MPC 75

Feasibility Study – Summary Report

MBB | CATIC | Association

B1 - Project Definition

Diese Projekt - Definition

ist ein Auszug aus dem Summary Report (Kapitel B1) ,dokumentiert den Projektstand zum Ende der Feasibility Study und gilt als:

MPC 75 Project Information

Issue 2 (07/87)

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LIST OF CONTENTS

1. INTRODUCTION

This report summarizes the study results jointly obtained by MBB and CATIC with regard to the technical feasibility of the MPC 75.

The Memorandum of Understanding between CATIC and MBB stated the following objectives for Group B "Project":

> "Determine technology readiness status and define any needed technological developments to enhance the success of the programme.
>
> Develop preliminary aircraft sizing and configuration options and perform appropriate trade-off studies so as to narrow the many possible options to a smaller group of most promising ones".

Questions related to the organizational problems of a cooperation were at first covered in Group B also, but later on they gained such importance that the formation of dedicated Working Groups (B_2 "Organization and Procedures", B_3 "Quality Assurance and Certification", B_4 "Standardization") became necessary. The Group dealing with technology and aircraft configuration was then designated Group B1 "Project Definition".

This report covers the work of Group B_1 only. The main results can be summarized as follows:

- The world-wide market study indicates the requirements for an advanced regional passenger aircraft with a capacity of approx. 75 seats, having a design range of 1500 .m., cruise speed of approx. M = 0.75 and an initial cruise altitude of not less than 35000 ft.
- The baseline configuration of the MPC 75 is designed to meet these requirements It incorporates two rear-mounted ultra by-pass engines for propulsion and utilizes advanced technologies in aerodynamics, materials, and systems for improved comfort, operational flexibility and superior economics.

INTRODUCTION

- The MPC 75 baseline configuration has a four abreast cabin cross section. With 32 inches seat pitch, the capacity of a single class layout is 76 seats. With 30 inch seat pitch in a high density layout, the seating capacity is increased up to 84 seats.
- The performance analysis shows that the baseline configuration meets all technical and market requirements, including the critical mission of Kunming-Chengdu.
- The MPC 75 is very competitive in terms of block fuel and direct operating cost compared with the existing aircraft of the same class.
- The engine availability study shows that only the GE38 UDF is a suitable candidate powerplant so far, but the PW-Allison 501-M80E engine and other alternatives are still under consideration.
- The results of the feasibility study demonstrate that the MPC 75 aircraft is technically feasible, but further refinement of the baseline configuration is still necessary. Especially the requirements of potential customers must become better known, and must be reflected in the final configuration.

2. REVIEW OF ACTIVITIES

2.1 Way of working

MBB and CATIC discussed and agreed the overall work plan, and performed the study in close cooperation.

Typically, detail work was done independently in the parent companies; results were exchanged in the context of a General Meeting; conclusions were then drawn and detail work plans were established covering the period up to the next meeting. However, on two occasions, CATIC engineers stayed at MBB in Hamburg for an extended working period as the status of work required so.

2.2 Main lines of action

Initially, three actions were carried out in parallel: assessment of technical requirements (derived from market needs), assessment of status of technology, and comparison of methodology (using an example aircraft). A Baseline Aircraft was then defined, and was optimized and refined by means of parametric variations, trade-offs, and some analysis of critical components and systems. This Baseline Aircraft was used in presentations to selected airlines (CAAC, LH), thus stimulating a first market reaction to MPC 75.

The question of propulsion/engine availability was dealt with as a priority item, and regular contacts with engine manufacturers were maintained.

2.3 Major Events

26.1.86 to 6.2.86	● Time schedule and work procedure of Group B agreed.
Hamburg	● Example aircraft selected to check consistency of engineering methods of MBB and CATIC.

13.3.86 to 25.3.86 Xian	● First results of example aircraft study discussed. ● Preliminary information of operational requirements from CAAC.
26.5.86 to 6.6.86 Hamburg	● Discussion on example aircraft continued. ● General configuration of Baseline Aircraft agreed. ● Main design requirements agreed. ● Visit to CIMBER airline and European ATC authorities by joint MBB/CATIC team.
20.9.86 to 28.9.86 Xian	● Example aircraft exercise completed, good agreement achieved. ● Analysis of baseline configuration and trade-offs presented and discussed. ● Possible advanced technologies and benefits identified and listed. ● Part of MBB delegation visits CARDC.
24.11.86 to 19.12.86 Hamburg	● Baseline configuration improved (Revision 1) ● Wing area variation allowing for the baseline and stretched version ● Contribution to airline presentation brochure.

23.2.87 to 13.3.87 Hamburg	● Baseline configuration finished for feasibility study.
22.4.87 to 30.4.87 Hamburg	● Results of alternative configuration with PW-Allison engine reviewed. ● Feasibility of advanced structure (CFRP wing box) and advanced aerodynamics (NLF) discussed, conclusion positive. ● Major systems discussed, suitable solutions identified. ● First contact with 13 European airlines established to improve information on design requirements. ● First draft of Technical Description available.
13.5.87 to 20.5.87 Guilin	● Summary Report drafted and agreed.

2.4 General Results

The work carried out in 1986/87 has demonstrated that engineers from CATIC and MBB are able to cooperate succesfully in defining an aircraft, despite still existing problems caused by the large distance and partially insufficient communication lines. A very high degree of agreement was achieved in all technical matters covered. Discussions and working sessions took place in a professional, matter-of-fact, but open and friendly atmosphere.

3. DESIGN REQUIREMENTS

Basic market requirements obtained from the Market Group were translated into a set of Design Requirements, see Fig. 3.1. In general, performance requirements stated are similar to the level of contemporary regional airliners.

The nature of this information is still very preliminary and limited. More substantiation is highly desirable in order to establish a better yardstick against which the aircraft can be compared.

The only specific mission requirement so far was that indicated by CAAC: A flight from Kunming to Chengdu, involving high elevation, high temperature airfield performance, see Fig. 3.2.

In order to improve the situation on the requirements side, some additional information was collected from a limited number of European airlines, on the basis of initial, general contacts. These contacts are not fully representative; in addition, uncertainties exist on the operator's side because the effect of the anticipated liberalization and the changing environment in Europe is not yet fully assessable.

Nevertheless, from this information and the latest inputs received from local administrations of CAAC, the following preliminary conclusions may be drawn:

> There is some confirmation of the Basic Project Requirements, but on the other hand there appears to be a trend towards a requirement for increased passenger capacity, more cabin comfort, and less range.

Fig. 3.1: SUMMARY OF DESIGN REQUIREMENTS

Capacity	Start with 75 seats, 32" pitch single class. Stretch potential to 100 seats, 32" pitch single class. (Later indication: There is the possibility that the above single class recommendation could change to business/economy mixed class with the same number of seats).
Range	1500 nm with full passenger load, but without cargo; provisions for future increase.
Cruise speed	About M = 0.75
One engine inoperative ceiling	16000 ft, ISA + 10° C
Take-off field performance	6000 ft SL, + ISA + 18° C, MTOW 5200 ft SL, ISA, MTOW 6900 ft, 6500 ft elevation, ISA, MTOW
FAR landing field length	4300 ft SL, wet runway, Typ. miss. L.W.
Noise	FAR part 36 stage III or better
Comfort Standard	Similar to F28, (Later recommendation: Perceptive as well as physical comfort level not worse than the 1990's 100+seater single-aisle aircraft; aisle width should consider unobstructed passenger movements within the cabin during galley service; airline inputs needed.)
Economics	DOC Target: SMC better than current aircraft of the same category; SMC at least equal to F100 with 100 passengers.

4. BASELINE AIRCRAFT

4.1 General

A Baseline Aircraft configuration was defined, fulfilling the initial design requirements.

It must be understood that the Baseline Aircraft is by no means the final solution. It is rather a preliminary solution which fits the market needs and is well enough engineered to match technical needs as well.

Hence, the Baseline Aircraft can be reasonably used for checks against requirements or competition aircraft and to indicate the attainable level of payload flexibility, comfort, performance, and economics.

Also, it serves as a starting point of optimization and refinement, and it helps to stimulate reactions from potential customers.

4.2 Configuration

General

The Baseline Aircraft configuration, as far as possible, reflects the market needs and technical possibilities as seen today. The configuration has been optimized for the basic capacity of approx. 75 seats. However, there is an inherent capability for future growth to increased capacity and extended range.

The Baseline Aircraft reflects the standards typical of main line operators. New technologies have been incorporated where they are expected to be cost effective (see chapt. 5).

BASELINE AIRCRAFT

Wing

The planform and profile of the clean wing without leading edge devices were chosen to match the aerodynamic requirements for natural laminar flow. The single-slatted Fowler flaps are used for high lift and to vary the wing camber in accordance with flight conditions. The wing takes full advantages of the strength and stiffness of its composite structure to minimize induced drag through a high Aspect Ratio and to save weight.

Fuselage

A four-abreast cross-section was chosen for optimum cabin flexibility with access at front and rear. The cross-section provides for high passenger comfort standard and ample underfloor capacity for baggage and some revenue cargo.

Propulsion

The General Electric GE38 UDF is considered as the prime engine candidate. In consequence of the pusher engine configuration and from consideration of noise and noise fatigue, the engines are arranged at the rear fuselage. See also Chapter 7 "Engine Choice".

Empennage

In consequence of the engine position, a T-tail fin-stabilizer arrangement has been chosen.

Figures 4.1 to 4.8 present main features of the MPC 75 Baseline Aircraft.

4.3 Weights

The weights reflect the latest status of the Baseline Aircraft definition and include the effects of using advanced materials and manufacturing techniques. There is confidence that the level of weights is realistic as they are justifiable against existing aircraft of the same class. Some weight reduction appears possible as the aircraft definition becomes more specific. See Weight Summary, Fig. 4.9.

4.4 Performance

The Baseline Aircraft performance reflects the best aerodynamic qualities - including natural laminar flow - that can realistically be assumed at the present state of technology and aircraft definition. Engine data have been used as furnished by the manufacturer. See Fig. 4.10 for the Performance Summary and Fig. 4.11 for Payload-Range.

All performance requirements are met or even bettered. Only the "high altitude T.O. case" (6900 ft field length at MTOW, 6500 ft elevation) is not met: this T.O. field can only be achieved at a reduced T.O. weight giving a range with 76 passengers of 750 nm. Whether this is significant, or can be tolerated, can only be clarified through contacts with potential operators. It should be noted that the only well defined "hot and high" case is fulfilled: the Kunming-Chengdu mission can be flown even under the most adverse conditions.

4.5 Stretch Potential

A preliminary study has been made on the stretch potential of the MPC 75. It was found that a stretch of up to approx. 100 seats (as stipulated by the design requirement) would be feasible. For this version, MTOW will increase to approx. 34000 kg, and engine thrust must grow by some 25 - 30 %. This thrust growth just about appears to be possible for the GE38 UDF as a longer term development. This implies increased engine weight and dimensions. Both from thrust availability and from airframe structural reasons, stretched versions must be considered as mid-to-longterm developments.

