C-130 Investigators Handbook

Chapter 5. Investigator Equipment Packages

This chapter is intended to provide investigators with complete information about structural and electrical guidelines that must be followed as part of the design and construction of research equipment for the C-130. While the content of this chapter is intended to be as comprehensive as possible, investigators should also be aware that EOL personnel will assist investigators with meeting all of the requirements set forth herein for the C-130. Contact information for appropriate EOL personnel is provided throughout this chapter in order to facilitate communications between users and EOL staff. **New procedures imposing instrumentation flight testing prior to an instrument's inclusion in a research payload have been adopted. Check Chapter 8 for details.**

An accurate estimate of the weight and size of user equipment to be installed on the aircraft is a critically-important requirement in the initial request for aviation support. Estimated weights and sizes also must include any support equipment (e.g., gas cylinders, spares, tools, supplies) which are to be carried on the aircraft during ferry or research flights. RAF's feasibility evaluation of a program is based on this information. Any changes to the original proposal will require a reevaluation of the proposed flight profiles, and possibly require changes in the cabin layout, to comply with aircraft balance requirements. A sample cabin layout showing possible rack and seat configurations appears in Figure 5.1.

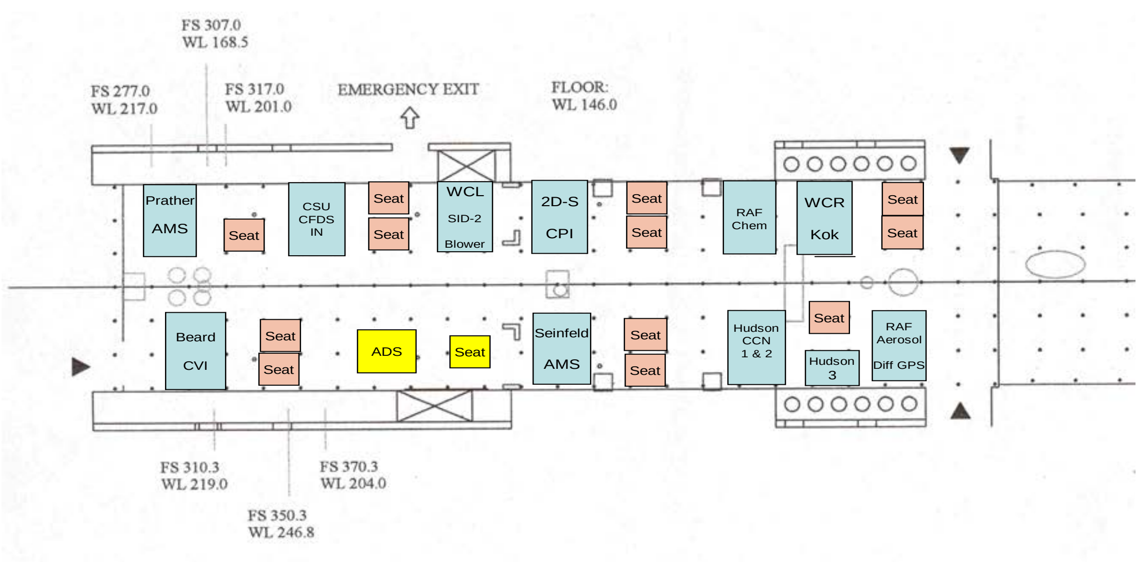

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Figure 5.1 Typical Research Cabin Configuration

Prior to installation on the aircraft, all user equipment will be weighed and identified by an appropriate tag and entered in the instrumentation log book. Prior to departure, all spares, supplies and associated gear, including personal baggage, also will be weighed and properly marked. These actual weights will be used in the weight-and-balance calculations required for the safe operation of the aircraft. Strict compliance is mandatory. Any un-weighed and unmarked items will be removed from the aircraft.

5.1 Design Criteria

All equipment that attaches to or is used on the NSF/NCAR aircraft must conform to the following basic design load criteria: emergency landing conditions, in-flight lift and drag forces and gust loads--all acting independently. Emergency landing loads are defined as loading that occurs during other than a normal landing, such as a wheels-up landing or veering off the runway. Lift and drag forces are defined as those loads encountered during flight at maximum design airspeed and sea level conditions due to the shape and size of externally-mounted equipment. In-flight gust loads are defined as the loads resulting from turbulence. The following design load criteria are from Federal Aviation Administration or aircraft manufacturer-approved data and include appropriate safety factors.

All equipment, including racks, instruments, pallets, tie-downs, etc., and supporting structure that attaches to hard-points inside the aircraft cabin (the cabin being defined as that space occupied by personnel) must be designed for the emergency landing conditions listed in Table 5.1. The emergency landing condition loads are independent of the in-flight loads and must be calculated separately.

