCE

Firing Angle:
Program Angle: 21.0 degrees - actual trajectory angle
Time to burnout: 69.0 sec.
Altitude at burnout: 23.4 miles
Velocity at burnout: 5204 ft. per sec.
Time to zenith:
Altitude at zenith: 95 miles
Time to blowoff:
Altitude at blowoff:
Flight duration:
Impact coordinates: 131 miles North (range).
Payload weight:
Empty rocket weight: 9050 lbs.
Empty rocket C. G.: 237.4 inches
Gross weight at takeoff: 28,727 lbs.

BALLISTIC DATA

Theodolites: Data 0 to 200 sec.
Camera: Bowen-Knapp
Telescope: Data 0 to 200 sec., rocket visible to 330 sec.
Radar: No data, beacon failed
Doppler: Data 0 to 160 sec.
Impact location: Ground and air search.

DATA RECOVERY

Telemeter: Good record
Physical recovery: None.

EXPERIMENTAL DATA

Comments: No data, all instruments went off at takeoff.

COMMENTS

Rocket performance: Extraordinary range introduced by control system failure, rocket extremely unstable after burnout.

REPORTS AND PAPERS

"Preliminary Report on Firing of V-2 No. 16, 5 December 1946," White Sands Proving Ground.

Report No. 695, by H. P. Hitchcock, Ballistic Research Laborat 'es, Aberdeen Proving Ground, April 1949.

Report No. 639, by H. P. Hotchcock and V. M. Reklis, Ballistic Research Laboratories, Aberdeen Proving Ground, October 1947.

"V-2 Report No. 8," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 28 January 1947.

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510 General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 17
17 December 1946

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 2212 MST
Altitude: 114.0 miles

UPPER AIR INSTRUMENTS

Cosmic Radiation: Two geiger counter telescopes and Alpha particle emulsions.
Artificial Meteors: Ejection of M9A1 Rifle grenades at 70, 80, & 90 sec.
Other: Fungus Spores (National Institute of Health).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 23 channel PPM/AM system.
Recorder: Two brass tape recorders.
Physical recovery: Warhead separation explosive in control chamber

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations.
- Cameras: Two Ballistic and three Bowen-Knapp stations.
- Telescopes:
- Radar: Two modified SCR-584 S-Band radar stations
- Doppler: Four stations.

Airborne
- Beacon: AN/APN-55 S-Band transponder.
- Doppler: DOVAP Transciever
- Radio Cutoff: AN/ARW-17 FM control receiver for command fuel cutoff.
- Gyroscopes: One roll and one zenith angle.
- Other: Routine rocket performance instruments (General Electric Company).

ROCKET PERFORMANCE

Firing Angle: 000.0 degrees true
Program angle: 3.0 degrees
Time to burnout: 69.6 sec
Altitude at burnout: 25.4 miles
Velocity at burnout: 5402 ft. per sec.
Time to zenith: 249 sec
Altitude at zenith: 114.0 miles
Time to blowoff: 439 sec
Altitude at blowoff: 9.5 miles
Flight Duration: 439 sec (time to blowoff)
Impact coordinates: 18.5 miles north and 6.3 miles east
Payload weight: 1650 lbs.
Unfueled rocket weight: 8797 lbs.
Unfueled rocket C. G. : 238.2 inches
Gross weight at takeoff: 29, 199 lbs.

BALLISTIC DATA

Theodolites: Trajectory data; Mitchell- 0-68.25 sec, Askania 0 to 71 sec
Cameras: Ballistic - camera operation good for 150 sec., sync. & timing unsuccessful; Bowen-Knapp- one camera successful.
Telescopes: Tracked 0 - 100 sec, followed thereafter.
Radar: Trajectory data 0 to 368 sec, spotty thereafter.
Doppler: Velocity and position data 7.2 sec to 440 sec.
Impact Location: Ground and air search.
Other: Gyroscope roll data good.

DATA RECOVERY

Telemeter: Satisfactory records.
Physical recovery: Rocket blowup did not occur but did tear apart from aerodynamic forces. Recorder, grenade camera and fungus spores not recovered. Alpha particle film recovered.
Airborne recorder: No data, recorder not recovered.

EXPERIMENTAL DATA

Cosmic radiation: Telescope operated satisfactorily. No data from film.
Artificial meteors: No data, experiment failed to operate.
Fungus spores: No data, spores not recovered.

COMMENTS

Rocket performance: Normal ascent, tumble during descent according to doppler signals. Rocket exploded at 440 sec.

REPORTS AND PAPERS

"High Altitude Research Using the V-2 Rocket, March 1946 - April 1947," by L. W. Fraser and E. H. Seigler, APL Bumblebee Series Report No. 81, The Johns Hopkins University Applied Laboratory, July 1948.

BRL Report No. 695, by H. P. Hitchcock, Aberdeen Proving Ground Ballistic Research Physics Laboratory, July 1948.

BRL Report No. 639, by H. P. Hitchcock and V. M. Reklis, Aberdeen Proving Ground Ballistic Research Laboratories, October 1947.

"V-2 Report No. 8," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 28 January 1947.

UPPER AIR ROCKET SUMMARY

V-2
NO. 18
10 January 1947

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1413 MST
Altitude: 72.2 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Two geiger counter telescopes; and nuclear research emulsions.

DATA RECOVERY INSTRUMENTS

Telemeter: PX-TA501, NRL 23 channel P[illegible] system.
Airborne recorder: NRL nine channel neon lamp recorder.
Physical recovery: Warhead separation explosives in control section.
"Daughter" ejection device in mid-section (Air Material Command).

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell andeight Askania stations
- Cameras: One Ballistic and three Bowen Knapp stations
- Telescopes: One station.
- Radar: One AN/CPS-4 S band station and one AN/CPS-5 L band station
- Doppler: Four stations
- Impact location: None

Airborne
- Beacon: AN/APN-55 S band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and recovery blowup.
- Aspect: Photocells and roll gyroscope.

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: 6.25 degrees at 58 sec.
Time to burnout: 60 sec.
Altitude at burnout: 20.5 miles
Velocity at burnout: 4600 ft. per sec.
Time to zenith:
Altitude at zenith: 72.2 miles
Time to blowoff: 300 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates: 24.6 miles North and 4.8 miles West.
Payload weight: 2286 lbs.
Unfueled rocket weight: 9,140 lbs.
Unfueled rocket C.G.: 240.9 inches.
Gross weight at takeoff: 28,355 lbs.

BALLISTIC DATA

Theodolites: Mitchel data 0 to 60 sec.
Cameras: Bowen-Knapp - satisfactory operation; Ballistic - images to burnout
Telescope: Tracked beyond zenith
Radar: Data 0 to 300 sec.
Doppler: Failed at 220 sec., periodic interruptions from rocket roll.

DATA RECOVERY

Telemeter: Satisfactory operation
Airborne recorder: Good record
Physical recovery: Recorder in excellent condition; "Daughter" not recovered in spite of excellent tracking of its internal beacon.

EXPERIMENTAL DATA

Cosmic radiation: Data obtained on penetration of 2 and 4 cm. of lead. Soft radiation observed as about 15% of total, may be ascribed to primary electrons.

COMMENTS

Rocket performance: Propulsion below normal. Steering system error introduced roll beginning at 40 sec. which reached 60 rpm.

REPORTS AND PAPERS

"Upper Atmosphere Research Report No. IV," by H. E. Newell, Jr. and J. W. Siry, NRL Report No. R-3171, Naval Research Laboratory, October 1947.
"V-2 Report No. 8," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 4 February 1947.
Report No. 695, by H. P. Hitchcock, Aberdeen Proving Ground Ballistic Research Laboratories, April 1949.

UPPER AIR ROCKET SUMMARY

V-2
NO. 19

23 January 1947

IDENTIFICATION

Agency: General Electric Company
Time: 1722 MST
Altitude: 31.0 miles.

UPPER AIR INSTRUMENTS

Comments: No upper air research instruments in this rocket.

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501,23 channel NRL pulse sequential system; and 28 channel Hermes PWM-FM system.
Physical recovery: None.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Two Ballistic and three Bowen-Knapp stations
- Telescopes: One station
- Radar: One modified SCR-584 S-Band station
- Doppler: Four stations
- Impact location: None.

Airborne
- Beacon: AN/APN-55 (XE-2) S-Band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Other: Rocket propulsion and control performance instruments.

ROCKET PERFORMANCE

Firing angle: 000 degrees
Program angle: 7 degrees
Time to burnout: 59.0 sec.
Altitude at burnout: 14.6 miles
Velocity at burnout: 2300 ft. per sec.
Time to zenith: 118 sec.
Altitude at zenith: 31 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 239 sec.
Impact coordinates: 10 3 miles North, 12.4 miles West
Payload weight: 2200 lbs.
Unfueled rocket weight: 9140 lbs.
Unfueled rocket C. G.: 241 inches
Gross weight at takeoff: 28,355 lbs.

BALLISTIC DATA

Theodolites: Mitchell trajectory 0 to 239 sec., Askania trajectory data
Cameras: Bowen-Knapp data satisfactory; Ballistic cameras for test only,
Telescopes: Trajectory data until after peak
Radar: Trajectory data 0 to 239 sec.
Doppler: No data
Impact location: By optical fix and search.

DATA RECOVERY

Telemeter: Sporadic during cutoff and when rocket was broadside and rolling, good in latter part of flight.
Physical recovery: Nothing recovered, remaining fuels exploded at impact.

COMMENTS

Rocket performance: Takeoff irregular, roll began shortly after. Propulsion normal to 40 sec., then far below normal. Roll rate increased to 80 RPM.

REPORTS AND PAPERS

Report on A-4 Rocket No. 19, Project Hermes Report No. 55204, General Electric Company.
Preliminary Report of Firing of V-2 No. 19, White Sands Proving Ground.
Report No. 695, by H. P. Hitchcock, Ballistic Research Laboratories, Aberdeen Proving Ground, April 1949.
"V-2 Report No. 8," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 28 January 1947.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 20

20 February 1947

IDENTIFICATION

Agency: Air Research and Development Command
Time: 1116 MST
Altitude: 68.0 miles.

UPPER AIR INSTRUMENTS

Pressure-temperature: Ram pressure at nose tip with ion gage and pressure on cone with four ion type gages (Univ. of Michigan).
Ionosphere: Vertical incidence propagation transmitters (AFCRC). Bipolar probe measurement of ion current flow (Univ. of Michigan).
Sky brightness: Photomultiplier tubes with filters (AFCRC).
Biological: Rye seeds, cotton seeds, and fruit flies.
Other: Voltage breakdown measurements AFCRC).

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501 channel N[illegible] PPM-AM system
Physical recovery: Separation of forward portion of rocket with TNT and prima cord. (New Mexico School of Mines). Blossom, ejection of cannister and lowering by parachute (Cambridge Field Station).

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and six Askania stations
- Cameras: Two Ballistic and three Bowen-Knapp stations
- Telescopes: One station
- Radar: Two modified SCR-584 S-Band stations
- Doppler: Four stations
- Impact location: None.

Airborne
- Beacon: AN/APN-55 (XE-2) S-Band transponder.
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
- Aspect: Four AAF K-25 cameras in midsection (WPAFB)
- Other: Routine rocket propulsion and control performance instruments. (G. E. Co.).

ROCKET PERFORMANCE

Firing angle:
Program angle:
Time to burnout: 58.0 sec.
Altitude at burnout: 17 miles
Velocity at burnout: 4062 ft. per sec.
Time to zenith: 190 sec.
Altitude at zenith: 68 miles
Time to blowoff: 285 sec.
Altitude at blowoff: 40 miles
Flight duration: 419 sec.
Impact coordinates: 13.4 miles North and 14.4 miles West
Payload weight:
Unfueled rocket weight: 9390 lbs.
Unfueled rocket C. G.: 243.1 inches
Gross weight at takeoff: 28,455 lbs.

BALLISTIC DATA

Theodolites: Satisfactory Mitchell and Askania operation
Cameras: Satisfactory data from two Ballistic and three Bowen-Knapp stations
Telescopes: Satisfactory images 0 to 100 sec.
Radar: Fair tracking to impact, poor 180 to 240 sec. telemeter interference with beacon
Doppler: Good data 0 to 285 sec.

DATA RECOVERY

Telemeter: Good record 0 to 260 sec. intermittent thereafter from roll
Physical recovery: Nose separation failed, rocket exploded at impact. Parachute recovery very good. Aspect cameras not recovered.

EXPERIMENTAL DATA

Ionosphere; Propagation transmitters failed after burnout, no data. Bipolar probe data in good agreement with expected electron density values, interpretation of data in doubt.
Pressure-temperature: Pressure data from 55.3 to 66.5 miles. Temperature lower than NACA standard.
Sky brightness: Satisfactory equipment operation, data poor after 40 sec. due to rocket roll
Biological: Seeds recovered and flies still alive.
Voltage breakdown: Data questionable.

COMMENTS

Rocket performance: Excellent performance 0 to 27 sec., at this time pitch motion disturbance occurred. Roll begain at 37.3 sec. and increased to 1 r.p.s. by burnout. Combustion chamber pressure began to drop at 55.5 sec. Jet vane 3 did not operate normally.
Ballistics: Optical instruments hampered by sun's position, haze, and clouds.

REPORTS AND PAPERS

Preliminary Report of V-2 Firing No. 20, ORDBS White Sands Proving Ground, dated 24 Feb. 1947.
Report on A-4 (V-2 Rocket No. 20), Prepared by Physical Science Laboratory, New Mexico College of Agriculture and Mechanic Arts for Ballistic Research Laboratories, Aberdeen Proving Ground.
Telemetering Report, A-4 Rocket No. 20, Prepared by Physical Science Laboratory, New Mexico College of Agriculture and Mechanic Arts, for Naval Research Laboratory.
"Atmospheric Pressure and Temperature Measurements Between the Altitudes of 40 and 110 Kilometers," Upper Air Research Program Report No. 2, Engineering Research Institute, University of Michigan, Contract W33-038 ac-14050(15719).
Upper Air Research Program Report No. 1, Air Material, Command, Cambridge Field Station, 1 September 1947.
"University of Michigan Bi-Polar Probe Experiment," Phys. Rev. 76:987, 1949.
"Dynamic Probe Measurements in the Ionosphere," Upper Air Research Program, Report No. 3, Engineering Research Institute, University of Michigan.
Report No. 695, by H. P. Hitchcock, Ballistic Research Laboratories, Aberdeen Proving Ground, April 1949.
"Panel Report No. 20," Minutes of Meeting of the Upper Atmosphere Rocket Research Panel on 21 April 1949.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 21
7 March 1947

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1123 MST
Altitude: 101 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Two geiger counter telescopes (NRL)
Pressure-temperature: Ram pressure gage installation at nose tip. Nose cone pressure gages at base of nose section. Tail section pressure gages ahead of fins. Skin temperature gages on nose cone (NRL)
Solar radiation: Solar spectrograph (NRL)
Ionosphere: C. W. propagation transmitter (NRL)
Biological: Selected seeds (Harvard)

DATA RECOVERY INSTRUMENTS

Telemeter: AN/DKT-1, 23 channel pulse sequential system
Airborne recorder: NRL 20 channel neon lamp camera recorder
Physical recovery: Separation of forward portion of rocket with TNT, and separation of tail section with Prima-cord

BALLISTIC INSTRUMENTS

Firing range
- Theodolites: Mitchell, C & E Stations; Askania, C, F, G, N, O, & P Stations
- Cameras: Ballistic, D & R Stations; Bowen-Knapp, U, V, & W Stations
- Tracking telescopes: C Station
- Doppler: B, F, G, & K Stations
- Radar: Two modified SCR-584 S-band radars

Airborne
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17, 3-channel command fuel cutoff, 2-channel command blowup
- Beacon: APN-55
- Other: Roll photocells: 3 photocells at 120 intervals
- Gyro: Roll gyroscope
- Vibration: Three vibration pickups, one along the longitudinal axis and the remaining two along the pitch and yaw axis, respectively

ROCKET PERFORMANCE

Firing angle: 0°
Program angle: 7° from the vertical
Time to burnout: 63 sec
Altitude at burnout: 18.5 miles
Velocity at burnout: 5120 ft per sec
Time to zenith: 220 sec
Altitude at zenith: 101 miles
Time to blowoff: 327-330 sec. Breakup at 406 sec
Altitude at blowoff: Breakup of rocket at 28 miles
Flight duration:
Impact coordinates: 36 miles north, 1.8 miles east
Payload weight: 2365 lb
Unfueled rocket weight: 9180 lb
Unfueled rocket C. G.:
Gross weight at takeoff: 28,030 lb

BALLISTIC DATA

Theodolites: Mitchell, Trajectory 0 to 54.38 sec; Askania, Trajectory 0 to 79.75 sec (Data from 30.75 computed from one instrument only)
Cameras: No data
Tracking telescope: No data
Doppler: No data
Radar: No data
Roll photocells: Roll 0 to 406 sec
Gyroscope: Roll 0 to 406 sec
Vibration: Vibration in the plane normal to the rocket's main axis was too small to be measured by this installation. Vibrations along the principal rocket axis were recorded between 42 and 57 cycles. The peak vibrational velocities ranged between 1.06 and 1.82 in. per sec. The vibration was not continuous in character, and it seems that it was in the nature of shocks originating with the propulsion unit. The upper limit at which vibration could be observed was limited by sampling character of the telemeter.

DATA RECOVERY

Telemeter: Good record to 225 sec and sporadic signals from this time onward.
Recorder: A complete record of the flight was obtained and this data used in preference to the telemeter record.
Physical recovery: All recovery items were returned in good condition, despite the fact that the rocket did not break up until it was well within the atmosphere. The items were widely scattered in the White Sands region, some of which were recovered only after several days of search. The material did deteriorate somewhat from this exposure.

EXPERIMENTAL DATA

Considerable showers of nonelectronic origin were noted. Of 887 events recorded in flight, 275 of them were not associated with showers. Of these (above the atmosphere) 25% were absorbed in 6 cm of lead, assumed to be nonprimary electrons; 59% penetrated 12 cm of lead; the remaining 16% were absorbed in 16 cm of lead. The ratio of total radiation to that of free space at sea level was 11.5. The ratio of the hard component to that of free space at sea level was 9.0.

Pressure-Temperature: Pressures were measured and temperatures calculated to an altitude of 70 km. The temperatures began to lag behind the NACA estimated mean temperatures at 40 km. At 55 km the temperatures were different by 30°; at 70 km the calculated temperatures were 50° lower than estimated. The estimated accuracies are within plus or minus 10°. Skin-temperature rise on the 1/16-in. aluminum nose section was 100° C. Ambient pressures measured on the tail section from ground level to 180 km were rather close to the predicted value, the figures comparing within experimental error.

Solar radiation: The spectra showed 12 lines of Si I of great intensity. A strong line of C I was found at 2478 A. Other lines were identified as definite V I, V II, Cr II, Mn II, Co I, and Al II; probable Na I, Ni I, Ni II, Cr I, Co II, Be I, and Al I; possible, Pi I and Cu I. There appears to be regions of general absorption between 2836 and 2893 A and between 2442 and 2472 A.

Ionosphere-Propagation Experiment: The measurements give evidence as to the presence of a D-layer as a sharp drop in signal level at the critical frequency was noticed above 60 kilometers. This altitude is in general agreement with the previous estimates of the location of the D-layer.

Biological: Ten plants were grown from the recovered seed. Eight were normal and two showed pollen sterility approaching 50%. There is some suggestion that a lethal mutation had been induced; however, both the slightly reduced germination and increased sterility of these two plants could have been caused by exposure to high temperatures.

COMMENTS

Rocket Performance: The flight appeared to be quite normal. The impact was three degrees east of predicted azimuth. The performance of the power plant was quite satisfactory, although it was slightly below predicted performance. The rocket attained a roll period of approximately 40 sec and did not exhibit an unusual amount of yaw after burnout.

Experiments: All of the experiments performed quite well. Perhaps, the vibration experiment should have been provided for better data recovery. The information from this experiment should only be used as a guide as it is possible that considerable vibration exists at higher frequencies.

REPORTS AND PAPERS

Project Directive, NRL Serial S78-1(119)(1320), 1320-492/46, dated Oct. 29, 1946
WSPG Preliminary Report, EBDetchmendy/1s/164, dated March 11, 1947
Trajectory of A-4, Round Number 21, based on Mitchell phototheodolite observations prepared by Missile Ballistics Branch, BRL, APG
Trajectory of A-4, Round Number 21, Graphical and Numerical Data, based on Askania phototheodolite observations, prepared by Missile Ballistics Branch, BRL, APG
Meteorological Measurements for March 7, 1947 WSPG Air-Weather Section
"Pressures and Temperatures of the Atmosphere to 120 Kilometers" by N. Best, R. Havens, and H. Lagow, Phys. Rev., 71: 915-6, June 15, 1947
"Further Cosmic Ray Experiments above the Atmosphere" by E. H. Krause and S. Golian, The Phys. Rev., 71: 918, June 15, 1947
"Upper Atmosphere Research Report No. IV," by H. E. Newell, Jr. and J. W. Siry, Eds., NRL Report R 3171, Naval Research Laboratory, October 1947
"Photography from the V-2 at Altitudes Ranging up to 160 Kilometers," by T. A. Bergstralh, NRL Report No. R-3083, Naval Research Laboratory, April 1947

UPPER AIR ROCKET SUMMARY

V-2
NO. 22

1 April 1947

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1310 MST
Altitude: 80.3 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Two geiger counter telescopes and alpha particle emulsions
Solar radiation: Ultra violet spectrograph (APL); and one ultraviolet spectrograph (Yerkes Observatory).
High altitude photography: 16 mm. GSAP motion picture camera.

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501 23 channel NRL PPM-AM system
Airborne recorders: Three brass tape recorders
Physical recovery: Separation of forward portion of rocket with TNT and prima cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and eight Askania stations
Cameras: Two Ballistic and three Bowen-Knapp stations
Telescopes: Two stations
Radar: Two modified SCR-584 S-Band stations
Doppler: Number of stations not known
Impact location: None.

Airborne
Beacon: AN/APN-55 (XE-2) S-Band transponder
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
Aspect: Roll photocell and gyro, and zenith angle gyro.

ROCKET PERFORMANCE

Firing angle: 000 degrees
Program angle: 5.6 degrees
Time to burnout: 57.0/60.5 sec.
Altitude at burnout: 19.9 miles
Velocity at burnout: 4457 ft. per sec. max. at 60.5 sec.
Time to zenith:
Altitude at zenith: 803 miles
Time to blowoff: 344 sec.
Altitude at blowoff: 23.5 miles
Flight duration:
Impact coordinates: 25 miles North and 3.5 miles East
Payload weight: 2200 lbs.
Unfueled rocket weight: 8800 lbs.
Unfueled rocket C. G.: 235.4 inches
Gross weight at takeoff: 28,095 lbs.

BALLISTIC DATA

Theodolites: Mitchell trajectory data 0 to 65.6 sec., Askania trajectory date 0 to 96 sec.
Cameras: Trajectory data from three Ballistic stations, data from one Bowen-Knapp station
Telescopes: One tracked 70 sec., another throughout flight
Radar: No data, beacon failed
Doppler: Data 0 to 344 sec.
Impact location: Air and ground search
Aspect: Roll data from gyro, photocell in good agreement.

DATA RECOVERY

Telemeter: No comments furnished
Recorder: Both recorders not receovered
Physical recovery: Film and camera not recovered.

EXPERIMENTAL DATA

Cosmic radiation: No comments furnished
Solar radiation: Spectograms between 30 and 50 miles obtained from APL spectrograph; Yerkes spectrograph failed.

COMMENTS

Rocket performance: Propulsion cutoff in two stages by rocket timer.

REPORTS AND PAPERS

"High Altitude Research Using the V-2 Rocket, March 1946 - April 1947," by L. W. Fraser, and E. H. Seigler, Bumblebee Series Report No. 81, Applied Physics Laboratory, The Johns Hopkins University, July 1948.

"The Ultra-Violet Spectrum of the Sun from V-2 Rockets," by J. J. Hopfield and H. E. Clearman, Jr., Phys. Rev. 73:877, 1948.

"Preliminary Report on High Altitude Photography," by C. T. Holliday, Photogr. Engr. 1:16, 1950.

Report No. 695, by H. P. Hitchcock, Ballistic Research Laboratories, Aberdeen Proving Ground, April 1950.

"V-2 Report No. 10," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on May 7, 1947.

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 23

8 April 1947

IDENTIFICATION

Agency: Applied Physics Laboratory
Time: 1713 MST
Altitude: 63.5 miles.

UPPER AIR INSTRUMENTS

Cosmic radiation: Two geiger counter telescopes
Solar radiation: Ultra-violet spectrograph
High altitude photography: One modified K-25 camera.

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501, 23 channel NRL PPM-AM system
Airborne recorder: Neon lamp photographic recorder
Physical recovery: Separation of nose by TNT and prima cord.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Two stations
- Radar: Two modified SCR-584 S-Band stations
- Doppler: Four stations
- Impact location: None.

Airborne
- Beacon: AN/APN-55 (XE-2) S-Band transponder
- Doppler: DOVAP transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and recovery blowoff
- Aspect: Roll photocell and gyro, and one zenith angle gyro.

ROCKET PERFORMANCE

Firing angle: 000 degrees
Program angle: 5.2 degrees
Time to burnout: 57.0/60.0 sec.
Altitude at burnout: 19.5 miles
Velocity at burnout: 3825 ft. per sec.
Time to zenith:
Altitude at zenith: 63.5 miles
Time to blowoff: 323 sec.
Altitude at blowoff:
Flight duration:
Impact coordinates: 19 miles North and 0.7 miles West.
Payload weight:
Unfueled rocket weight: 8840 lbs.
Unfueled rocket C. G.,: 238 inches
Gross weight at takeoff: 27,460 lbs.

BALLISTICS DATA

Theodolites: Mitchell trajectory data 0 to 64.7 sec., Askania data 25 to 90.3 sec.
Cameras: Bowen-Knapp - satisfactory, Ballistic data 28 to 63 sec.
Telescopes: No information furnished
Radar: Tracked for 320 sec., partial data because cameras jammed
Doppler: Data 0 to 90 sec., signals noisy and intermittent thereafter
Impact location: No information furnished
Aspect: Roll photocell - no data; Gyro data good - roll period 9 sec.

DATA RECOVERY

Telemeter: No information furnished
Physical recovery: Good recovery of camera, spectrograph, and recorder
Recorder: Failed to operate.

