# NATIONAL SCIENTIFIC BALLOON FACILITY
# LONG DURATION BALLOON FLIGHT
## FY '03 APPLICATION FORM

This Flight Request form is for users requesting LDB (Long Duration Balloon) Flights only. If you anticipate a conventional flight requirement in addition to a LDB flight, please provide complete details for your conventional support on the standard NSBF Flight Request form. Please complete this form in its entirety and return to:

**Attn: LDB Flight Request**
**National Scientific Balloon Facility**
**P.O. Box 319: FM 3224**
**Palestine, Texas 75802-0319**

**Telephone: 903 729 0271 Fax: 903 723 8056**

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Questions? Direct inquiries concerning LDB support to:

Bill Stepp
Operations Manager
Tel. (903) 723 8035
Fax (903) 723 8056
E-mail: Bill.Stepp@master.nsbf.nasa.gov

Bryan D. Stilwell
LDB Group Supervisor
Tel. (903) 723-8097
Fax (903) 723-8082
E-mail: stilwell@master.nsbf.nasa.gov

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1. Principal Scientific Experimenter:

________________________________________
(Name)

________________________________________
(Organization)

________________________________________
(Address)

________________________________________
(City) (State) (Country) (Postal Code)

________________________________________
(Telephone) (Fax)

________________________________________
(Email Address)

2. Co-Investigator (Please list the Co-Investigator who will have primary responsibility on this flight):

______________________________________________
(Name)

______________________________________________
(Organization)

______________________________________________
(Address)

______________________________________________
(City) (State) (Country) (Postal Code)

______________________________________________
(Telephone) (Fax)

______________________________________________
(Email Address)

3. Project Officer or Delegate familiar with engineering aspects of experiment:

______________________________________________
(Name)

______________________________________________
(Organization)

______________________________________________
(Address)

______________________________________________
(City) (State) (Country) (Postal Code)

______________________________________________
(Telephone) (Fax)

______________________________________________
(Email Address)

4. Source of Funding / Research Grant:

5. Number of Flights: _______________ Dates: _______________

6. Launch Location: ______________________________________________

7. Dimensions of Science Payload: _______________ Weight: _______________
**(Enclose Drawings or Photos if Available)** **(Science Only)**

8. Desired Float Altitude: _______________ Desired Float Duration: _____________

9. Describe minimum altitude requirement, altitude stability, ascent/descent rate requirements, and any other particular altitude requirements you may have:

________________________________________________________________

________________________________________________________________

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________________________________________________________________

10. NSBF normally provides steel shot as ballast. Please indicate your preference if you desire other than steel ballast: (STEEL / GLASS)

11. List any restrictions on the proximity of the science payload to other equipment, electronics, ballast, or to the balloon. List any special balloon design specifications that you are aware of, e.g. no radar reflective tape, attached ducts, minimum polypowder lubrication, etc.

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

12. Has this payload been flown before by the NSBF? (YES / NO)
(Note: New payloads require a “test flight” prior to integration for a LDB mission.)

Launch Location: ______________________________________________

Date(s): ______________________________________________________

13. Are other experimenters participating with you in the flight(s) covered by this request? (YES / NO)

Please provide their names and organizations: ____________________________

________________________________________________________________

________________________________________________________________

If this is a cooperative program, describe each party's degree of involvement:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

14. Please provide names of <u>all</u> participants in your group who will be supporting the flight. This list must include all personnel at the launch site. In case of campaigns outside the United States, the NSBF and NASA are required to inform the host country about the nationality of all campaign participants.

| NAME / CITIZENSHIP | NAME / CITIZENSHIP |
|---|---|
| ______________________ | ______________________ |
| ______________________ | ______________________ |
| ______________________ | ______________________ |
| ______________________ | ______________________ |

Non U.S. citizens will not be allowed on any launch site without prior approval. Please provide the following for each non U.S. citizen:

a.) Birthplace

b.) Date of Birth

c.) Passport Number

d.) Country of Citizenship

15. LDB payloads require pre-deployment integration and testing with all flight systems in the "FULL UP" mode to include LDB support systems and Science instruments, electronic systems and any flight computer software.
All gondola fabrication must be completed at this time as well. All pre-deployment integration and testing is normally performed at the NSBF facility in Palestine, Texas during July for upcoming Antarctica flights and during March for upcoming Fairbanks flights. Please delineate the location, a.) Pre-deployment Integration or b.) Launch Site when answering the following:

**Gases:** List the quantity and type of gases that you wish the NSBF to order in support of your program. Refer to enclosure 2 for specific instructions.

a.) Palestine: ________________________________________________

________________________________________________

b.) Launch Site: ________________________________________________

________________________________________________

**Radioactive Materials or Lasers:** Will you be using radioactive material or lasers in flight? (YES / NO) ; in ground support? (YES / NO) ; in calibration? (YES / NO).

If yes, list radioactive sources / lasers to be used to include their maximum activity / wattage:

a.) Palestine: ________________________________________________

________________________________________________

b.) Launch Site: ________________________________________________

________________________________________________

**Expendables:** Other than those directly required by the NSBF for its flight support, expendables must be paid for directly by the experimenter's group or from monies transferred to NASA and made available to the NSBF as described in Enclosure 2. The NSBF will assist in determining whether these items are considered routine support. List those items which you expect NSBF to provide for you:

a.) Palestine: ______________________________________________

______________________________________________

b.) Launch Site: ______________________________________________

______________________________________________

**Services:** The NSBF has a machine shop and environmental test facilities which can be made available for your use during the pre-deployment integration. Such services are limited or non-existent at the launch site. List any such services you require:

a.) Palestine: ______________________________________________

______________________________________________

**AC Power Requirements:** List your AC Power Requirements to include voltage, phase, line frequency, and nominal current. Please identify peak current loads you may impose.

a.) Palestine: ______________________________________________

______________________________________________

b.) Launch Site: ______________________________________________

______________________________________________

**Work Space Requirement:** Please list your work space requirements. (Please note such things as hoists, Internet connects, etc.)

a.) Palestine : ______________________________

______________________________

b.) Launch Site: ______________________________

______________________________

16. Do you anticipate not having any portion of your experiment completed and in "flight ready" mode at the end of the pre-deployment integration? Are there requirements which preclude having everything assembled due to the nature of the instrument (e.g. emulsions prepared after scheduled pre-deployment integration and shipped directly to launch site for final installation before launch)? Please explain:

______________________________

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17. Do you require any portion of your experiment to be shipped anywhere other than directly to the launch site once pre-deployment integration is completed? Please explain:

______________________________

______________________________

______________________________

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18. Briefly describe the scientific experiment and its objectives in layman terms:

______________________________________________________________

______________________________________________________________

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19. Do you plan to fly a pointing rotator / free swivel? (YES / NO)

Please describe your pointing requirements to include the direction of pointing and duty cycle of pointing for each of your observations or reason for a swivel requirement:

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

20. Has this rotator / swivel been previously flown? (YES / NO)

When was it last flown? ____________________________

When was it last modified? ____________________________

When was it last pull-tested? ____________________________

Note: The NSBF requires strict compliance with the established policy requiring all single-point failure threaded fasteners to be procured from an approved source. Single-point failure fasteners will be tested to confirm that they are manufactured as specified. Refer to Enclosure-4 for a copy of the established policy and approved threaded fastener source list.

21. A thermal analysis is required for all LDB flights. Has a thermal analysis been performed on this instrument and gondola? (YES / NO)

22. Please describe your proposed placement of the SIP onto the gondola to include description of structure used to protect the SIP upon impact. (Please include drawings for illustration. Preliminary hand drawn illustrations are acceptable if that is all you have available at this time.) Annotation of your components adjacent to the SIP along with a description of what they contain, power consumed, thermal coatings, etc. is highly desirable. Refer to Appendix E.

______________________________________________________________________

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**The LDB Telemetry and Electronics Support differs from the conventional support. Please refer to the attached appendices as a guide and reference for completing this section of the flight application form.**

23. LDB Telemetry Requirements:

Please place a checkmark in each category for the type of telemetry subsystem you plan to utilize. Currently, the Antarctica Configuration SIP utilizes the TDRSS (COMM1) and HF/ARGOS (COMM2) subsystems. The Mid-Latitude SIP Configuration utilizes the TDRSS (COMM1) and INMARSAT-C (COMM2) subsystems. The Science Stack is normally used for those experimenters who do not have a flight computer of their own with which to interface to the COMM1 and COMM2 science ports (but can be used for redundancy). LOS (Line-Of-Sight) commanding is available through each COMM system over the science ports and to the Science Stack (option). Commanding via the COMM systems is available through the COMM science ports or to the Science Stack.

Science flight computer and ground computer interface requirements are provided in Enclosure 8 and Enclosure 9 respectively. It is understood that the experimenter will arrive at NSBF for pre-campaign integration with interface connectors and proper cable lengths ready for integration. GSE computer and flight computer processing software will also be written, installed, and tested prior to arrival at NSBF.

(For TDRSS SIP configurations, it is an absolute requirement that the experimenter's GSE computer be at Palestine. Experimenter's are responsible for setup and operation of their GSE equipment.
For other SIP configurations, the experimenter is encouraged to utilize the capability available at the OCC to supplement the data received at the ROCC.)

| LDB SUPPORT INSTRUMENT PACKAGE SUBSYSTEM | CHECK IF YOU INTEND TO USE. |
|---|---|
| TDRSS (COMM1) HIGH RATE AND LOW RATE SCIENCE PORT | |
| HF (ANTARCTICA ONLY) LOW RATE SCIENCE PORT | |
| INMARSAT-C (COMM2) LOW RATE SCIENCE PORT (Mid-Latitude Only) | |
| SCIENCE DEDICATED LOS L-BAND/S-BAND RETURN TM | |
| SCIENCE DEDICATED ARGOS PTT (YOU CONTROL THE PTT, REFER ENCLOSURE 12) | |
| GSE INTERFACE WITH LDB AT THE LAUNCH SITE | |
| GSE INTERFACE WITH LDB AT THE POCC IN PALESTINE, TEXAS | |
| SCIENCE STACK INTERFACE FOR HOUSEKEEPING AND CMDS. (OPTION) REQUIRED IF YOU NEED OPEN COLLECTOR DISCRETE COMMANDS FROM SIP. | |

24. Do you intend to furnish your own "forward" command system or "return" telemetry system? If so, please provide the following information:

| Frequency | Purpose | Data Rate | Modulation | Authorization No. |
|---|---|---|---|---|
| ________ | (TM / CMD) | ________ | _________ | ______________ |
| ________ | (TM / CMD) | ________ | _________ | ______________ |
| ________ | (TM / CMD) | ________ | _________ | ______________ |
| ________ | (TM / CMD) | ________ | _________ | ______________ |

25. LOS (Line of Site) return telemetry via L-Band or S-Band transmitter is normally offered only during ascent and while within range of the launch site. If you indicated a desire to use this support, please provide the following information:

Data Rate? __________ Coding? (i.e. NRZ, Bi-Phase) ___________

(Analog tape recording of LOS Return Telemetry is standard for all balloon flights.)

Do you require a PCM Decommutator / Bit Sync?____________________
(PCM Encoders are not provided by NSBF.)

26. Please list your flight instruments power requirements (voltage / watts):

____________________________________________________________________

____________________________________________________________________

Do you intend to utilize a PV Power system? (YES / NO)
(NSBF does not provide PV Power systems for experimenters. However, NSBF can assist you with selection of a vendor for a LDB approved PV Power System.)

Do you intend to utilize Lithium Batteries for flight use? (YES / NO)

Do you require the NSBF to purchase your lithium batteries? (YES / NO)

List your lithium battery requirements below, to include any batteries you may require for pre-flight ground testing:

| **Battery** | Cells/Pack | Loaded Voltage | Amp-Hour Capacity | Quantity Required |
|---|---|---|---|---|
| B7901-10 | 10 | 26 | 30 | |
| B7901-11 | 11 | 29 | 30 | |
| B7901-12 | 12 | 32 | 30 | |
| B9660 | 10 | 26 | 8 | |
| B9525 | 5 | 14 | 8 | |
| B1347 | 5 | 14 | 1 | |
| G20-12 | 1 | 2.6 | 8 | |
| G62-12 | 1 | 2.6 | 30 | |

(Batteries ordered per this request will be held by NSBF only for the fiscal year the flight request is submitted. Should you be required to submit another Flight Application, even though you have not used the batteries from an earlier request, be sure to specify your battery requirements.)

