COLUMBIA SCIENTIFIC BALLOON FACILITY

BALLOON OPERATIONS SUPPORT

NASA BALLOON PROGRAM
CONTRACT NO. NNG15WA53C

FLIGHT APPLICATION INSTRUCTIONS

DRAFT

OF-300-11-H
REV A
FEBRUARY 3, 2016

Columbia Scientific Balloon Facility
Orbital ATK, Inc.
Space Systems Group, Technical Services Division
7500 Greenway Center Drive #700
Greenbelt, MD 20770

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Approved by: Mona Breeding Date: February 3, 2016

CHANGE LOG

DESCRIPTION	REVISION	DATE
Original issue	-	February 23, 2012
Updated contact list, history	A	February 3, 2016

DRAFT

PREFACE

WHY USE SCIENTIFIC BALLOONS

Balloon payloads provide information on the atmosphere, the universe, the Sun, and the near-Earth and space environment. As with sounding rockets, scientific balloons are valuable tools for scientists and undergraduate and graduate students conducting work in scientific fields.

Balloons offer a low-cost, quick-response method for doing scientific investigations. Scientific balloons offer important advantages, for example:

- Balloons are mobile; they can be launched where the scientist needs to conduct the experiment.
- Balloons can be readied for flight in as little as six months.
- Balloons can take instruments above 99 percent of the screening effects of the earth's atmosphere.
- Balloons beat the staggering costs of multi-million dollar rocket launches.
- Balloon payload instruments can be rapidly upgraded to keep up with developments in detector technology.
- Balloon flight cycle time can be very short so that several flights can be performed every year.

TYPES OF RESEARCH

Some types of research for which balloons are used are:

- Cosmic ray astrophysics
- Gamma ray and X-ray astrophysics
- Optical and ultra-violet astrophysics
- Infrared/submillimeter astrophysics
- Atmospheric sciences
- Magnetospherics
- Micrometeorite particles

DRAFT

ABOUT CSBF

ORGANIZATION

Since its inception, the CSBF has been a Government-owned, contractor-operated institution. Originally called the Scientific Balloon Facility, the facility was established in Boulder, Colorado in 1961 under the auspices of the National Science Foundation (NSF). The facility was moved to Palestine, Texas in 1963 and was renamed the National Scientific Balloon Facility (NSBF) on July 1, 1972.

In October 1982, sponsorship of the NSBF was transferred from the National Science Foundation to the National Aeronautics and Space Administration (NASA), and the NSBF became a separate entity under the University Corporation for Atmospheric Research (UCAR). At that time, the NSF issued NASA an indefinite user permit for all land and other real property at NSBF in Palestine, Texas.

In October 1987, the NASA contract to operate the NSBF was awarded to the Physical Science Laboratory under the auspices of New Mexico State University in Las Cruces, New Mexico. The contract is administered by Goddard Space Flight Center's (GSFC) Wallops Flight Facility in Wallops Island, Virginia.

On August 23, 2005 NASA signed off on a plan by U.S. Congressman Jeb Hensarling (R-Texas) to rename the NSBF to the Columbia Scientific Balloon Facility (CSBF) in honor of the seven astronauts who perished during the loss of the Space Shuttle Columbia.

In November 2014, NASA awarded the contract to operate the CSBF to the Space Systems Group, Technical Services Division of Orbital Sciences Corporation in Greenbelt, Maryland.

PURPOSE

The purpose of the CSBF is to provide a permanent complex for scientific balloon flight operations. The CSBF provides the services of launching and tracking large (400-ft diameter), unmanned, high altitude (120,000+ feet) research balloons, and recovering the scientific experiments suspended beneath them. Our customers include NASA centers, universities, and scientific groups from all over the world.

HISTORY

The CSBF provides complete balloon operations services and engineering support to the United States and foreign scientific communities. In over 50 years of operation, CSBF personnel have launched more than 2,000 balloons for 35 universities, 23 other research agencies, and 33 foreign groups. These launches were conducted at the permanent launch site in Palestine and at remote sites within the contiguous United States, Alaska, and Hawaii, as well as at foreign sites in Antarctica, Argentina, Australia, Brazil, Canada, India, New Zealand, Sicily, and Sweden.

During this span of years there has been a dramatic increase in the sophistication of experiments and demands for service. This can best be shown by comparisons of the growth in payload weight, balloon size, and the amount of electronic support provided between 1963 and 2005. The

DRAFT

average payload increased from 407 pounds in 1964 to more than 6,000 pounds in 2005. Average balloon volume has increased from 2.8 million cubic feet (MCF) in 1964 to over 39.57-MCF in 2005. Although some special-purpose larger balloons and heavier suspended payload weights have been launched by CSBF personnel, standard operating limits of approximately 40-MCF volume balloons and suspended weights of 6,000 pounds are currently in effect. The routine launching of balloons with volumes greater than 25-MCF and with suspended weights greater than 4,500 pounds is a unique capability in scientific ballooning.

SERVICES

CSBF fulfills the need for dependable flight support through the following activities:

- Planning and developing facilities and providing operational services to meet the balloon flight support requirements of the scientific community
- Providing consulting services in the field of scientific ballooning
- Meeting future scientific balloon flight support needs by evaluating trends in research involving the use of balloons, then performing the research, development, testing, and evaluation necessary to develop more advanced services

CSBF operations services include:

- Inflating the balloon
- Launching the balloon
- Providing telecommanding services and data retrieval with reliable electronics systems
- Tracking and recovering the payload

Some of the areas of engineering support are:

- Balloon systems design
- Balloon materials research
- Electronics design
- Gondola design
- Thermal analysis

Additional support areas include:

- Power system design
- Instrumentation design and integration
- Recovery system design

This document is intended to summarize the services provided by CSBF and provide general guidelines and requirements for users interested in or requesting balloon flight support services.

DRAFT

This page intentionally left blank.

DRAFT

TABLE OF CONTENTS

CHANGE LOG II

PREFACE I

Why Use Scientific Balloons i
Types of Research i
About CSBF ii
Organization ii
Purpose ii
History ii
Services iii

TABLE OF CONTENTS V

LIST OF TABLES VIII

LIST OF FIGURES IX

GLOSSARY X

OVERVIEW 11

Flight Application Procedure 11
Additional Documentation Required 12
Flight Scheduling 13
CSBF Support Services 13

CONVENTIONAL BALLOON FLIGHT SUPPORT APPLICATION 14

Part I – Science 14
Disciplines 14
LDB Test Flights 14
Science Description 14
Description 15
Objectives 15
Part II – Contacts 15
Primary Contact 15
Secondary Contact 15
Funding 15
NASA Sponsored 15
Non-NASA Sponsored 15
Part III – Flight Profile 16
Launch Site 16
Estimated Site Arrival Date 16
Requested Flight Date 16
Float Requirements 16
Minimum 16
Desired 16
Other Flight Profile Requirements 16

DRAFT

Ascent/Descent Rates 16
Payload Reel Down 16
Valving 16
Other 16
Part IV –Minimum Science Success Criteria 17
Science Objectives 17
Balloon and Support Systems 17
Meteorological Support 17
Part V – Payload/Gondola Data 17
Payload/Gondola 17
Part VI – Special Balloon Requirements 17
No Radar Reflective Tape 17
Attached Ducts 18
Part VII – Ground Support 18
Network and IT Requirements 18
Services 18
Part VIII – Expendables 18
Gas/Cryogen Estimate 18
Ballast 18
Other Expendables 18
Part IX – Battery Requirements 18
Batteries 18
Part X – Electronics 19
CSBF Telecommanding System 19
Airborne Telemetry 19
Ground Telemetry 20
Part XI – Safety 20
Hazardous Materials List 20
Radioactive Materials 21
Part XII – Future Requirements 21
Part XIII – Agreement 21
Waiver of Claims Form 21
Hold Harmless from Indemnification Form 22