EXPERIMENTAL DATA

Cosmic radiation: No information furnished
Solar radiation: No information furnished
High altitude photography: No results, camera began operating five minutes before takeoff.

COMMENTS

Rocket performance: Propulsion cutoff in two stages by rocket timer.

REPORTS AND PAPERS

"High Altitude Research Using the V-2 Rocket, March 1946 - April 1947," by L. W. Fraser and E. H. Seigler, Bumblebee Series Report No. 81, Applied Physics Laboratory, the Johns Hopkins University, July 1948.
Report No. 695, by H. P. Hitchcock, Ballistic Research Laboratories, Aberdeen Proving Ground, April 1949.
"V-2 Report No. 10," Minutes of Meeting ot the V-2 Upper Atmosphere Research Panel on 7 May 1947.
"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

UPPER AIR ROCKET SUMMARY

V-2
NO. 24

17 April 1947

IDENTIFICATION

Agency: General Electric Company
Time: 1622 MST
Altitude: 88.5 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Nine high explosive ejection charges for temperature measurements by flash and sound ranging. (SCEL)

DATA RECOVERY INSTRUMENTS

Telemeter: 28 channel Hermes PWM-FM system
Physical recovery: None

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations
Cameras: Two Ballistic and two Bowen-Knapp stations
Telescopes: Two stations
Radar: Two modified SCR-584 S-Band stations
Doppler: Four stations
Impact location: Cambridge Field Station Beacon Triangulation system.

Airborne
Beacon: Ionosphere unit (Cambridge Field Station)
Doppler: DOVAP transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff
Other: Routine rocket propulsion and control performance instruments.

Other:
Pressure: 23 differential gages distributed along length of ram-jet diffuser cone.

ROCKET PERFORMANCE

Firing angle: 000 degrees
Program angle: 8.5 degrees
Time to burnout: 66.0 sec.
Altitude at burnout: 20.6 miles
Velocity at burnout: 4710 ft. per sec.
Time to zenith: 221 sec.
Altitude at zenith: 88.5 miles
Time to blowoff:
Altitude at blowoff:
Flight duration: 395 sec.
Impact coordinates: 44.8 miles North and 6.6 miles West
Payload weight: 2200 lbs.
Unfueled rocket weight: 9061 lbs.
Unfueled rocket C. G.: 239.4 inches
Gross weight at takeoff: 27,776 lbs.

BALLISTIC DATA

Theodolites: Satisfactory data
Cameras: Satisfactory data
Telescopes: Satisfactory data
Radar: Very good data, some interference with beacon by telemeter
Doppler: Good signals received
Impact location: Ground and air search.

DATA RECOVERY

Telemeter: Record intermittent at times but good during critical period
Physical recovery: None.

EXPERIMENTAL DATA

Temperature-pressure: No data, only one ejection charge exploded.

COMMENTS

Rocket performance: Maximum velocity lower than predicted, attributed to roll which began at 57.5 sec.
Experiments: Ram-jet diffuser test successful
Ballistic instruments: Better than average results
Rocket modifications: Normal warhead replaced with supersonic ram-jet diffuser cone.

REPORTS AND PAPERS

"Preliminary Information on V-2 Rocket No. 24, to be fired 17 April 1947," White Sands Proving Ground, dated 11 April 1947.

"Report of V-2 Firing No. 24, 17 April 1947," White Sands Proving Ground, dated 21 April 1947.

G. E. Data Folder No. 85529, Telemetry data A-4 Rocket No. 24, General Electric Company, dated August 1947.

Trajectory of A-4 No. 24, based on Mitchell Photo Theodolite Observations, Ballistic Research Laboratories, Aberdeen Proving Ground.

Report No, 695, by H. P. Hitchcock, Ballistic Research Laboratories, Aberdeen Proving Ground, April 1949.

"V-2 Report No. 10," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 7 May 1947.

"V-2 Report No. 14," Minutes of Meeting of the V-2 Upper Atmosphere Research Panel on 28 January 1948.

"Final Report, Project Hermes V-2 Missile Program," by L. D. White, Report No. R52A0510, General Electric Company, September 1952.

IDENTIFICATION

2 April 1948

Time of firing: 0640 MST
Agency: University of Michigan for SCEL
Altitude: 89.5 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Twelve grenades (SCEL). Four polonium alphatrons to provide pressure measurement from atmospheric pressure to 5 mm Hg (Mich. U.). Four Pirani gages - pressures from 5 to 0.01 mm Hg (Mich. U.).
Composition: Three evacuated air-sampling bottles with associated timer and pyrotechnic openers and sealers
Cosmic radiation: Two Geiger counter telescopes (NRL)
Solar radiation: One solar spectrograph (NRL)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 23-channel PPM-AM system
Airborne recorder: Three heliograph cameras in fins of tail section
Physical recovery: Warhead and tail separation with primer cord and TNT. Forward separation at base of instrument compartment.

BALLISTIC INSTRUMENTS

Firing range
Theodolites: Three Mitchell and seven Askania stations
Cameras: Three Bowen-Knapp and two ballistic stations
Telescopes: Four stations
Radar: Two modified SCR-584 S-band stations
Doppler: Four stations

Airborne
Beacon: AN/APN-55 S/band transponder
Doppler: T-4 Dovap transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and recovery blowup
Other: Routine propulsion and control performance (G. E.)

ROCKET INFORMATION

Payload weight: About 2200 lb
Unfueled rocket weight: 9742 lb
Gross weight at takeoff: 29,100 lb

ROCKET PERFORMANCE

Firing angle: Vertical
Program angle: Seven degrees (radar)
Time to burnout: 69.3 sec
Velocity at burnout: 4682 ft/sec
Altitude at burnout: 123,000 ft
Time to zenith: 220.3 sec
Altitude at zenith: 89.5 miles
Time to tail blowoff: 298 sec
Altitude at tail blowoff: 71.5 miles
Impact coordinates: 47.3 mi. at 357 degrees from launcher (radar) 55 mi. north (heliograph) estimated

BALLISTIC DATA

Theodolites: Askania camera operations normal 0 to 69 sec, Mitchell-trajectory data 16 to 372 sec, uncorrected after 67 sec
Cameras: Bowen-Knapp operations normal. Ballistic — good photographs, poor synchronization
Telescopes: Poor images Station I from 0 to 70 sec, spectro record 0 to 100 sec Station II, Station IV tracked throughout flight, poor images
Radar: Trajectory data from 0 to 372.5 sec (automatic track) 372.5 to 476.5 sec (manual track)
Doppler: Trajectory data from 8.5 to 298.0 sec from triplets KFB, FGB, and FGK
Aspect: Heliograph attitude and aspect graphical data from 0 to 370 sec

DATA RECOVERY

Telemeter: Pressure measurements: Channels 16 through 21. No data on channels 18 and 19. Bottle opening and closing signals on channel 23 — channel inactive — no signals.
Physical recovery: Air-sampling bottles thrown clear on impact and recovered in excellent condition.
The three heliograph cameras were recovered in a more or less battered condition; a cursory examination indicated useful information from all units.

EXPERIMENTAL DATA

No air samples — pyrotechnic openers failed to fire.
Although some of the pressure gages operated, because of the large instrumental errors and the incompleteness of the data, the calculations of pressure and temperature were of little value. Six of 12 grenades were observed to be ejected.

COMMENTS

Rocket performance: Excellent, no roll
Other: Three attempts to launch V-2, 25 were made in the year preceding the final successful attempt

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," L. M. Jones and H. W. Neill, Engineering Research Institute, University of Michigan, Final Progress Report, Contract W-36-039 sc-32307, Oct. 31, 1950

IDENTIFICATION

15 May 1947

Time of firing: 1604 MST
Agency: Naval Research Laboratory
Altitude: 84 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Stagnation pressure. Ambient pressures on nose cone and tail section.
Cosmic radiation: Geiger-counter telescope (vertical component of soft radiation)
Solar radiation: Two solar spectrographs
Ionosphere: Radio propagation transmitters
Other: Roll and pitch gyroscopes, K-25 aerial cameras (2), 16-mm GSAP (4)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PXTA-501 23-channel pulse sequential system
Airborne recorder: NRL 8-channel neon lamp film recorder
Physical recovery: Nose separation by TNT. Tail separation by primer cord.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Two ballistic stations
Telescopes: Two stations
Radar: Two SCR-584 S-band stations
Doppler: Four stations

Airborne
Beacon: S-band APN-55
Doppler: In use
Radio cutoff: AN/ARW-37 command cutoff and blowoff

ROCKET INFORMATION

Unfueled rocket weight: 9827 lb
Unfueled rocket C. G.: 242.5 in.
Gross weight at takeoff: 29,492 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Time to burnout: 64.2 sec
Velocity at burnout: 4760 ft/sec
Altitude at burnout: 114,880 ft
Altitude at zenith: 84.0 miles

BALLISTIC DATA

Theodolites: Mitchell - one station tracked 46 sec, the other tracked 200 sec,
Askania - four stations tracked almost to impact, two stations to 172 sec and two stations to 50 sec
Cameras: Bowen-Knapp - satisfactory operation. Ballistic - images to 5 sec after burnout.
Telescopes: Satisfactory operation, 4.5-in., telescope shows forward part of rocket smoking at 70 sec
Radar: Radar beacon failed after 50 sec, radars tracked to 53 sec
Doppler: Good signals until 64.2 sec
Impact location: Visual - air and ground search

COMMENTS

Rocket modifications: Pressurized dome installed over telemeter antenna
Rocket performance: Rocket flew off course, 40 degrees east of north from takeoff to impact (east of Alamogordo). Explosion in rocket at 64.25 sec while still under thrust. Blowoff impossible at this time under normal circuit conditions. Warhead was separated during descent and never found. Afterbody in very good condition after impact; however, fins did not separate from tank section even though primer cord was detonated.

IDENTIFICATION

9 Oct 1947

Time of firing: 1215 MST
Agency: General Electric Company
Altitude: 97.0 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Skin temperature measurement equipment at six locations on specially constructed nose cone and also on instrument compartment door. Absolute pressure gage for measuring pressure.
Composition: Three air sampling bottles in the opening and closing devices (U. of Michigan)
Solar radiation: Ultraviolet spectrograph (NRL)

ROCKET PERFORMANCE INSTRUMENTS

Special plated and polished nose cone, with imbedded thermistors for measuring skin temperatures, was attached to missile

DATA RECOVERY INSTRUMENTS

Telemeter: 28-channel General Electric PWM-FM telemetry system
Physical recovery: Separation of nose section with TNT and primer cord

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and three Askania stations
- Cameras: Two ballistic stations and more than one Bowen-Knapp station
- Telescopes: At least two stations
- Radar: Two modified SCR-584 S-band stations
- Doppler: Locations not given

Airborne:
- Beacon: Modified AN/APN-55 S-band transponder
- Doppler: Dovap transceiver
- Radio cutoff: Two ARW-17 FM control receivers for command fuel cutoff and recovery
- Other: Rocket propulsion and control performance instruments (G. E.)

ROCKET INFORMATION

Payload weight: 2200 lb
Unfueled rocket weight: 9107 lb
Unfueled rocket C.G.: 240.1 in.
Gross weight at takeoff: 28,772 lb

ROCKET PERFORMANCE

Firing angle: 0 degrees
Program angle: Seven degrees
Altitude at burnout: 120,000 ft
Time to burnout: 63.5 sec
Velocity at burnout: 5020 ft/sec
Altitude at zenith: 97.0 miles
Time to tail blowoff: 84.5 sec
Altitude at tail blowoff: 232,000 ft
Impact coordinates: 27.5 mi. north, 16.5 mi. east

BALLISTIC DATA

Theodolites: Operation satisfactory
Cameras: Satisfactory Bowen-Knapp operation
Telescopes: Operation satisfactory
Radar: Operated satisfactorily to 84.4 sec
Doppler: Operated satisfactorily to 84.4 sec

DATA RECOVERY

Telemeter: Solid signals received for 64 sec, except for a one-half sec break. Modulation disappeared at 64 sec and unmodulated signal continued until 84 sec at time of warhead blowoff.
Physical recovery: One air-sampling bottle recovered. Spectrograph recovered in near-perfect condition.

EXPERIMENTAL DATA

Excellent records obtained from temperature measuring equipment for period covered by telemetry records.
Pressure gage functioned normally during period covered by telemetry records, and excellent records were obtained.
Solar radiation spectrograms obtained before blowoff extended down to 2600A; although of good quality, not much was added to data obtained previously.
Very significant supersonic heat transfer data obtained as result of temperature instrumentation.

COMMENTS

Rocket performance: First 50 sec of flight entirely normal. At this time missile turned sharply to the left, reaching and holding a course approximately 30 degrees from the original heading. There was an internal explosion at 83.5 sec.
Other: No clues as to reason for premature warhead blowoff

REPORTS AND PAPERS

Report on A-4 Missile No. 27, Including Skin Temperature Measurements to Mach No. 5, R. P. Haviland, General Electric Report No. 55256, 22 April 1948
Supersonic Convective Heat Transfer Correlation from Skin Temperature Measurements on a V-2 in Flight, General Engineering Lab, General Electric Company, 21 June 1948

(Continues)

Atmospheric Temperature and Pressure Variation with Altitude for Flight of A-4 Missile No. 27, W. W. Fischer, TR 55257

Supersonic Convective Heat Transfer Correlations from Skin-Temperature Measurements During Flights of V-2 Rockets No. 27 and No. 19, W. W. Fischer, G. E. Report 55258, July 1949

IDENTIFICATION

8 December 1947

Time of firing: 1442 MST
Agency: Air Research and Development Command
Altitude: 65 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: One ion type pressure gage to measure ram pressure on truncated cone. Four ion type pressure gages on side of cone. One Pirani type pressure gage on side of cone. One Pirani type pressure gage a few inches forward of No. 1 fin. Aspect camera for pressure gage interpretation. (Michigan U.)
Skin temperature measurements: AC resistance bridge with commutator to measure temperature change in nickel temperature-sensing elements distributed along rocket skin (Boston University)
Solar soft x-ray studies: Densitometer packets with x-ray type photographic film behind filters of varying thicknesses of evaporated aluminum (of the order of a few microns) which are opaque to visible light
Vertical incidence ionosphere propagation experiment: Synchronized ground and rocketborne equipment to measure delay time of low-frequency pulse traveling through the E layer by comparison with travel time of undelayed high-frequency signal (AFCRC)
Oblique incidence ionosphere propagation experiment: Ground-transmitted signal travels over very long path. Receivers both in rocket and on ground. Rocket transmitter retransmits signal received in rocket to ground receiver. Measures attenuation of wave passing downward through E layer reflected from F layer (Boston University).
Aspect project: Four still cameras and three motion picture cameras to record data of rocket aspect; cameras are housed in containers to be lowered by parachute on ejection (WADC and FILRAD)
Sky brightness project: Twelve photomultiplier tubes installed on warhead doors, with one door on east side and one door on west side (AFCRC)

ROCKET PERFORMANCE INSTRUMENTS

Heliograph altitude recorder: Heliograph recorders installed in Fins II, III, and IV for cinematographic record of apparent position of sun and horizon as seen from rocket fins (SCEL)
Beacon triangulation system: Track rocket by electronic triangulation system (AFCRC)
Voltage breakdown: Three sets of electrodes at varying spacing mounted on surface of rocket nose cone

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PPM-AM telemetering system - transmitter with frequency of 1025 Mc was located in control compartment of missile
Physical recovery: Separation of warhead from body of missile. Separation of four aluminum cylindrical containers approximately 11 inches in diameter and 13 inches in length. These canisters are lowered to earth by an 8-foot nylon ribbon chute.

Supplement
February 1958

BALLISTIC INSTRUMENTS

Firing Range

Theodolites: Two Mitchell and four Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Two stations
Radar: Two S-band radars were used

Airborne

Beacon: Ionosphere beacon in warhead. A radar beacon, AN/APN-55 (XE), located in tail section of rocket.
Radio cutoff: Two ARW-17 radio receivers at 40.780 Mc located in control compartment for fuel cutoff and warhead blowoff
Other: Routine rocket performance (G. E.)

ROCKET INFORMATION

Unfueled rocket weight: 9485 lb
Gross weight at takeoff: 29,050 lb

ROCKET PERFORMANCE

Program angle: Seven degrees
Time to burnout: 65 sec
Velocity at burnout: 3939 ft/sec
Altitude at burnout: 16-17 miles
Time to zenith: 180 sec
Altitude at zenith: 65 miles
Time to tail blowoff: 300 sec (approximate)
Altitude at tail blowoff: 22.4 miles
Flight duration: 340 sec to warhead impact (estimated)
Impact coördinates: Approximately 28 mi north of firing site and 1/2 mi east

BALLISTIC DATA

Theodolites: Mitchell to near peak, Askania to impact
Cameras: Ballistic film plates good. All Bowen-Knapp camera operations satisfactory.
Telescopes: Telescope I tracked to impact, but had intermittent jams. Warhead blowoff was photographed. Telescope II lost rocket prior to peak.
Radar: Both radars tracked rocket for approximately 315 sec. They indicated that the rocket drifted slightly to east after blowoff.
Beacon triangulation system: Tracking beacon worked satisfactorily after canister separation
Aspect: Data from the three aspect cameras mounted in the mid-body clearly show the motion of the rocket in roll, pitch, and yaw. A slow roll with a period of approximately 80 sec was indicated, and this was substantiated by the action of the ionization gages. The aspect camera information shows rather irregular motions in both pitch and yaw.

DATA RECOVERY

Telemeter: A good telemetering record was obtained until approximately 310 sec, which was shortly after the warhead blowoff

(Continues)

DATA RECOVERY (Continued)

Physical recovery: Rocket body was minus warhead and tail fins at impact; components scattered on violet impact. Two aspect canisters found in rocket mid-body at impact. Blossom parachute minus canister located approximately 15 miles from rocket impact. Canister smashed by impact. Fourth parachute from aspect canister found, minus canister, approximately 22 miles from impact. One 16-mm movie camera from aspect canister found 1/2 miles south of rocket impact. One heliograph, in good condition, found approximately 1/2 mile south of rocket impact.

EXPERIMENTAL DATA

Sky brightness experiment: Scattered light measurements made with interference filters that were peaked at 4280, 4720, 5350, 5670 and 6150A obtained from ground to 35 km verified magnitude of intensities and correlation with atmospheric density as obtained from previous flight

Solar soft x-ray studies: Two packets installed in rocket; one recovered, but foil was missing, eliminating results

Skin temperature experiment: Temperature-time curves obtained. Test flight of equipment; low accuracy.

Voltage breakdown: Data were obtained only in the altitude interval of 12 km to 22 km. Density data computed in this interval was in agreement with known densities within experimental err[illegible] After fuel burnout no data were obtained due to some failure.

Pressure and temperature experiment: Pressure data obtained from 46 km to 100 km. Temperatures computed by means of barometric equation are consistently lower value than the NACA mean standard.

Oblique incidence ionosphere propagation experiment: Rocket flight too low for penetration into E layer; some propagation patterns obtained for very long path

Vertical incidence ionosphere propagation experiment: Equipment worked well; data obtained only for lower part of E layer because of low altitude

COMMENTS

Rocket performance: Exceptionally stable flight. Held calculated course, but failed to obtain calculated maximum altitude.

REPORTS AND PAPERS

WSPG Report of V-2 Firing No. 28, ORDBS 471.94 (a), 15 December 1947

Telemetering Report, A-4 Rocket 28, prepared by Physical Science Lab., New Mexico College of A. & M.A. for BRL, Aberdeen Proving Ground, Contract N173S-11218 December 8, 1947

"Upper Air Research Program," Report No. 1 by the Navigation Laboratory, AMC, Cambridge Field Station, 1 September 1947

"Atmospheric Pressure & Temperature Measurements Between the Altitudes of 40 and 110 Kilometers," Upper Air Research Program Progress Report No. 2, 1 July 1948, Engineering Research Institute, University of Michigan, Contract W33-038-ac-14050

"Upper Air Research Program," Report No. 3 by the Upper Air Laboratory, ERHU, AMC, Cambridge Field Station, 1 April 1949

Final Report No. P-2106-11 for Blossom Series, W. F. Gould, The Franklin Institute Laboratories for Research and Development, 1 March 1950, Contract AF19(122)-33

REPORTS AND PAPERS (Continued)

"Dynamic Probe Measurements in the Ionosphere," A. Reifman and W. G. Dow, Phys. Rev. 76:987 (1949)

"Day Sky Brightness Measured by Rocketborne Photoelectric Photometers," H. A. Miley, et al., Trans. Am. Geophys. Union (in press)

IDENTIFICATION

10 July 1947

Time of firing: 1218 MST
Agency: Naval Research Laboratory
Altitude: 10.1 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Pressure gages on tail section ahead of fins
Cosmic radiation: Geiger-counter telescope
Ionosphere: Ion probe at nose tip. Generating voltmeter (electrostatic field) at midsection.
Other: Simulant agent experiment - Camp Detrick, Indiana, seed containers in control chamber - Harvard College Observatory

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PXTA-501, 23-channel pulse sequential system
Airborne recorder: NRL 13-channel neon lamp photographic recorder
Physical recovery: Warhead separation explosives in control chamber

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and six Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Two stations
Radar: Two modified SCR 584's
Doppler: Four stations

Airborne
Beacon: AN/APN-55 (XE)
Doppler: Dovap transceiver
Radio cutoff: AN/ARW-37 command cutoff and blowoff
Other: Roll, pitch, and yaw gyroscopes in control chamber consolidated vibration pickup in control chamber. Three GSAP 16-mm cameras on tail fins. Prism flame spectrograph on tail fin.
Range safety sky screens

ROCKET INFORMATION

Unfueled rocket weight: 9522 lb
Unfueled rocket C.G.: 241.8 in.
Gross weight at takeoff: 28,187 lb

ROCKET PERFORMANCE

Program angle: Five degrees
Time to burnout: 32 sec

ROCKET PERFORMANCE (Continued)

Velocity at burnout: 1525 ft/sec
Altitude at burnout: 24,800 ft
Time to zenith: 76 sec
Altitude at zenith: 10.1 miles
Flight duration: 138 sec
Impact coordinates: 1.4 mi. north, 0.96 mi. east

BALLISTIC DATA

Theodolites: Trajectory data from 0 to 138 sec
Cameras: Trajectory data throughout field of view of camera
Telescopes: Altitude data from 0 to 138 sec
Radar: Trajectory data from 0 to 138 sec
Doppler: Velocity and position data from 39 to 136 sec
Impact location: Optical and radar bearings at impact
Other: Vibration: Frequencies detected between 36 and 40 cps. At 40 cps peak acceleration 1.17g - probable error ±20%. Vibration only during powered flight.

DATA RECOVERY

Physical recovery: No recovery. The rocket struck intact with about half the propellants aboard. The explosion destroyed everything.

EXPERIMENTAL DATA

No new data were obtained from this firing due to the low peak altitude

COMMENTS

Rocket performance: Shortly after takeoff the rocket attained yaw to the east. Propulsion cutoff was initiated at 32 sec when it was determined the rocket would land outside the range if allowed to continue in powered flight. Faulty control system. First firing from new launching position. Bearing to impact, 38 degrees east of north.

UPPER AIR ROCKET SUMMARY

V-2
NO. 25

Agency: Signal Corps Engineering Laboratory (University of Michigan).
Time: 0640 MST
Altitude: 89.5 miles

2 April 1948

Experiments: Pressure-temperature, composition. Cosmic radiation, solar radiation (NRL).

V-2
NO. 26

Agency: Naval Research Laboratory
Time: 1604 MST
Altitude: 84.0 miles

15 May 1947

Experiments: Cosmic radiation, Solar radiation, Pressure-temperature, Ionosphere.

V-2
NO. 27

Agency: General Electric Company
Time: 1215 MST
Altitude: 97.0 miles

15 May 1947

Experiments: Solar radiation (NRL). Composition (Univ. of Mich.).

V-2
NO. 28

Agency: Air Research and Development Command
Time: 1442 MST
Altitude: 65.0 miles

8 December 1947

Experiments: Pressure-temperature (Univ. of Mich.). Solar radiation, Sky brightness, and Ionosphere (AFCRC). Ionosphere (Boston U.).

V-2
NO. 29

Agency: Naval Research Laboratory
Time: 1218 MST
Altitude: 10.1 miles

10 July 1947

Experiments: Cosmic radiation, Pressure-temperature, Ionosphere. Simulant Agent (Camp Detrick). Biological (Harvard Univ.)

IDENTIFICATION

29 July 1947

Time of firing: 0555 MST
Agency: Applied Physics Laboratory, Johns Hopkins University
Altitude: 99.9 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Single Geiger counter in nose extension. Four pulse ionization chambers (APL)
Solar radiation: Ultraviolet solar spectrograph (APL)
High altitude photography: K25 camera

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PXTA-501 23-channel PPM-AM system
Physical recovery: Warhead blowoff by radio command

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Two stations
- Radar: Two modified S-band stations
- Doppler: Four stations

Airborne:
- Beacon: AN/APN-55 S-band transponder
- Doppler: Dovap transceiver
- Radio cutoff: AN/ARW-17 FM control receiver for command blowoff and cutoff
- Aspect: Two gyroscopes

ROCKET INFORMATION

Unfueled rocket weight: 8533 lb
Unfueled rocket C.G.: 226.2 in.
Gross weight at takeoff: 27,023 lb

ROCKET PERFORMANCE

Firing angle: 1.5 degrees
Program angle: Approximately one degree
Time to burnout: 62.5 sec
Velocity at burnout: 4962 ft/sec
Altitude at burnout: 119,800 ft
Time to zenith: 224.5 sec
Altitude at zenith: 99.9 miles

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 361 sec
Altitude at tail blowoff: 239,000 ft
Flight duration: 361 sec
Impact coordinates: Four mi. west, 200 yd south of launcher

BALLISTIC DATA

Theodolites: Mitchell - trajectory data from 0 to 63.62 sec, Askania - trajectory data from 0 to 73.25 sec
Cameras: Bowen-Knapp - records for first 2000 ft, ballistic - images 0 to 62.5 sec
Telescopes: Very good tracking
Radar: Beacon intermittent throughout flight, strong at summit; complete tracking from one radar from 0 to 300 sec
Doppler: Excellent signals at all stations with numerous interruptions
Impact location: Visual and ground search

EXPERIMENTAL DATA

Ultraviolet spectrum obtained to 2600A. Burst producing component of cosmic rays measured up to 160 km. Counting rate rose to 49/sec at 19.8 km, then rate fell off, reaching plateau from about 55 km to 161 km with average rate of 22.4/sec. Primary flux 0.12 particle/sec/cm^2/steradian.

