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I. SUMMARY

The National Scientific Balloon Facility flew a total of 76 flights in FY 1975. Of these, 71 were in direct support of scientific research and 5 in support of the NSBF test and evaluation effort. These flights were for 50 scientific groups from 31 institutions and 5 countries.

While we flew only 4 flights from locations other than Palestine, the interest in these expeditionary flights remain high. We have received requests for flights from Canada, the northern U. S., Sicily, Brazil and Australia for FY 1976.

The overall success rate was 89.5%, the highest in the history of the NSBF. Balloon failures accounted for 5 of the failures, with electronics, operations and causes unknown each accounting for one failure.

Several other accomplishments are worthy of note. First, Flight 893-P for W. Lewin of M.I.T. marked the flight of the largest balloon ever flown, 1,489,452 M$^3$ (52.6 MCF). The next flight, 894-P for L. Heidt of NCAR, was the 1,000th flight flown by the NSBF. This includes 894 from Palestine plus 106 from other locations.

In the development field, the Long Duration Project is progressing satisfactorily. We are slightly behind our original schedule due to un-antitipated delays in negotiating key contracts. We have developed and tested a new balloon-destruct device and a radar reflective tape for balloon construction.

We note with regret the death of Dr. K. O. Kiepenheuer, Director of
the Fraunhofer Institut. Dr. Kiepenheuer was a good friend of the NSBF. He passed away quite suddenly during a visit to the observatory in Ensenada, Mexico.
II. OPERATIONS

FLIGHT SERVICES BY THE NSBF CREW

Seventy-two (72) flights were flown from Palestine, Texas, one (1) from North Battleford, Canada, one (1) from Watertown, South Dakota and two (2) from Sioux City, Iowa for a total of 76 flights. There were seventy-one operational flights and five (5) engineering flights.

We had a total of eight (8) failures, the nature of which were as follows:

- Balloons: 5
- Operations: 1
- Electronics: 1
- Unknown: 1

Balloons accounted for the majority of the failures. Each balloon failure was a different size balloon and they varied from 14,160 M$^3$ to 437,341 M$^3$. Three of the failures occurred on the launch pad and two on ascent.

The operations failure involved the parachute separation device. The motor command was activated when the package was at an altitude of approximately 3,000 feet. As the parachute with the gondola continued descending the beacon antenna came in contact with high power electric transmission lines which caused the squibbs to fire. This separated the gondola from the parachute prematurely and the gondola fell approximately fifty (50) feet and was severely damaged. The operational procedure has been changed in that the tracking pilot will not activate the motor
command unless the package is landing in a clear area away from power lines.

The electronics failure was due to the private line reed of the command receiver being incorrectly installed. This allowed the receiver to respond to all commands instead of only those specifically addressed to this flight. The flight was terminated prematurely; however, the package was recovered in good condition. Tone command receivers are now checked with both private line transmitters to prevent this type of failure. Also, in the near future PCM commands will be used entirely which will prevent this type of failure.

The unknown failure was due to premature termination. An extensive post flight investigation of all possible failure modes failed to reveal the cause of the premature termination. Two possible causes were (1) a spurious command and (2) a seam opening in the balloon since the descent started during the period of maximum solar heating. The PCM command system will greatly reduce the possibility of spurious commands.

Three (3) of the flights flown from remote locations were with balloons that varied from 441,800 M$^3$ to 735,698 M$^3$. One of the flights was flown from Canada to observe a rare lunar occultation of the Crab. Two of the flights were flown during the turn-around in the Northern part of the United States, one floated at 3.15 millibars for 46.4 hours and the other at 3.50 millibars for 56.3 hours.

Of particular note were two flights; the first had a payload of 3,028.6 Kgs which is the heaviest payload launched with the dynamic method. This flight floated at 6.0 millibars for 37.3 hours. The second
flight was the largest balloon ever to be launched. It was 1,489,516 M$^3$ in volume, had a payload of 1,462.8 Kgs and floated at 1.69 millibars for 13.3 hours.

The average payload weight which was 844.9 Kgs was a significant increase over the past two years. The 1974 average was 654 Kgs and the 1973 average was 797 Kgs.

The average balloon volume was 267,706 M$^3$ which was an increase of over 60,000 M$^3$.

The overall success rate was the best in the history of the NSBF. Of seventy-six (76) balloon flights the success rate was 89.5%.

**FLIGHT OPERATIONS IMPROVEMENTS**

Several tests have been made on a new balloon destruct device. In this system, the rip lines are taped to a gore to avoid any possibility of knotting or snarling when the balloon is fully inflated. The tests to date have been successful but further tests are required before we will declare the device operational.

A new radar reflective load tape was tested on Flight 892-P, 22 May. FAA radar tracked the balloon with outstanding results. Several more balloons are being procured with this tape for further evaluation.
ELECTRONIC IMPROVEMENTS

CONSOLIDATED INSTRUMENT PACKAGE

Ten (10) complete Consolidated Instrument Packages (CIP) were received in late October. One (1) complete package was assembled and successfully test flown on 12 June 1975. Temperatures were monitored at eight (8) places within the package and all remained within design limits.

Some very small modifications must be made to these packages and environmental tests of each package made before they will be placed in operation. We have also ordered spare on-board components for replacement of parts as they become damaged.

COMPUTER

An additional PDP/11 Computer has been placed on order. This computer will be utilized in one of the mobile telemetry and command stations. This station will be completed during the coming fiscal year to give full PCM data support and will be utilized to support field programs as well as a secondary check-out station here at Palestine.

AIRCRAFT TRACKING

The VHF L-Band tracking system has been installed in both aircraft and is considered to be fully operational. This not only provides tracking but also command verification and Rosemount altitude readout on board the aircraft.

TERMINATION PACKAGE

The new PCM command termination decoder design has been completed and
environmentally tested. This device was flown on several flights as a piggy-back for flight test. It is now being flown parallel with the tone termination decoder and will soon replace the tone system on all flights.
Figure 1. This chart shows how the NSBF balloon flight support has been distributed among the broad scientific disciplines.
<table>
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<tr>
<th>YEAR</th>
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<td>26%</td>
<td>19%</td>
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<td>9%</td>
<td>6%</td>
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<td>7%</td>
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<td>2%</td>
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<tr>
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<td>9%</td>
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<td>4%</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>UNKNOWN</td>
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<td>1.3%</td>
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</table>

Figure 2. The number of flights attempted by the NSBF operations crew from all locations and the percentage frequency of failures are shown by years in both the graph and the table. The table also provides a breakdown by failure type.
Figure 3. This graph shows the trend in average payload weight over the years.
Figure 4. This graph shows the average balloon volume flown over the years.
Figure 5. Balloon Volume Distribution for FY 1975 Flights

Figure 6. Payload Weight Distribution for FY 1975 Flights
The major activities of the engineering department in FY 1975 were directed toward the long duration ballooning development program. In other priority development programs such as extreme altitude and heavy load ballooning little work was accomplished because of major emphasis on long duration. However, other support programs involved in materials research and testing, balloon envelope stress analysis, balloon dynamics and scientific gondola thermal analysis were all continued from FY 1974.

Extensive work in nearly all these areas were performed at Texas A & M University. Additionally, other programs in support of the long duration development were performed on a sub-contracted basis along with our own in-house research capabilities.

These programs and associated support efforts are discussed in the following sections.

LONG DURATION BALLOONING DEVELOPMENT PROGRAM

NSF funding for development of a long duration ballooning capability began in FY 1975. This effort, called Project Boomerang, consists of two parallel efforts, development of the balloon vehicle and development of supporting electronic systems. Two engineers were added to the staff to aid in this program. I. Steve Smith, Aeronautical Engineer, was hired for assistance in vehicle development and Mallik Putcha, Electronics Engineer, hired to assist in the electronics development.

A steering committee was formed (reference Committee Section of this Report) to advise the NSBF in this program. A formal meeting was held in Chicago on 18 April 1975. Both major study and design subcontractors,
G. T. Sheldahl and Raytheon, made presentations to the committee. In addition, separate meetings without sub-contractors present were held in Washington, D. C. on 19 May 1975 with Dr. Jim Kurfess and Dr. Glenn Frye and in Tuscon with Dr. W. Hoffman on 17 June 1975.

Development of the balloon vehicle in FY 1975 consisted primarily of a major sub-contracted design and development program; planning and design of instrumentation for a balloon test flight and computerized reduction of the flight data.

The electronics effort during FY 1975 concentrated on a system definition study with a secondary effort in the design of instrumentation for superpressure balloon test flights.

Accomplishments in these areas are outlined in the sections below:

1) Vehicle Development

   a. Design & Development Program

       In January of 1975, a contract was awarded to G. T. Sheldahl Co., for study, design and development of the Long Duration Platform (LDP) vehicle. Areas of effort included 1) materials testing, evaluation, availability, cost and selection; 2) balloon shape, considering stresses and stress patterns, ease of manufacturing, size vs weight and cost; 3) finite element analysis, both macro-structure and micro-structure; 4) thermal balance and float stability; 5) component tests and 6) overall cost trade-offs.

       A meeting was held at the contract start to define the basic objectives and design parameters, problem areas, approaches to problem solving and interaction between all individuals and
organizations involved in the LDP development. The following parameters were set at the meeting:

1. Design Payload - 227 Kgs (500 lbs)
2. Design Altitude - 39.6 Km (130,000 ft) (3 Mbs)
3. Float Duration - 100 days
4. Float Stability - ± 0.5 Mbs
5. Launch Method - Dynamic preferred but final determination to be made after design is complete.
6. Launch Conditions - + 50° C to - 20° C
   Assume 2g load at balloon base
7. Storage Temperature - + 75° C to - 40° C
8. Ascent Conditions - - 80° C temperature. 3.5 to 5 m/sec ascent rate. Ballast must be supported throughout ascent.
9. Inflation Fitting - 12 - 25 cm diameter, 2 required
10. Destruct System - 2 required

The program is divided into two phases, consisting of a preliminary design and study phase and a final design phase including drawings and specifications. During FY 1975 the first phase was completed and the second phase work initiated. A material and configuration were selected as a result of the Phase I effort and further testing of the material and detailed analysis of the configuration and components will comprise the majority of Phase II work. The following major areas of study were undertaken in Phase I.
Materials - The overall design relationships for this development are shown in Figure 1. It is clear from a brief study of these relationships that knowledge of daytime/nighttime temperature excursions and balloon leakage are keys to the material strength (and hence size) required. Material selection appears therefore to be the key ingredient in development of the LDP. In fact, other factors of shape, components and launching are determined, in part, by material selection.

A number of different materials were evaluated, both individually and in combination, including; films of polyester, polyethylene, nylon and Tedlar and scrim yarns of Dacron and Aramid (Kevlar). Crack growth and propagation of films were investigated using fracture mechanics/critical crack growth analysis and diaphragm crack testing. Both room and cold temperatures and constant strain rate and creep conditions were used in the investigation which revealed an apparent need for a rip-stop material and also a means of reducing stress in the film. Scrim reinforcing was one obvious solution to these problems.

A number of outdoor weathering and accelerated ultra-violet tests were made on both fibers and films. It was learned that apparently there is no known relationship between accelerated and outdoor ageing. All results to date, using both techniques, indicate a requirement for a UV barrier to protect both film and scrim. A layer of vacuum deposited aluminum serves this
Figure 1 -

LONG DURATION PROGRAM DESIGN RELATIONSHIPS
purpose and will be utilized on the test vehicles until further degradation information is available.

A second problem of utmost concern to the success of this program is the obtaining of accurate measurements of $\alpha$ and $\varepsilon$ of various materials. The accuracy of daytime/nighttime skin and helium excursions is determined by the accuracy of these measurements. Further laboratory tests and actual flight tests of model spheres are being conducted to improve this accuracy. An additional unknown input is that of earth albedo as the balloon passes over varying ground conditions. Maximum, minimum and average values were assumed from the best possible data available and a study of balloon sensitivity to albedo was performed.