Do you require the lithium batteries during pre-campaign integration at Palestine? (YES / NO)

# PRE-FLIGHT SUCCESS CRITERIA

Notes:

1. The NSBF always strives to meet the comprehensive success criterion as established by the experimenter. Therefore, unless a reasonable chance exists of meeting that criterion as stated, the flight application will be deemed unacceptable.

2. At the launch site, the NSBF will make very effort to meet the comprehensive success criterion. Under no circumstances will the NSBF attempt to launch your experiment unless the minimum success criterion can be met.

**Please type or print legibly.**

1. Briefly state the minimum scientific objective which must be met to achieve a mission success. ____________________________________________

   ____________________________________________

2. Balloon Performance Requirements:

   Float Duration (Hrs) - Desired___________; Minimum Acceptable

   Float Altitude (Ft) - Desired___________; Minimum Acceptable
   Altitude Stability - Desired_____________; Minimum Acceptable

   Give full details of any other pertinent balloon and/or NSBF support systems (telemetry, commanding, recovery, etc.) performance requirements with desired and minimum criteria.

   ____________________________________________

   ____________________________________________

3. Experiment Performance - Detectors, Pointing Systems, etc. (Give a summary of the desired and required performance for the experiment.

   ____________________________________________

4. Provide details on any other data source or support element separate from the balloon flight but necessary to achieve mission success (e.g., instrumented sounding balloons, instrumented aircraft, satellite overpass, independent ground station measurements, National Weather Service Radiosonde Data, NSBF Radar Tracking Data).

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

5. Proposed Date of Flight ____________________

Launch Site ____________________

____________________

Name (Type or Print) ____________________

____________________

Organization ____________________

____________________

Signature ____________________

Date ____________

# GENERAL POLICY/PROCEDURAL INFORMATION

## EFFECTIVE FY 1993

## 1. BALLOON FLIGHT SUPPORT APPLICATION

All scientific groups requesting NASA/NSBF support must submit a Balloon Flight Application. The form is issued from, and must be returned to the NSBF by 1 June for each application year. Initial point of contact with the NSBF is Mrs. Bettie Furman (telephone, 903-723-8002). Normally, the application is valid only for the next fiscal year.

**Science groups requesting Long Duration Balloon (LDB) support involving transcontinental flights or launches from Antarctica must submit a LDB Flight Application at least two years in advance of the requested support. The advance application for LDB flights is due to the long lead time required for logistics in addition to operational planning with associated support organizations.** Mr. Bobby Nock (telephone 757-824-1324) is the NASA LDB Program Manager and he should be contacted directly regarding LDB flight support applications. Specific details regarding LDB flight requirements not addressed in the Balloon Flight Support Application forms will be covered through direct contact with the science group.

Science groups that are submitting a Balloon Flight Support Application for the first time, or groups that are submitting an application for a new gondola that has not been launched by NSBF before, must also contact the NASA Balloon Projects Branch. The points of contact are Mr. Harvey Needleman or Mr. Bobby Nock. This contact is to inform NASA of the new project and enable planning to begin prior to the time that NSBF submits the proposed flight program to NASA. Contact should be made about the same time that the Balloon Flight Support Application is submitted to NSBF.

Mr. Harvey Needleman or Mr. Bobby Nock
NASA/Goddard Space Flight Facility
Wallops Flight Facility
Balloon Projects Branch
Wallops Island, Virginia 23337
Telephone: (757) 824-1453 or 1324
Fax: (757) 824-2149

## 2. PRE-FLIGHT MINIMUM SUCCESS CRITERIA

All scientific groups requesting NASA/NSBF flight support must submit the Pre-Flight Minimum Success Criteria form, along with the Balloon Support Application. This form provides insight into the science performance requirements, and it is used to assess the scientists needs. The launch support group will use the requirements for flight planning. A launch will not be attempted without assurance that the minimum scientific requirements can be met. Furthermore, a launch will not be attempted without a realistic probability of being able to achieve the desired scientific requirements. Therefore, the experimenters should be realistic in specifying criteria.

The NSBF should be informed of any changes in requirements or schedule as they may effect costs and program plans.

## 3. NOTIFICATION

The scientific group will be notified within three weeks of the application receipt and informed of any problems associated with flight requirements. Subsequent notification will be made upon receipt of NASA flight program approval.

## 4. NON-NASA-SPONSORED PROGRAMS

All funding for non-NASA sponsored users must be provided through fund transfers from the sponsoring agency to NASA. Upon receipt of the funds, NASA approves the NSBF to establish an account for the user. (A users fee is not assessed to national users.)

Foreign users are required to have a Memorandum of Understanding (MOU) with NASA Headquarters. Additionally, foreign users will be assessed a users fee for each flight. All funding, including the users fee must be provided to NASA as per the established MOU.

No direct procurement can be made by the NSBF for services until the necessary agreements are in place and monies have been received from the user.

Information regarding cost estimates, contractual agreements, MOU's with NASA and instructions pertinent to the transfer of funds may be obtained by contacting:

Ms. Bernice Merritt
NASA/Goddard Space Flight Center
Wallops Flight Facility
Balloon Projects Branch
Wallops Island, Virginia 23337
Telephone - (757) 824-1353

## 5. CAMPAIGN REQUIREMENTS MEETING

Every major remote campaign on large projects requiring operational support will include a Campaign Requirement Meeting (CRM). Each science group is required to participate in a scheduled CRM to review NSBF support plans as well as science requirements once the project or campaign has been approved.

**LDB Flights will undergo more stringent review than that which is performed for conventional flights to include:**

- **Project Initiation Conference (PIC).**
- **Pre-Campaign Conference.**
- **Continental U.S. Test Flight (new gondolas).**
- **Review of Thermal and Mechanical Certification.**
- **Pre-deployment integration with LDB Support Systems and compatibility testing at Palestine, Texas.**
- **Mission Readiness Review (MRR) following pre-deployment integration.**

## 6. USER PURCHASED BALLOONS

The NSBF will launch balloons purchased directly by the users. However, the balloon design and manufacturing records must be reviewed by the NSBF to assure compliance with NASA/NSBF specification and quality control.

## 7. BATTERIES

The NSBF provides batteries to NASA programs and upon request, will act as a battery purchasing agent for non-NASA funded experimenters. Batteries cannot be purchased until funds are received by NASA and authorization is received by NSBF. However, only lithium cells and/or packs of the type routinely used by the NSBF will be available. The user should detail battery requirements in Part II of the Balloon Flight Support Application (Enclosure 1) and ensure that the necessary funds are made available.

## 8. GONDOLA DESIGN CERTIFICATION

All range users must provide NSBF with gondola and suspension structural design information, material specifications, load test information, etc., prior to arrival at the launch site. Final gondola design certification shall be performed by the NSBF using the NASA/NSBF accepted criteria. NASA-sponsored experimenters requesting balloon flights at launch sites other than Palestine, Texas and not requiring NSBF services shall forward this information to the Balloon Projects Branch at Wallops Flight Facility. Any further distribution will be made from that office. Details of these criteria are included in Enclosure 3.

## 9. RADIOACTIVE SOURCES

All range users must submit the following documentation to the NSBF Radiological Safety Officer at least four weeks prior to the arrival of the science group to a launch site:

a. Copy of the Radioactive Material License for their institution.

b. Current leak test documentation for all radioactive material. License and laws of the State of Texas require that Alpha-emitting sources be tested every three months.

Other sealed sources must be tested every six months. Any source arriving without a current test certificate will be impounded until it is leak tested, even if it requires gondola disassembly. The scientific investigator will be responsible for all costs incurred for leak tests at the NSBF.

c. A list of the individuals in the science group who are authorized to handle radioactive sources.

In addition, range users who intend to bring radioactive sources to the NSBF or other launch site are required to complete the Radioactive Material Hold Harmless and Indemnification (Enclosure #4). This form is to be submitted with the Balloon Flight Support Application.

**LDB experimenters are required to contact the NSBF Campaign Manager for coordination of shipment and handling of sources being used at the various launch sites. For Antarctica, this information must be submitted with the ASA (Antarctica Support Associates) Support Information Package which is submitted in April prior to the Antarctic summer season which the sources will be used.**

## 10. WAIVER OF CLAIMS

All user institutions and users are required to complete the NSBF Waiver of Claims Form (Enclosure # 5).

The person signing for the user institutions and users must be someone who can "bind" the organization, e.g., Contracting Officer, Contracting Manager, Principal Investigator, Division Head.

The NSBF will retain the waivers on file by institution name, through the effective date on the claim form. This form will cover all scientists from their respective institution for that time period.

The waiver form should be sent by the user institution or user, with the other data that is provided when a scientist makes a request for NSBF services.

The scientist must understand that both the scientist and his/her employer have to sign the waiver and return it to the NSBF before flights will be authorized.

If a scientist or institution has questions concerning the waiver form, they should contact Ms. Bettie Furman Administrator, NSBF Site Managers Office.

## 11. GASES

In order to assure timely delivery of cryogens and specialty gases, the following procedure must be followed:

**FOR DOMESTIC FLIGHTS:**

> **No less than fourteen (14) days** prior to arrival at launch site, each science group is requested to notify Ms. Bettie Furman of their cryogen/specialty gas requirement. This may be accomplished by letter or via telephone at NSBF, (903) 723-8002.

**FOR REMOTE CAMPAIGNS:**

> **No less than twenty-one (21) days** prior to arrival at launch site, each science group is requested to notify Ms. Bettie Furman of their cryogen/specialty gas requirement. This may be accomplished by letter or via telephone at NSBF, (903) 723-8002.

**LDB Flight cryogen and gas requirements are handled differently than that for conventional flights. The NSBF Campaign Manager will coordinate with the LDB science user concerning gas and cryogen support. For Antarctica, certain logistics demands may require shipment of specialty gases as much as a year in advance. Therefore, it is important to identify these needs early enough to accommodate your needs. Any gases or cryogens required during the pre-deployment integration at Palestine will be handled in accordance with the other instructions contained in this section.**

The Administrator in the NSBF Site Manager's Office will ensure the gases are ordered, only after notification as outlined above. Even if such gases were identified on the flight request, you must still notify Ms. Furman at the NSBF.

Liquid nitrogen, liquid helium, dry oxygen, argon, nitrogen and helium can be readily obtained. Any other type of gas is considered a specialty gas. **Please allow thirty (30) days for delivery of specialty gases for domestic flights and forty-five (45) days for remote campaigns.**

Hospital grade and industrial grade dry nitrogen is readily available.

Orders will be placed only for those flights which have been approved. Each flight, that has been approved, has an established funding level based upon the information you provided in the flight request. Should your gas requirement exceed this level, NASA will have to provide approval for any dollar amounts exceeding the established funding level.

## 12. POST FLIGHT SCIENCE ASSESSMENT

A post flight assessment of the preliminary science results is required. A form is available from NSBF, and it will be given to the Principal Investigator at the post flight critique held by the NSBF Operations Department. The completed form should be mailed to Mr. Harvey Needleman, NASA-WFF, at the address on the form. NASA-WFF will not establish the NASA-reported mission performance until a post flight assessment form is received. Significant delay in receipt of the form could impact future flight support.

## 13. POINT OF CONTACT

Ms. Bettie Furman is the point of contact at the NSBF for information regarding users services. She coordinates with the proper NSBF activity to assure timely response to the users' questions. She should be informed immediately of any changes in requirements or schedule as they may affect costs and program plans. Ms. Furman can be contacted at (903) 723-8002.

## NATIONAL SCIENTIFIC BALLOON FACILITIES

## STRUCTURAL REQUIREMENTS FOR BALLOON GONDOLAS

The gondola certification program helps to ensure that containment frames and suspension systems supplied by scientists are mechanically capable of withstanding the stresses placed on them by launch, flight, termination, and impact.

