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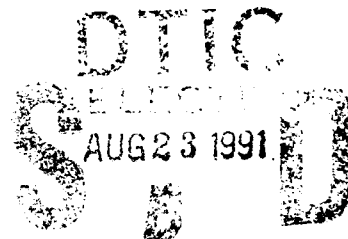


Engineering and Instrumentation Support
of GL Research Balloon Program

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26 July 1991



Final Report
1 December 1987-10 December 1989

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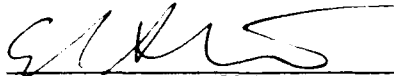
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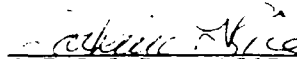


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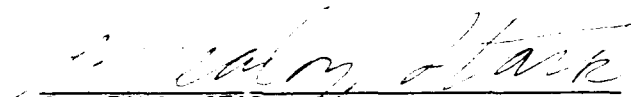


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SUMMARY

The activity during this report period was primarily concerned with command and instrumentation preflight support for the command and data acquisition systems, batteries, control room and launch systems support, balloon and parachute rigging support, payload support, aircraft observer and recovery crew support, design and fabrication support for balloon payload systems, including gondola systems, pointing controls, navigational systems, scientific instrumentation, and ground support instrumentation and services.

A continuing effort was made to improve the quality of support given to Geophysics Laboratory (GL) and to the other agencies and users involved in the balloon operations, as well as to enhance the utilization of the equipment and facilities at GL and Holloman Air Force Base (AFB).



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I INTRODUCTION

This final report summarizes the work performed by the Balloon Systems Section of the Physical Science Laboratory (PSL) under Contract No. F19628-88-C-0009 entitled " Engineering and Instrumentation Support of the GL Research Balloon Program."

II LIST OF CONTRIBUTING ENGINEERS

The following PSL engineers contributed to this effort:

<u>Name</u>	<u>Function</u>
Squire Seagraves	Section Chief
David Gorman	Group Supervisor
Warren Harkey	Senior Engineer
Harold Shaw	Senior Engineer
Barry Rishel	Senior Programmer
John Baker	Engineer

In addition to the above engineers, three technicians supported this effort on a full-time basis, and approximately ten technicians supported the effort on a part-time basis.

III SUMMARY OF SUPPORT PROVIDED

The purpose of this effort was to conduct engineering and instrumentation operations for balloon launch support at Holloman Air Force Base, New Mexico and various remote locations. The types of support provided can be broadly categorized in two areas: (1) program support, and (2) launch support. The former support is more research or developmental-oriented to enhance the long term or future capabilities of GL's Research Balloon Program; whereas, the latter is oriented toward the day-to-day engineering and instrumentation support of balloon launch operations. Each category of support is summarized in this report.

A. PROGRAM SUPPORT

Several efforts were undertaken by the Physical Science Laboratory during the course of this contract to enhance the capabilities and successfulness of the balloon program, which included the Control Center Van, Balloon Control Packages, and Telemetry.

• 1. Control Center Van

The communications rack was completely rebuilt and recabled. Antennas were mounted and RF cabling run to the roof. A four channel VHF transceiver was installed along with a UHF unit. A PSL intercom master station was mounted in the rack. A video monitor and AM transceiver were installed to provide full communications capability and operating convenience. This was accomplished in June 1988.

The EMR713 word selector failed and was sent to California for repair. A replacement unit was borrowed from a White Sands Missile Range (WSMR) PSL group in August 1988.

The Van was transported to Northrup Strip at WSMR to support ABLE III checkouts. The van was used for preflight and flight. The van was then returned to Holloman AFB. This occurred September 1988.

In October 1988, the Van was transported to the FAIR site at WSMR to support the SMARTV Project. The Van was setup to support the command and data recording requirements of the project. Plugs were installed on the power cables so that they could directly mate with field power generators.

The telemetry van components were made operational with the new FORTRAN telemetry software in January 1989.