As a result of hundreds of separate calculations it was shown that a Kevlar scrim on a 13 micron polyester film resulted in the least amount of stress in the film and the smallest, and hence least costly, vehicle. Figure 2, illustrates the selected composite material.

Configuration - Computerized balloon design calculations were made by Justin Smalley of RSF on four (4) shapes; spherical, natural shape, natural shape round top, and sphere-on-cone. Comparisons of these data narrowed the selection to spherical and natural shape round top. Finite element analysis was then performed on these two configurations. Four load introduction schemes on the spherical shape
COMPONENTS:
- 6.35 μm Polyester
- 2000 Å Vapor Deposit Aluminum
- 3.8 μm Adhesive
- 6.35 μm Polyester
- 400 d. Aramid yarn, adhesive coated

WEIGHT: 32.39/m²

Figure 2 -

LONG DURATION PROGRAM MATERIAL SELECTION
were analyzed along with the round top analysis. All appeared feasible from a stress-standpoint, but the round top was chosen for its simplification of both manufacturing and launching.

Trade-off Studies - Trade-offs of various combinations of films and fibers were made to determine balloon size and cost vs skin stress, yarn size and spacing. Both an average and extreme environment were considered. The results of these trade-offs showed the combination of Kevlar/polyester to be superior. Figure 3 illustrates balloon size vs material combinations for average and extreme environments. This chart, in combination with costing, yarn size and yarn spacing graphs resulted in the selected material shown in Figure 2.

b. Associated Programs - Vehicle Design

Dynamics - A computer program previously written for calculating thermal balance of zero-pressure polyethylene balloons was changed significantly and utilized for superpressure balloons. Dr. Jan Kreider of Environmental Consulting Services, Inc., (ECS), the originator of the program, accomplished these changes to evaluate various balloon materials and sensitivity of the vehicle to external influences. Changes to the program included 1) addition of the use of a tow balloon; 2) revised calculation method for simultaneous solution of non-linear differential equations in the program; 3) addition of balloon stress calculations; 4) capability to examine altitude change due to volume change if \( \Delta P \leq 0 \); 5) revised
Superpressure balloon diameter vs film stress for various combinations of materials with UV screen. Yarn size and spacing vary with film stress.

Figure 3 -

LONG DURATION PROGRAM BALLOON SIZE
atmospheric temperature tables; 6) change in albedo with changing declination angle or reflective earth surface;
7) examination of cloud temperature and its influence on black ball temperature.

Using this revised program, comparative calculations were made for vehicle super-temperatures in previously flown superpressure balloons and planned test flight designs. Influence of seasons of the year, albedo, film modulus, balloon size, $\alpha/\varepsilon$ radiometric film properties and black ball temperature on balloon daytime/nighttime superpressure, rate of rise and float stability were determined. Altitude fluctuations were calculated including new float altitude if the balloon superpressure becomes equal to or less than zero.

Through a coordinated effort with the Sheldahl design program, ECS has calculated the balloon dynamics for selected films and provided guidance to Sheldahl in their computations. Further test flights will provide calibration points for the model enabling some refinement to the program. Also, increased accuracy in determination of film radiometric properties and albedo and black ball values will improve the reliability of the computed results.

Material Testing - Through the use of the balloon film testing laboratory at Texas A & M University (TAMU), various LDP materials and load patches have been tested. This work was
accomplished by Dr. L. Dale Webb with assistance from Dr. James Noel in support of both the Sheldahl program and the NSBF test flights and in-house research.

A mutilation tester was devised and just recently put into operation to evaluate and compare various films under a wrinkled/unwrinkled loading pattern for pin-hole resistance. A number of polyester films, both laminated and unlaminated are currently being tested, along with a nylon film and reinforced polyethylene. Additionally, film samples with various designs of load patches are also being compared for tear resistance under cold temperatures.

Using a 112 cm circular diaphragm tester, simulated gore segments with load patches or other components attached have been tested for strength and stress distribution under varying temperatures. A newly designed load patch is currently being evaluated with this apparatus.

In addition, tests using a standard tensile tester were performed to determine uniaxial film modulus and modulus change with changing strain rate and temperature. Biaxial creep tests of polyester and nylon films were also conducted. The nylon film exhibited a variable stress/creep relationship indicating a problem area with this film. Further tests and studies will be made on the nylon to determine more accurately the creep characteristics.

Balloon Design - Dr. James Rand of TAMU developed a finite
element analysis program to calculate stresses on selected portions of a balloon envelope. It has been used primarily to investigate the stress field around a superpressure balloon load patch. Using this technique, a number of different load patch configurations have been analysed. Stresses were also computed for balloons used on test flights for comparison purposes.

Another phase of the design work at TAMU involved overall stress analysis of various sizes of spherical superpressure balloons fabricated from a range of material thicknesses. Stresses caused by both superpressure and payload weight were superimposed and a total theoretical stress distribution over the entire surface of the balloon was calculated.

c. Test Flight - 56.8 M Sphere

1. Planning & Preparations

As an intermediate step toward the goal of supporting a 227 Kg payload at 39.6 Km, a 56.8 M polyester superpressure spherical balloon was purchased, designed to carry a 147 Kg payload at 36.6 Km. The main purpose of the flight was to measure as many physical parameters as feasibly possible that might affect the balloon performance during flight. This was done through skin-mounted strain gauges and thermistors, up-cameras, helium and air temperature measurements and load line stresses.

The plan called for an early morning launch, float at
36.6 Km and termination 2 hours after sunset (approximately 12 hours after launch). Instrumentation included the following:

<table>
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<th>ITEM</th>
<th>QUANTITY</th>
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<tr>
<td>Balloon skin temperatures</td>
<td>9</td>
</tr>
<tr>
<td>Balloon helium temperatures</td>
<td>5</td>
</tr>
<tr>
<td>Air temperature (1000' below balloon)</td>
<td>2</td>
</tr>
<tr>
<td>Skin strain gauges</td>
<td>6</td>
</tr>
<tr>
<td>Load patch strain gauges</td>
<td>8</td>
</tr>
<tr>
<td>Load line strain gauges</td>
<td>122</td>
</tr>
<tr>
<td>Balloon pressure, differential</td>
<td>1</td>
</tr>
<tr>
<td>Ballast load cell</td>
<td>1</td>
</tr>
<tr>
<td>Black ball and net radiometer</td>
<td>3</td>
</tr>
<tr>
<td>Up-Cameras</td>
<td>2</td>
</tr>
<tr>
<td>Various component temperatures</td>
<td>3</td>
</tr>
<tr>
<td>Various voltage monitors</td>
<td>6</td>
</tr>
</tbody>
</table>

To achieve these measurements new equipment designs were accomplished and component studies made. A special thermistor bead was purchased and special circuitry designed to optimize read-out accuracy and negate the effect of self-heating in the thermistors. A base end fitting was designed and fabricated capable of retaining the 122 load lines from the balloon. The design allows read-out of the stress on each line nearly continuously throughout the flight. A complete calibration was made of the fitting after
lines were installed. Testing showed read-out capability within ± 1 lb.

A special instrumentation package was specifically designed for the flight. It included signal conditioning circuits for thermistors and strain gauges, a ballast load cell, and a differential pressure gauge to monitor balloon superpressure. The package was designed with considerable redundancy and was thoroughly tested prior to the flight to insure that reliable data would be obtained. All systems performed well during the flight and provided excellent data even though the balloon did not reach float altitude. The package was recovered undamaged and will be available for support of future tests.

2. Flight and Data Analysis

The test flight was conducted on 15 April 1975. Inflation, launch and early stages of ascent were relatively smooth. At an altitude of 12.6 Km the ascent rate slowed and the balloon leveled off at 13.3 Km. By dropping ballast and cutting the tow balloon an altitude of 15.5 Km was achieved. All ballast was expended at that time and the flight was terminated. The package was recovered undamaged. Also recovered was the base fitting with the complete skirt and load patches attached and the rosemount balloon pressure package tied to the skirt. Various sections of the balloon were recovered including two (2) undamaged internal thermistors, internal patches and lines and envelope strain gauges.
Excellent thermistor, strain gauge and load line data was obtained. Initial data reduction and analysis was made based on data obtained as a "real-time" print-out from the NSBF PDP 11/20 computer. Thorough detailed reduction of the digital data to graphical form was begun utilizing the NCAR 7600/6600 computer. All main frame and sub-frame data was reduced and then "de-spiked" and smoothed.

Analysis of the plotted data reveals rapid loading/off-loading of the load lines during the launch process. Definite shifting of the load patterns around the balloon was found. Most important however, is the complete off-loading of at least two (2) lines during the latter portions of the flight, indicating a pulled out patch. The thermistor data (skin, helium and air temperatures) followed predicted patterns almost perfectly. The air thermistors followed exactly the data obtained from a radiosonde flight launched shortly after the sphere was launched. A full report on this flight will be available in the near future.

2) Electronics Development

a. System Definition Study

A Request for Proposals was issued in September which defined the requirements for electronic support systems on long duration balloon flights. The RFP requested proposals for a system definition study which would investigate possible approaches that could meet these requirements and for the preparation of a system
specification which would define the equipment necessary to configure such a system.

The requirements consisted of four major areas; data acquisition, balloon tracking, telecommand, and power, with an overlapping requirement for the establishment of a reliable link between orbiting balloons and earth tracking stations. The detailed requirements had been established as a result of a survey of the scientific ballooning community.

Five proposals were received and after extensive evaluation the subcontract was awarded to Raytheon Company, in Sudbury, Mass. NSF approval was obtained during January and the study effort began in early February.

During early discussions with Raytheon it was decided that two approaches should be considered for communication between the balloons and earth stations; a high frequency (HF) radio link and relay via a synchronous satellite. The two approaches were to be considered independently so that comparisons could be made. A subcontract change was issued to add the satellite study.

Review meetings held at Raytheon in March and April included presentation of preliminary results of the HF propagation analysis. These results indicated that a fairly complex system would be required if the specified data acquisition reliability was to be obtained.

Raytheon submitted an interim report on 7 May covering their
analysis and recommendations for possible long duration electronics systems. The report included a description of the analysis techniques, examples and summaries of the results, and recommendations for implementation of a system.

An HF system which meets our requirements will require the following capabilities and techniques:

- A power-gain produce of 26 dBW
- Modulation technique which accommodates multipath
- Dual Diversity
- Forward Error Correction Coding
- 12 Frequency authorizations covering HF band
- A minimum of 6 ground stations
- Quiet locations for ground stations

Several options were presented in the hardware descriptions from which we can select a configuration to meet our budget and requirements.

The coverage of possible satellite systems was not as complete as the HF section because of the limited time available for that part of the study. Several candidate systems were analysed however, and the results showed that the MARISAT system is the most promising. The most difficult problems to overcome are obtaining authorization to use the satellite frequencies and the impact of antenna orientation on scientific gondola pointing stability. If these problems can be overcome, it appears that this approach could be implemented for considerably less money than an HF system.
although long term operating and maintenance costs would balance the two approaches out at close to the same level.

During a review of the interim report it was established that minimum reliability specifications could possibly be met with only four HF ground stations instead of six. This would have a significant impact on the acquisition and operating costs of such a system.

After reviewing the interim report and discussing it with the steering committee it has been decided to postpone a final decision on the electronics development until further study of the possible use of a satellite relay has been completed. This approach appears to be in the best interest of the program for the long term and it was endorsed by all members of the committee.

Raytheon has been instructed to complete the system specification for an HF approach and it should be completed by early July. Investigations are underway to determine whether authorization can be obtained to use the MARISAT system on an experimental basis until the NASA-TDRS satellite system becomes operational around 1980.