SUPPLIES AND EQUIPMENT 23
User-Purchased Balloons 23
Ordering Gases and Cryogens 23
Delivery Lead Times for Gases and Cryogens 23
Placing Gas/Cryogen Orders 24
Documentation Required for Gases and Cryogens 25
Returning Empty Gas/Cryogen Cylinders 25

PREFLIGHT ACTIVITIES 26
Mission Readiness Review 26
Flight Requirements Meeting 26
Preflight Minimum Success Criteria Form 27
Postflight Minimum Success Assessment Form 27

DRAFT

Gondola Design Certification 27
Gondola Design Criteria 27
Thermal Analysis 29
Threaded Fastener Integrity Requirements 29
Gondola Design Specifications 29
Gondola Design Review 30
Visual Inspection by CSBF Engineering 30
Pressure Vessel Certification 31
Documentation Required 31
Radioactive Materials Inspection 31
Radioactive Material Documentation Required 31
CSBF and Scientific Equipment Integration 32
Interface Compatibility Check 32
Rigging Equipment Check 32
Meteorological Support 33
Flight Status Meeting 33
Gondola Weight Recording 33
Mission Flight Readiness Review 33

LAUNCH ACTIVITIES 34
Weather Monitoring 34
Payload Pickup 34
Payload Transport to the Launch Pad 35
Flight Train Layout and Inspection 35
Balloon Inflation 37
Launch 38

IN-FLIGHT ACTIVITIES 40
Telemetry Support 40
Termination and Recovery 40

POST-FLIGHT ACTIVITIES 43
Minimum Success Assessment 43
Empty Gas/Cryogen Cylinder Returns 43

ADDITIONAL DOCUMENTATION 44

CONTACTS 45

DRAFT

LIST OF TABLES

Table 1 - Balloon-Centric SMD Organization 14
Table 2 - Battery Types 19
Table 3 - Notification and Delivery Schedules for Gases/Cryogens 24
Table 4 - Sources for Gas/Cryogen Order Forms 24
Table 5 - How to Submit a Gas/Cryogen Order Form 25
Table 6 - Contact List for CSBF and Balloon Program Office 45

DRAFT

LIST OF FIGURES

Figure 1 - Mobile Launch Vehicle 34
Figure 2 - Payload Suspended on Launch Pad 35
Figure 3 - Flight train layout 35
Figure 4 - Balloon being laid out 36
Figure 5 - Attaching the parachute 36
Figure 6 - Balloon bubble preparation on spool 37
Figure 7 - Balloon being filled with helium 37
Figure 8 - Balloon just prior to launch 38
Figure 9. Diagram of flight train and balloon layout 38
Figure 10 - Spool release 38
Figure 11 - Payload release from launch vehicle 39
Figure 12 - Balloon ascending 39
Figure 13 - Payload descent on parachute after flight termination 40
Figure 14 - Landing 41
Figure 15 - Parachute recovery 41
Figure 16 - Payload landing site 42
Figure 17 - Payload recovery 42

DRAFT

GLOSSARY

BPO	NASA Goddard Space Flight Center/Wallops Flight Facility Balloon Program Office
CIP	Consolidated Instrument Package
CSBF	Columbia Scientific Balloon Facility
FM	frequency modulation
FRR	flight readiness review
GSE	ground station equipment
LDB	long-duration ballooning
MOU	Memo of Understanding
NASA	National Aeronautics and Space Administration
nm	nautical mile
NMSU	New Mexico State University
PCM	pulse code modulation
PI	principal investigator for the science group
PSL	Physical Science Laboratory of New Mexico State University
QC/QA	quality control/quality assurance
RF	radio frequency
RSO	Radiation Safety Officer
SMD	Science Mission Directorate
ULDB	ultra-long-duration ballooning
V	volt

DRAFT

OVERVIEW

This document provides science groups with general information regarding the policies and procedures for preparing and submitting applications for conventional balloon flight support from the Columbia Scientific Balloon Facility (CSBF). It includes:

- Instructions for completing the application process and related forms
- Funding requirements for non-NASA sponsored users
- Options for user-supplied equipment
- Required certifications
- Typical procedures to expect from pre- to post-flight

Additionally, this document contains a list of associated reference materials along with a list of critical contacts for information and support throughout the entire application process.

FLIGHT APPLICATION PROCEDURE

Each year the CSBF accepts applications from scientific investigators to support balloon flights from Palestine, Texas or a variety of remote sites. The investigator submits a balloon flight support application for either a conventional balloon flight or a long-duration balloon (LDB) flight.

Conventional balloon flights are those with flight durations ranging from a few hours to a few days, and use direct line-of-sight electronics for commands and data. Conventional flights are typically conducted from the CSBF launch sites in Palestine, Texas; Ft. Sumner, New Mexico; Lynn Lake, Canada; and Kiruna, Sweden; however, there have been conventional flights launched from Australia and Alaska. Conventional balloon flight applications can be downloaded from the CSBF Web site at http://www.nsbf.nasa.gov/convdocs.html.

Long-duration balloon (LDB) flights normally traverse between continents or circumnavigate one of the poles, and may last as long as four weeks. LDB flights rely on satellite-based electronic systems for commands and data. These flights are usually conducted from one of the LDB launch sites in Sweden, Alaska, Australia, or Antarctica. LDB flight support applications can be downloaded from the CSBF Web site at http://www.nsbf.nasa.gov/ldbdocs.html.[1]

[1] The LDB Balloon Flight Support Application is a different form than the Conventional Balloon Flight Support Application and must be used by those flight candidates requesting long-duration flight support involving transcontinental flights or launches from the Arctic or Antarctic. These candidates must submit an LDB Balloon Flight Support Application to CSBF at least two years in advance of the requested support. The advance application for LDB flights is due to the long lead times required for logistics and operational planning with associated support organizations.

Contact the NASA Balloon Program Office (see Table 7 on page 36) regarding LDB balloon flight support early in the payload development process. CSBF and the Balloon Program Office will use direct discussions with the science group to cover specific details regarding LDB flight requirements not addressed in the LDB Balloon Flight Support Application.

DRAFT

The applications contain detailed flight requirements information which the CSBF uses for planning purposes. This includes the types of services and equipment required for the flight and required support for rigging, electronics, meteorology, and aviation. To obtain NASA/CSBF balloon flight support for the forthcoming fiscal year, science groups must complete a balloon flight support application form and return the form to CSBF. In general, applications are due by June 15 of each year.

CSBF reviews the applications to determine the basic types of services and equipment required to support each flight before adding the project to the Flight Candidate Program. By July 1 each year, CSBF submits the Flight Candidate Program to NASA Goddard Space Flight Center/ Wallops Flight Facility Balloon Program Office (BPO) for approval.

When the flight schedule has been approved, the BPO forwards it to the CSBF and technical coordination begins between CSBF engineers and the science group.

ADDITIONAL DOCUMENTATION REQUIRED

In addition to the flight support application, the science group must meet certain design and safety requirements and may have to provide supporting documentation in the following areas:

- Gondola design certification
- Pressure vessel certification
- Hazardous materials used on the ground and/or in flight

Refer to *Part XI – Safety* on page 20, the Gondola Design Certification section on page 27, and the Radioactive Materials Inspection section on page 31 for details.