COMMENTS

Rocket modifications: Extension at nose tip to house Geiger counter (Bakelite cylinder)
Rocket performance: Rocket inclined 1.5 degrees north on launcher. Trajectory angle near vertical, program was not introduced.

REPORTS AND PAPERS

"Exploratory Cosmic Ray Observations at High Altitudes by Means of Rockets," J. A. Van Allen, Sky and Telescope 7:171 (1948)
"Cosmic-Ray Bursts in the Upper Atmosphere," H. E. Tatel and J. A. Van Allen, Phys. Rev. 73:87 (1948)
"Synopsis of Ballistic Measurements of the A4 Rockets Launched from November 1946 to July 1947," H. P. Hitchcock, Report No. 695, BRL-APG, April 1949
"The Cosmic-Ray Counting Rate of a Single Geiger Counter from Ground Level to 161 Kilometers Altitude," J. A. Van Allen and H. E. Tatel, Phys. Rev. 73:245 (1948)
"The Ultraviolet Spectrum of the Sun from V-2 Rockets," John J. Hopfield and Harold E. Clearman, Jr., Phys. Rev. 73:877 (1948)
"The Cosmic-Ray Intensity Above the Atmosphere," A. V. Gangnes, J. F. Jenkins, Jr. and J. A. Van Allen, Phys. Rev. 75:57 (1949)

IDENTIFICATION

8 December 1949

Time of firing: 1214 MST
Agency: Air Research and Development Command
Altitude: 81 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature:

Skin temperature experiment: Nickle temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distributed along rocket skin (B. U.)

Emission spectrum experiment: High-powered pulsed transmitter operating in the neighborhood of 1.4 Mc to create electrostatic field resulting in emission glow (AFCRC)

Oblique incidence ionosphere propagation experiment: Ground-transmitted signal travels over very long path. Receivers both in rocket and on ground. Rocket transmitter retransmits signal received in rocket to ground receiver. Measures attenuation of wave passing downward through E layer reflected from F layer. (B. U.)

Vertical incidence ionosphere propagation experiment: Synchronized ground and airborne equipment to measure delay time of low-frequency pulse traveling through the E layer by comparison with travel time of undelayed high-frequency signal (AFCRC)

Luxembourg experiment and artificial airglow: Intermittently pulsed "disturbing" transmitter; pulsed transmitter to radiate "wanted" signal; phototube detectors with filters and cameras. There is some evidence that glow is localized in immediate vicinity of rocket. (Tufts College, Utah U. and AFCRC.)

Other:

Acoustical studies: One condenser and one crystal microphone to measure meteoric impacts and acoustic noise (Temple U.)

Phototube experiment: Six multiplier phototubes and associated filters and circuits were located in Zone C of the warhead; they were mounted in groups of three near doors on opposite sides of warhead (AFCRC), Project No. 67 (Aero-Medical Lab., WPAFB)

Solar radiation: Soft x-ray study - a number of packets, each containing photographic film with a stepped-wedge type aluminum filter, were placed on surface of warhead, missile body, and fins (AFCRC)

ROCKET PERFORMANCE INSTRUMENTS

Beacon triangulation studies: System used to obtain an accurate trajectory. Airborne 470-493.5 Mc beacon transmits range pulses to four ground stations. (AFCRC).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PPM-AM telemetering system, 30 channels, transmitter type AN/DKT-2 (XN-1); BRL telemetering equipment (doppler) used as single channel

DATA RECOVERY INSTRUMENTS (Continued)

Physical recovery: Separation at peak altitude by radio command to ARW-37 cutoff receiver

Blossom IV-D nose section to be separated from missile body by means of four pistons actuated by an explosive charge (FILRAD, WADC)

Parachute recovery: Parachute system consists of a red 80-ft nylon ribbon main canopy and a 16-ft nylon ribbon drag parachute (FILRAD, WADC)

BALLISTIC INSTRUMENTS

Firing Range

Theodolites: One Mitchell and four Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Four stations
Radar: Two modified S-band radars
Doppler: Four stations

Airborne

Radio cutoff: One ARW-37 radio receiver operating at 54.5 Mc was located in control compartment for use in fuel cutoff and parachute ejection
Other: Routine rocket performance instrumentation

ROCKET INFORMATION

Unfueled rocket weight: 10,211 lb
Gross weight at takeoff: 29,695 lb

ROCKET PERFORMANCE

Program angle: Seven degrees from vertical
Time to burnout: 64.6 sec
Velocity at burnout: 4410 ft/sec
Altitude at burnout: 20.1 miles
Time to zenith: 204.5 sec
Altitude at zenith: 81 miles
Flight duration: 346 sec to impact
Impact coordinates: Main body - 37.8 mi. from the launcher on azimuth of 357 degrees 46'; warhead - about 2 mi. north of main body

BALLISTIC DATA

Theodolites: Sketchy Askania data available after burnout until approximately 100 sec, Mitchell data obtained from about 45 to 106 sec and at intervals earlier

Cameras: Bowen-Knapp images for 13 sec. Ballistic - images infrequent because of clouds.

Telescopes: Tracked over peak and through separation

Radar: Good signal until 160.5 sec and from 183 sec until 219.5 sec; sporadic thereafter

Doppler: Good signal received until 80 sec

DATA RECOVERY

Telemeter: NRL telemetering system signal was good until warhead separation, at which time synchronizing pulse disappeared

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DATA RECOVERY (Continued)

Physical recovery: K-25 camera was damaged, but film usable. Warhead, minus parachute, was in badly damaged condition.

EXPERIMENTAL DATA

Soft x-ray study: Packets on main body of rocket severely damaged upon impact; packets on warhead, though recovered, damaged to extent that no data were obtainable
Skin temperature: Excellent curves of temperature vs time for heating effects due to frictional dissipation between various points on the missile and adjacent air molecules
Oblique incidence propagation experiment: Excessive interference, poor data
Vertical incidence ionosphere propagation experiment: Intermittent operation, no satisfactory results
Acoustical studies: Acoustical noise related to progress of flight; about 66 pips were attributed to meteoric impacts
Phototube experiment: This experiment, as indicated by the telemetering records, performed very well and yields some important data on sky brightness studies
Emission spectrum: Discharge not sufficiently diffused to produce desired spectra
Beacon triangulation studies: Good trajectory to 61 sec, intermittent thereafter
Luxembourg experiment: As a result of intermittent operation, insufficient data were obtained to realize significant results

COMMENTS

Rocket modifications: Rocket carried new elongated nose section (Blossom) which provides for 80 to 100 cubic feet of space for research instruments. Length of original V-2 was increased by one diameter.
Rocket performance: Takeoff was normal. Steering was good and performance of the propulsion unit was better than predicted.

REPORTS AND PAPERS

"Investigation of the Ionosphere Utilizing Sounding Rockets," Upper Atmosphere Research Laboratory, Boston University, Contract AF19(122)-36, Report No. 3, 31 May 1950
"Luxembourg Equipment, Common Power Supply," Tufts College, Contract AF19(122)-89, Progress Report No. 2, 15 September - 15 December 1949
"Research in the Physical Properties of the Upper Atmosphere, With Special Emphasis on Acoustical Studies with V-2 Rockets," Research Institute of Temple University, Contract W19-122 ac-12, Report No. 8, 24 May 1950

IDENTIFICATION

16 September 1949

Time of firing: 1619 MST
Agency: Air Research and Development Command
Altitude: 2.6 miles

UPPER AIR INSTRUMENTS

Skin temperature measurements: Nickel temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distrubuted along rocket skin (B. U.)

Emission spectrum experiment: High-powered pulsed transmitter operating in the neighborhood of 1.4 Mc to create electrostatic field producing an emission glow (Tufts College and AFCRC)

Phototube experiment: Six multiplier phototubes, mounted in groups of three on opposite sides of warhead, to measure light radiation of electrostatic probe experiment (AFCRC)

Vertical incidence ionosphere experiment: Synchronized ground and rocketborne equipment to measure delay time of low-frequency pulse traveling through the E layer by comparison with travel time of undelayed high-frequency signal (AFCRC)

Luxembourg experiment and artificial airglow: Intermittently pulsed "disturbing" transmitter, pulsed transmitter to radiate "wanted" signal, phototube detectors with filters, cameras (Tufts College, University of Utah, AFCRC)

Acoustical studies: Meteoric impacts and acoustic noise. One condenser and one crystal microphone. (Temple University).

Cosmic radiation particle detection experiment: Two sealed cadmium covered paraffin spheres containing nuclear emulsion plates, and two sealed rectangular iron boxes containing nuclear emulsion plates and lead, placed in Zone C of warhead. (U. of Chicago).

Soft solar x-ray studies: Packets each containing photographic film with a stepped-wedge type aluminum filter were placed on surface of rocket (AFCRC)

ROCKET PERFORMANCE INSTRUMENTS

Beacon triangulation studies: Triangulation system used to obtain accurate trajectory. Airborne 470-493.5 Mc beacon transmits range pulses to 4 ground stations. (AFCRC).

Data transmission utilizing television and beacon techniques: Airborne television camera and transmitter to supply observations of ground and parachute performance. Portion of television raster utilized for ranging. (AFCRC, B. U., and Tufts College). Project Albert III: (Aero-Medical Lab., WPAFB).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL AN-DKT-2 (XN-1) PPM-AM telemetering system operating at frequency of 1025 Mc 30 channels. G. E. telemetering system - 30 channels. BRL telemetering equipment (Hermes).

Physical recovery: Blossom warhead to be separated from rocket body by means of four pistons actuated by explosive charge. To be lowered by parachute after separation. One red 64-ft nylon ribbon main canopy used in conjunction with a 16-ft nylon ribbon drag parachute.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and eight Askania stations
Cameras: Three ballistic and three Bowen-Knapp stations
Telescopes: Three stations
Radar: Two S-band radars
Doppler: Six stations
Impact location: E and C stations of the impact point computer were operated

Airborne:
Beacon: APN/55 - S-band
Radio cutoff: One ARW-37 radio receiver operating at 54.5 Mc was located in control compartment for fuel cutoff and parachute ejection
Other: Routine rocket performance instrumentation

ROCKET INFORMATION

Unfueled rocket weight: 9996 lb
Unfueled rocket C.G.: 260.5 in.
Gross weight at takeoff: 29,195 lb

ROCKET PERFORMANCE

Program angle: Two degrees at 13 sec
Time to burnout: 24.7 sec (fuel cutoff)
Velocity at burnout: 620 ft/sec
Altitude at burnout: 1.7 miles
Time to zenith: 42.5 sec
Altitude at zenith: 2.6 miles
Time to tail blowoff: 48.2 sec (signal given but not effected)
Flight duration: 82.9 sec
Impact coordinates: Main body and warhead - approximately 3/4 mi. west and 1/2 mi. north of the launcher. Nose tip - 200 yd south of main impact.

BALLISTIC DATA

Theodolites: Askania - to impact, Mitchell - to impact
Cameras: Missile did not climb high enough during burning period for recording of images by ballistic cameras. Bowen-Knapp - for approximately 17 sec of flight.
Telescopes: Tracked main body to impact.
Radar: Good signal until 10.5 sec, when beacon went out abruptly
Doppler: Noisy signal on six stations, faded out at about 26.7 sec
Impact location: Trackers at E and C stations followed the rocket to impact

DATA RECOVERY

Telemeter: NRL telemetering equipment functioned normally throughout flight of missile. Hermes telemetry - good signal obtained.
Physical recovery:
Blossom IV-C experiment - after two explosions in rocket, attempt was made to save warhead and parachute by giving warhead blowoff command at 48.2 seconds. However, command was not effected.
Parachute experiment - parachute ejection did not take place

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Instrument rack with all instruments was badly damaged by impact and fire. Two cameras in main body were recovered in good but not operable condition. Nose cone was badly broken up. Parachute was badly burned.

EXPERIMENTAL DATA

Because of the nature of the flight, no data were obtained from the soft x-ray studies, phototube experiment, vertical incidence ionosphere experiment, acoustical studies, particle detection experiment, emission spectrum experiment, Luxembourg experiment and artificial airglow

Skin temperature measurements: Measurements obtained for duration of short flight

Beacon triangulation studies: Good signal to impact

Data transmission utilizing television and beacon techniques: Good signals until second explosion

COMMENTS

Rocket modifications: This was the third V-2 to carry an elongated nose section, giving an additional length of one diameter to the rocket

Rocket performance: After firing time had been delayed twice, takeoff appeared normal. At 10.7 sec small explosion occurred in tail section and west fin disintegrated; missile began to roll and yaw. Second explosion at 24.2 sec in tail section and missile began to tumble. Blowoff command given at 48.2 sec, but command was not effected.

Other: Upon impact a high order explosion occurred, scattering parts and fragments over a wide area; flames of the burning fuel appeared to be about 80 ft high. The instrument and parachute compartment remained at the point of impact.

REPORTS AND PAPERS

"Rocket-Borne Television Camera Utilizing the RCA Type 5527 Iconoscope," W. C. Moore, Part II, Technical Note No. 7, Upper Atmosphere Research Laboratory, Boston University, 4 April 1950, Contract AF19(122)-36

"Research in the Physical Properties of the Upper Atmosphere, With Special Emphasis on Acoustical Studies with V-2 Rockets," Research Institute of Temple University, Report No. 6, 8 February 1950, Contract W19-122-ac-12

"Investigation of the Ionosphere Utilizing Sounding Rockets," Upper Atmosphere Research Laboratory, Boston University, Report No. 2, 1 September - 30 November 1949, Contract AF19(122)-36

UPPER AIR ROCKET SUMMARY

V-2
NO. 33

IDENTIFICATION

2 September 1948

Time of firing: 1800 MST
Agency: University of Michigan for SCEL
Altitude: 93.6 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: SCEL sound grenades. Shock wave angle measurement for temperature. Ram and cone surface pressure gages for temperature.
Composition: Two evacuated air-sampling bottles with associated timer and pyrotechnic opening and sealing devices

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501 23-channel PPM-AM system
Physical recovery: Warhead control compartment separation by TNT

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and seven Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: One modified SCR-584 S-band station

Airborne
- Beacon: AN/APN-55 S-band transponder
- Radio cutoff: AN/DRW-37 FM control receiver for command cutoff and blowoff
- Aspect: Three Giannini heliograph cameras
- Other: Routine rocket propulsion and control performance instrumentation (G. E.)

ROCKET INFORMATION

Payload weight: 2535 lb
Unfueled rocket weight: 8422 lb
Takeoff weight: 27,840 lb
Flight duration: 600 sec estimated

ROCKET PERFORMANCE

Program angle: Seven degrees North
Time to burnout: 65.3 sec
Velocity at burnout: 4800 ft/sec
Altitude at burnout: 123,200 ft
Time to zenith: 225 sec
Altitude at zenith: 93.6 miles

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 370 sec
Altitude at tail blowoff: 276,000 ft
Impact coordinates: Main body - 39.5 mi. north, 2.9 mi. west of launcher; warhead - 40 mi. north, 3.5 mi. west of launcher

BALLISTIC DATA

Theodolites: Askania trajectory data from 1.6 to 69.6 sec
Radar: Trajectory data from 0 to 369.5 sec

DATA RECOVERY

Telemeter: Data from 0 to 18 sec, and from 50.5 to 52.5 sec; none thereafter
Physical recovery: Two air-sampling bottles recovered. Three heliographs in excellent condition.

EXPERIMENTAL DATA

Upper air composition: No data
No air samples - one bottle seal ruptured at impact, opener failed on other bottle
Because of the telemeter failure no information was obtained from the shock wave angle experiment or the cone pressure experiment

COMMENTS

Rocket modifications: Four Pirani gages mounted on extension rods were placed at 90-degree intervals, eight in. from the longitudinal axis of a 40-degree right circular cone. The rods were driven through an excursion of 8 in. with a period of about 3 sec in a direction parallel to the cone axis so as to intercept the shock wave.

An opening for the ram-pressure Pirani gage was placed in the tip of the cone and four openings for cone side-pressure gages were placed at 90-degree intervals on the cone surface

The holes for the grenades were located radially in the base of the warhead

Rocket performance: Excellent

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," L. M. Jones and H. W. Neill, Engineering Research Institute, University of Michigan, Final Progress Report, Contract No. W-36-039-sc-32307, October 31, 1950

IDENTIFICATION

22 January 1948

Time of firing: 1312 MST
Agency: Naval Research Laboratory
Altitude: 99 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Stagnation pressure gages at nose tip. Ambient pressure gages at warhead base. Ambient pressure gages ahead of tail fins.
Cosmic radiation: Wilson cloud chamber
Ionosphere: Ionosphere propagation transmitters. Positive ion gage.

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501, 23-channel PPM-AM system
Physical recovery: Warhead separation explosives in control chamber. Cloud chamber camera secured to motor with elevator cable.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and seven Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Two stations
- Radar: Two SCR-584's
- Doppler: Four stations

Airborne
- Beacon: APN-55, S-band radar beacon
- Doppler: Dovap transceiver
- Radio cutoff: Two AN/ARW-7 receivers command cutoff and blowoff
- Other: Roll, pitch, and yaw gyroscopes. Spin stabilization jatos.

ROCKET INFORMATION

Unfueled rocket weight: 9548 lb
Gross weight at takeoff: 29,013 lb

ROCKET PERFORMANCE

Program angle: Seven degrees
Time to burnout: 67 sec
Velocity at burnout: 4985 ft/sec
Altitude at burnout: 23.5 miles
Time to zenith: 228 sec
Altitude at zenith: 99 miles
Time to tail blowoff: 408 sec (explosion)
Altitude at tail blowoff: 6.2 miles

ROCKET PERFORMANCE (Continued)

Flight duration: 420 sec approximately
Impact coordinates: 48 mi. north

BALLISTIC DATA

Theodolites: Mitchell - Tracked down to ground haze; Askania - satisfactory operation
Cameras: Bowen-Knapp - Satisfactory operations
Telescopes: One station tracked 60 sec, other 72 sec. Test station tracked throughout flight.
Radar: Both radars tracked until 408 sec. Good data records obtained.
Doppler: Good signals until after burnout, then considerable interference from ionosphere experiment. Data tabulated from 0 to 126 sec, poor after 116 sec.

DATA RECOVERY

Physical recovery: The warhead separation explosives did not operate

COMMENTS

Rocket performance: Two-rpm roll rate after burnout. Rocket oscillated during descent. Radio blowoff signal given at 310 sec, timer signal at 325 sec. Warhead did not separate until rocket disintegrated from violent explosion at 408 sec. Yaw less than five degrees during burning. Good propulsion performance.

UPPER AIR ROCKET SUMMARY

V-2
NO. 30

Agency: Applied Physics Laboratory
Time: 0555 MST
Altitude: 99.9 miles

29 July 1947

Experiments: Cosmic radiation, Solar radiation, High altitude photography.

V-2
NO. 31

Agency: Air Research and Development Command
Time: 1214 MST
Altitude: 81.0 miles

8 December 1949

Experiments: Solar radiation, Sky brightness, Ionosphere (AFCRC). Ionosphere, Skin Temperature (Boston Univ.)

V-2
NO. 32

Agency: Air Research and Development Command
Time: 1619 MST
Altitude: 2.6 miles

16 September 1949

Experiments: Cosmic radiation (Univ. of Chicago). Solar radiation, Ionosphere (AFCRC). Air glow (Tufts College, AFCRC, Univ. of Utah).

V-2
NO. 33

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1800 MST
Altitude: 93.6 miles

2 September 1948

Experiments: Pressure-temperature (SCEL). Composition (Univ. of Mich.)

V-2
NO. 34

Agency: Naval Research Laboratory
Time: 1312 MST
Altitude: 99.0 miles

22 January 1948

Experiments: Cosmic radiation, Pressure-temperature, Ionosphere.

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

27 May 1948

Time of firing: 0716 MST
Agency: Applied Physics Laboratory, Johns Hopkins University
Altitude: 86.75 miles

UPPER AIR INSTRUMENTS

Composition: Air-sample bottles (SCEL, Mich. U.)
Cosmic radiation: Single Geiger counter in nose extension. Four pulse ionization chambers heavily shielded with lead (APL)
Solar radiation: Ultraviolet solar spectrograph (APL)
Other: High altitude photography: K 25 with infrared film

DATA RECOVERY INSTRUMENTS

Telemeter: PXTA-501 23-channel PPM-AM system
Physical recovery: Warhead blowoff by radio command, primer cord and TNT to sever forward portion of rocket

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Two ballistic and two Bowen-Knapp stations
Telescopes: Three stations
Radar: Two modified SCR-584 S-band stations

Airborne
Beacon: AN/APN-55 (XE-2)
Radio cutoff: AN/ARW-17 FM control receiver command fuel cutoff and blowoff
Aspect: Giannini heliographs, four arrays of photocells
Other: Routine rocket propulsion and control performance instruments (G. E.)

ROCKET INFORMATION

Unfueled rocket weight: 10,400 lb
Gross weight at takeoff: 29,868 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: Seven degrees
Time to burnout: 66 sec
Velocity at burnout: 4590 ft/sec
Altitude at burnout: 21.8 miles
Time to zenith: 217 sec
Altitude at zenith: 86.75 miles

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 341.6 sec
Altitude at tail blowoff: 38.6 miles
Flight duration: 573 sec
Impact coordinates: 41 mi. north, 2 mi. west

BALLISTIC DATA

Theodolites: Askania trajectory data from 0 to 217 sec; Mitchell trajectory data from 0 to 70 sec
Cameras: Ballistic - satisfactory operation from one station, no data from other. Bowen-Knapp - satisfactory operations.
Telescopes: One 4.5-in. telescope tracked to 110 sec
Radar: Trajectory data from 0 to 350 sec

DATA RECOVERY

Physical recovery: Spectrograph in 16-ft crater - recovered. Camera recovered four hours after firing.

EXPERIMENTAL DATA

Cosmic ray: Single counter confirmed V-2 30 data. No information on ion chambers, composition, or solar radiation.
Photography: Cameras ran 68 sec

COMMENTS

Rocket performance: Rocket very steady and rolled little

REPORTS AND PAPERS

"The Cosmic-Ray Intensity Above the Atmosphere," A. V. Gangnes, J. F. Jenkins, Jr. and J. A. Van Allen, Phys. Rev. 75:57 (1949)

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

6 February 1948

Time of firing: 1015 MST
Agency: General Electric Company
Altitude: 69 miles

UPPER AIR INSTRUMENTS

No upper air instruments were installed in this rocket

DATA RECOVERY INSTRUMENTS

Telemeter: 28-channel G. E. PWM/FM system
Physical recovery: Warhead separation explosives in control chamber

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and seven Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Two stations
- Radar: Two modified SCR-584 S-band radars
- Doppler: Four stations

Airborne
- Beacon: G. E. S-band transponder
- Doppler: Dovap transceiver
- Radio cutoff: Two AN/ARW-17 receivers for command fuel cutoff and blowoff
- Aspect: Three heliographs in tail fins (SCEL)

ROCKET INFORMATION

Payload weight: 2200 lb
Unfueled rocket weight: 8879 lb
Unfueled rocket C.G.: 233.3 in.
Gross weight at takeoff: 28,454 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees true
Program angle: Program and course manually introduced
Time to burnout: 67 sec
Velocity at burnout: 4,850 ft/sec
Altitude at burnout: 22 miles
Time to zenith: 197 sec
Altitude at zenith: 69 miles
Time to blowoff: 315 sec
Altitude at tail blowoff: 28 miles
Flight duration: 440 sec

ROCKET PERFORMANCE (Continued)

Impact coordinates: Body - 3.7 mi. east and 1.4 mi. south; warhead - 2.4 mi. east and 1.8 mi. south

BALLISTIC DATA

Theodolites: Complete flight tracked, operation satisfactory
Cameras: 13 sec of flight recorded
Telescopes: Complete flight tracked
Radar: Poor beacon signals received to blowoff
Doppler: Record to blowoff with few gaps
Impact location: Visual with ground search

DATA RECOVERY

Telemeter: Record from 0 to 44 sec
Physical recovery: Two heliographs recovered

COMMENTS

Rocket performance: Satisfactory
Experiment: Rocket successfully maneuvered by manual ground command for first 40 sec of burning
Other: Spare cutoff transmitter needed to effect blowoff

IDENTIFICATION

11 June 1948

Time of firing: 0322 MST
Agency: Air Research and Development Command
Altitude: 38.7 miles

UPPER AIR INSTRUMENTS

Soft solar x-ray measurements: Densitometer packets with x-ray type photographic film behind filters of varying thickness of evaporated aluminum (of the order of a few microns) which are opaque to visible light (AFCRC)
Ambient pressure and temperature measurements: Two type VG-1A ionization pressure gages on mid-body of rocket. One Phillips pressure gage on mid-body of rocket. Special cannister for shock wave angle determination. (Mich. U.)
Skin temperature measurement: Nickel temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distributed along rocket skin (Boston U.)
Vertical incidence ionosphere propagation experiment: Synchronized ground and rocketborne equipment to measure delay time of low-frequency pulse traveling through the E layer by comparison with travel time of undelayed high-frequency signal (AFCRC)
Luxembourg experiment and artificial airglow: Intermittently pulsed "disturbing" transmitter, with probe to excite artificial airglow, vertical-incidence ionosphere transmitter furnishing wanted signal; phototube detectors with filters and optical spectrograph (AFCRC)
Sky brightness measurement experiment: Three photoelectric tubes located in nose section, pointed directly at Luxembourg antenna (AFCRC)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 23-channel telemetering system; 1025-Mc transmitter located in control compartment
Physical recovery: Parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: SCR-584, S-band
- Doppler: Four stations

Airborne
- Beacon: Miniature beacon installed in tip of nose cone to telemeter time of parachute ejection and aid in tracking of nose section (AFCRC)
- Doppler: Dovap transceiver
- Radio cutoff: One ARW-37 radio receiver at 54.4 Mc located in control compartment of rocket for fuel cutoff or warhead blowoff
- Other: Routine rocket performance instrumentation

ROCKET INFORMATION

Unfueled rocket weight: 10,161 lb
Gross weight at takeoff: 29,529 lb

ROCKET PERFORMANCE

Program angle: Seven degrees
Time to burnout: 57.5 sec
Velocity at burnout: 3003 ft/sec
Altitude at burnout: 13.1 miles
Time to zenith: 150.5 sec
Altitude at zenith: 38.7 miles
Time to tail blowoff: 96 sec
Altitude at tail blowoff: 29.8 mi. (ascending)
Flight duration: 282 sec
Impact coordinates: Main body - 17 mi. north; warhead - 16 mi. north

BALLISTIC DATA

Theodolites: Askania - good operations through burnout; Mitchell - good records through burnout
Cameras: Ballistic - operations very good; Bowen-Knapp - operations satisfactory
Telescopes: Telescope I - tracker followed rocket approximately 180 sec; noted intermittent glow after burnout. Telescope II, N station - rocket lost in clouds 5 or 10 sec after takeoff. Telescope III followed rocket approximately 170 sec. Telescope IV used for a spectrograph experiment.
Radar: SCEL beacon radar tracked through peak
Doppler: Good signals throughout flight

DATA RECOVERY

Telemeter: Good telemetering record obtained for 74 sec, loss of record from 74 to 128 sec. From 128 sec to 283 sec, record was intermittent.
Physical recovery: Warhead and parachutes. One spectrograph film casette from rocket tail fin No. 1. Main body, intact up to impact, landed point down at high velocity, resulting in complete disintegration of rocket. Components scattered.