**For LDB Flights, serious consideration must be given to the recovery aspects (note Enclosure 11 - Mechanical; *Recovery Requirements)* when planning the dismantling and gondola component breakdown requirements.**

The NSBF Engineering Department uses the scientist's design information and stress analysis to assess a gondola's suitability and to certify the structure. The scientist is responsible for the design and analysis of the gondola. The gondola stress analysis must be performed by an engineer whose qualifications must be provided to the NSBF in the form of a brief resume. Primary point of contact is the Manager of NSBF Engineering contacted through Ms. Bettie Furman at (903) 723-8002.*

Although NSBF engineers are available to answer questions on design problems or unusual projects, the NSBF certifying engineer's primary role is to identify critical structures, determine whether the analysis has examined these structures and spot-check pertinent calculations. Based on the stress analysis provided, the engineer gives the gondola an overall rating and determines how much weight the entire structure can handle. The scientist then is notified upon approval of the design and stress analysis.

Using the following guidelines, the scientist must provide design specifications and a stress analysis of the gondola to the NSBF at least 60 days prior to the anticipated flight date.

1. Drawings showing the relative locations and dimensions of all structural and load-bearing gondola members. Materials identification shall be included in all drawings.

2. At least one complete assembly drawing.

3. Working drawings and specifications for all purchased and fabricated mechanical components and assemblies that are part of the flight train (e.g., rotators, swivels, turnbuckles, crevices, rings, and universal joints).

4. A stress analysis of all major structural members, including decks and ballast attachment points. Identify the components, equipment, and weights comprising the loads.

5. A statement certifying that the aforementioned requirements have been met. This statement must be signed by the principal investigator and the engineer responsible for the gondola structure.

The documentation for a certified gondola design is filed by the NSBF Engineering Department, and gondolas need not be re-analyzed for subsequent flights unless design changes are made. However, NSBF engineers visually reinspect the assembled gondola before each flight, and the principal investigator is required to sign a statement verifying that the previously certified design was not changed.

The following design criteria should be used in planning gondola structures and suspension. Gondolas must be designed so that all load-carrying structural members, joints, connectors, decks, and suspension systems are capable of withstanding the conditions listed below without ultimate structural failure.

1. A load 10 times the weight of the payload applied vertically at the suspension point.

2. For multiple-cable suspension systems, each cable must have an ultimate strength greater than five times the weight of the payload divided by the sine of the angle that the cable makes with horizontal (should be >30 degrees) in a normal flight configuration. Cable terminations, cable attachments, and gondola structural members must be capable of withstanding the load described above. Some exceptions to this criterion may be allowed for gondolas with more than four suspension points at the discretion of the NSBF certifying engineer.

3. A load five times the weight of the payload applied at the suspension point and 45 degrees to the vertical. This load factor must be accounted for in the direction perpendicular to the gondola's short side, perpendicular to the gondola's long side, and in the direction of the major rigid support members at the top of the gondola structure. If flexible cable suspension systems are used, they must be able to withstand uneven loading caused by cable buckling.

4. A side acceleration of 5 g applied to all components and equipment attached to and/or onboard the gondola structure or any portion of the flight system below the balloon.

5. All critical mechanical structures and assemblies must consider the effects of stress concentration factors when analyzed. The ultimate strength of the element should be derated proportionately to the applicable stress concentration factor. The stress concentration factors shall be based upon the specific load case and standard mechanical engineering design practices. A specific example of a structural element in which stress concentrations are to be considered is the shaft and housing of a swivel or rotator assembly.

   If a particular element does not pass when derated by the full effects of the stress concentration factor, the stress analyst must demonstrate that other factors such as material ductility offset the effects of stress concentrations. For instance, a tensile/pull test of an assembly can be used to demonstrate that it has an ultimate strength greater that the above criteria will allow. The NSBF recommends that proof tests be conducted by the science group as a standard practice to ensure that their hardware has adequate strength.

6. The ductility of all materials used for critical mechanical elements shall be considered in the analysis of the gondola structure. Specifically, the NSBF does not encourage the use of materials that are determined to be brittle or that are not recommended for use in shock loading applications. Close examination of all materials that have a percent elongation less than or equal to 10% at an ambient temperature of -60 degrees Celsius shall be made to determine if the material is to be considered brittle.

   If a material is determined to be brittle, the certification criteria listed in paragraphs 1, 3 and 4 must be multiplied by a factor of 1.5. That is, the particular element that is fabricated using a brittle material must be able to sustain a 15 g vertical load, a 7.5 g load at 45 degrees, and a 7.5 g horizontal load without failure.

The gondola design also must ensure that all scientific equipment, NSBF equipment, and ballast remain contained when subjected to the loads described above and that the gondola is capable of supporting the weight of NSBF equipment. The NSBF Engineering Department should be contacted during the design stage for information on equipment and ballast weight for the flight.

The following assumptions are made by the NSBF certifying engineer in reviewing gondola design analysis:

1. The suspension point is defined as the point where the scientist-furnished gondola suspension equipment interfaces with the NSBF furnished flight system hardware.

2. The payload weight includes the gondola structure, all scientific equipment and components, and all NSBF equipment (including ballast) affixed to the structure below the gondola suspension point.

3. For analysis purposes, the base of the gondola may be assumed to be rigidly fixed (i.e., in a static condition). Other boundary conditions may be used upon prior approval of the NSBF.

The final stage of gondola certification is a visual inspection by an NSBF engineer. The gondola is checked for adequate suspension and crush pad cushioning. In addition, the certifying engineer checks welds and verifies that the construction matches the description submitted by the user.

*Manager of Engineering will assign a staff engineer to interface with each payload group.

# GSFC FASTENER INTEGRITY REQUIREMENTS

The Suborbital Projects and Operations Directorate (SPOD) is requesting exclusion for SOD programs except as noted herein.

The sounding rocket and balloon programs are established efforts that share the relatively low cost, high risk, rapid response philosophy of obtaining a maximum in scientific return at a minimum cost. The programs have relied on comprehensive testing structural analysis, and inspection to serve as the check and balance for flight reliability.

To ensure the integrity of fasteners used in Code 800 flight programs, but in keeping with the nature of these programs, Code 800 will implement a new policy. This requires all future procurements of structural threaded fasteners intended to be used for flight hardware and safety critical (where a single failure could result in injury to personnel or damage to property or flight hardware by dropping or losing control of the load) nuts and bolts and GSE hardware to be procured from one of the following, or to include a requirement to meet a tensile load specification.

a. Defense Industrial Supply center

b. Vendors that appear on the approved sources list (Appendix I of GSFC Spec. S-313-100)

c. Vendors supplying traceable certifications

A minimum sample of three items from each procurement will be tested to demonstrate compliance with the procurement specification, unless procured from sources a,b, or c above. Items exceeding the tensile test capability or which for other reasons are not suitable for tensile test may be hardness tested to determine equivalent strength. Organizations not having testing capabilities may send sample test items to the Experimental Mechanical Construction Section (Code 821.2) for testing.

Threaded fasteners which are single-point failure items on flight hardware or which have single-point failure with personnel safety implications on ground support equipment will be load tested and visually inspected in all cases.

This same policy will be imposed on the contractors for hardware provided in support of these programs. The flight experimenters, however, would be considered exempt from these policies although they would be informed of the concerns and the approved sources and would be offered the use of services of Code 821.2 for sample testing of threaded fasteners. Successful comprehensive testing of integrated systems will still provide the basis for final flight approval, except for the balloon program. The balloon program will continue to rely on structural analysis, inspection, and in the case of single-point failure fasteners, tensile or hardness testing will be performed. Safety critical items, in all cases, will continue to be emphasized.

If you have any questions about the implementation of this policy, contact the NSBF Engineering Manager through Bettie Furman at (903) 723-8002.

# LIST OF GSFC-APPROVED MANUFACTURERS

(From: Appendix I, GSFC S-313-100)

Safe life or single-point fasteners must be made by these manufacturers or by manufacturers that are audited by the developer. Fasteners may be purchased directly from the manufacturer or from any distributor.

B&B Specialties Inc.
4321 E. La Palma Avenue
Anaheim, CA 92807
(714) 993 1600

BEK Level 1 Inc.
721 E. Compton Blvd.
Compton, CA 90220
(310) 324 0580

Bristol Industries
630 E. Lambert Rd.
Brea, CA 92622
(714) 990 4121

California Screw Products
14957 Gwenchris Ave.
Paramount, CA 90723
(213) 633 6626

Crescent Mfg. Co.
700 Geo. Washington Tpk.
Burlington, CT 06013
(203) 673 2591

Fastener Innovation
Technology Inc.
13215 South Western Avenue
Gardena, CA 90249
(213) 538 1111

Fastener Technology Corp.
7415 Fulton Avenue
North Hollywood, CA 91605
(818) 764 6467

GS Aerospace
1307 Wanamaker Ave.
Ontario, CA 91761
(714) 988 0053

Hi-Shear Corp.
2600 Skypark Dr.
Torrence, CA 90509
(213) 326 8110

Mercury Aerospace Fasteners

11800 Sherman Way
P.O. Box 9759
North Hollywood, CA 91609
(818) 982 4800

J.I. Morris Company
394 Elm Street
Southbride, MA 01550
(508) 764 4394

PB Fasteners
1700 W. 132nd St.
Gardena, CA 90249
(213) 321 3121
(limited direct sales)

Pilgrim Screw Corporation
P.O. Box 1452
120 Sprague Street
Providence, RI 02901
(401) 274 4090

Quality Aircraft Screw Inc.
1465 Brasher Street
Anaheim, CA 92807
(714) 693 5595

Screwcorp
13001 E. Temple Street
City of Industry, CA 91746
(818)369 3333 Product Info.
(310)522 0700 Product Orders

Sonic Industries, Inc.
13210 South Western Avenue
Gardena, CA 90249
(310) 532 8382

SPS Technologies
Highland Avenue
Jenkintown, PA 19046
(215) 572 3000
(215) 572 3208 Unbrako

SPS Technologies
2701 S. Harbor Blvd.
Santa Ana, CA 92702
(213) 545 9311

# HOLD HARMLESS AND INDEMNIFICATION

The ______________________________________________________________

**(Name of Institution, e.g., NASA Center, NOAA, NRL, University Name, etc.)**

agrees to Indemnify and Hold Harmless the Physical Science Laboratory of New Mexico State University (PSL/NMSU), its Regents, Officers, and employees from any liability whatsoever (including legal costs) associated with damages or death resulting from a radioactive substance provided by

______________________________________________________________

**(Name of Scientific User at NSBF)**

and carried on a balloon flight launched, flown, and recovered by PSL/NMSU National Scientific Balloon Facilities (NSBF) for the

______________________________________________________________

**(Name of Subgroup, e.g., Department, Section, etc., at Institution)**

whose address is______________________________________________

Name:_________________________________________________________

**(Official with Authority to Legally Bind Institution)**

Title:__________________________________________________________

**(Official's Title at Institution)**

Date:__________________________________________________________

**(Date Official Signs this Document)**

# Waiver of Claims
# Against The Physical Science Laboratory
# New Mexico State University

With regard to Balloon Flight Services provided by New Mexico State University/Physical Science Laboratory, the operators of the National Scientific Balloon Facilities (NSBF), under contract with the National Aeronautics and Space Administration (NASA), the requiring institution identified below, agrees not to assert any claim or claims against the New Mexico State University/Physical Science Laboratory, the National Aeronautics and Space Administration, or their employees or agents, for loss or damage to any instrument or scientific equipment (including loss of or damage to the balloon) provided by the requiring institution and carried on a Balloon Flight provided by the National Scientific Balloon Facilities, or consequential damages resulting from such loss or damages, except with respect to any such loss or damages resulting solely from the fault or negligence of the New Mexico State University/Physical Science Laboratory. This waiver shall be in effect from to________________inclusive.

