

From The Cockpit



Joining the Super Hercules family: the IAF's first C-130J on the flight line at Marietta, Georgia.

Tactical Relevance of the Super Hercules

At Lockheed Martin Aeronautics Company in Marietta, Ga., where we build the C-130J Super Hercules, we hear from our customer pilots and loadmasters that the C-130J is a pleasure to operate in the most demanding of missions. As the company chief test pilot for airlift programmes, I certainly agree with them.

Recently, we had the opportunity to showcase the C-130J at the 2010 Farnborough Air Show. A detailed look at the planning and execution of this year's show routine offers a chance to understand why we, the aircrew, enjoy making this airplane perform. While an air show demonstration and an actual mission differ in a number of ways, the C-130J's unique capabilities are common to the success of both. The air show routine offers the perfect showcase for the aircraft's power and agility, and a view from the pilot's seat

reveals the situational awareness which allows safe manoeuvres close the crowd and the ground.

As an over-powered straight-wing turboprop, the C-130J can perform very

tight turns with excess power to climb. At air show weights, we approach 900-foot radius turns with turn rates over 15 degree per second. This radius is exceptional for any airplane including



IAF C-130J.



The platypus-type nose housing the weather radar.



The first IAF C-130J at the final assembly-line.

a fighter and the turn rate is competitive as well. At this cornering speed condition, it is very unusual to have excess power to climb. Combine this exceptional manoeuvring performance with the situational awareness provided by state-of-the-art head-up and head-down flight display technology and a unique air show routine can be created!

The head-down navigation display with GPS accuracy is standard on modern aircraft, but the C-130J has a few important details included. The large head-down display scale can be set to a 1.5 nautical mile radius, at which setting the pilot can accurately fly the airplane symbol around a 900-foot displayed circle. Also, a course prediction arc for one minute of future travel is displayed in front of the airplane symbol. The combination of these two details allows the pilot to fly a very dynamic routine precisely on a desired course over the ground. The curved path predictor is used to connect the turns with the straight paths defined by a flight plan. During each high-bank turn, g force is adjusted at constant bank angle to make the predictive arc tangent to the next straight line on the head-down display. The pilot then rolls out precisely as the flight plan line rotates to align with the airplane symbol. On each straight line segment, the transition point to begin the next manoeuvre is defined as a waypoint on the flight plan. The spectator sees the airplane rapidly roll to a high-bank and then stay at a constant bank until a single motion rapid rollout exactly on course. The fighter airplanes using the excellent outside reference provided by a bubble canopy cannot achieve the accuracy over the ground possible with the C-130J head-down display.

With the large head-up display, each pitch and roll manoeuvres can be executed repeatedly, including manoeuvres going up steeply or coming down steeply combined with high-bank turns. The detail in the head-up display allows parameters to be easily set with accuracy, including pitch to one degree; roll to two degrees; airspeed to within two knots of stall warning, regardless of the configuration; sideslip to within two degrees of the sideslip alert; and vertical acceleration to .01 g.

The first C-130J for India ran its engines for the first time on 21 September and the aircraft is being prepared for its maiden flight early in October. The aircraft's distinctive air-to-air refueling probe can be seen over the left side of the cockpit.



In-flight refueling probe being prepared for installation.

Each manoeuvre is developed in the simulator and test flown with an altitude cushion. This precisely defines the three dimensional path and energy state throughout the manoeuvre. Then a series of these manoeuvres can be adjusted and linked together with the predictable end of one manoeuvre (known airspeed, heading, altitude, pitch, angle of bank and power setting) becoming the repeatable entry conditions to begin the next. The result is a very predictable show profile in three dimensions and time which can be effectively adjusted real-time for winds. Once the show is defined, the simulator is used to develop and test an escape manoeuvre for all conceivable failures, including the worst-case scenarios of engine failures at steep angles of bank. The complete show is then flown at an airfield 'NOTAMed' by the FAA for air show practice. The first routines are conducted with an altitude buffer and then the altitude is stepped down on subsequent routines. Before the opening day, the flight display can be conducted with confidence and safety margins at the air show altitude limits (typically to 500 feet above ground level or AGL) and close to the crowd line (routinely within 100 feet of the display line limit).

We spend a lot of time considering how to minimise strain on the airplane during this show. If we were not so diligent this type of show could lead to frequent minor overstresses, airspeed exceedances and accelerated aircraft life usage. We choose the best loading condition to minimise stress including zero cargo, no loose equipment, and a low fuel load maintained in primary fuel management. We are careful to plan and practice each manoeuvre with margins set back from the limits in g, speed, and altitude. We also are careful to we make very smooth pitch inputs when at the higher speeds, and we always execute high g and high roll rates separately. Although it might not be obvious, this planning results in maintaining large margins away from any overstress or exceedance conditions. Besides, the details of every manoeuvre is recorded by the airplane systems and is analysed after the show, the same way aircrews and maintainers can analyse their C-130Js after training and mission flights.

I have had the pleasure of flying the Super Hercules at a number of air shows and am always amazed by the reactions of the audience. People don't imagine a cargo plane being so nimble in the skies. We achieve an air show routine within the same airspace dimensions of a modern fighter's routine. It is theoretically possible because of the C-130J shape and thrust. It is comfortable and safe for the pilot to achieve because the displays provide an unprecedented level of detailed information. I have been flying the C-130J since its



Nearly there! With engines installed, C-130Js in the final assembly line.

very early days, but on each flight, am reminded why this airplane is so well-liked. It's built on a proven platform that has been fine-tuned over the course of 55 years, gaining strength and enhancing capability with every variant. This plane literally communicates with the aircrew, providing the necessary information to conduct the most effective missions. Its integration of cutting-edge technology translates to faster training times for crews, getting them out of the classroom and into skies with the knowledge and skills to excel. It allows a young, three person aircrew to safely move more cargo and complete more missions for its military customers in one day than thought possible in the past.

Reliable. Advanced. Flexible. Manoeuvrable. Safe. These are just some adjectives to describe the C-130J Super Hercules. And, some of the reasons I am proud to be a part of the C-130J community!

Wayne Roberts

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*Its tail number identifies the
third Super Hercules of the IAF.*