2. Balloon Control Packages

Robert Woods worked on a new balloon control package at Hanscom AFB from June 13-30, 1989, to replace the ones destroyed in a test flight.

3. Telemetry (TM)

Wheels were installed on the portable telemetry rack to make it easier to use in high bay areas in July 1988. A tripod was also fabricated in July so the four foot S-Band Telemetry receiving dish could be used at remote launch sites.

A PCATS (a portable telemetry station) system was programmed for balloon control real-time displays. The system was used for checkouts at Building 850 and then moved to the fire station at Northrup for the same purpose in September 1988.

The telemetry station was modified to provide high speed data transfers to the GL Micro-VAX computer. Space was made in Building 850's Telemetry Station for the Micro-VAX computer for real-time operations in September 1988.

After the ABLE flight the telemetry station was reconfigured for SCRIBE 88 support. The PCATS System was reprogrammed and used to provide balloon control function displays in the high bay in September 1988.

Ralph Cowie of the Geophysics Laboratory reconfigured the tethered balloon telemetry package for the X-Drone package in September 1988, with PSL assistance.

In October 1988, a Portable telemetry system was programmed to provide backup telemetry real-time displays for the SMARTV Project.

A time insertion unit, buffered data channel, and a time code generator were connected to the portable PDP-11/34 computer to checkout the new FORTRAN telemetry software. The PDP was made to emulate each of GL's telemetry stations so that debugging could occur for each telemetry station. This was accomplished in December 1988.

In January 1989, a version of the new FORTRAN telemetry station software was installed on the Digital Equipment Corporation (DEC) 11/34 computers at Holloman AFB. The telemetry room computer was made operational with the new software.

A new portable telemetry system was delivered to Holloman AFB. Barry Rishel (PSL) met with Ken Walker (GL) at WSMR and cleared up problems in one of the portable telemetry systems in use at GL.

The PCM-IIB flight packages were bench tested to verify operation after the May 1989 ASCHAN flight.

Bob Woods traveled to Hanscom AFB where he modified a new IM-64 PCM encoder to use in the PCM-IIB TM packages flown out of Holloman AFB. He helped build a mixer card to be used in the PCM-III TM packages. The PCM-IIB TM packages were bench checked and new transponder was assembled. This was accomplished in August 1989.

In October 1989, the IM-64 telemetry encoder was installed in the PCM-2B telemetry packages and tested during high bay checks.

Real-time programmer, Barry Rishel, worked on documenting the FORTRAN telemetry station software in November 1989. The portable telemetry station was configured to evaluate the telemetry station at Hanscom AFB and Holloman AFB using components from the station at Holloman AFB. Station setup software and real-time display software were exercised. The software handles both of the HSII decommunication boards and the EEMR 700 series equipment. Documentation proceeded along with software checkouts.

4. Key Personnel Changes

David Gorman became Group Supervisor at Holloman AFB in August 1988. He worked with T. Mansfield, Major Pershing, and GL Engineering staff to support launches.

David Gorman, the PSL On-Site Supervisor at Holloman AFB, transferred to another section within the Laboratory (PSL) in May 1989.

5. Miscellaneous

June 1988

The high hoist system and a throttle cable on the Smith Berger winch were repaired. There was also 14000 ft of new Kevlar cable installed on the winch. Helium was transferred to GL's trailer from Jack Kelly's trailer.

July 1988

The air ejector samples were cleaned and control valves checked for proper operation. The high pressure spheres were checked for valve leaks. This was in preparation for an ASHCAN flight.

August 1988

- A flight frame was built for the X-Drone project out of metallic parts.

October 1988

- Transmitters and batteries were ordered for the Antarctic Path Finder Project.

November 1988

The ASHCAN payload was partially disassembled so that control packages and cabling could be used on a demonstration flight. The payload was tested and verified flight ready. PSL meteorologist, Ralph Reynolds and Launch technician, Charlie Houghton supported the Thermasonde Launches at Kirtland AFB.