Institution:______________________________________________________________________

**(E.g. Agency Name, University Name, etc.)**

______________________________________________________________________

**(Department, Section, etc.)**

Name: ______________________________________________________________________

**(Official with authority to legally bind institution)**

Title: ______________________________________________________________________

**(Title of above official)**

Date: ______________________________________________________________________

**(Date official signs this document)**

# Enclosure 7

## LDB Support Overview

**1.) LDB Launch Locations:** LDB missions are currently supported for launch from McMurdo, Antarctica, Fairbanks, Alaska and Alice Springs, Australia. LDB circumglobal flights have been conducted with the following described systems from McMurdo and Fairbanks.

**McMurdo, Antarctica:** Launches are conducted from what was formerly known as William's Field located about seven miles from McMurdo on the Ross Ice Shelf. Since 1996, the launch site has been operated exclusively as a field camp to support balloon operations. Launch site position is on or about 77.86 degrees South Latitude and 167.13 Degrees East Longitude near sea level. A single circumpolar flight trajectory is nominally 9 to 12 days, traveling to the west, and typically bounded between 73 to 82 degrees south latitude for balloon float altitudes of 115,000 to 130,000 feet. For mission planning purposes, logistics requirements are quite stringent; therefore, experiment, payload, and ground support equipment must be flight ready prior to departure from the United States. Logistics, housing, meals, and other on-site support is provided by NSF (National Science Foundation) who has responsibility for management of U.S. sponsored polar programs in Antarctica.

Launch operations are normally conducted from about 1 December through 10 January each year. However, due to end-of-season logistics, you should plan to be flight ready by 5 December so that your flight can be conducted with minimum risk of interfering with other NSF logistics support requirements. Approval for launch after January 1 through January 10 is with NSF concurrence and can be driven based upon other polar projects being supported. Flights may remain aloft as late as 21 January but recovery assets become scarcer near the end of the season. Experimenters hoping for two circumpolar trajectories should plan to be flight ready absolutely no later than 5 December in order to allow sufficient time to conduct an 18 to 21 day flight mission, allow for launch delays, and be accommodating within the NSF logistics support schedule for termination and recovery.

NSBF support personnel normally arrive at McMurdo around 15 November each year. Science personnel may arrive earlier if required to insure their flight readiness date. This scheduling will be coordinated by the NSBF Campaign Manager. Typical departure dates from Antarctica run no later than around 20th to 30th of January in order to insure complete departure of equipment and personnel before the NSF's "Winter-Over" operations begin.

Shipping of all NSBF equipment in support of each year's campaign is no later than middle of August in order to allow time for equipment to arrive at Port Hueneme, California for on-forward ocean shipment to New Zealand and then to McMurdo by air. This includes experiments, ground station equipment, flight equipment, and all final shipments required for flight support the following November. Although NSBF arranges for the shipping carrier from Palestine to Port Hueneme, experimenters are expected to provide proper shipping containers and perform their own packing prior to shipment. NSBF ships heavy items such as balloons and helium to McMurdo one year in advance so special balloon configuration requirements must be identified early enough to be built and shipped. This typically means that special balloon requirements must be identified and approved no later than the first of May for operations which require them to be used two summer seasons hence in order to allow sufficient time for special engineering considerations, construction, and shipment to Port Hueneme, California prior to on-forwarding to Antarctica.

Because shipment of equipment is due out by mid August, pre-deployment integration at Palestine must be concluded by the end of July each year. *Following this integration and compatibility testing, a Mission Readiness Review (MRR) is conducted prior to shipment to assess the readiness of both the experimenter and the NSBF.* Scheduling and special support required for the pre-deployment integration will be jointly worked out between the experimenter and NSBF once the flight request is reviewed. It should be understood that all equipment is shipped directly from the NSBF to Port Hueneme following pre-deployment integration. After pre-deployment integration, no configuration changes to the science experiment or the NSBF support systems are allowed following integration without approval from the Mission Readiness Review technical panel.

Pertinent details as to thermal environment and configuration, balloon performance, mechanical configuration, telemetry support, and ground support will be reviewed following receipt of the *Flight Application Form*.

**Fairbanks, Alaska:** Fairbanks is located about 64.67 Degrees North Latitude and 147.07 Degrees West Longitude. Launch operations are normally conducted between 1 June and 10 July of each year. Flight trajectory is to the west with a single circumglobal route bounded between 60 degrees and 70 degrees north latitude for a 9 to 12 day mission and then terminated over Alaska or Canada. Float altitudes of 115,000 to 130,000 feet can be expected.

Pre-deployment integration at Palestine will be normally concluded by the first of May. *A MRR will be conducted at Palestine following integration and compatibility testing to assess readiness prior to shipping of equipment to Fairbanks.* Scheduling and special support required for the pre-deployment integration will be jointly worked out between the experimenter and NSBF once the flight request is reviewed. It should be understood that all equipment is shipped directly from the NSBF to Fairbanks following pre-deployment integration. The NSBF Campaign Manager will coordinate final shipping from Palestine to Fairbanks. No configuration changes to the science experiment or the NSBF support systems are allowed following integration unless approved by the Mission Readiness Review technical panel.

Pertinent details as to thermal environment and configuration, balloon performance, mechanical configuration, telemetry support, and ground support will be reviewed following receipt of the *Flight Application Form.*

**Alice Springs, Australia:** As of this writing, planning and analysis is still underway for a future Alice Springs LDB campaigns. Experimenters requiring an Alice Springs launch site should contact the NSBF concerning the latest planning updates.

**2.) SIP (Support Instrument Package) Configuration:** Two SIP configurations currently exist (with some minor variance per science needs) depending upon whether you fly from McMurdo, Fairbanks, or Alice Springs. Every SIP has a similar architecture centered around a COMM1 and COMM2 flight telemetry system. Some redundancy is provided between the functions supported by COMM1 and COMM2. Each COMM system has its own flight computer which supports RS232 communications with forward and return telemetry to the science user. Each COMM system is powered off its own separate power bus (two separate PV power systems are flown for each SIP.) Enclosures 8 and 9 provide information concerning the science port interface to COMM 1 and COMM 2. The following explanation of various subsystems is provided to assist you with planning your TM support requirements.

**INMARSAT-C:** INMARSAT Standard C provides global forward and return telemetry with the balloon via four geostationary satellites located at 15.5 degrees west longitude (AOR East), 54.5 degrees west longitude (AOR West), 64.5 degrees East longitude (IOR), and 178 degrees East longitude (POR). Coverage is limited at extreme latitudes: however, it can be expected to provide over 50% coverage for Antarctica for latitudes less than 78 degrees south. Commands may be sent to the payload anytime the balloon is within satellite coverage. Commands (forward TM) can be sent from both the OCC at Palestine and the ROCC at the launch site. Data (return TM) is received at both the OCC and ROCC while the balloon is in visible satellite coverage and usually within a few minutes of transmission from the balloon depending upon the load of network traffic.

Science return telemetry and forward command data is accessed via INMARSAT through the SIP's COMM2 science port. Science users do not have direct control over the flight INMARSAT terminal. All science data written to the COMM2 science port is also logged on hard disk, for the duration of the flight mission**,** which is recovered only after flight termination and physical recovery of the science payload (see enclosure 9.) Although the COMM2 science port operates at 2400 baud, bear in mind this is a packetized system and return data throughput is one 255 byte packet every 15 minutes when the flight INMARSAT terminal is logged into a given ocean region satellite. The latest science data packet passed along to the LDB SIP SPU prior to transmission is what gets sent. Aggregate return telemetry via COMM2 is approximately 1020 bytes of data every hour.

**ARGOS PTT's:** The HF/ARGOS COMM system has an ARGOS PTT used for low data rate return telemetry. This PTT (Platform Transmitter Terminal) transmits 32 byte packets asynchronously every 60 seconds. Data is recovered as it is relayed through polar orbiting sun-synchronous satellites at a frequency dependant upon the latitude the balloon is flown. At least two satellites are operational continuously and are in view of the platform on an average of ten minutes for each satellite pass. The following table gives an idea of satellite visibility that can be expected over a 24-hour period at different latitudes.

| PTT (BALLOON)<br><br>LATITUDE | CUMULATIVE VISIBILITY OVER 24 HOUR PERIOD | MINIMUM NUMBER OF SATELLITE PASSES OVER 24 HR. PERIOD | MEAN NUMBER OF SATELLITE PASSES OVER 24 HR. PERIOD | MAXIMUM NUMBER OF SATELLITE PASSES OVER 24 HR. PERIOD |
|---|---|---|---|---|
| **+/- 0 deg.** | **80 min.** | **6** | **7** | **8** |
| **+/- 15 deg.** | **88 min.** | **8** | **8** | **9** |
| **+/- 30 deg.** | **100 min.** | **8** | **9** | **12** |
| **+/- 45 deg.** | **128 min.** | **10** | **11** | **12** |
| **+/- 55 deg.** | **170 min.** | **16** | **16** | **18** |
| **+/- 65 deg.** | **246 min.** | **21** | **22** | **23** |
| **+/- 75 deg.** | **322 min.** | **28** | **28** | **28** |
| **+/- 90 deg.** | **384 min.** | **28** | **28** | **28** |

ARGOS return telemetry is available at the ROCC (Remote Operations Control Center) in Antarctica and the OCC (Operations Control Center) located in Palestine. ARGOS data is near “real time” within a few minutes of actual transmission in Antarctica. It is between 3 to 5 hours old for data received at Palestine.

If so desired, the experimenter can be provided a PTT for their dedicated use. However, this will require you to provide a serial isolator to the PTT’s RS-232 input to insure isolation from the other SIP systems. Power to this PTT is provided by the SIP. You will have to provide the PTT Control Commands (see Enclosure 12). The ARGOS system provides no error correction for return telemetry; therefore, it is highly recommended that you include exclusive OR checksumming.

**TDRSS:** Nominal TDRSS support for LDB offers 6 kilo bit return telemetry continuously (the low rate science interface is also available). The SIP records all science data onto flight hard drives which are received by the SIP CPU at the rate of 6 kbps (aggregate) X 21 days. Provision can be made to recover this recorded data during playback in flight by utilizing the TDRSS SA (Single Access) mode at higher data rates. NSBF is limited to an approximately ten minute period every hour for SA support. However, playback at the lower MA (Multiple Access) rate of 2 kbps can be accomplished as well, and still maintain “real-time” return over the other channel at 2 kbps (The I & Q channels can operate as two independent 2 kb channels or as a single combined 6 kb channel only during MA services.)

The POCC (Payload Operations Control Center) located at Palestine is the only location which TDRSS science data and commanding is accessed during the flight. Support is available in the field to verify TDRSS return and forward TM using a special test set; however, this does not allow for science access to TDRSS TM and commanding other than when working around the payload in close proximity during pre-flight preparations.

**Science Stack:**

A science stack can be made available which provides analog and digital return telemetry and discreet command outputs Refer to Enclosure 10 for more information. This stack is accessed by either the COMM 1 or COMM 2 telemetry links.

**LOS (Line-of-Site) Return Telemetry:**

An L-Band or S-Band telemetry transmitter can be made available for science use for monitoring data while within line-of-site of the launch site. Serial isolation to this transmitter is required and will be provided by the SIP. The experimenter is responsible for any encoding the signal may require (i.e. bi-phase, NRZ-M, etc.) as well as setting of proper signal levels into the transmitter (contact the NSBF for information concerning proper signal level settings). Experimenters should plan to utilize a telemetry VCO if planning to run RS-232 data into the transmitter.

**Antarctica Configuration SIP:** Antarctica SIP's are configured with **HF (High Frequency)** radio **commanding** which provides regional command capability for commands transmitted from McMurdo. Return telemetry is supported with ARGOS on. A "science" dedicated ARGOS PTT is offered which transmits only the experimenters data (32 bytes every 60 seconds.) In lieu of a dedicated PTT, the experimenter is also offered time on the LDB COMM Housekeeping PTT which also is used to transmit NSBF's LDB housekeeping data; however, the data packets are not combined with science therefore the transmission schedule includes six transmissions dedicated to only LDB housekeeping data followed by one transmission dedicated to only science data. Science data is stored onboard the COMM flight computer's hard disk drive which is available following recovery of the payload. The other possible COMM link science telemetry support options are described in the preceding sections under **TDRSS and INMARSAT**.

