Spanish–Indonesian Cooperation in The Development, Production, Certification and Marketing of CN–235 Commuter Aircraft

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INTRODUCTION

CN-235 is a 44 passenger aircraft that since 1987 has been delivered to commercial airlines and military services in many countries in the world, among others for commuter and feeder routes in Indonesia. It was conceived in 1978 and developed jointly by CASA (Construcciones Aeronauticas SA) of the Kingdom of Spain and the presently known Industri Pesawat Terbang Nusantara (PT IPTN) of the Republic of Indonesia with the establishment of a joint company, AIRTECH. This company was founded on October 17, 1979. The President of the Company is the President and Chief Executive Officer of PT IPTN, and the President and Chief Executive of CASA serves as the Vice President. At its conception, the basic configuration of the CN-235 aircraft to be developed will accomodate 35 passengers and will be powered by twin turboprop engines.

CASA was founded in 1932 and has manufactured many aircraft and helicopters of foreign design, including Northrop F-5 fighter and MBB BO-105. CASA's own Project Office has designed several aircraft under contract to the Spanish Air Ministry, including C-212 Aviocar and C-101 Aviojet jet trainer. As a full member of Airbus Industrie, it also manufactures horizontal tail surfaces, landing gear doors and forward passenger doors for the Airbus A300/310/320 family of wide bodied transport aircraft, and a fuselage section of the A320. CASA has also been involved with other international contracts with other aircraft manufacturers. To date CASA has seven factories.

The Indonesian Aircraft Industry PT Industri Pesawat Terbang Nusantara was founded in 1976. It was established in parallel with the corresponding industrial support institutions related to manpower, research and development in suitable stages. In this conjunction, the Agency for the Assessment and Application of Technology (BPP Teknologi) and the Center for Science, Research and Technology (PUSPIPTEK) were founded in 1978. The Laboratory for Structural Testing (Laboratorium Uji Konstruksi, LUK) and Laboratory for Aerodynamics, Gasdynamics and Vibration (Laboratorium Aerodinamika, Gasdinamika dan Getaran, LAGG) were established within BPP Teknologi at the premises of PUSPIPTEK, Serpong, featuring modern testing facilities suitable for supporting advanced and aeronautical industries.

Looking back into its development, we feel that we are very proud of being able to offer the world a product of advanced technology through international cooperation , which has been farsightedly promoted by Theodore von Karman. It is with this very spirit in mind that we would like to share with the distinguished and knowledgeable participants of the present ICAS Congress the philosophy, motivation and experiences of this international endeavour.

In this international cooperation, not only there are gaps in technological status, but two different cultural background and economic motivations are present. Therefore, it is felt fitting to elaborate the details as it may appear for individual country, as well as to elaborate factors that are common to both.

CN-235 AS INSTRUMENT FOR THE SPANISH QUEST FOR ENTERING THE INTERNATIONAL MARKET FOR CIVIL TRANSPORT AIRCRAFTS AND THE INDONESIAN QUEST FOR INDUSTRIAL TRANSFORMATION

When the idea of cooperative venture to develop a marketable civil transport aircraft was offered by Indonesia, accompanied by equal share and the availability of capital to Spain for the related transfer of technology to Indonesia, the idea becomes apparent, that a mutually beneficial cooperation between a European country representing the North and a developing one in the orient representing the South is possible and beneficial not only for the technology transfer of the developing Indonesia, but also for the economic interest of Spain.

The international cooperation that has taken place in the CN-235 program is partially attributed to the industrial transformation scheme adopted in the Indonesian National Development

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Plan. When in 1974 the Government of Indonesia decided to boost the development of the aircraft industry as part of its national development, a strategy for industrial transformation was progressively formulated. Indonesia's general policy for national development is focussed on the three main goals of increasing basic capital, utilising resources optimally for self reliance, and applying science and technology in conformity with demand and priority. The establishment of the presently known PT Industri Pesawat Terbang Nusantara (IPTN) marked the initiation of the strategy for industrial transformation. This strategy, reformulated in the inaugural address of the first author as an honorary fellow at DGLR, in essence is aimed to develop the technological capability of Indonesia as a backbone for its national development appropriate to its socio-cultural setting in the modern world by starting from the end product and ending with its generic elements. The ultimate objective of the industrial transformation strategy is transforming the nation from an agriculturally based society into an industrial society, and additionally, for IPTN, to achieve world wide recognition as a viable aircraft manufacturing company. The strategy for industrial transformation has been formulated in four phases, in which CN-235 program is part of the second phase, i.e:

Phase One: Technology Acquisition through the Transfer of Existing Technology to achieve an added value process, capitalizing on the acquisition of manufacturing capability of advanced technology product already in the market. The aim of this phase is to attain and develop technological ability with regards to the design, technical aspects and the production of advanced products which have already been developed by advanced industrial countries;

Phase Two: Integration of acquired and existing technology into the design and production of completely new products to be introduced in the international market. This second phase emphasized the ability to design including the ability to integrate and optimize the design of components for a new system. The capability to test newly designed products is also developed in this stage.

Phase Three: Development of existing and new technology into the design and production of completely new products to be introduced in the international market. During this third phase, innovations will be introduced, and new technologies are created to produce the latest and most modern products based on market needs;

Phase Four: Acquisition of large scale basic research capability and the implementation of basic research as key elements in the introduction of competitive generic technologies.

Along with it, nine vehicles of industrial transformation have been identified. These are aeronautics and aerospace industry, maritime and shipbuilding industry, land transportation industry, telecommunication and electronics industry, energy industry, engineering industry, agricultural and heavy equipments industry, defense system industry, and other industries which may grow as a consequence of the growth of the above mentioned industries.

Aircraft technology as the most advanced technology has been considered to be economically, culturally and technically appropriate to be chosen as the spearhead of the industrial transformation initiative. It was conceived already in 1976, that reliance to natural resources is only temporary, and Indonesia cannot escape from relying on its large population as the most appropriate resources. High technology and human resources are essentially identical, and the development of its potential can no more be delayed.

The application of the strategy for industrial transformation in the aircraft industry is depicted in Figure 1. The first phase is carried out by the production under license of Spanish CASA C-212 Aviocar under progressive manufacturing scheme. The completion of this scheme marked the beginning of the second phase. CN-235 Program carried out by IPTN in cooperation with CASA through the joint venture company Aircraft Technology Industries (Airtech) constitutes the second phase of this general strategy for industrial transformation for Indonesia in the framework of Indonesian national development. The conception and the design of the aircraft is carried out through international cooperation.

Most recently, in 1989, based on the successful progress of the implementation of the industrial transformation strategy, the Agency for the Strategic Industries has been created by a presidential decree. Under the decree, the State Minister for Research and Technology is responsible for the creation, management and development of the state-owned companies which the President considers strategic. The Minister performs this function in his capacity as chairman of this Agency. Ten state owned companies, including IPTN, have been considered to be strategic, and all of them represent the nine vehicles for industrial transformation. These strategic industries are expected to serve as spearhead for establishing industrial excellence of other national industries.