Table 5.1. Emergency Landing Criteria

Load Direction	Load Factor (Ultimate) Occupied Areas	Load Factor (Ultimate) Unoccupied Areas
Forward	9.0 g (9.0 x wt. of equip.)	3.0 g
Up	3.0 g (3.0 x wt. of equip.)	2.0 g
Down	6.0 g (6.0 x wt. of equip.)	4.5 g
Side	3.0 g (3.0 x wt. of equip.)	1.5 g
Aft	1.5 g (1.5 x wt. of equip.)	1.5 g

All externally-mounted equipment and supporting structure that attaches to external hard-points on the aircraft must be designed for the airspeed (lift and drag) loads and the in-flight gust loads. For the C-130 these criteria are:

Airspeed – 250 kias at sea level conditions
In Flight Gust Loads – 8.25 g down and 5.25 g up.

The Aeronautical Engineering Department of the RAF will assist in the interpretation of these criteria as well as provide guidance in the design or attachment of user-supplied equipment on the NSF/NCAR aircraft.

All equipment for pressurized aircraft (e.g., optical view ports, air sampling chambers, valves or lines) must maintain the pressure differential between cabin pressure on one side and outside ambient pressure on the other. It must be designed to a collapse or burst pressure of at least 1.1 kg/cm2 (15.6 psi) for the C-130Q independent of other loads.

***NOTE**: Due to the low ground clearance of the C-130 fuselage, an added maximum length limit will be imposed on all belly mounted equipment - regardless of the associated gust loads. No belly mounted equipment can extend more than 10'' from the aircraft skin. It has been demonstrated that aerosol and gas sampling inlets of this length are still long enough to reach the free atmosphere outside the aircraft boundary layer even at the aft most sampling location (FS 682).*

5.2 Structural Considerations

This section sets forth the guidelines to be followed for the design, fabrication, and approval of investigator research equipment to be flown onboard the NSF/NCAR C-130. The design, modification, and installation of airborne research equipment is one of the more demanding and time consuming aspects of airborne research.

All equipment must also be designed or modified to attach to the various mounting points and instrument racks on the NSF/NCAR C-130. Properly securing all equipment and ensuring that the equipment loads can be reacted to by the aircraft is a mandated requirement to ensure the safety of each crew member and the safe operation of the aircraft. A detailed description of the aircraft mounting points is provided in Chapter 2 of this handbook.

Newly designed, commercially-purchased, and other equipment not designed for aircraft use must be evaluated for structural integrity and, if necessary, be modified or strengthened to comply with the criteria outlined in this section. Also, all equipment designed for aircraft use will be reviewed for conformity to design and installation specifications. In addition to structural considerations, any wiring in user-supplied equipment must adhere to guidelines established and outlined herein.

Equipment designs that fail to comply with the guidelines of this handbook or hardware that fails to conform to the design documentation will not be installed on the aircraft until the deficiencies are corrected. In the event that the deficiencies cannot be corrected, the equipment will not be permitted on board the aircraft for flight research. RAF Aeronautical Engineering personnel will assist the user in understanding and complying with the requirements of this section.

5.2.1 Materials

Metallic

Aluminum is the preferred material for the fabrication of parts because of its good strength to weight ratio, formability and machineability, availability and cost. Of the numerous alloys available, it is generally best to select 2024, 6061, or 7075 aluminum alloys based upon previous aircraft industry usage and good availability. The following guidelines for aluminum alloy and temper selection should be considered:

• For sheet metal applications (material thickness < 0.125 inches) 2024-T3 clad sheet and 7075-T6 clad sheet are preferred. The advantage of the 2024-T3 clad sheet over the stronger 7075-T6 sheet is that 2024 can be formed in the T3 temper while 7075 material should be formed in the O temper and heat treated after all forming processes.

• For plate material required for machined parts, 2124-T851 or 7075-T7351 should be used for there increased fatigue and fracture properties.

• Extruded material should be 7075-T73 or –T76.

• For lightly loaded structures or if welding is absolutely necessary, 6061 aluminum alloy should be used. Welded materials should be utilized in statically loaded structures only. If loading is repetitive or cyclic, strict quality control during fabrication and the development of on-going inspection requirements (x-ray, dye-penetrant) is necessary to ensure voids, inclusions, and incomplete fusion typical of welded structures to not adversely affect the strength and service life of the component. 6061 must be heat treated after welding in order to develop full strength capability. Material left in the as welded condition will be in the annealed state (O temper) with little strength in the heat-affected zone near the weld.

For machined fittings where aluminum provides insufficient strength or for welded structures, it is preferable to use low alloy steels or corrosion resisting (stainless steel, A286) materials. The 4130, 4140, and 4340 low alloy steels are commonly used and available in a variety of product forms. These steels do require corrosion prevention treatment and thus are not normally used in exterior applications on aircraft. 17-4PH, 15-5PH, and 17-7PH precipitation hardened stainless steels and A286 are commonly used corrosion resistant materials. These materials are strengthened by heat treatment and should not be used in the annealed condition. The 300 series stainless steels are austenitic stainless steels. They can be cold worked to provide additional strength and are readily formed without requiring additional finishing and heat treatment.