A fall-back system utilizing a reduced capability HF link will be available for early flights should problems arise in establishing the satellite system at an early date. Systems common to both approaches such as the Transit Tracking System will be developed as independent sub-systems and can be utilized either way. This approach will allow us to support some flights as soon as the
balloon vehicle is ready and will hopefully provide the support required by all scientific groups when the TDRS is available.

BALLOON MATERIALS AND QUALITY CONTROL

Texas A & M University (TAMU) - In addition to the material testing performed in support of the long duration project, testing of other balloon materials continued, along with development of new apparatus. A materials testing index was completed and will be published early in FY 1976. Samples of film from three balloon failures were tested on the race-track. No deterioration in film or seal quality was found. New polyethylene and copolymer films were also race-track evaluated to determine whether they were suitable as balloon films. Several promising candidates are undergoing further testing.

New apparatus completed in FY 1975 included the previously discussed mutilation tester. It is actually a 'clefting tester' in that a tube of material is pressurized in a bent configuration, thereby forming a cleft in the underside of the tube, and is then rotated to cause the cleft to rotate around the tube. An environmental chamber for this device controls temperature from + 50° C to - 120° C ± 1° C. A twisting and crushing film tube tester was also fabricated and experimented with as a mutilation tester. The prototype of a production model multi-station race-track diaphragm tester was built and tested. It permits 3 tests to be conducted every 8-10 minutes compared to the one test every half-hour rate with the single station tester. The large (112 cm) diaphragm tester was built and used in the long duration program as described previously. An environmental chamber
for this tester will control temperature within \( \pm 2^\circ \text{C} \), from \(+ 30^\circ \text{C}\) to \(- 100^\circ \text{C}\).

Biaxial and uniaxial tests of oriented nylon film were conducted to investigate creep properties. Discrepancies in the results require further work to be done in FY 1976.

Nylon Material Evaluation - An interim report was submitted by Raven Industries, Inc., discussing test results on a biaxially oriented nylon film. Discrepancies in results were found in the creep characteristics similar to those found at TAMU. Tests comparing varying regions of a single film web will be run in FY 1976 along with roll to roll comparison. Water absorption tests are complete including tensile, elongation and weight changes. These factors all appear fairly insignificant in the vehicle design process.

Poly + - Dacron scrim reinforced polyethylene (Poly +) material manufactured by Sheldahl Inc., was sent to CNES/Zodiac 'Espace for fabrication into a balloon envelope. Under separate agreement with CNES, a 990 M³ balloon was fabricated and shipped to Sheldahl. Inspection of the film, both by Zodiac and Sheldahl revealed a large number of small holes in the film. It was determined that these were caused by blocking of the adhesive from one layer of film to another. The problem can be solved in future material by a slight change in adhesive and curing. End fittings were designed and one set pull tested. A second set will be installed in the balloon, the majority of the holes patched and a final inspection performed. The balloon will then be ground inflated and pressurized to failure to evaluate seals, fittings, fabrication techniques, and usable strength of material in a fabricated structure.
In addition to all of the aforementioned projects, Texas A & M University (TAMU) personnel have been involved in the following programs in support of our engineering programs:

- Consultant/Advisor on all phases of the Long Duration Program

- Beginning analysis of critical flaw size vs stress relationships in plastic films.

- Calculations of thermal insulation requirements for approximately 10 scientific gondolas.

- Presentation of the following papers at the 8th AFCRL Scientific Balloon Symposium:
  

**COMPUTER AND DATA SYSTEM**

A Digital Equipment Corporation Model LA 30 Decwriter was installed with the DEC PDP-11 computing system to replace the ASR 33 Teletype as an input/output terminal. A BM 873 Restart Loader was also installed as part of the computer hardware. This equipment has greatly enhanced the
operation of our digital data system by increasing the speed of operation and reducing noise. The RK 11, 1.2 megaword movable head disk and the expanded core memory, installed in FY 1974, has greatly increased the system utility.

The RK 11 disk, with its large storage capacity, can store many system utility files and operation programs. Fortran programs have been written for independent operation and some users have utilized Fortran for flight programming. The removable disk cartridge capability allows users to bring their own flight or data analysis programs to use with the NSBF system.

Several computer programs have been developed by NSBF for generating digital computer tapes for final data analysis at the users facility and for real-time presentation of flight performance parameters of the scientific instrument. Special programs were developed for unusual bit-stream formats and minor data analysis presentation. Some utility programs for digital tape handling are being developed.

Assistance with program and computer operation was provided Massachusetts Institute of Technology, Ballistics Research Labs, University of California at Riverside and University of Chicago. These organizations provided their own computer software for special analysis requirements.

The computer was used in supporting 34 flights during the year.
IV. **ADMINISTRATION**

**PERSONNEL**

The staff of the National Scientific Balloon Facility on 30 June 1975 consisted of forty-seven (47) full-time employees and one (1) part-time employee. Two of the full-time positions are for engineers working in the Long Duration Balloon Development Program. The full-time staff allowance is classified as follows:

<table>
<thead>
<tr>
<th>Position</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>6</td>
</tr>
<tr>
<td>Clerical</td>
<td>(5\frac{1}{2})</td>
</tr>
<tr>
<td>Engineers</td>
<td>6</td>
</tr>
<tr>
<td>Guards</td>
<td>3</td>
</tr>
<tr>
<td>Machinist</td>
<td>1</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1</td>
</tr>
<tr>
<td>Mechanic</td>
<td>1</td>
</tr>
<tr>
<td>Meteorologists</td>
<td>2</td>
</tr>
<tr>
<td>Pilots</td>
<td>2</td>
</tr>
<tr>
<td>Technicians</td>
<td>20</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>(47\frac{1}{2})</td>
</tr>
</tbody>
</table>

The Minority Technician Training Program that was established at the NSBF on 3 September 1973, ended on 30 June 1975. All three (3) of the Black Technicians in the program had job offers for employment outside NCAR when they finished their training.

Staff changes for the period 1 July 1974 through 30 June 1975 were as follows:

1. *22 July 1974* - Andres Flores resigned as a temporary summer employee (student) in the Machine Shop, to take a full-time job.

2. *29 July 1974* - Theresa Smith resigned as a temporary summer
employee (student) doing clerical and typing assignments, to return to college.

3. **29 July 1974** - Patsy Rohne was hired as a part-time clerk-typist in the Administration Department.

4. **1 August 1974** - Don Brooks was reassigned from Shop Supervisor, Electronics Shop, to Supervisor, Electronics Section.

5. **1 August 1974** - Michael King, Sr. Electronics Technician was reassigned to Shop Supervisor, Electronics Shop.

6. **1 August 1974** - Earl Smith was reassigned from Supervisor Electronics Section, to Special Assistant (to Robert Kubara) for Electronic Systems.

7. **1 August 1974** - Mack Gore was reassigned from an engineering position in the Engineering Department to the Operations Department as Special Assistant (to Robert Kubara) for Mechanical Systems.


9. **3 August 1974** - Bert Ricard was hired as a Casual Security Guard in the Administration Department.

10. **12 August 1974** - Raymond Musick was hired as a Temporary Balloon Technician.

11. **16 August 1974** - Gerald Hooks was terminated as a Plant Maintenance Engineer in the Operations Department.

12. **20 August 1974** - Cortney Henning completed a two (2) week assignment in the Machine Shop as a temporary machinist.

13. **25 August 1974** - Art Gusa was reassigned from Administrative Assistant in the Administration Department, to Plant Maintenance Engineer in the Operations Department.

14. **25 August 1974** - Alice Cradler was promoted from Secretary to Administrative Assistant in the Administration Department.

15. **26 August 1974** - I. Steve Smith, Jr., was hired as a Balloon Development Engineer in the Long Duration Balloon Development Program.

16. **3 September 1974** - Joan Cruse was hired as a Secretary in the Administration Department.
17. 16 September 1974 - Mallik Putcha was hired as a Communications Engineer in the Long Duration Balloon Development Program.

18. 21 October 1974 - Spencer Petri was hired as an Electronics Technician.

19. 25 October 1974 - Raymond Musick completed his assignment as a Temporary Balloon Technician.

20. 1 January 1975 - Virgil Vice was promoted to Electronics Technician III (Non-exempt Range 22).

21. 1 January 1975 - Theo Johnson was promoted to Electronics Technician III (Non-exempt Range 22).

22. 1 January 1975 - John Sparling was promoted to Electronics Technician III (Non-exempt Range 22).

23. 8 January 1975 - Mary Nash resigned as a Casual Clerk-Typist to seek full-time employment.

24. 1 May 1975 - Randall Brown was hired as a Temporary Balloon Technician.

25. 16 May 1975 - John Jackson resigned as a Weather/Observer/Rawinsonde Operator Trainee, to accept full time employment in Rusk, Texas.

26. 30 June 1975 - Herman Bell, Electronics Technician Trainee, completed his training period and accepted full time employment elsewhere.

27. 30 June 1975 - Norman Lincoln, Engineering Technician Trainee, completed his training period and accepted full-time employment elsewhere. Messrs. Jackson, Bell and Lincoln worked under a Minority Technician Training Program that was established at the NSBF in September 1973.

FUNDING

Continued Operations funding in FY 1975 was $1,072,000. The add-on increment for Long Duration Development was $600,000. The NSBF also received $100,000 from NASA Headquarters for Research and Development.

The FY 1975 Continued Operations Budget for the NSBF on 30 June 1975
is broken down as follows:

<table>
<thead>
<tr>
<th></th>
<th>SALARIES</th>
<th>SUPPLIES</th>
<th>SERVICES &amp; EQUIPMENT</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Administration</td>
<td>$164,239</td>
<td>$ 78,025</td>
<td>$ 242,264</td>
<td></td>
</tr>
<tr>
<td>2. Engineering</td>
<td>64,581</td>
<td>574</td>
<td>65,155</td>
<td></td>
</tr>
<tr>
<td>3. Operations</td>
<td>486,987</td>
<td>254,598</td>
<td>741,585</td>
<td></td>
</tr>
<tr>
<td>4. Safety &amp; Standards</td>
<td>21,749</td>
<td>1,847</td>
<td>23,596</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>$737,556</td>
<td>$335,044</td>
<td>$1,072,600</td>
<td></td>
</tr>
</tbody>
</table>

**COMMITTEE MEETINGS**

Two meetings of the NSBF Advisory Panel were held during the year. In addition, one meeting of the Operations and Development Sub-Committee was held.

The Sub-Committee met in Palestine on 30 July 1974. This report was approved at the meeting of the Panel on 15 October. This report specifically commended the NSBF on the zero-failure rate in electronics during the past year.

The fall meeting of the Panel was held at M.I.T. on 15 October 1974. The main item of business was the NSBF five Year Plan. Many useful suggestions were offered and the plan approved.

The spring meeting was held at NCAR in Boulder on 15 March 1975. Two new members attended for the first time, Dr. D. Murcray of the University of Denver, and Dr. R. Golden, NASA-JSC. They replaced Drs. Mantis, Reiter and Hemenway whose terms had expired.

The major business was the role of the Panel. Dr. Bretherton met with
the Panel during the morning session. The role of the Panel was described as reviewing the operations of the NSBF and assisting NCAR, UCAR and the NSF in long range planning and relations with the community. The Panel reports to the Director, ATD.

OTHER MEETINGS

The NCAR Review Panel for the NSBF met in Palestine on 22-23 April 1975. The Panel members were Dr. W. Webber, Chairman, Dr. N. Boggess, Dr. A. Buffington and Dr. H. Schiff.

A meeting of the Scientific Ballooning Association was held during the annual AFCRL Balloon Symposium on 3 October. It was decided that the association had an important role to fill and should be continued. Shipley was elected President.