Fig. 4.1: CONFIGURATION

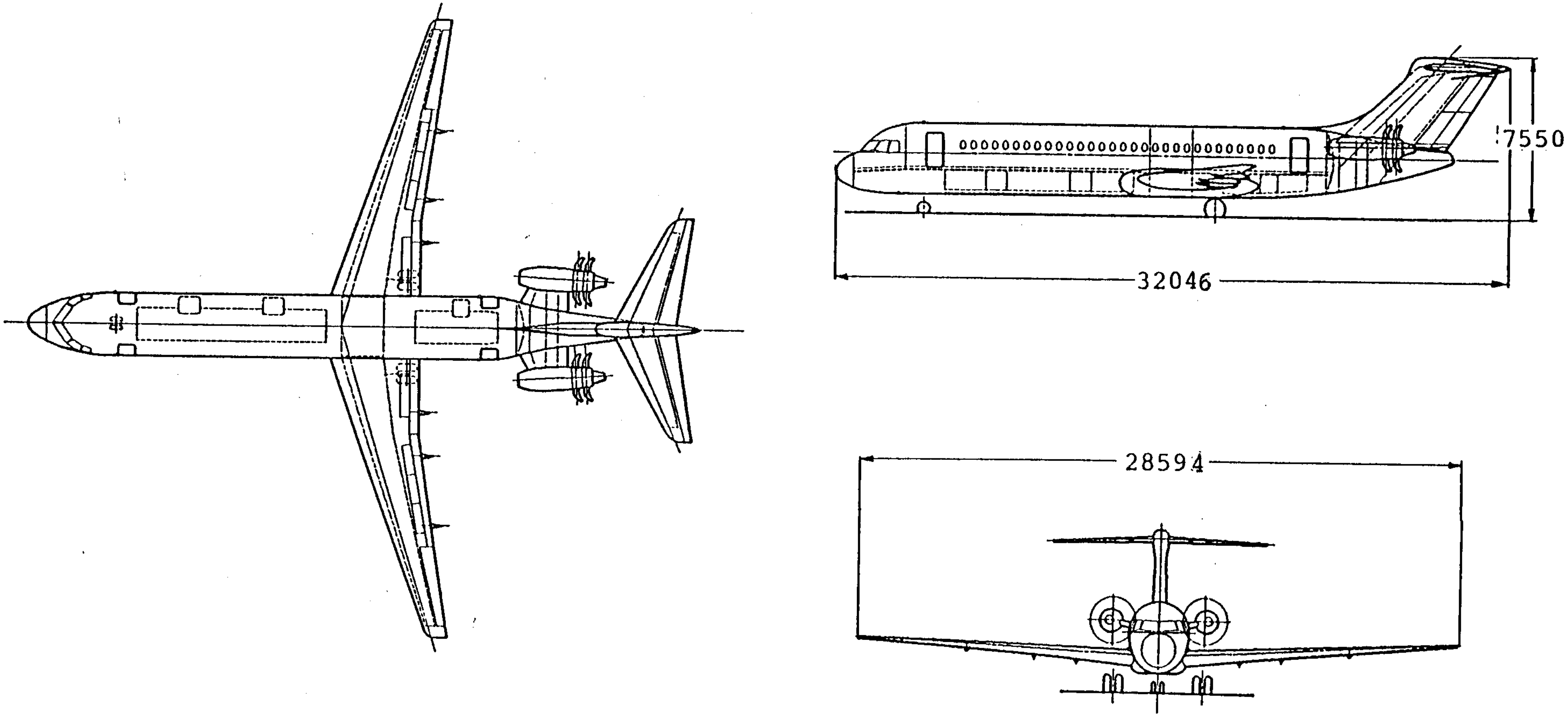


Fig. 4.2: MAIN DATA

SEATING CAPACITY	All Economy 32"	76
	Mixed Class 32"/36"	69
	High Density 30"	84
GEOMETRY	Length, Overall	32,05 m
	Height, Overall	7,55 m
	Span	28,59 m
	Wing Area	75,00 m^2
	Wing Aspect Ratio	10,90
	Wing Sweep	17 deg
ENGINE	Type	UHB
	Designation	GE38-B5 UDF
	Number	2
	Thrust SL. ST. INST.	9620 lb
RUNWAY LOADING	ACN (flexible and rigid runway, medium subgrade)	16....18

Fig. 4.3: FUSELAGE CROSS SECTION

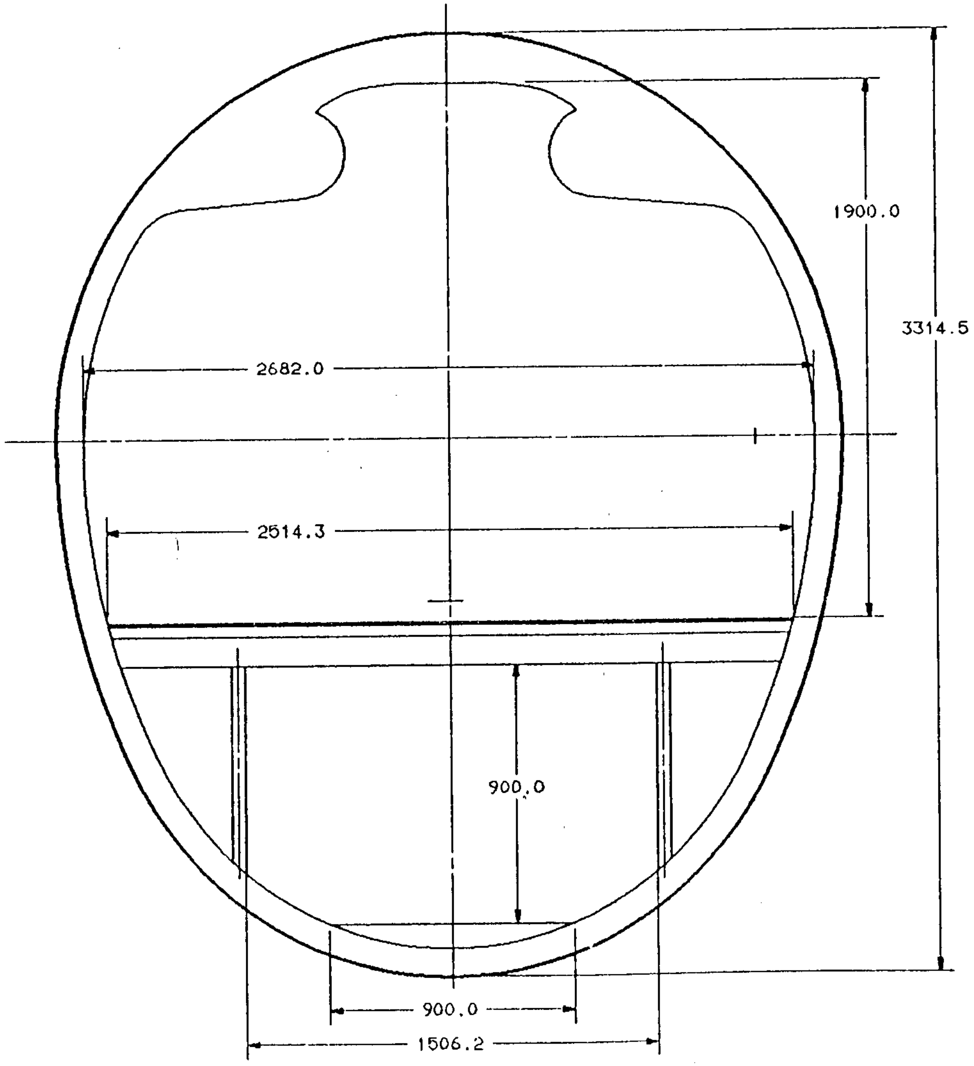
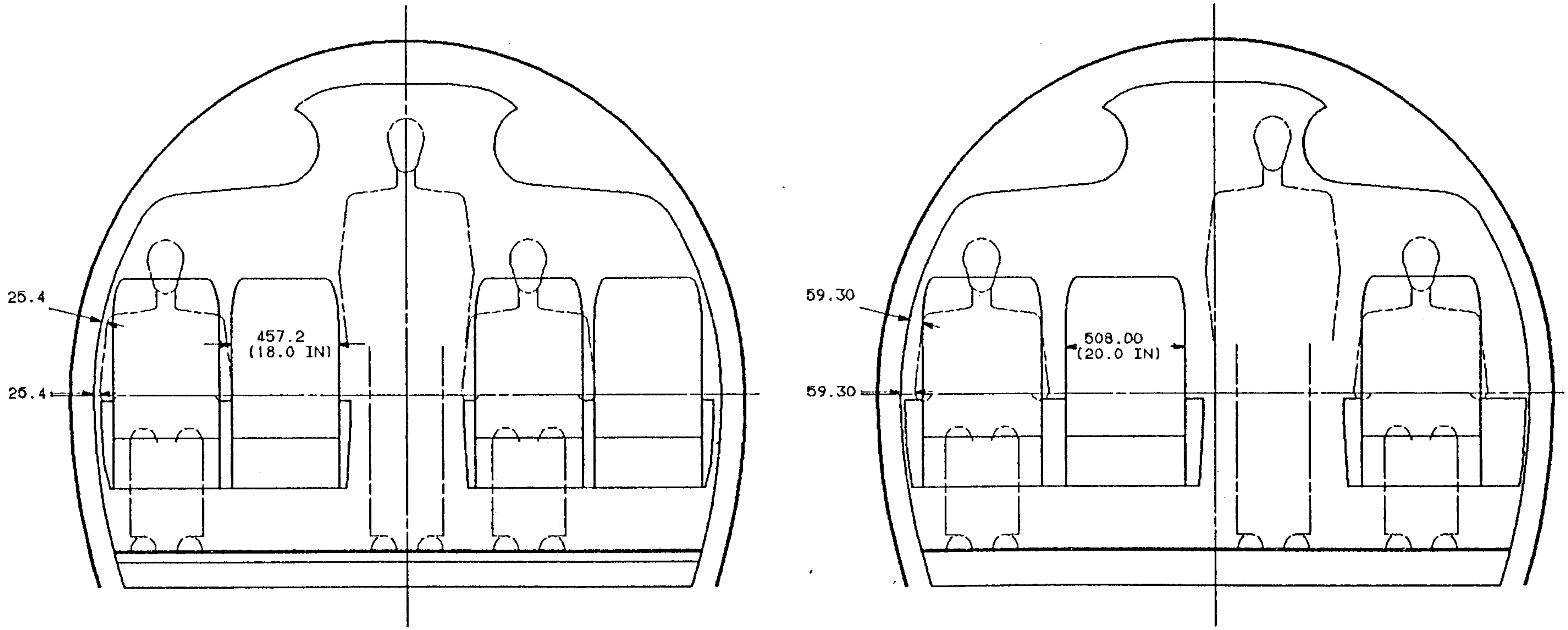


Fig. 4.4: CABIN CROSS SECTION



TOURIST CLASS
4 ABREAST
AISLE WIDTH 19"
NOMINAL SEAT WIDTH 42"

FIRST CLASS
3 ABREAST
AISLE WIDTH 23.7"
NOMINAL SEAT WIDTH 50"

Fig. 4.5: CABIN LAYOUT

ALL TOURIST

76 SEATS 32" PITCH

G GALLEY	(4X TROLLEYS)
L LAVATORY	(2X)
A ATTENDANT-SEAT	(2X)
C COAT STOWAGE	(2X)

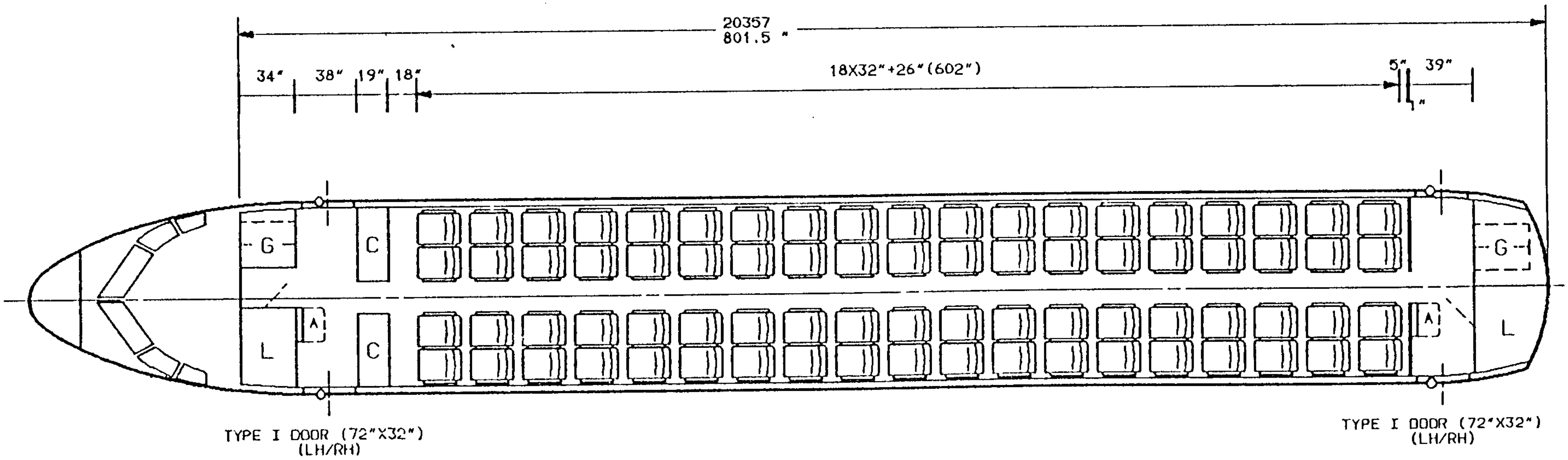


Fig. 4.6: Cabin Layout

MIXED CLASS

9 SEATS 36" PITCH
60 SEATS 32" PITCH

69 SEATS TOTAL

G GALLEY	(5X TROLLEYS)
L LAVATORY	(2X)
A ATTENDANT-SEAT	(3X)
C COAT STOWAGE	(2X)

