

# CN-235: multi-role commuter

When six new and several not-so-new aircraft are all aiming at the same market, it pays an aircraft manufacturer to know a lot about the particular sector in which it is dealing. It is even more helpful if it has already excelled in that sector with a previous product.

With the CN-235, Casa and Nurtanio are chasing the 30-40-seat commuter market with an aircraft which owes much to the highly successful Casa C-212 Aviocar. The Aviocar started life in 1964 as a 19-seat light-utility military transport, and grew into a 28-seat regional commuter, notching up 339 sales in 30 countries. It is still selling. But, despite its good pedigree, the 39-seat CN-235 is up against some tough competition. Another five new aircraft, the Shorts 360, de Havilland Dash 8, ATR-42, Embraer Brasilia, and Saab-Fairchild SF.340, vie to grab an estimated market for at least 1,800 commuters over the next ten years.

Casa is as aware as any of its competitors that profits for all five manufacturers will not come easily, but it stresses that the CN-235, which costs \$4.93 million in 1983 dollars, is off to a good start. Hard domestic sales already account for 106 aircraft—a pre-rollout figure unmatched by any of its peers. There is also plenty of interest from non-domestic commuter airlines in what will be the only truly passenger/cargo/military aircraft in its class. One Puerto Rican carrier, Prinair, recently took options on five CN-235s to replace its Convair 580s. The options could well be converted into firm orders at the September 10 rollout.

Rollout takes place almost simultaneously in Spain and Indonesia, subject only to local time constraints. The event is of particular significance for Casa since it occurs during the year of its sixtieth anniversary. Nurtanio also has cause to celebrate, for the CN-235 will be Indonesia's first really significant aircraft programme. Minister for Research and Technology Dr B. J. Habibie has been a powerful force behind the project from its inception. This is the first real test of his country's credibility as an aircraft manufacturer, although, as a licence-builder of the C-212 since 1973, Nurtanio was certainly well placed to join equally in building a bigger brother.

The CN-235 will have a vital social impact in Indonesia. As well as providing a springboard for other high technology industries, it will fulfil a pressing need for better air transport within the country. The population of 150 million is spread



With 106 firm pre-rollout sales, the Casa/Nurtanio CN-235 is poised to grab a healthy share of the commuter market. **Julian Moxon** looks at the technical details.

across a chain of 13,400 islands, 6,000 of which are inhabited. Communication among the islands is essential if development is to be assured, and the CN-235 will be a fundamental link in that chain. So far, 34 aircraft have been ordered by the three national commuter airlines, Merpati, Deraya, and Pelita. The Indonesian Air Force and Navy have taken advantage of the CN-235's military usefulness, ordering another 50 aircraft between them, so the CN-235 is going to be a familiar sight in the local skies.

## Spanish need

The 22 aircraft destined for Spain will be operated by Aviaco and funded by the National Institute for Industry (which holds 70 per cent of Casa's stock). Casa's sales and marketing chief, Pablo de Bergia, notes that Spain has suffered for many years from the lack of the right aircraft to fly its regional routes. Its air transport system is currently flown by McDonnell Douglas DC-9s, "a rather expensive solution", he adds. "The CN-235 will be ideal for the job, opening up many areas, such as the Canary Islands and North Africa, to economical travel."

Orders from the Spanish Air Force—which was behind the development of the C-212 and accounted for most of the early sales—have yet to materialise, although Casa "sincerely hopes" that the aircraft will prove suitable. Recent

purchase of the F/A-18, however, has left the Air Force with little money to spare.

Studies by Casa on what kind of aircraft was needed included the C-214, having a cross section similar to that of the C-212 but carrying a four-ton payload (double that of the smaller aircraft), and the four-engined C-401, with a pressurised circular fuselage, five-abreast seating and an 8-ton payload. The advent of US de-regulation in 1978 pushed the size of the new aircraft towards the 30-40 seat configuration that the US market wanted. Casa notes that the result of the studies proves the "base two transport system". This states, perhaps obviously, that when sufficient traffic is generated between two cities to demand the operation of two aircraft of a particular size (in this case, two 19-seat C-212s), they can be more efficiently served with the introduction of one aircraft of twice the size. A major factor in all of this was the availability of new-generation engines, vital if direct operating costs were to be cut sufficiently to make the new aircraft competitive. The General Electric CT7, Pratt & Whitney PW100 and Garrett TPE331-15 were all on offer in time for the new commuters.