EXPERIMENTAL DATA

Ambient pressure and temperature measurements: No pressure data obtained due to low altitude. No data on shock wave angle determination due to low altitude.
Skin temperature measurement: Curves of temperature vs time for heating effects due to frictional dissipation between various points on the missile and adjacent air molecules
Spectrograph study: No data since light source (artificially induced aurora) did not function
Vertical incidence ionosphere propagation experiment: No data obtained due to insufficient altitude, although there was some measurable retardation at the maximum altitude
Soft x-ray measurements: Two packets were recovered; in one the foil was missing, and the other showed pinhole fogging only
Miniature beacon experiment: Functioned satisfactorily. Impact of the warhead was determined from signal received by ground stations from the beacon.
Sky brightness measurement: No data obtained

(Continues)

EXPERIMENTAL DATA (Continued)

Luxembourg experiment and artificial airglow: No data due to failure of transmitter

COMMENTS

Rocket performance: Takeoff apparently normal; cutoff occurred unusually early at 57.7 sec. Warhead separated by cutoff receiver at 96 sec. Canister ejected at 92 sec. Rocket was very stable up to time of burnout; a roll of approximately 20 rpm started after burnout.

IDENTIFICATION

19 April 1948

Time of firing: 1254 MST
Agency: Naval Research Laboratory
Altitude: 34.8 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Pressure gages on tail section
Cosmic radiation: Nuclear research emulsions
Solar radiation: Sunfollower solar spectrograph
Ionosphere: Generating voltmeter (electrostatic field) on midsection. Positive ion collector on nose.
Metro cameras: Meteorological data from wind effects on vapor trail
Other: Cross jet attenuation transmitters and receivers

DATA RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-1) 30-channel pulse position system
Airborne recorder: Solar spectrogram recording camera
Physical recovery: Sunfollower-spectrograph ejector mechanism with parachute; warhead separation explosives in control section

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and seven Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two modified SCR-584 stations
- Doppler: Four stations
- Impact location: Sound ranging

ROCKET INFORMATION

Unfueled rocket weight: 9169 lb
Gross weight at takeoff: 28,287 lb

ROCKET PERFORMANCE

Program angle: 15 degrees (actual)
Time to burnout: 57.1 sec
Velocity at burnout: 3680 ft/sec
Altitude at burnout: 15 miles
Time to zenith: 134.5 sec
Altitude at zenith: 34.8 miles
Time to tail blowoff: 60.1 sec
Altitude at tail blowoff: 17 miles

ROCKET PERFORMANCE (Continued)

Flight duration: 305 sec
Impact coordinates: 32 mi. north, 7 mi. west

BALLISTIC DATA

Theodolites: Mitchell - both stations tracked to 95 sec, one to impact; Askania - trajectory data from 0 to 60 sec
Cameras: Bowen-Knapp - satisfactory operations; ballistic - good record for 70 sec
Telescopes: satisfactory operations
Radar: Tracked for entire flight
Doppler: Fair signals until blowoff

DATA RECOVERY

Physical recovery: Sunfollower ejected at fuel cutoff and separated as shown by telescope film, but never recovered. Warhead separation explosives set off at 60 sec.

COMMENTS

Rocket performance: Propulsion normal. Steering faulty, between 13 and 29 sec rocket rolled 40 to 50 degrees and returned to normal four times, then began 8.3 rpm roll. Rocket began to deviate to the west and propulsion was terminated to prevent crossing range boundary.

IDENTIFICATION

19 March 1948

Time of firing: 1610 MST
Agency: General Electric Company
Altitude: 3.4 miles

UPPER AIR INSTRUMENTS

Temperature: Flash and sound grenades to obtain anomalous propagation of sound data (SCEL)
Composition: Air sampling bottles in "Blossom" canister. (Michigan U.)
Other: Upper air wind vectors from drift of grenade puffs and talcum "smoke" generator (SCEL)
Earth's magnetic field (ARDC)

DATA RECOVERY INSTRUMENTS

Telemeter: G. E. PWM/FM, 28-channel system (production model)
Physical recovery: Warhead separation explosives in control chamber. "Blossom" canister containing air-sample bottles.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and eight Askania stations
Cameras: Three Bowen-Knapp stations
Telescopes: Three stations
Radar: Two modified SCR-584 S-band stations
Doppler: Four stations

Airborne
Beacon: AN/APN-55 S-band transponder
Doppler: Dovap transceiver
Radio cutoff: One ARW-17 receiver for command fuel cutoff and blowoff
Aspect: Three heliographs in tail fins
Other: Vibration sensitive yaw and pitch accelerometers
Velocity meter (gyroscopic integrating accelerometer)

ROCKET INFORMATION

Payload weight: 2200 lb
Unfueled rocket weight: 9659 lb
Gross weight at takeoff: 29,074 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees true
Program angle: 7.0 degrees from vertical
Time to burnout: 28.5 sec

ROCKET PERFORMANCE (Continued)

Velocity at burnout: 530 ft/sec
Time to zenith: 54.3 sec
Altitude at zenith: 3.4 miles
Time to tail blowoff: 65.2 sec (explosion)
Altitude at tail blowoff: 2.5 miles
Flight duration: 91.5 sec
Impact coordinates: 1 mi. south and 1/2 mi. east

BALLISTIC DATA

Theodolites: Askania and Mitchell tracked rocket and "Blossom" to impact
Cameras: Satisfactory operations
Telescopes: Satisfactory operations
Radar: Complete flight record
Doppler: Readable signals at two stations
Vibration: Instrument section yaw and pitch plane vibrations (40 cps max.) negligible magnitude
Other: Rocket velocity measured to reasonable order of accuracy with precessing gyro

DATA RECOVERY

Telemeter: Crosstalk between three channels, satisfactory otherwise
Physical recovery: Heliographs, "Blossom" parachute, and canister recovered. Pilot parachute not recovered.

EXPERIMENTAL DATA

Low altitude flight prevented any experimental data recovery

COMMENTS

Rocket modifications: "Blossom" ejector mechanism
Rocket performance: Early burnout due to low pressure air failure probably caused by regulator malfunction
Experiments: Talcum generator produced satisfactory "smoke" trails at low altitude
Other: Blossom ejection satisfactory at low altitudes

UPPER AIR ROCKET SUMMARY

V-2
NO. 35

Agency: Applied Physics Laboratory
Time: 0716 MST
Altitude: 86.8 miles

27 May 1948

Experiments: Cosmic radiation, Solar radiation, High atltidue photography. Composition (Univ. of Mich.).

V-2
NO. 36

Agency: General Electric Company
Time: 1015 MST
Altitude: 69.0 miles

6 February 1948

Experiments: No upper air experiments.

V-2
NO. 37

Agency: Air Research and Development Command
Time: 0322 MST
Altitude: 38.7 miles

11 June 1948

Experiments: Pressure-temperature (Univ. of Mich.). Skin temperature (Boston Univ.). Ionosphere, Artificial air glow (AFCRC). Artificial air glow (Univ. of Mich.).

V-2
NO. 38

Agency: Naval Research Laboratory
Time: 1254 MST
Altitude: 34.8 miles

19 April 1948

Experiments: Cosmic radiation, Solar radiation, Pressure-temperature, Ionosphere.

V-2
NO. 39

Agency: General Electric Company
Time: 1610 MST
Altitude: 3.4 miles

19 March 1948

Experiments: Temperature-pressure (SCEL). Composition (Univ. of Mich.). Earth's magnetic field (AFCRC). Upper air winds (SCEL).

UPPER AIR ROCKET SUMMARY

V-2
NO. 40

IDENTIFICATION

26 July 1948

Time of firing: 1103 MST
Agency: Applied Physics Laboratory, Johns Hopkins University
Altitude: 54.0 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Pirani cone temperature probe (Signal Corps, Mich. U.)
Cosmic radiation: Four arrays of 3 Geiger tubes each surrounded by various thicknesses of lead. One array in nose extension (APL).
Composition: Two air-sampling bottles with associated opening and sealing devices (Signal Corps-Mich. U.)
Other: Skin temperature-sensitive paint on warhead. (Southern Research Institute.)

ROCKET PERFORMANCE INSTRUMENTS

High altitude photography (APL). Modified K-25 camera loaded with Super XX film.

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PXTA-501 23-channel PPM-AM system
Physical recovery: Warhead blowoff by radio command. Explosives in control chamber to separate forward portion of rocket.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and five Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Four stations
Radar: Two modified SCR-584 S-band stations
Doppler: Four stations

Airborne
Beacon: APN-55 S-band transponder
Doppler: Dovap transceiver
Radio cutoff: AN/ARW-17 FM control receiver for command fuel cutoff and blowoff
Aspect: Three Gianinni heliographs. Four arrays of photocells.
Other: Rocket propulsion and control performance instruments

ROCKET INFORMATION

Unfueled rocket weight: 9942 lb
Gross weight at takeoff: 29,510 lb

ROCKET PERFORMANCE

Program angle: Seven degrees
Time to burnout: 61.5 sec
Velocity at burnout: 3874 ft/sec
Altitude at burnout: 18.7 miles
Time to zenith: 180.5 sec
Altitude at zenith: 60.0 miles
Time to tail blowoff: 295 sec
Altitude at tail blowoff: 21 miles
Flight duration: 521 sec
Impact coordinates: 21 mi. north, 2 mi. east

BALLISTIC DATA

Theodolites: Askania - good record through burning almost to peak
Cameras: Ballistic and Bowen-Knapp - satisfactory operations
Telescopes: Good data for complete flight
Radar: Fair trajectory data from 0 to 170 sec, no record from 170 to 390 sec
Doppler: Position and velocity data from 0 to 295 sec

DATA RECOVERY

Physical recovery: Camera, heliographs and air-sample bottles recovered. Warhead with temperature-sensitive paint samples not recovered.

COMMENTS

Rocket performance: Premature fuel cutoff at 61 sec by turbine overspeed. Roll rate 2 rpm beginning at 70 sec.

REPORTS AND PAPERS

"Preliminary Report on High Altitude Photography," Clyde T. Holliday, Photographic Engineering 1:16 (1950)
"Seeing the Earth From 80 Miles Up," Clyde T. Holliday, National Geographic Magazine XCVIII:511 (1950)
"Transition Effects of the Primary Cosmic Radiation in Lead, Aluminum and in the Atmosphere," J. A. Van Allen, Proceedings of the Echo Lake Cosmic Ray Symposium June 23-28, 1949, Published by the Office of Naval Research, November 1949, pp. 95-102
"Photographic Determination of the Orientation of a Rocket," L. W. Fraser and R. S. Ostrander, Photographic Engineering 1 (No. 1):105 (1950)

IDENTIFICATION

21 March 1949

Time of firing: 2343 MST
Agency: Air Research and Development Command
Altitude: 83.0 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Skin temperature studies: Nickel temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distributed along rocket skin (Boston U.)
Soft solar x-ray study: Four packets containing photographic film were placed on surface of warhead (AFCRC)
Photographic studies: Two modified GSAP cameras with prisms were mounted in warhead to view Luxembourg probe and record power discharge and afterglow of the probe (WPAFB & FILRAD)
Phototube experiment: Three multiplier phototubes, with associated filters and circuits, were located in warhead near a window (AFCRC)
Spectrograph study: Two spectrographs located in instrument compartment to record light produced in vicinity of Luxembourg probe (AFCRC)
Airglow experiment: A high-power, low frequency Luxembourg transmitter was used for this experiment; peak power of approximately 60 kilowatts and generator pulses of 25-microsec duration which would be radiated off a probe on the nose of the warhead (AFCRC)
Photoelectric analysis by UCLA: Two photoelectric detecting devices located at ground stations to observe discharge produced by Luxembourg transmitter
Voltage breakdown experiment: Three sets of electrodes at varying spacing mounted on surface of rocket nose cone (AFCRC)
Common power supply experiments: Battery-powered 400-cycle motor generator sets used to supply power for all experiments (AFCRC)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL PXTA-501 PPM-AM 23-channel telemetering system was used, but a slot antenna (cavity type) located on outer shell of the Blossom was used in lieu of standard NRL turnstile. BRL PWM 28-channel telemetering system was used to record rocket performance measurements.
Airborne recorder: Tufts College data recorder unit to record rocketborne experimental data in voltage form
Physical recovery: Separation of warhead by radio command to ARW-37 FM control receiver, and, in event of failure by this means, separation was to be effected by a timer. Parachute studies - 100-ft canopy type parachute, a 4-ft pilot chute, and a 32-ft flat circular brake parachute (WPAFB and FILRAD). Blossom IV-A experiment - new elongated nose section was to be lowered to earth by parachute (FILRAD).

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations

BALLISTIC INSTRUMENTS (Continued)

Cameras: Two ballistic and two Bowen-Knapp stations
Telescopes: Four stations
Radar: Two modified SCR-584 S-band stations
Doppler: Six stations

Airborne
Beacon: 470-493.5 Mc beacon to provide measure of delay time through the E layer. Utilized new flush-mounted antennas. (U. of Utah and AFCRC.)
Doppler: Doppler carried
Radio cutoff: ARW-37 FM control receiver for command cutoff and blowoff
Aspect: Pitch and yaw gyroscopes
Vibration: Pickups in rockets
Other: Triangulation tests - recording of replies from ionosphere beacon at four ground stations to provide position coordinates of rocket in flight (AFCRC)

ROCKET INFORMATION

Unfueled rocket weight: 9971 lb
Gross weight at takeoff: 29,636 lb

ROCKET PERFORMANCE

Firing angle: Four degrees west of north
Program angle: Seven degrees
Time to burnout: 65.7 sec
Velocity at burnout: 4466 ft/sec
Altitude at burnout: 20.34 miles
Time to zenith: 211.0 sec
Altitude at zenith: 83 miles
Flight duration: Approximately 380 sec
Impact coordinates: 33.4 mi. north, 0.8 mi. east

BALLISTIC DATA

Theodolites: Coordinate data from 0 to about 70 sec, uncorrected data to 120 sec
Cameras: Mitchell - good records at one station
Ballistic - good images recorded at D and R stations through burnout
Bowen-Knapp - satisfactory records at U and V stations
Telescopes: Good images 0 to 80 sec from 3 stations. Spectrograph at T-IV recorded Luxembourg effect.
Radar: Trajectory data from 0 to 335.5 sec
Doppler: Trajectory data from 0 to 371.2 sec

DATA RECOVERY

Telemeter: PPM-AM - excellent signals from 0 to 376 sec, but recorders were jammed; BRL PWM-AM - no record, telemeter power failure
Physical recovery: None, since the Blossom experiment failed
Airborne recorder: Recorder destroyed at impact

(Continues)

EXPERIMENTAL DATA

Airglow experiment: Failed to operate except for 13 sec near the end of flight
Ionosphere beacon experiment: Beacon operated well until fuel burnout and for a brief period near peak altitude; however, its failure during the remainder of the flight resulted in recovery of very little usable data
Photographic studies: Since the Luxembourg system did not operate, the cameras mounted in the Blossom IV-A recovered no data
Phototube experiment: Telemetering records indicated that equipment functioned satisfactorily; however, desired data were not obtained, due to failure of the Luxembourg transmitter
Spectrograph study: No information, due to failure of the Luxembourg transmitter and destruction of rocket at impact
Skin temperature studies: Telemetering monitoring during flight indicated normal operation of this equipment; however, due to jamming of the NRL telemeter recorders for these channels, information was lost
Soft x-ray study: Film packets were destroyed at impact
Blossom IV-A experiment: Both means of ejecting the Blossom IV-A failed; the Blossom remained with the rocket and was completely demolished upon impact
Parachute studies: Failure of the Blossom to separate from the rocket prevented ejection of the parachute
Skin temperature studies: Telemetering monitoring during flight indicated normal operation of equipment, but information was lost because telemeter recorders for these channels jammed
Common power supply experiment: Common power supply functioned satisfactorily throughout the flight
Photoelectric analysis by UCLA: Failure of Luxembourg transmitter resulted in no data being obtained
Voltage breakdown experiment: The 0.1-cm gap gave a Paschen curve which was translated into pressure readings for the altitude range from 15 to 55 km; pressure compares well with accepted values. The 1-cm and 100-cm gap were inoperative because the stream intensity and gap area to width ratio were detrimental for cascade ionization.
Triangulation tests: Good trajectory during initial portion of flight

COMMENTS

Rocket modifications: Rocket carried new elongated nose section, Blossom IV-A, which provided from 80 to 100 cu ft of space for research instruments. Length of the original V-2 was increased by one diameter.
Rocket performance: Takeoff and flight appeared normal. However, parachute ejection system failed, and since no provision had been made for warhead blowoff other than parachute ejection system, rocket remained intact over complete flight.

IDENTIFICATION

9 December 1948

Time of firing: 0908 MST
Agency: Signal Corps Engineering Laboratory
Altitude: 67.4 miles

UPPER AIR INSTRUMENTS

Pressure-temperature-winds: Probe experiment of four probes fastened to main access doors to measure flight temperature, vibration, and shock wave effects (Mich. U.)
Solar radiation: Soft x-ray densitometer experiment (NRL)
Smoke trail experiment: To determine speeds and directions of winds at altitudes above 100,000 feet (Edgewood Arsenal)
Shadowgraph experiment: Consisting of a small rectangular wedge fastened to nose tip of rocket and an optical system to photograph the discontinuity in the shock wave off the wedge
Biological: Seed containers for the determination of the effects of cosmic rays on living cells

DATA RECOVERY INSTRUMENTS

Telemeter: The NRL 23-channel PXTA-501 system
Physical recovery: Separation of nose section with TNT

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Eight Askania and two Mitchell stations
Cameras: Two ballistic, three Bowen-Knapp, one spectro camera at T1, and two metro cameras
Telescopes: Four stations
Radar: Two SCEL 584 S-band units

Airborne
Radio cutoff: AN/ARW-37 radio receiver
Aspect: Three heliographs installed in tail fins
Other: Routine rocket propulsion and control performance instruments

ROCKET INFORMATION

Unfueled rocket weight: 8741 lb
Gross weight at takeoff: 28,106 lb (approximately)

ROCKET PERFORMANCE

Program angle: Seven degrees north from vertical
Time to burnout: 65.3 sec
Velocity at burnout: 4000 ft/sec

ROCKET PERFORMANCE (Continued)

Altitude at burnout: 22.4 miles
Time to zenith: 191 sec
Altitude at zenith: 67.4 miles
Time to tail blowoff: 288.7 sec
Altitude at tail blowoff: 39.8 miles
Flight duration: 551 sec (main body)
Impact coordinates: main body - north 26.3 mi., east 10.8 mi.; nose section - north 29.4 mi., east 10.4 mi.

BALLISTIC DATA

Theodolites: Satisfactory operation, some Askania stations tracked rocket to impact
Cameras: Satisfactory operation
Telescopes: Satisfactory operation
Radar: Beacon was fair and tracking was in automatic for about half of flight

DATA RECOVERY

Telemeter: Normal operation until warhead blowoff
Physical recovery: Warhead separation was effective. All items for which recovery was desired were recovered in excellent condition.

EXPERIMENTAL DATA

Smoke trail experiment: A photographic record of the smoke was obtained from 67 sec until 89.2 sec. Indications are that the experiment was a distinct success.
Shadowgraph experiment: Film casette was recovered in excellent condition

COMMENTS

Rocket performance: Flight was normal to 22 sec at which time the rocket began to rock and pitch. Failure of vane III at 22 sec caused the erratic flight. The cause of the vane failure was not determined.

IDENTIFICATION

5 August 1948

Time of firing: 0507 MST
Agency: Naval Research Laboratory
Altitude: 103.0 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Philips and Pirani gages installed on the warhead and on the tail section; a ram pressure probe extended beyond the nose of the rocket
Cosmic radiation: Wilson cloud chamber to study the reaction of primary cosmic rays in passing through different materials; a seven Geiger counter tube bundle to measure gamma ray activity; one package of Ilford plates
Solar radiation: A solar spectrograph, the record to be used in the determination of the vertical distribution of ozone in the earth's atmosphere; a soft x-ray densitometer experiment
Ionosphere: Two generating voltmeters; positive and negative ion collectors for determination of ion density
Other: Two K-25 cameras for earth photography and a classified experiment

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 30-channel system
Physical recovery: Separation of nose section with TNT

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Seven Askania and two Mitchell stations
Cameras: Bowen-Knapp
Telescopes: Four tracking
Radar: Modified SCR-584

Airborne
Beacon: In use
Radio cutoff: AN/ARW-37
Aspect: Schwein gyroscopes to determine rocket aspect
Other: Routine rocket propulsion and performance instruments; vibration instruments

ROCKET INFORMATION

Unfueled rocket weight: 8993 lb
Gross weight at takeoff: 28,685 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: Seven degrees to north

ROCKET PERFORMANCE (Continued)

Time to burnout: 64.6 sec
Velocity at burnout: 5400 ft/sec
Altitude at burnout: 23 miles
Time to zenith: 228 sec
Altitude at zenith: 103.0 miles
Time to tail blowoff: 336.4 sec
Altitutde at tail blowoff: 70 miles (approximately)
Flight duration: 550 sec (approximately)
Impact coordinates: Main body - 51 mi. north, 7 mi. west; instrumentation - 53 mi. north, 6 mi. west

BALLISTIC DATA

Theodolites: Good records almost to impact
Telescopes: Good records almost to impact
Radar: Data to 176.5 sec

DATA RECOVERY

Telemeter: Ended abruptly at 27.85 sec
Physical recovery: Separation was effective. The main body was broken up very little on impact. The warhead dug itself into the ground to a depth of 6 to 8 ft. All required recovery was successful.

EXPERIMENTAL DATA

The spectrograph failed at about the same time as the telemeter. The cloud chamber gave no data. No useful data were obtained on most of the experiments because of the telemeter failure.

COMMENTS

Rocket performance: Takeoff was normal. At about 25 sec a puff of smoke was observed at the tail. However, the rocket continued in normal flight and appeared to be stable. Roll was introduced in a counterclockwise direction by means of trim tabs. One pullaway plug failed at takeoff; the plug stayed on the launching platform. This left a hole in the tail section. The recovered rocket showed indications of a flash fire which was probably caused by the jet flame blowing into this hole and igniting fuel vapors. The fire was of short duration and apparently did not affect the rocket performance. The spectrograph wiring was charred in several places and there was indication of a short circuit. The condition of the wiring indicated an external fire rather than a short from the wiring as a cause of the fire.

UPPER AIR ROCKET SUMMARY

V-2
NO. 44

IDENTIFICATION

18 November 1948

Time of firing: 1534 MST
Agency: General Electric Company
Altitude: 90.3 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Thirty-four absolute pressure gages for measuring surface and internal pressure distribution in a Hermes B-1 ram-jet diffuser which replaced the customary warhead installation
Composition: Two air-sampling bottles (Mich. U.)
Solar radiation: Four thermoluminescent strips (NRL), four soft x-ray film packs
Biological: Five seed containers (Harvard, New Mexico College)

DATA RECOVERY INSTRUMENTS

Telemeter: One [illegible]3-channel Hermes telemetry system; one 30-channel AN/DKT-2 (XN-1) (NRL)
Physical recovery: Separation of forward portion of rocket with TNT

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and eight Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two modified SCR-584 (S-band) stations
- Doppler: Five receiving stations

Airborne
- Beacon: Type AN/APN-55
- Doppler: Dovap transceiver
- Radio cutoff: AN/ARW-37 FM control receiver
- Other: Two telemetering gyros for measuring missile attitude. Three vibration pickups installed, one along each axis. Pickup outputs transmitted by a specially modified Hermes telemetry unit to ground station where oscillographic and wire recordings were made.

ROCKET INFORMATION

Payload weight: 2245 lb
Unfueled rocket weight: 8858 lb
Gross weight at takeoff: 28,376 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: Seven degrees

ROCKET PERFORMANCE (Continued)

Time to burnout: 63.5 sec
Velocity at burnout: 5150 ft/sec
Altitude at burnout: 20.2 miles
Time to zenith: 218 sec
Altitude at zenith: 90.3 miles
Time to tail blowoff: 350.9 sec
Altitude at tail blowoff: 39.2 miles
Flight duration: 594.5 sec
Impact coordinates: Main body - 27.2 mi. north, 7.5 mi. east; warhead - 30.5 mi. north, 4.7 mi. east

BALLISTIC DATA

Theodolites: Askania - trajectory 0 to 73.08 sec; Mitchell - to 70 sec
Cameras: Performance satisfactory
Telescopes: Fairly complete records from all telescopes. No roll (±5 degrees) detected up to burnout.
Radar: Satisfactory performance, tracked the missile to impact
Doppler: No data after 40 sec
Other: Both yaw and pitch axis telemetering gyros performed satisfactorily. Vibration equipment produced a good record during powered portion of flight but signal became noisy at 64 sec. Analysis of oscillographic records and wire recordings showed little correlation between vibration frequencies and amplitudes.

DATA RECOVERY

Telemeter: Hermes equipment functioned satisfactorily up to about 56 sec. Reception from AN/DKT-2 (XN-1) very sporadic; no data obtained.
Physical recovery: Effected except for two thermoluminescent strips

EXPERIMENTAL DATA

Pressure-temperature: Good data were obtained while telemetry signals were received

COMMENTS

Rocket modifications: Ram-jet diffuser attached to front of warhead did not affect stability or performance
Rocket performance: Performance of rocket equaled that predicted for normal flight. Steering was good.
Experiments: Loss of telemetry signal early in flight prevented securing much useful ram-jet diffuser data

REPORTS AND PAPERS

"A Flight Test of the Hermes B Diffuser on an A-4 Rocket," W. F. Dankhoff, General Electric Report R49A0526 (Confidential Report, Unclassified Title), July 1949

UPPER AIR ROCKET SUMMARY

V-2
NO. 40

Agency: Applied Physics Laboratory
Time: 1103 MST
Altitude: 54.0 miles

26 July 1948

Experiments: Cosmic radiation, High altitude photography. Shock wave temperature, Composition (Univ. of Mich.).