**Mid-Latitude Configuration (Fairbanks) SIP:** COMM1 is configured around TDRSS and COMM2 is configured around INMARSAT-C. Please refer to these respective preceding sections concerning these support capabilities. If you desire, a science dedicated PTT can be made available for your use to transmit 32 bytes every 60 seconds.

**LDB Ground Stations:** (Refer to Enclosure 8.) The ROCC (Remote Operations Control Center - launch site) and OCC (Operations Control Center - Palestine) provide similar capabilities. The *Science GSE Computer to LDB GSE Computer interface (Enclosure 8)* is the same for both the ROCC and OCC configurations. The ROCC is used at both the Antarctica and the Mid-Latitude launch sites. The ROCC is the primary NSBF Control Center during launch and after the balloon reaches float altitude and prior to it leaving the launch site TM coverage range. Operations Control is then handed over to the OCC at Palestine.

The OCC in Palestine is the only point of interface for the experimenter requiring TDRSS support. All TDRSS return telemetry and forward commanding is available only at the OCC. In addition, Mid-Latitude data from ARGOS and INMARSAT-C is also available at the OCC. Forward INMARSAT-C commands can be sent from the OCC for any region of flight operation. The same restrictions apply to TDRSS flights in Antarctica which require the experimenter to have his GSE located at the OCC.

# Enclosure 8

## Science to Ground Computer Interface Specifications

Science will be interfaced to the ground control computer via two RS232-C ports. This interface provides a means of getting data to the payload and receiving data from the payload. One port will be used to send commands and the other will be used to receive data. The ground support computer will constantly monitor the science interface port for requests. **(Note: These two ports communicate at two different baud rates. See details below.)**

The ground support computer operator controls all access to all communication links. The ground support computer operator can disable access to any uplink at any time. The scientist will specify what link he or she wishes to use to transmit to the balloon. Scientists will receive an error message if their selected link is disabled. If the link is not disabled, and a request-to-send packet is received from science, the data will be repacketized and sent through desired link consisting of LOS, COMM 1 or COMM 2.

### PHYSICAL INTERFACE:

<u>Downlink (return TM) Port:</u> 19,200 Baud, 8 data bits, 1 stop bit, no parity std. RS232-C DB25 DTE.

<u>Command Uplink Port:</u> 2400 Baud, 8 data bits, 1 stop bit, no parity std. RS232-C DB25 DTE.

(Note: This interface does not utilize CTS or DTR. It is 3 - wires using only Tx, Rx, and GND...no hardware handshaking.)

**continued.....**

## COMMAND UPLINK:

> In Byte 4, you specify the number of byes following (up to 20) which you are sending as command data starting at byte 5.

### Required Formats of Request-to-Send Packets

| | |
|---|---|
| Byte 1: | Start Byte: ascii.dle (ascii.dle = $10_H$) |
| Byte 2: | Link Routing: 0,1,2 |
| Byte 3: | Routing address: 9,C |
| Byte 4: | Length: up to 20, must be a multiple of 2 |
| Byte 5-?: | Data: even number of bytes up to 20 |
| Byte ?+1: | Stop Byte: ascii.etx (ascii.etx = $3_H$) |

Byte 2 specifies the link routing as follows:

$0_H$ Selects LOS as the Link
$1_H$ Selects COMM 1 as the Link
$2_H$ Selects COMM 2 as the Link

Byte 3 specifies the routing address:

$9_H$ Selects Science Interface COMM 1
$C_H$ Selects Science Interface COMM 2

> A *SIP Command Routing Block Diagram* Is illustrated at the end of Enclosure 9.

**continued...**

## Valid Combinations of Bytes 2 and 3 of the Request to Send Packet

| BYTE 2 (Link Selection) | BYTE 3 (Routing Address) |
|---|---|
| 0 (LOS) | $9_H$=COMM 1 or $C_H$=COMM 2 |
| 1 (COMM 1) | 9 |
| 2 (COMM 2) | C |

The experimenter doesn't have to worry about the balloon number. The LDB GSE handles this automatically.

The following example illustrates how the science input is interpreted:

**Example: Suppose the science request packet is:**

**Byte 1:** **ascii.dle**
**Byte 2:** **0**

**Byte 3:** **9**
**Byte 4:** **4**
**Byte 5-8:** **9, A, B, C**
**Byte 9:** **ascii.etx**

**Assuming the balloon number is 0 then, the following two LDB packets will be sent via the LOS command link to COMM 1:**

**Packet 1: FA F3 09 F6 09 F6 0A F5**
**Packet 2: FA F3 09 F6 0B F4 0C F3**

**Eight Byte Command Binary Format**

| Byte Number | Value Binary | Hex | Description |
|---|---|---|---|
| 0 | 11111010 | FA | Sync Word 1 |
| 1 | 11110011 | F3 | Sync Word 2 |
| 2 | **BBBB***RRRR* | ?? | **Balloon**/*Routing* Address |
| 3 | ???????? | ?? | One's Complement byte 2 |
| 4 | XXXXXXXX | ?? | AART Address or Science command byte 1 or Flight CPU command byte 1 |
| 5 | ???????? | ?? | One's complement byte 4 |
| 6 | XXXXXXXX | ?? | Command select or Science command byte 2 or Flight CPU command byte 2 |
| 7 | ???????? | ?? | One's complement of byte 6 |

Experimenter data is contained in bytes 4 and 6 in each of above packets. Experimenter commands off the SIP's science port is defined in Enclosure 9 under ID Byte $14_H$. The above example is given only to illustrate how the physical transmission is made going to the SIP.

**continued...**

### Data Addressed to Comm Science Command Interface Port (Routing Address $9_H$ and $C_H$)

On the ground, science command data will be repacketized two bytes at a time. Once received on board, the data will be repacketized by the LDB flight computer and will be sent to the onboard science interface port (two bytes at a time) in the format specified by the "Science to Flight Computer Interface Specifications" (see Enclosure 9).

### Accessing the Science Discrete Command Deck

Science has no direct access to this deck. Science can command this deck by verbally requesting the LDB ground station operator to send a command to this deck. The LDB command program must be configured to support which science commands are being utilized on the discrete command deck. A description of the capabilities of the Science Discrete command deck is given in Enclosure 10.

### Aircraft Line-of-Sight Command Support for Science

Science will be interfaced to the LDB aircraft computer via one RS232 interface. The interface will be used as an uplink for science commanding. This interface will behave as described for the ground support equipment except that only LOS commands are available on the aircraft (no ARGOS, INMARSAT, or TDRSS).

### Acknowledgment Packet Format

In all cases after a packet is received by the ground support computer, an acknowledgment packet will be sent to science to indicate whether or not the commands were transmitted.

| | | | |
|---|---|---|---|
| Byte 1: | Sync byte 1 = $FA_H$ | | |
| Byte 2: | Sync byte 2 = $F3_H$ | | |
| Byte 3: | Acknowledgment Byte | = | $00_H$ |
| | or | = | $0A_H$ |
| | or | = | $0B_H$ |
| | or | = | $0C_H$ |
| | ($00_H$, commands transmitted) | | |
| | ($0A_H$, $0B_H$, $0C_H$, $0D_H$ commands not transmitted) | | |

**continued...**

An acknowledgment byte of hex A, B, or C indicates that the ground support computer did not send the command packet. Any of the following can cause this to occur:

ERROR CODES:

$0A_H$> GSE operator disabled science from sending commands,
$0B_H$> Routing address does not match the selected link,
$0C_H$> The link selected was not enabled,
$0D_H$> All other cases.

**An acknowledgment byte of $00_H$ indicates that the commands were sent. This does not mean that the science payload received the commands. Science must monitor their own telemetry data to determine whether or not their equipment received and responded to their commands. All command packets received by the ground support computer will be time-tagged and logged along with their transmission status. NOTE: It is possible that if more than two bytes are sent, the payload (SIP) may not receive them all in rare cases of dropouts in a particular RF link.**

## DOWNLINK

Science telemetry data will be time-tagged and logged, repacketized and sent to science via the science telemetry interface port. The following summarizes the various packet formats in which science telemetry data will be sent to science.

### A. INMARSAT

Byte 1: Sync 1 = $FA_H$
Byte 2: Sync 2 = $FC_H$
Byte 3: Origin byte
  Lower nibble:
    bits 0 .. 2: ($0_H$-Science Housekeeping Deck or $1_H$-Low Rate Science Port)
    bit 3: ($0_H$-COMM1 or $1_H$-COMM2)
  Upper nibble: is zeroed out by LDB computer
Byte 4: 0 (not used, zero inserted)
Byte 5: Length of data (MSB)
Byte 6: Length of data (LSB)
Byte 7-N: Data (1..length)
Byte N+1: Checksum ($\Sigma$ bytes 3-N)

Bytes 5 and 6 tell how many bytes follow from Byte 7 to Byte 7+N.

### B. HF/ARGOS

Byte 1: Sync 1 = $FA_H$
Byte 2: Sync 2 = $FD_H$
Byte 3: Origin byte
  Lower nibble:
    bits 0 .. 2: ($0_H$-Science Housekeeping Deck or $1_H$-Low Rate Science Port)
    bit 3: ($0_H$-COMM1 or $1_H$-COMM2)
  Upper nibble: is zeroed out by LDB computer
Byte 4: 0 (not used, zero inserted)
Byte 5: 0
Byte 6: 1D
Bytes 7-35: Data (29 bytes)
Byte 36: Checksum ($\Sigma$ bytes 3-35)

## C. TDRSS

Byte 1: Sync 1 = $FA_H$
Byte 2: Sync 2 = $FF_H$
Byte 3: Origin byte
  Lower nibble:
    bits 0 .. 2: ($0_H$-Housekeeping Deck, $1_H$-Low Rate Science Port, $2_H$-High Rate Science Port)
    bit 3: ($0_H$-COMM1 or $1_H$-COMM2)
  Upper nibble: is zeroed out by LDB computer
Byte 4: 0 (not used, zero inserted)
Byte 5: Length of data (MSB)
Byte 6: Length of data (LSB)
Byte 7-N: Data (1..length)
Byte N+1: Checksum ($\Sigma$ bytes 3-?)

> Bytes 5 and 6 tell how many bytes follow from Byte 7 to Byte 7+N.

## D. Science Option PTT

Byte 1: Sync 1 = $FA_H$
Byte 2: Sync 2 = $FE_H$
Bytes 3-34: Data (32 bytes)

## END

# Enclosure 9

## Science to Flight Computer Interface Specifications

### I. Science Comm Port

This document describes the interface to the low rate and high rate science interfaces. A low rate science support interface (RS232) is available on each Communication Link computer (COMM1 and COMM2) simultaneously. Either of these serial lines can handle low rate science data to be included in the downlink, uplink commands addressed to the science experiment, and SIP data (GPS position, GPS time, and MKS pressure if requested by the science.) Data sent by the science to the two communications link need not be the same, if the science chooses increased data downlink over redundancy. The high rate science support interface (RS232) is available only from the SIP's TDRSS communication link.

**Physical Interface**

**Low Rate Science Interface**

1200 baud, 8 data bits, 1 stop bit, no parity
standard RS232-C DB9 DTE

(Note: This interface does not utilize CTS or DTR. It is 3 - wires using only Tx, Rx, and GND...no hardware handshaking.)

**High Rate Science Interface**

19,200 baud, 8 data bits, 1 stop bit, no parity
standard RS232-C DB9 DTE

(Note: This interface does not utilize CTS or DTR. It is 3 - wires using only Tx, Rx, and GND...no hardware handshaking.)

**continued...**

## Software Interface

### High Rate Science Interface

The High Rate Science Interface will log and transmit all data presented to it. There is no format requirement like that required for the Low Rate port (i.e. ascii.dle, ascii.etx, etc.) Whatever is presented to the High Rate Port is what gets logged and transmitted. The Science must ensure that the average bit rate to the High Rate Science Interface is not greater than 6Kbit/Second. (If requesting dual channel mode, then must be able to switch to 2 Kbit/Second. See Enclosure 7, page 4, under TDRSS.) Note of Caution: no error checking or synchronization will be provided. The system will log what is received. Experimenters need to do their own encoding to provide for the above operations.