Detail design of the CN-235 began after the feasibility studies were completed in early 1981. The aim was a simple, rugged, multi-purpose aircraft suitable for civilian and military passenger and utility work, and requiring minimum ground-support. These requirements immediately dis-





tanced the aircraft from its competitors, particularly as the decision was taken to incorporate the rear door which had proved so successful on the C-212.

Utility means cargo, which Casa/Nurtanio thinks is one of the keys to increasing the profit of a contemporary commuter aircraft. "We felt that many of our potential customers wanted an aircraft capable of carrying airline-standard containers as well as passengers", says de Bergia. "The CN-235 will, in fact, be the only aircraft of its size with the ability to transport 88in wide pallets, making it cargo-compatible with the widebodies".

All this flexibility takes its toll in overall weight and performance. "We are conscious of the penalties" comments Casa research and development chief Signor Jose Lopez-Ruiz "but when we interviewed current C-212 operators, we found tremendous support for the idea of the rear door". After that, he continues, it was a question of optimising the shape of the CN-235 to accommodate it. Recent introduction of computer-aided design at both Casa and Nurtanio was invaluable in checking the various possibilities and helping to define the best configuration. The result allows a cruising speed of 245kt at 18,000ft, with a range equivalent to four 100 n.m. sectors—with a 45min IFR reserve margin. The CN-235 therefore flies a good deal lower, and slightly slower, than its contemporaries. Cynics might say that problems with cargo door pressurisation were the major factors in deciding cruise height, speed and range. Cabin pressure is, in fact, only 3.5p.s.i., well under half that of an aircraft designed to cruise at over 30,000ft. But Lopez Ruiz has another answer. "Why fly higher over a

one-hour sector? Increasing cruise altitude certainly equals more range over long distances, but over the short hops that the CN-235 will excel at, flying lower means shorter block times, increasing productivity. We have put the emphasis on climb characteristics so that we can reach our cruise altitude as fast as possible. Low cabin pressure helps minimise structural weight, especially around the rear doors".

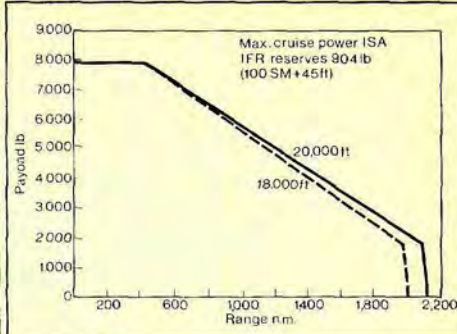
Pre-certification development costs of the CN-235 will come to around \$100 million, considerably less than the \$200-\$250 million average of the opposition. De Bergia admits that the low cost of labour in the respective partner countries, coupled with the introduction of computer-aided design and manufacture, has helped considerably, "but we had to sharpen our pencil leads to find other ways to prune costs".

### Structural simplicity

Part of the answer is directly related to the CN-235's structural simplicity. Lopez-Ruiz, who was the man responsible for the highly successful C-212, has intended all along that the design philosophy of the new aircraft should follow that of its smaller brother, although some simplicity has had to be lost to fuselage pressurisation, and growth.

The high-wing configuration was dictated by the demand that CN-235 must be able to operate from dusty, paved runways. A high de Havilland-Dash 8-type tail was excluded, however, to preserve commonality with C-212 experience and to keep the rear end simple, and light.

Although several wing profiles and configurations were studied, the decision was made to stick to the proven advantages of the Naca 65 section used in the C-212, with minor modifications. The wing, with its two main spars positioned at 15 and 55 per cent of the chord, offers a good combination of climb and cruise performance, and lower sensitivity to deviations in shape compared with other profiles. Modifications from the original C-212 profile include an increased leading edge radius, and a blunter trailing edge to simplify manufacture. The CN-235 wing also loses its predecessor's relatively



complex double-slotted flap, although Casa says that the new single-slotted replacement has almost the same high-lift characteristics.