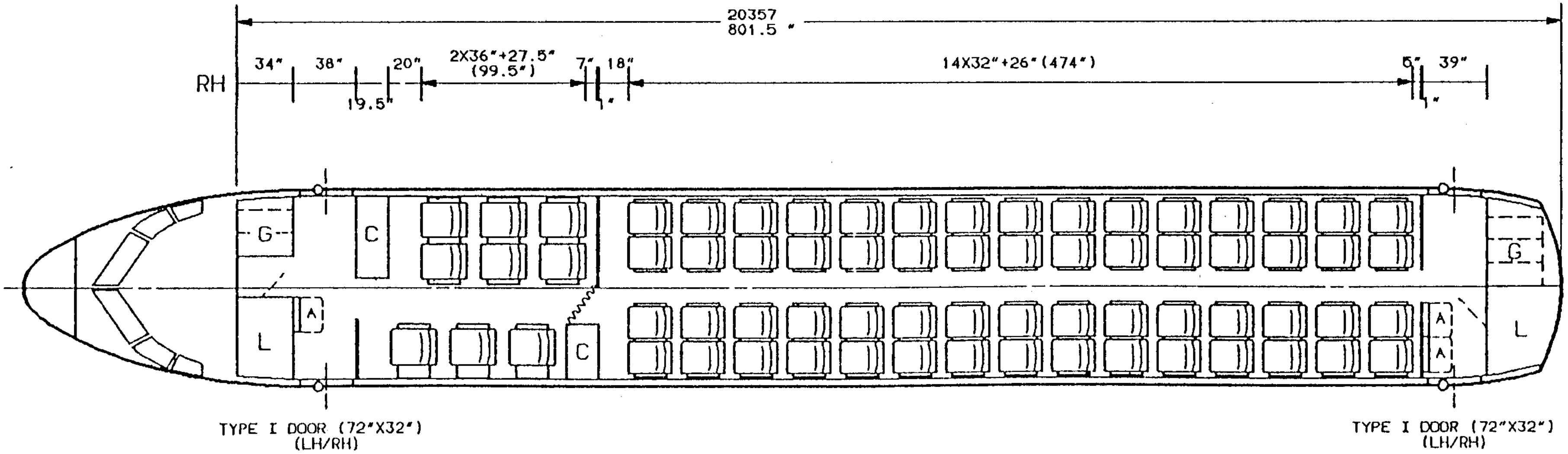


Fig. 4.7: Cabin Layout

HIGH DENSITY

84 SEATS 30 PITCH

G	GALLEY	(4X TROLLEYS)
L	LAVATORY	(2X)
A	ATTENDANT-SEAT	(2X)
S	STOWAGE	(2X)

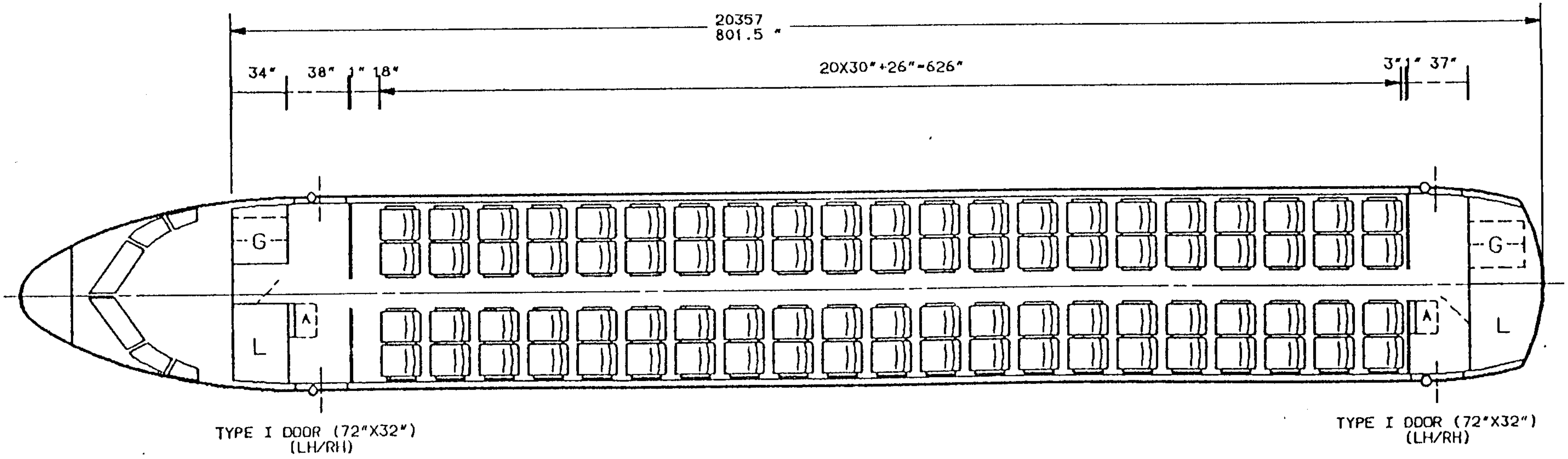


Fig. 4.8: CARGO COMPARTMENTS

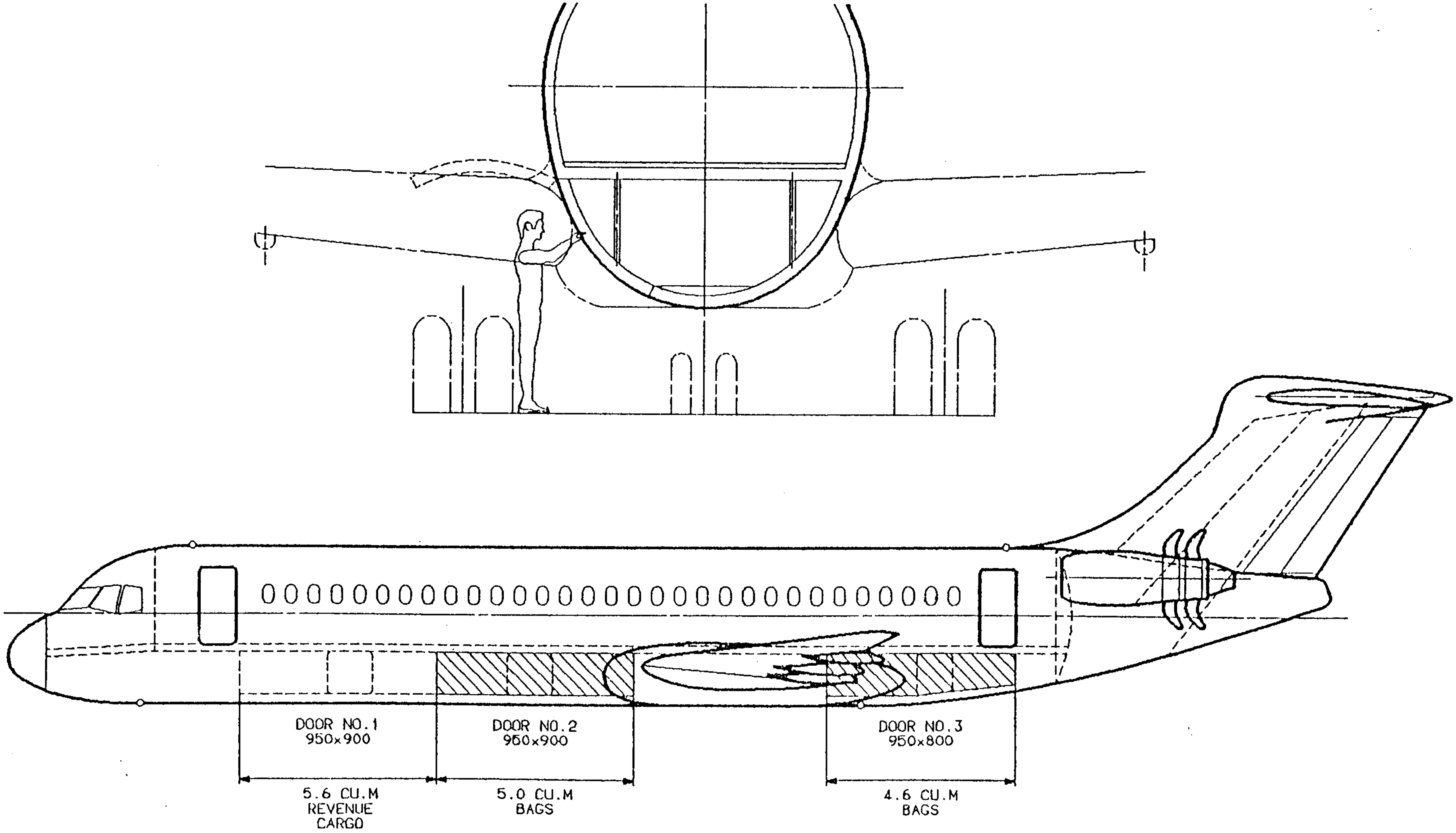


Fig. 4.9: WEIGHT SUMMARY

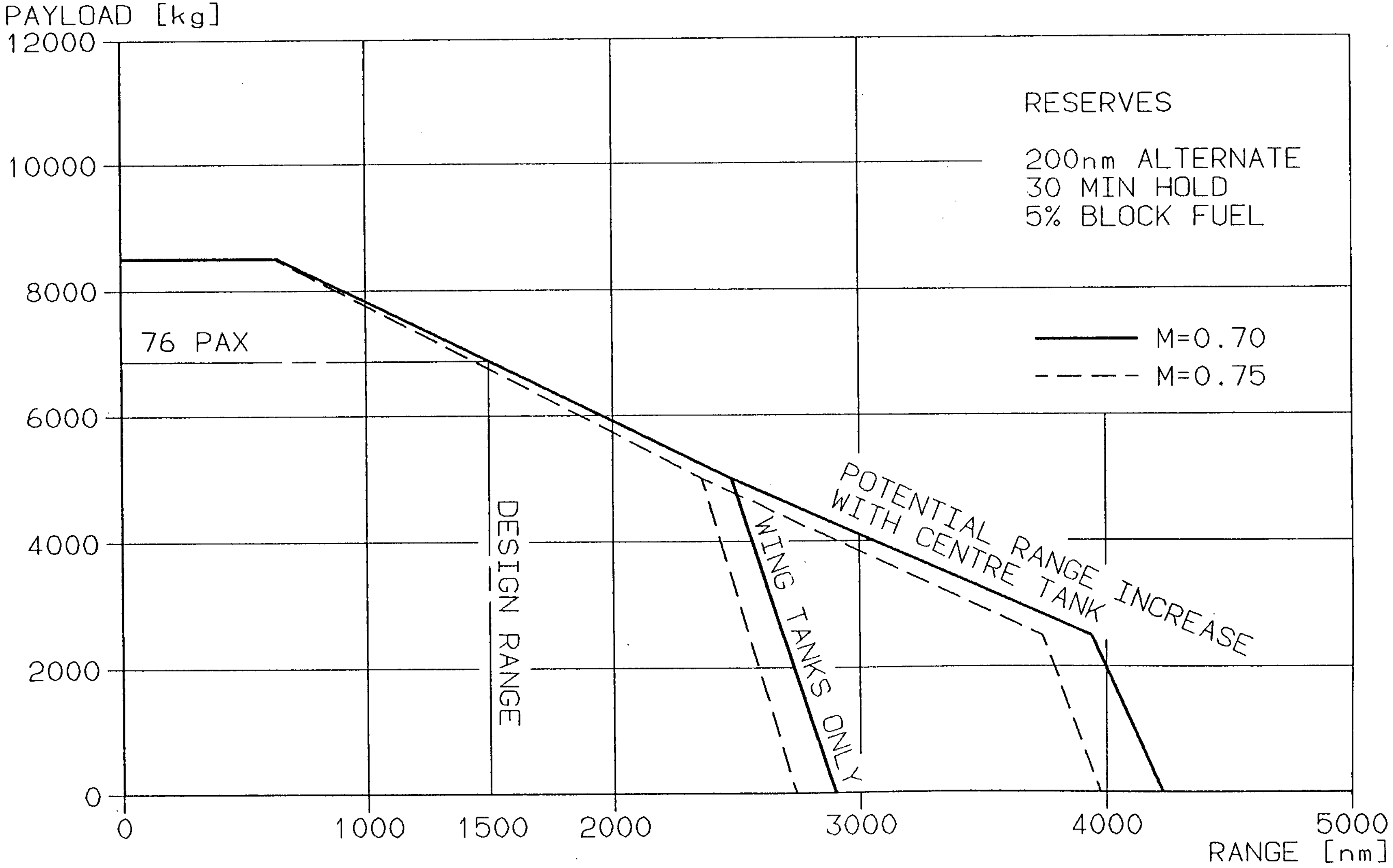
WEIGHT SUMMARY

Max. Take-off Weight	30000 kg
Max. Landing Weight	28500 kg
Max. Zero Fuel Weight	27325 kg
Operating Weight Empty	18825 kg
Manufacturers Weight Empty	17293 kg
Max. Payload	8500 kg
Max. Fuel Capactiy	6150 kg

Fig. 4.10: PERFORMANCE SUMMARY

			REQUIRED	ACHIEVED	REMARKS
RANGE WITH FULL PASSENGER	LRC	(nm)	1500	1500	MET
RANGE WITH MAX FUEL	LRC	(nm)	-	2500	
FAR T.O. FIELD LENGTH	SL, ISA, MTOW	(ft)	5200	5100	MET
	SL, ISA+18, MTOW	(ft)	6000	5700	MET
	6500 ft, ISA, MTOW	(ft)	6900	9700	Requirement met only at TOW for 750 nm Range
FAR LAND. FIELD LENGTH AT TYP. MISS. LW	SL, WET RUNWAY	(ft)	4300	4200	MET
ASSOCIATED APPROACH SPEED		(kts)	-	115	-
INITIAL CRUISE ALTITUDE	500 ft/MIN, M=0.7	(ft)	-	36000	-
1-ENGINE-INOP CEILING	ISA+10°C	(ft)	16000	16500	MET
MAX. CRUISE MACH NUMBER	(35000 ft)		0.75	0.76	MET
MISSION KUNMING - CHENGDU				see Fig. 3.2	MET

Fig. 4.11: PAYLOAD-RANGE



5. ALTERNATIVE CONFIGURATION WITH PW-ALLISON 501-M80E ENGINE

A study was made on the PW-Allison engine as an alternative to the basic GE38 UDF. For matching the Baseline Aircraft configuration to the PW-Allison engine, the philosophy was to keep the wing position constant relative to the aft pressure bulkhead, and to balance the high engine weight by inserting a fuselage section in front of the wing and to match the tail size accordingly, see Fig. 5.1 and 5.2.