MOTIVATION AND OBJECTIVES OF CN-235 PROGRAM

In the late seventies, the growth of the world market demand for a third level aircraft transport in the 30 to 40 passenger range was viewed to be very promising. In the domestic market, such perspective has been reflected by the large air transportation need commensurate with the national development plan, as well as the need for large number of military transport aircrafts for national security.

Independently from each other, CASA and IPTN proceeded to study possible aircraft design configurations to meet this world market demand,

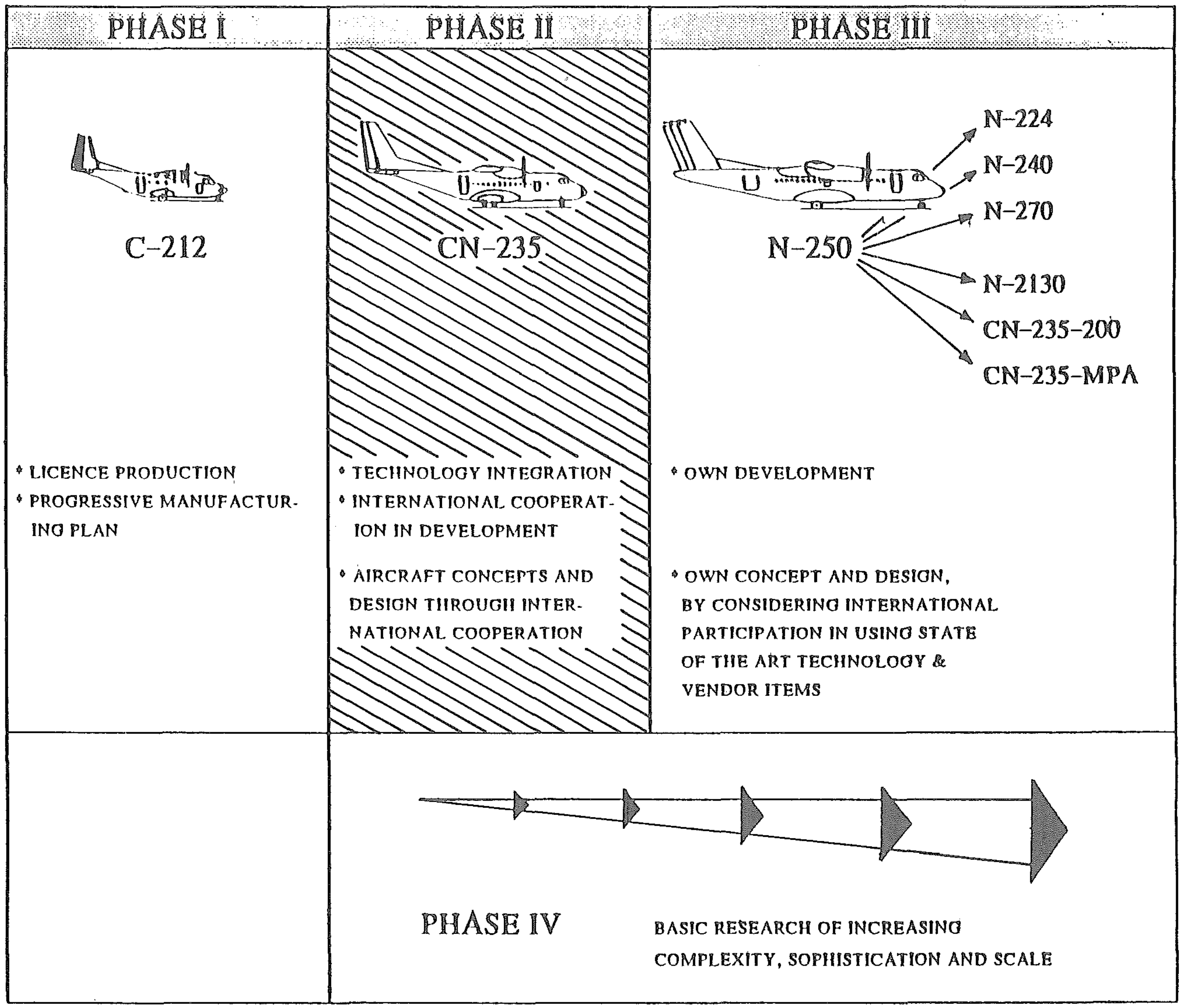

Fig. 1. Strategy of Industrial Transformation in Aircraft Technology

including the possibility to stretch the CASA C-212.

Motivated by such need, in October 1979 CASA and IPTN agreed to establish a joint development program to design, develop, manufacture and market a commuter aircraft taking advantage of the design philosophy of CASA C-212 and other military transport aircrafts.

Consequently CASA and IPTN have established the Aircraft Technologies Industries, abbreviated as AIRTECH, to undertake as its first joint program the design, development, manufacturing and marketing of a new aircraft. As a base line, similar general philosophy of the CASA C-212 would be of advantage, but dimensions will be adapted to market demands and new engines available in the future. The aircraft shall be certified under FAR 25 rules for civil operation and similar rules but with the corresponding exceptions for military operation.

PROGRAM DEVELOPMENT AND IMPLEMENTATION

A first visit to Madrid of a technical team from IPTN was made in November 1979, followed by a joint meeting in Bandung, January 1980 It was then decided to establish the first phase of the development program (March - December 1980).

The first part of the first phase (from March to July 1980) of this project has been carried out and concluded in Madrid-Getafe by a joint working team of CASA and IPTN.

Various alternative aircraft configurations have been studied in order to meet actual market demands ; among these alternatives were:

Alternative 1 "Stretched" version of the C-212

- Same cross section of C-212
- Fuselage length increased to admit 30 passenger, 3-abreast

- Increased wing area
- Turboprop engine of 1200 to 1300 SHP class
- Landing gear non-retractable. Similar philosophy of C-212
- Intended high commonality with C-212

Alternative 2 Wide body with rectangular cross section

- Fuselage similar to the C-212, with enlarged dimensions
- Cross section permiting 4-abreast and 88" pallets
- Turboprop engine of 1500 to 1700 SHP class
- Landing gear retractable/non-retractable
- Growth capability

Alternative 3 Wide body with truncated circular cross section

- Cross section permitting 4-abreast and 88" pallets
- Identical passenger capability to the Alternative No.1
- Less cargo flexibility than the Alternative No.2
- Possibility of cabin pressurization
- Turboprop engine of 1500 to 1700 SHP class
- Landing gear retractable
- Growth capability

Associated with each alternative several versions are considered. The line of aircrafts under consideration with their main features is schematically shown in Table 1. Finally it was decided to adopt one version of the last alternative as the basic design configuration.

Table 2 shows the main civil and military transport aircraft within a range of 15 to 60 passengers or 2000 to 10000 Kgs military load. Finally Table 3 shows the characteristics of PT6 A-65, TPE331-X, TPE331-15R, CT7-5, PT7A-1R and PT7A-2R engines which were under consideration for the propulsion of the aircraft described.

The initiation of CN-235 Program by IPTN in cooperation with CASA through the joint venture company Aircraft Technology Industries (Airtech) will serve to integrate the technology acquired in the first stage as well as the existing one to produce a new product to be offerred to the domestic and world market. Following the strategy for industrial transformation, this phase has been manifested in a joint venture with Spain that allowed IPTN's engineers and technicians to actively take part in the design of a new aircraft, the CN-235. To this end, the cooperation with CASA in the Airtech joint venture company was created on equal partnership basis. The work share of both partners has been formulated such that IPTN manufactures the interior, rear center fuselage, tail unit and outer wing, while CASA is in charge of the nose fuselage, center wing and center fuselage. Figure 2 schematically exhibits the work share of each partner for CN-235 from the design to manufacturing stage.

