C-130 Investigators Handbook

Chapter 3. Performance

The Lockheed C-130Q is a pressurized, high-wing, turbo-propeller airplane which was designed as a military cargo aircraft. It is powered by four Allison T56-A-15 constant-speed, axial-flow, turbine engines that drive four-bladed, full-feathering, reversible-pitch turbo-propellers. Flight is approved in known icing conditions; however, certain external instrumentation installations may restrict operation in icing conditions.

Table 3.1 summarizes the basic performance characteristics of NSF/NCAR's Lockheed C-130Q Hercules aircraft.

Table 3.2 has some examples of expected maximum flight times.

The following considerations were used in constructing Table 3.1 and Table 3.2:

1. **Standard day**: The standard day is defined as sea level, zero wind with a temperature of 15C and is used here to specify typical runway length and gross weight requirements. The NSF/NCAR Hercules is operated in accordance with the balanced field concept. This means that the airplane must have enough runway to accelerate to a specified speed (known as the critical engine failure speed), have an engine failure at that point, and either continue to takeoff successfully or stop on the remaining length of the runway. Furthermore, a minimum rate of climb on three engines must be assured.

   There are numerous factors to be considered in determining the distance needed for takeoff or landing. The most significant of these are air temperature, pressure altitude and the gross weight of the airplane. The following examples illustrate the large increases in runway length required by changes in these factors.

   The runway required for a fully loaded Hercules (155,000 lb) at sea level with zero wind and a temperature of 15C is 6,300 ft. At the same temperature, the Hercules would require 8,400 ft of runway and would be weight-limited to 145,000 lb when taking off from an airport elevation of 6,000 ft. Significant increases in temperature result in a substantial reduction in performance. At -7C, a fully loaded Hercules taking off from a sea level base would require 5,700 ft of runway. At 32C, all other conditions remaining the same, 7,200 ft of runway would be required. Each of the above examples assumes a dry runway. Takeoff weight may also be limited because of the requirement to maintain a specified climb rate after takeoff.

   A combination of high airport elevation and high temperature results in a dramatic decline in an aircraft's takeoff performance. Normally, the only variable over which we have control is the gross weight of the airplane. Assuming that each crew member and all research equipment are essential to

the mission, we are faced with reducing fuel load when a lower gross weight is necessary to comply with the balanced runway requirement. The result, of course, is a reduction in range and/or the endurance of the aircraft.

2. **Visual flight rules (VFR)**: VFR is briefly defined as a flight out of clouds and below 18,000 ft above mean sea level. A minimum of 45 minutes of reserve fuel is required to allow for diversions to alternate landing fields, should the primary destination airport be closed. Additional reserve fuel may be necessary depending on the distance to a suitable alternate.

3. **Instrument flight rules (IFR)**: All flights at flight level 180 and above, as well as flight in clouds and in terminal control areas, must be conducted under instrument flight rules. This means that all phases of the flight must be conducted under the control of the appropriate air traffic control facility. The aircraft must have fuel to fly to the destination airport and then to a designated alternate airport, plus 45 minutes of reserve fuel.

4. **Cruising range**: The following example will illustrate how Table 3.1 can be used to calculate a rough estimate of the cruising range of the aircraft. Taking off from sea level with full fuel (62,000 lb) and climbing to 15,000 ft, 1,700 lb of fuel are used, and 44 nmi are flown in the 14 minutes required to climb. Considering 12,000 lb of fuel are required for standard operating reserve and IFR reserve, 52,940 lb of fuel are available for research (62,000 lb - 12,000 lb - 1,700 lb = 48,300 lb). At 15,000 ft and a research speed of 190 KIAS (240 KTAS) is obtained with an average fuel flow of 4,740 lb/hr. With 48,300 lb of fuel available for research, 10.2 hours of research can be flown. At a true airspeed of 240 kt, 2,445 nmi of research can be flown (48,300 lb @ 4,740 lb/hr = 10.2 hours x 240 kt. = 2,445 nmi). The 2,445 nmi of research, plus 44 nmi flown in the climb equals 2,489 nmi total range.

   It should be noted that reserve fuel requirements may be considerably higher in areas with no suitable landing alternates. The result would be less fuel available for research and, therefore, less total range. In addition, descents and climbs for atmospheric soundings consume more fuel than cruising, and total range will be reduced. The values in Table 1 are for a standard atmosphere and a standard aircraft. They do not take into consideration parasitic drag of externally-mounted research equipment which will reduce performance.

Table 3.1
PERFORMANCE SPECIFICATIONS (STANDARD DAY)
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)
Typical Runway Length Requirements		
Sea Level - ISA - 155,000 lb gross wt	6,300 ft	
5,000 ft elevation - ISA - 155,000 lb gross wt	8,500 ft	
Cruise Speeds		
Maximum distance	290 kt TAS (True Airspeed)	
Research (typical)	200-220 kt IAS (Indicated Airspeed)	
Slow flight	150 kt IAS	
Maximum speed (with instrument pods installed)	250 kt IAS	
Fuel Flow Average at Research Speed (190 kt Indicated Airspeed)		
@ 1,000 ft MSL, 194 kt TAS (True Airspeed)	5,300 lb/hr	
@ 5,000 ft MSL, 204 kt TAS	5,000 lb/hr	
@ 10,000 ft MSL, 220 kt TAS	4,870 lb/hr	
@ 15,000 ft MSL, 240 kt TAS	4,740 lb/hr	
@ 22,000 ft MSL, 274 kt TAS	4,400 lb/hr	

Maximum Range (With IFR Reserve and Full Fuel--No Wind)

Altitude	Total Distance (nmi)	Total Flight Time (hr)
< 1,000 ft	1,944	10.1
5,000 ft	2,200	10.7
10,000 ft	2,470	10.9
15,000 ft	2,700	11.1
20,000 ft	2,970	11.3
25,000 ft	3,184	11.7

Climbing Performance

To	Time	Fuel	Distance to Climb (From Sea Level)
5,000 ft	3 min	500 lb	10 nmi
10,000 ft	8 min	1,000 lb	24 nmi
15,000 ft	14 min	1,700 lb	44 nmi
20,000 ft	24 min	2,700 lb	80 nmi

Cabin Altitude @ 28,000 ft Operating Altitude	5,000 ft
Maximum Endurance (With IFR Reserve) @ Optimum Altitude	12.0 hr (Augmented flight crew required)

Observer Stations Available

Ferry flights	12
Research flights	14

Table 3.2
FLIGHT PLANNING ESTIMATES
Lockheed Model C-130Q Hercules
Registration Number N130AR

Assumptions:	Full fuel at takeoff Transit to and from operating area at high altitude (> 18,000 ft) **IFR fuel reserves**	
Distance from Base (nmi)	**Research Duration at Low Altitude (hr)**	**Total Flight Time (hours)**
940	3.8	10.7
700	5.1	10.3
500	6.4	10.2
300	7.7	10.1
150	8.6	10.0