Compared to the Baseline Aircraft there is a larger passenger and cargo capacity, and the weights in general are higher. On the field performance side there is some benefit on take-off, due to engine thrust but there is some penalty on landing due to higher wing loading. In terms of block fuel there is some increase in trip fuel, but the specific fuel burn is lower due to the higher passenger capacity.

It must be noted that the study is still at a very preliminary stage. Also, the engine configuration used is outdated meanwhile according to the manufacturers' information, and no new information is available so far. However, the main problem is clear: Using the PW-Allison 501-M80E engine would shift the initial capacity to above 90 seats, which is not in line with the present requirement for about 75 seats. On the other hand, the engine does not offer a practical solution for a later stretched version as major components in the rear end of the aircraft would have to be completely redesigned (rear cone, pylons, empennage).

In summary, the PW-Allison as it stands now, does not offer a good alternative solution.

Fig. 5.1: ALTERNATIVE CONFIGURATION

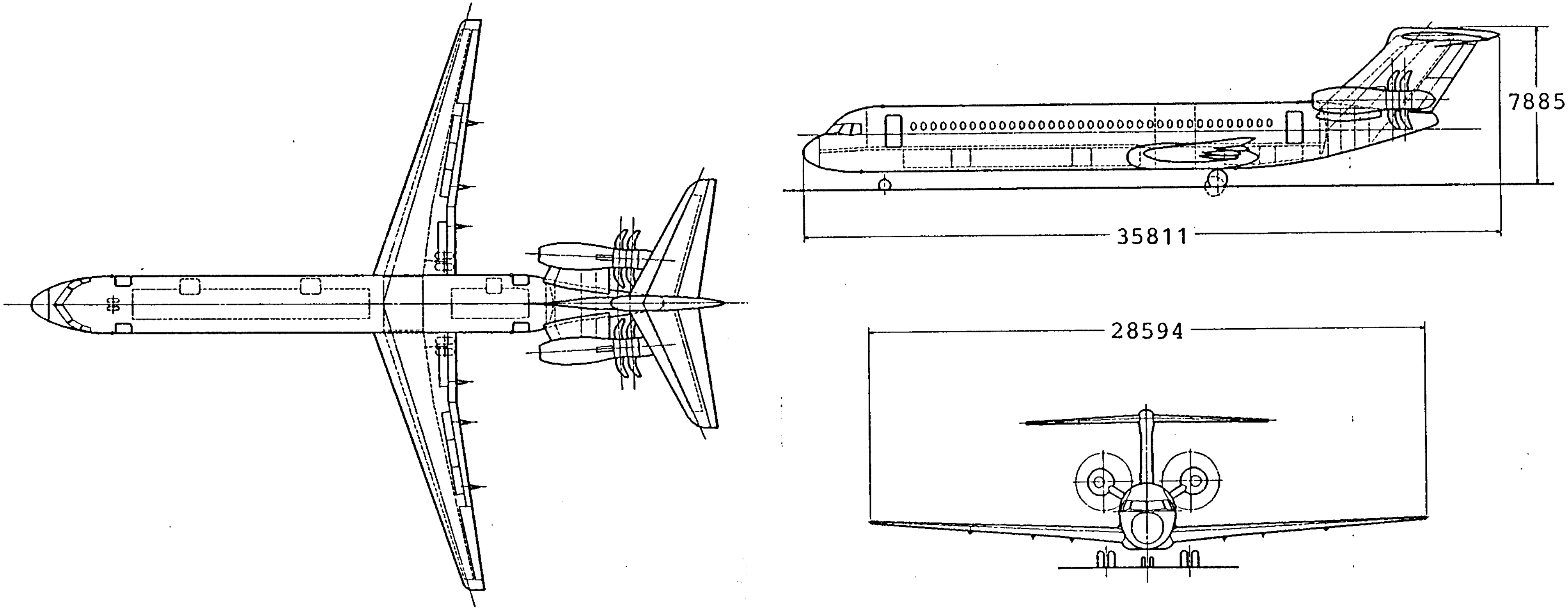


Fig. 5.2: MAIN DATA

		MPC 75 BASELINE	STUDY ALTERNATIVE
SEATING CAPACITY 32", ALL-Y		76	92
SPAN	(m)	28.59	28.59
LENGTH, OVERALL	(m)	32.05	35.82
WING AREA	(m^2)	75.00	75.00
WING ASPECT RATIO		10.90	10.90
ENGINE TYPE		UDF GE 38-B5	ALLISON 501-M80E
NUMBER OF ENGINES		2	2
T.O.-THRUST SL. S. INST.	(lbs)	9620	14500
MAX. T.O. WEIGHT	(kg)	30000	34700
MANUF. WEIGHT EMPTY	(kg)	17293	19800
OPERAT. WEIGHT EMPTY	(kg)	18825	21600
MAX. PAYLOAD	(kg)	8500	
BLOCKFUEL, 1000 nm, MACH 0.75	(kg)	2460	2625
SPECIFIC FUEL BURN	(kg/pass./nm)	0.0324	0.0285

6. ADVANCED TECHNOLOGIES

6.1 General

During the first part of the feasibility study phase a number of over 50 technology items have been considered as possible candidates for MPC 75. These technologies have been discussed with respect to:

- Status of Research and Development work
- Benefits and Penalties
- Configuration impact

For a number of technologies there were two or more alternative solutions.

The next step was the preliminary selection of feasible technologies or optimum technology alternatives for the Baseline Aircraft.

The technology items finally selected must meet a number of criteria. To mention only the most important ones, they must

- comply with airworthiness requirements
- be economically feasible
- meet the airline's requirements
- be ready according to MPC 75 programme planning
- meet the challenge of competition aircraft

ADVANCED TECHNOLOGIES

To show the economic feasibility of technologies, detailed trade-off studies based on suitable data input must be performed. These trade-off studies are under way and first results will be available in the second half of 1987. But these optimization procedures will go on during the pre-development phase up to the GO AHEAD in 1990.

Up to now a presentation of the MPC 75 has been made to only a very limited number of airlines. From these meetings no requirements were made known which would help in the selection of technologies. Only one general statement is known from the market group: "MPC 75 is an airplane for main line operators", i.e. for airlines which are qualified to operate and maintain aircraft of advanced technical status.

Most technologies are already available or under development at MBB or CATIC and will be available in the time frame of the MPC 75 programme plan. But for a limited number of technologies already existing technology development programmes must be slightly modified to fit in with the MPC 75 goals and time planning. For some technologies detailed development programmes must be established and put into operation by the management.

To meet the challenge of future competition aircraft the MBB/CATIC experts will have to monitor and evaluate the technological developments of potential competitor aircraft manufacturers. This may provide further guidance in selecting advanced technologies.

For new technologies, airworthiness criteria often are not known at the beginning, but certification rules will be developed in parallel with and strongly influencing the technical solution.

From the above remarks it is evident that the first selection of technologies is based on preliminary information only and may have to be changed during the pre-development phase.

6.2 Airframe Technologies

The technology items preliminary selected for the Baseline Aircraft are:

Advanced Aerodynamics:

- Natural Laminar Flow
- Variable Camber to support NLF

There is mutual agreement between the partner companies that natural laminar flow can be assumed for the Baseline Aircraft as there is confidence that research programmes under way can be made to meet the MPC 75 needs, particularly as the MPC 75 design parameters are less demanding.

The surface smoothness requirements associated with natural laminar flow are very high but, again, there is confidence that the targets can be met.

Advanced Structures and Materials:

- Composite Wing Structure
- Composite horizontal and vertical stabilizer
- Aluminium-Lithium fuselage

Indications are that a composite wing is feasible. Material properties are not expected to pose any problems. Also, some of the more critical problems like surface quality and lightning protection can be solved as has been concluded from several design studies and specific research work.

With regard to advanced metallic materials, again, it is expected that they will be available in time, ready to be used, e.g. on the fuselage.

6.3 Systems

The systems selected for the Baseline Aircraft include the following features which are not standard on contemporary regional airliners:

- Environmental Control System: Main engine shaft-driven compressor with vapour cycle packs
- Electric Power System: Using an advanced power distribution management system
- Flight Controls: Fly-by-Wire system with mechanical back-up
- Ice and Rain Protection, Cleaning: Combined liquid anti-ice and insect-contamination protection system
- Cockpit: 2-man cockpit based on Fly-by-Wire similar to A320 philosophy
- Centralized Maintenance and Monitoring System: Similar to A320 philosophy with some improvements
- Data Bus: ARINC 429. Depending on hardware availability/maturity, and data rate necessities: ARINC 629, if useful in mixed version with ARINC 429.
- Cabin Intercommunication Data System: Provision for the installation of CIDS according to the airlines' requirements

Of the systems listed above none requires the development of a completely new technology. However, technical solutions must be adapted to the specific MPC 75 design features, such as the Ultra-High-Bypass-Ratio engines used or the Natural Laminar Flow wing.

7. ENGINE CHOICE

7.1 General

The desire for lower fuel consumption has led to the development of "propfan" or "ultra high bypass" engines. The development and the test results of these engines over the last years prove the viability of the technology. These engines appear to offer a suitable means of propulsion for the MPC 75.

The MPC 75 Baseline Aircraft needs approximately 10000 lb take-off thrust. Two open rotor counter-rotating propfan engines are currently offered for the MPC 75:

- GE38 Boosted UDF (9600 lb), an ungeared propfan
- PW-Allison 501-M80E (14800 lb), a geared propfan

Close contact has been maintained with both GE and PW-Allison during the Feasibility Study.

Ducted, geared ultra high bypass engines could also be used in principle. However, their availability within the time frame must be doubted. Engines of the right thrust class have not even been considered by the manufacturers.

There is no modern conventional high-bypass engine available which would suit the MPC 75, and no plan to develop such engine is known.

7.2 GE38 UDF

The GE38 UDF uses open rotor, gearless, counter-rotating fans in combination with the boosted core of the GE27. This core has already run more than 500 hours on a test stand and is to become the nucleus of a whole new family of GE engines.

The GE38 Boosted UDF performance is of adequate level for the MPC 75 Baseline Aircraft requirements. Versions with higher thrust ratings will not be available from the very beginning, but will need some development time. A mid-term thrust growth of some 15 % will be possible without change of engine geometry. A longterm thrust growth capability of up to 30 % was quoted by the manufacturer.

Although a geared propfan should be theoretically better in SFC than an ungeared, the ungeared GE38 UDF has nearly the same specific fuel consumption as the geared PW-Allison 501-M80E, which has the disadvantage of using an old-technology core. Furthermore, the GE38 is lighter in weight and smaller in dimensions.

7.3 PW-Allison 501-M80E

PW-Allison offer an open rotor geared counter-rotating propfan engine, the PW-Allison 501-M80E. Its core goes back to the well-proven T56/501, but is to be derived directly from the 501-M80C version, which was selected in late 1985 by the US Navy to power the OSPREY Tilt Rotor Aircraft. The rotor will come from Hamilton Standard, who have worked for many years in the field of propellers and propfans.