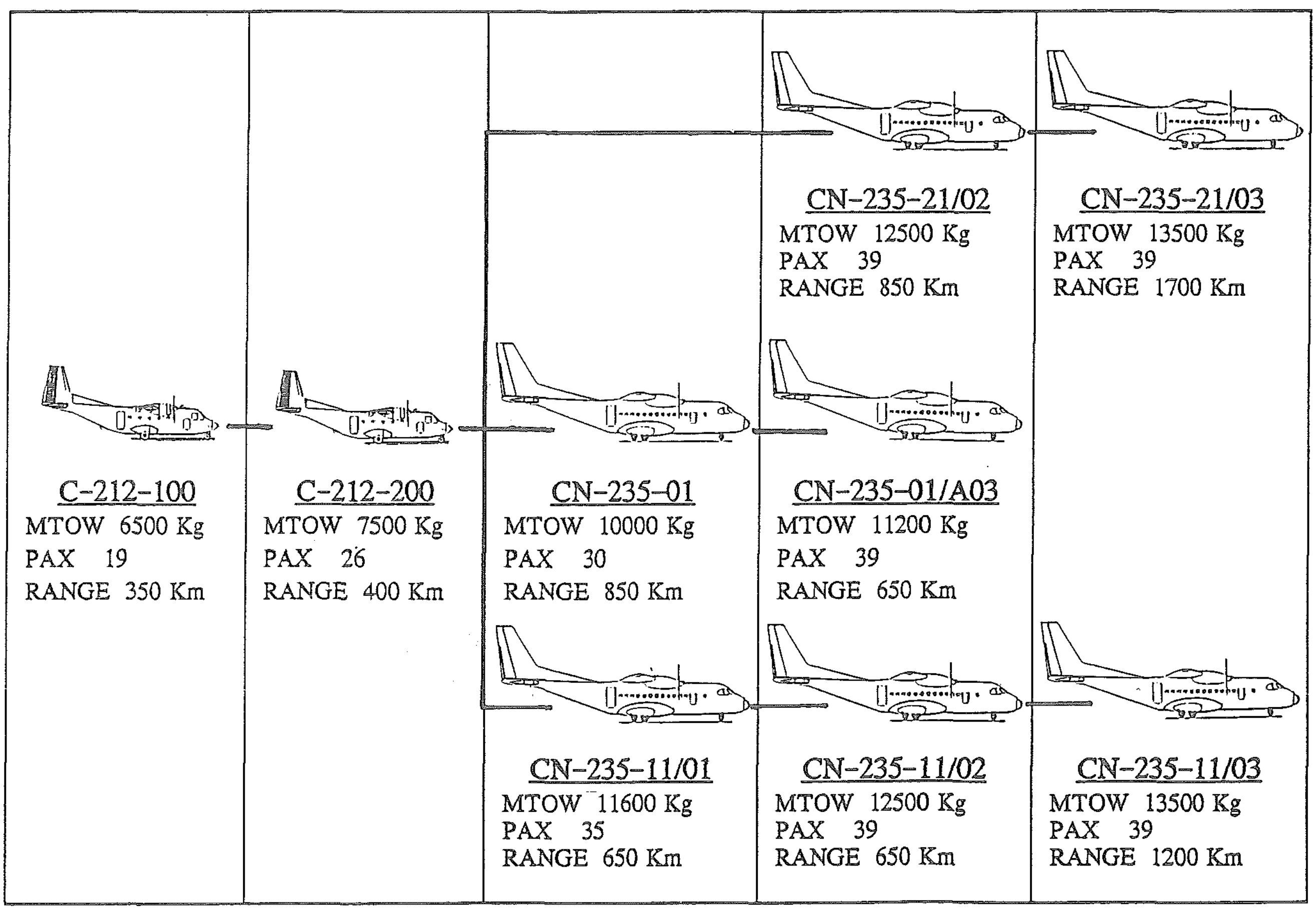

Table 1. Schematic of Various Configuration of CN-235 Aircraft

No	AIRCRAFT	ENGINES		PAYLOAD					DIMENSIONS					RANGE Km			TAKE OFF		LANDING		
		No and Type	MAX. T.O POWER SHP	MAX. T.O. Kg	MAX. LAND Kg	MIN. OPERAT. Kg	MAX. P/L Kg	MAX. FUEL Kg	SPAN m	LENGTH OVERALL m	HEIGHT OVERALL m	WING AREA m2	MAX. SPEED Km/h	WITH MAX. PAYLOAD Kg	WITH MAX. FUEL Kg	PAYLOAD Kg	GROUND DISTANCE m	TOTAL DISTANCE m	GROUND DISTANCE m	TOTAL DISTANCE m	
1	LOCKHEED C.130 H	4 x ALLISON 756-A-15	4 x 4608	Normal 70310 Max. 79380	58970	34169	19872		40.41		11.66	162.12	621	4002	8264	—	1091	1573	533	838	
2	TRANSALL C.160	2 x R. R. Type RTy. 20 MK. 22.	2x 6100	51000	47000	28946	16000	16000	40.0	32.40	12.36	160.10	518	1700	6300	—	747	900	550	869	
3	AERITALIA G.222	2 x G. E. T64-GE-P4D	2x 3400	Normal 24500 Max. 26500	26500	15600	8500		28.70	22.70	9.80	82.00	540	700	4950	—	840	1250	550	1200	
4	HAWKER SIDDELEY 748 SERIE 2A	2 x R. R. DART RDo 7MK534-2	2x 2280	Normal 21092 Max. 23133	Normal 19504 Max. 21546	11545	Normal 5918 Max. 7959		30.02	20.42	7.57	75.35		1714	2613	4321	756	927	347	567	
5	DE HAVILLAND CANADA DHC-5 BUFFALO	2 x G. E. CT64-820-4	2 x 3133	A.18597 B.22316	17735 21273	11412	5443 8164		29.26	24.08	8.73	87.8	A.463 B.420	648 1112	3280	—	289 701	381 276	168 259	346 613	A: unprep. fields B: prep. fields
6	FOKKER - VFWF 27 500M	2 X R.R. DART MK 532-7R	2 x 2140	20410		A.11300 B.11491	6617 6427		29.00	25.06	8.71	70.0	480	—	2213	—	—	579	—	704	A: Cargo v. B: Paratr. v.
7	DE HAVILLAND CANADA DHC-4 CARIBOU	2 x P & W R-2000-7M2	2 x 1450	A.12928 B.14197	12928	8283	3965		29.15	22.13	9.70	84.72	347	390	2103	—	221	345	204	376	A: Normal B: Ferry
8	DOUGLAS DC-3	3 x P & W R-2000-SIC	3 x 1200	11441	11080	A. 7657	—	—	28.90	19.63	5.20	91.70	331	—	2420	—	—	—	—	—	A: O.E.W
9	CN 235	2 x G.E. CT7-9C	2 x 1700	14400	14200	9400	4200	4000	25.81	21.35	8.17	59.10	454	759	—	—	—	675	—	625	
10	N-250	2 x ALLISON GMA 2100	—	22000	21800	—	6000	—	28.00	26.30	8.37	65.03	593	1482	—	—	—	—	—	—	

