

C-130 Investigators Handbook

Chapter 1. Basic Specifications

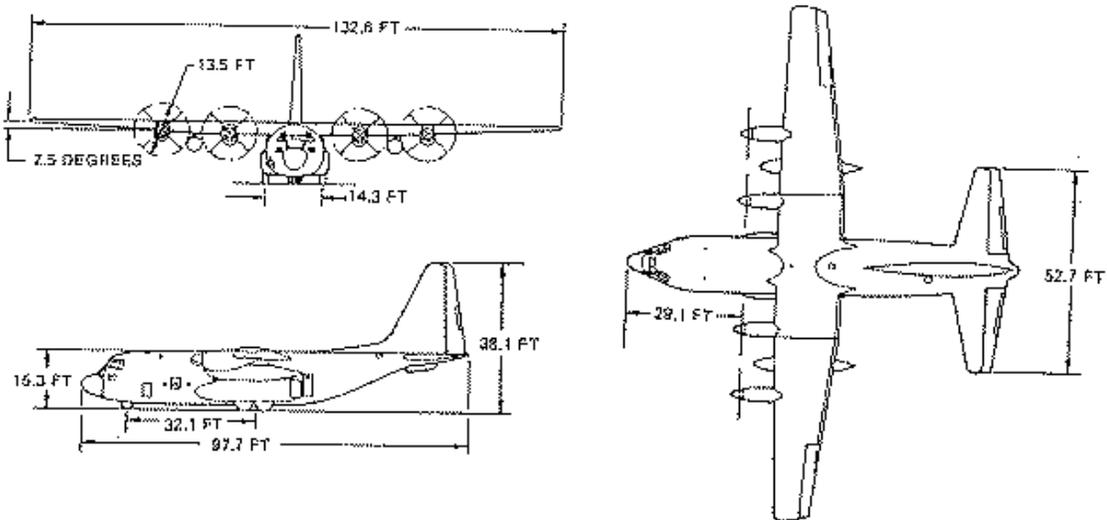
1.1 General View (external diagrams)

The Lockheed C-130Q Hercules is a four-engine, medium-size utility aircraft which has proven to be one of the most well-known and versatile aircraft ever built. For reference purposes, the aircraft is similar to a standard model C-130H except for electrical and air-conditioning modifications. It has twice the heating/cooling capacity of a standard C-130H and ultimately more than twice the electrical power. (At present 40 kVA are available for research.) The aircraft is an all-metal, high-wing monoplane, powered by four Allison T-56-A-15 turbo-prop engines. It is equipped with dual-wheel, tricycle landing gear with the main gear wheels arranged in tandem and the nose gear arranged side-by-side. N130AR was placed in service (by the USN) in 1985 and is the youngest aircraft in the NSF/NCAR/RAF fleet.



Figure 1.1 The NSF/NCAR C-130Q (N130AR) aircraft.

The performance figures for the NSF/NCAR C-130Q Hercules aircraft are summarized in Table 1 below. Chapter 3 on platform performance provides detailed information for scientists to outline realistic, research flight plans. During a research program, the NCAR pilots, who are responsible for the detailed planning of specific flight profiles, will work closely with the requestor.



. Figure 1.2 Three views of the C-130Q aircraft

The interior of the Hercules includes a flight deck and a "payload" cabin compartment. During flights, the flight deck has a crew of three and a mission-scientist station position. This area also has two crew-rest positions which can accommodate two temporary observer stations. The aft cabin area is approximately 40 feet long, 9 feet in height, and 10 feet wide. An integral loading ramp and cargo door system is located under the tail section. Figure 1.3 shows the cross section of the fuselage. The configuration of the cabin can be changed to accommodate individual project instrumentation needs. Sectionalized seat tracks (rails) are installed to rack up instrumentation anywhere in the cabin area.