A demonstrator engine PW-Allison 578-DX is planned to fly on a MD80 in late 1987. However, up to April 1987 the final configuration of the PW-Allison engine was not fixed (warm prop - cold prop configuration).

The PW-Allison 501-M80E actually is somewhat too big for MPC 75; it would better suit a 90 - 110-seater aircraft, for which it is basically intended.

7.4 Engine Development Status

Of the two engines currently considered for the MPC 75, the GE38 is the prime candidate. The development status and future availability of the GE38 hence is of very big importance for the MPC 75 project as it stands today.

Engine manufacturers have concentrated their efforts during the last years on engines for the 150 seater aircraft class, which offers a very large market and has led to competing airframe developments and projects respectively (A320, 7J7, MD91/92).

Engines for smaller aircraft will follow the principle chosen for the 150 seater. Specifically, GE plans to transfer the propulsor technology it is now developing for the GE36 UDF (the GE entry into the 150-seater engine class) to the GE38, utilizing the existing GE27 core as a basis to reduce development cost.

General Electric and PW-Allison have been active in developing their specific open-rotor engine technology during the last years. General Electric has gained a lead: After successfull lab tests in 1985/early 1986, a demonstrator engine was flown on a Boeing 727 from August 86 to February 87. Results prompted Boeing in April 1987 into selecting the GE 36 UDF as the prime engine to offer on the 7J7 project. After further detail improvement, the demonstrator engine flew again on May 18, 1987 on an MD80. Hence, it appears to be a realistic claim that the GE36 can be developed in time for the 7J7 to enter flight tests in 1991. (The same sort of timing is envisaged for the MD91/92). If these plans are followed through, the UDF propulsor technology will be developed far enough to enter a GE38 development programme in 1990, as required for MPC 75 programme starting.

Whether GE in fact will commit itself to the development of the GE38, will depend to a high degree on the credibility and market interest the MPC 75 project can create in the next years, and the general development of the market of this class of aircraft.

In short, the actual availability of the GE38 is not yet ensured: however, developments during the last years have greatly enhanced the prospects.

8. COMPETITION

In order to establish another yardstick against which to compare the Baseline Aircraft, some competitors have been analysed. A general survey is given in the figure 8.1.

Of the competing aircraft considered, only the BAe-146-100 and the F28 MK4000 are really in the same class as MPC 75; of these two types the F28-4000 is no longer in production. The ATR 72 is a smaller aircraft using turboprop engines. It is offered with a range of 1500 nm: however, this aircraft is not really suited for such ranges because of its low flight altitude (hence poor ride comfort) and low cruise speed. On the other hand, the F100 is a much bigger aircraft than MPC 75.

For the comparison, all aircraft considered were brought to the same standards as best as was possible on the basis of the information available. Thus, genuine comparability was ensured with respect to the most relevant parameters like seat pitch and hence number of passengers, cabin layout, specific cargo volume, weights and mission data such as speeds, altitude, reserves etc.

Attention is drawn to the data on seat width/aisle width. The MPC 75 clearly provides a better standard than all competing aircraft.

The MPC 75 offers good range, high speed (BAe-146 often is criticized for being too slow!) and high cruise altitude. The field performance corresponds to current standards, with only the 4-engines BAe-146 offering significant advantages in this one respect. Finally, the MPC 75 combines good comfort and performance with good economics, as can be seen from Chapter 9.

Fig. 8.1: SUMMARY OF DATA

		MPC 75	ATR 72	BAe146 -100	F28 MK4000	F100
WEIGHTS						
MAX. TAKE-OFF WEIGHT	(kg)	30000	21500	37308	33112	41505
MANUFACTURER'S WEIGHT EMPTY	(kg)	17293	11040	19300	15850	21000
OPERATING WEIGHT EMPTY 1)	(kg)	18825	12303	20879	17374	23125
MAX. PAYLOAD	(kg)	8500	7097	9058	10749	11575
GEOMETRY						
OVERALL LENGTH	(m)	32.05	27.17	26.16	29.61	35.53
SPAN	(m)	28.59	27.05	26.34	25.07	28.08
WING AREA	(m^2)	75.0	61.0	77.3	79.0	94.7
WING ASPECT RATIO		10.9	12.0	9.0	7.96	8.33

1) ADJUSTED FOR COMPARABLE CABIN STANDARD

Fig. 8.1: SUMMARY OF DATA (cont.)

		MPC 75	ATR 72	BAe 146 -100	F28 MK4000	F100
CABIN/HOLD						
SEATS, 32" STAND. [1]		76	60	76	74	107
SEATS ABREAST		4	4	6	5	5
SEAT WIDTH AISLE WIDTH, NOM.	(in)	42-19-42	40-18-40	57.5-16 -57.5	59.2-17 -40.3	59.2-17 -40.3
FREIGHT HOLD VOLUME PER PASSENGER	(m^3)	0.206	0.20 [2]	0.187	0.182	0.164
ENGINE						
TYPE		UHB	TURBOPROP	TURBOPROP	TURBOPROP	TURBOPROPF
DESIGNATION		GE38B5 UDF	PW 124	ALF502 -R3	RR SPEY	RR TAY
NUMBER		2	2	4	2	2
POWER, SL, ST		9620 lb	2400 shp	6700 lb	9850 lb	13320 lb

[1] ADJUSTED FOR COMPARABLE CABIN STANDARD

[2] ADJUSTED FOR COMPARABLE BAGGAGE VOLUME ON MAIN DECK

Fig. 8.1: SUMMARY OF DATA (cont.)

		MPC 75	ATR 72	BAe 146 -100	F28 MK4000	F100
PERFORMANCE						
RANGE WITH FUEL PASS. 1)	(nm)	1550	1550	1350	1250	1305
WITH MAX. FUEL 1)	(nm)	2620	2290	1350	1492	1690
TAKE-OFF FIELD LENGTH SL, ISA, MTOW	(ft)	5100	5000	4000	5230	5900
CRUISE SPEED 2)	(Mach No)	0.7	0.43 3)	0.63	0.7	0.7
CRUISE ALTITUDE 2)	(ft)	37000	25000	30000	35000	35000

1) RESERVES: 150 NM ALTERNATE, 45 min HOLD

2) TYPICAL, USED FOR ANALYSIS OF BLOCKFUEL AND DOC

3) MAX. POSSIBLE

9. ECONOMICS

The MPC 75, with GE 38 B5-UDF engines and other advanced technology features incorporated, offers advanced economics:

- The MPC 75 combines the advantages of jet speed (like F-28, F-100) with the fuel economy of propeller aircraft (like ATR-72). See Fig.: 9.1; 9.2; 9.3

- The MPC 75 has lower direct operating cost (DOC) than that of competitor aircraft with the same level of passenger seating.

DOC has been calculated using the agreed CATIC/MBB method. Basic input data and assumptions are given in Fig. 9.4. Results are shown in Fig. 9.5, 9.6 for 500 nm and 1000 nm cases. It can be seen that the DOC per seatmile of MPC 75 is

18 % better than that of the BAe-146

7 % better than that of the F-28, and

5 % better than that of the ATR-72 at 500 nm, with the DOC advantage increasing even more for the longer stage lengths. MPC 75 also meets the design target of seatmile cost at least equal to F100 with 100 passengers.

- If economic conditions, such as fuel prices, utilization, interest rates, labour cost or aircraft price are changed, the DOC of the MPC 75 is still relatively better than the competitor aircraft, see Fig. 9.7.

