The Development of N-250 Military Version

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Abstract: - This paper describes the development of N-250 Military version (N-250 TRD). The N-250 TRD is development from its high speed predecessor, the N-250 civil version. Like its predecessor, the N-250 TRD is equipped with two 2,439 kW (3,271 shp) Rolls-Royce Allison AE 2100C turboprops, each driving a Dowty Rotol R384/6123-FX8 six-blade propeller. Its mission capabilities include : troops transport mission, paratroops dropping mission, cargo and LAPES (Low Altitude Parachute Extraction System).

Key-Words: - troops transport mission, paratroops dropping mission, LAPES (Low Altitude Parachute Extraction System), military transport aircraft, beavertail after body, aircraft design, aerodynamic configuration

1 Introduction

Like many aircraft manufacturer, to maximise the useable of their aircraft, Indonesian Aerospace (IAe) have studied to convert the N-250 civil version into military transport version (i.e. : Tactical Transport Aircraft, N-250 TRD).

This conversion is unique, because from the beginning, the N-250 is not to be design for military transport version. The first difficulty is its height to sill is too hight (1.645 m) compare to CN-235 (height to sill = 1.22 m), because N-250's fuselage use circular cross-section (diameter = 2.9 m) compare to CN-235's fuselage use same diameter flattened circular cross-section. The second difficulty, especially for LAPES mission, is N-250's fuselage is not incorporated with cargo ramp/door.

To solve the above problem, the original aft fuselage of N-250 is replaced by a new aft fuselage with upswept rear end incorporating cargo ramp/door.

For this study, two type of a new aft fuselage were studied. The first is beavertail after body (CN-235 type) and the second is high crown after body (C-141 type).

For paratroops dropping mission, aft exit door (both sides) is replaced by flight operable paratroops door (900 mm x 1,752 mm).

Another modification is environmental control system (ECS) is moved from behind the aft fuselage pressure bulkhead to the under floor space behind the main landing gear stowage.

This paper describes the involvement of the author as the leader of aircraft configuration design department at Indonesian Aerospace (IAe) during the development of the N-250 TRD with beavertail after body (CN-235 type) [1].

2 N-250 TRD Configuration

Fuselage with rear loading after bodies generally has an after body which sweeps up sharply on the lower surface and has a flat section which swings down to serve as a loading ramp. The requirement for load clearance at the extreme end of the loading door often results in a fuselage which has virtually no lateral contraction. That is, the aft fuselage does not contract when seen from the top view.

The structural design objectives of a rear loading after body are generally directed to minimizing weight, length, ramp angle, and ramp complexity. In addition "straight-in" loading and airdrop capability are usually desired. These objectives have generally been met with a beavertail after body design (no lateral contraction with large camber ratio and small contraction ratio). Such after bodies are found in almost all cargo helicopters and in some cargo aircraft such as the CN-235, the C-130 (Hercules) and Caribou transports.

The general arrangement of N-250 TRD with beavertail after body (CN-235 type) is shown in Figure 1. To accommodate the auxiliary power unit (APU), the aft part of the aft fuselage need to be enlarged, as shown in Figure 2.

Paratroops can be accommodated on side wall folding seats with safety harness that are installed on the mounting provisions attached to the frame structures, as shown in Figure 3. This aircraft can accommodate 60 paratroops.

Dropping can be performed by static line or free

fall. The static line will be installed to the aircraft structure.