A Long Duration Development Steering Committee was appointed to advise on problems of the developments. The members are Drs. J. Kurfess, NRL, W. Hoffman, Steward Observatory, University of Arizona and Glenn Frye, Case Western Reserve University. The work of this committee is reported under the Long Duration Section.
V. SAFETY AND STANDARDS

SAFETY

An aggressive safety program was continued in FY 1975. Monthly inspections and meetings were conducted. More than 100 safety related actions were taken during the year.

FAILURE AND MALFUNCTION INVESTIGATIONS

The policy of the facility to fully investigate all flight failures and malfunctions was actively pursued. As a result, some new operational procedures have evolved and increasing attention is being directed towards improved quality control practices.

STANDARDS

A comprehensive set of standards has been established for a preventive maintenance program for electronic equipment, and for motor vehicles, mechanized and rolling stock equipment. All scheduled inspections and maintenance requirements are identified, responsibilities are defined, all discrepancies are noted, and a record of corrective action is maintained. The activities and responsibilities of the motor vehicle section have been greatly expanded. As a result of these actions it is anticipated that equipment breakdowns and outages, both minor and major, will be significantly reduced.
VI. BASE DEVELOPMENT

FACILITIES

A seal coat was put on the new launch pad in order to seal the surface from water penetration and reduce on-the-surface temperature. The seal coat consists of a coating of asphalt covered with crushed rock. This work was performed by E. W. Hable and Sons, Inc., constructors of the pad, at a cost of $30,000. The work was completed in October, 1974.

Taking advantage of the availability of equipment, we contracted with E. W. Hable to apply a temporary seal coat to the parking area adjacent to the office and shop areas. This parking area is still deteriorating and should be entirely redone in the near future.

A contract has been signed for the extension of the back bay. This will add 6.1 meters to the existing structure. This work will commence in the near future.

A second Stratoport has been obtained from NASA. It was located at Marshall Space Flight Center and used for the last Stratoscope flights. A contract has been let for the construction of the concrete pad and power lines have been laid to the site. It will be situated to the north of the access road to the new pad.
VII. PLANS FOR FY 1976

The NSBF will continue to offer both engineering and operational support to all authorized scientific groups. We expect the total number of flights to be between 85 and 90. We expect an increase of the large volume, heavy payload experiments along with an increasing number of smaller but very sophisticated experiments.

Our remote operation capability will be improved with the addition of a second mobile telemetry and command station during the year. This station will be completely compatible with the present Palestine ground station, including a PDP 11 computer. This second station will also prove most valuable as a scientific check out station during the long turn-around period.

We will fly six to seven flights from Canada during July and August. An expedition to Brazil for November has been proposed. An expedition to Australia in the spring is also under consideration.

A new contract for aircraft lease has been written that will give us both a Cessna 401 and 310 during the year. The 401 is both larger and super-charged and will allow us to provide better down range support. The 310 is marginal due to the increased electronics load required aboard the plane.

The development effort will again be devoted almost exclusively to the long duration program. Prototype balloons will have been designed, built and tested. The ground electronics will have been designed but procurement of the prototype station may be deferred due to lack of funds.
Staging space for scientific experiments will remain a problem. Funds have been requested in FY 1977 budget for a new staging building. Design for this building is planned in FY 1976.
<table>
<thead>
<tr>
<th>Flight Number</th>
<th>Date</th>
<th>Experimenter &amp; Organization</th>
<th>Type of Experiment</th>
<th>Balloon Volume (M³)</th>
<th>Gauge &amp; Material</th>
<th>Manufacturer</th>
<th>Payload Weight (Kgs)</th>
<th>Float Time (Hrs)</th>
<th>Pressure Float Alt. (MB)</th>
<th>Flight Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>835-P</td>
<td>11 July</td>
<td>V. Schonfelder, Max-Planck Institute</td>
<td>Gamma ray telescope in the energy range 1-10 MeV</td>
<td>569,453</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>901.7</td>
<td>6.0</td>
<td>2.51</td>
<td>Success</td>
</tr>
<tr>
<td>836-P</td>
<td>17 July</td>
<td>D. Ramsden, Univ. of Southampton</td>
<td>Study of the low energy gamma ray spectrum of the Crab Nebula</td>
<td>329,213</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>703.3</td>
<td>5.4</td>
<td>3.40</td>
<td>Success</td>
</tr>
<tr>
<td>837-P</td>
<td>22 July</td>
<td>K. Griesen, Cornell University</td>
<td>Large size (100 inch diameter) high energy gamma-ray telescope</td>
<td>587,882</td>
<td>20.32 µ Poly</td>
<td>Winzen</td>
<td>2089.3</td>
<td>6.2</td>
<td>4.66</td>
<td>Success</td>
</tr>
<tr>
<td>838-P</td>
<td>23 July</td>
<td>F. Low, Univ. of Arizona</td>
<td>Low background far-infrared telescope to study galactic center region and other bright sources</td>
<td>14,160</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>220.0</td>
<td>9.3</td>
<td>18.0</td>
<td>Success</td>
</tr>
<tr>
<td>839-P</td>
<td>24 July</td>
<td>P. Richards, Univ. of California/Berkeley</td>
<td>A liquid helium spectrometer used in measurement of the sub-millimeter radiation spectrum coming to the earth</td>
<td>329,213</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>608.3</td>
<td>4.0</td>
<td>3.0</td>
<td>Success</td>
</tr>
<tr>
<td>840-P</td>
<td>31 July</td>
<td>E. Chupp, Univ. of New Hampshire</td>
<td>Large shielded gamma ray telescope (0.1-10.0 MeV) used to measure gamma rays from celestial bodies</td>
<td>299,452</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>792.5</td>
<td>4.6</td>
<td>4.0</td>
<td>Success</td>
</tr>
<tr>
<td>841-P</td>
<td>12 August</td>
<td>W. Hoffman/L. Lenke, Max-Planck Institute</td>
<td>Near infrared observation of Milky Way, zodiacal light, galactic center, and OH airglow</td>
<td>26,621</td>
<td>38.10 µ Poly</td>
<td>Winzen</td>
<td>586.9</td>
<td>21.0</td>
<td>10.1</td>
<td>Success</td>
</tr>
<tr>
<td>842-P</td>
<td>13 August</td>
<td>R. Weiss, MIT</td>
<td>Measurement of isotropy of the cosmic background radiation in the spectral region embracing the blackbody peak</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>553.9</td>
<td>5.2</td>
<td>2.35</td>
<td>Success</td>
</tr>
<tr>
<td>843-P</td>
<td>22 August</td>
<td>D. Wilkinson, Princeton Univ.</td>
<td>To measure the anisotropy of the cosmic background radiation</td>
<td>14,160</td>
<td>23.40 µ Poly</td>
<td>Raven</td>
<td>284.9</td>
<td>6.6</td>
<td>22.3</td>
<td>Success</td>
</tr>
<tr>
<td>844-P</td>
<td>4 Sept</td>
<td>N. Olson, NCAR/GISP</td>
<td>Test flight carrier balloon system</td>
<td>14,160</td>
<td>23.40 µ Poly</td>
<td>Raven</td>
<td>194.6</td>
<td>7.1</td>
<td>18.3</td>
<td>Success</td>
</tr>
<tr>
<td>845-P</td>
<td>6 Sept</td>
<td>L. Lenke, Max-Planck Institute</td>
<td>Far infrared telescope for a survey of the Milky Way for bright sources longer than 50 microns</td>
<td>56,634</td>
<td>23.40 µ Poly</td>
<td>Winzen</td>
<td>548.4</td>
<td>8.0</td>
<td>10.5</td>
<td>Success</td>
</tr>
<tr>
<td>846-P</td>
<td>22 Sept</td>
<td>C. Swift, Ames Research Center</td>
<td>Astronomy investigations with a large balloon-borne telescope</td>
<td>107,321</td>
<td>38.10 µ Poly</td>
<td>Winzen</td>
<td>1152.6</td>
<td>12.2</td>
<td>10.8</td>
<td>Success</td>
</tr>
</tbody>
</table>
## SUMMARY OF FLIGHTS