V-2
NO. 41

Agency: Air Research and Development Command
Time: 2343 MST
Altitude: 83.0 miles

21 March 1949

Experiments: Skin temperature (Boston Univ.). Ionosphere (AFCRC and Univ. of Utah). Artificial air glow (WPAFB, AFCRC, FILRAD). Solar radiation (AFCRC).

V-2
NO. 42

Agency: Signal Corps Engineering Laboratories
Time: 0908 MST
Altitude: 67.4 miles

9 December 1948

Experiments: High altitude winds. Temperature-pressure, Shock wave angle (University of Michigan). Solar radiation (NRL).

V-2
NO. 43

Agency: Naval Research Laboratory
Time: 0507 MST
Altitude: 103.0 miles

5 August 1948

Experiments: Cosmic radiation, Pressure-temperature, Ionosphere, Solar radiation, High altitude photography.

V-2
NO. 44

Agency: General Electric Company
Time: 1534 MST
Altitude: 90.3 miles

18 November 1948

Experiments: Composition (Univ. of Mich.). Solar radiation (NRL). Biological (Harvard Col., NMCA&MA).

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

28 January 1949

Time of firing: 1020 MST
Agency: Naval Research Laboratory
Altitude: 37.2 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Stagnation pressure on nose tip. Pressure on nose and tail sections.
Cosmic radiation: Soft gamma component Geiger counter bundle. Hard gamma component Geiger counter telescope.
Solar radiation: Thermoluminescent strips
Ionosphere: Radio propagation experiment. Ion collectors. Electrostatic field (generating voltmeter). Soft x-ray film detectors. Beryllium window photon counters. Photoemission detector (modified generating voltmeter).
Other: Two K-25 aerial cameras and one GSAP camera for high altitude photography. Seed samples.

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 30-channel AN/DKT-2(XN-1) pulse position system
Airborne recorder: Ten-channel photographic recorder
Physical recovery: Nose cone separation explosives in control chamber

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Four stations
Radar: Two SCR-584 S-band

Airborne
Beacon: APN-55
Radio cutoff: AN/ARW-37 command cutoff and blowoff
Other: Roll gyro and photocells
Pitch and yaw gyros

Other
BRL spectro camera

ROCKET INFORMATION

Payload weight: 2733 lb (including ballast)
Unfueled rocket weight: 9537 lb
Gross weight at takeoff: 29,452 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: Seven degrees from vertical
Time to burnout: 56.4 sec (cutoff)
Velocity at burnout: 2970 ft/sec
Altitude at burnout: 12.2 miles
Time to zenith: 149 sec
Altitude at zenith: 37.2 miles
Time to tail blowoff: Did not function
Flight duration: 264 sec
Impact coordinates: 10.5 mi. north, 4 mi. east

BALLISTIC DATA

Theodolites: Good images and tracking from Askanias to impact. Images to 70 sec from one Mitchell.
Cameras: Bowen-Knapp - good operations, ballistic - good operations
Telescopes: Complete images and tracking from two, no images after 118 sec on third, fourth had no visibility
Radar: Good record to impact from one radar

DATA RECOVERY

Telemeter: Excellent record for entire flight
Physical recovery: Equipment completely destroyed at impact, blowup system failed

EXPERIMENTAL DATA

Cosmic radiation - Comparison of V-2 and Aerobee (NRL-2) results indicate no possibility of low energy gamma rays from sun. Insufficient data due to low altitude to draw conclusions from telescope experiment.

COMMENTS

Rocket performance: Propulsion performance below normal, control defective - rocket turned east and emergenvy fuel cutoff given. Rocket pitched and rolled after burnout. Angle of attack 45 degrees at peak, nose down at 189 sec, horizontal at 195 sec.

UPPER AIR ROCKET SUMMARY

V-2
NO.46

IDENTIFICATION

5 May 1949

Time of firing: 0815 MST
Agency: General Electric Company
Altitude: 5.45 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Thirty-four absolute pressure gages to measure surface and internal pressure distribution in a Hermes B-1 ram-jet diffuser
Solar radiation: Extreme ultraviolet thermoluminescent detectors (NRL), four soft x-radiation detectors (NRL)

DATA RECOVERY INSTRUMENTS

Telemeter: Two PWM/FM 28-channel telemeter systems
Physical recovery: Warhead separation explosives in control chamber

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and seven Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Four stations
Radar: Two modified SCR-584 S-band radars
Doppler: Stations not indicated

Airborne
Beacon: AN/APN-55 S-band transponder
Doppler: Dovap transceiver
Radio cutoff: AN/ARW-37 receiver for command fuel cutoff and blowoff
Other: Roll, pitch, and yaw gyros to measure missile attitude

ROCKET PERFORMANCE INSTRUMENTS

Doppler: Directional coupler to determine mismatch between Dovap transmitter and antenna
Camera: Spectro camera on Telescope T-I to obtain spectrograms of the rocket flame

ROCKET INFORMATION

Unfueled rocket weight: 9200 lb
Unfueled rocket C.G.: 248.5 in.
Gross weight at takeoff: 28,940 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees true
Program angle: Seven degrees from vertical
Time to burnout: 25.5 sec (premature cutoff)
Altitude at burnout: 2.3 miles
Velocity at burnout: 1050 ft/sec
Time to zenith: 58.8 sec
Altitude at zenith: 5.45 miles
Time to tail blowoff: 61.75 sec
Altitude at tail blowoff: 5.42 miles
Flight duration: 121.24 sec
Impact coordinates: Main body - 1.33 mi. north, 0.86 mi. east; warhead - 1.25 mi. north, 0.68 mi. east

BALLISTIC DATA

Theodolites: Coordinate data from takeoff to 121.24 sec
Cameras: Ballistic data for most of flight; Bowen-Knapp data from 0 to 13 sec
Telescopes: Aspect data from takeoff to 121.24 sec
Radar: Data from takeoff to 121.24 sec
Doppler: Good signal to 61.7 sec
Gyros: Attitude data takeoff to 61.75 sec
Spectro cameras: Rocket flame spectrograms

DATA RECOVERY

Telemeter: System No. 1 - satisfactory record 4.0 to 61.75 sec
System No. 2 - satisfactory record 0.0 to 50.5 and 53.5 to 55.5 sec
Physical recovery: X-ray and thermoluminescent detectors recovered

EXPERIMENTAL DATA

Solar radiation: No usable data obtained
X-radiation: No usable data obtained
Pressure-temperature: Good data obtained on all ram-jet diffuser pressures; data duplicates that of V-2 No. 44

COMMENTS

Rocket modifications: Ram-jet diffuser replaced standard warhead
Rocket performance: Performance normal up to premature cutoff
Experiments: Solar and x-radiation experiments failed to produce data due to low rocket altitude

REPORTS AND PAPERS

"Pressure and Mach Number Analysis of the Second A-4 Test Diffuser," W. R. Nial, General Electric Technical Manual, pp. 761-793

IDENTIFICATION

14 June 1949

Time of firing: 1535 MST
Agency: Air Research and Development Command
Altitude: Approximately 83 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Emulsion type sensitive plates for detection of high energy particles (U. of Chicago)
Soft solar x-ray study: Four packets, each containing photographic film with a stepped-wedge type aluminum filter, were placed on surface of warhead (AFCRC)
Skin temperature experiment: Nickel temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distributed along rocket skin (Boston U.)
Ambient temperature and pressure measurement: One ionization type pressure gage (Mich. U.)
Pitot tube experiment: Pitot tube located on tip of nose cone for measurement of ram and static pressures (Equip. Lab., WPAFB)
Mass spectrometer: Mass spectrometer set to measure helium to argon ratio and oxygen to nitrogen ratio as a function of altitude (Cook Research Labs.)
Oblique incidence ionosphere propagation experiment: Ground-transmitted signal travels over very long path. Receivers both in rocket and on ground. Rocket transmitter retransmits signal received in rocket t ground receiver. Measures attenuation of wave passing downward through E layer reflected from F layer. (Boston U.)
Sequencing and separation controls: Control equipment to actuate ejection system, television and parachute cameras, and antenna switches (FILRAD)
Data transmission experiment (utilizing telemetering and television techniques): Television system for observation of ground from rocket in ascent and portion of descent, and observation of opening of parachutes (AFCRC, Boston U., and Tufts College)
Biological experiment: Project Albert II (Aero-Medical Lab., WPAFB)

ROCKET PERFORMANCE INSTRUMENTS

Photographic studies: Four GSAP type cameras located in parachute compartment, one K-17 camera in instrument compartment, one K-25 camera in instrument compartment, four GSAP cameras in instrument compartment (Photo Lab., WPAFB)
Warhead aspect gyros experiment: Two indicators, gyro type J1 modified, one type AN/N6 camera, one aircraft clock, lighting system, and mirrors (Equip. Lab., WPAFB)
Beacon triangulation studies: Use of tracking beacon system to obtain trajectory of rocket and Blossom; evaluation of system of triangulation (AFCRC and Oklahoma A and M College)

DATA RECOVERY INSTRUMENTS

Telemeter: Ballistic research laboratory telemetering equipment (Hermes) operating at 149.22 Mc. Thirty channels.

Airborne recorder: Universal airborne detector recorder (Cook Research Laboratories) - 13-channel magnetic tape recorder. Tufts College recorder, 15 channels.

Physical recovery: Separation of warhead by radio command to ARW-37 cutoff receiver

Blossom IV-B experiment - New elongated nose section to be separated from rocket body and lowered by parachute (FILRAD, Equip. Lab., WPAFB, and AFCRC)

Parachute studies - 100-ft nylon main canopy used in conjunction with a 32-ft nylon drag parachute (Equip. Lab., WPAFB)

BALLISTIC INSTRUMENTS

Firing Range

Theodolites: Two Mitchell and eight Askania stations
Cameras: Two ballistic and three Bowen-Knapp stations
Telescopes: Four stations
Radar: Two S-band stations
Doppler: Six stations
Impact location: Impact point computer

Airborne

Beacon: AN/DRW-1, S-band beacon
Doppler: Dovap T-5 missile unit
Radio cutoff: One ARW-37 radio receiver operating at 54.5 Mc located in control compartment for fuel cutoff and parachute ejection
Other: Routine rocket performance instrumentation (G. E.)

ROCKET INFORMATION

Unfueled rocket weight: 10,575 lb
Gross weight at takeoff: 30,443 lb

ROCKET PERFORMANCE

Program angle: 10 degrees at 50 sec
Time to burnout: 67-67.3 sec
Velocity at burnout: 4412 ft/sec
Altitude at burnout: 21 miles (approximately)
Time to zenith: 211 sec
Altitude at zenith: 83 miles (approximately)
Time to tail blowoff: 266.3 sec
Altitude at tail blowoff: 70 miles (approximately)
Flight duration: 550 sec (estimate)
Impact coordinates: Main body - 38.53 mi. north, 1.9 mi. west; warhead - 1.91 mi. south, 0.03 mi. west of main body; control compartment - scattered over area of several square miles south of warhead

(Continues)

BALLISTIC DATA

Theodolites: Mitchell - images until shortly after burnout; Askania - data reduced through burnout
Cameras: Bowen-Knapp data for first 10-15 sec; ballistic - good images until burnout
Telescopes: Good coverage
Radar: Beacon signal stopped at 74.5 sec
Doppler: Good signals until explosion (266.3 sec), record reduced from 62-75 sec

DATA RECOVERY

Telemeter: Hermes telemetering equipment operated normally and record was obtained up to 266 sec, at which time control compartment was blown off
Physical recovery: Blossom IV-B experiment - ejection system functioned as intended
Parachute studies: Warhead separated from parachute, Blossom nose was blown off by the parachute ejection system, and control compartment was blown off by TNT changes
Airborne recorder: Magnetic tape suffered damage upon impact, but upon careful reassembly, about an 80% usable record was obtained

EXPERIMENTAL DATA

Skin temperature experiment: Curves of temperature vs time for heating effects due to frictional dissipation between various points on the missile and adjacent air molecules, with some gaps due to telemetering
Oblique incidence ionosphere propagation experiment: Bureau of Standards ground transmitter failed, no data
Ambient temperature and pressure measurements: No results reported
Mass spectrometer: Oxygen to nitrogen ratio equipment failed, no data obtained. Helium to argon ratio equipment showed 21% change from ground to 83 miles altitude, which was not considered significant.
Soft x-ray study: Particle detection experiment, and photographic studies were last on impact
Warhead aspect gyros experiment: Data recorded by camera and all but one film pack destroyed upon impact
Beacon triangulation studies: Only one of the four ground stations received synchronization signals from beacon, due to loss of a modulator cable at station at Sacramento Peak. One station received excellent signals at all times until altitude of 14 miles on downward leg of trajectory.
Sequencing and separation controls: Controls worked satisfactorily
Data transmission experiment (by television techniques): Experiment functioned for approximately four minutes of flight. Pictures on screen showed cloud formation and curvature of earth. Equipment for transmission by telemetering techniques functioned for over four minutes of flight.

COMMENTS

Rocket modifications: This was the second rocket to carry the elongated nose section, increasing length of original V-2 by one diameter
Rocket performance: Takeoff and flight were normal, with rocket propulsion giving better than average performance and exceeding calculated performance
Pitot tube experiment: Good recording of data obtained

REPORTS AND PAPERS

"Rocket-Borne Television Camera Utilizing the RCA Type 5527 Iconoscope," W. C. Moore, Part II, Technical Note 7, Upper Atmosphere Research Laboratory, Boston University, 4 April 1950

IDENTIFICATION

17 February 1949

Time of firing: 1000 MST
Agency: Applied Physics Laboratory, Johns Hopkins University
Altitude: 62.5 miles

UPPER AIR INSTRUMENTS

Composition: One air-sampling bottle (Signal Corps, Mich. U.)
Cosmic radiation: Three arrays of three Geiger tubes each surrounded by various thicknesses of aluminum. Single pulse ionization chamber in nose extension. Fourfold Geiger tube specific ionization telescope (APL).
Solar radiation: Two thermoluminescent detectors (NRL)
High altitude photography: Three K-25 cameras with black and white, infrared, and aero kodacolor film
Biological experiment: Fruit flies

DATA RECOVERY INSTRUMENTS

Telemeter: NRL telemetering
Physical recovery: Warhead blowoff by radio command

ROCKET INFORMATION

Unfueled rocket weight: 9652 lb
Gross weight at takeoff: 29,217 lb

ROCKET PERFORMANCE

Program angle: Seven degrees
Time to burnout: 63.5 sec
Velocity at burnout: 4440 ft/sec
Altitude at burnout: 20.6 miles
Time to zenith: 205 sec
Altitude at zenith: 79.5 miles
Time to tail blowoff: 321.2 sec
Altitude at tail blowoff: 39.1 miles
Flight duration: 568.5 sec
Impact coordinates: 37.4 mi. north, 1.4 mi. east

BALLISTIC INSTRUMENTS

Theodolites: Mitchell - good images from 0 to 70 sec; Askania - data reduced from 0 to 75 sec
Cameras: Bowen-Knapp - operations satisfactory; ballistic - satisfactory, some images obscured by vapor trail
Telescopes: Good operation
Radar: To 568 sec

DATA RECOVERY

Physical recovery: Air-sample bottle punctured by fragment. All cameras recovered. Thermoluminescent detectors recovered, one operated satisfactorily.

COMMENTS

Rocket performance: Roll rate - 1 Rev/10.9 sec at 70 sec, 1 Rev/10.2 sec at 107 sec
Other: Impact predictor operated

REPORTS AND PAPERS

"The Specific Ionization of the Cosmic Radiation Above the Atmosphere," S. F. Singer, Phys. Rev. 76:701 (1949)

"The Zenith Angle Dependence of the Cosmic Radiation Above the Atmosphere at $\lambda = 41°N$," S. F. Singer, Phys. Rev. 77:729 (1950)

"On the Nature of the Cosmic Radiation Near the Pfotzer Maximum at $\lambda = 41°N$," S. F. Singer, Phys. Rev. 77:730 (1950)

IDENTIFICATION

29 September 1949

Time of firing: 0958 MST
Agency: Naval Research Laboratory
Altitude: 93.7 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Stagnation pressure at nose
Cosmic radiation: Minimum ionization emulsions
Solar radiation: Extreme ultraviolet and soft x-ray photon counters
Ionosphere: Radio propagation experiment. Ion collectors. Electrostatic field. Photo emission. Soft x-ray film detectors.
Other: Meteoric dust collectors

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 30-channel pulse position AN/DKT-1(XN-1)
Airborne recorder: 15-channel photo recorder
Physical recovery: Nose separation explosives in control chamber

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and nine Askania stations
- Cameras: Three ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two SCR-584 S-band stations
- Impact location: Impact point computer

Airborne
- Beacon: APN-55 S-band
- Radio cutoff: AN/ARW-37 command fuel cutoff and blowoff
- Other: BRL spectro camera

ROCKET INFORMATION

Unfueled rocket weight: 9276 lb
Unfueled rocket C.G.: 236.2 in.
Gross weight at takeoff: 28,911 lb

ROCKET PERFORMANCE

Program angle: Seven degrees from vertical
Time to burnout: 64.5 sec
Velocity at burnout: 5000 ft/sec
Altitude at burnout: 20.9 miles
Time to zenith: 225 sec
Altitude at zenith: 93.7 miles

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 336.8 sec
Altitude at tail blowoff: 56 miles
Flight duration: 470 sec (last radar signal)
Impact coordinates: 43.5 mi. north, 3 mi. west

BALLISTIC DATA

Theodolites: Askania data for 95 sec, Mitchell data for 56 sec
Cameras: Complete records
Telescopes: Aspect data for 71 sec
Radar: Tracking data for 470 sec except for intervals near end of burning
Impact location: No prediction from impact point computer due to loss of tracking at 30 sec

COMMENTS

Rocket performance: Normal performance, rocket started to roll at 67 sec (fin tabs positioned)

REPORTS AND PAPERS

J. E. Jackson, "Rocket-Borne Instrumentation for Ionosphere Propagation Experiments," NRL Report 3909, January 1952

J. C. Seddon, "Propagation Measurements in the Ionosphere by Means of Rockets," Trans. Am. Geophys. Union 33:322 (Abst.) (1952).

J. C. Seddon, Upper Atmosphere Research Report No. XXII - "Rocket Investigations of the Ionosphere by a Radio Propagation Method," NRL Report 4304, March 1954

J. C. Seddon, "Propagation Measurements in the Ionosphere With the Aid of Rockets," in "Rocket Exploration of the Upper Atmosphere," edited by R. L. F. Boyd and M. J. Seaton, London:Pergamon Press, 1954, pp. 214-222

J. C. Seddon, "Electron Densities in the Ionosphere," J. Geophys. Res. 59:463, December 1954

V-2
NO. 45

Agency: Naval Research Laboratory
Time: 1020 MST
Altitude: 37.2 miles

28 January 1949

Experiments: Cosmic radiation, Solar radiation, Pressure-temperature, Ionosphere, High altitude photography. Seed samples (Harvard College).

V-2
NO. 46

Agency: General Electric Company
Time: 0815 MST
Altitude: 5.5 miles

5 May 1949

Experiments: Solar radiation (NRL).

V-2
NO. 47

Agency: Air Research and Development Command
Time: 1535 MST
Altitude: 83.0 miles

14 June 1949

Experiments: Cosmic radiation (Univ. of Chicago). Skin temperature, Ionosphere (Boston Univ.). Pressure-temperature (Univ. of Mich.). Ram pressure (Equip. Lab., WPAFB). Composition (Cook Res. Labs.).

V-2
NO. 48

Agency: Applied Physics Laboratory
Time: 1000 MST
Altitude: 62.5 miles

17 February 1949

Experiments: Cosmic radiation, High altitude photography. Solar radiation (NRL). Composition (Univ. of Mich.). Biological.

V-2
NO. 49

Agency: Naval Research Laboratory
Time: 0958 MST
Altitude: 93.7 miles

29 September 1949

Experiments: Solar radiation, Density, Ionosphere, Meteoric dust collectors. Cosmic radiation.

UPPER AIR ROCKET SUMMARY

V-2
NO. 50

IDENTIFICATION

11 April 1949

Time of firing: 1505 MST
Agency: University of Michigan for SCEL
Altitude: 54.2 miles

UPPER AIR INSTRUMENTS

Density-pressure-temperature: Shock wave angle measurement for temperature. Two needle probes and two ram probes. Ram and cone surface pressure gages for temperature.
Composition: Two evacuated air-sampling bottles with associated timer and pyrotechnic opening and sealing devices
Solar radiation: Thermoluminescent detectors. Soft x-ray densitometers (NRL).
Biological: Effect of cosmic rays on genes and chromosomes (NRL)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL type AN/DKT-2
Airborne recorder: Cook Research Laboratories 13-channel FM magnetic tape recorder in parallel with telemeter
Physical recovery: Warhead plus control compartment separated by detonation of eight one-half pound blocks of TNT

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Two Mitchell and seven Askania stations
- Cameras: Two ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two SCR-584 S-band units

Airborne
- Radio cutoff: AN/DRW-37
- Aspect: Three Giannini heliograph cameras
- Other: Missile performance instruments (G. E.)

ROCKET INFORMATION

Payload weight: 2873 lb
Unfueled rocket weight: 9530 lb
Takeoff weight: 28,973 lb

ROCKET PERFORMANCE

Program angle: Seven degrees north from vertical
Time to burnout: 62.66 sec
Velocity at booster burnout: 3450 ft/sec (vertical)
Altitude at burnout: 101,200 ft

ROCKET PERFORMANCE (Continued)

Time to zenith: 170.16 sec
Altitude at zenith: 286,200 ft
Time to tail blowoff: 248.05 sec
Altitude at tail blowoff: 194,000 ft
Impact coordinates: Warhead - 20.9 mi. north, 0.32 mi. east of launcher; midbody - 19.38 mi. north, 0.32 mi. east of launcher

BALLISTIC DATA

Theodolites: Askania trajectory data from 0 to 357.16 sec
Telescopes: Preliminary flight data from 25.3 to 328.2 sec

DATA RECOVERY

Telemeter: Data recorded throughout the sensitivity ranges of both probe Pirani gages and ram and side Pirani gages
Airborne recorder: Although magnetic tape recorder smashed on impact, casette containing flight tape recovered in good condition. Since a good-quality telemeter record was obtained, it, rather than the recorder record, was used for data reduction.
Physical recovery: Two air-sampling bottles badly smashed. Three heliographs in excellent condition. Magnetic tape recorder casette and tape. Two thermoluminescent detectors. Three of four soft x-ray densitometers. Four seed and bacteria containers.

EXPERIMENTAL DATA

Both air-sampling bottles opened on impact - no samples. Excellent ram and side-cone pressure measurements made throughout range of ram and side Pirani gages. However, instrumental errors found to be too large to give calculation of ambient temperature with useful accuracy. Five shock-wave signals in the vicinity of 100,000 ft were recorded. These were reduced to temperature using Askania altitude and velocity data. Results show good agreement with balloon temperature measurements taken at the same time. Thus the shock angle method was demonstrated as feasible for making instantaneous, independent temperature measurements.

COMMENTS

Rocket modifications: Four Pirani gages mounted on extension rods were placed at 90 degree intervals eight in. from the longitudinal axis of a 40-degree right circular cone. The rods were driven through an excursion of eight in. with a period of about three seconds in a direction parallel to the cone axis so as to intercept the shock wave.

An opening for the ram-pressure Pirani gage was placed in the tip of the cone and four openings for cone side-pressure gages were placed at 90-degree intervals on the cone surface.

The 40-degree cone was filled with ice water to keep the Pirani gages at constant temperature.

Rocket performance: A disturbance in the jet was noted at 43.4 sec, and from that time until command burnout there was intermittent burning of fuel. Hence peak altitude was appreciably less than expected, and because some fuel remained in the tanks, the midbody exploded on impact.

UPPER AIR ROCKET SUMMARY

V-2
NO. 51

IDENTIFICATION

31 August 1950

Time of firing: 1009 MST
Agency: Air Research and Development Command
Altitude: 84.8 miles

UPPER AIR INSTRUMENTS

Soft solar x-ray studies: Packets, each containing photographic film covered with an opaque evaporated aluminum film, were placed on surface of warhead (AFCRC)
Skin and boundary layer temperature experiment: Nickel temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distributed along rocket skin (Boston U.)
Oblique incidence ionosphere propagation experiment: Ground-transmitted signal travels over very long path. Receivers both in rocket and on ground. Rocket transmitter retransmits signal received in rocket to ground receiver. Measures attenuation of wave passing downward through E layer reflected from F layer. (Boston U.)
Acoustical studies: Three systems of microphones and associated amplifiers set directly into shell of nose cone (Temple U.)
Sky brightness studies: Six multiplier phototubes, with associated filters, were located in instrument compartment (AFCRC)
Data recording by photo technique: Six cameras - one B-2, 16-mm (motion picture) in parachute section, one Bel' ınd Howell, 16-mm (motion picture) in instrument section, two robot (still pictures) cameras in instrument section, and two modified GSAP cameras in mid-body (AFCRC)
Ballistic research laboratory test oscillator biological experiment: Project MX 1450 (WPAFB)
Cannonball experiment: Gyro-stabilized sphere having temperature insulated zones and containing 14 thermocouples, time and temperature recording devices, gyroscope, and breakup and recovery means. (Armour Research Foundation of Illinois Institute of Tech.)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 30-channel system. AFCRC beacon used to telemeter multiplexed information from experiments.
Airborne recorder: Film recording galvanometer for Project Cannonball
Physical recovery: Warhead separation to be effected at peak altitude by radio command to AıIW-37 cutoff receiver.

Blossom IV-G - Fifth of series of rockets carrying elongated Blossom nose section. Instrument compartment made of two hard wooden sections; nose cone was an aluminum shell with a probe antenna, four telemetering blade antennas, and an insulator mounted on its tip. Blossom nose section was to be separated from main body by means of four pistons actuated by explosive charge.