### Low Rate Science Interface

Because the Low Rate Science Interface is a more complicated interface, it will be implemented using a message protocol. The format of a message is

*ascii.dle, ID Byte, optional data bytes, ascii.etx*

(ascii.dle = $10_H$ and ascii.etx = $3_H$)

The message protocol will follow in more detail.

## Low Rate Science Interface Messages From LDB COMM CPU to Science:

### GPS position ( ID byte = $10_H$ )

The format of the GPS position message is

*ascii.dle, $10_H$, longitude, latitude, altitude, satellite status1, satellite status2 ascii.etx*

Where longitude, latitude, and altitude are 4 byte ***IEEE std 754*** single precision real format numbers. Longitude and latitude are in degrees. Altitude is in meters. Satellite status1 & satellite2 are bytes.

**continued...**

**An example of a real number will be generated to show the byte order.**

| LSB | | | MSB | | |
|---|---|---|---|---|---|
| 109 | 120 | 238 | 191 | = | -1.86305E00 |

LSB (109) is sent first and MSB (191) is sent last.

The bytes are packed to form a single precision real format number as follows:

```
     MSB                                                  LSB
    1|0 1 1 1 1 1 1  1|1 1 0 1 1 1 0   0 1 1 1 1 0 0 0   0 1 1 0 1 1 0 1
  A  |      B         |                        C
```

A: Sign bit, 1=negative 0=positive

B: Exponent, Represented using Excess Notation;
(8 bit represented above) - 127 = Actual Exponent

i.e. 01111111 (127) - 127 = 0;
10000000 (128) - 127 = 1;
10000001 (129) - 127 = 2, etc.

C: Mantissa, Only the fractional part of the mantissa is given above.
All data is *normalized with the "Phantom Bit"* 1 as *given.*

$\Sigma 2^{(-N)}$ = Fractional mantissa

Where N = 1,2,4,5,6,9,10,11,12,17,18,20,21,23 for above example reading the bits from left to right under part C.

$\therefore$ (Phantom Bit).(Fractional Mantissa) X $2^0$ = -1.86305E00

If exponent had been E02, then:
(Phantom Bit).(Fractional Mantissa) X $2^2$ = -7.4522

A zero exponent combined with a zero mantissa represents zero: *if the mantissa is nonzero, it is taken as a non-normalized number.*

Sign notation is negative for west longitudes and south latitudes.

**continued...**

| | | |
|---|---|---|
| Satellite status1 | = | $3_H$ => 3 sat, 2D |
| | | $4_H$ => 4 sat, 3D |
| Satellite status2 | = | $0_H$ => Doing position fixes |
| | = | $1_H$ => Do not have GPS time |
| | = | $2_H$ => Waiting for almanac collection |
| | = | $3_H$ => PDOP is too high |
| | = | $4_H$ => 0 satellites |
| | = | $5_H$ => 1 satellite |
| | = | $6_H$ => 2 satellites |
| | = | $7_H$ => 3 satellites |
| | = | $8_H$ => 0 usable satellites |
| | = | $9_H$ => 1 usable satellite |
| | = | $A_H$ => 2 usable satellites |
| | = | $B_H$ => 3 usable satellites |

**NOTE:** For the GPS to be giving current information Satellite status1 must be 3 or 4 and satellite status2 must be 0.

**GPS time ( ID byte = $11_H$ )**

The format of the GPS time is

*ascii.dle, $11_H$, GPS time of week, GPS week number, GPS/UTC time offset, CPU time, ascii.etx*

where GPS time of week represents the number of seconds since Sunday at 12:00 AM. The GPS week number is referenced from week #1 starting January 6, 1980. GPS/UTC time offset should be subtracted from the GPS time to obtain UTC time. If GPS time of week is < 0 then the current GPS time is not known. The GPS time is updated in the LDB COMM CPU every 15 seconds when the GPS receiver is not doing position fixes and every 150 seconds when the GPS receiver is doing position fixes. GPS time of week and GPS/UTC offset are 4 byte real numbers. GPS week number is a 2 byte integer. CPU time is seconds from midnight today synchronized to GPS time when status1 > 3, status2 is 0, and CPU time is more than 60 seconds off.

NOTE: This time should not be used for exact timekeeping purposes.

**MKS pressure altitude ( ID byte = $12_H$ )**

The format of the MKS pressure altitude message is:

*ascii.dle, $12_H$, MKS Hi, MKS Mid, MKS Lo, ascii.etx*

MKS pressure altitude is two bytes where the MSB is transmitted first.
The LDB Payload Engineer will provide, upon request, the switch points to be used so you will know which sensor (Hi, Mid, or Lo) to use while in its “active” linear range. MKS sensors are defined here as:

| | | |
|---|---|---|
| MKS Hi | = | high altitude sensor (0 to 10 torr) |
| MKS Mid | = | mid altitude sensor (0 to 100 torr) |
| MKS Lo | = | low altitude sensor (0 to 1000 torr) |

## MKS Algorithms

MKS pressure is derived from a linear equation of the type y=mx + b (where x=number of counts given in each two byte packet and y=pressure in millibars. You will need to get the m and b variables for this equation from the LDB Payload Engineer as it is dependent upon each set of sensors and their calibration coefficients. Pressure Altitude is expressed in terms of Standard Atmosphere.

Let Z = Natural Log( pressure )

$$\text{Altitude in feet} = 156776.89 + -25410.089 * Z + 462.44626 * Z^2 + 130.61746 * Z^3 + -20.0116288 * Z^4$$

## Request Science Data ( ID byte = $13_H$ )

The format of the Request Science log data is:

*ascii.dle, $13_H$, ascii.etx*

This message informs the science interface that the LDB COMM computer is ready to accept a message packet from the Science Interface. The COMM computer will repeat this message at science transmissions opportunities when its LDB science buffer is empty (the most recent science data passed over to the LDB flight computer is what gets transmitted when the LDB science buffer is empty); however, all science data requested by the LDB flight computer is logged onto the LDB hard disk drive whether it gets transmitted or not. Presently, the LDB flight computer polls the science port for new data every 30 seconds.

## Science Command ( ID byte = $14_H$ )

The format of the Science Command message is

*ascii.dle, $14_H$, length (always 2), data, ascii.etx*

The message relays data addressed to the science package from the GSE systems. The *length* is the number of bytes of data passed to the science which is always two based on the LDB command format. If more than two bytes were sent from the GSE, then it is possible that some bytes do not pass error checking and therefore are not passed to the science interface. The *data* is the data bytes passed to the science.

**Eight Byte Command Binary Format**

| Byte Number | Value Binary | Hex | Description |
|---|---|---|---|
| 0 | 11111010 | FA | Sync Word 1 |
| 1 | 11110011 | F3 | Sync Word 2 |
| 2 | **BBBB***RRRR* | ?? | **Balloon**/*Routing* Address |
| 3 | ???????? | ?? | One's Complement byte 2 |
| 4 | XXXXXXXX | ?? | AART Address or<br>Science command byte 1 or<br>Flight CPU command byte 1 |
| 5 | ???????? | ?? | One's complement byte 4 |
| 6 | XXXXXXXX | ?? | Command select or<br>Science command byte 2 or<br>Flight CPU command byte 2 |
| 7 | ???????? | ?? | One's complement of byte 6 |

## Science Message to the LDB COMM Computer:

### Request GPS position ( ID byte = $50_H$ )

The format of this message is

*ascii.dle, $50_H$, ascii.etx*

This message request the LDB COMM computer to send a GPS position message.

### Request GPS time ( ID byte = $51_H$ )

The format of Request GPS time message is

*ascii.dle, $51_H$, ascii.etx*

This message request the LDB COMM computer to send a GPS time message.

### Request MKS Altitude message ( ID byte = $52_H$ )

The format of the Request MKS Altitude message is *ascii.dle, $52_H$, ascii.etx*

This message request the LDB COMM computer to send a MKS Altitude message.

## Science Data Message ( ID Byte = $53_H$ )

The format of Science Data Message is
*ascii.dle, $53_H$, data length, data, ascii.etx*

This message contains the data which the LDB COMM computer is to transmit to the ground and log in the low rate science data log. This message must be in response to a Request Science Data message. Data length is a byte whose value must be between 1 and 255. Data is length bytes of data which will be transmitted and stored on board.

If the communication link is HF/ARGOS up to 255 byte per packet can be sent to the HF/ARGOS link, but only the first 29 bytes of that packet will be transmitted via ARGOS (this is a limitation of the ARGOS PTT link). Furthermore, only 1 of 6 HF/ARGOS PTT transmissions incorporates science data so return is limited to one 29 byte packet every six minutes while the satellites are overhead. Because the ARGOS link can be unreliable (packets can be lost) you should include in your data packet format enough information to determine which packets are received on the ground.

# Low Rate Science Interface Messages (Examples)

| Message Initiated from Science Computer | | Response from LDB Comm Computer |
|---|---|---|
| Request GPS Position (50h) | → | GPS Position (10h) |
| Request GPS Time (51h) | → | GPS Time (11h) |
| Request MKS Altitude (52h) | → | MKS Altitude (12h) |

| Message Initiated from LDB Comm Computer | | Response from Science Computer |
|---|---|---|
| Request Science Data (13h)<br>[every 30 seconds] | → | Science Data Message (53h)<br>[Optional Response] |
| Science Command (14h) | → | No Response Requried |

# Enclosure 10

## Science Stack

A *Science Stack* option is available which provides:

- 32 analog channels return TM (12 bit resolution)
- 16 digital channels return TM
- 28 Open-Collector Command Outputs (200 ma maximum @ 50 volts @ 100 milli-seconds).
- 4 optional diode clamp command returns to be used if suppression diode is not available on science relay operating on Open Collector Outputs.)
- 1 Timed Open Collector Command Output (200 ma maximum @ 50 volts)
- 5 Volt Reference

One Science Stack provides the above listed functions which can be accessed by either COMM1 or COMM2. Normally, the Science Stack is an option used by those experimenters with simple telemetry support requirements and who do not wish to incorporate their own flight data and command processing computer with which to integrate to the COMM science interfaces. The science stack can also be used for redundant commanding and/or housekeeping in addition to the COMM science interfaces.

The science stack is interrogated by the LDB flight computers (COMM1 or COMM2) and return telemetry is brought down on the selected COMM link (configured before launch and is typically the link which offers the highest data rate or best command link, but is selectable). Commands from the respective COMM system are accordingly routed to the Science Stack upon recognition of the proper stack address and command decode for the individual open collector outputs. This is all managed by the LDB system and the Experimenter only has to be concerned with proper hardware integration to the Science Stack. (Please reference Appendix-B, Science to GSE Computer Interface Specifications.)

See Enclosure 9, p.7, “Science Data Message”, same limitations apply to only the first 29 bytes of a maximum 255 byte “return” packet can be transmitted via Argos.