<table>
<thead>
<tr>
<th>FLIGHT NUMBER</th>
<th>DATE</th>
<th>EXPERIMENTER &amp; ORGANIZATION</th>
<th>TYPE OF EXPERIMENT</th>
<th>BALLOON VOLUME (M³)</th>
<th>GAUGE &amp; MATERIAL</th>
<th>MANUFACTURER</th>
<th>PAYLOAD WEIGHT (KGS)</th>
<th>FLOAT TIME (HRS)</th>
<th>PRESSURE FLOAT ALT. (MB)</th>
<th>FLIGHT SUCCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>847-P</td>
<td>23 Sept.</td>
<td>R. Hanel Goddard Space Flight Center</td>
<td>Infrared scanning interferometer to measure background radiation of earth's atmosphere</td>
<td>16,990</td>
<td>38.00 µ Poly</td>
<td>Raven</td>
<td>592.0</td>
<td>6.7</td>
<td>32.5</td>
<td>Operations Failure</td>
</tr>
<tr>
<td>848-P</td>
<td>27 Sept.</td>
<td>D. Lemke Max-Planck Institute</td>
<td>Measure radioactivity and the Milky Way with 6 ultraviolet telescopes at wave-lengths between 1930 and 3400Å</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>595.1</td>
<td>4.8</td>
<td>2.26</td>
<td>Success</td>
</tr>
<tr>
<td>849-P</td>
<td>29 Sept.</td>
<td>P. Meyer Univ. of Chicago</td>
<td>Measure charge composition and energy spectrum of cosmic ray nuclei with energies between 6 and 200 GeV per nucleon</td>
<td>592,320</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>1730.4</td>
<td>12.9</td>
<td>3.86</td>
<td>Failure - Cause Unknown</td>
</tr>
<tr>
<td>850-P</td>
<td>30 Sept.</td>
<td>R. Zander Univ. of Liege</td>
<td>Spectroscopic recording of the infrared solar radiation from 2.5 to 3.0 microns and from 5.5 to 9.0 microns</td>
<td>74,631</td>
<td>38.10 µ Poly</td>
<td>Winzen</td>
<td>1275.6</td>
<td>4.3</td>
<td>16.8</td>
<td>Electronics Failure</td>
</tr>
<tr>
<td>851-P</td>
<td>1 Oct.</td>
<td>G. Keller/Aberdeen Proving Grounds and D. Murckay/University of Denver</td>
<td>Measurements of concentrations of minor constituents, both ions and neutrals of the stratosphere</td>
<td>329,213</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>454.0</td>
<td>3.6</td>
<td>2.9</td>
<td>Success</td>
</tr>
<tr>
<td>852-P</td>
<td>2 Oct.</td>
<td>A. Jennings University College London</td>
<td>Observations in the far-infrared of HII regions many of which have energy emission a million times that of the sun</td>
<td>87,783</td>
<td>30.48 µ Poly</td>
<td>Winzen</td>
<td>667.6</td>
<td>11.7</td>
<td>9.60</td>
<td>Success</td>
</tr>
<tr>
<td>853-P</td>
<td>6 Oct.</td>
<td>P. Meyer Univ. of Chicago</td>
<td>Measure charge composition and energy spectrum of cosmic ray nuclei with energies between 6 and 200 GeV per nucleon</td>
<td>592,320</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>1733.3</td>
<td>41.2</td>
<td>3.55</td>
<td>Success</td>
</tr>
<tr>
<td>854-P</td>
<td>9 Oct.</td>
<td>R. Zander Univ. of Liege</td>
<td>Spectroscopic recording of the infrared solar radiation from 2.5 to 3.0 microns and from 5.5 to 9.0 microns with a resolving power better than 0.04 cm</td>
<td>87,783</td>
<td>50.80 µ Poly</td>
<td>Winzen</td>
<td>1265.5</td>
<td>8.8</td>
<td>16.2</td>
<td>Success</td>
</tr>
<tr>
<td>855-P</td>
<td>9 Oct.</td>
<td>T. Komdo NASA/JSC</td>
<td>Telescope spectrometer to investigate the stellar chromospheres through observation of Mg II doublet spectra</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>796.0</td>
<td>6.2</td>
<td>2.75</td>
<td>Success</td>
</tr>
<tr>
<td>FLIGHT NUMBER</td>
<td>DATE</td>
<td>EXPERIMENTER &amp; ORGANIZATION</td>
<td>TYPE OF EXPERIMENT</td>
<td>BALLOON VOLUME (M³)</td>
<td>GAUGE &amp; MATERIAL</td>
<td>MANUFACTURER</td>
<td>PAYLOAD WEIGHT (KGS)</td>
<td>FLOAT TIME (HRS)</td>
<td>PRESSURE FLOAT ALT. (MB)</td>
<td>FLIGHT SUCCESS</td>
</tr>
<tr>
<td>---------------</td>
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<tr>
<td>856-P</td>
<td>11 Oct.</td>
<td>M. Olson NCAR/GAMP</td>
<td>Test flight of carrier balloon system</td>
<td>14,160</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>178.1</td>
<td>8.0</td>
<td>15.0</td>
<td>Success</td>
</tr>
<tr>
<td>857-P</td>
<td>11 Oct.</td>
<td>A. Boksenberg/</td>
<td>High resolution UV spectograph photographing about 160 Å, at</td>
<td>569,580</td>
<td>12.70 µ Poly</td>
<td>Winszen</td>
<td>732.1</td>
<td>2.4</td>
<td>2.29</td>
<td>Success</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U/College London</td>
<td>0.1 Å resolution at 2800 Å interstellar and stellar information</td>
<td></td>
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</tr>
<tr>
<td>858-P</td>
<td>12 Oct.</td>
<td>R. Yasui JPL</td>
<td>Solar cell calibration</td>
<td>65,267</td>
<td>17.78 µ Poly</td>
<td>Winszen</td>
<td>159.7</td>
<td>6.5</td>
<td>4.6</td>
<td>Success</td>
</tr>
<tr>
<td>859-P</td>
<td>12 Oct.</td>
<td>R. Van Duinen U/Groningen</td>
<td>Measure the infrared output of different types of sources in specific bandwidths in the range of 20 to 200 microns with a 60 cm infrared telescope mounted in a star tracker oriented gondola</td>
<td>329,233</td>
<td>12.70 µ Poly</td>
<td>Winszen</td>
<td>816.0</td>
<td>7.8</td>
<td>3.65</td>
<td>Success</td>
</tr>
<tr>
<td>860-P</td>
<td>17 Oct.</td>
<td>C. Hemenway Dudley Observatory</td>
<td>A meteorite collection system which utilizes a 25 foot diameter plastic film funnel suspended 304.9 M below a superpressure balloon</td>
<td>14,160</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>293.1</td>
<td>41.7</td>
<td>24.0</td>
<td>Success</td>
</tr>
<tr>
<td>861-P</td>
<td>18 Oct.</td>
<td>R. Jennings U/College London</td>
<td>Observations in the far-infrared of H II regions many of which have energy emission a million times that of the sun</td>
<td>87,783</td>
<td>30.48 µ Poly</td>
<td>Winszen</td>
<td>679.3</td>
<td>11.3</td>
<td>9.3</td>
<td>Success</td>
</tr>
<tr>
<td>862-P</td>
<td>20 Oct.</td>
<td>R. Zander U/Liege</td>
<td>Spectroscopic recordings of the infrared solar radiation from 2.5 to 3.0 microns and from 5.5 to 9.0 microns with a resolving power better than 0.04 cm⁻²</td>
<td>122,334</td>
<td>25.40 µ Poly</td>
<td>Winszen</td>
<td>1194.9</td>
<td>8.9</td>
<td>11.0</td>
<td>Success</td>
</tr>
<tr>
<td>863-P</td>
<td>23 Oct.</td>
<td>R. Van Duinen U/Groningen</td>
<td>Measure the infrared output of different types of sources in specific bandwidths in the range of 20 to 200 microns with a 60 cm infrared telescope mounted in a star tracker oriented gondola</td>
<td>87,783</td>
<td>50.80 µ Poly</td>
<td>Winszen</td>
<td>822.0</td>
<td>8.3</td>
<td>12.0</td>
<td>Success</td>
</tr>
<tr>
<td>864-P</td>
<td>24 Oct.</td>
<td>R. Yasui JPL</td>
<td>Solar cell calibration</td>
<td>65,267</td>
<td>17.78 µ Poly</td>
<td>Winszen</td>
<td>156.1</td>
<td>3.4</td>
<td>4.6</td>
<td>Success</td>
</tr>
<tr>
<td>FLIGHT NUMBER</td>
<td>DATE</td>
<td>EXPERIMENTER &amp; ORGANIZATION</td>
<td>TYPE OF EXPERIMENT</td>
<td>BALLOON VOLUME (M³)</td>
<td>GAUGE &amp; MATERIAL</td>
<td>MANUFACTURER</td>
<td>PAYLOAD WEIGHT (KGS)</td>
<td>FLOAT TIME (HRS)</td>
<td>PRESSURE FLOAT ALT. (MB)</td>
<td>FLIGHT SUCCESS</td>
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<tr>
<td>865-P</td>
<td>5 Nov.</td>
<td>B. Jennings, U/College London</td>
<td>Observations in the far-infra-red of H II regions many of which have energy emission a million times that of the sun</td>
<td>87,783</td>
<td>30.48 µ Poly</td>
<td>Winsen</td>
<td>702.8</td>
<td>3.9</td>
<td>10.0</td>
<td>Success</td>
</tr>
<tr>
<td>866-P</td>
<td>6 Nov.</td>
<td>C. Fichiel, D. Kniffen, GSFC</td>
<td>To verify, in a space environment, engineering concepts to be used in configuring the satellite experiment</td>
<td>314,319</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>1187.9</td>
<td>6.2</td>
<td>5.3</td>
<td>Success</td>
</tr>
<tr>
<td>867-P</td>
<td>12 Nov.</td>
<td>W. Craddock, NASA/JSC</td>
<td>Test flight to determine the stability of a guide surface parachute</td>
<td>127,487</td>
<td>15.24 µ Poly</td>
<td>Winsen</td>
<td>268.5</td>
<td>.8</td>
<td>3.01</td>
<td>Success</td>
</tr>
<tr>
<td>868-P</td>
<td>25 Nov.</td>
<td>J. Anderson, U/Pittsburgh and NASA/JSC</td>
<td>To measure the absolute concentration of atomic oxygen between 40 and 20 kilometers using ultra-violet atomic resonance fluorescence</td>
<td>314,319</td>
<td>15.24 µ Poly</td>
<td>Winsen</td>
<td>268.5</td>
<td>.8</td>
<td>3.04</td>
<td>Success</td>
</tr>
<tr>
<td>869-P</td>
<td>3 Dec.</td>
<td>D. Murray, U/Denver</td>
<td>The study of atmospheric transmission in the 15 µ region as a function of altitude</td>
<td>127,487</td>
<td>12.70 µ Poly</td>
<td>Winsen</td>
<td>628.9</td>
<td>2.9</td>
<td>2.96</td>
<td>Success</td>
</tr>
<tr>
<td>870-P</td>
<td>17 Dec.</td>
<td>J. Matteson, U/California, San Diego</td>
<td>Test flight of 0.1 to 10 MeV gamma ray telescope for HEAO-2 satellite</td>
<td>143,284</td>
<td>15.24 µ Poly</td>
<td>Winsen</td>
<td>761.1</td>
<td>8.4</td>
<td>6.0</td>
<td>Success</td>
</tr>
<tr>
<td>871-P</td>
<td>6 Jan.</td>
<td>M. Palling, U/California San Diego</td>
<td>X-ray telescope observations in high sensitivity mode of cluster of galaxies in Perseus region</td>
<td>329,213</td>
<td>12.70 µ Poly</td>
<td>Winsen</td>
<td>845.4</td>
<td>N/A</td>
<td>N/A</td>
<td>Balloon Failure</td>
</tr>
<tr>
<td>872-P</td>
<td>7 Feb.</td>
<td>J. Anderson, U/Pittsburgh and NASA/JSC</td>
<td>One in a series of flights conducted to measure various stratospheric species</td>
<td>434,934</td>
<td>12.70 µ Poly</td>
<td>Winsen</td>
<td>282.6</td>
<td>.3</td>
<td>1.63</td>
<td>Success</td>
</tr>
<tr>
<td>873-P</td>
<td>9 Feb.</td>
<td>F. Low, U/Air Force</td>
<td>Low background far infrared telescope to study galactic center region and other bright sources</td>
<td>14,160</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>231.8</td>
<td>4.5</td>
<td>17.6</td>
<td>Success</td>
</tr>
<tr>
<td>874-P</td>
<td>20 Feb.</td>
<td>L. Heidt, NCAR</td>
<td>Payload designed to inhale 16 separate air samples using cryogenic &quot;pumps&quot; as the balloon is valved down from 115,000 to 60,000 feet</td>
<td>104,384</td>
<td>12.70 µ Poly</td>
<td>Winsen</td>
<td>527.6</td>
<td>N/A</td>
<td>N/A</td>
<td>Balloon Failure</td>
</tr>
<tr>
<td>FLIGHT NUMBER</td>
<td>DATE</td>
<td>EXPERIMENTER &amp; ORGANIZATION</td>
<td>TYPE OF EXPERIMENT</td>
<td>BALLOON VOLUME (M^3)</td>
<td>GAUGE &amp; MATERIAL</td>
<td>MANUFACTURER</td>
<td>PAYLOAD WEIGHT (KGS)</td>
<td>FLOAT TIME (HRS)</td>
<td>PRESSURE FLOAT ALT. (MB)</td>
<td>FLIGHT SUCCESS</td>
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<tr>
<td>875-P</td>
<td>12 Feb.</td>
<td>P. Fowler</td>
<td>Cosmic ray detector intended to measure the abundance of elements in the charge range 102 - 50 in the primary cosmic rays</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winsten</td>
<td>991.1</td>
<td>5.3</td>
<td>3.15</td>
<td>Success</td>
</tr>
<tr>
<td>876-P</td>
<td>20 Feb.</td>
<td>R. Staubert</td>
<td>Observation of extrasolar x-ray sources in the energy range of 20-250 KeV</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winsten</td>
<td>529.8</td>