Parachute recovery - Main parachute canopy, 64 ft in diameter, and 16 ft-diameter ribbon drag parachute for lowering of warhead

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Three ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two S-band radars
- Impact point computer: Radar impact predictor

Airborne
- Beacon: Radar beacon, APN-55, S-band
- Radio cutoff: ARW-37 cutoff receiver

ROCKET INFORMATION

Unfueled rocket weight: 10,683 lb
Unfueled rocket C.G.: 272.8 in.
Gross weight at takeoff: 30,178 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: Seven degrees from vertical
Time to burnout: 64.8 sec
Altitude at burnout: 20.5 miles
Time to zenith: 214.5 sec
Altitude at zenith: 84.8 miles
Time to tail blowoff: 221.0 sec
Altitude at tail blowoff: 84.7 miles
Flight duration: 373 sec
Impact coordinates: 36.1 mi. at azimuth of 357 degrees from blockhouse

BALLISTIC DATA

Theodolites: Mitchell data to about 75 sec, Askania data until separation
Cameras: Ballistic - records to burnout, Good Bowen-Knapp records
Radar: Good signal received throughout flight until 373 sec
Impact location: One tracker followed missile nearly until peak

DATA RECOVERY

Physical recovery: Warhead separation occurred at zenith.

Main parachute failed to support load of the warhead. Parachute, upon recovery, gave evidence of severe damage due to high temperature.

Film from cameras in both the mid-body and warhead were recovered. Mid-body cameras showed warhead separation.

All soft x-ray packets were recovered from warhead at impact site.

Cannonball recovered.

Film casette for Project MX 1450 recovered.

Airborne recorder: Film recorder from Project Cannonball recovered in excellent condition

(Continues)

EXPERIMENTAL DATA

Cannonball experiment: No data obtained; outer protective cover failed to separate. All other phases of equipment worked well, i.e., Cannonball ejection from warhead and ejection and recovery of data recorder.

Skin and boundary layer temperature experiment: Curves of temperature vs time for heating effects due to frictional dissipation between various points on the missile and adjacent air molecules were obtained for rocket fins only.

Oblique incidence ionosphere propagation experiment: Excellent data. Firing occurred during ionospheric storm. Very-long-path propagation data show radio wave being "ducted" or trapped between ionospheric layers. Ion density measures obtained through the tabulation of absorption value of signal as it passes through the layer.

Acoustical studies: Noise levels lower than anticipated; meteoric impacts less intense than in V-2 No. 31.

Sky brightness studies: Intensity of sky light measured from ground to 135 km through two interference filters peaked at 4278 A and 5590 A. Values from ground to 35 km consistent with previous measurements of intensity vs altitude; from 35 to 135 km a relatively large and constant amount of light (approximately 1% of ground value) was obtained.

Soft x-ray studies: Eleven packets in experiment. Six damaged, yielding no useful information. Darkening of film in remaining five packets definitely verified presence of soft x-rays and approximately confirms order of magnitude of predicted intensity (10^8 quanta/cm in 8-12 A range).

COMMENTS

Rocket modifications: Nose section differed from previously launched rockets of Blossom series in that it was an aluminum shell with a probe antenna, four telemetering blade antennas, and an insulator mounted on its tip; instrument compartment was composed of two hardwood sections with aluminum access doors

Rocket performance: Preliminary stage, takeoff, and flight appeared good; propulsion performance was near optimum, and steering was good. Missile disintegration occurred on the downleg at an altitude of 11.5 miles.

REPORTS AND PAPERS

"Day Sky Brightness Measured by Rocketborne Photoelectric Photometers," H. A. Miley et al., Trans. Am. Geophys. Union (in press)

IDENTIFICATION

28 June 1951

Time of firing: 1443 MST
Agency: Air Research and Development Command
Altitude: 18,900 ft

UPPER AIR INSTRUMENTS

The solar constant: Determination of intensity of solar radiation at the limit of the atmosphere by use of semi-conductor flake bolometers exposed to the radiation (R. I. State)
Ultraviolet radiation from the sun: A coronagraph spectrograph positioned in the direction of the sun by a biaxial pointing control (U. of Colorado)
Solar soft x-ray studies: Packets with photographic x-ray film protected by opaque filters of aluminum were exposed on surface of the rocket (AFCRC)
Vertical incidence ionosphere experiment: Synchronized ground and airborne equipment to measure delay time of low-frequency pulse traveling through the E layer by comparison with travel time of undelayed high-frequency signal (AFCRC and U. of Utah)
Photographic studies: Four cameras in instrument section - one modified Cineflex 35-mm motion picture camera, two modified 16-mm motion picture cameras, and one modified 16-mm high speed camera (AFCRC)
Ultraviolet characteristics of the upper atmosphere: One F/1.5 modified Maksutov-Bouwers type spectrograph (U. of Denver)
Sky infrared measurements: Photocell (type CE-25VA/B) for measurement of sky infrared intensities (AFCRC)
Sky brightness experiment: Monochromatic photometers mounted on two access doors located 180 degrees apart to measure scattered light and day airglow (AFCRC)
Biological experiment: Project MX-1450 (Aero-Medical Lab., WPAFB)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL telemetering system
Airborne recorder: Tufts College proportional data recorder - used to supplement normal telemetering facilities; data recorded on 16-mm film
Physical recovery:

Parachute studies - Eight ft ribbon chute to recover Aerobee nose section (see "Rocket Modifications") (Equip. Lab., WPAFB)

Blossom IV-F - standard Blossom nose cone modified as in "Rocket Modifications" to be blown off as Aerobee nose cone is ejected (Ludwig Honold Mfg. Co.)

Aerobee nose cone was to be ejected at approximately 50 miles altitude on downleg of trajectory. Approximately 10-20 sec later remainder of instrument section was to be separated from main body by TNT charges and fall free with no attempt at parachute recovery.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Four Mitchell and eight Askania stations

BALLISTIC INSTRUMENTS (Continued)

Cameras: Three Bowen-Knapp stations
Telescopes: Five stations
Radar: Two S-band radars
Impact location: Impact point computer

Airborne

Beacon: 470-493.5 Mc beacon to provide trajectory information and information on delay of a 4.45-Mc ground transmitted pulse (AFCRL)
Radio cutoff: ARW-37

ROCKET INFORMATION

Unfueled rocket weight: 9781 lb
Unfueled rocket C.G.: 266.1 in. from venturi exit
Gross weight at takeoff: 29,431 lb

ROCKET PERFORMANCE

Program angle: Seven degrees from vertical
Time to zenith: 47 sec
Altitude at zenith: 18,900 ft
Flight duration: 89.0 sec to warhead impact, 100.0 sec to tail section impact
Impact coordinates: Main body - 0.7 mi. at azimuth of 56 degrees 52 ft 18 in., warhead - 0.6 mi. at azimuth of 59 degrees 2 ft 52 in.

BALLISTIC DATA

Theodolites: Askania and Mitchell had images until impact
Cameras: Bowen-Knapp had image until 16.9 sec
Telescopes: Until impact
Radar: Good beacon signal received until 7.9 sec; beacon did not operate after that time
Impact location: Two trackers followed missile until impact
Other: Impact computer - C and E station trackers followed to impact

DATA RECOVERY

Telemeter: Telemetering signals solid until 47.2 sec
Physical recovery: Instrumentation destroyed upon impact with exception of four cameras installed for photo studies
Airborne recorder: No recovery, due to nature of impact

EXPERIMENTAL DATA

Due to nature of the flight, no data were obtained from the upper air instrumentation flown in this rocket

(Continues)

Rocket modifications: Instrumentation for the solar radiation experiment and the ultraviolet radiation experiment was housed in an Aerobee nose section faired into the Blossom nose section. Instruments for both experiments were contained in a single housing which was to have been pointed at the sun by the University of Colorado biaxial pointing control. This Aerobee nose extended 43 in. beyond Station Zero of standard Blossom IV.

Rocket performance: The abnormally short flight was due to an explosion in tail section shortly after X time. At this time (approximately eight sec) several pieces of the tail were blown off. Thrust continued and steering was satisfactory, but, with loss of portions of the tail section, cutoff was called for at approximately 22 sec.

IDENTIFICATION

17 February 1950

Time of firing: 1101 MST
Agency: Naval Research Laboratory
Altitude: 92.4 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Stagnation pressure on nose tip, pressure on nose cone and tail section
Cosmic radiation: Geiger counter telescope. Ilford nuclear emulsions.
Solar radiation: Thermoluminescent receiver. Soft x-ray film detectors.

DATA RECOVERY INSTRUMENTS

Telemeter: NRL 30-channel AN/DKT-2(XN-1) pulse position system
Airborne recorder: NRL 12-channel CR photographic recorder
Physical recovery: Nose cone separation explosives in control chamber

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell stations
- Cameras: Three ballistic and three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two SCR-584 S-band radars
- Impact location: Impact point computer

Airborne
- Beacon: APN-55 S-band
- Radio cutoff: DRW-4 command fuel cutoff and blowoff
- Aspect: Roll, pitch, and yaw aspect gyros. NRL aspect cameras.
- Other: BRL spectro camera

ROCKET INFORMATION

Payload weight: 3140 lb
Unfueled rocket weight: 9900 lb
Unfueled rocket C.G.: 252.8 in. (above burner base)
Gross weight at takeoff: 29,433 lb

ROCKET PERFORMANCE

Time to burnout: 64.4 sec
Velocity at burnout: 4830 ft/sec
Altitude at burnout: 21.7 miles
Time to zenith: 222 sec
Altitude at zenith: 92.4 miles
Time to tail blowoff: 337.3 sec

ROCKET PERFORMANCE (Continued)

Altitude at blowoff: 56 miles (approximately)
Flight duration: 515.4 sec (impact of main body)
Impact coordinates: 40.5 mi. north, 2 mi. west

BALLISTIC DATA

Theodolites: Mitchell trajectory data from 0 to 70 sec, Askania trajectory data from 0 to 70 sec
Cameras: Bowen-Knapp and ballistic cameras - complete data
Telescopes: Altitude data from 0 to 60 sec
Radar: Trajectory data from 0 to 273 sec
Impact location: Predicted within 1.5 miles

DATA RECOVERY

Telemeter: Strong signals received. No break in record until 337 sec
Physical recovery: 20% of thermoluminescent strips recovered in good condition. Cosmic ray film pack was total loss. One aspect camera total loss, film badly damaged in the other but usable. Most of x-ray detectors recovered.
Airborne recorder: Recorder film damaged but usable

COMMENTS

Rocket modifications: A .38 caliber, 0.22 in. long cylinder inserted in aluminum nose cone
Rocket performance: Rocket performance slightly better than normal

IDENTIFICATION

18 January 1951

Time of firing: 1314 MST
Agency: Naval Research Laboratory
Altitude: One mile

UPPER AIR INSTRUMENTS

Cosmic radiation: Minimum ionization emulsions
Solar radiation: Photon counters. Solar spectrograph with one-axis sunfollower. Thermoluminescent crystals. Solar x-ray film detectors.

DATA RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2(XN-1) 30-channel pulse position system
Physical recovery: Warhead separation explosives in the control section and nose cone separation primer cord in nose cone. Cable attached between sunfollower and tail section of rocket.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Two S-band stations
- Impact location: Impact point computer

Airborne
- Beacon: APN-55
- Radio cutoff: AN/ARW-37 command cutoff and blowoff
- Aspect: Two NRL horizon aspect cameras. Roll photocells. Three Reeves Inst. Co. gyroscopes.
- Other: Bureau of Standards ionosphere height-finding station. Spectro camera.

ROCKET INFORMATION

Unfueled rocket weight: 9296 lb
Unfueled rocket C.G.: 238 in.
Gross weight at takeoff: 29,227 lb

ROCKET PERFORMANCE

Firing angle: 0 degrees
Program angle: Seven degrees
Time to burnout: 42.2 sec
Time to zenith: 54 sec
Altitude at zenith: One mile

COMMENTS

Rocket performance: The rocket burned for 13 sec in the launcher before taking off with very low thrust and was near vertical for next 36 sec. At this time it began to pitch north very rapidly; below normal thrust due to very poor mixture ratio rich in alcohol. No explanation available for apparent obstruction in oxygen feed lines.

Experiments: The experiments were a total loss

UPPER AIR ROCKET SUMMARY

V-2
NO. 50

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 1501 MST
Altitude: 54.2 miles

11 April 1949

Experiments: Pressure-temperature, Composition. Solar radiation (NRL). Biological.

V-2
NO. 51

Agency: Air Research and Development Command
Time: 1009 MST
Altitude: 84.8 miles

31 August 1950

Experiments: Solar radiation (Armour Res. Found, and Ill. Inst. of Tech.). Skin temperature, Ionosphere (Boston Univ.). Sky brightness, Solar radiation (AFCRC). Meteorites (Temple Univ.). Biological (WPAFB).

V-2
NO. 52

Agency: Air Research and Development Command
Time: 1443 MST
Altitude: 3.6 miles

28 June 1951

Experiments: Solar Radiation (Rhode Island State Col., Univ. of Colo., AFCRC). Sky brightness (AFCRC, Univ. of Denver). Ionosphere (AFCRC and Univ. of Utah). Biological (Aero. Med. Lab., WPAFB).

V-2
NO. 53

Agency: Naval Research Laboratory
Time: 1101 MST
Altitude: 92.4 miles

17 February 1950

Experiments: Cosmic radiation, Solar radiation, Pressure-temperature.

V-2
NO. 54

Agency: Naval Research Laboratory
Time: 1314 MST
Altitude: 1.0 miles

18 January 1951

Experiments: Cosmic radiation, Solar radiation.

UPPER AIR ROCKET SUMMARY

V-2
NO. 55

IDENTIFICATION

14 June 1951

Agency: Naval Research Laboratory
Altitude: 0 miles

UPPER AIR INSTRUMENTS

Cosmic radiation: Specially sensitized film packs (NRL, NIH)
Solar radiation: Photo counters to measure radiant energy in the spectral bands 0-100A and 1100-1900A. Sunfollower spectrograph to measure radiation 1000-2000A. Detection of soft X-rays near 1200A by means of thermoluminescent crystals. Film plate densitometer for detection of soft X-radiation (NRL). Radiation effects on Chemical Corps test material (Chemical Corps).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL AN/DKT-2(XN-1) 30-channel system

COMMENTS

Rocket performance: The rocket blew up on the stand at beginning of main stage

IDENTIFICATION

18 November 1949

Time of firing: 0903 MST
Agency: University of Michigan for SCEL
Altitude: 77 miles

UPPER AIR INSTRUMENTS

Temperature: Twelve flash and sound grenades (SCEL). Four Pirani gages to probe shock wave angle for temperature (Mich. U.)
Composition: Two evacuated air-sampling bottles with associated timer and pyrotechnic opening and sealing devices
Cosmic radiation: Cosmic ray tracking plates for meson and proton detection (AEC)
Other: Talcum generator to permit tracking of high altitude winds (SCEL)

DATA RECOVERY INSTRUMENTS

Telemeter: NRL AN/DKT-2 30-channel PPM-AM system
Airborne recorder: Cook Research Laboratories 13-channel FM magnetic tape recorder in parallel with telemeter
Physical recovery: Warhead and instrument compartment separated by TNT detonation

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and seven Askania stations
- Cameras: Three ballistic and three Bowen-Knapp stations
- Telescopes: Three stations
- Radar: Two SCR-584 modified S-band stations

Airborne
- Beacon: APN-55 S-band transponder
- Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff and blowoff
- Aspect: Three Giannini heliograph cameras. APL K-25 camera for aerial reconnaissance and missile aspect.

ROCKET PERFORMANCE

Program angle: Seven degrees
Firing time: 0903 MST
Time to burnout: 65.34 sec
Velocity at burnout: 4280 ft/sec
Altitude at burnout: 21.6 miles
Time to zenith: 205.85 sec
Altitude at zenith: 77 miles
Time to tail blowoff: 318.1 sec
Altitude at tail blowoff: 21.7 miles
Impact coordinates: Mid-body - 33.33 mi. north, 3.11 mi. east of launcher

BALLISTIC DATA

Theodolites: Askania trajectory data from 3 to 355 sec. Mitchell trajectory data from 1 to 74.8 sec.
Telescopes: Attitude data from 4.4 to 80 sec
Radar: Trajectory data from 0 to 586 sec
Aspect: Giannini data. APL K-25 camera aspect data.

DATA RECOVERY

Telemeter: Excellent records on all channels beyond the time required for all experiments
Airborne recorder: Cook magnetic tape recorder - excellent records until 70 seconds (Mich. U.)
Physical recovery: Two air-sampling bottles in apparently good condition. AEC cosmic ray plates. Cook magnetic tape recorder casette. Giannini heliographs - operated in flight and recovered. APL aspect and reconnaissance camera - excellent record over peak.

EXPERIMENTAL DATA

Air-sampling bottle sealers failed to operate - no samples. All four Pirani gages gave excellent data in the altitude region of 85,000 to 130,000 ft. At this point, one gage or its circuit failed. Three-gage data were obtained up to 145,000 ft, then a second gage went out. Signals were obtained from the two remaining gages up to 230,000 ft at which point both burned out due to overheating at the low pressure.

Although no yaw data were available from 183,000 to 230,000 ft, reduction was made of the three- and four-probe data. The temperatures obtained agree well with measurements by other methods. The results show that the shock wave angle method is useful for making instantaneous, independent measurements of temperature to 230,000 ft.

COMMENTS

Rocket modifications: Four Pirani gages mounted on extension rods were placed at 90-degree intervals 8 in. from the longitudinal axis of a 40-degree right circular cone. The rods were driven through an excursion of 8 in. with a period of about 3 sec in a direction parallel to the cone axis so as to intercept the shock wave.

Holes for the SCEL grenades were located on radii at the base of the warhead.

Rocket performance: Normal in all respects
Experimental: The Cook magnetic recorder and two Piranis failed at about the time one grenade should have fired. This grenade was later found to be jammed in the warhead. It is thought that the ejection charge may have damaged some circuits.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," L. M. Jones, and H. W. Neill, Engineering Research Institute, University of Michigan, Final Progress Report, Contract W-36-039-sc-32307

IDENTIFICATION

8 March 1951

Time of firing: 2016 MST
Agency: Air Research and Development Command
Altitude: 1.9 miles

UPPER AIR INSTRUMENTS

Soft solar X-ray studies: A number of packets, each containing photographic film with a single thickness filter, were placed on surfaces of the rocket (AFCRC)
Skin temperature experiment: Nickel temperature-sensitive elements, commutated in one arm of ac resistance bridge, to sense heat change in flush-mounted thin steel diaphragms distributed along rocket skin (B. U.)
Atmospheric composition studies: Grating spectrograph, Littau type, aperture f2.9, electrodeless discharge light source (AFCRC)
Emission spectrum experiment: Crystal controlled rf generator operating at 1.4 Mc and square wave modulated at 979 cps to create a strong electrostatic field. Rocket was split by insulating section just forward of control compartment and operated as a doublet antenna for this generator (Tufts College and AFCRC)
Luxembourg experiment: Pulsed transmitter operating at 3.5 Mc and synchronized with emission spectrum generator to investigate cross modulation (U. of Utah, Tufts College, and AFCRL)
Synchronizing beacon: A 493.5-470 Mc beacon provides synchronizing signals from ground transmitter for emission spectrum and Luxembourg experiments (HAFB, Oklahoma A and M, and AFCRC)
Photoelectric detection of artificial airglow: Six multiplier phototubes with associated interference filters and circuits installed in instrument compartment (Naval Ordnance Test Station)
Photographic detection of artificial airglow: Eight motion picture GSAP 16-mm cameras (modified and re-geared) for recording intensity of emission spectrum experiment glow discharge. Four located in instrument compartment and four in missile body. (AFCRC).
Night sky infrared measurements: Phototube with appropriate filter and amplifier to measure infrared radiation in the night sky (AFCRC and HAFB)
Common power supply: Three 2.8-kva inverters, each powered by eight type ER-8-30 batteries. Output of two inverters used for Luxembourg equipment, and output from third served as common power supply for rocket.

DATA RECOVERY INSTRUMENTS

Telemeter: NRL telemetering system. Hermes telemetering system.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell stations
Cameras: Two Bowen-Knapp stations
Radar: S-band radar, MPQ/12

ROCKET INFORMATION

Unfueled rocket weight: 10,407 lb
Unfueled rocket C.G.: 267.9 in.
Gross weight at takeoff: 30,067 lb

ROCKET PERFORMANCE

Program angle: 7 degrees
Time to zenith: 33.5 sec
Altitude at zenith: 1.9 miles
Flight duration: Approximately 65.1 sec
Impact coordinates: 3818 ft at azimuth of 110 degrees 37 ft

BALLISTIC DATA

Radar: Beacon went out at 16.0 sec. Radar was returned to straight reflection and tracked rocket from 18.0 sec to impact in automatic.

EXPERIMENTAL DATA

No experimental results due to nature of flight

COMMENTS

Rocket modifications: The typical V-2 rocket was modified by increasing the length of the missile by one diameter. Nose section differed from previously launched Blossoms in that recovery by parachute was not a test objective. An insulated section required for the Luxembourg and emission spectrum experiments was used in place of the original parachute compartment.

Rocket performance: Preliminary stage and takeoff appeared normal and missile rose as expected for approximately 15 sec. At approximately 15.5 sec an explosion occurred in the propulsion section of missile; a second explosion occurred at approximately 18.5 sec, and a third, at 19.5 sec, which destroyed a large portion of the tail section.

Never Fired

UPPER AIR ROCKET SUMMARY

V-2
NO. 59

IDENTIFICATION

20 May 1952

Time of firing: 0906 MST
Agency: Signal Corps Engineering Laboratory, University of Michigan
Altitude: 75 miles

UPPER AIR INSTRUMENTS

Composition: Seven sample bottles mounted at the forward end were flown. These contained $C^{14}O_2$ contaminators. The array was covered with an ejectable false cone. The bottles were equipped with an improved model pyrotechnic opener and cold-weld sealer. The bottles were grouped in three canisters - two containing three bottles of 500 cu in. capacity, and one containing one bottle of 2100 cu in. capacity. Each canister was equipped with a silicone rubber-Fiberglas ribbon parachute. The samples were more or less evenly spaced in the altitude range 58 to 104 kilometers.

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse-widening feature of radar beacon used as a one-channel system
Airborne recorder: An APL-furnished camera used to record missile aspect during sampling
Physical recovery: Nose cone separated by jato, warhead by primer cord; sampling bottles separated with blasting caps and piston charges, and lowered by parachute

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and six Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Four stations
- Radar: Three S-band and one X-band
- Impact computer: Impact predictor

Airborne
- Beacon: AN/APN-55
- Radio cutoff: AN/DRW-4

ROCKET INFORMATION

Unfueled rocket weight: 10,525 lb

ROCKET PERFORMANCE

Firing time: 0906 MST
Program angle: Seven degrees
Time to burnout: 69 sec

ROCKET PERFORMANCE (Continued)

Velocity at burnout: 4120 ft/sec
Altitude at burnout: 23.4 miles
Time to zenith: 200 sec
Altitude at zenith: 400,000 ft
Impact coordinates: Main body and tail cone - 28.1 mi. north, 0.6 mi. east; nose cone - 26 mi. north, 1 mi. east; warhead - 29 mi. north, 2 mi. west; canisters - 24.7 mi. north, 1.3 mi. east; 24.5 mi. north, 1.8 mi. east; 25.2 mi. north, 1.8 mi. east

BALLISTIC DATA

Theodolites: Askania trajectory data from 0 to 54 sec. Mitchell trajectory data from 0 to 60 sec.
Cameras: Bowen-Knapp trajectory data from 0 to 15.4 sec
Telescopes: Optical conditions very poor; data from 0 to 40 sec
Radar: Trajectory data from 0 to 101 sec

DATA RECOVERY

Telemeter: Although radar beacon operated, its pulse-widening feature did not
Airborne recorder: Aspect camera found to be in reusable condition, and its film yielded excellent pictures to beyond peak
Physical recovery: All canisters and bottles recovered in excellent shape. All parachutes operated perfectly. Jato in nose cone found unfired, indicating that cone may not have come off.

EXPERIMENTAL DATA

Samples were obtained from at least five of the seven bottles. One bottle leaked and one has not yet been opened. The results verify the results from Aerobees SC-17 and SC-21; that is, an increase in the relative amounts of helium and neon with respect to nitrogen and a corresponding decrease in argon were measured. This separation starts at about 58 km and increases more or less smoothly with altitude but with less magnitude than required by Dalton's law. No $C^{14}O_2$ contamination was detected.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Engineering Research Institute, University of Michigan, Progress Report No. 2, Contract DA-36-039 sc-15443, July 31, 1952

UPPER AIR ROCKET SUMMARY

V-2
NO. 55

Agency: Naval Research Laboratory
Time:
Altitude: 0.0 miles

14 June 1951

Experiments: Cosmic radiation (NRL, Nat. Inst. of Health). Solar radiation, Biological (U. S. Army Chem. Corps).

V-2
NO. 56

Agency: Signal Corps Engineering Laboratories (Univ. of Michigan)
Time: 0903 MST
Altitude: 77.0 miles

18 November 1949

Experiments: Pressure-temperature, High altitude winds (SCEL). Composition (Univ. of Mich.). Cosmic radiation (AEC).

V-2
NO. 57

Agency: Air Research and Development Command
Time: 2016 MST
Altitude: 1.9 miles

8 March 1951

Experiments: Composition (AFCRC, Tufts Col., USNOTS). X-radiation (AFCRC). Sky brightness (AFCRC & HAFB).

V-2
NO. 58

Comment: This rocket never fired.

V-2
NO. 59

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 0906 MST
Altitude: 64.3 miles

20 May 1952

Experiments: Composition, High altitude photography.

IDENTIFICATION

29 October 1951

Time of firing: 1404 MST
Agency: Signal Corps Engineering Laboratory, University of Michigan
Altitude: 87.6 miles

UPPER AIR INSTRUMENTS

Temperature: "Moving probe" method for ambient temperature as a function of shock wave angle. An array of ten probes was used to over-determine the shock wave and to measure shock wave curvature. Probes were covered with false cone during high heating portion of trajectory. This equipment was practically the same as on Aerobees SC-15 and SC-19. The experiment is similar also to that of V-2 Nos. 33, 50, and 56. In the latter cases the probes moved, whereas in the Aerobees and V-2 60 the cone moved.