**continued...**

## The Science Stack is comprised of the following science decks:

### 1.) Science Discrete Command Deck

**The hex addresses for enabling the 28 commands are as follows:**

| OUTPUT | HEX ADDRESS | OUTPUT | HEX ADDRESS |
|---|---|---|---|
| OUTPUT 1 | 09 | OUTPUT 15 | 21 |
| OUTPUT 2 | 0A | OUTPUT 16 | 22 |
| OUTPUT 3 | 0B | OUTPUT 17 | 23 |
| OUTPUT 4 | 0C | OUTPUT 18 | 24 |
| OUTPUT 5 | 0D | OUTPUT 19 | 25 |
| OUTPUT 6 | 0E | OUTPUT 20 | 26 |
| OUTPUT 7 | 0F | OUTPUT 21 | 27 |
| OUTPUT 8 | 11 | OUTPUT 22 | 41 |
| OUTPUT 9 | 12 | OUTPUT 23 | 42 |
| OUTPUT 10 | 13 | OUTPUT 24 | 43 |
| OUTPUT 11 | 14 | OUTPUT 25 | 44 |
| OUTPUT 12 | 15 | OUTPUT 26 | 45 |
| OUTPUT 13 | 16 | OUTPUT 27 | 46 |
| OUTPUT 14 | 17 | OUTPUT 28 | 47 |

**Physical Interface:** DB 37P Connector (You provide 37S)

| **Pins** | **Description** |
|---|---|
| 1 Thru 28 | Outputs 1 Thru 28 |
| 29 | Clamp (not used if transient suppressor diode is on relay) |
| 30 | Digital Ground |
| 31 | Clamp (not used if transient suppressor diode is on relay) |
| 32 | Digital Ground |
| 33 | Clamp (not used if transient suppressor diode is on relay) |
| 34 | Digital Ground |
| 35 | Clamp (not used if transient suppressor diode is on relay) |
| 36 | Digital Ground |

### 2.) Science Timed Command Outputs:

**Physical Interface:** DB 9P connector (You provide 9S)

| **Pins** | **Description** |
|---|---|
| 1 | Ground |
| 2 | Output |

**Continued...**

## 3.) Housekeeping Deck (Return TM):

**Analog Return TM Physical Interface:** DB 37P Connector (You Provide 37S)

| Pins | Description |
|---|---|
| 1 Thru 32 | Analog Inputs (0 to 5 Vdc) 12 bit resolution |
| 33 Thru 36 | Analog Grounds (signal return) |
| 37 | 5 Volt Reference (buffered through LT 1078) |

**Digital Return TM Physical Interface:** DB 35 P Connector (You Provide 25S)

| Pins | Description |
|---|---|
| 1 Thru 16 | Digital Inputs (Input on 74HC375 - threshold is 1.5 vdc.) |
| 18 Thru 20 | Digital Grounds (signal return) |
| 21 Thru 25 | Unused |

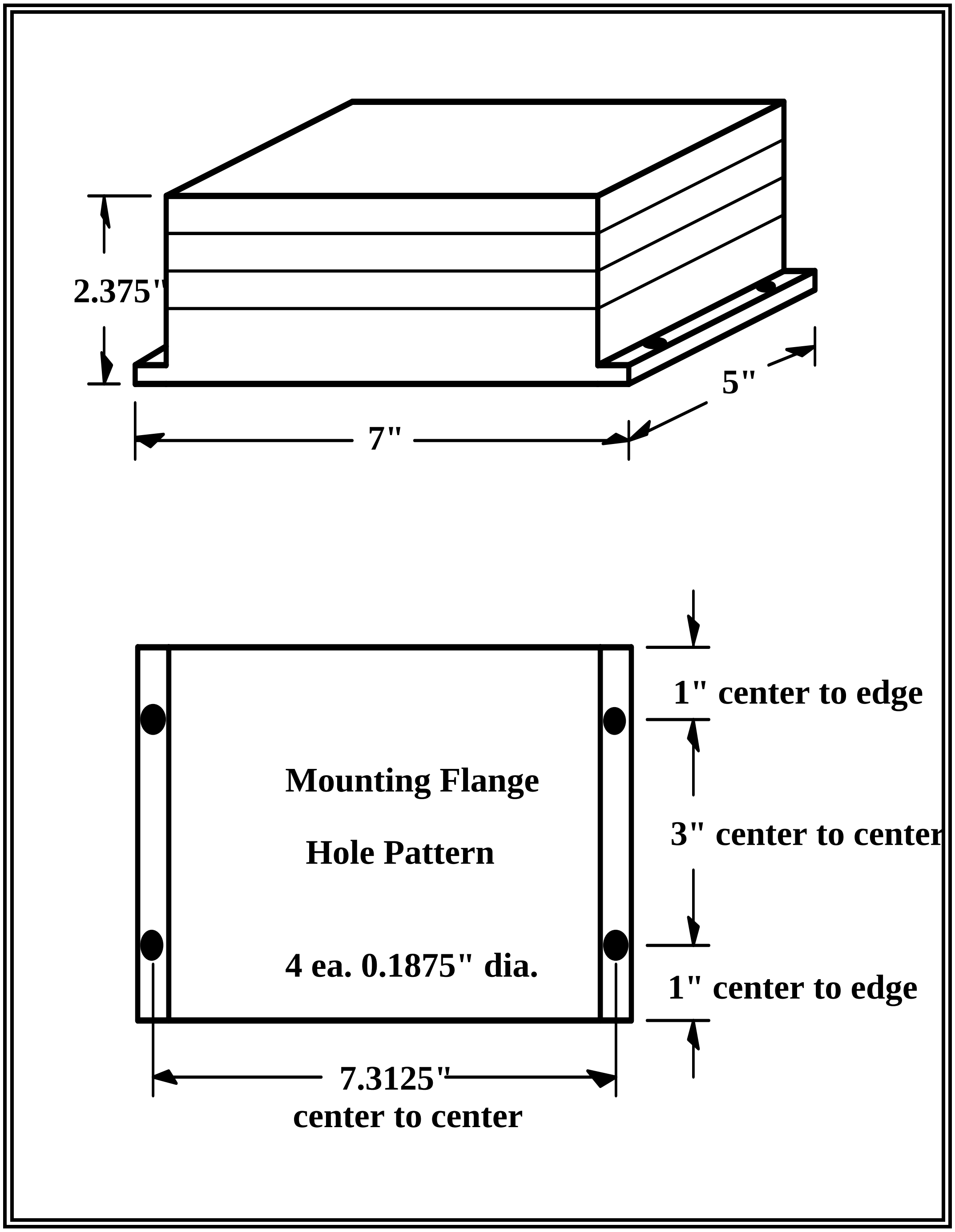
## 4.) Physical and Power Interface Specifications:

The experimenter is responsible for accommodation of mounting the Science Stack as well as providing power to the Stack. The Science Stack is serially isolated from the SIP via serial isolator built into the Stack's Power Deck. NSBF will provide the cable going from the SIP to the Science Stack.

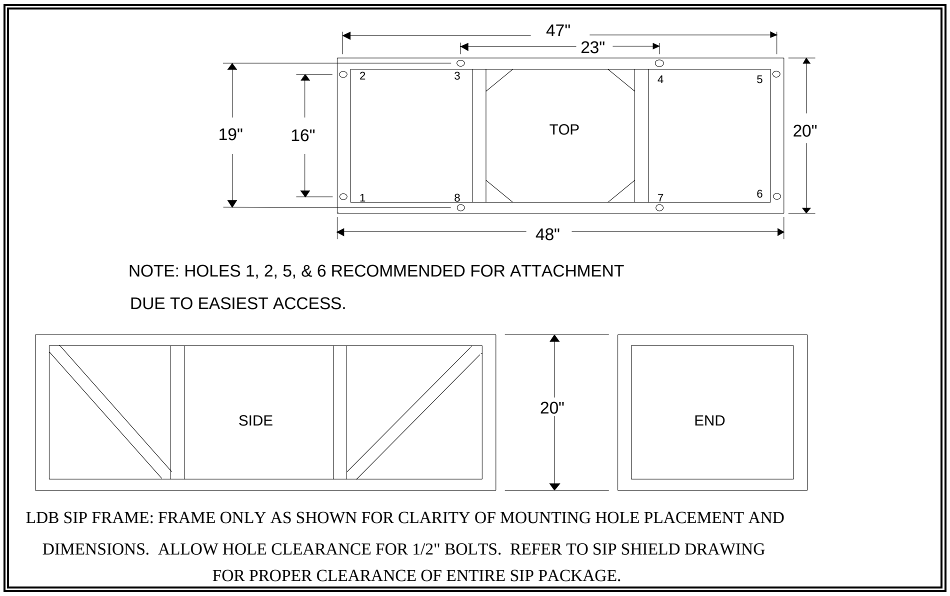
**Power:** Provide 16 - 32 vdc at 50 ma (maximum current.)

Pin 1 – Power
Pin 6 – Ground

**Mounting:** (following page)

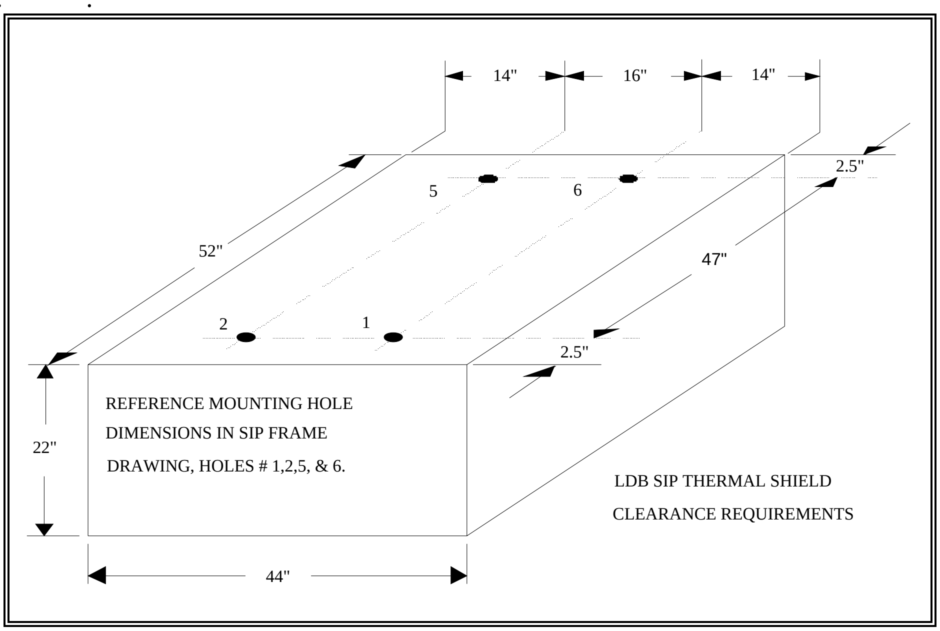

2.375"
5"
7"
1" center to edge
Mounting Flange
Hole Pattern
3" center to center
4 ea. 0.1875" dia.
1" center to edge
7.3125"
center to center

# Enclosure 11
# Mechanical




## SIP Mounting Requirements:

The SIP is normally mounted by the top four outside mounting holes having 17/32 clearance. For most gondolas, this has been accomplished by suspending the SIP from the gondola structure. Electrical and thermal isolation between the SIP and SIP Thermal Shield is required with respect to the gondola. Normally, holes # 1, #2, #5, and #6 are used for mounting the SIP to the gondola. .




Clearance must be provided to accommodate the SIP Thermal Shield as shown here. Access to all four sides after mounting to the gondola is an absolute requirement. The SIP Thermal Shield must not be blocked by any structure on any of the four sides in order to facilitate heat transfer away from the SIP. Deviations from this configuration will be handled on a case-by-case basis. Be sure to contact the NSBF LDB Group Supervisor or Assigned LDB Payload Engineer concerning any unique mounting requirements other than that discussed here.

Normally, NSBF will attach ballast onto the gondola structure, not the SIP frame. Again, special cases where you may require having the SIP "sit" on a gondola frame or shelf will have to be given special consideration.