Table 2. Civil and military transport aircraft within a range of 15 to 60 passengers or 2000 to 10000 kgs military load

STATIC SEA LEVEL PERFORMANCE (ENGINE UNINSTALLED)

ENGINE	DRY WEIGHT (Kg)	RATING	S.H.P	AVAILABLE UP TO	S.F.C (lb/SHP hr)	PROPELLER r.p.m
TPE 331-X	236	Automatic Power Reserve (O.E.I)	1275	ISA + 39 C	0.557	1751
		Take-Off	1200	ISA + 32 C	0.563	1684
PT6A-65	216	Automatic Power Reserve (O.E.I)	1294	ISA + 17 C	0.578	1700
		Take-Off	1230	ISA + 6 C	0.584	1700
TPE 331-15R	259	Automatic Power Reserve (O.E.I)	1716	ISA + 1 C	0.506	1446
		Take-Off	1645	ISA	0.502	1390
CT7-5	307	Automatic Power Reserve (O.E.I)	1630	ISA + 20 C	0.466	1381
		Take-Off	1600	ISA + 15 C	0.468	1381
PT7A-1R	374	Automatic Power Reserve (O.E.I)	1590	ISA + 24 C	0.561	1300
		Take-Off	1500	ISA + 22 C	0.573	1300
PT7A-2R	393	Automatic Power Reserve (O.E.I)	1802	ISA + 13 C	0.541	1200
		Take-Off	1700	ISA + 12 C	0.549	1200

Table 3. Characteristics of engines which were under consideration for the propulsion of the aircraft

The first phase of the CN-235 program, i.e. predesign and market study, was carried out at the end of 1979, while the second phase, i.e. design, tools manufacturing, detailed parts manufacturing, final assembly and first flight , was initiated in 1980 and completed in 1983.

On September 10, 1983, the roll out of the first two prototypes took place simultaneusly at Getafe (for the P-1 prototype Elena) and at Bandung (for the P-2 prototype Tetuko), attended and dedicated by His Royal Highness King Carlos of the Kingdom of Spain in Madrid and His Excellency President Suharto of the Republic of Indonesia in Badung. The maiden flight of both prototypes took place on November 11, 1983 (CASA) and December 30th, 1983 (IPTN).

The third phase comprises certification and first delivery. In June 1986, it was certified by the Spanish - Indonesian Joint Certification Board, and more significantly, on 3 December 1986 by the American Federal Aviation Agency (FAA).

In September 1984, one year after the roll-out of the first prototype, orders for the new plane already amounted to several dozen units at a unit cost of $ 6 million. The domestic market has provided most orders, complemented by the strong support of the Indonesian Government to create a conducive market in concert with the policy of establishing the Indonesian Aircraft Industry as a vehicle for industrial transformation, thus boosting the growth of CN-235 sales on the Indonesian domestic market and its eventual entry into the international competition.

DESIGN PHILOSOPHY

The CN-235 aircraft features a wide body concept, with ramp door to facilitate all purpose transport suitable for developing as well as industrialised countries. It has a four abreast single aisle seating arrangement. Although 35 passenger seats was considered as its basic configuration, operational aircraft can accomodate up to some 44 passengers. The philosophy underlying the design of CN-235 is consistent with the "big aircraft in a small plane" design philosophy adopted by IPTN at the outset. The selection of CASA C-212 as the type of aircraft to be developed at IPTN was made as a realization of this philosophy. By "big aircraft" philosophy, the transfer of aircraft technology to IPTN will simultaneously enhance further development in the design and manufacture of larger aircrafts.

Prevailing considerations in the design philosophy of CN-235 can be summarised as follows. First, market pull considerations. As an islands continent, which stretches as distant as 3000 miles from westmost point to easmost one and 1000 miles from north to south, Indonesia has to rely on aircrafts and ships for its transportation. In addition, as the fifth largest nation in terms of its population, Indonesia's large population which has been growing from 120 millions in 1976 to 180 millions in 1992 emphasised the need of commuter and medium air transportation for its daily economic routine. In addition, the mere geographic considerations requires the need of national security through air support, such as transportation of logistics and maritime patrol.