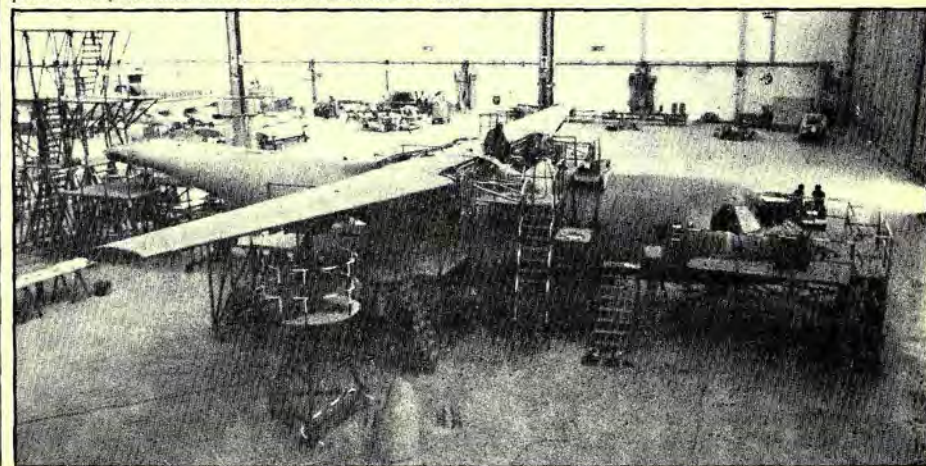
Unusually, the wing is held completely clear of the fuselage by the two frames to which it is bolted. This, says Lopez-Ruiz, makes for an exceptionally clean and completely independent fuselage structure, so that wing loads are not transmitted to the pressurised part of the airframe. Another advantage is that the air conditioning system can be squeezed neatly in between the wing and fuselage, where it sits over the c.g. This shortens ducts to the airframe and from the engine.

The disadvantage of so much wing-to-fuselage separation is, of course, the aerodynamic discontinuity at the junction. Casa worked long and hard on the best solution to minimise drag. This proved to be a much bigger fairing than originally thought necessary. The fairing is currently built of glassfibre reinforced plastic (GRP), but will eventually be made of Kevlar or carbonfibre reinforced plastic (CFRP).

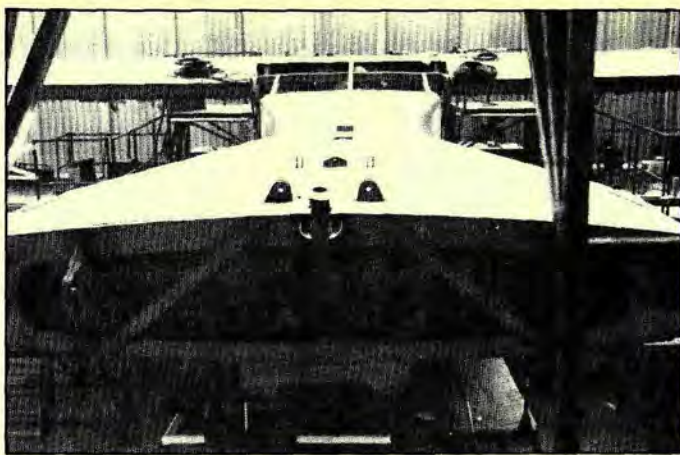
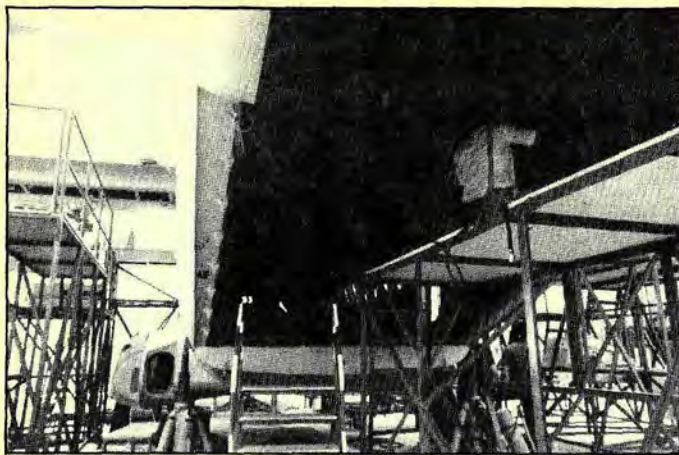
The tandem-wheel undercarriage follows an idea tried on the proposed C-401. The aim is to achieve the simplest possible design commensurate with working from poor runway surfaces, while offering long life and high reliability for intensive commuter or military operations.