All material property data used in strength calculation should be from DOT/FAA/AR-MMPDS-01, Metallic Materials Properties Development and Standardization (formerly Mil-Hdbk-5H), or other acceptable data.

Non-Metallic
Commercial electronic components need not comply with these requirements. Additionally, small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that would not contribute significantly to the propagation of a fire are exempted per Title 14, Code of Federal Regulations, Part 25, Appendix F, Part 1(a)(1)(v). Unique electronic components, wiring and cabling external to individual electronic boxes, and plumbing between different pieces of research equipment are expected to comply with this memo.

Materials that are flammable, produce smoke, or emit toxic fumes when exposed to a combustible or high-temperature environment should not be used in research equipment assemblies. The following non-metallic materials are acceptable for cable and wiring insulation and for supply and exhaust line plumbing:

- Teflon TFE (tetraflourethylene)
- Teflon PFA (perflouroalkoxy)
- Teflon FEP (flourinated ethylene propylene)
- Teflon PTFE (polytetraflouroethylene)
- Tefzel ETFE (ethylene & tetraflouroethylene)
- Halar ECTFE (ethylene & monochlorotriflouroethylene)
- Kynar PVDF (homopolymer of vinylidene flouride)
- Silicone Rubber
- Polysulfone
- Hypalon CSPE (chlorosulfonated polyethylene)
- Neoprene (polychloroprene)
- Natural Rubber (NR isoprene)

The following materials are not acceptable for use in research systems to be carried aboard NSF/NCAR aircraft:

- Polyester
- Nylon
- Polyvinyl Chloride (PVC)
- Polyethylene (PE)
- Polypropylene
- Polyurethane
- Kapton (polymide resin)

Experimenters are responsible for reviewing their drawings and parts lists to ensure non-acceptable materials are not specified for use in their system design. Non-metallic materials not listed in this memo must have data substantiating the acceptable use of the material aboard aircraft. If no such data exist, the experimenter will be required to demonstrate compliance with Title 14, Code of Federal Regulations, Part 25.853(a). One method of showing compliance for materials in compartments occupied by crew and for electrical system components is detailed in Title 14, Code of Federal Regulations, Part 25, Appendix F, Part 1(a)(1)(v) and Title 14, Code of Federal Regulations, Part 25, Appendix F, Part 1(a)(3) respectively. NCAR RAF will supply copies of these applicable sections upon request. Alternate methods of showing compliance must be negotiated with NCAR RAF Engineering, Operations, and Safety. The experimenter should allow ample time for this process prior to anticipated participation in research programs.

NCAR RAF personnel will inspect experimenter packages prior to installation on the aircraft. Experimenters should be able to provide certification for materials used in their equipment assembly. Material certifications should be requested from the supplier when material is ordered. Failure to provide acceptable information or data could result in equipment rework prior to obtaining approval for installation aboard the aircraft.

Hazardous

Hazardous materials can be included in a C-130 research payload, but all such materials must be identified at the time of the initial facility request in order to allow adequate time for the RAF to review their impact on flight operations. The following equipment/materials require such a special review:

- Lasers
- RF Emitters
- Cryogens (oxygen, hydrogen, methane, ethane, and ethylene are prohibited)
- Compressed Gases
- Toxic Gases (may require containment)
- Batteries
- Pressure Vessels/Systems
- Motors/Pumps (except for small fan units in commercial electronic equipment – 400 Hz motors rated explosion proof or totally enclosed non-ventilated are preferred; DC brush-type motors are generally not acceptable)
- Heaters (surfaces >130 ^{o}F require shielding and labeling)
- Power Distribution Equipment
- Radioactive Materials
- Flammable/Noxious Materials (PVC jacketed wire [except in commercial units] and cable or plumbing is not acceptable - Teflon based materials should be used; consult RAF Safety Committee concerning material acceptability)

The decision to permit hazardous materials and/or instruments to be used on board NSF/NCAR aircraft will be made by the RAF Safety Committee after a complete review of the materials and equipment involved. The committee will ensure that the aircraft and the personnel on board are not subject to unreasonable hazards under conditions which can be expected during the conduct of the operation. The committee will specify safeguards, when appropriate. Researchers should prepare and submit safety documentation to the RAF Safety Committee and coordinate with RAF Project Management to ensure that appropriate approvals are obtained prior to the start of operations.