Fig. 9.1: BLOCKFUEL, BLOCKTIME

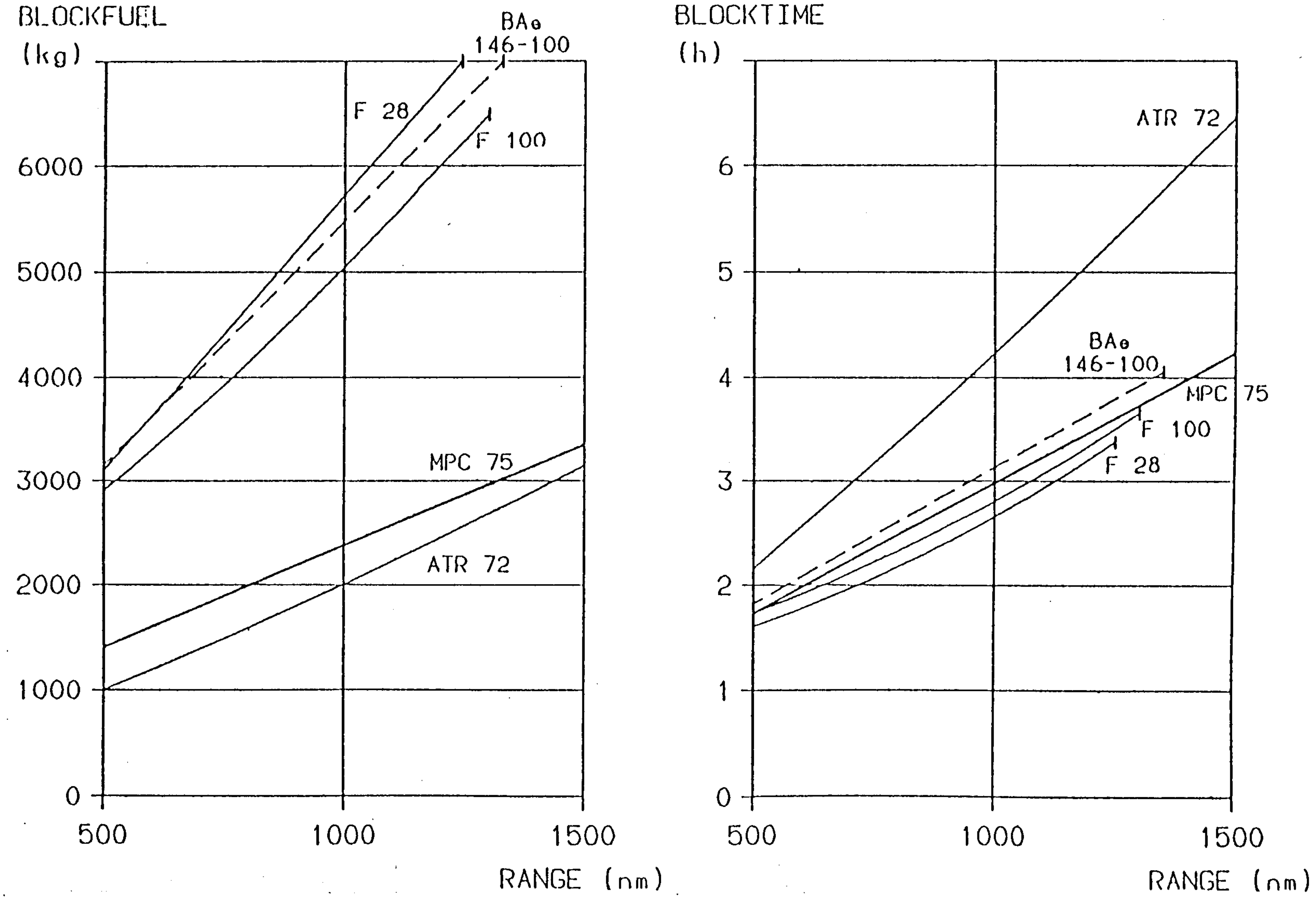


Fig. 9.2: FUEL ECONOMY 500 nm

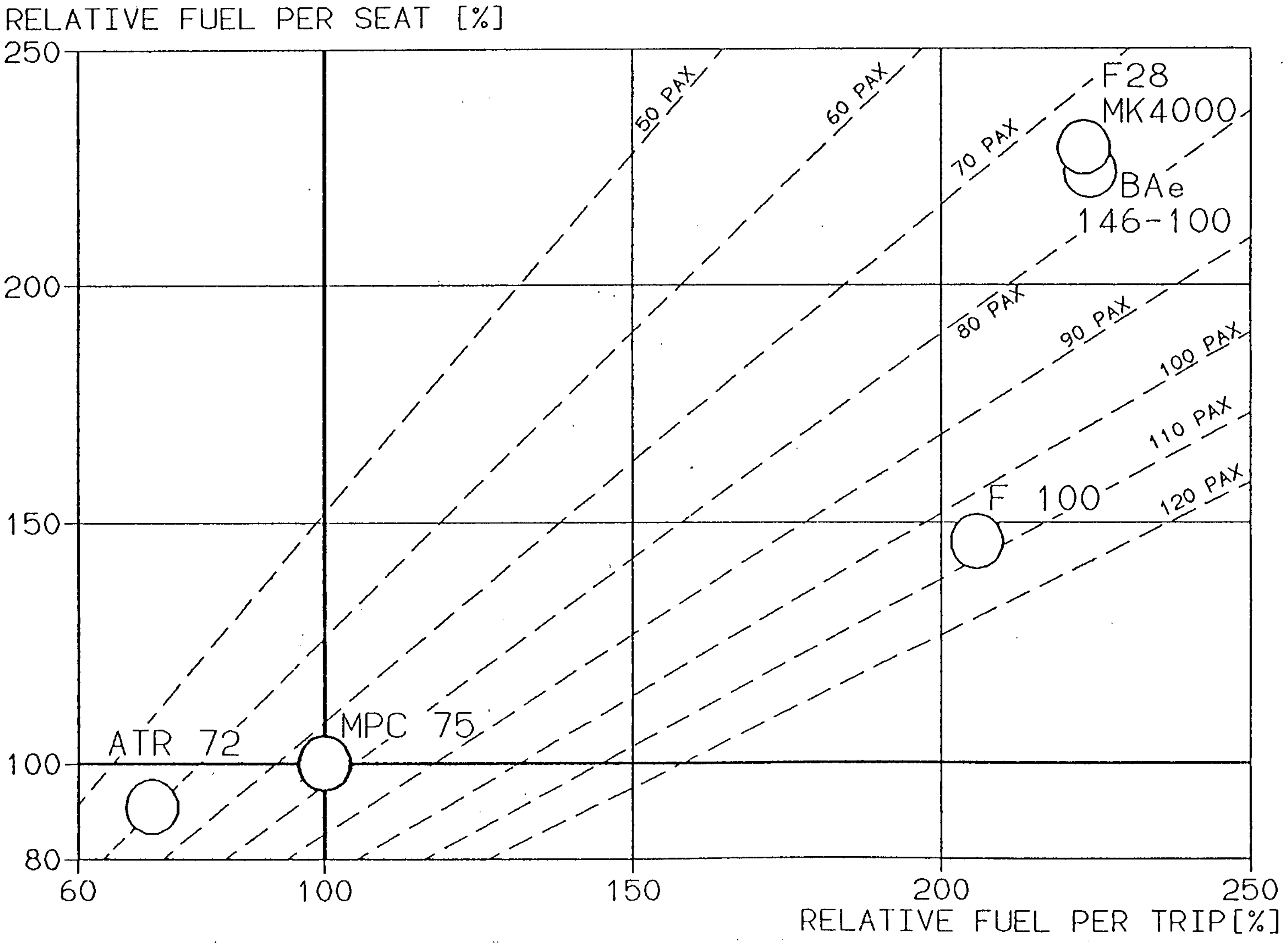


Fig. 9.3: FUEL ECONOMY 1000 nm

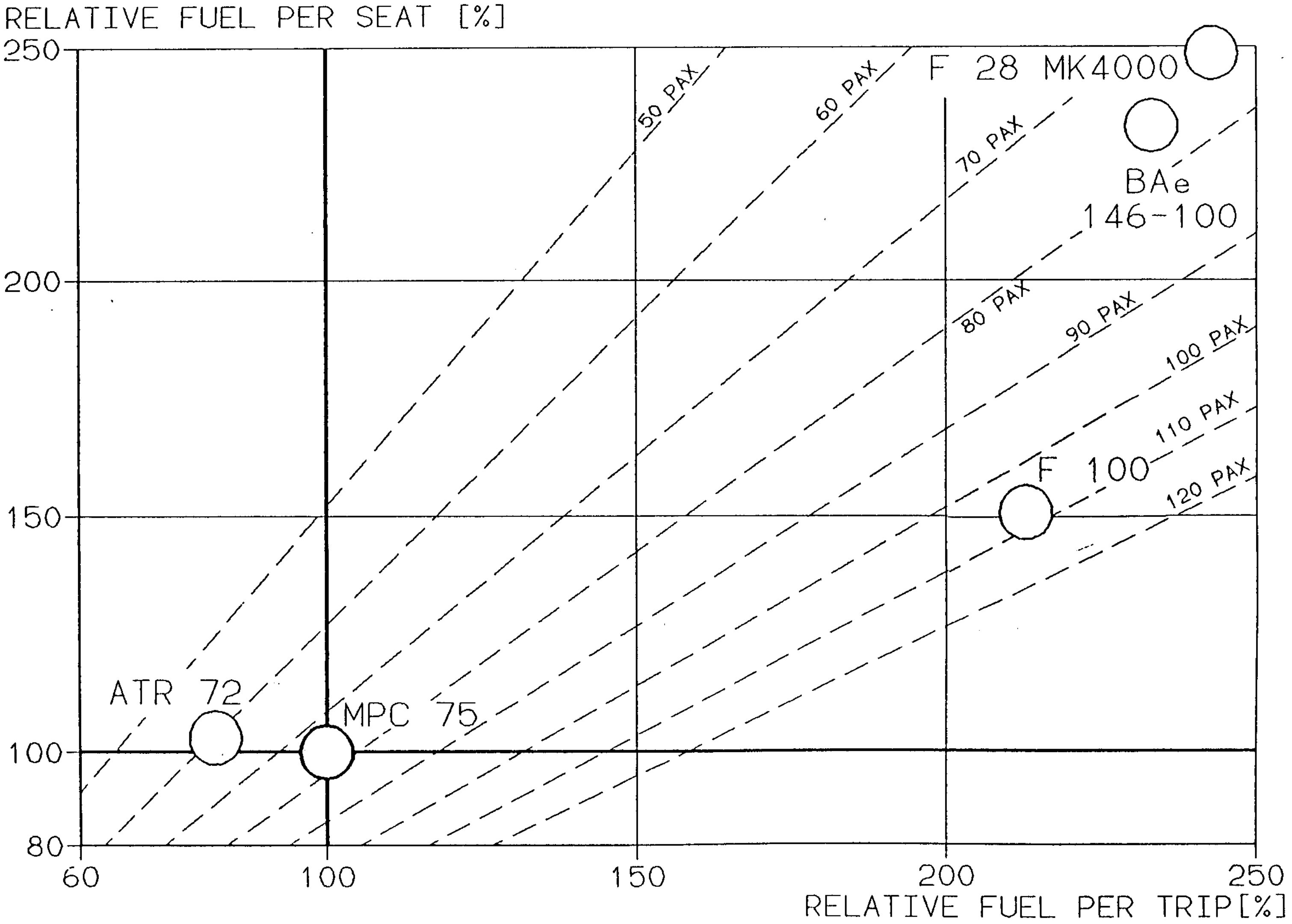


Fig. 9.4 : BASIC ASSUMPTIONS FOR DOC ANALYSIS

General

Depreciation - over 15 years down to 10 % residual value

Interest - mean level of 6 % per annum

Insurance - 5 % of aircraft price

Fuel price - 1 $ per US gallon

Annual Utilization - 2000 hours basis

Aircraft	MPC 75	ATR 72	BAe146-100	F28-4000	F100
Aircraft Price	$14.0m	$8.6m	$14.8m	$13.5m	$19.0m
Engine Price per engine	$ 2.0m	$0.75m	$ 1.2m	$ 1.07m	$ 1.8m