Each wheel works independently of its neighbour, and is mounted on one of two articulated legs, each of which is joined to a main fuselage frame. The legs are connected by a single retraction/

The CN-235 at Casa's Getafe factory in July. Computer-aided design helped optimise the final shape, particularly around the windscreen and rear door







Fundamental to the CN-235's multi-role concept is the enormous rear cargo ramp/door, left. Note undercarriage sponson. Right An unusual view looking forwards along the rear fuselage

extension jack. The design means that all loads are carried within this very simple, fail-safe, structure. Standard or high floatability tyres can be used without changing brakes or axles. With high floatability tyres fitted, says Casa, practically no airfield will be forbidden to the CN-235.

Undercarriage doors are not fitted on the main wheels, eliminating all of the associated mechanisms and saving weight. In fact, the wheels protrude slightly from their fairings, so that wheels-up landings can be tolerated with the minimum of damage to the airframe.

The fuselage is of conventional, semi-monocoque construction, consisting of

longerons, frames, stringers, and skin panels. The circular cross-section, slightly flattened underneath was crucial to the whole Casa/Nurtanio philosophy of a passenger transport with military and cargo potential. The CN-235 finished up with a wider fuselage than all its contemporaries, the design driver being the need to accommodate both standard LD-3 containers and 88in-wide pallets. This gave very comfortable four-abreast seating, with a 20in aisle running between standard medium-range airline seats. The arrangement will give each passenger around one cubic metre of space—about the same as a Boeing 737 or 727.

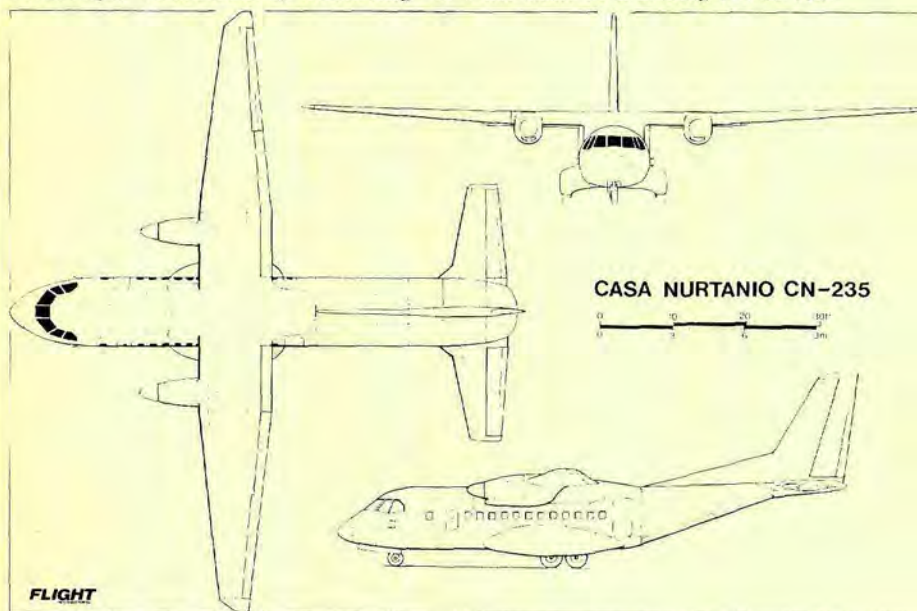
The CN-235's 92.8in floor width—almost 5in more than that of the 88in pallets—came about because of its military role, which called for the fittings that would be needed if the pallets were to be dispensed from the rear door at low level. The result is a fuselage that, at least in the first CN-235 version, will be quite short and plump, but which is eminently stretchable. A 50-seat "CN-250" has already been discussed.