December 1988

Strobe lights were repaired and checked for use on balloon flights in 1989. The computer in the control center was sent to the manufacturer for repair. The computer was returned to Holloman AFB from the manufacturer in good condition. A new portable Telemetry station was taken to Holloman AFB to support the demonstration flight. The unit was set up and programmed for use during high bay payload checks. The unit was returned to PSL in Las Cruces to complete software enhancement after the demonstration flight was canceled. A smart valve was assembled and checked for use on a tether flight by the Navy. Squire Seagraves participated in a planning meeting at GSFC in Greenbelt, MD, on a proposed Antarctic gamma ray experiment. The proposed experiment is part of NASA's planetary exploration program and will be a joint Soviet/American operation. The experiment will be conducted in December 1991/January 1992 time frame.

February 1989

A PSL engineer and PSL technicians at Holloman AFB began evaluation of an autotrack antenna that was shipped to Holloman AFB from Hanscom AFB in 1988. The evaluation was necessary because it had been stored outside for several years. It was determined that the mechanical elements of the Azimuth and Elevation drives functioned properly. Other February 1989 tasks included: building ballast hopper test boxes, control center operation test, tape recorder preventative maintenance, repair of hydraulic brake and drive systems on the tether winch, and frequency checks on the HT220 VHF radios.

March 1989

PSL assisted GL personnel in the fabrication of a mounting plate for a tether balloon sleeve. The ongoing vehicle maintenance activities were conducted as required.

May 1989

PSL provided telemetry support at Holloman AFB and backup support from N200 at WSMR. We provided one aircraft observer and one recovery technician. Post flight data playbacks were conducted at Holloman AFB for the University of Denver and GL. PSL personnel provided support for the integration testing on an GL Rocket.

June 1989

Preventive maintenance work on the Benson Ridge VHF repeater, changing batteries, setting aneroids for TAAP, making blower cables for TAAP, building antenna cables, and mounting the antenna on the TAAP vans was work that occurred at Holloman AFB. Intercom stations were rewired, and radios and telephones were installed at the SCAT site for the TAAP test flight.

July 1989

An GL S-Band antenna system (Oklahoma State University) was picked up at WSMR. The unit is for tracking balloon flights from Holloman AFB and at remote launch locations. Batteries were recharged and tested following the TAAP test flights at Holloman AFB. The emergency power system at Building 850 at Holloman AFB was tested when a new generator was installed.

August 1989

Batteries were charged and load tested for possible use in upcoming balloon flights. Maintenance work was conducted on fourteen support vehicles.

September 1989

Vehicle maintenance activities continued. The PCM-2B telemetry and control packages were mounted on a gondola and the system rigged for a test flight. The payload was fully implemented and checked for flight.

October 1989

A set of communication cables for the Buffer Data Channel were removed from the Telemetry Van and sent to Ken Walker at GL at their request. Maintenance work was conducted on Telemetry Room in Building 850. A power supply was repaired, and patch board cables were reworked. The EV-13 helium valves were built up and solenoids were changed on the ballast hopper to provide selection of 12, 24, or 28 volt operation. The DO-ALL bandsaw was disassembled, painted, motor settings calibrated, and returned to excellent working order.

November 1989

A technician's workbench was modified to facilitate the checkouts and/or repair of the PCM IIB telemetry package. Twenty-eight (28) volt power supplies were mounted on the benches, and a DC power connector with control switches and fusing was installed. AC power outlets were also added to the system. Connectors were completed on two parachutes, bringing the total to twelve parachutes rigged.

B. FREE BALLOON SUPPORT

1. ASHCAN

Integration of the ASHCAN payload with new control packages continued during August 1988 and was completed. All systems were verified as flight ready.

The delay completing the ASHCAN payload integration and poor weather conditions left insufficient time to fly the payload before the arrival of the ABLE III payload at Holloman AFB.