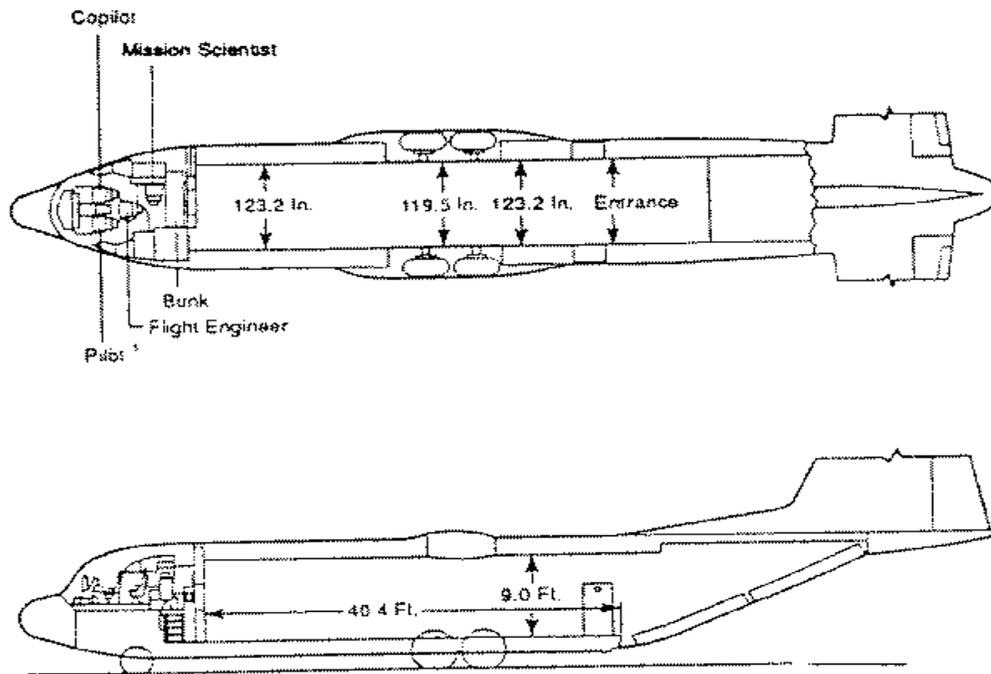


Figure 1.3 C-130Q fuselage cross section.

1.2 Cabin Layout

The basic configuration of the C-130 cabin appears in Figure 1.4. Key support features intended to facilitate research such as external apertures, access points to the community exhaust system, and cylinder storage areas are clearly marked. The pattern of floor hardpoints lay the framework for designing research payload layouts.

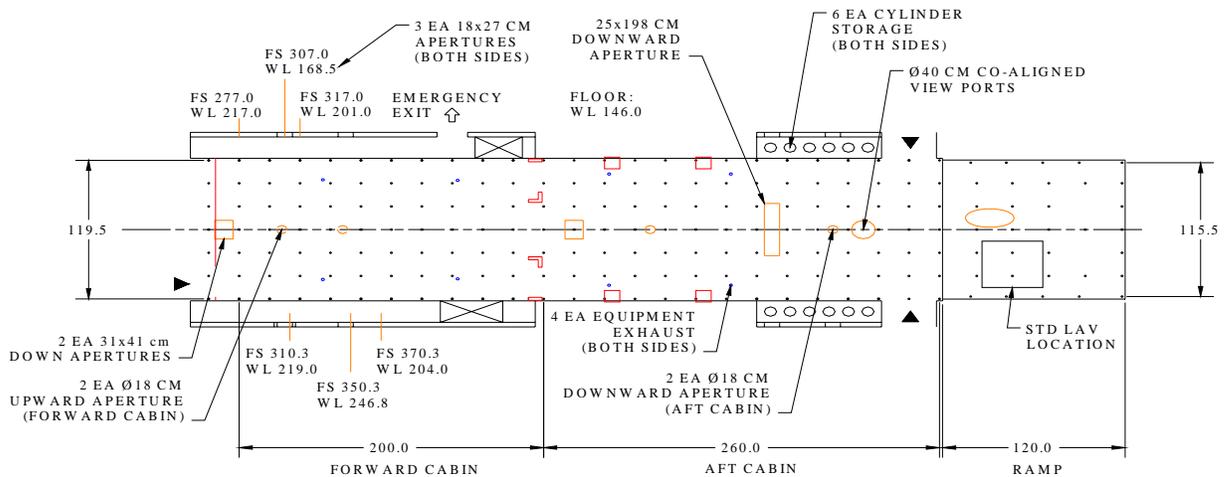


Figure 1.4 C-130 Cabin Configuration

1.2.1 Observer positions

The maximum crew complement for the C-130 is 19, comprised of RAF flight crew, instrumentation operators and scientific observers. The minimum flight crew is: 2 pilots; 1 flight engineer; and 1 ADS operator / load master. All crew members (research and support) must have access to approved seating for all takeoff and landing cycles. The location/layout of the seats is quite flexible and is usually driven by the need for dedicated instrument operators for some of the research instrumentation. A unique payload layout will be established for each field project depending on the specific needs of that project. Any such layout must allow adequate spacing for emergency egress from the aircraft and account for free access to certain emergency equipment. This can affect grouping of the seats at certain locations. All seat locations have an area under the seat for personal storage and are equipped with access to the ICS communications system as well as a source of emergency oxygen.