Baggage will be carried behind the passenger cabin, either in a net slung across the free volume enclosed by the rear doors, or in a specially designed container. The latter idea would reduce turn-round time, since passengers could deposit their bags in the container at the check-in desk. This could then be exchanged directly with the one in the aircraft.

The CN-235's low pressurisation level meant that a relatively straightforward cargo-door design could be adopted. Upper and lower doors are operated by one and two jacks respectively, the doors being attached in the middle by seven latches—a similar system to that used for the Hercules and Transall transports. The doors cannot be opened when the cabin is under pressure.

Computer-aided design has figured extensively in optimising shapes and contours, particularly around the nose, where the flat windshield panels have been carefully blended with the CN-235's well-rounded snout. The cockpit has been designed to please pilots as much as the Aviocar's does—plenty of space, with excellent visibility, especially at the side—another result of the multi-role demand.

The era of digital avionics was just beginning as the CN-235 designers were starting work. But the conservative design philosophy has prevailed, so that the full five-CRT electronic flight instrumentation system (Efis) is available only as an option. Standard avionics for the CN-235 is Collins-supplied, as, indeed, is the suggested Efis system. If customers do opt for Efis, they get the four-tube system under the standard price of a CN-235, paying extra for the fifth CRT, which would be the usual multifunction display for engine and systems information, and weather radar.



#### CASA-NURTANIO CN-235 LEADING DATA

##### Dimensions

Length 70ft Height 27ft Wingspan 85ft Cabin Length 32ft Cabin width (max) 8ft 10in Cabin height 6ft 3in Passenger seats 39 at 31in pitch Baggage capacity 250 cu ft Cargo capacity four LD-3 containers, two 88in pallets or Combi (moveable bulkhead) Landing gear track 12ft 9in Wing area 636 sq ft.

##### Weights

Maximum take-off weight 28,769lb Maximum landing weight 28,659lb Operational weight, empty 18,132lb Maximum payload (pax configuration) 7,881lb (cargo configuration) 9,479lb.

##### Performance

(ISA, maximum take-off weight)

Take-off field length 2,633ft Landing field length 3,445ft Maximum cruising speed 245kt (15,000ft) Range (max payload, max cruise, IFR reserves) 430 n.m. Maximum rate of climb (fully loaded) 1,775ft/min Ceiling 28,500ft.



### CN.235 production

Casa and Nurtanio share equally in production of the CN.235. Casa has design leadership, and is responsible for the centre wing-box, inner wings, landing gear, centre fuselage, and nose. Nurtanio will build the rear fuselage, tailplane and fin, outer wings, ailerons, and outboard flaps. The Spanish prototype is being built at Casa's Getafe facility outside Madrid. Series production aircraft will be assembled at Seville and at Bandung, Indonesia.

### CN.235 orders

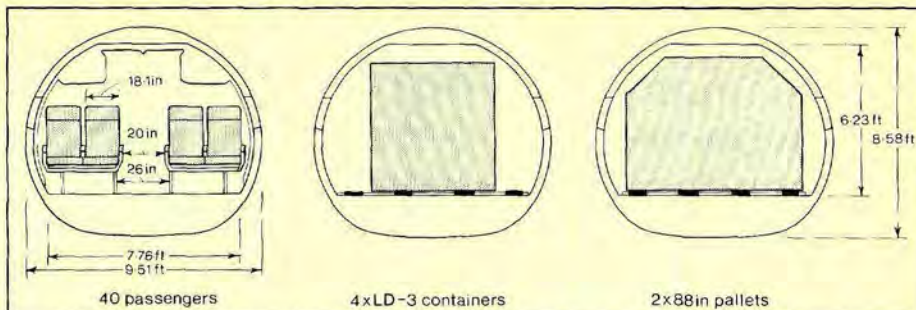
Operator	Orders	Options
Aviaco (Spain)	22	—
Deraya (Indonesia)	10	—
Merpati (Indonesia)	14	14
Pelita (Indonesia)	10	—
Automotores Salta (Argentina)	—	4
Prinair (Puerto Rico)	—	5
Indonesian Air Force	32	—
Indonesian Navy	18	—
<b>Total</b>	<b>106</b>	<b>23</b>

Casa accepts that Efis brings immediate advantages in the precision and flexibility of presented information, and that there is a natural tendency to get behind the latest innovations in the business. "But above all, the CN-235 had to be simple", says Lopez-Ruiz "It will be used by operators who cannot pay for the infancy troubles which would be insoluble by conventional means". Thus, the CN-235's manufacturers reveal once again their careful attention to non-US markets, in which they believe that their multi-role commuter will achieve more than half of its sales.