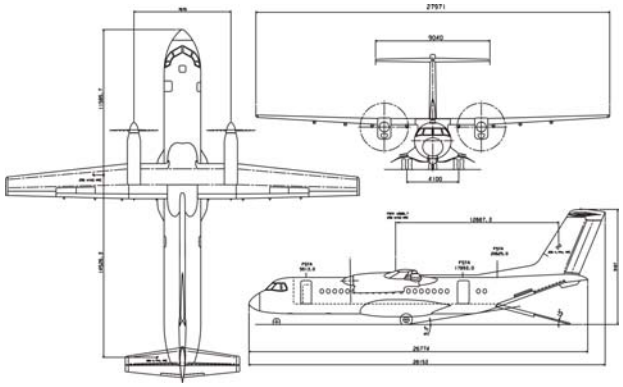

Figure 1. The general arrangement of N-250 TRD

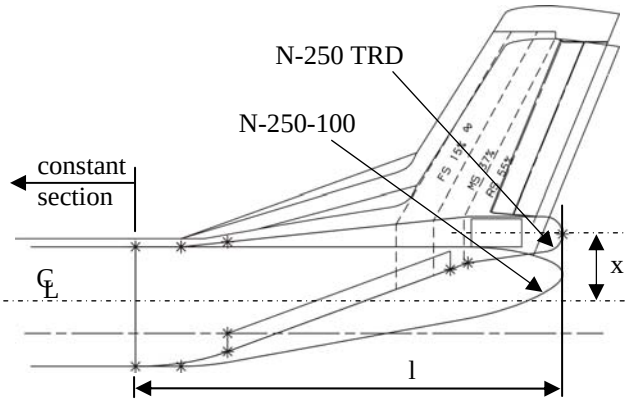

Figure 2. The aft fuselage of N-250 TRD development

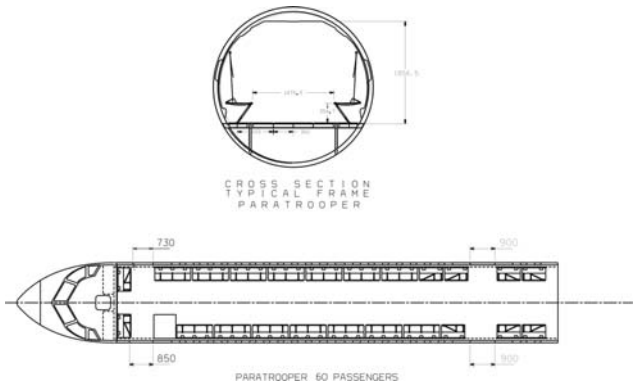

Figure 3. Cabin layout for 60 paratroops

Paratroops doors shall be at the rear left and right. These two doors shall have a size of 900 mm x 1,750 mm and inward sliding opening to the rear.

Cabin layout for troops transport mission is as shown in Figure 4. This aircraft can accommodate 76 troops.

While cabin layout for cargo transport mission is as shown in Figure 5. This aircraft can accommodate 7 LD3.

Figure 6 shows the N-250 TRD during LAPES (Low Altitude Parachute Extraction System) configuration.

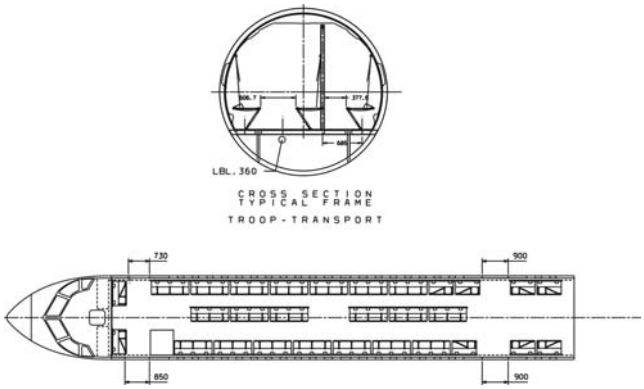

Figure 4. Cabin layout for 76 troops

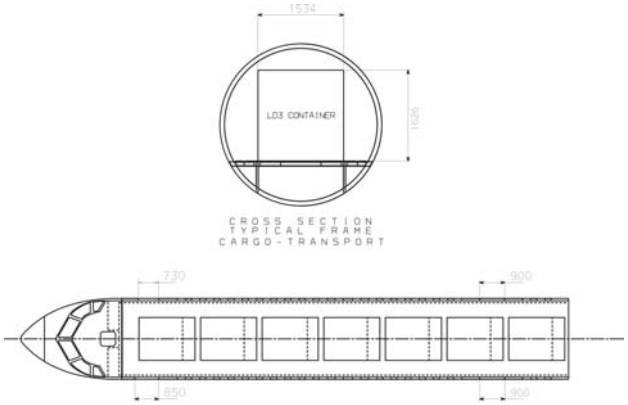

Figure 5. Cabin layout for 7 LD3

Figure 6. N-250 TRD and CN-235 during LAPES

3 N-250 TRD DESIGN WEIGHT

The maximum take-off weight (MTOW) of N-250 TRD is kept similar with its predecessor. The big difference is come from the structure of aft fuselage, its mean the N-250 TRD have extra weight compare to the N-250-100, this will effects the operating empty weight (OEW) and MPLW.

The design weight of N-250 TRD is shown below.