Fig. 9.5: DIRECT OPERATING COST 500 nm

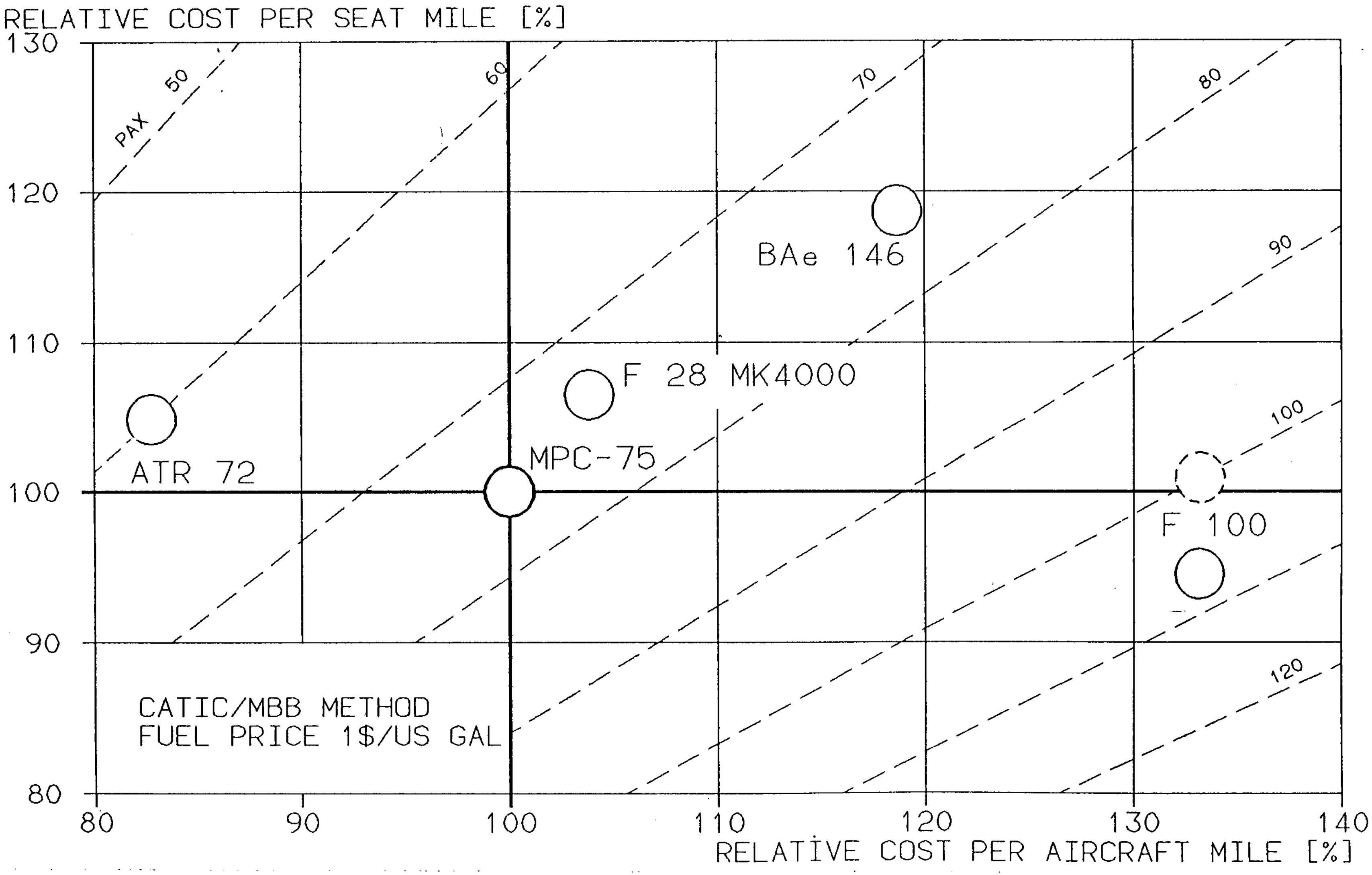


Fig. 9.6: DIRECT OPERATING COST 1000 nm

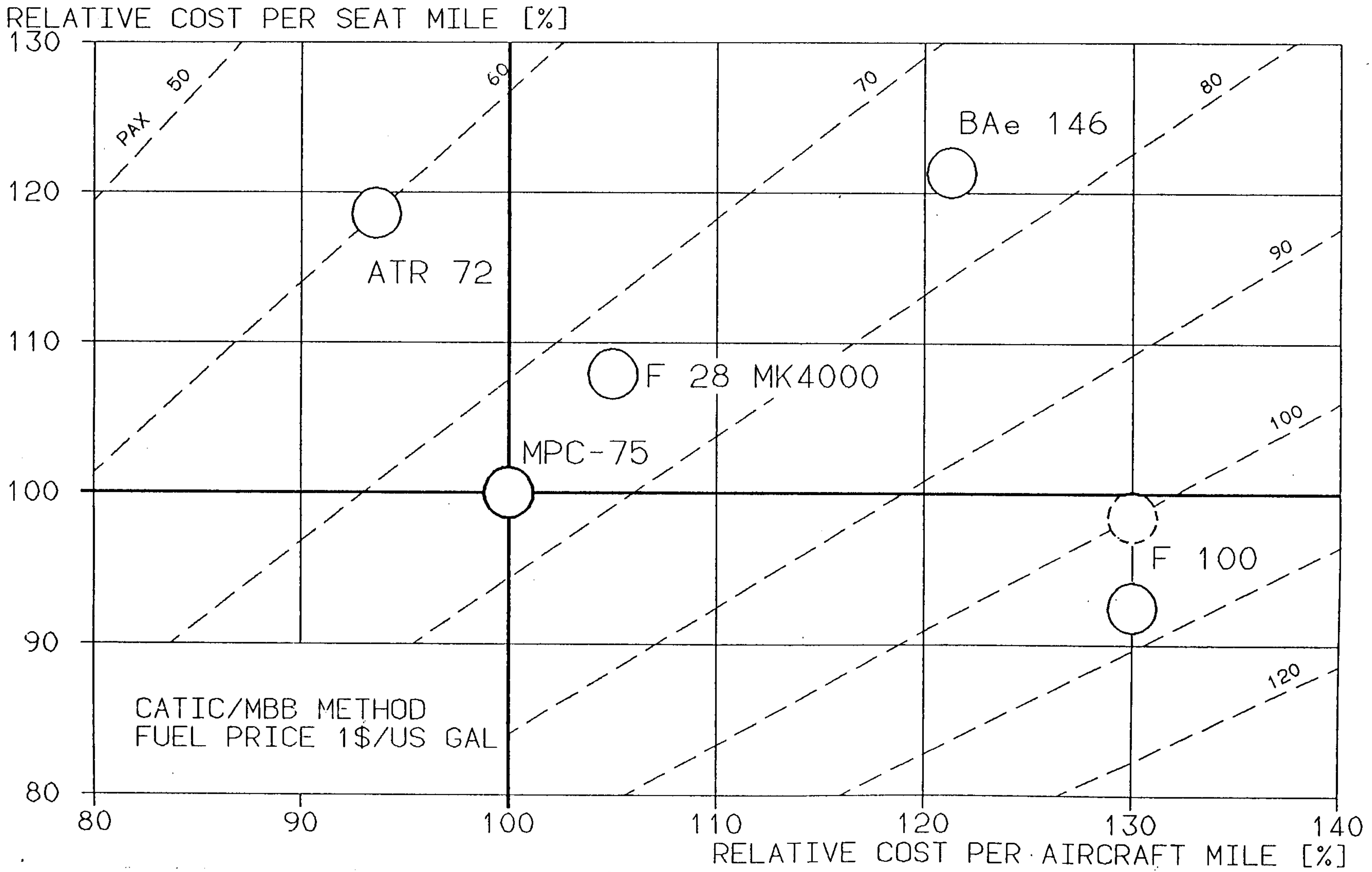


Fig. 9.7: DIRECT OPERATING COST SENSITIVITY

MPC 75 SEAT MILE COST ADVANTAGE RELATIVE TO:	ATR 72		BAe 146-100	
	500 NM	1000 NM	500 NM	1000 NM
WITH BASIC ASSUMPTIONS	4.8 %	18.6 %	18.6 %	21.3 %
IF FUEL PRICES				
DECREASE FROM $ 1.00 TO $ 0.50	5.5	19.2	13.4	15.1
INCREASE FROM $ 1.00 TO $ 2.00	3.7	17.5	27.8	31.9
IF UTILIZATION GOES				
UP FROM 2000 TO 3000 hrs	7.2	21.3	20.1	23.1
DOWN FROM 2000 TO 1000 hrs	0.5	13.9	16.0	18.1
IF INTEREST RATES				
DECREASE FROM 6% TO 0%	8.7	22.7	21.0	24.1
INCREASE FROM 6% TO 12%	2.4	15.9	17.2	19.5
IF LABOUR COST GOES				
DOWN FROM $ 40 TO $ 20	4.5	18.3	19.6	22.3
UP FROM $ 40 TO $ 60	5.2	18.9	17.9	20.4
IF A/C PRICE GOES				
DOWN BY 20%	6.0	20.0	19.6	22.5
UP BY 20%	3.7	17.5	17.8	20.4

10. CONCLUSIONS

General

Working on MPC 75 configuration development in the Feasibility Study Phase, engineers from MBB and CATIC have cooperated effectively, despite the large distance and partially inadequate communication lines. The way of working proved to be adequate for the Feasibility Study Phase, but a more intensive and more integrated way of working together will become necessary when the programme progresses into the Pre-Development Phase.

Requirements

Market needs as seen today lead to realistic and feasible technical requirements. The performance level specified is in general similar to current aircraft, while improvements are required with regard to design range, cabin comfort level and - of course - economics. More information from potential customers is required to establish a practical and definitive set of design requirements.

Advanced Technologies

Various new technologies not yet utilized in current regional aircraft are either state-of the-art today, or there is well-founded confidence that such technologies can be realized within the time frame of the MPC 75. It is expected that such technologies will significantly contribute to the competitivity of MPC 75. A preliminary selection of advanced technologies and systems has been made after checking their technical status. However, further analysis and research work is required for the final selection in view of the stringent criteria for MPC 75.

Engine Choice

The GE38 UDF appears to be the best choice for the propulsion of MPC 75, as it is in the right thrust class for the Baseline Aircraft and offers advantages in terms of weight and dimensions relative to the higher-thrust PW-Allison 501-M80E propfan engine.

CONCLUSIONS

The time schedule for the GE38 UDF roughly matches the development programme of MPC 75. The actual availability of the engine is not yet ensured; however, events during the last years have greatly enhanced the prospect.

Baseline Configuration

A baseline configuration was defined which meets the design requirements. It will not be the final solution, but is only the starting point for further refinement and optimization. Performance analysis and comparison of current regional aircraft show that the MPC 75 Baseline Configuration is very competitive in terms of speed, cruise altitude, comfort, and fuel consumption. In fact, it combines the speed of a jet aircraft with the fuel saving characteristics of a propeller aircraft.

MPC 75 offers distinct Direct Operating Cost advantages relative to known competitors. Sensitivity analysis shows that this advantage is maintained even under widely varying economic conditions.

A first study shows that there is a stretch capability up to approx. 100 seats, but only as a long-term development consistent with the future thrust growth capability of the GE38 UDF.

Need for further Activities

Confirmation or modification of the requirements through direct contact with potential customers is urgently required. There is the need for continuing refinement and optimization of the Baseline Configuration, for trade-offs, and analysis of alternative solutions. The analysis and research work related to advanced technologies and systems must go on. The dialogue with the engine manufacturers must be kept up and even be intensified, as engine availability largely depends upon the credibility of the MPC 75 project.

CONCLUSIONS

Recommendation

It is suggested that the joint engineering activities of CATIC and MBB are continued, to lead over into the Pre-development Phase without slow-down or interruption.

LIST OF APPENDICES EXCEPT B1-4.1 IN SEPARATE VOLUME

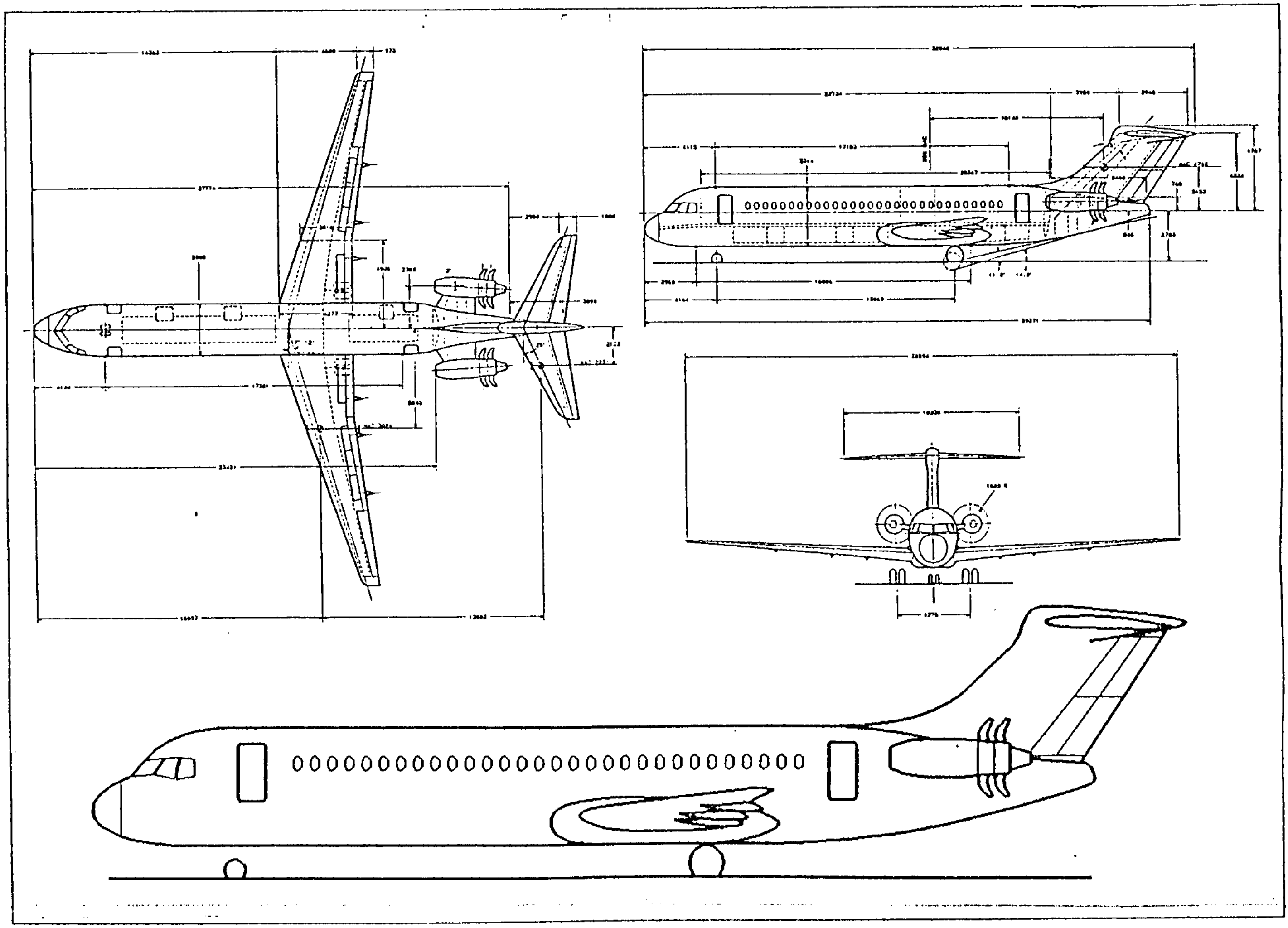
APPENDIX: B1-4.1

SUBJECT : TECHNICAL DESCRIPTION
(BASELINE AIRCRAFT)

GROUP : B1 "PROJECT DEFINITION"

MPC 75 Technical Description

MBB CATIC Association



CONTENTS

1.0 INTRODUCTION

The MPC 75 is designed as an advanced Regional aircraft to carry 76 passengers at 32 inch pitch over a design range of 1500 nm, flying at a cruise speed of M=0.7 to M=0.75, at an initial cruise altitude of not less than 35000 ft. and achieving seat mile costs better than any other aircraft in its category. e.g. BAe 146, F28-4000, ATR 72, etc.

Prime objectives that have been considered in the design are:-

Safety
Reliability
Environmental Compatibility
Flexibility
Passenger Appeal
Structural Simplicity
Advanced Technology Concepts
Low Fuel Consumption
Economical Operation
Stretch Capability

Detailed requirements and objectives are given in a separate note.

The MPC 75 is a low wing aircraft with T-tail and two rear-mounted ultra by-pass engines. The engine currently being studied in the baseline configuration is the GE 38 B5 UDF.(Other types of ultra by-pass engines are under study)

The overall configuration is consistent with the intention to utilize advanced technologies in aerodynamics, structures, materials, systems and propulsion for improved safety, operational capabilities and superior economics.

This document summarizes the characteristics of the MPC 75, the regional passenger transport aircraft currently under study by MBB and CATIC. The aircraft described is the MPC 75 "Baseline Configuration" (MPC 75-001-B), a 76-seater aircraft powered by two General Electric GE 38 B5 Unducted Fan engines.