5.2.2 Fasteners

All fasteners should be aircraft quality hardware (to AN, MS, or NAS standards and specifications). Table 5.1 provides information on commonly used aircraft fasteners:

Designation	Fastener Description
Conventional Rivets	
MS20470AD	Protruding Head Solid Rivet
MS20426AD	Flush, Full Size Head
NAS1097	Flush, Reduced Head
HI-Loks	
HL18	Protruding Shear Head Pin
HL19	Flush Shear Head Pin
HL70	Shear Collar
HL20	Protruding Tension Head
HL21	Pin Flush Tension Head
HL86	Pin Tension Collar
Bolts/Screws	
AN3-AN20	Hex Head Bolt (125 ksi)
NAS6203-NAS6220	Hex Head Bolt (160 ksi)
MS24694	Flush Head, Phillips Drive (125 ksi)
NAS517	Flush Head, Phillips Drive (160 ksi)
AN525	Washer Head, Phillips Drive Screw
MS27039	Pan Head, Phillips Drive (125 ksi)
NAS623	Pan Head, Phillips Drive (160 ksi)
Washers	
NAS1149	Plain Washer
AN970	Large Area Flat Washer
Nuts	
MS21042	Hex Nut, Low Height, Self Lock (160 ksi tension)
MS21044	Hex Head, Full Height, Nylon Lock (125 ksi tension)
NAS1804	12 point, Full height (180 ksi tension)
MS21059	Floating Nutplate, Std Spacing
MS21075	Floating Nutplate, Mini Spacing
MS21061	Floating Nutplate, Std Spacing, One Lug
NAS1473	Self Sealing Nutplate, Std Spacing
NAS1474	Self Sealing Nutplate, Mini Spacing
Inserts	
MS21209	Locking Helical Coil Wire
MS51830	Screw Thread, Key Locked, Regular Duty (Keensert)
MS51831	Screw Thread, Key Locked, Heavy Duty (Keensert)
MS51832	Screw Thread, Key Locked, Extra Heavy Duty (Keensert)
Blind Fasteners	
NAS1669	Hex Head Blind Bolt (Jo-Bolt)
NAS1670	Flush Head Blind Bolt (Jo-Bolt)
M7885/2	Protruding Head Blind Rivet (Cherry-Max CR3213))
M7885/3	Flush Head Blind Rivet (Cherry Max CR3212)
M7885/13	Flush Shear Head Blind Rivet

Table 5.1. Aircraft-Quality Fasteners

5.2.3 Equipment Racks

The majority of equipment installed in the cabin of the C-130 will be mounted in standard racks designed by NCAR that attach to the floor of the aircraft. The racks are designed to accept standard nineteen inch wide rack mountable equipment. Mounting rails conforming to the universal spacing of EIA Standard RS-310 are provided on each side of the rack both forward and aft facing. There are two types of NCAR racks that can be made available for use.

Standard RAF Double Wide C-130 Racks

Figure 5.2 shows the dimensions of a standard, double-bay C-130 rack. The maximum equipment weight in the instrumentation rack is 408 kg (900 lbs total, 450 lbs per bay), and the maximum overturning moment is 206 kg-m (18,000 lb-in total, 9,000 in-lbs per bay). The moment arm is measured from the bottom of the rack to the center of gravity - **CG** - of the equipment. Asymmetrical loading of the rack bays will reduce the maximum allowable weight limit for the overall rack. A horizontal offset of the total rack CG by 3” reduces the total load limit to 355 kg (780 lbs). An offset of 6” reduces the total load limit to 320 kg (700 lbs). Attachment points are available on the top of the rack and equipment can be mounted in that location as long as the overturning moment for the rack remains within the allowable limit.

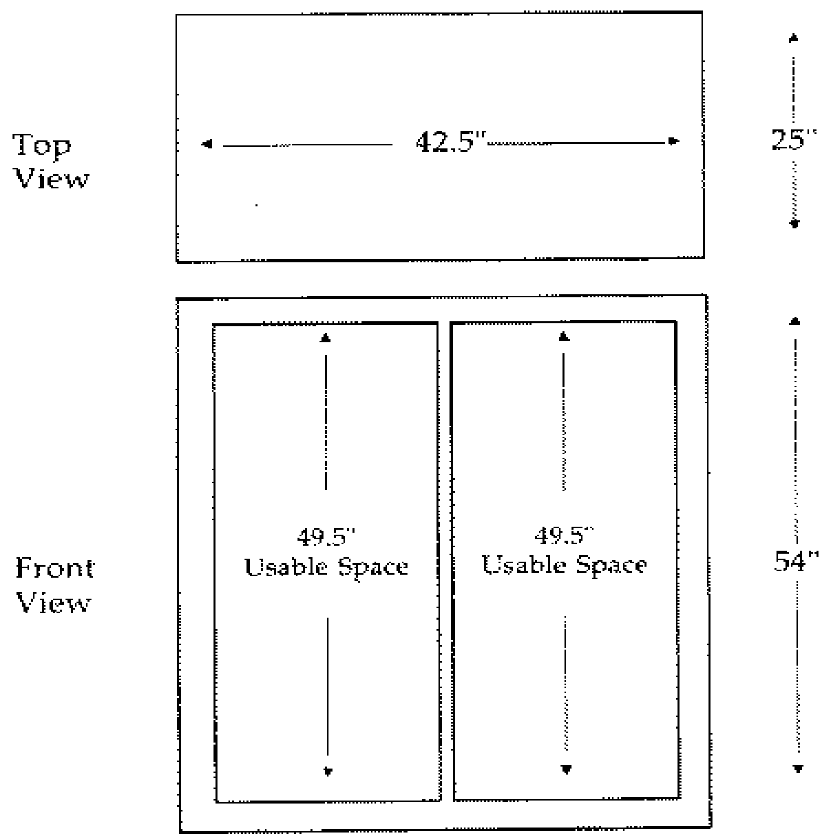

Figure 5.2. Standard C-130 Equipment Rack; each bay is 19" wide.