**LDB Weights:**

The following weights are provided for estimating total gondola weights, stress analysis, etc. These weights will vary depending upon specific upper antenna boom requirements, PV array size requirements, antenna cable lengths, etc.

| | |
|---|---|
| **-Sip and Thermal Shield** | **380 lbs.** |
| **-Ballast Hopper / Load Cell / Ballast Valves** | **23 lbs.** |
| **-LDB Solar Array** | **130 lbs.** |
| **-PV Panels** | |
| **-Support Frame** | |
| **-Various Sensors & Antennas** | |
| **-Upper Antenna Boom / Antennas / Cabling** | **40 lbs.** |

## Gondola Configuration:

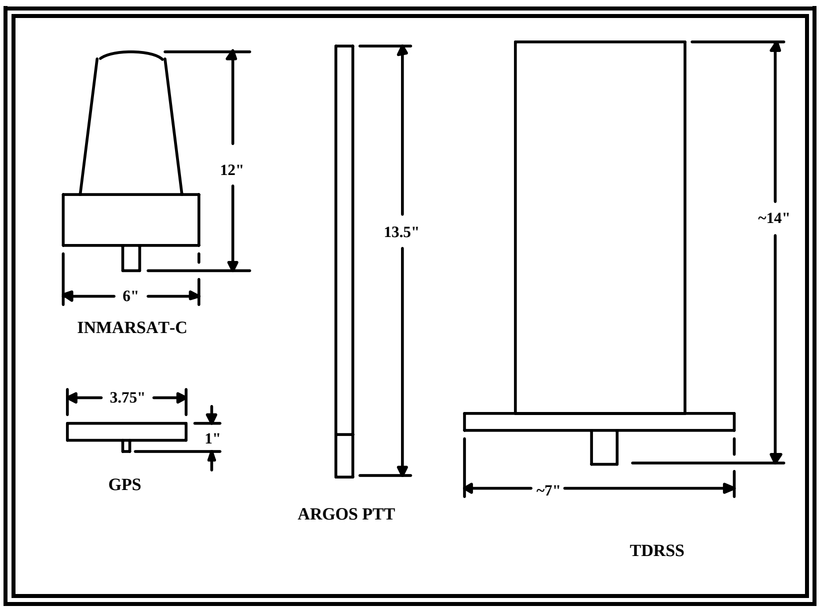
A simplified block diagram view as shown here illustrates a typical configuration (excluding science PV array.) The SIP and suspended LDB PV array is thermally and electrically isolated from the science gondola frame.

The optional rotator or free swivel must include electrical slip rings to accommodate the SIP's serial communications lines going to the Terminate Electronics package. Eight slip rings are required but it is recommended that spares be included.

The LDB PV array is normally a four sided array even with rotators being flown in order to assure operation in the event of rotator failure. Special configurations which differ from the basic concept shown above require consultation with the NSBF prior to completing the final configuration definition. Factors influencing LDB PV Array size include gondola height, Science PV Array structure, and other factors impacting shading on the PV Array. No shading of the PV array is allowed for any angle of the gondola with respect to the sun at any elevation. Other factors impacting placement of all PV (science and LDB) panels includes thermal consideration such that no vulnerable components are placed directly to the backside of a PV panel.

**Antennas:**

LDB flies a number of antennas which must be mounted on top the gondola with minimum obscuration horizon to horizon for 360 degrees about each antenna. Obviously, gondola suspension members will provide some obscuration; however, from experience this has been of little negative impact when the antennas are placed properly. Orientation of these top mounted antennas may require judicious placement depending upon pointing requirements of any given experiment. A rule-of-thumb is to insure that placement is such so as to maximize visibility of the INMARSAT-C and TDRSS antennas to any point on the geostationary orbiting satellite arc as seen from the balloon. The ARGOS and GPS antennas must view polar orbiting satellites.




Antenna dimensions are as shown here. Other antennas for line-of-sight forward and return communications are mounted on the bottom of the LDB Solar array. If you don't provide a location for placement of the top antennas, NSBF will provide a boom attached to your gondola to mount these antennas on. Antennas are electrically isolated from the gondola.

Antennas Included at the top are:

**1 - TDRSS**
**1 - INMARSAT-C**
**3 - GPS**
**3 - ARGOS PTT**
**(4 ARGOS if dedicated Science PTT is used.)**

| ANTENNA | LOCATION | FUNCTION | FREQ (MHZ) | EIRP | TYPE | CABLE | CONNECTOR TYPE |
|---|---|---|---|---|---|---|---|
| INMARSAT | TOP | CMD/TM | RX 1626.5 TO 1646.5 | N/A | OMNI RHCP | RG214 | N-FEMALE |
| “ | ” | “ | TX 1530.0 TO 1545.0 | 15 WATTS | “ | ” | “ |
| TDRSS | TOP | CMD/TM | 2106.5 (Rx) 2287.5 (Tx) | 9 dbW Peak | OMNI LHCP | RIGID COAX | N-FEMALE |
| GPS | TOP | RX / NAV | 1575.42 | N/A | RHCP | RG223 | SMA |
| ARGOS | TOP | TX/TM | 401.65 | 1 WATT | 1/4 VERT. | RG223 | BNC |
| L-BAND | BOTTOM | TX/LOS TM | 1444.5-1525.5 | 2 WATT | 1/4VERT. | RG214 | N-FEMALE |
| S-BAND | BOTTOM | TX/LOS TM | 2378.5-2387.5 | 5 WATT | 1/4 VERT. | RG214 | N-FEMALE |
| UHF | BOTTOM | RX/LOS CMD | 429.5 | N/A | 1/4 VERT. | RG223 | BNC |
| HF | BOTTOM | RX/CMD | 3.0-15.0 | N/A | 30' VERT. | RG223 | BNC |

## Thermal:

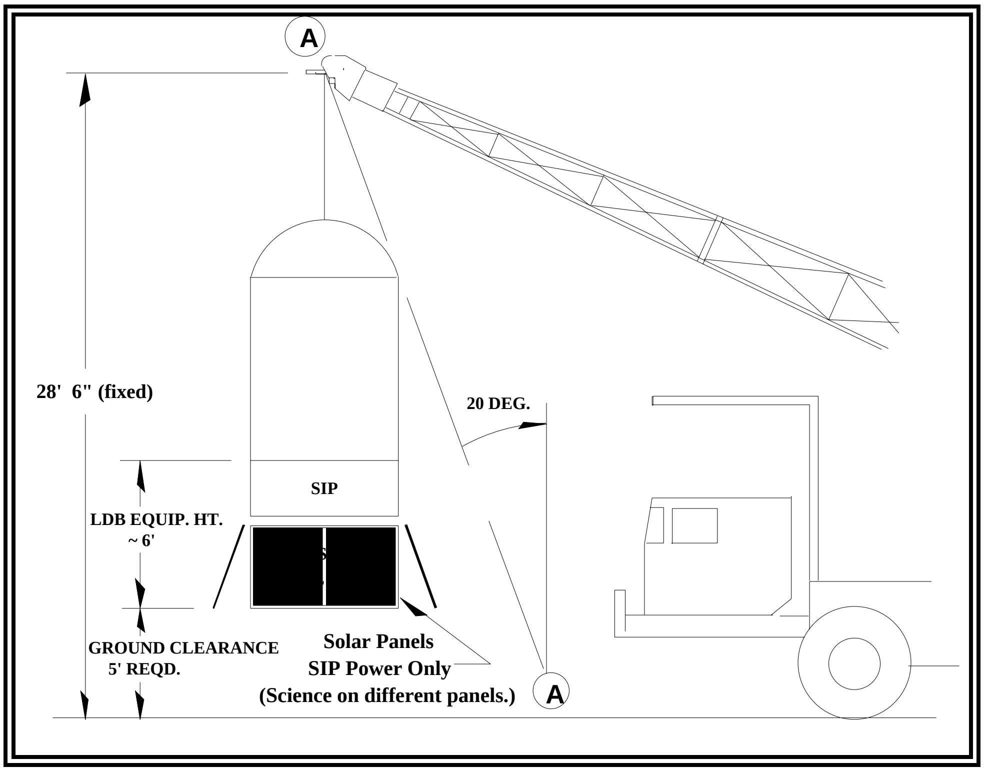
A thermal analysis is required for each LDB science payload.  This analysis must be completed sufficiently in advance of final integration at Palestine to insure proper configurations are made prior to shipment to the field.

LDB Project Thermal Analysis support is provided only for NSBF’s equipment and systems.  Experimenters need to have their own thermal analysis support in order to calculate their operating parameters within the chosen environment.  Environmental flight conditions differ between Antarctica flights and Northern Hemisphere (Fairbanks) flights.

The LDB Project’s Thermal Analyst will work with the Experimenter’s Thermal Analyst to resolve intra system thermal coupling issues, etc.  Due to the length of time to perform this analysis, it is important to establish the gondola configuration and mounting location for the SIP, solar arrays, and instruments as soon as possible.  Results of the thermal analysis can result in change of requirements for mounting locations and/or component surface coatings, thermal shields, etc.

## Launch Vehicle Restrictions in Antarctica

For each NSBF Antarctic campaign, a launch vehicle is temporarily created by mounting a payload support structure on an all-terrain truck borrowed from the U.S. Antarctic Program's vehicle fleet at McMurdo Station. Because of the limited load carrying capacities of that truck and the snow surface on which it operates, NSBF's launching capabilities in Antarctica are more limited than they are elsewhere. A variety of loads are exerted on any launch vehicle. Analysis shows that these loads can be safely managed for the Antarctic launch vehicle only if gross inflation does not exceed 9500 lbs. Gross inflation is the sum of balloon weight, total suspended weight below the balloon and free lift.




In addition to the 9500 lbs. gross inflation limit, there are also dimensional and geometric limitations on Antarctic launches. These limits are illustrated in the accompanying diagram of an LDB payload suspended on the Antarctic launch vehicle. The diagram should make the following points clear:

1.) The height of the payload suspension point on the launch vehicle is fixed at 28 feet 6 inches above the ground surface.

2.) A minimum ground clearance of 5 feet between the ground surface and the lowest point of the LDB payload is required.

3.) The combined height of the LDB Support Instrumentation Package (SIP) and the LDB omnidirectional solar panel array is approximately 6 feet. The SIP has been shown in the diagram mounted externally at the base of the science gondola. Other mounting configurations for the SIP may be possible.

4.) The dashed line, marked "A", describes a plane which delimits acceptable and unacceptable payload geometry. Experience has shown that any payload element which extends above and to the right of this dashed line will strike the underside of the boom during the launch.

**Recovery Requirements:**

**Antarctica -** From a science, economical, and environmental standpoint, it is highly desirable to recover 100% of the payload. To date only one gondola has been recovered utilizing the LC-130 aircraft. This is largely due to accessibility of the aircraft (the LC-130) and surface conditions at or near the impact site.

Most recoveries are done with a Twin Otter or Helicopter. Making use of the Twin Otter, each discipline must be aware of the usable space and configuration with this aircraft. The cargo door opening of the Twin Otter is: 56.0" wide X 50.0" high. Two hundred pounds per square foot is the limitation of the cargo density. Because the Twin Otter cargo holding area tapers from fore to aft and because of other operations considerations, final coordination of your recovery package dimensions must be coordinated with the NSBF Campaign Manager. The Twin Otter can usually get off the snow surface with 2,200 lbs. on board. This capacity diminishes with altitude and poor surface conditions.

The helicopters have a very limited inside cargo carrying capacity and can sling loads up to 1,800 lbs. As you can see by the above dimensions, several trips are required for a complete recovery. With this information, each science group should be building payloads such that they will break down into components that will fit in the Twin Otter or helicopter. Weights are manageable by a limited ground crew. Various components must withstand extended periods of time exposed on the Antarctic surface waiting for a recovery to take place. ***Payloads built with a single source recovery aircraft in mind, IE. LC-130 Hercules, run the risk of not getting their payload recovered.***

**Greenland -** For Fairbanks back to Canada trajectories, termination and recovery from Greenland is now planned only as a contingency in the event of an emergency. NSBF currently plans on utilizing its own aircraft for the terminate portion of the operations. LC-130's operated by the New York Air National Guard (NYANG) might be available for recovery. Other options for recovery do exist but at high cost. There are ski-equipped Twin Otters available in Canada and Iceland, but again are quite expensive to use for recovery. NSBF will be making use of the NYANG while they are positioned in Thule, Greenland supporting other NSF and military missions. This means that if a recovery opportunity is missed while they (NYANG) are positioned in Greenland, the payload would need to rest on the ice sheet until they return to Greenland or until other arrangements can be made. Again, final coordination for recovery requirements will be made with the NSBF Campaign Manager.

**Fairbanks and Alice Springs** - Normally, recovery for “mid latitude” type launches will be handled in much the same manner as currently done for conventional ballooning. Various helicopter and ground recovery assets will be used. Gondola design should take into account ease of recovery in remote locations which often require helicopter lifts.

# Enclosure 12

## Science Dedicated ST-5 ARGOS PTT Interface Specifications

If you desire use of a dedicated ARGOS PTT, a vendors interface specification and control document will be sent to you.  NSBF will provide the power for this PTT along with the mounting location on the SIP.  However, you will have to provide a serial isolator to maintain electrical isolation from the SIP.