In March, the PCM IIB flight packages were bench tested and verified flight ready. The packages were re-installed on the ASHCAN payload. The ASHCAN sensors were tested. One air ejector door valve did not work properly. The matter was not pursued because the ASHCAN flight was postponed until May 1989.

The payload was highbay tested for flight worthiness and the telemetry station configured for mission support. Full up support for the ASHCAN flight began on May 1, 1989. Two Get Away Special (GAS) experiments from Utah

State University and Brigham Young University were piggy backed on the ASHCAN gondola. The Get Away Specials were being space tested prior to scheduling on NASA's Shuttle program. The experiments were passive systems and PSL did not provide telemetry interfaces. A launch of the payload was attempted on May 9; however the balloon burst shortly after release from the launch arm and before payload release from the crane. The payload was successfully launched on the morning of May 10. The flight went according to plan, and the termination occurred about five miles north of Orogrande, New Mexico. The filters from the samplers were removed in good condition and sent to the laboratory in Washington, D.C., for analysis. PSL provided most of the support for the flight including recovery aircraft and telemetry.

2. ABLE III

Ten 3B622 batteries were filled for the ABLE III flight. The parachute and cabling were made flight ready. The telemetry stations were programmed to support the ABLE III flight.

The ABLE III prelaunch preparations were supported during the first half of September 1988. Preflight checks were conducted at Northrup on 8 and 9 September and the balloon was successfully flown on 15 September 1988. Ground recovery operations were supported following the flight. The recovery aircraft was on stand by for the flight but was not required during the recovery operation since the payload was recovered at WSMR about 4 miles west of the Northrup runway.

The flight data from the ABLE III flight was recovered from analog tapes, and digitized. The data was then put on TK50 tapes for Lt. M. Estes at GL in January 1989.

3. SCRIBE 88

The SCRIBE 88 prelaunch preparations were supported from about the 16 September 1988 until the project was canceled. All phases of preflight checks and integration were supported. The telemetry station was operated daily to provide real-time data displays and data recording.

The SCRIBE payload arrived at Holloman AFB on May 5, 1989. The Telemetry station was reconfigured for SCRIBE support and high bay testing was initiated. The payload was checked, batteries were filled and tested, and the high frequency communication system was repaired by R. Cowie (GL). An aircraft antenna was changed, and the University of Denver computer was interfaced to the telemetry room in preparation for the SCRIBE Flight. Weather problems caused the flight to be rescheduled every day from 17 May through 23 May. The payload was launched on 23 May shortly after midnight. A very successful flight was terminated south of Roswell, New Mexico. The experimenter recorded excellent data, the first they had received in two years.

4. Antarctic Pathfinder

Two Antarctic Pathfinder balloons were flight tested at Holloman AFB on November 2 and 3, 1988. PSL personnel supported the test flights with the launch crew and with preflight preparation. The additional Pathfinder balloons were flown on November 29 and 30, 1988. The Launch operation was video taped for the Air Force by a PSL technician. The ARGOS PTT's were not delivered in time to send to McMurdo for the Pathfinder program. Units from NASA/WFF/NSBF were borrowed for use and sent to Synergetics for certification in November 1988.

The units were certified by Synergetics and shipped to GL, Hanscom AFB, MA, along with five antennas in December 1988. Lithium batteries were also included in the shipment of equipment to McMurdo for the Pathfinder Project.

Help was provided to build ballast hoppers for Pathfinder balloon flights. Pathfinder balloons and parachutes were received.

Parachute and rigging work was conducted on the new Pathfinder Systems. The components were assembled into the Flight Trains for initial test flights. PSL assisted in the testing of the new Pathfinder tracking system. Battery packs for the sondes were installed. Pathfinder flights were supported on the following dates: H89-13 on 09/22/89; H89-14 on 09/23/89; H89-15 on 09/24/89; H89-16 on 09/26/89; H89-17 on 09/29/89; H89-18 on 09/30/89; and H89-19 on 09/30/89. New parts were fabricated for the ballast hoppers, and the launch arm was serviced for use on Pathfinder balloon launches.