1.3 Loading Ramp & Door

The aircraft may be operated un-pressurized with the ramp lowered and locked in the horizontal position. The ramp is heavily structured, and apparatus could be extended to overhang the ramp's lip after takeoff. Further aft, the upper cargo door, which swings up, can also be opened and locked in place in flight either by itself or in combination with the ramp. The ramp/door combination provides the capability to drop large objects from the aircraft either by parachute extraction or by free fall in

combination with a standard C-130 cargo-handling system. (The cargo-handling system is not available on this aircraft in its present configuration.)

1.4 Weight & Balance (weight, fuel, payload)

Research flight operations and payload options are governed by the platform specific load limitations summarized in Table 1.4. Payloads can be expanded beyond the full fuel limit listed by trading in-flight endurance (reduced fuel load) for added instrumentation at a rate of roughly 5,000 lb per hour of fuel up to the max zero fuel weight limit. NCAR determines the aircraft's research zero fuel weight and center of gravity (either by weighing the aircraft or by numerical computation of the configuration) prior to each mission to ensure the aircraft remains within the approved C-130 flight envelope. Note that, irregardless of the weight limitations or cabin configuration, the maximum crew compliment (OPS & Research) that can be carried on the C-130 is 19.

Table 1.4 Load Limitations Lockheed Model C-130Q Hercules Registration Number N130AR		
Category	Weight	
Maximum gross weight for takeoff	155,000 lb	
Maximum gross weight for landing	130,000 lb	
Maximum zero fuel weight	105,000 lb	
Operating weight (crew of 3, no fuel, basic instruments)	82,000 lb	
Fuel capacity	9,500 gallons (62,000 lb)	
Payload (crew and all equipment)	23,000 lb	13,000 lb (with full fuel)

1. **Maximum gross weight:** Sometimes referred to as the "all-up gross weight," this is the maximum allowable weight of the aircraft, crew, passengers, fuel, and equipment. It also is referred to as maximum ramp weight.
2. **Payload:** Difference between the empty weight and the maximum zero-fuel weight. Crew and baggage are included in this figure.
3. **Maximum zero-fuel weight:** This is the maximum allowable weight of the aircraft plus complete payload, including all crew members, baggage, spare parts, etc. Fuel is not included in this figure. Any weight added beyond the maximum zero fuel weight must be fuel.
4. **Maximum landing weight:** The maximum weight at which a normal landing can be made. Any landing executed when the aircraft weight exceeds this

figure would be an emergency situation. (The C-130 aircraft, with maximum gross weight at take off, requires approximately 5 hours of flying time to reach the maximum landing weight.)

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.

1.5 Cabin Pressurization

Under most circumstances the aircraft will be operated under full cabin pressurization. Cabin pressure altitudes are maintained at 5000 ft equivalent or less up to a maximum research altitude of 25,000 ft. The pressure relief valve setting is 7.8 psi. The aircraft is equipped with an emergency release system for a rapid exchange of the entire cabin volume in case of smoke or the release of and toxic material.

1.6 Communications & Navigation

1.6.1 Integrated Flight Management System (FMS)

The C-130 is equipped with a Global Wulfsberg GNS-XLS Flight Management System with inputs from inertial reference systems (IRS), a built in GPS receiver and VOR/DME system to compute present position. The FMS provides interfaces to aircraft flight direction instrumentation such as the auto-pilot and horizontal situation indicator. The CDU provides waypoint and navigation information to the pilots.

1.6.2 Communications Systems

The aircraft is equipped with the following communications equipment. Frequency ranges are provided so that investigators can engineer their equipment to utilize frequencies other than those specified for various C-130 systems in order to prevent interference with aircraft equipment.

High Frequency (HF) Communications: Dual HF transceivers provide 99 user-programmable preset channels and 280,000 discrete operating frequencies covering the 2.0000 – 29.9999 MHz range in 100 Hz increments. Wire antennae (2) run from the top of the tail to the top of the forward fuselage.

Very High Frequency (VHF) Communications: Dual VHF communications transceivers provide AM voice communications in the frequency range of 118.0 – 136.975 MHz in 8.33 kHz increments for a total of 1360 separate channels. The use of these frequencies for scientific purposes (ie. Other than routine contact with the Federal Aviation Administration [FAA] requires that NCAR apply for authorization in advance of the project. It is important that project specific communications needs be clearly defined by the investigators in the C-130 Facility Request Form.