DATA RECOVERY INSTRUMENTS

Telemeter: 30-channel NRL telemeter; telemeter feature of Dovap used as a single-channel system
Airborne recorder: Two APL cameras to record missile aspect; a Mich. U. 13-channel magnetic tape recorder as backup for telemeter
Physical recovery: Nose cone separated by jato; warhead separated by primer cord

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and six Askania stations
Cameras: Two Bowen-Knapp stations
Telescopes: Four stations
Radar: Two S-band units
Doppler: Transmitter and receivers
Impact location: Two trackers

Airborne
Beacon: AN/APN-55s
Doppler: Type T-4 Dovap transponder
Radio cutoff: AN/ARW-37

ROCKET INFORMATION

Payload weight: 3500 lb
Unfueled rocket weight: 10,221 lb
Unfueled rocket C.G.: 258 in. from tail
Takeoff weight: 30,639 lb

ROCKET PERFORMANCE

Program angle: Seven degrees
Firing time: 1404 MST
Time to burnout: 70.5 sec
Velocity at burnout: 4600 ft/sec
Altitude at burnout: 25 miles
Time to zenith: 220 sec
Altitude at zenith: 87.6 miles
Time to tail blowoff: 382.3 sec
Altitude at tail blowoff: 10.8 miles
Impact coordinates: Warhead - 42 mi. north, 3 or 4 mi. east

BALLISTIC DATA

Theodolites: Askania trajectory data from 0 to 405 sec. Mitchell trajectory data from 0 to 221 sec.
Cameras: Bowen-Knapp trajectory data from 0 to 17.9 sec
Telescopes: Images to 384 sec
Radar: Trajectory data to 382 sec
Doppler: Trajectory data to 290 sec

DATA RECOVERY

Telemeter: Good record from 0 to 163 sec and from 225 to 382 sec. Inoperative from 163 to 225 sec.
Airborne recorder: Tape recorder inoperative throughout flight; film in one camera casette badly broken up, while that in second camera was perfect except for three breaks
Physical recovery: Warhead blowoff at 60,000 ft on downleg. Much damage but camera film recovered as noted.

EXPERIMENTAL DATA

Probe mechanism failed to move until after peak. A few scattered signals were obtained on downleg but no useful results were obtained.

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Engineering Research Institute, University of Michigan, Progress Report No. 5, Contract DA-36-039 sc-125, February 29, 1952

IDENTIFICATION

26 October 1950

Time of firing: 1602 MST
Agency: Ballistic Research Laboratories
Altitude: 5.0 miles

UPPER AIR INSTRUMENTS

Pressure: Ten total-pressure tubes close to the nose cone surface. Four differential pressure gages for pitch and yaw measurements. Two static pressure gages on nose cone surface. One total-pressure gage outside nose cone boundary layer for Mach number. (BRL).
Temperature: Thirty-three skin temperature gages in resistance bridges cemented to inside surface of nose skin (BRL). Twenty-four temperature sensing elements on body and one tail fin (Boston U.).

ROCKET PERFORMANCE INSTRUMENTS

Control and propulsion performance: Information on the control and performance of the missile during and after burning (G. E.)

DATA RECOVERY INSTRUMENTS

Telemeter: Two Hermes-PWM-PM telemetering sets with 28 channels, each operating at a rate of 30 per sec. One doppler telemetering set with 12 channels operating at a rate of 6 per sec.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Three Mitchell and eight Askania stations
- Cameras: Three Bowen-Knapp stations
- Telescopes: Five stations
- Radar: Two modified SCR 584 S-band stations
- Doppler: Eight stations
- Impact location: Impact point computer - two stations

Airborne
- Beacon: APN-55 S-band transponder
- Doppler: Dovap transceiver
- Radio cutoff: ARW-37, FM control receiver for command blowoff and cutoff
- Other: Spheredop transmitter

ROCKET INFORMATION

Payload weight: 3700 lb (warhead)
Unfueled rocket weight: 8807 lb
Unfueled rocket C.G.: 237.9 in.
Gross weight at takeoff: 28,180 lb

ROCKET PERFORMANCE

Firing angle: six degrees from vertical
Program angle: Six degrees from horizontal at thrust cessation
Time to burnout: 40.7 sec (explosion in the missile)
Velocity at burnout: 3153 ft/sec
Altitude at burnout: 3.94 miles
Time to zenith: 59 sec
Altitude at zenith: 5.0 miles
Flight duration: 107 sec
Impact coordinates: 15.4 mi. north, 0.2 mi. west

BALLISTIC DATA

Theodolites: Mitchell trajectory data from 0 to 50 sec; Askania trajectory data from 0 to 50 sec
Cameras: Bowen-Knapp trajectory data while in field of view
Telescopes: Complete records for five telescopes. Yaw and orientation data to 50 sec.
Radar: Trajectory from 0 to 50 sec
Doppler: Trajectory data from 0 to 50 sec
Impact location: Tracked to explosion

DATA RECOVERY

Telemeter: Complete record - BRL, G. E., 50% record - Boston U.

EXPERIMENTAL DATA

Boundary layer flow: Pressure and skin temperature data indicated that heat transfer from air to rocket surface was greater than that required to damp small boundary layer oscillations. The boundary layer over the nose cone appeared to be laminar at Reynolds numbers from 0.5×10^8 to 1.0×10^8. The rocket reached Mach three at 25,000 feet in approximately horizontal flight before it exploded abruptly from unknown causes. (BRL).
Surface temperature measurements: Data were received only for those elements located on the main body of the rocket. Results of the experiment are classified. (Boston U.).

COMMENTS

Rocket modifications: The standard V-2 warhead was replaced by a highly polished metal cone with included angle of 20 degrees and having a length of more than eight feet. This constituted the test area for the boundary layer experiment.
Rocket performance: Rocket was programmed to reach horizontal flight at approximately 25,000 ft at a speed of Mach four. The rocket exploded at 50 sec for reasons unknown, at which time the speed was Mach three.
Experiments: The experiment was considered successful despite rocket explosion. Sufficiently high velocity was attained to prove experimentally that removal of heat from the boundary layer by the rocket skin will result in laminar flow at high Reynolds Numbers.

(Continues)

REPORTS AND PAPERS

"The Flush-Mounting Temperature Sensing Unit," Technical Note No. 1, Excerpts from Progress Reports Nos. 4 and 6, Project Skin Temperature, Upper Atmosphere Research Laboratory, Boston University

"The Stability of the Laminar Boundary Layer in a Compressible Fluid," L. Lees, NACA T.N. 1360, July 1947

UPPER AIR ROCKET SUMMARY

V-2
TF-1

IDENTIFICATION

22 August 1951

Time of firing: 1200 MST
Altitude: 132.6 miles

UPPER AIR INSTRUMENTS

No upper atmosphere research experiments

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

20 May 1952

Time of firing: 0906 MST
Agency: Signal Corps Engineering Laboratories (University of Michigan)
Altitude: 64.3 miles

UPPER AIR INSTRUMENTS

Composition, high altitude photography

COMMENTS

Same firing also listed as V-2 No. 59

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

22 August 1952

Time of firing: 0033 MST
Agency: Naval Research Laboratory
Altitude: 48.5 miles

UPPER AIR INSTRUMENTS

Pressure-temperature: Two Philips gages (NRL)
Cosmic radiation: Specially sensitized film pack
Solar radiation: Film plate densitometers for detection of soft X-rays (NRL)
Composition: A radio frequency mass spectrometer designed to obtain composition of the atmosphere between mass numbers 48 and 5 in the altitude range 60 to 94 miles (NRL)
Other: Rotating coil to measure earth's magnetic field (NRL). Night sky infrared measurements (AFCRC).

DATA RECOVERY INSTRUMENTS

Telemeter: NRL system

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Askania and Mitchell
Cameras: Ballistic and Bowen-Knapp
Radar: 2 stations
Impact location: Impact point computer

Airborne
Beacon: Beacon transponder
Radio cutoff: AN/ARW-37 cutoff receiver
Other: A German-made gyro-type integrating accelerometer

ROCKET INFORMATION

Unfueled rocket weight: 9294 lb
Unfueled rocket C.G.: 238.1 in. from venturi exit
Gross weight at takeoff: 28,000 lb

ROCKET PERFORMANCE

Program angle: Seven degrees true north
Time to burnout: 53.1 sec
Velocity at burnout: 3420 ft/sec
Altitude at burnout:
Time to zenith: 160.6 sec
Altitude at zenith: 48.5 miles

ROCKET PERFORMANCE (Continued)

Time to tail blowoff: 217.4 sec
Flight duration: 280 sec
Impact coordinates: 20.68 mi. at 355.5 degrees azimuth from Army blockhouse

BALLISTIC DATA

Theodolites: Askania to 70 sec, Mitchell to 62 sec
Cameras: Ballistic to 54 sec, Bowen-Knapp to 15 sec
Radar: To 269.5 sec
Impact location: From 0 to 102 sec and 113 to 150.5 sec

COMMENTS

Rocket performance: The missile functioned well until 53.25 sec, at which time there was a marked decrease in thrust. The failure has not been explained, but the most logical cause was failure of the 25-ton valve by fire or vibration.

UPPER AIR ROCKET SUMMARY

V-2
NO. 60

29 October 1951

Agency: Signal Corps Engineering Laboratories (University of Michigan)
Time: 1404 MST
Altitude: 87.6 miles

Experiments: Pressure-temperature.

V-2
NO. 61

26 October 1950

Agency: Ballistic Research Laboratories
Time: 1602 MST
Altitude: 5.0

Experiments: No upper air research experiments.

V-2
TF-1

22 August 1951

Agency:
Time: 1200 MST
Altitude: 132.5 miles

Experiments: No upper air research experiments.

V-2
TF-2

20 May 1952

Agency: Signal Corps Engineering Laboratories (University of Michigan)
Time: 0906 MST
Altitude: 64.3 miles

Experiments: Composition, High altitude photography.
Comment: Same firing also listed as V-2 No. 59.

V-2
TF-3

22 August 1952

Agency: Naval Research Laboratory
Time: 0033 MST
Altitude: 4[illegible] miles

Experiments: Composition, Pressure, Magnetic field, Solar radiation. Cosmic radiation (Natl. Inst. of Health). Sky brightness (AFCRC).

This rocket was never fired

UPPER AIR ROCKET SUMMARY

IDENTIFICATION

19 September 1955

Time of firing: 0849 MST
Agency: Signal Corps Engineering Laboratory, University of Michigan
Altitude: 4.4 miles

UPPER AIR INSTRUMENTS

Composition: Same sample-bottle instrumentation as in V-2 No. 59

DATA RECOVERY INSTRUMENTS

Telemeter: Pulse-widening feature of radar beacon used as a single-channel system
Airborne recorder: One APL camera to record missile aspect
Physical recovery: Nose cone separated by M-2 jato; warhead separated by primer cord

BALLISTIC INSTRUMENTS

Airborne
Beacon: AN/APN-55s
Radio cutoff: AN/ARW-37 FM control cutoff receiver

ROCKET INFORMATION

Unfueled rocket weight: 10,140 lb
Unfueled rocket C.G.: 257.5 in. from venturi exit
Takeoff weight: 29,701 lb

ROCKET PERFORMANCE

Firing angle: 0.0 degrees
Program angle: Seven degrees
Firing time: 0850 MST
Altitude at zenith: 23,300 ft
Impact time: 90.33 sec
Impact coordinates: 0.537 mi. at 320 degrees azimuth

BALLISTIC DATA

Theodolites: Askania trajectory data from 0 to 25 sec
Cameras: Bowen-Knapp trajectory data from 0 to 14 sec
Radar: Trajectory data from 14 to 87 sec

DATA RECOVERY

Physical recovery: Parachutes recovered in fair shape

EXPERIMENTAL DATA

No results

COMMENTS

Rocket performance: Explosion in tail section at 27 sec, thrust terminated. Rocket demolished on impact

REPORTS AND PAPERS

"Atmospheric Phenomena at High Altitudes," Engineering Research Institute, University of Michigan, Progress Report No. 3, Contract DA-36-039 sc-15443, October 1952

WSPG Report of V-2 TF-5

FDL Advance Data Report No. 333, Numerical and graphical trajectory data from Bowen-Knapp observations of V-2 TF-5

FDL Advance Data Report No. 463, Numerical and graphical trajectory data from Askania observations of V-2 TF-5

WSSCA Radar Data Report, Numerical and graphical trajectory data from radar observations of V-2 TF-5

UPPER AIR ROCKET SUMMARY

V-2
G. E. SPECIAL

IDENTIFICATION

20 November 1947

Time of firing: 1647 MST
Agency: General Electric Company
Altitude: 16.6 miles

UPPER AIR INSTRUMENTS

No upper atmosphere experiments

NAVY-DPPO PRNC WASH., D.C.

V-2
TF-4

Comment: This rocket never fired.

V-2
TF-5

19 September 1952

Agency: Signal Corps Engineering Laboratories (University of Michigan).
Time: 0849 MST
Altitude: 16.8 miles

Experiments: Temperature, Composition, Cosmic radiation (Natl. Inst. of Health).

V-2
G. E. SPECIAL

20 November 1947

Agency: General Electric Company
Time: 1647 MST
Altitude: 16.6 miles

Experiments: No upper air research experiments.

10. THE VIKING ROCKET

Description

Characteristics - Table

Firings - Table
Naval Research Laboratory Viking Rocket Firings

Data Sheets

Viking Rocket

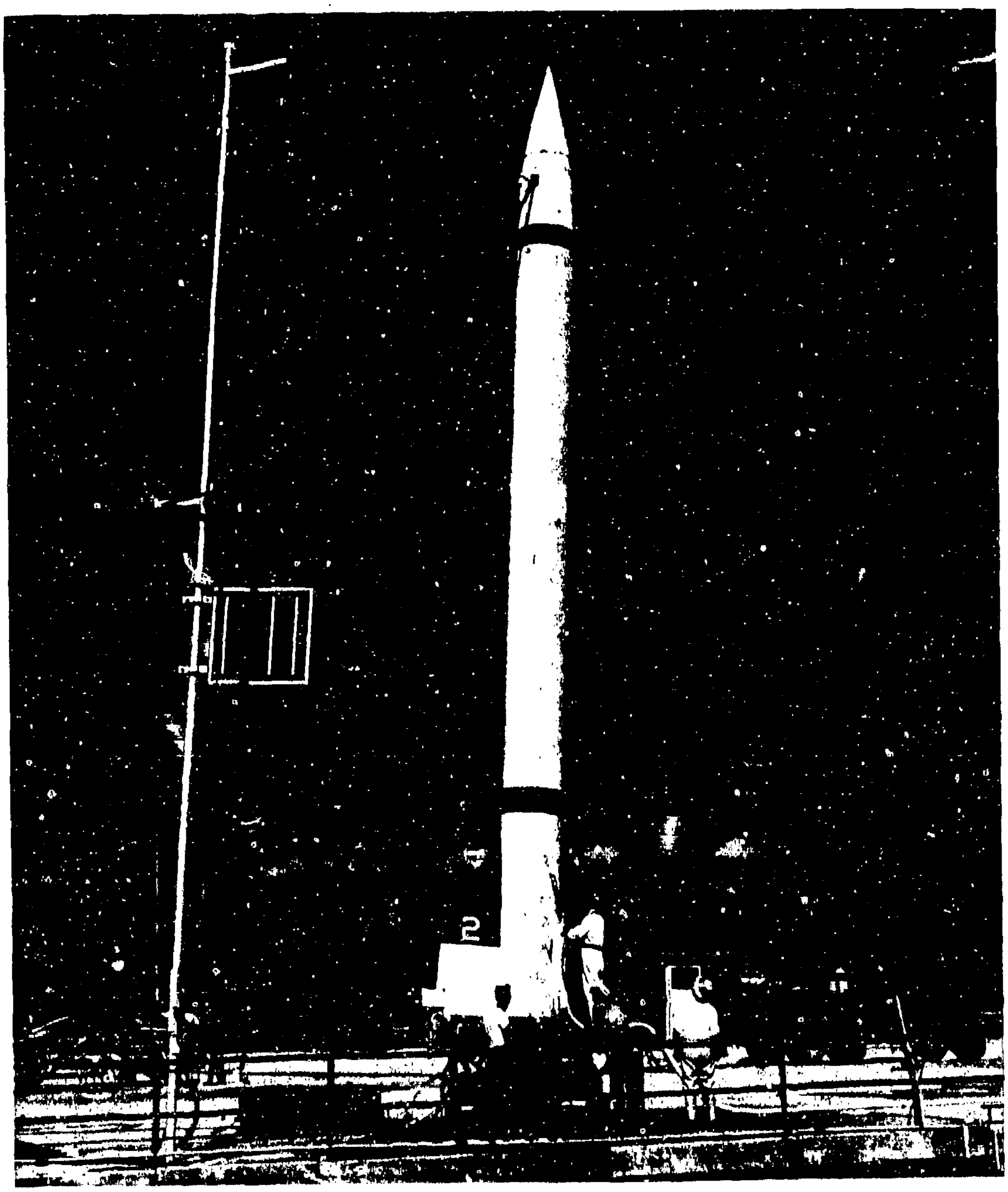

Figure 10.1 - The Viking Rocket

10. THE VIKING ROCKET

The Viking is a vertically launched sounding rocket designed to carry a 500-pound instrument load to altitudes above 100 miles. It is a conically tipped cylinder 46.5 feet long with a diameter of 32 inches and has four equally spaced fins at the after end of the cylinder. Propulsive force is obtained from a liquid propellant rocket motor which is spent at an altitude of about 25 miles. It is stabilized* in flight and controlled in trajectory by an internal control system. The major characteristics of the Viking are given in Table 10.1 and the firings are summarized in Table 10.2.

Instrument Space and Structure

The rocket consists of five major sections: a nose section, an instrument section, a control section, a tank section, and a tail section. Upper air instrument space is contained within the nose and instrument sections, except for very small volumes that are available in the tail section. The removable and pressurizable nose cone provides 13.5 cu ft of instrument space within a cone-ogive configuration that is 79 inches long and which has a maximum diameter of 30 inches. An additional 12 cu ft is provided by the 31-inch long ogive-cylinder instrument section which has a maximum diameter of 32 inches. This section is also removable, but it is not pressurized.

The instruments are installed on a structure that fits within the nose section and which is attached to the nose cone by means of four mounting tabs near the base of the nose cone. Instruments are installed within the nose section by bolting them to plywood bulkheads. In some special cases they are mounted on the rocket skin when they are both light in weight and need access through the skin.

The remaining sections of the rocket are devoted to the rocket's control and propulsive systems. The gyros and controls are located just behind the instrument section; then follows the pressurizing gas sphere, and the oxygen and alcohol tanks. The tail section contains the steam plant, propellant pumps, hydraulic power system, and the rocket motor.

Electrical Wiring and Antennas

Electrical connections and r-f transmission cables are routed from the forward to the after sections of the rocket through external shrouds mounted on the tank section. External circuits from the blockhouse for the control, monitoring, and auxiliary powering of instruments within the rocket are connected through a receptacle in the instrument section. The connector is electrically ejected automatically just prior to ignition of the rocket motor. Similar circuits associated with the rocket's control and propulsion systems are connected through two pull-away connectors at the base of the rocket. These connectors are disengaged by upward motion of the rocket.

Antennas for the radio telemeter, radio cutoff, radio doppler, radar beacon, and other radio devices are generally mounted on the tail fins in the form of outrigger turnstiles, or as rods along the trailing edges of the fins.

Propulsion

The regenerative-type rocket motor burns a mixture of alcohol and liquid oxygen. These two liquids are injected into the combustion chamber by propellant pumps driven

*cf. Rocket Stability, Sect. 6.

by a steam turbine which is powered by the rapid decomposition of concentrated hydrogen peroxide. The propulsion system is semi-automatic in operation and is controlled from the blockhouse. Propellant ignition is obtained with a pyro-technic squib inserted into the combustion chamber through the nozzle. Ordinarily, the propellants are allowed to burn until one of them is exhausted. In the event that it becomes necessary to terminate propulsion prior to propellant exhaustion, a command via the radio cutoff receiver will stop the steam plant operation, thus terminating rocket thrust.

Control and Stabilization

During powered flight the rocket is stabilized in the pitch, yaw, and roll planes by internal controls. These controls are based on error signals, from gyro pickoffs, which are differentiated, amplified, and fed to solenoid controlled hydraulic valves. For pitch and yaw corrections, these valves control servos which rotate the gimbal mounted motor about either or both of its two axes, thereby slightly altering the direction of thrust. Roll correction is obtained by diverting turbine exhaust steam through ports on opposing fins and by means of trim tabs at the outboard trailing edge of the same two fins. The roll hydraulic valves control the position of steam deflectors which are mechanically linked to the trim tabs. Two other fixed trim tabs are located on the remaining two fins; these may be present to compensate for fin asymmetry. The trajectory of the rocket is initially established by a predetermined tilt manually introduced into the firing platform. The control gyros are then aligned to the rocket axes. The firing platform has a permanent azimuth of 1.6 degrees East of North to compensate for the Coriolis force.

A coasting flight stabilization system is under development whereby the rocket control system can be used to operate an array of gas jets. These jets provide correcting moments in pitch, yaw, and roll to reduce error moments introduced at or after the end of burning.

Firing Platform

The Vikings are always statically fired prior to flight firing. The same platform and location are used for both static and flight firing. During static firing the rocket is bolted to the launching platform to prevent it from taking off. An opening under the platform leads into a large water cooled pit lined with concrete, which deflects hot gases away from the rocket.

Design, Development, and Firing Services

The Viking airframe and controls were designed and developed by the Glenn L. Martin Company, and the propulsion system was designed and developed by the Reaction Motors, Incorporated. The project is under the technical direction of the Naval Research Laboratory. The Viking firing crew is composed of personnel from the Glenn L. Martin Company, Reaction Motors, Incorporated, the Naval Research Laboratory, and the U.S. Naval Ordnance Missile Test Facility. Supporting services are provided by the White Sands Proving Ground and the U.S. Naval Ordnance Missile Test Facility.

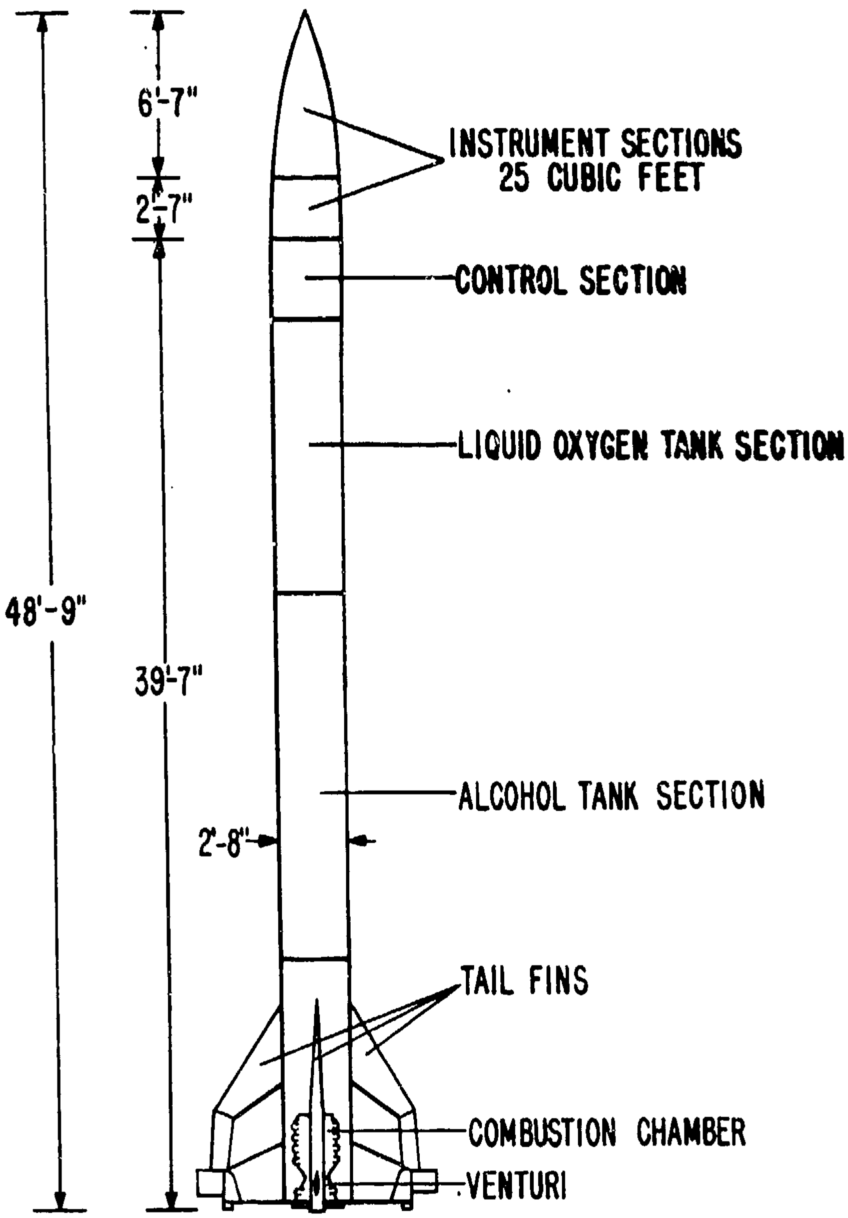

Figure 10.2 - The Viking Rocket, cross-sectional view

TABLE 10.1

CHARACTERISTICS OF VIKING ROCKET

DIMENSIONS	
Total Length	585 in.
Diameter	32 in.
Fin Span	110 in.
WEIGHTS	
Payload	500 lb (nominal)
INSTRUMENT SPACE	
Nose Section	Generally pressurized, approximately conical in shape, detachable.
Apex angle	25 deg.
Height	79 in.
Maximum diameter	30 in.
Volume	13.5 cu ft
Forward instrument Section	Unpressurized, immediately behind nose, approximately cylindrical, two access doors, detachable.
Height	51 in.
Diameter	32 in.
Volume	12 cu ft
Other	Small unpressurized volumes in motor section.
ANTENNA CAPACITY	
Used	Outrigger turnstiles on two fins. Rods on each of four fins. Whips on body.
Others Possible	Outrigger turnstiles on two remaining fins. Notches in fins. Slots in body. Probe at nose.
PERFORMANCE	
Maximum Altitude	136 mi (394 lb payload). 107 mi (675 lb payload).
Time to zenith	266 sec (approximate).
Flight Duration	500 sec (estimated).
Time Above 18.6 miles	410 sec (approximate).
FLIGHT CHARACTERISTICS	
Acceleration	Maximum of about 7 g.
Duration of Acceleration	About 70 sec.
Maximum Velocity	About 5900 ft per sec.
Skin Temperature Rise	Several hundred degrees on nose cone.
Vibration Characteristics	Significant amplitudes observed in nose at frequencies between 200 and 400 cycles during burning, insignificant after burnout. Could be possible source of trouble to high gain electronic equipment.