<td>6.6</td>
<td>2.2</td>
<td>Success</td>
</tr>
<tr>
<td>877-P</td>
<td>14 March</td>
<td>R. Staubert</td>
<td>Observation of extrasolar x-ray sources in the energy range of 20-250 KeV</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winsten</td>
<td>530.8</td>
<td>N/A</td>
<td>N/A</td>
<td>Balloon Failure</td>
</tr>
<tr>
<td>878-P</td>
<td>14 March</td>
<td>Y. Komô</td>
<td>A balloon-borne telescope spectrometer to investigate the stellar chromospheres</td>
<td>437,341</td>
<td>12.70 µ Poly</td>
<td>Winsten</td>
<td>807.4</td>
<td>11.4</td>
<td>2.8</td>
<td>Success</td>
</tr>
<tr>
<td>879-P</td>
<td>25 March</td>
<td>C. Swift</td>
<td>Observations of several galactic and extra-galactic objects that emit infrared radiation</td>
<td>107,424</td>
<td>38.10 µ Poly</td>
<td>Raven</td>
<td>1042.3</td>
<td>3.5</td>
<td>11.0</td>
<td>Success</td>
</tr>
<tr>
<td>880-P</td>
<td>3 April</td>
<td>C. Swift</td>
<td>Observations of several galactic and extra-galactic objects that emit infrared radiation</td>
<td>113,300</td>
<td>38.10 µ Poly</td>
<td>Raven</td>
<td>1042.9</td>
<td>N/A</td>
<td>N/A</td>
<td>Balloon Failure</td>
</tr>
<tr>
<td>881-P</td>
<td>15 April</td>
<td>N. Pavey</td>
<td>Test of superpressure balloon</td>
<td>96,360</td>
<td>23.0 Mylar S</td>
<td>Raven</td>
<td>155.3</td>
<td>N/A</td>
<td>N/A</td>
<td>Success</td>
</tr>
<tr>
<td>882-P</td>
<td>1 May</td>
<td>J. Ormes</td>
<td>Energy spectrum of high energy cosmic radiation</td>
<td>612,093</td>
<td>22.86 µ Poly</td>
<td>Winsten</td>
<td>3028.6</td>
<td>37.3</td>
<td>6.0</td>
<td>Success</td>
</tr>
<tr>
<td>883-P</td>
<td>7 May</td>
<td>M. Core</td>
<td>Test of balloon destruct line</td>
<td>721</td>
<td>25.40 µ Poly</td>
<td>Winsten</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Success</td>
</tr>
<tr>
<td>884-P</td>
<td>8 May</td>
<td>J. Lord</td>
<td>Measurement of primary cosmic ray electron spectrum at energies above 100 GeV using an emulsion chamber</td>
<td>343,824</td>
<td>15.24 µ Poly</td>
<td>Winsten</td>
<td>417.3</td>
<td>29.3</td>
<td>4.2</td>
<td>Success</td>
</tr>
<tr>
<td>885-P</td>
<td>8 May</td>
<td>E. Chupp</td>
<td>Large gamma ray telescope</td>
<td>329,213</td>
<td>12.70 µ Poly</td>
<td>Winsten</td>
<td>966.2</td>
<td>16.0</td>
<td>3.50</td>
<td>Success</td>
</tr>
<tr>
<td>886-P</td>
<td>9 May</td>
<td>T. Cline</td>
<td>Gamma ray burst detector making survey for small frequently occurring x-ray bursts</td>
<td>441,800</td>
<td>15.24 µ Poly</td>
<td>Winsten</td>
<td>813.7</td>
<td>23.8</td>
<td>3.04</td>
<td>Success</td>
</tr>
<tr>
<td>FLIGHT NUMBER</td>
<td>DATE</td>
<td>EXPERIMENTER &amp; ORGANIZATION</td>
<td>TYPE OF EXPERIMENT</td>
<td>BALLOON VOLUME (M³)</td>
<td>GAUGE &amp; MATERIAL</td>
<td>MANUFACTURER</td>
<td>PAYLOAD WEIGHT (KGS)</td>
<td>FLOAT TIME (HRS)</td>
<td>PRESSURE FLOAT ALT. (MB)</td>
<td>FLIGHT SUCCESS</td>
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<tr>
<td>887-P</td>
<td>10 May</td>
<td>D. Wilkinson Princeton Univ.</td>
<td>Two microwave receivers to scan the sky to measure the anisotropy of the cosmic background radiation</td>
<td>14,160</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>313.8</td>
<td>9.6</td>
<td>22.0</td>
<td>Success</td>
</tr>
<tr>
<td>888-P</td>
<td>13 May</td>
<td>S. White/A. Zych U/California Riverside</td>
<td>A new UCR large-area double scattering telescope to measure neutrons and gamma rays from both the earth’s upper atmosphere and extra-terrestrial sources</td>
<td>580,850</td>
<td>12.70 µ Poly</td>
<td>Wintzen</td>
<td>1377.6</td>
<td>26.4</td>
<td>3.3</td>
<td>Success</td>
</tr>
<tr>
<td>889-P</td>
<td>17 May</td>
<td>J. Mehltretter Fraunhofer Inst.</td>
<td>Spectrostratocoupe as a mirror telescope with spectrograph for solar observations</td>
<td>162,616</td>
<td>25.40 µ Poly</td>
<td>Wintzen</td>
<td>2466.1</td>
<td>9.0</td>
<td>15.4</td>
<td>Success</td>
</tr>
<tr>
<td>890-P</td>
<td>17 May</td>
<td>G. Pati Smithsonian Obs.</td>
<td>A 1-meter balloon-borne telescope used for photochemistry and high resolution mapping of intense far-infrared (40-250 micron) sources at center of our galaxy</td>
<td>160,179</td>
<td>25.40 µ Poly</td>
<td>Wintzen</td>
<td>2216.2</td>
<td>10.3</td>
<td>14.0</td>
<td>Success</td>
</tr>
<tr>
<td>891-P</td>
<td>18 May</td>
<td>D. Ramsden U/Southampton</td>
<td>A very large x-ray telescope to observe fast fluctuations in x-ray sources within the galaxy including Hercules X-1 and Cygnus X-1</td>
<td>587,882</td>
<td>20.32 µ Poly</td>
<td>Wintzen</td>
<td>2233.0</td>
<td>13.6</td>
<td>4.8</td>
<td>Success</td>
</tr>
<tr>
<td>892-P</td>
<td>22 May</td>
<td>J. Fishman NASA/MSFC</td>
<td>X-ray detector system with a large sensitive area and wide field of view to be used to detect weak transient celestial x-ray bursts</td>
<td>329,213</td>
<td>12.70 µ Poly</td>
<td>Wintzen</td>
<td>839.1</td>
<td>23.0</td>
<td>3.55</td>
<td>Success</td>
</tr>
<tr>
<td>893-P</td>
<td>1 June</td>
<td>W. Levin M.I.T.</td>
<td>High energy x-ray observations of galactic and extra-galactic sources</td>
<td>1,489,474</td>
<td>12.70 µ Poly</td>
<td>Wintzen</td>
<td>1462.8</td>
<td>13.3</td>
<td>1.69</td>
<td>Success</td>
</tr>
<tr>
<td>894-P</td>
<td>2 June</td>
<td>L. Heidt NCAR</td>
<td>Cryogenic air sampler to inhale stratospheric air samples from 35 km to tropopause</td>
<td>104,384</td>
<td>12.70 µ Poly</td>
<td>Wintzen</td>
<td>560.1</td>
<td>7.2</td>
<td>6.65</td>
<td>Success</td>
</tr>
<tr>
<td>895-P</td>
<td>6 June</td>
<td>H. Yasui JPL</td>
<td>Solar cell calibration</td>
<td>65,267</td>
<td>17.78 µ Poly</td>
<td>Wintzen</td>
<td>171.5</td>
<td>6.1</td>
<td>4.64</td>
<td>Success</td>
</tr>
<tr>
<td>896-P</td>
<td>11 June</td>
<td>F. Low U/Arizona</td>
<td>Low background far infrared telescope to study galactic center region and other bright sources</td>
<td>56,630</td>
<td>19.00 µ Poly</td>
<td>Raven</td>
<td>245.8</td>
<td>11.2</td>
<td>6.9</td>
<td>Success</td>
</tr>
<tr>
<td>FLIGHT NUMBER</td>
<td>DATE</td>
<td>EXPERIMENTER &amp; ORGANIZATION</td>
<td>TYPE OF EXPERIMENT</td>
<td>BALLOON VOLUME (m³)</td>
<td>GAUGE &amp; MATERIAL</td>
<td>MANUFACTURER</td>
<td>PAYLOAD WEIGHT (KGS)</td>
<td>FLOAT TIME (HRS)</td>
<td>PRESSURE FLOAT ALT. (MB)</td>
<td>FLIGHT SUCCESS</td>
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<tr>
<td>897-P</td>
<td>12 June</td>
<td>E. Smith/J. Sparling NCAR/NSBF</td>
<td>Test of CIP package</td>
<td>151,585</td>
<td>19.00 µ Poly</td>
<td>Raven</td>
<td>274.0</td>
<td>7.4</td>
<td>3.9</td>
<td>Success</td>
</tr>
<tr>
<td>898-P</td>
<td>13 June</td>
<td>L. Heidt NCAR</td>
<td>Cryogenic air sampler to inhale 15 samples from 35 km down to 12 km as the balloon is being valved down. Analyses will determine the concentration of trace gases in the stratosphere</td>
<td>441,800</td>
<td>15.26 µ Poly</td>
<td>Winzen</td>
<td>405.5</td>
<td>4.4</td>
<td>2.28</td>
<td>Success</td>
</tr>
<tr>
<td>899-P</td>
<td>15 June</td>
<td>G. Fazio Smithsonian Obs.</td>
<td>A 1-meter balloon-borne telescope for photometry and high resolution mapping of intense far-infrared sources at the center of our galaxy</td>
<td>160,179</td>
<td>25.46 µ Poly</td>
<td>Winzen</td>
<td>2234.4</td>
<td>8.8</td>
<td>14.37</td>
<td>Success</td>
</tr>
<tr>
<td>900-P</td>
<td>21 June</td>
<td>R. Weiss M.I.T.</td>
<td>Sky survey to look for discrete astronomical sources at submillimeter wavelengths</td>
<td>143,284</td>
<td>15.26 µ Poly</td>
<td>Winzen</td>
<td>465.8</td>
<td>8.0</td>
<td>4.27</td>
<td>Success</td>
</tr>
<tr>
<td>901-P</td>
<td>23 June</td>
<td>M. Gore NCAR/NSBF</td>
<td>Test of balloon destruct line</td>
<td>721</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Success</td>
</tr>
<tr>
<td>902-P</td>
<td>23 June</td>
<td>M. Gore NCAR/NSBF</td>
<td>Rip line and valve test</td>
<td>721</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Success</td>
</tr>
<tr>
<td>903-P</td>
<td>23 June</td>
<td>M. Felling U/California San Diego</td>
<td>Observations of time variability in cosmic X-ray sources Hercules X-1, Cygnus X-1 and Cygnus X-3</td>
<td>437,361</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>539.4</td>
<td>6.3</td>
<td>2.92</td>
<td>Success</td>
</tr>
<tr>
<td>904-P</td>
<td>26 June</td>
<td>M. Olson NCAR</td>
<td>Test flight carrier balloon system</td>
<td>14,160</td>
<td>25.40 µ Poly</td>
<td>Raven</td>
<td>270.8</td>
<td>N/A</td>
<td>N/A</td>
<td>Balloon Failure</td>
</tr>
<tr>
<td>905-P</td>
<td>27 June</td>
<td>R. Yasui JPL</td>
<td>Solar cell calibration</td>
<td>65,267</td>
<td>17.78 µ Poly</td>
<td>Winzen</td>
<td>161.9</td>
<td>5.3</td>
<td>4.84</td>
<td>Success</td>
</tr>
<tr>
<td>906-P</td>
<td>27 June</td>
<td>F. Low U/Arizona</td>
<td>Low background far infrared telescope to study galactic center region and other bright sources</td>
<td>56,630</td>
<td>19.00 µ Poly</td>
<td>Raven</td>
<td>220.9</td>
<td>8.6</td>
<td>6.5</td>
<td>Success</td>
</tr>
<tr>
<td>103-N</td>
<td>13 Aug. 1976</td>
<td>W. Levin M.I.T.</td>
<td>To view galactic and extragalactic X-ray sources and map the Crab Nebula during a lunar occultation</td>
<td>566,360</td>
<td>12.70 µ Poly</td>
<td>Winzen</td>
<td>1144.5</td>
<td>4.3</td>
<td>3.25</td>
<td>Success</td>
</tr>
<tr>
<td>FLIGHT NUMBER</td>
<td>DATE</td>
<td>EXPERIMENTER &amp; ORGANIZATION</td>
<td>TYPE OF EXPERIMENT</td>
<td>BALLOON VOLUME (M³)</td>
<td>GAUGE &amp; MATERIAL</td>
<td>MANUFACTURER</td>
<td>PAYLOAD WEIGHT (KGS)</td>
<td>FLOAT TIME (HRS)</td>
<td>PRESSURE FLOAT ALT. (MB)</td>
<td>FLIGHT SUCCESS</td>
</tr>
<tr>
<td>---------------</td>
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<td>-----------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>104-N</td>
<td>27 Aug. 1974</td>
<td>L. Koch/B. Peters Danish Space Research Center</td>
<td>Instrument to measure the atomic number and velocity of primary cosmic ray nuclei. Preliminary model of a satellite instrument being developed for the HEAO program</td>
<td>87,783</td>
<td>30.48 μ Poly</td>
<td>Winzen</td>
<td>877.3</td>
<td>11.7</td>
<td>10.1</td>
<td>Success</td>
</tr>
<tr>
<td>105-N</td>
<td>13 Sept. 1974</td>
<td>B. Cartwright U/California Berkeley</td>
<td>Experiment to attempt to successfully analyze the isotopic composition of iron in the cosmic rays</td>
<td>735,698</td>
<td>15.24 μ Poly</td>
<td>Winzen</td>
<td>1655.6</td>
<td>46.4</td>
<td>3.15</td>
<td>Success</td>
</tr>
<tr>
<td>106-N</td>
<td>17 Sept. 1974</td>
<td>L. Koch/B. Peters Danish Space Research Center</td>
<td>Instrument to measure the atomic number and velocity of primary cosmic ray nuclei. Preliminary model of a satellite instrument being developed for the HEAO program</td>
<td>441,800</td>
<td>15.24 μ Poly</td>
<td>Winzen</td>
<td>1240.5</td>
<td>56.3</td>
<td>3.50</td>
<td>Success</td>
</tr>
</tbody>
</table>
APPENDIX B
Dr. George E. Keller, Ballistic Research Laboratories, Aberdeen Proving Ground