Intercommunications System (ICS):

The Intercommunications System (ICS) installed in the C-130 consists of twenty five main cabin stations, two paratroop, two cockpit bunk, one PI station, one flight instructor and one FE and two pilot stations. Main cabin user ICS stations provide 5-channel selections with volume control and call button.

User Station Locations

Dual ICS Stations
FS 390 left and right
FS 510 left and right
FS 596 left and right
FS 652 left and right
Cockpit Bunk FS 250 right
Rack

Triple ICS Station
FS 332 left and right

Single ICS Station
FS 850 right

Normal ICS Operation

Normal communications are typically station to station via one of the selected

Other IS Operation

User stations consist of channels A, B, C, D, & Local. Channels A, B, C, & D allow communication between all 25 Stations on each of the channels. The Local channel allows for communication between stations which are grouped together in groups of 2 and 3, dual or triple ICS stations. The PI station and the RAF tech station have access to channels A, B, C, & D as well. There is no communication access to the pilots, flight engineer, or radios from User stations. These types of communication would be coordinated through the PI or SYSOP station.

Communication over the aircraft radios is available through crew stations that have AIC ICS control and monitor panels. Note: all external communication must be coordinated with the flight crew. These stations are:

Pilots Pedestal
Copilots Pedestal
Flight Engineer, Overhead
Flight Instructor Left
Navigators Console (PI Station)
Cockpit Bunk
Systems Operators Console (SYSOP) ADS Rack
Left Paratroop Door
Right Paratroop Door

Crew Station Locations

Pilots Pedestal
Copilots Pedestal
Flight Engineer, Overhead
Flight Instructor Left
Navigators Console (PI Station)
Systems Operators Console (SYSOP) ADS

Left Paratroop Door
Right Paratroop Door

NOTE: The ICS offer no SATCOM or IRIDIUM communications.

Satellite Communication System (SATCOM): Iridium and Inmarsat SATCOM systems are both available on the NSF/NCAR C-130. An NAL A3LA Iridium Modem system is installed on the aircraft. The Inmarsat system is a Honeywell MCS-7163 Aero-H+/Swift 64 SATCOM system. The operating frequency range for the Iridium system is 1621.35 – 1626.5 MHz. The Inmarsat system transmits in a frequency range of 1626.5 – 1660.5 MHz and receives in a frequency range of 1530 – 1559 MHz.

Using a network of 66 low-earth orbiting (LEO) satellites, the NAL Iridium SATCOM system provides worldwide voice and data communications. RS-232 support built into the NAL cabin-mounted equipment supplies the capability for Internet dial-up connection at a maximum data transmission rate of 2.4 kilobits per second (kbps). The Honeywell Inmarsat system provides global voice, fax, and PC modem data capabilities using the Inmarsat Aero-H+ service. High speed data transfers at rates up to 128 kbps are possible using the Inmarsat Swift64 aeronautical High Speed Data (HSD) service.

Instruction in the use of the GV SATCOM systems – and additional materials describing the capabilities of the two systems – is provided to investigators by RAF personnel during preparation for aircraft field deployments. A copy of basic operating instructions for the C-130 SATCOM systems is included in Appendix B of this handbook.

Emergency Locator Transmitter (ELT): One (1) ELT System is installed in the aircraft. This system, an Artex C406-2 series ELT, is a third generation ELT that transmits at 121.5, 243.0, and 406 MHz. The system is capable of transmitting both aircraft position and aircraft identification.

1.6.3 Navigation Systems (IRS, GPS)

The aircraft is equipped with the following navigation equipment. Frequency ranges are provided so that investigators can engineer their equipment to utilize frequencies other than those specified for various C-130 systems in order to prevent interference with aircraft equipment.

VHF Navigation (VHFNAV), Instrument Landing System (ILS) and

Marker Beacon: Dual VHFNAV systems provide Omni-directional Range (VOR) and ILS capabilities for the crew. The ILS is made up of the Localizer, Glide Slope, and Marker Beacon. The ILS functions are used to provide range, azimuth, and vertical input to align the aircraft with the landing runway. Both Navigation receivers operate in a frequency range of 108.0 MHz – 117.95 MHz spaced 50 kHz apart. The Localizers (LOC) operate in the frequency range of 108 – 112 MHz, and the Glide Slope (GS) receivers operate in the frequency range of 329.3 – 335.0 MHz. These frequency ranges provide 200 VOR channels and 40 Localizer channels. The Marker Beacon antenna is optimally tuned to receive signals at 75 MHz at an input impedance of 50 ohms.