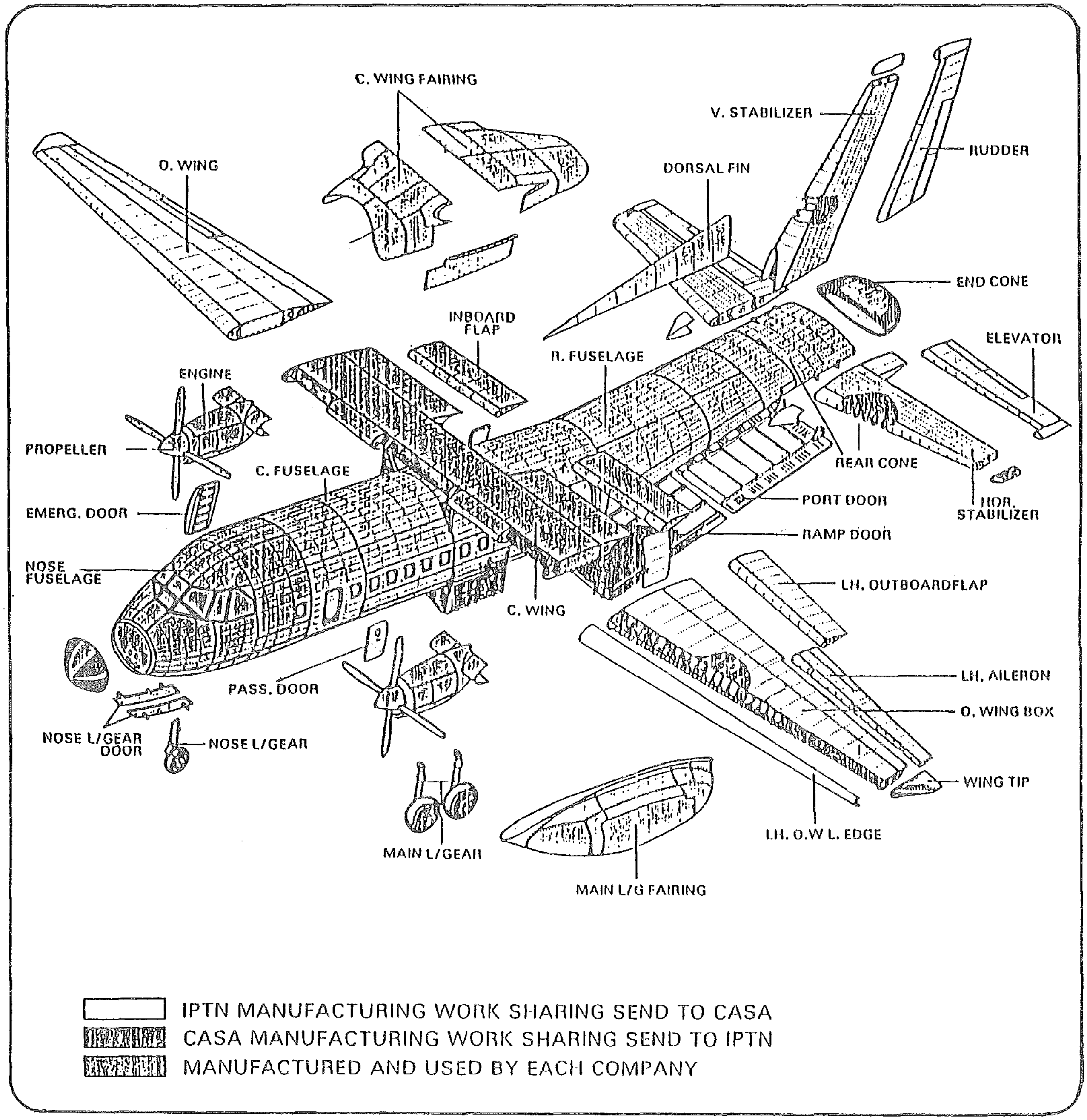

Fig. 2. Manufacturing Work Sharing of Structural Component CN-235

It is with these considerations in mind that Indonesia has a strong confidence in embarking upon an aircraft development program, which then can rely on its domestic market prospects as a basis to enter into the world market. The question is not whether it has to be done, but how can that be effectively carried out, in terms of technology, economic and socio- cultural aspects. To this end, the strategy for industrial transformation through four stages utilising nine vehicles is at hand. Additional aspects that should be taken into consideration in the design of marketable commuter aircraft is its versatility. Accessability for cargo transport, such as for containers transport would be of utmost importance. Convenience in conversion from cargo to passenger tansport, as well as for other utility transport (ambulance, search and rescue, forest fire fighting, artificial rain, etc) would be of great advantage. It is therefore decided that the aircraft to be designed should have the capability to transport containers effectively and efficiently, hence its wide body configuration, and it has to be highly convertible from passenger to cargo mode. The wide body configuration is also regarded as an attractive feature for commuter passengers transferring to and from long haul flights utilizing wide body intercontinental transporters.

Thus for Indonesia, CN-235 is indeed a vehicle for industrial transformation. It serves to meet the need for Indonesia for domestic commuter and short range transportation. Its development will enable Indonesia to embark upon its systematic and accelerated ways of technological development, which in essence is similar to the development of manpower resources as major capital for sustainable and integrated economic development. It is an agent for building a nation. At the same time the economic feasibility of CN-235 program relies on domestic market as a means for entering the highly competitive international market in the era of globalization. The prevailing labor market in Indonesia is also considered to be a competitive factor. It is also understood that CN-235 would be attractive for military transport and national security operations, thus enhancing its market penetration potential, in particular due to its capability to transport containers efficiently and effectively. In fact, economically it can be regarded to be very competitive to other existing military transport aircrafts.

In the design, attempts have been made to combine several advantageous features of existing transport aircrafts, hence reducing the required time for developing new aircraft in the market but still have great probability of meeting certification requirements. Therefore, its development time is impressively short, with very minimal windtunnel testing effort. However, its flight testing program requires extended time, although such case was dictated also by the utilization of only two flying prototypes. Nevertheless, altogether one may conclude that the effort was a complete success.

As a result of the extensive flight test effort, aircraft stability can be achieved. Drag minimization effort has been carried out, since with the adoption of the prevailing tail configuration, such effort was anticipated to be mandatory. Drag and weight minimization effort carried out for the development of the series aircrafts can also be regarded as successful. Some 10% of the weight can be taken off the prototype aircraft, and the aircraft has been rated as easy to handle by Aviation Week and Space Technology test pilot.

COOPERATIVE FRAMEWORK

It was agreed to commit 50-50 share in the joint project; IPTN has 50% share of the investment capital and CASA held the remaining 50% share of a total investment of US $ 100 million. Included in the CASA share is the cost for technology transfer to IPTN. Feasibility study and design work were carried out immediately in the months that followed; preliminary design was initiated in January 1980. In the design, development and certification work as well as in the co-production of the aircraft, both parties share equal responsibilities and division of work shares are clearly defined. The design and development of the aircraft have been carried out at both premises, i.e. at CASA facilities at Getafe (Madrid), Spain and IPTN facilities at Bandung, Indonesia. In some work packages, IPTN engineers are dispatched to Spain in a joint team, and in similar fashion, in some other work packages, CASA engineers are working jointly with IPTN engineers at IPTN premises in Indonesia. In the cooperation, a scheme for technology transfer has also been agreed. Coordination meetings have taken place monthly at either premises at alternate months. In addition, for the joint certification of the aircraft, both in Spain and Indonesia by their respective DGAC (Directorate General of Aircraft Communication) and internationally by FAA, a joint certification board (JCB) has been established, comprising all parties involved in the certification process. Close communication and cooperation between JCB and the working team of the project has been maintained.

The development of CN-235 aircraft have produced several versions thus far, among others CN-235-10, CN-235-100 and CN-235-200, all carried out jointly between CASA and IPTN. Initial production CN-235-10s have General Electric CT7-7A engines, while the later versions, CN-235-100s and CN-235-200s are powered by General Electric CT7-9C engines.

Marketing of the aircrafts are also arranged jointly. CASA markets the aircraft in the Americas and Europe, and IPTN in Asia, with other markets shared as appropriate.

Some 65% of the aircraft is built in Bandung and 35% in Getafe, a ratio that remains constant regardless of whether the aircraft is rolled out in Indonesia or in Spain. Because of this manufacturing ratio, and the highly competitive wage rates paid in Bandung - a fraction of current Western hourly rates - the CN-235 can be marketed at an attractive price.

Airtech and CN-235 made their first debut at Le Bourget Airshow in Paris in 1981. Mock up of the aircraft was exhibited and the relevant details of the aircraft were presented. Sales contract for the production aircrafts were signed, among others with Merpati Nusantara Airlines of Indonesia, which has opted for a firm commitment for the purchase of 15 aircrafts. In the meantime, a Memorandum of Understanding has been signed by Airtech and General Electric for the utilisation of GE CT7 series turboprop engine for the propulsion of the CN-235 aircraft.

The flight test series were carried out in Spain and Indonesia. In the setting up of the flight test facilities and personnel at IPTN, cooperation has also been established with the Institute for Flight Mechanics of DLR (then DFVLR) in Braunschweig. After intensive flight testing for more than two years, in Spain using P-1 prototype and in Indonesia utilising the P-2 prototype, Spanish and Indonesian certification was received on 20 June 1986, and type certification by FAA (parts 25 and 121) was granted on 3 December 1986. Static and Fatigue testings have been and are carried out at the Laboratory for Structural Testing (LUK-BPP Teknologi) at PUSPIPTEK premises in Serpong.