DRAFT

FLIGHT SCHEDULING

Flight scheduling is based on the conditions necessary for a successful flight, such as seasonal requirements or flight duration. For instance, flights requiring long float times must be scheduled close to spring and fall turnaround periods when float winds are light and variable.

Flight scheduling can also be affected by safety requirements that may restrict the flight trajectory. Flights from Palestine, Texas are scheduled for periods when payload impacts would be planned to occur over 200 miles west of Palestine. This period is normally between mid-May and late August.

Special flight requirements may require that a risk analysis be performed to determine the acceptable conditions under which the flight may be performed.

If the scientific user must reschedule a flight, CSBF will attempt to work the flight into the current year; however, such rescheduling is not always possible.

If a flight is postponed past the end of the fiscal year (September) for which a flight was approved, the application must be resubmitted unless the user is present at CSBF when the flight application expires. Special considerations may be made to extend an approved flight into the next fiscal year. These arrangements must be made with the NASA WFF BPO.

CSBF SUPPORT SERVICES

Flight support services provided by CSBF include:

- Balloon
- Helium
- Rigging
- Electronic interface
- Flight and staging facilities
- Services directly associated with flight support

This is funded by NASA for flights by NASA-sponsored scientists, but must be paid for by other U.S. scientists and foreign users.

DRAFT

CONVENTIONAL BALLOON FLIGHT SUPPORT APPLICATION

This section provides brief explanations of the information requested in the conventional balloon flight support application. The fields are listed in the order in which they occur on the application.

PART I – SCIENCE

The Science section of the application provides CSBF a general description of the science instrument and the science objectives of the flight.

DISCIPLINES

Disciplines are defined by NASA and reflect the nature of the scientific experiment being performed. They are also used to assist the CSBF and the BPO in tracking the various types of experiments using the balloon program. Table 1 lists the balloon-centric Science Mission Directorate (SMD) organization.

Table 1 - Balloon-Centric SMD Organization

DIVISION	SCIENCE DISCIPLINE	HQ OFFICIAL
Astrophysics	Infrared, Submillimeter, and Radio Astrophysics	Kartik Sheth
	Cosmic Ray and Particle Astrophysics	Vernon Jones
	X-Ray Astrophysics	Louis Kaluzienski
	Ultraviolet and Visible Astrophysics	Mario Perez
	Gamma-ray Astrophysics	Stefan Immler
Heliophysics	Geospace Sciences	Mona Kessel
	Solar and Heliospheric Physics	Jeffrey Newmark
	Upper Atmosphere Research	Kenneth Jucks
Solar System Exploration	Exo-Planets	Larry Petro
	Planetary Science	Jim Green
Special Projects		Vernon Jones

LDB TEST FLIGHTS

Indicate Yes if the flight is a conventional engineering/science validation flight in preparation for a future LDB flight.

SCIENCE DESCRIPTION

This text is used in briefs to NASA officials, as content in press releases, and in outreach and public relations programs. Please use layman's terms whenever possible.

DRAFT

DESCRIPTION Descriptive text explaining the general nature of the scientific experiment and instrument(s).

OBJECTIVES Descriptive text explaining the scientific objectives expected from the flight.

PART II – CONTACTS

The Contacts section provides information about the responsible individuals in the science group with whom flight and payload related information and scheduling can be communicated.

PRIMARY CONTACT

The primary contact is the principal investigator (PI) or individual responsible for the payload and balloon flight details.

SECONDARY CONTACT

The secondary contact is an individual who can be contacted in the event that the Primary Contact is unavailable.

FUNDING

This section describes the funding source responsible for covering the costs of the flight. This information will be included in the mission project plan submitted to the NASA BPO prior to the flight.

NASA SPONSORED

NASA Program

The name of the NASA program or grant providing funding.

Sponsoring Directorate

The name of the NASA directorate providing funding (see Table 1 on page 14).

Science Discipline Chief

The name of the responsible NASA official or discipline scientist within the sponsoring Directorate division.

NON-NASA SPONSORED All non-NASA-sponsored users provide funding through fund transfers from the sponsoring agency to NASA. Upon receipt of the funds, NASA approves the CSBF to establish an account for the user.

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

CSBF can make no direct procurement for equipment or services until the necessary agreements are in place and monies have been received from the user.

Users can contact the Balloon Program Office (see *Table 6* on page 45) for information regarding cost estimates, contractual agreements, MOUs with

DRAFT

NASA, and instructions pertinent to the transfer of funds.

PART III – FLIGHT PROFILE

The Flight Profile section provides details concerning science requirements that are used for flight planning, cost estimating, and scheduling.

LAUNCH SITE

The location at which the PI would most like the flight to occur based on the science requirements.

ESTIMATED SITE ARRIVAL DATE

The date the science team expects to arrive at the launch site for final preparations prior to the flight.

REQUESTED FLIGHT DATE

The date the science team prefers to launch based on the science requirements. Note that this date is tentative and dependent upon final BPO flight scheduling as well as weather conditions at the site.

FLOAT REQUIREMENTS

Float requirements data provides critical variables the CSBF uses in determining the balloon size needed for the flight. Additionally, this data is compared to climatological data for the launch date and location requested by the PI to determine whether the float requirements can be achieved.

MINIMUM

Entries in this column indicate the minimum altitude, time at float, and altitude stability at which the science experiment results can still be considered successful.

DESIRED

Entries in this column indicate the ideal altitude, time at float, altitude stability, and launch time for obtaining optimum results from the science experiment.

OTHER FLIGHT PROFILE REQUIREMENTS

Additional requirements to be considered by the CSBF so that minimum scientific success criteria can be met by the flight.

ASCENT/DESCENT RATES

A specific rate(s) at which the experiment must ascend to or descend from the minimum float altitude.

PAYLOAD REEL DOWN

A controlled lowering of the payload from the balloon by means of a reel.

VALVING

Controlled descent of the balloon by releasing helium from the valves.

OTHER

Any other special requirement not listed above affecting the general flight profile.

DRAFT

PART IV –MINIMUM SCIENCE SUCCESS CRITERIA

The preliminary minimum success criteria specify the scientist's minimum requirements for a successful flight. Before a flight can proceed, there must be a reasonable chance of meeting the minimum success criteria.

SCIENCE OBJECTIVES

State the minimum and desired scientific objectives that must be met to achieve mission success.

Provide a summary of the minimum and desired experiment (detectors, pointing systems, etc.) performance.

BALLOON AND SUPPORT SYSTEMS

Provide full details of the minimum and desired performance for any pertinent balloon, telemetry, commanding, or recovery requirements.

METEOROLOGICAL SUPPORT

Provide details of the minimum and desired performance on any other data source or support elements separate from the balloon flight but necessary to achieve mission success. For example:

- Instrumented sounding balloons
- Instrumented aircraft
- Satellite overpass
- Independent ground station measurements
- National Weather Service radiosonde data
- CSBF radar tracking data

PART V – PAYLOAD/GONDOLA DATA

PAYLOAD/GONDOLA

The Payload/Gondola section provides details about the size, weight, and other mechanical aspects of the science payload and gondola. Payloads that have previously flown enable CSBF to use prior exposure and knowledge about the payload during the gondola certification process. Indicate previous flight information where applicable and whether any mechanical changes have occurred to the payload or gondola since that flight.

Also indicate any restrictions that might exist, such as proximity of the payload to other items on the flight train.