Heavy equipment cantilevered from the face of the rack must be supported by rails or trays. The following chart from the NASA DC-8 Airborne Laboratory Experimenters Handbook, June 2002, is also applicable for the NCAR C130 rack (use High Rack sections):

	Low and Medium Rack			High Rack		
Standard panel height (in.)	M_{allow} (in.-lb)	W_{allow} Fwd/aft-mount (lb)		M_{allow} (in.-lb)	W_{allow} Fwd/aft-mount (lb)	
	case A	cases A and B	case C	case A	cases A and B	case C
3.5	73	23/35	38/63	123	53/53	92/129
5.25	84	35/52	50/80	185	79/79	118/155
7	124	46/70	61/98	245	105/105	144/181
8.75	163	58/87	73/115	305	132/132	171/208
10.5	244	70/105	85/133	365	158/158	197/234
12.25	2912	81/122	96/150	430	184/184	223/260
14	338	93/140	108/168	490	211/211	250/287
15.75				550	237/237	276/313
17.5				615	263/263	302/339
19.25				675	290/290	329/366
21				735	316/316	355/392
	△1	△1 △2 △4	△3 △4	△1	△1 △2 △5 △6	△3 △5 △6

Case D (figure A-3) requires engineering disposition/approval when equipment weight on tray exceeds 28 lb (Low/Medium Rack, aft-mounted) or 76 lbs (high rack, aft-mounted). Reduce these allowables by 1/2 if tray is fwd-mounted.

△1 Case A (cantilevered)

△2 Case B (cantilevered, supported on standard DC-8 light or heavy tray)

△3 Case C (attached and constrained by standard DC-8 heavy tray)

△4 Values based on 30 lb/in. flange allowable (fwd-mount) and 45 lb/in. flange allowable (aft-mount) in a 9-G forward loading condition

△5 Values based on 101 lb/in. flange allowable (fwd- and aft-mount) in a 9-G forward loading condition

△6 Component lateral CG displaced 25 percent left or right of equipment bay centerline

Standard RAF Single Bay GV Racks

The individual GV style racks are 50 inches high, 21.5 inches wide and 28 inches deep. There are 24U (42 inch) mounting rails on the forward and aft faces for standard 19 inch rack mountable equipment. The mounting rails are symmetrically centered vertically on the rack. The mounting faces of the rails are flush with the forward and aft faces of the rack. A 3/8 inch panel is attached to the top and bottom and can also be used for equipment mounting. These honeycomb panels require inserts to enable equipment mounting. There is 3.6 inches of clearance between the ends of the mounting rails and the inner surfaces of the panels. Figure 5.3 on the following page shows a standard cabin equipment rack.

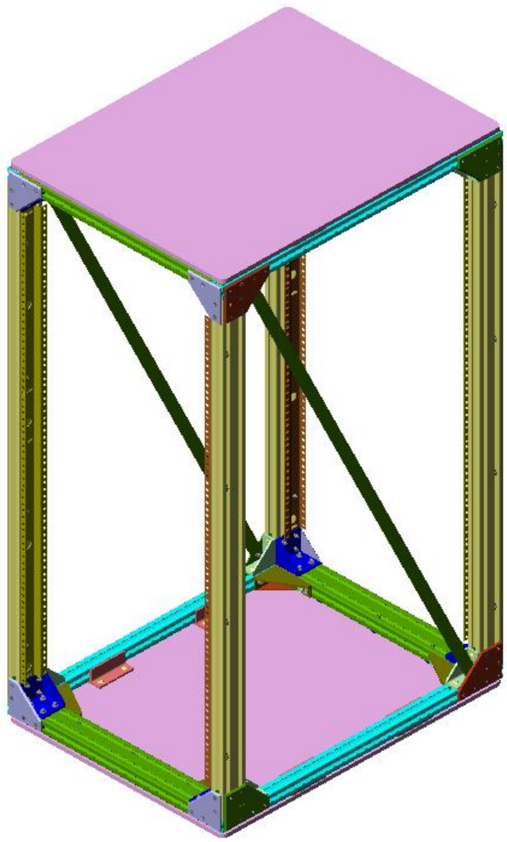

Figure 5.3. Standard GV Equipment Rack

The maximum allowable equipment weight is 350 pounds. The maximum allowable equipment overturning moment (measured from the bottom of the lower panel, i.e. the base of the rack) is 7,000 inch-pounds. Researchers should prepare a scaled layout of their rack configuration and determine:

- Individual component weight;
- Individual component panel height;
- Individual component center of gravity (cg) distance from panel;
- Total equipment weight (S component weights); and
- Total moment (S component weight x cg height from base)

Face mounted equipment weight and moment (weight x center of gravity distance from the mounting panel) must fall below the maximum allowable curves given in the following graphs:

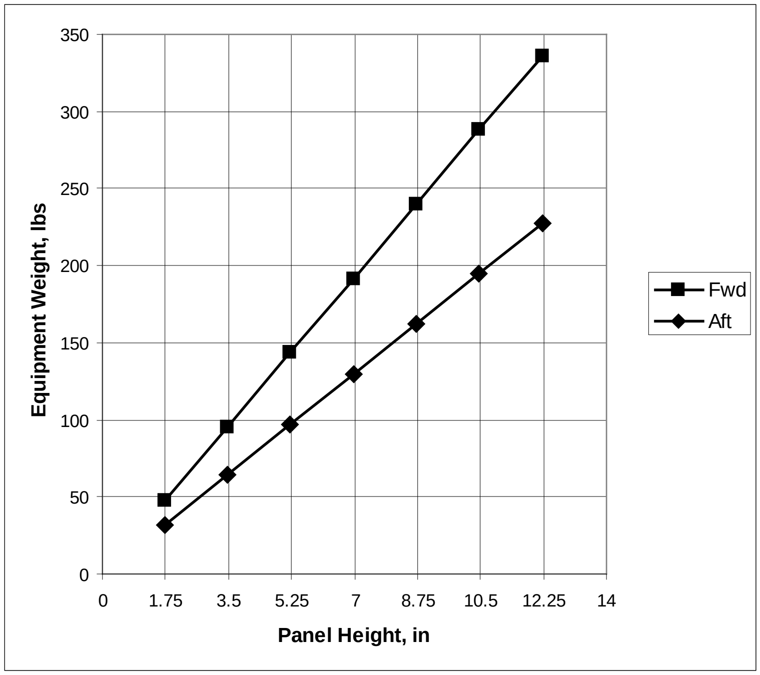

Figure 5.4. Allowable equipment weight for mounting to face chart.

For example, according to Figure 5.4, equipment weighing 75 pounds would require a 2U (3.75 inch) panel for forward face mounting or a 3U (5.25 inch) panel for aft face mounting.

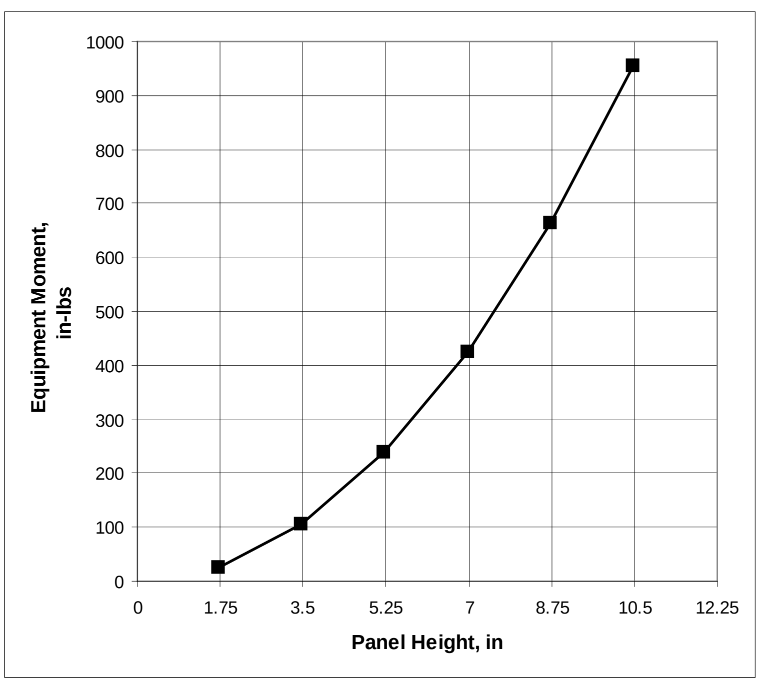

Figure 5.5. Allowable face-mounted equipment moment chart.

Per Figure 5.5, equipment weighing 50 pounds and 8 inches deep (center of gravity = 8 / 2 = 4 inches from the mounting panel) would produce a moment at the face of 200 inch-pounds (Moment = 50 x 4 = 200 inch-pounds) and would require a 3U (5.25 inch) mounting panel height minimum.

For equipment that falls above these allowable curves, additional internal support and bracing (longitudinal mounting rails or trays) will be required. Two types of trays for supporting non-rack mountable and/or heavy equipment are available. Aeronautical Engineering can assist the researcher in determining the proper support requirements.

Modifications to standard equipment racks are not permitted under any circumstances. Stress analysis of the rack structure, track attachments, and floor structure is not required, except for nonstandard installations.