SOME HIGHTLIGHTS OF CN-235 TECHNICAL DETAILS

The CN-235 carries up to 44 passengers at a cruising speed of 454 km/hr over a maximum range of 759 km with a maximum payload of 4,200 kgs.,

MAIN CHARACTERISTICS

MAIN DIMENSION		
SPAN	:	25.81 M
LENGHT	:	21.40 M
WING AREA	:	60.00 M2
WIDTH (OUTSIDE)	:	2.90 M
HEIGHT (OUTSIDE)	:	7.98 M
ENGINES	:	TWO G.E. CT7-9C
POWER AVAILABLE (INSTALLED)	:	A.P.R 1870 SHP AVAILABLE UP TO 33C,S.L-STATIC TAKE OFF. 1750 SHP AVAILABLE UP TO 41C,S.L-STATIC MAX. CONTINUOUS, 1750 SHP AVAILABLE UP TO 32C,120 KTAS MAX. CRUISE, 1700 SHP AVAILABLE UP TO 14C,220 KTAS
PROPELLERS	:	TWO H.S 14 RF-21, 4 BLADED PROPELLERS 11 FEET DIAMETER 1384 MAX. RPM.

Table 4. Main Characteristics of CN-235-100

making it ideal for inter-island operation. The CN-235's wing span is 25.8 m., its length 21.4 m. and height 8.17m. The two GE CT7-7A 1,700 HP engines have a very low fuel consumption.

Table 4 exhibits the main characteristics of the aircraft. Maneuvering envelope for the-100 configuration is exhibited in Figure 3 for an altitude of 25 000ft. The payload-range diagram for the cargo version is shown in Figure 4. Finally its typical direct operating cost is shown in Table 5.

CN-235 has a pressurized cabin and has the ability for short take-off and landing (STOL), and can land on unprepared airstrips. CN-235 is equipped with ramp and cargo doors, high wings and retractable landing gears.

In the design requirements and objectives of the twin turboprop CN-235, it was conceived that the 35-40 seater plane is intended to operate in mountainous or rough areas and to facilitate interisland communications. It can take off and land on short airstrips and has a rear ramp door appropriate for mixed transport (passengers and freight). Turboprop CT7-7A engines from General Electric are selected for their reliability, easy maintenance and low fuel consumption. The engines, control and communication circuits are made in the United States and Europe, whereas the airframe is fully manufactured in Indonesia. IPTN plans to make 100% of the airframe components. There are several versions, civilian (passengers or freight) and military.

First production aircraft made its initial flight on 19 August 1986. The first IPTN series production aircraft in Indonesia was delivered to Merpati Nusantara Airlines on December 15, 1986. CN-235 aircrafts are now flying regularly in Indonesia connecting cities such as Bandung, Jakarta, Palangkaraya, and other cities in Eastern Indonesia. Firm orders for CN-235 totalled 133 by May 1989, 59 Civil and 74 Military. Twenty two of these are for Spanish customers including two for the Air Force, equipped as VIP transports, and four for Binter Canarias. Four others are for Saudia Arabia, eight for the French Armee de l'Air, one each for the Equadorian Army and Navy, two for the Botswana Defense Force, one for the Panamanian National Guard, seven for the Moroccan Air Force and two for the US National Safety Council. The other 85 are for the Indonesian customers (Deraya 11, Merpati Nusantara Airlines 15, Pelita 10, Indonesian Air Force 32, and

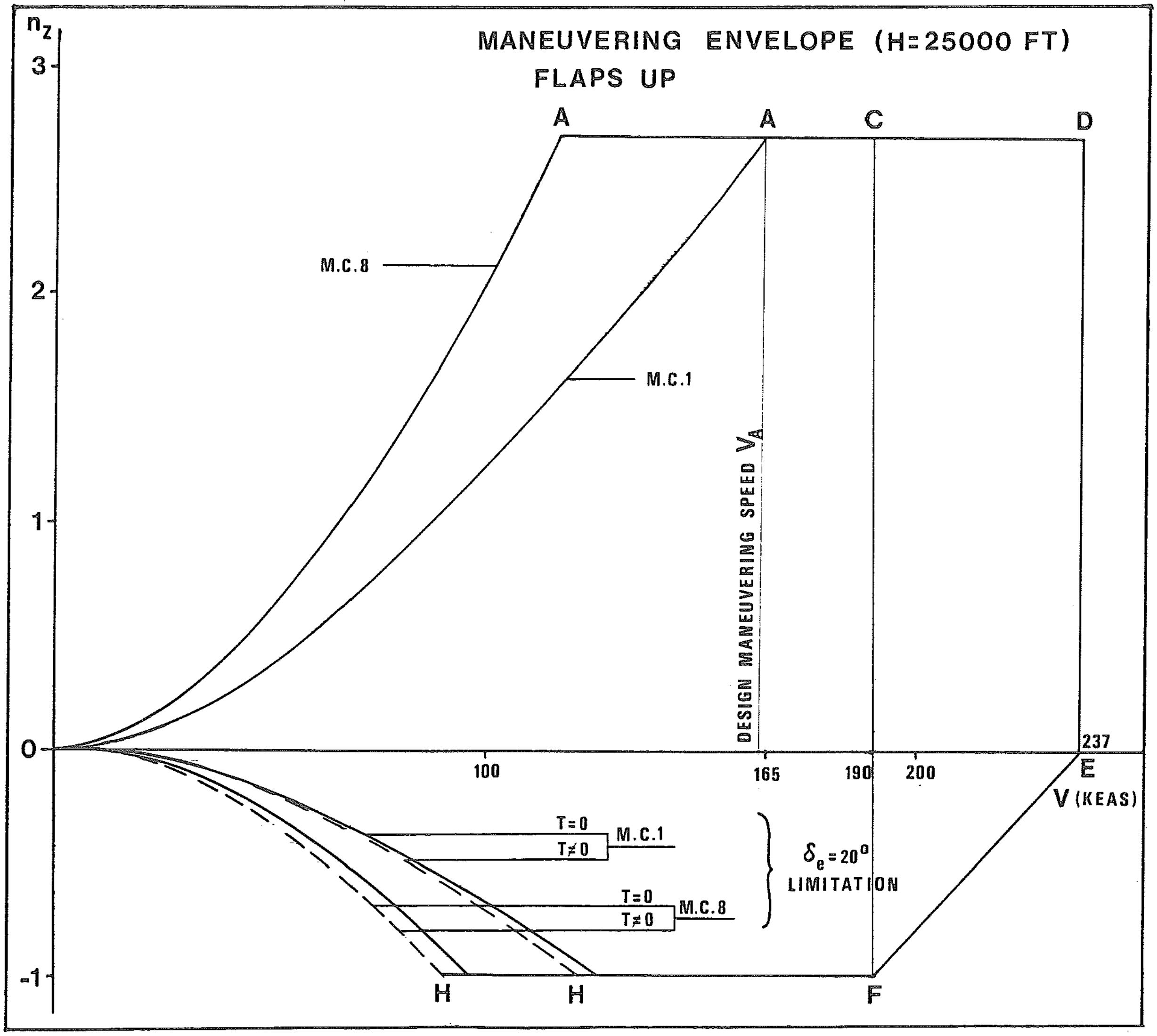

Fig. 3. Maneuvering Envelope for The –100 Configuration

Indonesian Navy 18, including six in ASW/ maritime patrol configuration). Based on the test flight performed by Aviation Week and Space Technology, the handling of the CN-235 aircraft has been cited as very easy. The President Director of Merpati Nusantara also commented that the aircraft is very economical to operate.