PART VI – SPECIAL BALLOON REQUIREMENTS

Use this section of the application to indicate any special balloon requirements that need to be taken into consideration.

NO RADAR REFLECTIVE TAPE

Radar reflective tape used on many standard balloon designs allows FAA ground-based radar to paint the balloon. The tape specifications are Lundy yarn #100/200 with a reflectivity of 200 to 2700 MHz. The reflective

DRAFT

nature of this tape may interfere with some types of experiments.

ATTACHED DUCTS

The two types of ducts used on balloons are *horsetail* and *attached*. Horsetail ducts hang downward and extend below the base fitting of a fully inflated balloon, whereas attached ducts follow the curvature of the balloon. In some cases, the free-floating nature of horsetail ducts could interfere with science instrument pointing or readings.

PART VII – GROUND SUPPORT

NETWORK AND IT REQUIREMENTS

Describe any network or IT requirements needed by the science group at the launch site.

SERVICES

Indicate any work area or shop support needed by the science group. Note: The Bemco environmental test chamber is only available in Palestine.

PART VIII – EXPENDABLES

GAS/CRYOGEN ESTIMATE

Although gas and cryogen requirements are included on the Balloon Flight Support Application, the information is used primarily by CSBF Operations for planning and scheduling, not for purchasing supplies or equipment.

> ***NOTE***
>
> *The PI needs to submit a separate Gas/Cryogen Order Form to CSBF Cryogen Purchasing at least two to three weeks prior to science group arrival at the launch site. See the Ordering Gases and Cryogens section on page 23 for detailed instructions on placing gas/cryogen orders.*

BALLAST

CSBF normally provides steel shot as ballast; however, if science requirements necessitate the use of non-magnetic ballast (sand) it can be provided.

OTHER EXPENDABLES

Indicate any expendables or services other than those normally supplied by CSBF for its flight support.

PART IX – BATTERY REQUIREMENTS

BATTERIES

CSBF provides batteries to NASA programs and, upon request, will act as a battery-purchasing agent for non-NASA-funded experimenters.

Lithium cells and other battery packs routinely used by CSBF are listed in Table 2 on the next page. The PI should detail battery requirements in the flight application form to enable CSBF adequate time to order the needed supply.

DRAFT

Table 2 - Battery Types

BATTERY	CELLS PER PACK	LOADED VOLTAGE	AMPERE HOUR*
B7901-10	10	26	30
B7901-11	11	29	30
B7901-12	12	32	30
B9660	10	26	7
B9525	5	14	7
B9808	4	11.2	1

* De-rate ampere-hour ratings for temperatures below -20°C.

PART X – ELECTRONICS

CSBF provides electronic flight support equipment for telemetry, command, and tracking. Electronics personnel are also available to assist the user with equipment interface and to provide information on CSBF electronics capabilities. To make full use of CSBF capabilities, the user must work closely with Electronics personnel during the planning and preparation of scientific electronics and the interface.

For detailed information concerning electronics, see the *CIP Command Interface User Handbook* at http://www.csbf.nasa.gov/convdocs.html.

CSBF TELECOMMANDING SYSTEM

The telecommanding system enables the scientist to control the scientific instrument during flight within transmission range of the launch site. It is also used by CSBF for flight control. The CSBF command system allows for a 16-bit parallel command word and a maximum of 77 discrete commands.

The CSBF telemetry system transmits data from the airborne scientific equipment to the CSBF ground support equipment (GSE) in frequency modulation (FM)/FM or pulse code modulation (PCM)/FM format. The radio frequency (RF) signal received by the GSE receiver is then patched to discriminators or directly to PCM decommutation equipment, depending on the modulation applied to the transmitted signal.

The transmission range of the CSBF GSE is limited to the radio horizon distance as determined by the altitude of the balloon. The theoretical radio horizon distance to a balloon from the ground station is approximately 335-nm at an altitude of 100,000-ft (305-km). Downrange telemetry support can be provided for flights passing beyond the range of the primary ground station. Downrange support is provided for all Fort Sumner campaigns. Support for other launch locations requires special long-range planning.

AIRBORNE TELEMETRY

CSBF uses a consolidated instrument package (CIP) for airborne electronics on conventional balloon flights. All airborne CSBF instrumentation is contained within the CIP. The CIP may be oriented

DRAFT

along any plane, but the connector panel must be accessible for preflight testing and connection. Although not required, it is preferable to securely attach the CIP within the gondola frame for protection.

CIP commanding uses a 16-bit data word and 77 available discreet commands (10 through 5C hexadecimal). These commands are accessible on the CIP J2 connector as open collector outputs with a maximum rating of 500-ma continuous and maximum 50-V pull-up voltage (an in-line current limiting resistor is also required). The computer output data stream to the CSBF GSE computer is specified in the *CIP Command Interface User Handbook.*

GROUND TELEMETRY

CSBF provides digital data logging and display programs that may be modified to meet the user's requirements. GSE equipment logs science data onto magnetic tape and provides the scientist with limited real-time data display.

A downrange telemetry station is used when the flight trajectory extends beyond the reception range of the launch site GSE. The downrange station uses the same equipment as the launch site GSE with the exception of the data-logging computer.

PART XI – SAFETY

All science groups planning to use hazardous materials are required to submit special ground and flight safety plans to address hazards associated with these items. Refer to the *Ground Safety Plan* and the gondola design documentation at http://www.csbf.nasa.gov/gondoladocs.html for details.

HAZARDOUS MATERIALS LIST

This section addresses handling and reporting requirements for hazardous materials associated with balloon payloads. Hazards most often associated with balloon payloads include:

- Radioactive materials
- Lasers
- Cryogenic materials
- Pressure vessels
- High voltage
- Pyrotechnics
- Toxic gases
- Superconducting magnets

The science group must furnish Material Safety Data Sheets (MSDS) for any hazardous material used in the flight. Subsequent sections discuss additional documentation that may be required based on the nature of the hazardous material.

See the Hazardous Systems Control section in the *Ground Safety Plan* and the Gondola Design Documentation at

DRAFT

http://www.csbf.nasa.gov/gondoladocs.html for additional details.

RADIOACTIVE MATERIALS

Some science groups require the use of small radioactive sources for instrument calibration. To facilitate the transfer of these radioactive materials from the user's home organization to the CSBF's Palestine launch site, the CSBF maintains a Texas Department of Health Radioactive Materials License. This license allows the CSBF to receive, possess, and store properly licensed instrument calibration sources that are to be used by research personnel in the course of experiments at the CSBF. Acceptable forms of radioactive materials are sealed and/or plated sources of any radioactive materials except special nuclear materials. The total activity of all sources at the CSBF is limited to 100-millicurie.

Science groups intending to bring radioactive sources to CSBF or other launch sites are required to complete the Hold Harmless and Indemnification form and submit it with the Balloon Flight Support Application.

When a radioactive source will be flown, CSBF must obtain Nuclear Launch Safety Approval (NLSA) prior to the flight. The CSBF Radiation Safety Officer will contact the principal investigator of the science group for details to secure NLSA from the NASA BPO. See the Radioactive Materials Inspection section on page 31 for more detailed information.

The use of radioactive sources for remote operations, both within the U.S. and at foreign locations, requires special arrangements. Users should contact the CSBF Radiation Safety Officer so that arrangements can be made to satisfy these requirements.