NOTE*: Interface hardware is available to allow two GV style racks to be mounted side-by-side, mimicking the total racks space available in a standard Double Wide C-130 rack. These racks are available for purchase through EOL/DFS.*

User Supplied Racks

User supplied racks and other nonstandard installations (optical benches, etc.), will require stress analysis of the support structure, equipment attachment locations, and floor attachments. Maximum equipment weights for the cabin floor cannot exceed any of the following parameters:

- 219 pounds per square foot uniformly distributed in the forward cabin
- 343 pounds per square foot in the aft cabin
- 45 pounds per square foot on the ramp

Floor tie down fittings are rated for either 10,000 lbs or 5,000 lbs static load, in any direction.

5.3 Electrical Considerations

The following sections provide guidance to investigators for the electrical design of equipment intended for flight on board the NSF/NCAR GV. Electrical components within a research system can be the source of potentially hazardous situations in flight, the latter of which can include interference with basic aircraft systems, fire, shock, etc. Correspondingly, care must be taken during the equipment selection and wiring processes in order to minimize these risks.

5.3.1 Wiring Guidelines

Instrument builders must demonstrate that all user-fabricated interconnecting wire (e.g., from component to component, component to aircraft interface, etc.) complies with the requisite FAA requirements. Wire and cable types referred to here include any special types of wire, such as high-speed data wire, fiber optic cable, coax cable, etc. NCAR recommends that Teflon jacketed wire be used by investigators to construct special purpose wire and cable as such wire is known to meet flammability testing requirements. Polyvinyl chloride (PVC) wiring is not permitted for these applications without specific approval due to hazards associated with smoke and noxious fumes generated when such wiring burns. Commercial power strips are not acceptable, unless they have been modified to incorporate an aircraft approved circuit breaker and aircraft approved wire.

In the case of existing research equipment (defined here as equipment that has been flown on a research aircraft prior to January 1, 2005), the FAA Denver Aircraft Certification Office (ACO) has agreed that demonstration of compliance with electrical wire insulation flammability requirements (via burn testing and/or the submission of Forms 8110-3) will not be required provided that the following conditions are met:

- Wiring and associated electrical components are enclosed in a metal box suitable for containing a fire;
- The box is positioned such that it is clearly visible in the aircraft cabin; and
- Power to the box can be easily disconnected via a main power switch or an aircraft grade circuit breaker.

Investigators should note, however, that FAA compliance will be required for any modifications made to pre-existing (previously flown) research equipment. Additionally, it must be emphasized that compliance will continue to be required for all user-fabricated interconnecting wiring (including the wire, tubing, chafe protection materials, etc.) that is external to a metal enclosure and that is located inside the GV cabin.

In general, workmanship in the wiring of user-supplied equipment shall be of the highest quality possible. Some examples of unacceptable workmanship include: insufficiently-soldered joints, cold solder joints, poor or inadequate insulation, and improper crimping. User-supplied equipment with substandard wiring will be repaired by the user and re-inspected by the RAF prior to installation on the aircraft.

5.3.2 Batteries

It is permissible for research equipment to make use of small numbers of AA, AAA or D-type alkaline or nickel-cadmium (Ni-Cd) batteries without special approval from the RAF. All other usage of batteries on the aircraft requires advance approval by RAF flight safety personnel. The RAF strongly recommends that investigators select batteries with benign chemistries that are hermetically sealed. The following battery types are recommended:

- Alkaline
- Silver-zinc (Ag-Zn)
- Nickel-cadmium (Ni-Cd)
- Sealed lead acid

When designing equipment that requires batteries, investigators should take into account the following considerations when making a battery selection:

- Battery assembly (see discussion above);

- Battery shipment into the field, including packaging requirements, safety issues, applicable shipping restrictions, battery shelf life limitations, and final disposal (hazardous material) requirements.

Specific RAF approval of battery use is required for batteries that make use of hazardous materials and/or in cases where the number of batteries to be used exceeds six (6). Additionally, investigators should be aware that approval of battery usage is dependent upon the total aircraft configuration and the assessed risk for all potential hazardous items on board the GV. Approval will be given for a specific GV project configuration or flight. Investigators are required to submit complete vendor specifications data sheets to the RAF Safety Committee for review prior to installation of the batteries and associated instrumentation on the aircraft.

5.3.3 Uninterruptible Power Supplies (UPS's)

Investigators should note that batteries within UPS's selected for use on the C-130 must meet the requirements set forth in Section 5.3.2 above. Additionally, UPS input power cords must meet the wiring practice specifications detailed in Section 5.3.1 of this chapter. All UPS units intended for use on the C-130 will be subject to inspection by RAF personnel.