The performance of the aircraft can be illustrated through the following comments. After flying the CN-235, R. Ropelewski, a test pilot, reports for Aviation Week & Space Technology (April 1987) that it is a good plane. Although slightly less rapid (by some 20 km/h) than its competitors (the Canadian Dash 8, the French-Italian ATR-42 and the Embraer from Brazil) because of its rather wide body, it is considered to be very good for short flights less than 385 km. Its width allows it to carry containers, or even aircraft engines like that of Mirage 2000 fighter which can only be loaded on board a Boeing 747 or a DC-10. According to the same pilot, the CN-235 is a strong aircraft, with good landing gears.

The development of CN-235 aircraft has resulted in several versions thus far, among others CN-235-10, CN-235-100 and CN-235-200, all carried out jointly between CASA and IPTN. Initial production of CN-235-10s have General Electric CT7-7A engines, while the later versions, CN-235-100s and CN-235-200s are powered by General Electric CT7-9C engines.

FURTHER DEVELOPMENT OF CN-235

Both CASA and IPTN are committed to continuing its technology development programs. This is essential since the aircraft industry must be able to meet diverse customer technological requirements for various aircraft missions. In this respect, IPTN continues to move forward in order to be able to meet such requirements. At this moment, IPTN's Flight Test Center is carrying out test of the CN-235 maritime patrol aircraft (MPA) version.

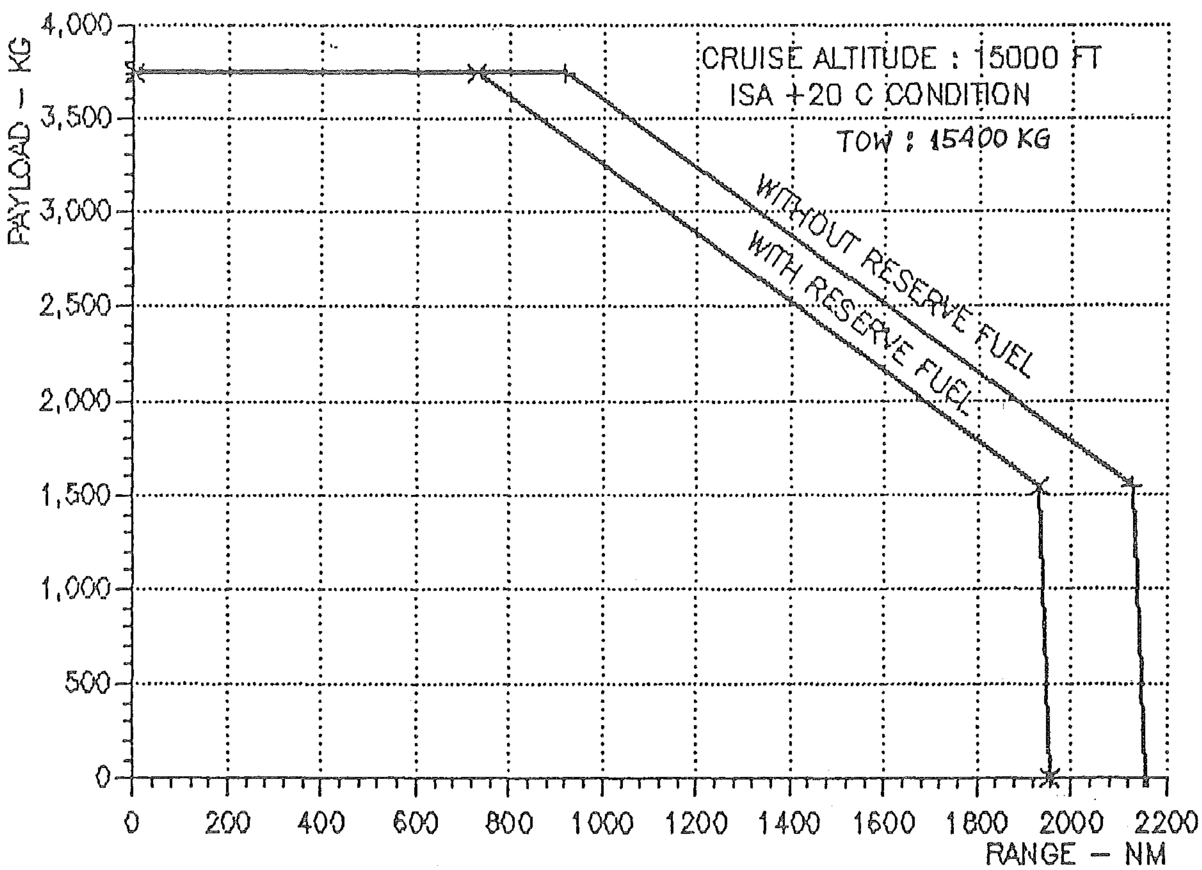

Fig. 4. Payload–Range Diagram for The Cargo Version

The former CN-235 P2 prototype currently used as a flying test bed is undergoing flight test programs with simulated maritime patrol external configurations. The configurations are achieved by installing a dummy long nose for Electronic Support Measures (ESM) and forward looking infra red (FLIR) radar. The objective of these tests is to verify that the CN-235 MPA version is able to perform a non-stop six-hour maritime surveillance. This means that the aircraft will have greater power and longer flight endurance. Such features are mandatory to the maritime patrol type aircraft.

Moreover, the testing is also intended to determine the effects of aerodynamic characteristics and handling quality of the MPA configuration aircraft. Hopefully, the CN-235 MPA version will meet all the requirements as defined by military and customer specifications.

In conjunction with this program, the CN-235 P2 is also undertaking heavy weight test programs. These programs investigate the airworthiness aspects of the aircraft whose weight is to be increased from 14,400 kgs. to 15,100 kgs., and ultimately to 15,750 kgs., with the flight endurance of non-stop six hours. With this improvement, it is hoped that the CN-235 MPA version will be able to perform maritime surveillance more effectively and for a longer duration.

The initial phase of the heavy weight test program indicated that the handling quality of the CN-235 MPA version satisfies the requirements. This signifies that it is in accordance with expectation. The success of this test will make IPTN more agressive in launching its marketing efforts by offering the CN-235 MPA to other states and customers, including the Indonesian Armed Forces.

From the technology view point, the first objective to be achieved in these MPA programs is increased mastery of electronic technology, because the MPA version of the CN-235 is equipped with Advanced Mission Avionics (AMA). The sophistication of AMA design and integration will be jointly carried out by IPTN and Boeing. Through this program, it is hoped that IPTN will be able to advance its capacity to absorb the state of the art technology.

The second objective is increased test technology, where IPTN gains new and valuable experience because the tests of the heavy weight and maritime patrol aircraft programs are different from those of civilian transport aircraft. Improving capability in test technology thus becomes a challenge for IPTN's test pilots and engineers who are involved in those activities.

In the aircraft structure technology, a third objective, IPTN's engineers are also challenged in their creativity. This is their first experience involving problems relating to increasing aircraft weight for military aircraft. Hence, they are faced with the problem of creating and designing stronger fail-safe aircraft structures.