PART XII – FUTURE REQUIREMENTS

Provide information on any balloon flights you have planned for the next three years to assist NASA/CSBF in developing flight support services. Even if your plans are not firm, identifying potential requirements facilitates the planning process. Include the anticipated number of flights through calendar year 2009 and the location and seasonal requirements of each. Also note any special support, services, or capability requirements not presently offered by the CSBF.

PART XIII – AGREEMENT

Sign and date the Flight Agreement to indicate you have read and agree with all requirements and conditions in the Balloon Flight Support Application, in this document, and other supporting documentation on the CSBF Web site.

WAIVER OF CLAIMS FORM

The Waiver of Claims form releases the Physical Science Laboratory

DRAFT

(PSL), New Mexico State University (NMSU), NASA, and their employees or agents, from claims for loss or damage to instruments or equipment carried on a flight. All users and user institutions are required to complete this form (NASA organizations and activities are exempt).

The person signing for the user institutions and users must be someone with the authority to legally bind the organization, e.g., Contracting Officer, Contracting Manager, Principal Investigator, or Division Head.

The Waiver Form should accompany the flight support application and other data provided when a scientist requests CSBF services. CSBF will authorize flights only after receipt of the waiver signed by both the scientist and the scientist's employer.

CSBF 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 institutions for that time period.

> **NOTE**
>
> *Extending the waiver's effective date several years eliminates the necessity of filing repeated forms with subsequent flight support requests.*

If a scientist or institution has questions concerning the waiver form, they should contact CSBF (see contact information in *Table 6* on page 45).

HOLD HARMLESS FROM INDEMNIFICATION FORM

The Hold Harmless from Indemnification Form releases the Physical Science Laboratory of New Mexico State University (PSL/NMSU), its Regents, Officers, and employees from any liability associated with any radioactive substance provided by the science group. All users and user institutions are required to complete this form (NASA organizations and activities are exempt).

The person signing for the user institutions and users must be someone with the authority to legally bind the organization, e.g., Contracting Officer, Contracting Manager, Principal Investigator, or Division Head.

The Hold Harmless form should accompany the flight support application and other data provided when a scientist requests CSBF services if the scientist plans to use a radioactive substance on the ground or during the flight. CSBF will authorize flights only after receipt of the form signed by the scientist's employer.

CSBF will retain the form on file by institution name. This form will cover all scientists from their respective institutions for that time period.

If a scientist or institution has questions concerning the Hold Harmless form, they should contact CSBF (see contact information in *Table 6* on page 45).

DRAFT

SUPPLIES AND EQUIPMENT

USER-PURCHASED BALLOONS

CSBF normally provides balloons used in supported campaigns; however, CSBF will launch balloons purchased directly by the users if the balloons comply with CSBF design and QC/QA requirements. CSBF must review and approve the balloon design prior to production to assure compliance with NASA/CSBF balloon specifications.

During balloon production, the normal CSBF QA and manufacturer QC procedures must be in force. Users can contact Jim Rotter, CSBF Balloon Quality Assurance Manager (see *Table 6* on page 45) for more information.

ORDERING GASES AND CRYOGENS

CSBF orders helium and other commonly used laboratory gases as required by each science group. Gases other than helium are not stocked at CSBF for the scientists' use; however, CSBF can order commonly used laboratory gases through a local supplier.

Orders for any gases and cryogens not listed on the Gas/Cryogen Order Form need to be placed with the Flight Operations Manager or designee.

Requirements for unusual or hazardous laboratory gases should be cleared with CSBF before arrival. The science group may have to arrange delivery if the gas is unavailable through the local supplier.

LDB flight gas and cryogen requirements are handled differently than those for conventional flights. The CSBF Campaign Manager will coordinate with the LDB science group concerning gas and cryogen support. Any gases or cryogens required during predeployment integration in Palestine will be handled according to the instructions in this section.

DELIVERY LEAD TIMES FOR GASES AND CRYOGENS

The procedures in this section help ensure timely delivery of cryogens and specialty gases. Ordering your gases and cryogens based on these timelines will help ensure timely delivery for your flight.

Please plan to have someone on hand at the launch site to receive the delivery. If this is not possible, the CSBF Campaign Manager and/or Crew Chief will be happy to work with you to arrange for receipt of the order.

DRAFT

Table 3 - Notification and Delivery Schedules for Gases/Cryogens

GAS TYPE	CAMPAIGN TYPE	ORDER FROM CSBF	DELIVERY TIME
COMPRESSED GAS ▪ Argon ▪ Carbon dioxide ▪ Helium ▪ Nitrogen ▪ Purified air CRYOGENS ▪ Liquid helium ▪ Liquid nitrogen	Domestic	14 days prior to arrival at launch site	5 to 10 days
	Remote	60 days prior to arrival at launch site	45 days
SPECIALTY GAS	Domestic	60 days prior to arrival at launch site	30 days
	Remote	60 days prior to arrival at launch site	45 days

PLACING GAS/CRYOGEN ORDERS

1. Obtain the gas/cryogen order form from one of the sources shown in Table 4.

Table 4 - Sources for Gas/Cryogen Order Forms

SOURCE	INSTRUCTIONS
Web download	Log on to http://www.nsbf.nasa.gov/bids.html and download the Gas/Cryogen Order Form to your PC.
E-mail	Send an e-mail requesting an order form to cryogens@csbf.nasa.gov, Subject: Gas/Cryogen Order Form Request.
Fax	Fax your request for an order form to (toll-free) 866-441-7849, Attn: Cryogens. Alternate fax: 903-723-8054 Attn: Cryogens. Please call 903-729-0271 to verify the fax was received.

2. Complete the order form online.

   Press the **TAB** key to move to each of the fields in the order form document, or click directly in a field to place the cursor in it.

   a. When you open the order form document, your cursor should automatically be positioned in the first field, *Scientist Group Name*. Type in the name and press **TAB** to move to the *Contact Name* field.

   b. Continue in this manner and type in all requested information in the Customer Information section of the form.

   c. Click in the *Qty* field to the left of the type of gas or cryogen you wish to order. Type the quantity you will need.

DRAFT

d. Press **TAB** to move to the *Date Required* field. Type the date you want the gas/cryogen delivered to the site.

e. Press **TAB** to move to the *Replenish Rate* field. Type the quantity and frequency at which you will need to have the gas/cryogen replenished during the campaign.

f. Press **TAB** to move to the *Notes* field. Type any additional information you feel will be helpful to CSBF Cryogens Purchasing in placing your order.

g. Repeat steps c through f until your order is complete.

> *NOTE*
>
> ***SPECIFY THE EXACT PURITIES DESIRED FOR EACH TYPE OF GAS ORDERED.***

h. Save the document and print a copy for your files.

3. Submit the order form to CSBF using one of the methods shown in Table 5.

Table 5 - How to Submit a Gas/Cryogen Order Form

SOURCE	INSTRUCTIONS
E-mail	Send as an e-mail attachment to: cryogens@csbf.nasa.gov, Subject: Gas/Cryogen Order Form Attached.
Fax	Fax the completed order form to (toll-free) 866-441-7849, Attn: Cryogens. Alternate fax: 903-723-8054, Attn: Cryogens Please call 903-729-0271 to verify the fax was received.

DOCUMENTATION REQUIRED FOR GASES AND CRYOGENS

All science groups planning to use gases and/or cryogenic materials may be required to submit special ground and flight safety plans to address hazards associated with these items. Refer to the *Ground Safety Plan* and the *Pressure Vessel Certification* documents at http://www.csbf.nasa.gov/gondoladocs.html for details.