C. TETHER BALLOON SUPPORT

1. SMARTV Project

In October 1988, the Telemetry Van was transported to the FAIR site at WSMR to support the SMARTV Project. The Van was made ready to support the command and data recording requirements. A Portable Telemetry System was programmed to provide backup telemetry, and real-time data displays for the SMARTV Project. Cement blocks used for anchors on a tri-tether system were also transported to the Fair site. Personnel traveled to Socorro, New Mexico, on October 11, 1988 in preparation of the flight support. The SMARTV tether was flown as Flight H88-10 from October 17 through October 20. The balloon was deflated on October 20, and then inflated on the October 23, as H88-11 for additional SMARTV Tests. The tether was deflated on October 29, 1988, and later inflated and flown as Flight H88-12 again in support of the SMARTV Project.

The operation commenced in November at the Fair site. PSL personnel provided the mooring crew, operated the Telemetry Van, and provided real-time control, commanding, and data logging. Testing was completed on November 23, 1988. The tethered balloon was recovered and all support equipment returned to Holloman AFB.

2. Lemoore Tether Support

Holloman activity during January was focused on preparation for a tether flight at the Lemoore Naval Air Station in California. The preparation activities included building a flight platform for the Navy instrumentation package, splicing Kevlar tether cables, charging batteries, preparing strobes, setting aneroids in the altitude chamber, waterproofing the EV-13 tether smart valves, and packing for the trip to California. A convoy of support vehicles left Holloman AFB on January 31, 1989, for the trip to Fresno, California. Joe Fumerola and Frank Candelaria drove in the convoy and remained for tether flight support.

The two above launch support technicians worked with the Air Force at Lemoore Naval Air Station to fly the tethered balloon. The tether balloon carried a Digital Scene Matching Area Correlator (DSMAC) package to altitude for study. This operation was conducted the first two weeks of February 1989.

3. Tethered Aerostat Antenna Program (TAAP)

Tethered Aerostat Antenna Program is a Navy operation being supported by GL. The support activity was provided at Holloman AFB during June and concentrated on system readiness for the TAAP. The TAAP was used in Hawaii during August to lift a 3000 ft antenna above ground. The system consisting of three (3) 30-40 ft trailers was made operational by GL engineers and PSL technicians. The Acceptance, Television, Telemetry, and pre-dress rehearsal were also accomplished. The tether balloon was test flown at Holloman AFB on June 27 and 31, 1989.

The TAAP system packing was completed and made ready to transport to Hawaii in July 1989. Joe Fumerola departed Holloman AFB along with the TAAP crew for Hawaii.

The Navy's first true test of a relocatable reconstitutable VLF broadcast system was conducted at Barking Sands, Kauai, Hawaii, in August 1989. This test (H89-12) using the Tethered Aerostat Antenna Program (TAAP), modified with a new transmitter and a two channel verdin system, successfully demonstrated ability to control both tactical and strategic submarines with a single relocate asset. The Aerostat broadcast was successfully copied throughout the Pacific Basin at San Diego, CA; Bangor, WA; Guam; Yokosuka, Japan; and by submarines at sea.

The TAAP trailers were unloaded following their return from Hawaii. Repair work began on TAAP mooring system in October 1989.

Work continued on general maintenance on the TAAP trailers. A fuel pump was replaced on the ONAN 8 kilowatt generator. Tool cabinets were added to the TAAP support trailer. Wire tracing and transformer testing were begun on the TAAP system to determine the cause of problems.

4. 45ILC Tether Balloon

PSL personnel supported the test flight of the 45ILC tether balloon (H8806) on 23 June 1988.

5. 19K Tether Balloon

The 19K tether test flight (H8807) was supported on June 27, 1988. The balloon and launch systems operated properly during the flight and were stored for probable use on a new program in the fall of 1988.