TABLE 10.1 (Continued)

FLIGHT CHARACTERISTICS (Continued)	
Aspect Behavior	
Powered flight	Stabilized in roll, pitch, and yaw by control system.
Coasting flight	Post burning stabilization system under development to maintain roll, pitch, and yaw displacements to within 5 degrees of initial alignment.

TABLE 10.2

NAVAL RESEARCH LABORATORY VIKING ROCKET FIRINGS

VIKING ROCKETS	DATE	TIME (LCT)	ALTITUDE (MILES)	EXPERIMENTS
1	3 May 49	0914	50.0	Pressure, temperature, photography
2	6 Sep 49	0957	32.3	Pressure, temperature, photography
3	9 Feb 50	1444	50.0	Solar radiation, cosmic radiation, pressure, temperature, photography
4	11 May 50	1608	105.0	Cosmic radiation, pressure, temperature (lat. 00°11.2' N, long. 161°25' W)
5	21 Nov 50	1018	108.4	Ionosphere, solar radiation, pressure, temperature, photography
6	12 Dec 50	0004	40.2	Pressure, density, composition, solar radiation, ionosphere
7	7 Aug 51	1100	136.0	Pressure, density, solar radiation, cosmic radiation; cosmic radiation (NIH)
8				Never fired
9	15 Dec 52	1438	136.0	Solar radiation, photography; cosmic radiation (NIH)

UPPER AIR ROCKET SUMMARY

VIKING
NO. 1

3 May 1949

IDENTIFICATION

Agency: Naval Research Laboratory
Time; 0914 MST
Altitude: 50.4 miles

UPPER-AIR INSTRUMENTS

Pressure-temperature: Stagnation pressure at nose tip; pressure at base of nose cone and ahead of fins. Skin temperature gages on nose and tail section.
Solar radiation: Six X-ray film detectors with foil filters.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-1) 30 channel PPM-AM system.
Physical recovery: No separation explosives installed.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell, six Askania, and two Tele-theodolite stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified SCR-584 S-band stations.
Doppler: At least three stations.
Impact location: Impact Point Computer and three sound ranging stations.

Airborne
Beacon: AN/DPW-1 S-band transponder.
Doppler: Dovap transceiver.
Radio cutoff: AN/ARW-37 FM control receiver.
Aspect: Two modified GSAP cameras.
Other: Longitudinal accelerometer; propulsion and steering performance instruments.

ROCKET PERFORMANCE

Firing angle: 3 degrees North and 0.2 degrees West (tilt from vertical).
Time to burnout: 54 sec.
Altitude at burnout: 14.6 miles
Velocity at burnout: 3500 ft. per sec.
Time to zenith: 163.5 sec.
Altitude at zenith: 50.4 miles
Time to blowoff: 290 sec. (rocket breakup).
Altitude to blowoff: 5 miles (rocket breakup).
Flight duration: 290 sec.
Impact coordinates: 10 miles North and 2.5 miles West.
Payload weight: 500 lbs.
Unfueled rocket weight: 2750 lbs.
Unfueld rocket C. G. :
Gross weight at takeoff: 9650 lbs.

BALLISTIC DATA

Theodolites: Coordinate data 0 to 76 sec.
Cameras: Coordinate data 0 to 8 sec.
Telescopes: Stations TI, TII, TIII, & TIV tracked 0 to 86, 0 to 39, 0 to 136, and 0 sec. respectively.
Radar: Coordinate data 0 to 290 sec.
Doppler: No useable signals during powered flight and only partially useable signals thereafter.
Impact location: Computer predicted 10.4 miles North and 2.8 miles West; no data of value from sound ranging stations.
Aspect: Determined completely for powered flight from gyros and optical instruments; no GSAP camera data.
Rocket performance: Good data obtained.

DATA RECOVERY

Telemeter: Good record for almost all channels 0 to 240 sec., some data lost due to momentary failure of external end organ battery.

Physical recovery: Aerodynamic forces tore rocket apart, fragments scattered over 4 sq. miles. X-ray detectors and GSAP cameras destroyed.

EXPERIMENTAL DATA

Solar radiation: No data.

Pressure-temperature: Ambient pressures measured from 24.9 to 45.4 miles, one measurement near peak (50.4 miles). Some pressures lower than by previous measurements. (40% low at 40.4 miles). Ambient data not obtained due to low ram pressure.

COMMENTS

Rocket performance: Power plant satisfactory except for short burning time resulting from steam plant leak. Control adequate in pitch and yaw, unsatisfactory in steady state roll errors.

REPORTS AND PAPERS

"Rocket Research Report No. 1," by M. W. Rosen and J. M. Bridger, NRL Report No. 3583, Naval Research Laboratory, December 1949.

"Pressures and Temperatures in the Earth's Upper Atmosphere," by R. Havens, R. Koll, and H. LaGow, Naval Research Laboratory Reprint, March 1950.

"The Pressure, Density, and Temperature of the Earth's Atmosphere to 160 Kilometers," by R. J. Havens, R. T. Koll, and H. E. LaGow, J. Geophys. Res., 57:59-72, March 1952.

UPPER AIR ROCKET SUMMARY

VIKING NO. 2

6 September 1949

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 0957 MST
Altitude: 32.3 miles

UPPER-AIR INSTRUMENTS

Solar radiation: Three X-ray film detectors with foil filters.
Pressure-temperature: Stagnation pressure gage at nose tip and ambient gages on tail section.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-2) 30 channel PPM-AM system.
Physical recovery: Prima cord to cut skin and shaped charge to cut cables for nose section separation.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell, one Tele-theodolite, and seven Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified SCR-584 S-band stations.
Doppler: Five stations.
Impact location: Impact Point Computer, sound ranging stations, and SCEL sound ranging set GR-3.

Airborne
Beacon: AN/DPW-1 S-band transponder.
Doppler: Dovap transceiver.
Radio cutoff: AN/ARW-37 FM control receiver.
Aspect: Two GSAP and two K-25 cameras.
Other: Longitudinal accelerometer; rocket propulsion and control performance instruments.

ROCKET PERFORMANCE

Firing angle: 3 degrees North (tilt from vertical).
Time to burnout: 49.5 sec.
Altitude at burnout: 11.1 miles.
Velocity at burnout: 2675 ft. per sec.
Time to zenith: 133 sec.
Altitude at zenith: 32.3 miles
Time to blowoff: 161.2 sec.
Altitude at blowoff: 30.1 miles
Flight duration: 506 sec. (afterbody); 394 sec. (nose).
Impact coordinates: 8.5 miles North, 0.2 miles East (nose); 8.4 miles North and 2.4 miles East (afterbody).
Payload weight: 412 lbs.
Unfueled rocket weight: 2680 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 9985 lbs.

BALLISTIC DATA

Theodolites: Coordinate data 0 to 161 sec.
Cameras: Coordinate data 0 to 12 sec.
Telescopes: Three stations tracked 0 to 161 sec., one station tracked nose to impact, two others tracked main body to impact.
Radar: Coordinate data 0 to 38 sec.
Doppler: Coordinate, velocity, and acceleration data 10 to 161 sec.
Impact location: Impact Point Computer and SCEL Geophone data within 1/2 mile of surveyed impact, no useful data from sound ranging stations.
Aspect: K-25 and GSAP photographs obtained.
Other: Good data obtained on propulsion and control performance.

DATA RECOVERY

Telemeter: Good records for all channels, several short interval interruptions from noise and loss of synchronization.
Physical recovery: Excellent recovery. Useable film from one K-25 and both GSAP cameras. Two of three X-ray detectors recovered.

EXPERIMENTAL DATA

Pressure-temperature: Excellent pressure measurement taken at 32.3 miles, when rocket was moving with low relative velocity, in substantial agreement with data from other rockets.

COMMENTS

Rocket performance: Prematur cutoff due to damage by leak developed in steam plant. Excellent control in pitch and yaw, satisfactory roll control.
Doppler: Improvement in antennas resulted in good performance.

REPORTS AND PAPERS

"Rocket Research Report No. 2," by M. W. Rosen and J. M. Bridger, NRL Report No. 3641, Naval Research Laboratory, March 1950.

"The Pressure, Density, and Temperature of the Earth's Atmosphere to 160 Kilometers," by R. Havens, R. Koll, and H. LaGow, J. Geophys. Res., 57:59-72, March 1952.

UPPER AIR ROCKET SUMMARY

VIKING
NO. 3

IDENTIFICATION

9 February 1950

Agency: Naval Research Laboratory
Time: 1444 MST
Altitude: 50.4 miles.

UPPER-AIR INSTRUMENTS

Cosmic radiation: Geiger counter telescope to measure zenith angle dependence of radiation. Minimum ionization emulsions.
Solar radiation: Ultraviolet spectrograph. X-ray film detectors with foil filters.
Pressure-temperature: Ram pressure gage at nose tip, ambient pressure gages on tail section.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-1) 30 channel PPM-AM system.
Physical recovery: Nose separation by primacord around rocket periphery and shaped charge to sever cable and piping.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and nine Askania stations.
Cameras: Three Ballistic and three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified SCR-584 S-band stations.
Doppler: None.
Impact location: Impact Point Computer and four sound ranging stations.

Airborne
Beacon: AN/APN-55 S-band transponder.
Radio cutoff: AN/ARW-37 FM control receiver for command blowoff and fuel cutoff.
Aspect: Two NRL wide angle horizon cameras.
Vibration: Vibration pickups in nose and propulsion unit mounting ring.
Other: Longitudinal accelerometer, rocket propulsion and control system performance instruments.

Other
Ionosphere: Bureau of Standards ionosphere height finding station.

ROCKET PERFORMANCE

Firing angle: 3.0 degrees North and 0.45 degrees West (tilt from vertical).
Time to burnout: 59.6 sec. (radio cutoff).
Altitude at burnout: 16.6 miles
Velocity at burnout: 3440 ft. per sec.
Time to zenith: 169 sec.
Altitude at zenith: 50.4 miles
Time to blowoff: 201.3 sec.
Altitude at blowoff: 47.5 miles
Flight duration: 420 sec. (time to impact).
Impact coordinates: 3 miles North, 18.7 miles West (Nose). 3.7 miles North, 20.2 miles West (afterbody).
Payload weight: 480 lbs.
Unfueled rocket weight: 2207 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 11,047 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 190 sec.
Cameras: Images obscured by vapor trail.
Telescopes: Attitude data 0 to 190 sec.
Radar: Trajectory data: 0 to 201 sec.
Impact location: Impact Point Computer prediction within 1/2 mile, Geophone data 1.3 miles in error, sound ranging not effective.

Aspect: Zenith angle 0 to 185 sec., swivel angle 0 to 185 sec. from aspect cameras.

Vibration: Significant amplitudes up to 2000 cycles near motor. Significant amplitudes up to 500 cycles in nose. Greatest amplitudes at less than 25 cycles. No significant vibration after cutoff.

Rocket Performance: Good data obtained.

DATA-RECOVERY

Telemeter: Partially satisfactory. Timing pulses lost intermittently. Intermittent external end organ battery resulted in loss of instruments supplied by it.

Physical Recovery: Nose section in fair condition. Afterbody badly damaged by explosion of residual fuels. Spectrograph and detectors in fair condition. One aspect camera in good condition. Cosmic ray emulsions badly damaged.

EXPERIMENTAL DATA

Solar radiation: No data due to insufficient altitude.

Cosmic radiation: No data due to low altitude and poor aspect.

Pressure-temperature: Altitude too low to obtain significant data with gages used. Some skin temperature measurements made at base of alcohol tank.

COMMENTS

Rocket performance: Power plant performance excellent, new seals in steam system stopped leak. Rocket began to roll shortly after takeoff and began westerly flight path deviation. Propulsion terminated by radio cutoff. Rocket rolled at 20 RPM during coasting flight.

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UPPER AIR ROCKET SUMMARY

VIKING NO. 4

11 May 1950

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1600 LCT
Location: 00° 11.2' North, 161° 25' West (U.S.S. Norton Sound)
Altitude: 105 miles

UPPER-AIR INSTRUMENTS

Cosmic radiation: Geiger and proportional counter telescope to measure ionization of primary radiation.
Pressure-temperature: Ram pressure gage at nose tip and ambient pressure gages on tail section.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2(XN-1) 30 channel PPM-AM systems.

BALLISTIC INSTRUMENTS

Radar: SP/SM S-band station on firing ship. Mark 25 and Mark 63 on support ship.
Beacon: AN/DPW-1 S-band transponder.
Other: Longitudinal accelerometer, rocket propulsion and control performance instruments.

ROCKET PERFORMANCE

Firing angle: Azimuth 150 degrees true; 2.35 degree inclination from vertical.
Time to burnout: 74 sec.
Altitude at burnout: 24 miles.
Velocity at burnout: 5160 ft. per sec.
Time to zenith: 242 sec.
Altitude at zenith: 105 miles.
Flight duration: 435 sec.
Impact coordinates: 8 miles range.
Payload weight: 900 lbs.
Unfueled rocket weight: 3,107 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 11,440 lbs.

BALLISTIC DATA

Radar: The SP/SM radar tracked throughout flight except for short duration intervals at burnout and before impact. The Mark 63 tracked for short interval after takeoff and the Mark 25 tracked until shortly after burnout. Acceleration data obtained from accelerometer.

DATA RECOVERY

Telemeter: Satisfactory record for entire flight except for short interval at burnout.
Physical recovery: None attempted.

EXPERIMENTAL DATA

Cosmic radiation: No results. Aspect information poor and low number of registered counts made the data statistically insignificant, Experiment identical to V-2 No. 53.
Pressure-temperature: Pressures obtained up to 42.3 miles. Densities obtained 24.9 to 41 miles. These pressure and density data in substantial agreement with White Sands measurements.

COMMENTS

Rocket performance: Propulsion near optimum, performance in excess of that expected. Steady state roll error small during initial flight, increased to 19 degrees at 68 sec. Roll began at cutoff, increasing to 30 RPM at 80 sec. and stabilized at 53 RPM by 90 sec. Inclination of rocket within 10 degrees of vertical until 100 sec. when it began to spiral away and attained an 85 degree inclination by 160 sec.

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UPPER AIR ROCKET SUMMARY

VIKING NO. 5

IDENTIFICATION

21 November 1950

Agency: Naval Research Laboratory
Time: 1018 MST
Altitude: 108.4 miles

UPPER-AIR INSTRUMENTS

Cosmic radiation: Minimum ionization emulsions.
Solar radiation: X-radiation by photoemission, ionization chamber, scintillation counter, photographic techniques, geiger counters.
Pressure-temperature: Ram pressure gage at nose tip, ambient pressure gages on tail section.
Ionosphere: Ion collector probe at nose tip, and two R. F. propagation transmitters.
Airglow: Oxygen green and sodium "D" line.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-1) 30 channel PPM-AM system.
Physical recovery: Nose section separation explosives ahead of fuel tank.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Three Mitchell and eight Askania stations.
Cameras: Three Bowen-Knapp stations.
Telescopes: Four stations.
Radar: Two modified SCR-584 S-band stations.
Doppler: None
Impact location: Impact Point Computer and SCEL Geophone Sound ranging set GR-3.

Airborne
Beacon: AN/DPW-1 S-band transponder.
Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff and recovery blowoff.
Aspect: Two modified GSAP horizon cameras.
Acceleration: Longitudinal accelerometer.
Other: Rocket propulsion and control system performance instruments.

Other
Ionosphere: Bureau of Standards ionosphere height finding station.

ROCKET PERFORMANCE

Firing angle: 3 degrees North (tilt from vertical).
Time to burnout: 78.9 sec.
Altitude at burnout: 25.3 miles
Velocity at burnout: 5150 ft. per sec.
Time to zenith: 248.4 sec.
Altitude at zenith: 108.4 miles
Time to blowoff: 438.5 sec. (rocket breakup).
Altitude at blowoff: 8 miles (rocket breakup).
Flight duration: 450 sec. (impact).
Impact coordinates: 8.0 miles North and 0.8 miles West.
Payload weight: 675 lbs.
Unfueled rocket weight: 2232 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 11,388 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 430 sec.
Cameras: Trajectory data 0 to 18 sec.
Telescopes: Attitude data 0 to 380 sec.
Radar: Trajectory data 0 to 436 sec.
Impact location: Impact Point Computer in error by 1.5 miles West of impact.
Aspect: Camera data - zenith, heading, and roll angles 0 to 360 sec.

DATA RECOVERY

Telemeter: Excellent record 0 to 441 sec., except for 1 sec. interval at burnout.
Physical recovery: Nose section separation explosives did not detonate. Aerodynamic forces tore rocket apart, and fair equipment recovery attained. Useable film from aspect cameras. Cosmic ray emulsions and X-ray detectors unusable.

EXPERIMENTAL DATA

Cosmic radiation: No data, emulsions destroyed.
Solar radiation, air glow, and ion probe: Data obtained, however not analyzed in detail.
Propagation: Data received throughout flight, complicated by rocket spin and oblique incidence of signals received. Preliminary effective electron densities: a) not greater than 0.1 x 10^4 electrons centimeters^{-3} below 44 miles, b) about 0.3 x 10^4 electrons centimeter^{-3} from 44 to 56 miles, c) steep E-layer gradient began about 57 miles with linear increase to (13.5) x 10^4 electrons centimeter^{-3} at 68 miles, d) remained near this value from 68 to 75 miles, e) monotonic increase 75 to 91 miles, f) reached (14.0) x 10^4 electrons centimeters^{-3} at 78 miles and (18.0) x 10^4 electrons centimeters^{-3} at 93 miles. General shape of lower E-region in agreement with previous NRL results.

COMMENTS

Rocket performance: Control during powered flight excellent. Roll program delayed 3.5 sec. by circuit error. Roll rate 16.5 RPM at 103 sec. increased to 24.2 RPM at 395 sec. Interaction between roll and gas jets caused increase in zenith angle and slow clockwise precision. Zenith angle varied between 65 degrees and 90 degrees while rocket slowly precessed with 72 sec. period after 140 sec.

Rocket Modifications: Two opposing 15 ft. whip antennas installed on instrument section and folded along rocket body during powered flight. Erected later by electrically driven screwjacks initiated by computing timer.

REPORTS AND PAPERS

"Rocket Research Report No. VII," by M. W. Rosen, J. M. Bridger, and H. Spitz, NRL Report No. 3830, Naval Research Laboratory, July 1951.

UPPER AIR ROCKET SUMMARY

VIKING NO. 6

12 December 1950

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 0004 MST
Altitude: 40.2 miles

UPPER-AIR INSTRUMENTS

Pressure-temperature: Ram pressure gage at nose tip, ambient pressure gages at base of nose section and on tail section.
Composition: Platinum wire atomic oxygen detector.
Ionosphere: Diffusion current collector to measure ion and electron current densities and energies. Generating voltmeter to measure electrostatic field on rocket.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-1) 30 channel PPM-AM system.
Physical recovery: None.

BALLISTIC INSTRUMENTS

Firing Range
Theodolites: Two Mitchell and four Askania stations.
Cameras: Three Ballistic and three Bowen-Knapp stations.
Telescopes: None
Radar: Two SCR-584 S-band stations.
Doppler: None
Impact location: Impact Point Computer and SCEL Geophone set GR-3.

Airborne
Beacon: AN/DPW-1 S-band transponder.
Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff.
Aspect: Two bolometers (night firing precluded use of cameras).
Acceleration: Longitudinal accelerometer.

Other
Ionosphere: Bureau of Standards ionosphere height finding equipment.

ROCKET PERFORMANCE

Firing angle: 3 degrees North (tilt from vertical)
Time to burnout: 69.6 sec.
Altitude at burnout: 22.6 miles
Velocity at burnout: 2600 ft. per sec. (Max. of 4030 ft. per sec attained earlier).
Time to zenith: 144.5 sec.
Altitude at zenith: 40.2 miles
Time to blowoff: No blowoff.
Flight duration: 291.7 sec.
Impact coordinates: 0.8 miles North and 7.6 miles East.
Payload weight: 344 lbs.
Empty rocket weight: 2484 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 10,892 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 66.9 sec.
Cameras: Bowen-Knapp trajectory data 0 to 16 sec., Ballistic trajectory data to 66.9 sec.
Radar: Trajectory data 0 to 96 sec.
Impact location: Incorrect predictions, confusion from erratic behavior of rocket.
Aspect: No data, excessive noise on bolometer channels.

DATA RECOVERY

Telemeter: Continuous record 0 to 220 sec, with 3 sec. gap at 65 sec., large record gaps 220 sec. to impact.
Physical recovery: No recovery installation, residual rocket fuels exploded, fragments recovered.

EXPERIMENTAL DATA

Composition: No data.
Ionosphere: No data.
Pressure-temperature: One measurement obtained at 40.2 miles with maximum error of 4%. Erratic behavior prevented other measurements.

COMMENTS

Rocket performance: Propulsion normal throughout burning period. Aerodynamic heating caused deformation of fins to begin at 47 sec. and rocket veered to East. Severe fin failure about 62 sec. Vertical velocity dropped from 4030 ft. per sec, at 62 sec. to 2600 ft. per sec. by 69.6 sec. due to high aerodynamic drag caused by large angle of attack.
Pressure: Pressure data significant in studying rocket behavior.
T-day experiments: This firing part of a coordinated group of firings (Aerobees SC-14, 15, & 16, and USAF-9) and Harvard College meteorite measurements.

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UPPER AIR ROCKET SUMMARY

VIKING NO. 7

7 August 1951

IDENTIFICATION

Agency: Naval Research Laboratory
Time: 1059 MST
Altitude: 136 miles

UPPER-AIR INSTRUMENTS

Cosmic radiation: Minimum ionization emulsions. NRL and National Institutes of Health.
Solar radiation: Six X-ray film detectors with foil filters.
Pressure-temperature: Ram pressure gage at nose tip, ambient pressure gages at base of nose section and on tail section. Pressure gage at base of rocket. Skin temperature gages on nose cone and in tail fins.

DATA-RECOVERY INSTRUMENTS

Telemeter: AN/DKT-2 (XN-1) 30 channel PPM-AM system.
Physical recovery: Nose section separation explosives ahead of oxygen tank.

BALLISTIC INSTRUMENTS

Firing Range
- Theodolites: Four Mitchell and seven Askania stations.
- Cameras: Two Bowen-Knapp stations.
- Telescopes: Three stations.
- Radar: Two modified SCR-584 S-band stations.
- Doppler: None
- Impact location: Impact Point Computer and SCEL Geophone set GR-3.

Airborne
- Beacon: AN/DPW-1 S-band transponder.
- Radio cutoff: AN/ARW-37 FM control receiver for command fuel cutoff and recovery blowoff.
- Aspect: NRL wide angle horizon camera and magnetometer.
- Acceleration: Longitudinal accelerometer.
- Other: Rocket propulsion and control system performance instruments.

Other
- Ionosphere: Bureau of Standards ionosphere height finding station.

ROCKET PERFORMANCE

Firing angle: 3.0 degree North (tilt from vertical).
Time to burnout: 71.9 sec.
Altitude at burnout: 27.1 miles
Velocity at burnout: 5864 ft. per sec.
Time to zenith: 265.8 sec.
Altitude at zenith: 136 miles
Time to blowoff: 430 sec.
Altitude at blowoff: 62 miles
Flight duration:
Impact coordinates: 49.3 miles North and 3.0 miles West.
Payload weight: 394 lbs.
Unfueled rocket weight: 2566 lbs.
Unfueled rocket C. G.:
Gross weight at takeoff: 10,728 lbs.

BALLISTIC DATA

Theodolites: Trajectory data 0 to 80 sec.
Cameras: Trajectory data 0 to 14 sec.
Telescopes: Poor image quality due to thin overcast.
Radar: Trajectory data: 0 to 374 sec.
Impact location: Predicted impact 9 miles North and 0.5 miles West of actual impact.
Aspect camera: Inclination and bearing of rocket 0 to 360 sec.

DATA RECOVERY

Telemeter: Excellent performance throughout flight.
Physical recovery: Nose and afterbody recovered in fair condition in same area. Some fragments scattered nearby. Evidence of fire around propellant tanks. Cosmic ray emulsions severely damaged by shock and exposure. Aspect camera in fair mechanical condition, film excellent. Three X-ray detectors recovered with foil windows ruptured.

EXPERIMENTAL DATA

Cosmic radiation: No data, emulsions damaged.
Solar radiation: No data, X-ray detectors damaged.
Pressure-temperature: Pressure data obtained from ground to 43.5 miles, and from 55.9 to 68.4 miles. Atmospheric density $(1.0 \pm 0.2) \times 10^{-7}$ gm. per cubic meter at 136 miles. Nose cone skin temperature max. of 290° C by 75 sec., dropped to approximately 160° C by 430 sec. Fin temperatures rose to max. of 140° by 140 sec. Upper air wind 179 miles per hour from Southeast at 124.3 miles altitude.

COMMENTS

Rocket performance: Optimum propellant mixture ratio attained, altitude 12 miles higher than expected. Control system operation excellent. Zenith angle maximum of 23 degrees during coastin flight, precession period 104 sec., 1.5 RPS spin deliberately introduced by control system.

Experiments: This and past firings indicate improved technique for protecting cosmic ray emulsions and X-ray detectors necessary.

Other: Aerodynamic heating damaged telemeter and beacon antennas. The telemeter antenna fairing cadmium plating (melting point - 320° C) was eroded during ascent as were the sides of the Kel-F (softening point 200° C) plastic dome. The dome softened and ruptured during descent. The beacon antenna dome softened and ruptured during ascent.

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VIKING NO. 8

Agency: Naval Research Laboratory.

Comments: This rocket never fired, destroyed during static firing.

VIKING NO. 9

15 December 1952

Agency: Naval Research Laboratory.
Time: 1438 MST
Altitude: 136 miles

Experiments: Solar radiation; High altitude photography. Cosmic radiation (National Institutes of Health).

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Non-critical information concerning the Aerobee, Deacon, V-2, and Viking rocket vehicles fired in the interest of upper atmosphere research as performed by U. S. agencies is summarized on convenient data sheets. General information about the history of upper air rocket research, the Upper Atmosphere Rocket Research Panel, the instrumenting agencies, rocket firing facilities, ballistic instruments, data recovery, and rocket instrumentation is given. Firing

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