RETURNING EMPTY GAS/CRYOGEN CYLINDERS

Notify the CSBF Campaign Manager and/or Crew Chief in charge when cylinder(s) are empty or before you leave the site. You may also e-mail cryogens@csbf.nasa.gov, Subject: Gas/Cryogen Returns. Please include the following return information for each cylinder:

- Science group name
- Release number
- Product/cylinder type
- Serial number

> ***NOTE***
>
> *This information should be on a tag with each cylinder provided by the gas contractor.*

DRAFT

PREFLIGHT ACTIVITIES

This section describes activities that occur after science group arrival at the launch site and prior to the actual launch. The activities include:

- Mission Readiness Review (MRR)
- Flight requirements meeting
- Gondola design and pressure vessel certification
- Radioactive materials inspection
- Equipment integration
- Interface compatibility check
- Rigging equipment check
- Meteorological support
- Flight status meeting
- Gondola weight recording
- Mission Flight Readiness Review (FRR)

MISSION READINESS REVIEW

The BPO is responsible for the MRR including scheduling, conducting, and reporting applicable action items. Both CSBF and all science groups will review the status of their progress prior to shipment of equipment to the launch site. Following successful completion of MRR requirements, the BPO will authorize the campaign to proceed. The Mission FRR will not be conducted until all action items are completed.

FLIGHT REQUIREMENTS MEETING

During this meeting, the science group and representatives of CSBF meet to review the scientist's minimum requirements for flight as approved by NASA BPO in the flight application.

The desired and minimum success criteria provide the launch support group with insight into the science performance requirements, allowing them to more completely assess the scientists' needs when developing requirements for flight planning. The experimenters need to be realistic in specifying success criteria.

The scientific investigator and a CSBF representative sign a flight requirements form setting these criteria. The resulting agreement between the scientist and the CSBF specifies the flight criteria that define a successful flight. Before a flight can proceed, there must be a reasonable chance of meeting the minimum success criteria established in this meeting. CSBF will not attempt a launch without assurance that the minimum scientific requirements can be met completely.

DRAFT

The flight candidates must inform CSBF of any changes in requirements or schedule as these may affect costs and program plans.

PREFLIGHT MINIMUM SUCCESS CRITERIA FORM

The CSBF Campaign Manager will provide a Preflight Minimum Success Criteria form to the PI at the flight requirements meeting. The PI will be asked to complete the form and return it at the flight readiness meeting.

The Preflight Minimum Success Criteria form presents a higher level of detail concerning minimum success criteria for the flight than those specified in the original Balloon Flight Support Application.

POSTFLIGHT MINIMUM SUCCESS ASSESSMENT FORM

CSBF will give the PI a Postflight Minimum Success Assessment form at the meeting. The PI is requested to return the completed form to the Campaign Manager before leaving the site.

GONDOLA DESIGN CERTIFICATION

The gondola design certification program is an FAA and NASA Safety program 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.

CSBF Mechanical Engineers use the scientist's design information and stress analysis to assess a gondola's suitability and to formally certify the structure as safe for flight. 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 CSBF in the form of a brief resume. The primary point of contact is the CSBF Gondola Certification Engineer (see CSBF Contact Information on page 45).

Although CSBF engineers are available to answer questions on design problems or unusual projects, the CSBF 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 is then notified of the certification based on his design and stress analysis.

GONDOLA DESIGN CRITERIA

Gondolas must be designed so that all load-carrying structural members, joins, connectors, decks, and suspension systems are capable of withstanding the conditions listed below without ultimate structural failure.

1. A load ten 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 the horizontal (≥30°) in a normal flight configuration.

DRAFT

Cable terminations, cable attachments, and gondola structural members must be capable of withstanding the load described above.

3. A load five times the weight of the payload applied at the suspension point and 45° to the vertical. This load factor must be accounted for in the direction perpendicular to the gondola's short side, in the direction 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 a flexible cable suspension system is used, it 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. The effects of stress concentration factors must be considered in the analyses of all critical mechanical structures and assemblies. The ultimate strength of the element should be de-rated 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.
6. If a particular element does not pass when de-rated 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 CSBF recommends that proof tests be conducted by the science group as a standard practice to ensure that their hardware has adequate strength.
7. The ductility of all materials used for critical mechanical elements shall be considered in the analysis of the gondola structure. Specifically, the CSBF 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 must also ensure that all scientific equipment, CSBF equipment, and ballast remain contained when subjected to the loads described above, and that the gondola is capable of supporting the weight of CSBF equipment. Scientists should contact CSBF during the design stage for information on equipment and ballast weight for the flight.

DRAFT

THERMAL ANALYSIS

CSBF has accumulated considerable experience in the thermal conditions encountered during a balloon flight. CSBF will provide recommendations concerning materials and gondola configuration to scientists who are designing gondolas and scientific experiments. However, it is the responsibility of the scientist to determine the thermal behavior of the payload during flight.

THREADED FASTENER INTEGRITY REQUIREMENTS

The BPO requires that structural threaded fasteners intended for use in flight hardware and safety-critical nuts and bolts should meet certain tensile load specifications or be procured from specific suppliers.

While flight experimenters themselves are considered exempt from these policies, we offer a list of approved vendors and services for sample testing of threaded fasteners. In the case of single-point failure fasteners, tensile or hardness testing will be performed and safety-critical items in all cases will continue to be emphasized. Threaded fasteners that 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.

For more information and a list of accepted vendors, see the *GSFC Fastener Integrity Requirements* document (OF-606-00-M) at http://www.csbf.nasa.gov/gondoladocs.html.

GONDOLA DESIGN SPECIFICATIONS

CSBF is required to certify all payload gondolas as safe for flight. To complete the certification requirements, all science groups must provide CSBF with gondola and suspension structural design information, material specifications, and load test information 60 days prior to arrival at the launch site. These include the following:

- Drawings that show the relative locations and dimensions of all structural and load-bearing gondola members as well as identify the materials
- At least one complete assembly drawing
- Working drawings and specifications for all purchased and fabricated mechanical components and assemblies that are part of the flight train (thread fasteners, rotators, swivels, turnbuckles, clevises, rings, and universal joints)
- A stress analysis of all major structural members, including decks and ballast attachment points, with the components, equipment, and weights comprising the loads identified
- A statement signed by the PI and the engineer responsible for the gondola structure that certifies that the aforementioned requirements have been met

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

DRAFT

design was not changed.

GONDOLA DESIGN REVIEW

The CSBF Engineering Department uses 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 CSBF in the form of a brief resume.

The following assumptions are made by the CSBF certifying engineer in reviewing gondola design analyses:

- The suspension point is defined as the point where the scientist-furnished gondola suspension equipment interfaces with CSBF-furnished flight system hardware.
- The payload weight includes the gondola structure, all scientific equipment and components, and all CSBF equipment (including ballast) affixed to the structure below the gondola suspension point.
- For analysis purposes, the base of the gondola may be assumed to be rigidly fixed (in a static condition).

Although CSBF engineers are available to answer questions on design problems or unusual projects, CSBF's primary role is to identify critical structures, determine whether the analysis has examined these structures, and spot-check pertinent calculations. The researcher is then notified upon approval of the design and stress analysis.

NASA-sponsored experimenters requesting balloon flights at launch sites other than Palestine, Texas *and not requiring CSBF services*, shall forward gondola design information to the Balloon Program Office at Wallops Flight Facility (see contact information in *Table 6* on page 45). The BPO will make any further distribution.

VISUAL INSPECTION BY CSBF ENGINEERING

The final stage of gondola certification is a visual inspection by a CSBF engineer after the payload is assembled.