D. TRAVEL

Robert Woods traveled to Hanscom AFB to build a new balloon control package on June 13-30, 1988.

PSL Personnel traveled to Amarillo, Texas to pickup helium trailers following the hydrostat tests.

Roger Bramlett traveled to Hanscom AFB August 11-14, and August 16-20, 1988, to support the ABLE III high bay integration testing. PSL provided the computer and interface necessary for a high speed data transfer to the GL Micro-VAX System.

Frank Candelaria traveled to Amarillo, Texas, on August 5-6, 1988 to conduct a helium transfer operation.

PSL personnel traveled to Socorro, New Mexico, and remained on TDY Status from October 11, 1988 until the end of the month.

Frank Candelaria, Robert Woods, and Joe Fumerola traveled to Socorro, New Mexico for the SMARTV tether operation (GL) between November 1-11, 1988.

Ralph Reynolds and Charlie Houghton traveled to Albuquerque, New Mexico, for the Thermosonde launches (GL) between November 14-18, 1988.

Squire Seagraves participated in a planning meeting on the 22 and 23 of December at GSFC in Greenbelt, MD on a proposed Antarctic gamma ray experiment. The experiment is planned as a joint Soviet/American Operation in December 1991/January 1992 time frame.

Joe Fumerola and Frank Candelaria traveled to Lemoore Naval Air Station in Fresno, California, January 31, 1989, for 17 days in support of the Tether balloon launch.

Joe Fumerola departed on July 31, 1989, with the TAAP crew for Hawaii to support tether test flights in August.

Robert Woods traveled to Hanscom AFB on July 31, 1989, to work on the PCM III balloon control flight package.

E. TRN'S

TRN 21, Telemetry System Modification, was initiated on March 29, 1989.

TRN 21, Telemetry System modification, was closed April 12, 1989.

TRN 02, GRAD support; TRN 06, Full Time support; TRN 08 Programmer Support; and TRN 09, Flight support were closed effective June 30, 1988.

TRN 07, TM Full Time support; and TRN 10, Full Time support at Holloman AFB were opened in July 1988.

TRN 11, Antenna Fabrication, was opened in August 1988.

TRN 18, Launch Support, was initiated to support the Free Flight demonstration planned for December 1988.

TRN 14, Full time support, was extend through February 28, 1989.

TRN 14, Full time support, was extended through May, 1989.

TRN 23, SCRIBE support; TRN 24, Pathfinder Balloon System Support; and TRN 25, Telemetry Antenna Fabrication Support were initiated. TRN 14, Full time support, was completed in May 1989.

TRN 16, SMARTV support, was completed; and TRN 26, Full time support, was initiated in June 1989.

TRN 27, Stripline Antennas, was initiated in July 1989.

TRN 19, Project BEAR, was completed. TRN 28, Telemetry Station up grade, was initiated in August 1989.

TRN 18, Launch Support; and TRN 25, S-Band Antennas were completed September 30, 1990. The following TRN's were extended through December 10, 1989: TRN 22, Electronic Technician Support; TRN 26, Full time support; TRN 27, Stripline antennas; TRN 28, Telemetry station upgrade; and TRN 29, Additional BEAR Telemetry.

TRN 22, Electronic Technician support; TRN 26, Full time support; and TRN 30, Telemetry Station Documentation were closed effective November 1989.

TRN 13, ABLE III Support, was opened during August 1988.

TRN 17, was initiated to support data formatting and reduction task on the ABLE project in November 1988. TRN 17, ABLE Data Reduction, was completed on September 30, 1990.

TRN 12, SCRIBE 88 Support, was opened during August 1988.

TRN 23, SCRIBE support, was completed September 30, 1989.

TRN 24, Pathfinder support, was completed in September 1989.

TRN 21, SMARTV support, was closed effective March 31, 1989.

An amendment to extend the period of performance on TRN 16, SMARTV support, through June 30, 1989 in April 1989.

TRN 20, Lemoore Tether support, was initiated in January 1989.