5.3.4 Electric Motors

Early consultation with RAF personnel during the electric motor selection process is essential and will help to avoid problems at the time of equipment installation. Each electric motor to be used on board the C-130 must be reviewed and approved by the RAF Safety Committee (genzling@ucar.edu). For all equipment that utilize high energy rotor devices (i.e., pumps), investigators will need to provide confirmation to the RAF that failure of the rotor(s) at high operating speeds will not adversely affect aircraft systems, structures, or occupants. Advisory Circular 25-22, Section 25.1461, *Equipment Containing High Energy Rotors*, details the procedures and requirements that must be met to ensure satisfactory operation of high energy rotor devices. Investigators can view and download this Advisory Circular online at http://www.gofir.com/fars/advisory/circulars/frame2.htm. Confirmation provided to the RAF can be in the form of a written manufacturer's statement, results of rotor device testing at an outside test facility, or results generated from investigator-conducted device testing witnessed by an NCAR engineer.

The usage of 400 Hz motors is preferred, as such motors do not introduce starting transient loads on the 60 Hz power converters employed on the aircraft. Larger motors (e.g. those used in vacuum pumps) must be protected by a thermal overload device. Additionally, single-phase motors must be equipped with solid state switches to inhibit arcing at the contacts during start up. In the absence of arc suppressors, motors must be shown to be spark free during operation.

Motors that are rated as explosion-proof or totally enclosed and non-ventilated are recommended for use on the C-130. However, many fractional horsepower, AC permanent split-capacitor motors are acceptable for use on the aircraft depending on their application and location and if they are proven to be safe in the event of motor failure. Large DC brush-type motors are generally not acceptable due to electrical arcing that occurs at the brushes.

5.3.5 Heaters

All heaters to be used on the C-130 must be reviewed by the RAF to ensure that electrical safety requirements are met, that proper circuit protection devices are used, and that any high temperature, exposed surfaces that might serve as ignition points for flammable gases or that may cause injury to flight personnel are identified. Exposed surfaces with temperatures above 54º C (130° F) are generally considered safety hazards and must be surrounded by adequate shielding and be labeled with caution signs.

5.3.6 High Voltage

Following guidance of Advisory Circular AC 25-10 (i) Guidance for installation of Miscellaneous, Non-required Electrical Instrumentation, "Because of the possibility of airplane decompression, a means must be provided for either automatic removal of power from all components containing CRT's or the installation of a barometric switch for each component using a CRT, unless the high voltage circuits and components have been shown to be free of arcing under appropriate environmental tests specified in RTCA DO-160B dated July 1984, or equivalent tests receiving prior approval by the FAA."

High Voltage is considered to be any piece of equipment using high voltage, 1000 volts or higher and with a current draw of more than 1.0 amp, used inside and/or outside the cabin.

With the advent of flat panel technology, display CRT's have become obsolete, other instruments may use some form of a CRT and they would need to comply. Consequently any instrument using high voltage, a Lidar may be an example, will be required to automatically remove power from the high voltage source if decompression is a possibility. Other acceptable means are to prove that there is no arcing potential or enclose the high voltage section, wiring and associated electrical components in a metal box suitable for containing a fire. Some forms of potting/conformal coating may be acceptable if the materials are proven to pass the 25.853(a). Investigators can choose to remove the power from only the high voltage section of the instrument or the whole instrument. Typically, the barometric switch is used to control a relay to remove power. They are relatively small and fairly economical, more so that enclosing in a certified metal box. http://umainstruments.com/ (Flight Instruments, Pressure Warning Switches) this would be up to the instrument builder to determine which way to go.

5.4 Data Recoding & Interface Capabilities

Information on the C-130 data acquisition and display system, available data interfaces and on board networks, and data and time broadcasts is provided in Chapter 2 of this handbook. Users are also referred to the *Aircraft Data Acquisition and Display System (ADADS) Reference Manual* for complete information on the aircraft's data recording and display capabilities.

5.5 Airflow Modeling Data & Availability

The RAF has the capability to examine the flow fields around key sections of the aircraft which can aid Users in preparing instrumentation for integration to the various external hard points on the fuselage and wings. Questions about available air flow and particle trajectory data products should be directed to Dave Rogers, RAF Scientist (dcrogers@ucar.edu), and Mark Lord, RAF Aeronautical Engineering (lord@ucar.edu).

Below is a summary of the air flow and particle trajectory data products that EOL has in its possession:

- Streamlines generated from the aircraft environmental outflow valve located on the forward right side of the aircraft;
- Particle concentration factors, concentration ratios, and accelerations on a vertical plane at the wing hard points for particle sizes of 20, 100, and 1000 microns;
- Particle concentration factors, concentration ratios, and accelerations on vertical (BL 3) and horizontal (WL 100, 145) planes through the fuselage for particle sizes of 20, 100 and 1000 microns;
- Boundary layer thickness along streamlines generated over the fuselage from the tip of the C-130 nose to the empennage. Except for deviations around protrusions (e.g., main gear fairing), the boundary layer thickness follows the basic rule of thumb of one inch of depth increase per each 100 inches of fuselage length (with fuselage length measured from the tip of the C-130 radome);
- Velocity magnitude contour plots, streamline plots, and velocity vector plots with the locations the same as those detailed in bullets 2 and 3, above; and
- Locations of supersonic regions at mach 0.77 and an aircraft angle of attack (AOA) of 2º.