**Flight 851-P, 1 October 1974**

**Purpose:** The purpose of this flight was to fly a balloon-borne mass spectrometer package for the first time and to use it to measure the positive ions and neutral molecules at an altitude of about 40 km through a sunrise period.

**Results:** From a ballooning standpoint, the flight was very successful. Unfortunately, as is so often the case with a new instrument, difficulties were encountered with the sampling package itself which prevented our taking any mass spectrometer data.

**Publications:** The only publication was an internal report, *Interim Memorandum Report No. 324 of the Ballistic Research Laboratories, "COSMEP Balloon Flight with Mass Spectrometer Package,"* December 1974.

Dr. Michael L. Olson, National Center for Atmospheric Research

**Flight 844-P, 4 September 1974 and Flight 856-P, 11 October 1974**

**Purpose:** The purpose of these flights was to test fly a Carrier Balloon System to determine the cause of interrogation failure of the system that was flown from Kourou, French Guiana in July 1974. Extensive telemetry from the Palestine equipment were added for monitoring package operation to isolate the failing subsystem.

**Results:** It was determined that radio frequency interference (RFI) seriously degraded the satellite signals used to initiate Omegasonde soundings. From these results receiver modifications were recommended to help overcome the interference problem. In addition basic package operation was tested since the special telemetry permitted selection of interference-free periods to send commands and thus initiate Omegasonde soundings.

Prof. D. G. Murcary, Dr. D. Wark and Dr. L. Stowe, University of Denver, NESS/NOAA

**Flight 869-P, 3 December 1974**

**Purpose:** The objective of the flight was to measure the variation of the atmospheric transmission in the 15 μm band with altitude. The transmission data were obtained with three separate instruments using the sun as a source. The instruments consisted of a grating spectrometer, a pressure modulated radiometer system and a filter radiometer system.
Results: The instrumentation worked very well and data were obtained at all altitudes from the ground through float (~40 km).

Publications: The data obtained during the balloon flight have not been completely reduced at this time. Preliminary results were presented at the spring meeting of the Optical Society which was held at Anaheim, California, March 19, 1975. In view of the success of the flight it is expected that several publications will be issued containing data obtained during the flight.

COSMIC RAY EXPERIMENTS

Drs. L. Koch and B. Peters, Danish Space Research Institute

Flight 104-N, 27 August 1974

Purpose: Technical flight of an instrument to measure the chemical and isotopic composition of primary cosmic ray nuclei. The instrument is a preliminary model of a satellite instrument to be launched on board the NASA HEAO-C satellite. Primary objective was selection of Cerenkov radiator materials and study of neon flash tube operating characteristics.

Results: The flight results permitted the optimization of instrument configuration and optimal settings of electronic parameters on the Flight # 106-N which was launched 3 weeks later.

Flight 106-N, 17 September 1974

Purpose: Test of teflon and aerogel plates as Cerenkov radiators for precise velocity measurements on cosmic ray nuclei. Collection of data base for development of software to be used in connection with the NASA HEAO program.

Results: Excellent results on the composition of primary cosmic ray nuclei. Confirmation of the suitability of both teflon and aerogel as Cerenkov radiators.

Publications: One paper on the behaviour of the aerogel as a low refractive index Cerenkov radiator. Two papers on the composition results on the primary cosmic radiation. All to be presented at the International Conference on Cosmic Rays, Munich, Germany, August 1975.

Dr. P. Meyer and J. H. Caldwell, University of Chicago


Purpose: The instrument used in these flights was designed to
measure the composition and energy spectra of cosmic ray nuclei with charge Z greater than 2 and with energies between 5 and 100 GeV per nucleon.

Results: During both flights, the instrument performed flawlessly. Over 25,000 high energy (> 5 GeV/n) nuclei were detected, by far the largest number to date. Data analysis is continuing at the present time.


Professor P. H. Fowler, University of Bristol

Flight 875-P, 12 February 1975

Purpose: This flight was the first successful flight of BUGS 2, a large area electronic cosmic ray detector, designed to record the passage of heavy primary cosmic ray nuclei (8< Z < 110) with good resolution. It uses the technique of gas scintillation from an argon-nitrogen mixture in three separate volumes

Results: Preliminary analysis of the data obtained, both in real time during the flight, and from the digital tapes recorded during the flight, indicate that the instrument performed well during the 6 hour float period, enabling us to plan a further flight for later this year, after mechanical damage sustained on landing has been repaired. Further analysis of the flight data will continue throughout this year.

Publications: The scientific results from this experiment will be published upon completion of the final analysis.

GAMMA AND X RAY EXPERIMENTS

Dr. V. Schoenfelder, Max-Planck-Institut

Flight 835-P, 11 July 1974

Purpose: This flight was performed to measure the energy spectrum of the diffuse cosmic gamma radiation between 1 and 10 MeV from different regions of the sky. The instrument used was a double Compton telescope. Furthermore, during one hour at float altitude the telescope axis was turned around to measure the zenith angle distribution of atmospheric gamma rays in this energy range.
Results: The energy spectrum of the diffus cosmic gamma radiation was determined for regions of the sky ranging from $b^1 = 0^\circ$ to $b^1 = +63^\circ$ and showed no statistically significant latitude dependence. The zenith angle distribution of atmospheric gamma rays between 1 - 10 MeV was determined from $0^\circ$ to $360^\circ$. The distribution shows a maximum in the horizontal direction - in contrast to theoretical predictions.

Publications: First results of this balloon flight will be published in the Proceedings of the XIV Int. Cosmic Ray Conf. in Munich, which will appear in August 1975.

"Angular Distribution of Atmospheric Gamma Radiation in the MeV-Range at High Balloon Altitudes", G. Lichti, C. Moyano, V. Schoenfelder.


Dr. D. Ramsden, University of Southampton

Flight 836-P, 17 July 1974

Purpose: The purpose of this flight was to repeat an earlier observation of the gamma ray emission from the Crab Nebula in the energy range from 600 Kev to 10 Mev. A previous flight had suggested that the emission was higher than that expected from the extrapolation of reliable spectra obtained at lower energies.

Results: A preliminary analysis of the data indicates that no similar anomaly was observed on this flight.

Professor Kenneth Greisen, Cornell University

Flight 837-P, 22 July 1974

Purpose: Two previous flights had measured quite different intensity values for the high energy (> 500 MeV) gamma rays from the Crab Nebula. This flight was intended to gather further information on the pulsed and steady gamma ray flux from the Crab and on their variability.

Results: The analysis of the data is still in progress.


Dr. E. L. Chupp, University of New Hampshire

Flight 840-P, 31 July 1974

Purpose: The primary objective of the flight was to use a large shielded detector to investigate the gamma ray line emission from the Galactic Center and to determine the effectiveness of a newly designed low background system.

Results: The float time was ≈ 5 hours during which many tests were performed to check operation of all parts of the system. All data so far analyzed indicates that everything operated as expected. The flight can be considered an unqualified success.

Publications: Analysis of data has not been completed; however, it is clear from the work done thus far that a study of reported gamma ray lines (> 1 MeV) from the Galactic Center can be carried out. Final analysis of this problem is being completed and we expect to have a paper for publication in the fall of 1975.

Flight 885-P, 8 May 1975

Purpose: The primary objective of the flight was to use a large shielded detector to investigate the gamma ray line emission from Cyg X-1 and Tau X-1. A controlled ascent and descent rate was also requested so that an investigation of the cosmic flux between 0.5-10 MeV could be made.

Results: After 8 hours into the flight a failure occurred in the orientation portion of the gondola so that the detector could not be pointed. Hence only one-half of the desired data on Cyg X-1 and no data on Tau X-1 was obtained. Detailed depth data was obtained on ascent. The flight duration was ≥ 18 hours. The instrument was badly damaged in the recovery and will require considerable rework before the next flight.

Publications: Analysis of the data is in progress.

Dr. D. Kniffen, NASA/Goddard Space Flight Center

Flight 866-P, 6 November 1974

Purpose: This flight consisted of a high energy (> 30 MeV) spark chamber gamma ray experiment telescope reconfigured to extend the threshold to lower energies and to improve angular resolution. Also included was a high sensitivity gamma ray burst detector flown in a search for very short bursts of gamma radiation from supernovae or other celestial objects.

Results: The flight was very successful, giving a large quantity of engineering data on the medium energy configuration and proving the burst mode trigger system. An examination of spark chamber events
associated with burst mode triggers shows no evidence for unusual events, and an upper limit is obtained on the rate of gamma ray bursts from supernova shocks.

**Publications:** Data analysis is not yet complete, but one paper is anticipated from this work.

Drs. R. Staubert and J. Trumper, University of Tubingen, Germany

**Flight 876-P, 20 February 1975**

**Purpose:** The purpose of this flight was to observe the Cyg-region with the Tubingen x-ray detector in the energy range of 20 - 180 keV. Especially it was to be looked for a 4.8 h periodic variation of the flux from Cyg X-3 which has been found at low energy x-rays and the IR.

**Results:** The flight was successful and three sources in Cyg were observed: Cyg X-3, Cyg X-1, Cyg X-2. Data reduction is in progress.

**Publications:** First results will be published at the 14th International Conference on Cosmic Rays, August 1975, Munich.

Dr. T. Cline, NASA/Goddard Space Flight Center

**Flight 886-P, 9 May 1975**

**Purpose:** This unusual flight required a simultaneous balloon flight (800 miles away in Sioux Falls, S.D.) with approximately an identical gondola in order to achieve coincident data for one day at ceiling in order to search for cosmic gamma ray bursts. Gamma ray bursts are so brief in their duration that one detector along, no matter how instrumented, cannot be trusted to perform unambiguous identification; but two at different latitudes would presumably be free from misinterpretation in terms of their coincident data.

**Results:** The two flights achieved 19 to 20 hours of simultaneous observation at between 3 and 4 millibars each out of about 40 hours contiguous data coverage. The results are presently being analyzed. The scientific results are not yet available at the time of this writing (May 22, 1975) but it is known that both instruments functioned properly; and that a clear measurement of the presence or absence of a measurable flux of small gamma ray bursts is expected to be the outcome.