For a typical mission profile, the CN-235 MPA is also able to fly for more than seven hours of endurance. The standard operational equipment of the CN-235 MPA includes among others the INS to Provide continuous accurate position, navigation, guidance data and special mission. Its INS/VLF is fully automatic, computerized navigation system utilizing very low frequency radio signals. It additionally provides accurate positional information anywhere in the globe. And more, the CN-235 MPA is also equiped with tactical data link for over the horizon targetting. All modern mission and operation equipment installed on the CN-235 MPA make it an all weather, effective maritime patrol aircraft.

ADVANTAGES GAINED AND LEARNING EXPERIENCE

The joint design, development, certification and production of CN-235 by CASA and IPTN , which have taken place between two nations with culturally, socially and economically different settings can be regarded as one impressive and successful cooperation. Both countries have tangible and intangible advantages drawn from this cooperation. In 1976, when IPTN was established, it has less than 500 personnel. Now, 16 years later, IPTN has about 15,000 employees and 1,700 university graduate engineers capable of carrying out modification, testing and qualification of any aircraft product. As an example, IPTN had successfully conducted the qualification of NBELL-412 into arms carrying aircraft and at present is carrying out development program to convert CN-235 into a maritime patrol type aircraft. Presently IPTN is also manufacturing under contract components of Boeing 737 and Boeing 767. At the end of the second phase of the industrial transformation period, IPTN engineers and technicians have acquired many experiences from the design, manufacturing, testing, certification and marketing CN-235 aircrafts into competitive market. Meanwhile, all the neceassary support infrastructures that were started to be built early in the second phase, such as aerospace research and testing facilities at Serpong are capable of providing effective services by the end of the second phase. Institute of Technology Bandung, from which many of IPTN and BPP Teknologi engineers graduated, has also enhanced its capability and quality. The Directorate of Aircraft Certification has now been established within the Directorate General of Air Communication and is working on Bilateral Aircraft Agreement with FAA.

Based on this experience and the technology gained from this cooperation taking place during the second phase, IPTN has been embarking on a regional 50 passenger aircraft N-250, which was initiated in 1987 and has already made its first debut in Le Bourget airshow in June 1989. Within the framework of industrial transformation, N-250 program for Indonesia constitute the manifestation of the third phase.

The N-250 aircraft is a twin turboprop high wing commuter aircraft having unique STOL capability. Unlike CN-235, the design technique utilized for this aircraft is employing as much computer graphics as possible and integrated to its production techniques using CAD/CAM interactive program. Several advanced technology items will be introduced, such as the use of composite materials, advanced cockpit including flat panels and flight management system, etc. A new feature that will also be used is the employment of Full Authority Digital Engine Control (FADEC) that will significantly reduce the pilot work load. In addition, advance six blade propeller to reduce acoustic level and fly by wire system will also be utilized.

For Spain, the cooperation with Indonesia, which began with C-212 program and finally with CN-235 program has develop the facilities and manufacturing capabilities that in turn increased the market penetration of Spanish aircraft products, particularly for civilian application. The increase of market penetration has resulted in better company organization and management. Experiences gained from the cooperation established with Indonesia has allowed the establishment of similar international cooperation in aircraft technology with other nations. To cite a specific example, experiences gained in the cooperation with Indonesia have been of great advantage in establishing cooperation with Turky for the licenced production of CN-235.

As a result of carrying out CN-235 program, CASA now possesses sophisticated and advanced design, manufacturing and testing facilities. Several innovative ideas arising from this cooperation can be implemented successfully by CASA in the development and improvement of the company.

Finally, the cooperation that was initiated in the field of aircraft technology has now improved cooperative and trade relationship between Spain and Indonesia, such as in primary commodities and tourism.

CONCLUDING REMARKS

In conclusion, the spirit of international cooperation afforded in the CN-235 program to a large extent has indeed transferred Indonesia from an agriculturally based into an industrially based society capable of producing modern and viable commuter aircrafts in the world market, and enhancing the international market penetration of Spanish products.

To arrive at the present achievement, it is realized that intensive preparations have to take place. The Government should be committed to a systematic and socio-economical as well as culturally suitable industrial transformation strategy. Mandatory infrastructural elements contributing to industrial transformation should be developed concurrently in appropriate phases with the industrial transformation vehicles proper. This means the requirements of a mature vision and far reaching development concepts and programs, experienced and cooperative key persons sharing common development objectives, as well as the support and development of bureaucratic elements. Aircraft technology as one of the most attractive advanced technology has been chosen as spearhead in the industrial transformation process due to domestic market potential attributed to the geographical and socio-cultural heritage as well

TYPICAL DIRECT OPERATING COST CN-235-100

Assumptions

1.	Aircraft Price	:	US$ 10,000,000.00
2.	Aircraft Utility	:	180 FH/year
3.	Depreciation Period	:	10 years
4.	Residual Value of Aircraft	:	10 %
5.	Rate of Insurance	:	1.5 % of Aircraft Price
6.	Crew Salary		
	Pilot Salary	:	US$ 2000.00/month
	Co-pilot Salary	:	US$ 1500.00/month
7.	Maximum Crew Utilization	:	1050 FH/year
8.	Fuel Price	:	US$ 1.1/gallon
9.	Average Fuel Consumption	:	420 kg/hour
10.	Oil Cost	:	2.5 % of Fuel Cost
11.	Maintenance Cost		
	Part & Material	:	US$ 80.00/FH
	Engine & Propeller Reserve	:	US$ 90.00/FH
	Main Hour Cost	:	US$ 25.00/FH

Direct Operating Cost Break-down

1.	Fuel Cost & Oil Cost	:	US$ 146.01/FH
2.	Maintenance Cost	:	US$ 195.00/FH
3.	Crew Cost	:	US$ 40.00/FH
4.	Depreciation Cost	:	US$ 500.00/FH
5.	Insurance Cost	:	US$ 83.33/FH
	Direct Operating Cost	:	US$ 964.34/FH

Table 5. Typical Direct Operating Cost of CN-235-100

as due to its technological sophistication that are essential and generic to other technologies. It is also realized that the industrial transformation process will take advantage of the manpower resources available, which in turn will develop improved quality and productivity.

The industrial transformation process which will bring Indonesia to a well developed and modern nation depends upon a number of basic and infrastructural needs, and development strategy to fulfill those needs. In this conjunction, several requirements have to be met. First, education and training in various fields of science and technology relevant to nation building should be accelerated. Second, a clear, realistic and consistently applied concept of the nature of the society to be developed and the technologies needed for its realization must be evolved. Third, technologies can only be transferred, adapted and further developed through application to concrete problems. Fourth, in order to develop self reliance, it is vital that the country solves the problem independently. Atsome point, technologies have to be developed endogenously. Fifth, encouragement and appropriate protection conducive to the development of national technological capability should be rendered until the ability to compete in the international market is achieved.

In conclusion, the spirit of international cooperation afforded in the CN-235 program to a large extent has indeed transformed Indonesia from an agriculturally based into an industrially based society capable of producing modern and viable commuter aircrafts in the world market, and enhancing the international market penetration of Spanish products.
The spirit of cooperation which has endured various obstacles have resulted in national confidence of each partner, and we believe will lead to broader cooperation with other international partners and in more sophisticated technologies required in this globalization era.