CSBF will perform final gondola design certification using NASA/CSBF accepted criteria. See http://www.csbf.nasa.gov/gondoladocs.html for details on these criteria.

When gondola assembly is complete, a CSBF engineer inspects the structure as the final step in the gondola certification process. The primary concerns at this point are:

- The actual structure matches the specifications described in the scientist's gondola certification documentation
- Adequate construction techniques have been used

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. The inspecting engineer will also spot-check the design for potential problems that may not have been evident in the documentation drawings.

DRAFT

PRESSURE VESSEL CERTIFICATION

Pressure vessel certification is performed in addition to the gondola certification process. While individual science groups are responsible for the design, fabrication, and testing of all pressure vessels associated with their payloads, test programs may be performed to the extent necessary to demonstrate that the pressure vessel(s) will not present an unacceptable risk to personnel or property as a consequence of ground or flight operations.

DOCUMENTATION REQUIRED

CSBF is required to certify all pressure vessels included on payload gondolas or used for ground support requirements. To complete certification requirements, all scientists must submit a brief description of the vessels for review and approval by CSBF. The description need not be overly elaborate; a few paragraphs will suffice. The statement should contain general information on:

- Intended use
- Design specifications of the vessel(s)
- Description of any ground testing performed on the vessel(s)
- Any flight history of the vessel(s)

See the *Pressure Vessel Certification* document for details on pressure vessels used in flight, and the *Ground Safety Plan* for details on ground-based pressure vessel systems. Both of these documents can be found at http://www.csbf.nasa.gov/gondoladocs.html.

RADIOACTIVE MATERIALS INSPECTION

The CSBF Radiation Safety Officer monitors radioactive sources used or stored at CSBF by scientific users, as well as sources used at remote launch sites. When a radioactive source will be flown, CSBF must obtain Nuclear Launch Safety Approval (NLSA) from the NASA Balloon Program Office prior to the flight.

Scientific users who plan to bring radioactive materials to the CSBF will be contacted by the Radiation Safety Officer shortly after arrival. The Radiation Safety Officer obtains approval from neighboring states for overflight and ensures compliance with the Texas Regulations for Control of Radiation.

Scientific sources are inventoried upon arrival and their activities and integrity are checked. If a source is to be flown, the method by which the source is secured to the gondola is also checked.

RADIOACTIVE MATERIAL DOCUMENTATION REQUIRED

All science groups must submit the following documentation to Garret Wilbanks, CSBF Radiation Safety Officer (see contact information in *Table 6* on page 45), 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.

DRAFT

- Current leak test documentation for all radioactive material. License and laws of the State of Texas require testing of Alpha-emitting sources every three months, and testing of other sealed sources every six months.

> **Important**
>
> *CSBF will impound any source arriving without a current test certificate. The source will remain impounded until it is leak tested, even if testing requires disassembly of the gondola. The PI will be responsible for all costs incurred for leak tests at the CSBF.*

- A list of the science group members authorized to handle radioactive sources.

CSBF AND SCIENTIFIC EQUIPMENT INTEGRATION

After the Flight Requirements Meeting, CSBF Electronics personnel will deliver an electronic interface (CIP) to the scientific group. This electronic flight support system provides a ground-to-balloon link through which the scientific user can command the onboard scientific equipment and receive and monitor telemetered data. The CIP transmits command, tracking, and telemetry signals between the airborne scientific payload and the ground station.

The CIP is set to transmit on a CSBF-assigned frequency and has open wires ready for installation in the scientific payload. In most cases, installation requires only a few hours, but a CSBF Electronics Technician will assist the scientific user if problems are encountered, provide some software programming support, and conduct compatibility tests of the electronic interface between the scientific payload and CSBF electronics. Refer to the *Command Interface Handbook* for details.

INTERFACE COMPATIBILITY CHECK

After the CIP has been installed in the scientific payload, CSBF Electronics personnel will check the electronic interface. The tests of scientific and CSBF instrumentation are conducted before flight and during normal working hours.

Detailed information on all electronic interfaces is contained in the *Command Interface Handbook.*

RIGGING EQUIPMENT CHECK

As part of the standard flight support service, Flight Operations personnel select, pull-test, and certify flight train equipment including the parachute, cable ladder, and associated cables and hardware. They also provide flight line rigging of the mechanical flight train.

DRAFT

METEOROLOGICAL SUPPORT

The CSBF has meteorological staff and facilities for flight support. CSBF's Atmospheric Scientists provide daily briefings to operations and science personnel to help identify launch opportunities and conditions affecting flight status.

FLIGHT STATUS MEETING

Flight status meetings are held daily with scientific users when one or more experiments are flight ready. CSBF Operations reviews the priority of waiting flights and verifies readiness with users. Scientists are briefed on anticipated flight opportunities and the extended weather forecast and are informed of scheduled meetings.

GONDOLA WEIGHT RECORDING

A final gondola weight is taken before the flight readiness review. The PI must sign an acknowledgement of the recorded weight.

MISSION FLIGHT READINESS REVIEW

The mission flight readiness review (FRR) is held no more than 72 hours before the flight. The mechanical certification of the entire flight train and the electronic compatibility tests are reviewed, and the flight profile is discussed.

Operations personnel establish the acceptable launch window and science payload pickup time. They then review the planned postflight recovery of the gondola. During the FRR CSBF verifies flight readiness and finalizes the flight plan.

If more than 72 hours elapse before the launch, a second briefing is held. Although science group personnel may be present at the briefing, their attendance is not required.

DRAFT

LAUNCH ACTIVITIES

This section describes launch support activities. These activities begin a few hours before launch. CSBF provides all launch facilities, equipment, and vehicles.

WEATHER MONITORING

CSBF Campaign Meteorologists calculate the potential launch window based on current and predicted weather conditions. The launch will proceed when there is little potential for significantly adverse conditions occurring too close to the projected launch time. Weather conditions are monitored from the occurrence of the flight readiness meeting up to the actual release of the balloon.

PAYLOAD PICKUP

On the day of the flight, CSBF support personnel will pick up the scientific payload using a crane-like machine called a mobile launch vehicle (Figure 1).

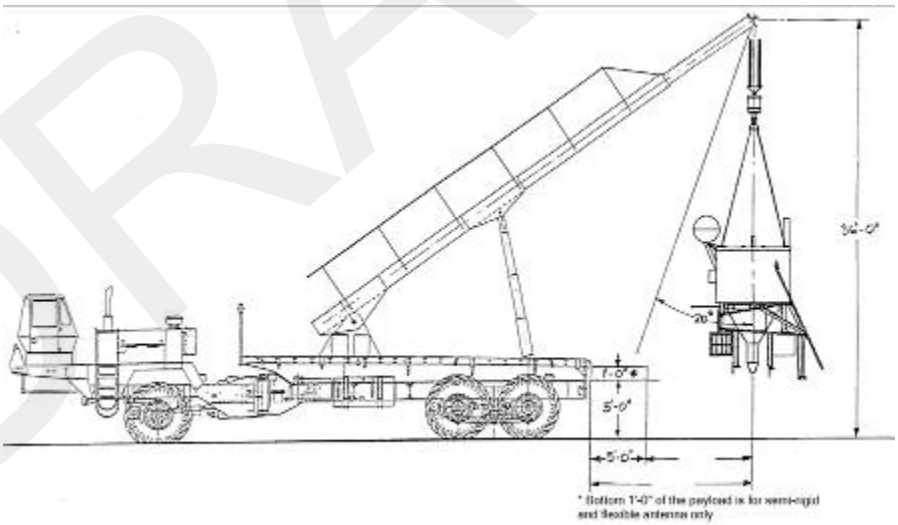

Figure 1 - Mobile Launch Vehicle

CSBF and science group personnel perform preflight electronics checks and interfacing of CSBF and scientific equipment.