Automatic Direction Finder (ADF): Dual solid state ADFs provide bearing and audio output information that pertain to a selected ground station. The bearing and

audio information are routed to the aircraft's navigation and intercommunication systems, respectively. The ADF can also be used for reception of voice or continuous wave (CW) transmissions.

Global Positioning System (GPS): Trimble Model 2100 TIO Global Navigation System Sensor Unit (GNSSUs) and a single antenna. Data from this sensor are provided to the Flight Management Control System (FMCS) for very accurate worldwide navigation capabilities. The GPS uses the Department of Defense (DOD) space-based satellite system to determine a three-dimensional aircraft position that consists of longitude, latitude, and altitude. The GNSSU is a twelve-channel GPS receiver that receives L1 transmissions (centered at 1575.42 +/-10 MHz) from the NAVSTAR GPS satellite constellation.

Distance Measuring Equipment (DME): The DME system consists of two (2) complete, independent and redundant systems. These units provide distance, time to station, ground speed, and station identification information for use by other aircraft systems. Each DME can track as many as three (3) ground stations at the same time. Channel 1 of either DME is normally paired with the on-side VOR (manually tuned), and the data are directly displayed to the flight crew. Channels 2 and 3 are used by the Flight Management System (FMS) for multi-sensor navigation and are automatically tuned. Both DME receiver functions operate in the L-band frequency range of 962 – 1213 MHz, and the transmitter functions operate in a frequency range of 1025 – 1150 MHz. The DME receiver operates 63 MHz above or below the transmitter frequency.

Air Traffic Control (ATC): Dual solid state ATC systems provide Mode A and Mode C identification replies to Air Traffic Control Radar Beacon System (ATCRBS) interrogators for tracking, identification, and altitude reporting. Mode A provides coded aircraft identification and Mode C provides aircraft altitude information. The ATC transducers receive interrogation pulses on a frequency of 1030 MHz and, in response to all valid interrogations, transmit coded replies on a frequency of 1090 MHz.

Traffic Collision Avoidance System (TCAS): One (1) TCAS 2000 (ACAS II/Change7) system and controls is installed in the GV to provide the flight crew with notifications of the presence of other transponder equipped traffic in the vicinity that may present a collision hazard. The TCAS/ACAS can track up to 50 airplanes simultaneously. The system provides aural alerts in the cockpit to the presence of traffic and visual plots on cockpit displays of the relative location of other airplanes and visual cues for evasive maneuvers are provided to the flight crew if collision is imminent. If both converging airplanes are equipped with TCAS/ACAS and mode S transponders, the systems mutually coordinate evasive maneuvers to ensure diverging flight paths. Both TCAS antennae on the GV operate at a transmit frequency of 1030 MHz and a receive frequency of 1090 MHz. The antennae have a nominal impedance of 50 Ohms.

Enhanced Ground Proximity Warning System (GPWS): The GPWS provides wind shear detection and alerting. GPWS also provides advanced ground proximity warning with increased terrain-ahead awareness. These features help prevent accidents caused by Controlled Flight into Terrain (CFIT). The GPWS monitors the

various sensor inputs for deviations that exceed predetermined parameters. The GPWS produces visual and audible warnings to notify the flight crew when any of the parameters are exceeded. The major feature of the enhanced GPWS is the incorporation of terrain awareness and display functions. The terrain awareness alerting algorithms in the GPWS computer continuously compute an advisory level and a warning level clearance envelope ahead of the aircraft. If the boundaries of these envelopes conflict with terrain elevation data in the terrain database, an alert or warning is issued.

1.6.4 Color Weather Radar

The weather avoidance radar aboard the NSF/NCAR C-130Q is a Collins WXR-700C, a C-band Doppler radar that can display radar reflectivity, areas of turbulence or a combined reflectivity-turbulence display. The Doppler display only operates at ranges less than 90 km. The radar also has a ground-mapping mode. The C-band transmit frequency of this radar provides improved storm penetration capabilities than would an X-band radar, thus improving the ability of the C-130Q to penetrate storms while avoiding the more intense storm areas. Reflectivity and velocity data can be recorded and displayed on any on-board workstation. Plans are underway for developing a combined aircraft track and radar display in real time. The main cockpit radar display is repeated in the quiet room area.

1.6.5 Radio Altimeter

The purpose of the RAD ALT system is to provide the flight crew with an accurate above ground level (AGL) altitude indication during low level flight. The range of the RAD ALT system is -20 to +2500 feet AGL. The radio altimeter antennae have an input impedance of 50 Ohms and operate within a low frequency range of 4200 – 4400 MHz.