**Publications:** The results will be published when they are finalized. At present, a description of the experiment is being presented at the May 29, 1975 COSPAR meeting in Varna, Bulgaria and it will be published in Astrophysics and Space Science.
Flight 888-P, 13 May 1975

Purpose: The purposes of this flight were to search for and measure the properties of neutrons and gamma rays from the sun; search for and measure the properties of gamma rays from celestial objects such as the Crab pulsar, SCO X-1 and the binary pulsar; look for bursts of gamma rays; measure the cosmic diffuse gamma rays and measure the properties of the atmospheric neutrons and gamma rays. Neutrons from 2 to 100 MeV and gamma rays from 0.5 to 30 MeV or higher were measured.

Results: Data were obtained on atmospheric neutrons and gamma rays during ascent and at altitudes of 107,000 to 130,000 ft during the night. The sun was observed for several hours on May 13. The Crab pulsar and other celestial sources were observed during the 30 hour flight. Much of this data was obtained at altitudes of 125,000 to 130,000 ft. As the flight was completed less than a week ago we do not yet have data analyzed but will have our quick analysis under way shortly and some preliminary results in two or three months with detailed results in one year.

Publications: The results from this flight will be published in the appropriate journals.

INFRARED EXPERIMENTS

Dr. F. Low, University of Arizona

Flight 838-P, 23 July 1974

Purpose: Far infrared observations of galactic sources using the 8-inch, low background, 3-axis telescope.

Results: This was the fourth flight of this system and one of the most successful. Observations were made of the Ophiuchus dark cloud region. In addition, many scans were made of the galactic plane. The instrumental sensitivity was high, and numerous sources were detected.

Publications: A paper is being prepared which discusses the Ophiuchus and galactic plane observations.

Flight 873-P, 9 February 1975

Purpose: Far infrared observations of galactic and extra galactic sources using the 8-inch, low background, 3-axis telescope.

Results: This was the fifth flight of this instrument. It was the first on which failures of the system resulted in complete failure to acquire usable data. Due to human error in the pre-flight checkout
flight, the declination drive motor was disconnected. In addition, there appeared to be for the first time radio interference problems affecting both bolometer outputs. Furthermore, the azimuth stabilization exhibited an intermittent servo instability.

Professor P. Richards, University of California, Berkeley

Flight 839-P, 24 July 1974

Purpose: The purpose of this flight was to measure the submillimeter night sky emission spectrum using a liquid helium cooled spectrophotometer. This provides a measurement of the cosmic background radiation in addition to the molecular line emission from the atmosphere. The submillimeter spectrum of the cosmic background radiation is of particular importance in determining the origin of this radiation.

Results: The flight met our highest expectations. The cosmic background radiation spectrum was established to be that of a $\approx 3$K blackbody consistent with the "Big Bang" theory for the origin of the universe. A simple model for the atmospheric emission was found to accurately fit the observed spectrum and values for the concentration of $O_3$ and $H_2O$ at an altitude of 38km were obtained.


Drs. D. Wilkinson and B. Corey, Princeton University

Flight 843-P, 22 August 1975

Purpose: The large-scale isotropy of microwave background radiation was studied at two wavelengths, $\lambda = 3$ cm and 1.5 cm. The goal was to observe the 0.1% effect due to the motion of the sun with respect to distant galaxies.

Results: Signals at 3 cm of order 0.3% were observed, apparently moving around the sky more rapidly than the expected effect. We are not sure of the origin of these signals. Diffraction of ground radar, high clouds on the horizon, or gondola swinging are our prime suspects. It is conceivable that the signals are due to residual atmosphere or celestial sources. The 1.5 cm tunnel diode amplifier failed at float. Another flight is planned with an improved, ground screen and tilt sensor; the 1.5 cm radiometer has been repaired.

Dr. R. Jennings, University College London


Purpose: The aim of this series of flights was to continue our programme of astronomical observations in the far infrared, using both a new three wave band photometer system and also a Michelson
Interferometer to make spectral observations.

Results: Spectra of Jupiter at a resolution of \( \sim 1 \text{ cm}^{-1} \) and of the Orion Nebula at 2 to 3 \( \text{cm}^{-1} \) were obtained. The analysis of this data is continuing.

Publications: The results will be included in the thesis to be presented by Mr. K. J. King for the Ph.D degree of London University. They are also to be published in the literature. Recent publications on previous balloon flights include the following:


"Far Infrared Observations of W 51 and the Galactic Centre", J. A. Alvarez, I. Furniss, R. E. Jennings, K. J. King and A.F.M. Moorwood, ibid, p. 69-78.

"Observations of W 3 in the 40-350 \( \mu \text{m/band} \)", I. Furniss, R. E. Jennings and A.F.M. Moorwood, ibid p. 89-90.


"40-350 \( \mu \text{m Observations of Galactic Sources} \)", I. Furniss, R. E. Jennings and A.F.M. Moorwood. Submitted to Astrophysical Journal.

"Infrared Observations at \( \gamma > 40 \mu \text{m of Compact HII Regions} \)", R.E. Jennings, Mittelberg Symposium, January 1975.

Drs. R. J. Van Duinen and H. Olthof, University of Groningen, Netherlands

Flight 859-P, 12 October 1974

Purpose: To perform far infrared photometric observations of galactic HII regions in four wavelength bands between 20 and 200 \( \mu \) using a 60 cm balloon-borne telescope "Maiden flight" of balloon-gondola.

Results: Performance of gondola satisfactory. Calibration of photometer on Jupiter.

Flight 863-P, 23 October 1974

Purpose: To perform far infrared photometric observations of galactic HII regions in four wavelength bands between 20 and 200 \( \mu \), using a 50 cm balloon-borne telescope.

Results: None, due to rapid evaporation of liquid helium in cryostat at float altitude.
Drs. David T. Wilkinson and B. Corey, Princeton University

Flight 887-P, 10 May 1975

Purpose: The experimental package was a slightly modified version of one flown in August, 1974. The purpose again was to measure the large-scale anisotropy of the cosmic microwave background at wavelengths of 1 1/2 and 3 cm. Such information can be used to determine the velocity of the earth relative to distant galaxies.

Results: Both microwave receivers performed satisfactorily at float, and 9 hours of good data were obtained. We are still in the early stages of data analysis. Preliminary indications are that we should be able to get down to the desired 0.1% sensitivity level in measuring the anisotropy.

Publications: A complete description of the flight and results is intended to go into the Ph.D. dissertation of B. Corey (Princeton University, 1975).

Dr. Giovanni Fazio, Center for Astrophysics HCO/SAO and University of Arizona

Flight 890-P, 17 May 1975

Purpose: To perform high resolution mapping and photometry of celestial sources at far infrared (40-250 microns) wavelengths, using a 102-cm balloon-borne telescope of the highest sensitivity.

Results: The flight was extremely successful, generating some of the highest resolution maps ever obtained at far infrared wavelengths with the greatest sensitivity available anywhere. During 8 hours at float, 19 sources were investigated. The more important observations include the Galactic Center Region, the Rho Ophiucus dark cloud, NGC 7538, and a cluster of seven H-II regions in the Southern Hemisphere near RCW-122. Maps were obtained with a 1' FWHM resolution and an absolute position of ± 10 arc sec. The noise equivalent flux was ~ 70 JY/(H_β)^1/2.

Publications: Two papers to be presented at the 146th AAS meeting in San Diego:


Flight 899-P, 16 June 1975

Purpose: To perform high resolution mapping and photometry of celestial sources at far infrared (40-250 micron) wavelengths using a 102-cm balloon-borne telescope of the highest sensitivity.

Results: The flight was extremely successful, again generating some of the highest resolution maps ever obtained at far infrared (40-250 microns) wavelengths, with the highest sensitivity available anywhere. During 8 hours at float, 17 sources were investigated, including the Galactic Center region, the infrared Star IRC-10216, Uranus, the H-II Regions M8, M20, M16, M17, W31, W33, the R Cr Aus. dark cloud, two H-II regions at -50 degrees declination and two galaxies, M82 and M83. Resolution and sensitivity were similar to flight 890-P.

OPTICAL AND UV ASTRONOMY

Drs. Y. Kondo, NASA/Johnson Space Center and J. Modisette and Thomas H. Morgan, Houston Baptist University

Flight 855-P, 9 October 1974

Purpose: To investigate stellar chromospheres, extended shells and mass loss through observations of the Mg II spectral features near 2800Å. Observations are performed by means of a balloon-borne ultraviolet stellar spectrometer.

Results: Seven stars, including two supergiants and a giant, were successfully observed.

Publications: Thus far, two journal publications and a meeting report resulted.


Flight 878-P, 14 March 1975

Purpose: To investigate stellar chromospheres, extended shells and mass loss through observations of the Mg II spectral features near 2800Å. Observations are performed by means of a balloon-borne ultraviolet stellar spectrometer.
Results: Twenty stars, including four supergiants and eight giants were successfully observed.

Publications: We are in the process of reducing and analyzing the observations. Publications are expected in the near future.

Drs. A. Boksenberg, University College London, and B. Bates, Queen's University, Belfast

Flight 857-P, 11 October 1974

Purpose: To photograph high-resolution spectra of early-type stars over the wavelength range 274 nm to 287 nm. Interstellar and stellar information on abundance of magnesium was the primary purpose leading also to the interstellar electron density to each star observed.

Results: No scientific data were obtained on this flight.

Publications: In this period papers were submitted, based on data from earlier flights. A paper on interstellar data was presented at the second European Regional Conference on Astronomy, at Trieste, Italy. Another paper is in press with the Royal Society. Detailed analyses of unreddened stellar data will be submitted to the Astrophysical Journal shortly. Two Ph.D.'s were awarded in this period, for work based on previous flights in this series.

SOLAR PHYSICS

Dr. R. Zander, Universite de Liege

Flight 854-P, 9 October 1974

Purpose: This flight was specifically devoted to the recording of the solar spectrum in the 2.5 to 2.8 microns region.

Results: The flight was successful and provided good solar spectra from 2.46 to 2.84 microns, with a spectral resolution of 0.04 cm\(^{-1}\). Fraunhofer lines have been identified and further informations on the concentration of CO\(_2\) and H\(_2\)O in the upper stratosphere have been deduced.

Flight 862-P, 20 October 1974

Purpose: This flight was the first one related to the second phase of our balloon program; the recording of the solar spectrum in spectral intervals lying between 3.0 and 15.0 microns, not accessible from the ground.

Results: Special attention was devoted to the investigation of telluric minor constituents. Very good sample data have been re-
corded between 3.3 and 8.1 microns, using a gallium doped germanium detector cooled down to 1.9° K with liquid helium. The spectral resolution is $(0.03 \pm 0.01) \text{ cm}^{-1}$. The data already analysed have provided precise values of the concentration of $\text{CH}_4$, $\text{N}_2\text{O}$, NO above 30 km altitude.

Dr. J. Mehlretter, Fraunhofer Institut

Flight 889-P, 17 May 1975

Purpose: This flight was the first successful flight of "Spektro-Stratoskop", a telescope and spectrograph for high-resolution solar observations.

Results: The flight, with a total of 5 1/2 hours of pure observation time, resulted in about 400 spectrograms and 1000 white light pictures of photospheric granulation, mainly at the center of the solar disk.

Publications: The observations are intended to support studies of dynamics in the solar atmosphere, leading to a better understanding of the processes causing the granulation and the nature of this phenomenon.

OTHER

Dr. R. Yasui, Jet Propulsion Laboratory


Purpose: These flights were conducted to provide calibration data on the short circuit current output of solar cells above 99.5% of the earth's atmosphere. When recovered, the individual solar cells are used as light intensity reference standards in either artificial light or terrestrial sunlight to aid in the evaluation of similar solar cells or solar arrays.

Results: The solar cells and associated sun tracking equipment were recovered without damage and the calibration data proved to be of high quality.

Publications: Calibration data is presently available in computer printout form and will be published as part of a final report expected to be released in July, 1975.