Note :

MFW = maximum fuel weight
MZFW = maximum zero fuel weight
MLW = maximum landing weight
MPLW = maximum payload weight

MTOW = 24800 KG
MFW = 4200 KG
MZFW = 21900 KG
MLW = 24600 KG

Troops transport :

OEW = 14610 KG
MPLW = 7290 KG

Paratroops dropping :

OEW = 14570 KG
MPLW = 7330 KG

Cargo : 7 LD3 container

OEW = 14670 KG
MPLW = 7230 KG

4 FUSELAGE

V/STOL (Vertical/Short Take-off and Landing) aircraft fuselages generally deviate considerably from an optimum streamline shape. This is due to the conflicting desires to maximize internal cargo volume and provide an adequate ramp for loading the cargo while minimizing overall length to reduce airframe weight.

This type of fuselage generally has an afterbody which sweeps up sharply on the lower surface and has a flat section which swings down to serve as a loading ramp. The requirement for load clearance at the extreme end of the loading door often results in a fuselage which has virtually no lateral contraction. That is, the aft fuselage does not contract when seen from the top view. In this work this type of afterbody will often be referred to as a "beavertail" afterbody (as shown in Figure 7). Fuselages of this type have been found to have a large amount of pressure drag caused by the afterbody. A study made by Gabriel, E.A. [2] of a fuselage of this type (CH-47 helicopter) showed that 1/3 of the fuselage drag was due to afterbody pressure drag.

Figure 7. A "beavertail" afterbody

5 N-250 TRD PERFORMANCE

The prediction of the N-250 TRD performance is based on the same maximum take-off weight of N-250-100 (i.e. : MTOW = 24800 KG). The only difference is come from the shape of aft fuselage, its mean the N-250 TRD have extra drag compare to the N-250-100.

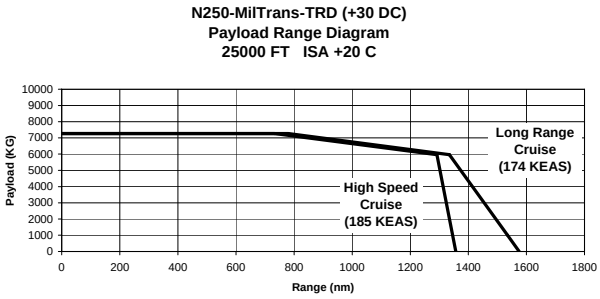

Figure 8. The payload-range performance of N-250 TRD

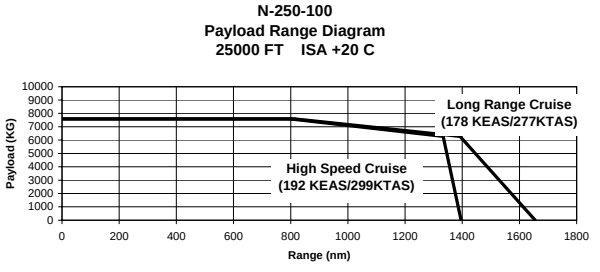

Figure 9. The payload-range performance of N-250-100

The payload-range performance of N-250 TRD is as shown in Figure 8. While the payload-range performance of N-250-100 is as shown in Figure 9.

Field length at S/L & ISA +20 DEG. C.

Take-off = 1373 m (4500 FT) AT MTOW
Landing = 1373 m (4500 FT) AT MLW

Cruise speed at 25000 FT & ISA +20 DEG. C.

N-250 TRD
Long range 174 KEAS / 271 KTAS
High speed 185 KEAS / 288 KTAS

N-250 -100
Long range 178 KEAS / 277 KTAS
High speed 192 KEAS / 299 KTAS

6 Discussion

Beside the advantage in having easy loading and unloading the cargo; it is very clear that incorporating the ramp for loading the cargo to the N-250 TRD will increased its operating empty weight (OEW) and drag and decreased maximum payload weight (MPLW).

The above snowball effect finally will decrease both the cruise speed and the payload-range performance of N-250 TRD compare to its predecessor (N-250-100)

7 Conclusion

From the above study, the N-250 TRD is technically feasible for a military tactical transport aircraft, with the same reservations that apply to the every new aircraft project, i.e. the economic aspects depend on the market demand, a large multidisciplinary research effort is needed in order to master the structure and aerodynamic aspects of the aft fuselage incorporated with cargo ramp/door.

It is recommended for the future derivatives, N-250 TRD should incorporate a high-crown afterbody with deep keel, as much as possible, to improve the aircraft performances.

References:

[1] N-250 Improvement Group, *N-250 Military Transport Study (N-250 Program)*, Indonesian Aerospace (IAe), Bandung, Indonesia, 2002.

[2] Gabriel, E.A., *Drag Estimation of V/STOL and Helicopter Fuselages with Rear Loading Ramp Afterbodies*, Boeing Vertol Division IOM 8-7447-1-98, June 8, 1967.