DRAFT

PAYLOAD TRANSPORT TO THE LAUNCH PAD

The mobile launch vehicle transports the payload from the staging area to the launch pad (Figure 2).

Figure 2 - Payload Suspended on Launch Pad

The scientific group completes any flight line checkout and final preparation of the scientific equipment.

FLIGHT TRAIN LAYOUT AND INSPECTION

If weather conditions remain positive for launch, the CSBF flight crew lays out the flight train and performs the flight line checkout.

The flight line crew lays out a protective ground cloth—the entire length of the flight train and balloon—to prevent ground contact damage to the flight train equipment, parachute, and balloon. The parachute stream is laid out onto the ground cloth and checked (Figure 3).

Figure 3 - Flight train layout

DRAFT

After the flight train and parachute are laid out, the balloon is laid out (Figure 4) and attached to the parachute (Figure 5).

Figure 4 - Balloon being laid out

Figure 5 - Attaching the parachute

DRAFT

BALLOON INFLATION

After flight line checkout, the CSBF crew begins balloon inflation. The crew attaches helium valves to the balloon (Figure 6). Helium is pumped into the balloon until the precalculated amount has been delivered (Figure 7).

Figure 6 - Balloon bubble preparation on spool

Figure 7 - Balloon being filled with helium

DRAFT

Figure 8 - Balloon just prior to launch

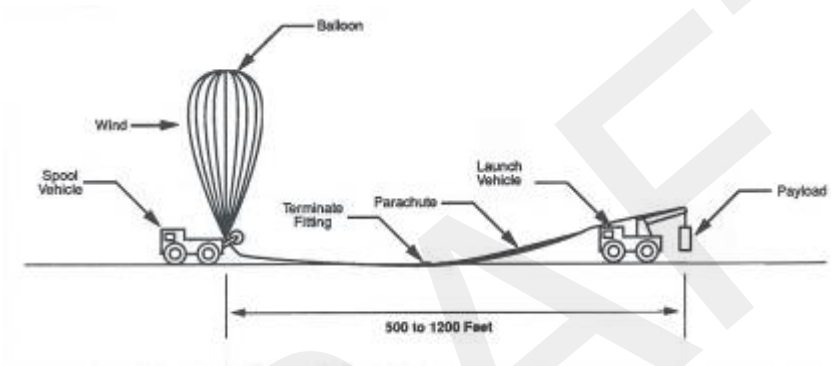

Figure 9. Diagram of flight train and balloon layout

LAUNCH

When the balloon is inflated with the proper amount of helium, it is released from the spool (Figure 10).

Figure 10 - Spool release

DRAFT

As the balloon rises, the crew maneuvers the mobile launch vehicle with the payload until the balloon is almost perpendicular above the vehicle before releasing the payload (Figure 11).

Figure 11 - Payload release from launch vehicle

The balloon and its cargo then begin the ascension to float altitude (Figure 12).

Figure 12 - Balloon ascending

DRAFT

IN-FLIGHT ACTIVITIES

TELEMETRY SUPPORT

All CSBF flight support systems will be on and continuously operational from prior to launch through the end of flight. The science instrument is powered on and executed at direction of the Principal Investigator. Data collection and command control is maintained continuously from prelaunch until end of flight.

The experiment team is responsible for analyzing the scientific data from the flight. CSBF will generate the required experiment data product during the flight and any agreed-to products as defined within the CSBF specific Flight Requirements form as soon as possible following the flight.

TERMINATION AND RECOVERY

The payload parachute release system (PPRS) is in line with the flight train and deploys immediately upon command activation, initiated at flight termination. Separated from the parachute and payload, the balloon carcass free-falls to the ground and the payload descends on the parachute (Figure 13).

Figure 13 - Payload descent on parachute after flight termination

DRAFT

Figure 14 - Landing

Upon landing, the semi-automatic parachute release (SAPR) system is initiated, separating the parachute from the payload to prevent the parachute from dragging and damaging the payload.

The balloon, parachute, and payload are then recovered.

Figure 15 - Parachute recovery

DRAFT

Figure 16 - Payload landing site

Figure 17 - Payload recovery

DRAFT

POST-FLIGHT ACTIVITIES

MINIMUM SUCCESS ASSESSMENT

CSBF will give the Principal Investigator a post-flight assessment form at the Flight Requirements Meeting held by the CSBF Operations Department. The Principal Investigator should ensure the completed form is returned to the Campaign Manager before leaving the site.

EMPTY GAS/CRYOGEN CYLINDER RETURNS

Notify the CSBF Campaign Manager and/or Crew Chief in charge when cylinder(s) are empty or before you leave the site.

You may also e-mail cryogens@csbf.nasa.gov, Subject: Gas/Cryogen Returns. Please include the following return information for each cylinder:

- Science group name
- Release number
- Product/cylinder type
- Serial number

> ***NOTE***
>
> *This information should be on a tag with each cylinder provided by Contractor as part of the contract requirement.*

DRAFT

ADDITIONAL DOCUMENTATION

For additional documentation, please visit the CSBF Web site at http://www.csbf.nasa.gov/docs.html.

DRAFT

CONTACTS

Table 6 - Contact List for CSBF and Balloon Program Office

SERVICE	CONTACT	
	CSBF	NASA/BPO
Cost estimates, fund transfers		David D. Gregory
First-time conventional and LDB flight notification	Hugo Franco	David D. Gregory*
Flight support applications – conventional	Mona Breeding, Hugo Franco	
Flight support applications – LDB	Mona Breeding, Bryan Stilwell	
Flight support documentation	Mona Breeding	
Gases, cryogens	CSBF Cryogen (Purchasing)	
Gondola design certification	Garret Wilbanks	
New gondola design notification	Garret Wilbanks	David D. Gregory*
Non-NASA sponsored funding		David D. Gregory
Post-flight assessments and forms	Mona Breeding	David D. Gregory
Pressure vessel certification	Garret Wilbanks	
Radioactive material documentation requirements	Garret Wilbanks	
Radioactive materials	Garret Wilbanks	
Requirements or schedules	Hugo Franco	
User-purchased balloons	Justin Marsh	
User services, questions	Hugo Franco	

** Contact in addition to CSBF*

ADDRESS	NAME	PHONE	FAX	E-MAIL
Columbia Scientific Balloon Facility 1510 East FM Road 3224 Palestine, Texas 75803	Mona Breeding	903-723-8086	903-723-8056	mona.breeding@csbf.nasa.gov
	Cryogens		903-723-8054	cryogens@csbf.nasa.gov
	Hugo Franco	903-723-8091	903-723-8056	hugo.franco@csbf.nasa.gov
	Garret Wilbanks	903-723-8020	903-731-8509	garret.wilbanks@csbf.nasa.gov
	Justin Marsh	903-723-8053	903-723-8056	justin.marsh@csbf.nasa.gov
	Bryan Stilwell	903-723-8097	903-731-8510	bryan.stilwell@csbf.nasa.gov
NASA/Goddard Space Flight Facility Wallops Flight Facility Balloon Program Office Wallops Island, Virginia 23337	David D. Gregory	757-824-2367	757-824-2149	david.d.gregory@nasa.gov

DRAFT