The key to the development of the new 30-40-seaters, besides deregulation in the USA, was the availability of new technology engines which would bring the kind of reductions in specific fuel burn that was needed for an acceptable direct operating cost. Three engines in the 1,500-2,000 s.h.p. class were studied for the CN-235; the two-shaft General Electric CT-7, three-shaft Pratt & Whitney (Canada) PW100, and the single-shaft Garrett TPE331-15R. After an intensive battle General Electric won, because it offered the best compromise between the kind of complexity which Casa/Nurtanio had been avoiding all along, and an engine that, having begun life 17 years ago at 575 s.h.p., was clearly nearing the end of its development potential.

Another attractive feature about the CT-7, which in its -5 version was also chosen for the Saab-Fairchild SF.340, was the maturity of the core. This is now accumulating time rapidly in the military T700 turboshaft powering US Army Black Hawks and Sikorsky 214STs. By the time the CN-235 is certificated, the core will have built up more than a million hours running time.

Casa also liked the support that was offered, and, for its mission, it says that the CT-7 was notably better on fuel burn.



But any idea that the CT-7, having originally been developed for helicopters, was therefore superior at the lower altitudes at which the CN-235 will be working, is discounted. "We saw no difference in altitude performance" says Casa. One spin-off from the turboshaft role, however, is that the CT-7 has an extremely efficient particle separator, which will be useful in dusty climes. No auxiliary power unit is fitted to the CN-235, the CT-7 being provided with a propeller lock so that the core can continue to provide electrical and hydraulic power if necessary. Under normal conditions, the electrical system is fed by two 28V, 400A starter/generators and two 20kVA alternators.

Propeller choice follows that of de Havilland, Embraer, and ATR. Hamilton Standard's 14RF "commuterprop" was specially developed to suit the new breed of regional transport aircraft. Particular attention was paid to low-speed efficiency, ruggedness, and low noise. The propeller is built from GRP shells encasing a solid aluminium spar, and is claimed to be half the weight of comparable aluminium types. On the CN-235 it will spin at 1,380 r.p.m.

Fuel is carried in four integral wing tanks. The pair in the centre take 550 US gal between them, another 810gal being accommodated in the outboard tanks. Fuel transfer is automatic, or by gravity in an emergency.

Simplicity again comes to the fore in the design of the flight control system, which is entirely conventional. Elevators, rudders, and ailerons are operated by cable and pulley, each control surface being

provided with a servo tab. Tail surfaces, and the right-hand aileron have electrical trim tabs. The four wing-flaps are each moved by two hydraulic jacks.

Composites figure less extensively on the CN-235 than on, say, the de Havilland Dash 8 (which in many ways is the CN-235's closest competitor). But Casa and Nurtanio have ambitious plans for the introduction of CFRP to some of the primary structures. Casa is currently making CFRP flaps for the Boeing 757, and is working on the design of a CFRP tailplane for the Airbus A320. It would eventually like to see the material used for all of the CN-235's flying surfaces, and in the dorsal fillet.

Static and dynamic airframe testing is being carried out in Indonesia and Spain. Fatigue trials will be conducted by Nurtanio in the Indonesian Government's new structural test laboratory located at Serpong, 30km south-east of Jakarta. Static tests began in July in the Getafe factory, which is where the Spanish prototype is being assembled. Around 960hr of flight testing is planned, taking place in both countries.

The healthy orderbook means that the production lines will be busy for 15 months if the planned output of four aircraft per month in each country is achieved. After that, the CN-235's salesmen hope that their aircraft will be selling well in the USA and the rest of the world. If the C-212's considerable success as a convertible commuter is anything to go by, its new brother will be making an even bigger contribution to its mother countries' developing aerospace industries. ■

*The General Electric CT-7 turboprop was chosen for its proven core and easy maintenance. The engine is based on the T700 military turboshaft*

