COLUMBIA SCIENTIFIC BALLOON FACILITY

ZZ-XNA-CSBF Rigging Best Practices

June 17, 2024

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INTRODUCTION

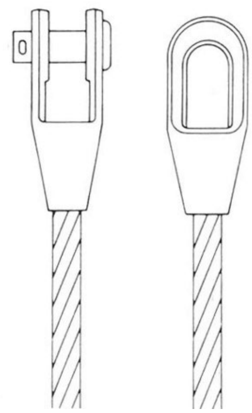
The following is a list of recommendations compiled by the CSBF Flight Operations Department. This document is designed to provide suggestions and general recommendations to the Scientific Ballooning Community. The intent is to help them avoid mistakes and common pitfalls that can compromise science and safety objectives, or cause delays and unnecessary costs.

Suspension Systems

- Use appropriate end fittings or thimble eyes to prevent cable damage from fatigue and/or lifting operations. A cable without these features will tend to "bird-cage" (see image below), potentially weakening the strength capacity of the cable.

- Thimble example

- Should use cables free of oil impregnation/residue. It has been observed that the thermal environment during flight can cause this oil to drip from the suspension system onto scientific equipment. Further, handling the cables during normal operations eliminates the need for any special handling equipment and prevent possible contamination of other sensitive items within the payload. Cables can be specified to be "DRY" when ordering from vendor. CSBF strongly recommends these suspension systems be fabricated with NO oil residue and appropriate end fittings at the correct angles and with thimbles where it applies.
- Cables with spelter end fittings are highly preferred.



- Suspension cables must be procured from vendors that can provide documentation for Proof of Load certification.

Payload Size and Complexity

- Payload weights and sizes have a direct effect on its ability to get launched; in general, the smaller and lighter the payload is, the better the chances of launching.
- Outside calibration and pointing exercises require, in general, good weather days that could be potential launch opportunities for the next science group on cue or the payload itself. Recommend limiting these when at all possible.
- Limit check out times whenever possible.
- Whenever possible, design payloads to be supported by movable carts, and to accommodate ballast hoppers. This allows for ease of operations during integrations and saves prep times before launch.
- Payloads should be designed to allow proper placement of jack stands and crush pads.
- Payloads should be designed to allow for proper access and installation of CSBF components such as SIP, antennae, suspension cables and other components.
- Payloads should be designed considering current restrictions on working under a suspended payload.
- Payloads should allow for the implementation of tag lines required for payload handling during launch.
- Rigging hardware provided by science groups need to be certified and approved by Wallops Safety Office's Code 391
- CSBF has historically used MP50 Molly Paste lubricant which is rated for the proper temperature extremes used during flights and on the ground at all launch locations.
- MP-50™ Moly Paste | Jet-Lube (jetlube.com)
- When payloads are suspended on the launch vehicle during compatibility tests, they are typically exposed to the elements for considerable amounts of time (over 8 hours). Externally mounted equipment such as antenna mounts and solar panels must be able to sustain surface crosswinds of up to 16 knots during testing.

Gondolas

Recovery Operations

The gondola should be easy to disassemble using conventional tools. Sensitive detectors which are easily removeable can be recovered quickly, even if the entire recovery process is lengthy.

Batteries must be easily accessible for removal by recovery crews because expended batteries and powered-up equipment pose fire hazards.

The designer can avoid many field recovery problems by adopting a modular design and by limiting the size and weight of the gondola or of individual components. Gondolas are transported on open trailers, and the road trip from the impact site back to the launch facility can be rough. The gondola typically experiences jolts of 5-g to 7-g throughout the ride and unprotected sensitive equipment may return to the facility covered with dust. A gondola that can be broken down into smaller units is easier to recover from inaccessible landing sites and to transport on recovery vehicles.

Whenever possible, delicate instruments should be positioned within the gondola in such a way that they can be removed in the field and packed separately for transportation from the impact site. The experimenter should provide appropriate containers for packing components in the field.

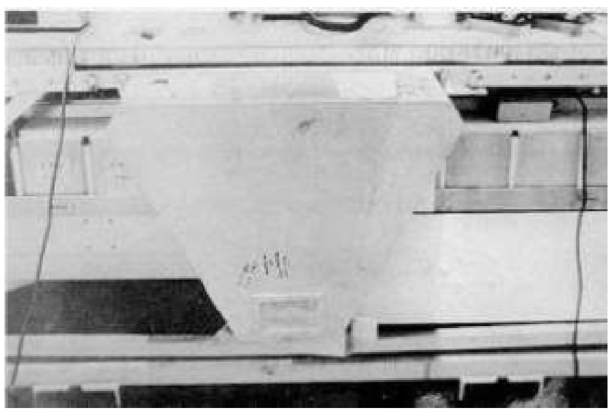
Most recoveries will require a device to lift the payload onto the recovery trailer. There is no hard requirement for hoist points on the gondola. However, the designer may wish to provide and/or label hoist points to aid the recovery crew.

WEIGHT

One of the critical elements of early design is the initial weight estimate. It is not uncommon for the gondola's final weight to be heavier than the original estimate. Therefore, the experimenter must carefully estimate the anticipated weight of all science instruments, science and CSBF electronics, and ballast. Further, the experimenter must build some flexibility into the design to accommodate added weight of experiment modifications. Changes in flight profile – longer flight times, higher altitudes, and flights through sunset – also increase gondola weight by adding ballast weight.

BALLAST HOPPER

The scientist may provide ballast hoppers to replace the standard hopper used by the CSBF. Custom hoppers may be side-mounted or may allow special ballast handling that would otherwise be impossible (see Figure below). CSBF should be contacted for information on hopper design and ballast valves if the scientist intends to construct custom hoppers.



Side-mounted ballast hopper

In designing the ballast attachment, the experimenter must anticipate the maximum ballast weight to be carried by the gondola and should be aware that factors such as increasing float altitude or flight time and floating through sunsets will increase ballast weight. Ballast requirements are based on the gross weight of the system: balloon, rigging, gondola, and ballast. More ballast is required for an evening or night ascent than a morning or daytime ascent. Increasing the float altitude requires a larger, heavier balloon and increased ballast for all phases of the flight. Extended turnaround flights may easily require in excess of 1000 pounds of ballast.

WHEELS OR WHEELED CART

At a remote launch site, a hoist may or may not be available for lifting and moving the gondola. In this situation the structure could be supported by a wheeled cart or cradle, which would allow work below and around the payload. Ideally, the cart/cradle would be tall enough to allow mounting of solar panels, crush pads, and ballast hoppers without lifting the structure.