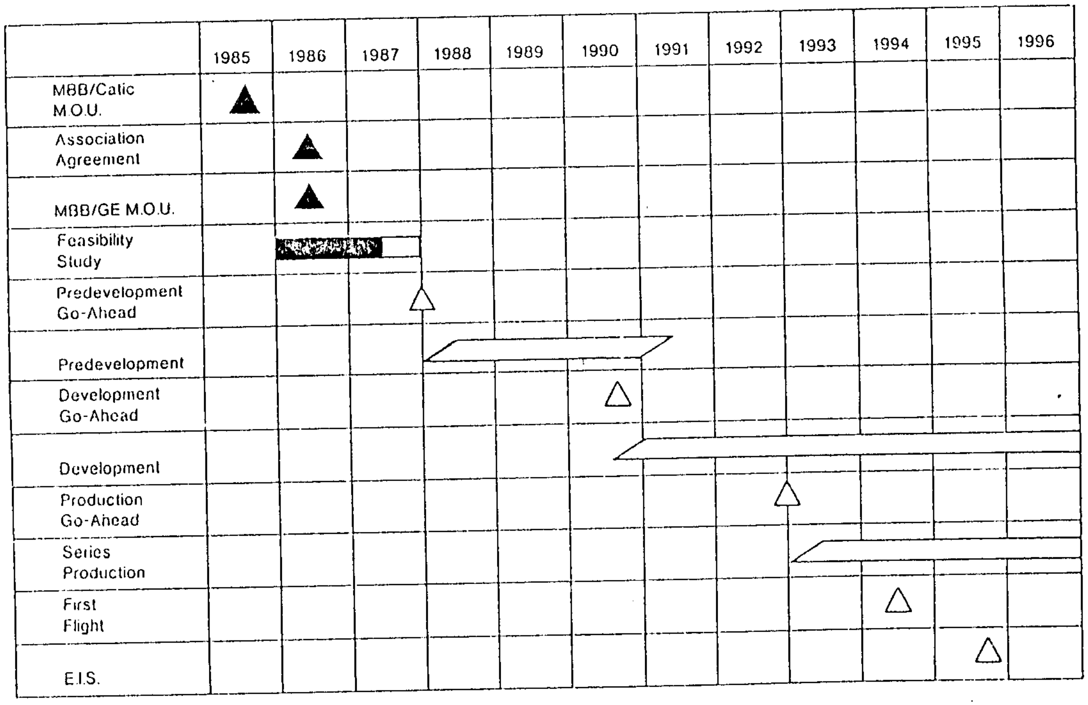
The MPC 75 configuration has not yet been finalised and the baseline configuration described in this document represents the current state of configuration development. It will be subject to modification as a consequence of a continuing process of technical refinement or changes in the requirements of potential customers. The baseline configuration as described is representative of the typical level of performance and economics of such a type of aircraft, as seen today. It will be used as a point of reference for trade-offs and optimisation studies, and thus will be the basis for further improvement.

The aircraft will be designed in compliance with the FAR Airworthiness Requirements and FAR36 Stage 3 noise level requirements.

2.0 DEVELOPMENT SCHEDULE

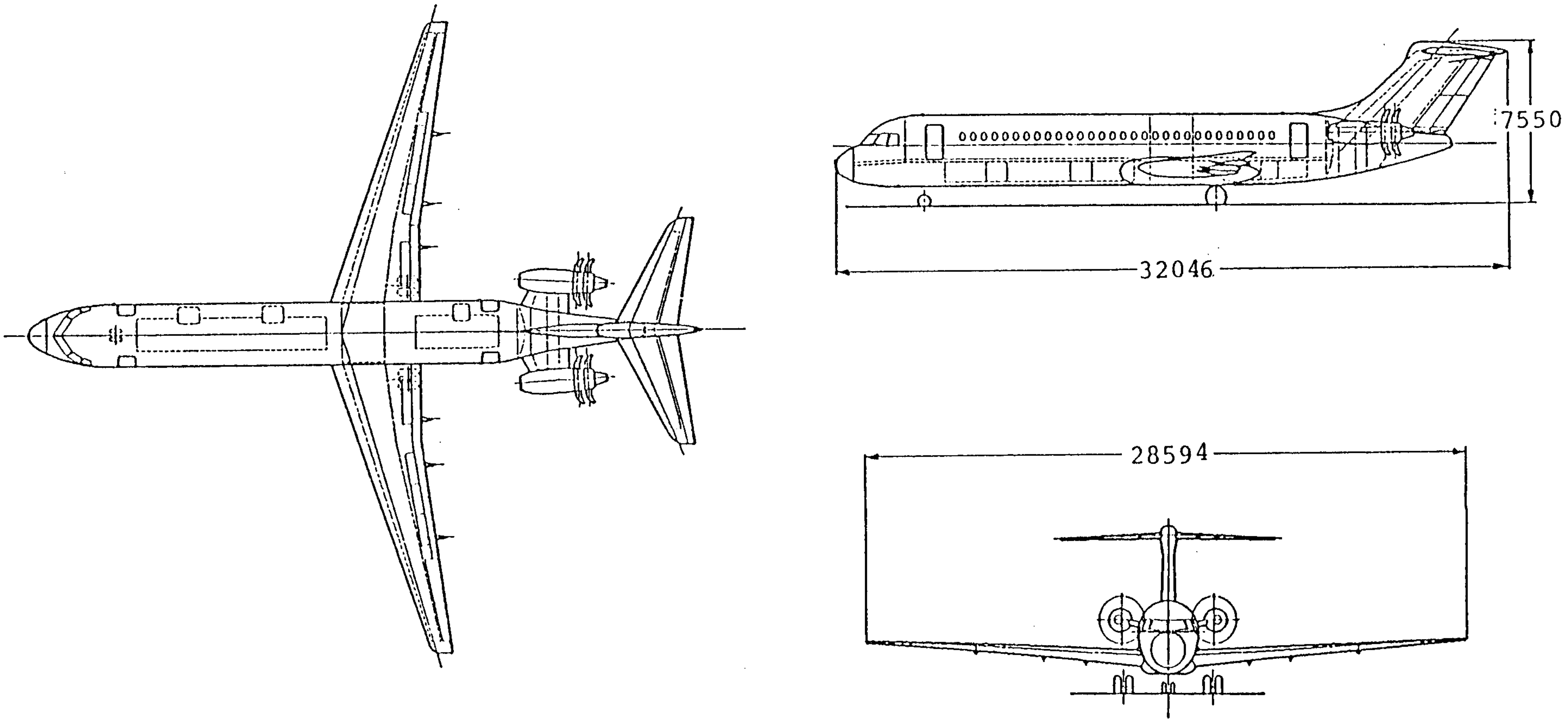
The diagram shows the planned Milestones for the MPC 75 up to entry into service in 1995. The filled-out triangles/bars indicate achieved data.

Timescale and Milestones



3.0 LEADING PARTICULARS

3.1 GENERAL ARRANGEMENT



3.2 DIMENSIONS

3.2.1 Main Data

Seating Capacity (All Economy at 32" pitch)	76
Span	28.594 m
Overall Length	32.046 m
Overall Height	7.550 m
Wheel track	4.276 m
Wheel base	13.869 m

3.2.2 Wing

Wing area	75 sq.m.
Sweep angle	17 deg.12 min.
Thickness/Chord ratio at root	15 %
Thickness/Chord ratio at tip	11 %
Thickness/Chord ratio at kink	12 %
Mean aerodynamic chord	3.024 m
Aspect ratio	10.9
Length of root chord	4.277 m
Length of tip chord	0.973 m
Taper ratio	0.228

3.2.3 Fuselage

Fuselage length	29.371 m
Fuselage width	2.880 m
Cabin length	20.367 m
Maximum pressure differential	8.0 psi

3.2.4 Tailplane

Area	21.0 sq.m
Span	10.23 m
Length of root chord	3.098 m
Length of tip chord	1.008 m
Sweep angle (at quarter chord)	25 deg.
Distance from centreline of fuselage to tailplane	4.334 m
Taper ratio	0.325
Thickness/chord ratio	10 %

3.2.5 Vertical Fin

Area	16.8 sq.m
Height	3.569 m
Length of root chord	5.468 m
Length of tip chord	3.945 m
Sweep angle (at quarter chord)	45 deg.
Taper ratio	0.721
Thickness/chord ratio	12 %

3.2.6 Nacelle

Horizontal distance from C/L of fuselage to C/L of nacelle	2.358 m
Vertical distance from C/L of fuselage to C/L of nacelle	0.546 m
Length of nacelle	138.3 in.
Diameter of nacelle	42.0 in.

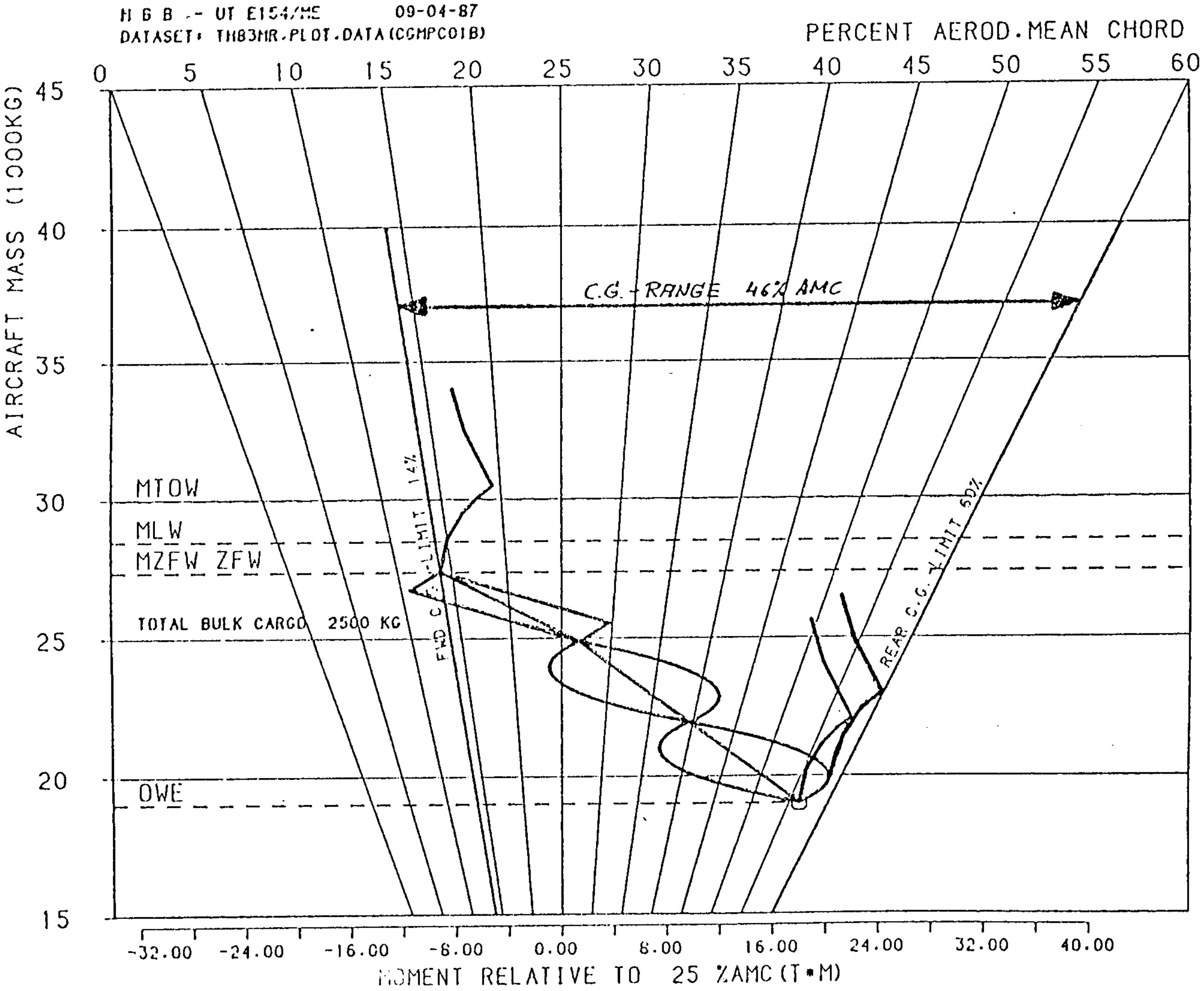
3.2.7 Cargo Compartment

Width	1.506 m
Height	0.9 m
Length (Forward)	9.0 m
Length (Rear)	4.0 m
Volume (Forward)	10.6 cu.m
Volume (Rear)	4.6 cu.m
Total Volume	15.2 cu.m

3.3 WEIGHTS SUMMARY

Ramp Weight	30200 kg.
Max. T.O.W.	30000 kg.
Max. Landing Weight	28500 kg.
Max. ZFW	27325 kg.
MWE	17293 kg.
OWE	18825 kg.
Max. Payload	8500 kg.
Max. Fuel capacity	6150 kg.

3.4 C.G. DIAGRAM



3.5 DESIGN SPEEDS

VS1	- kts.
VA	196 kts.
VB	210 kts.
VC	320 kts.
MC	0.76 Mach
VD	380 kts.*
MD	0.83 Mach
VF	- kts.
VNO	- kts.
VMO	350 kts.
MMO	0.82 Mach

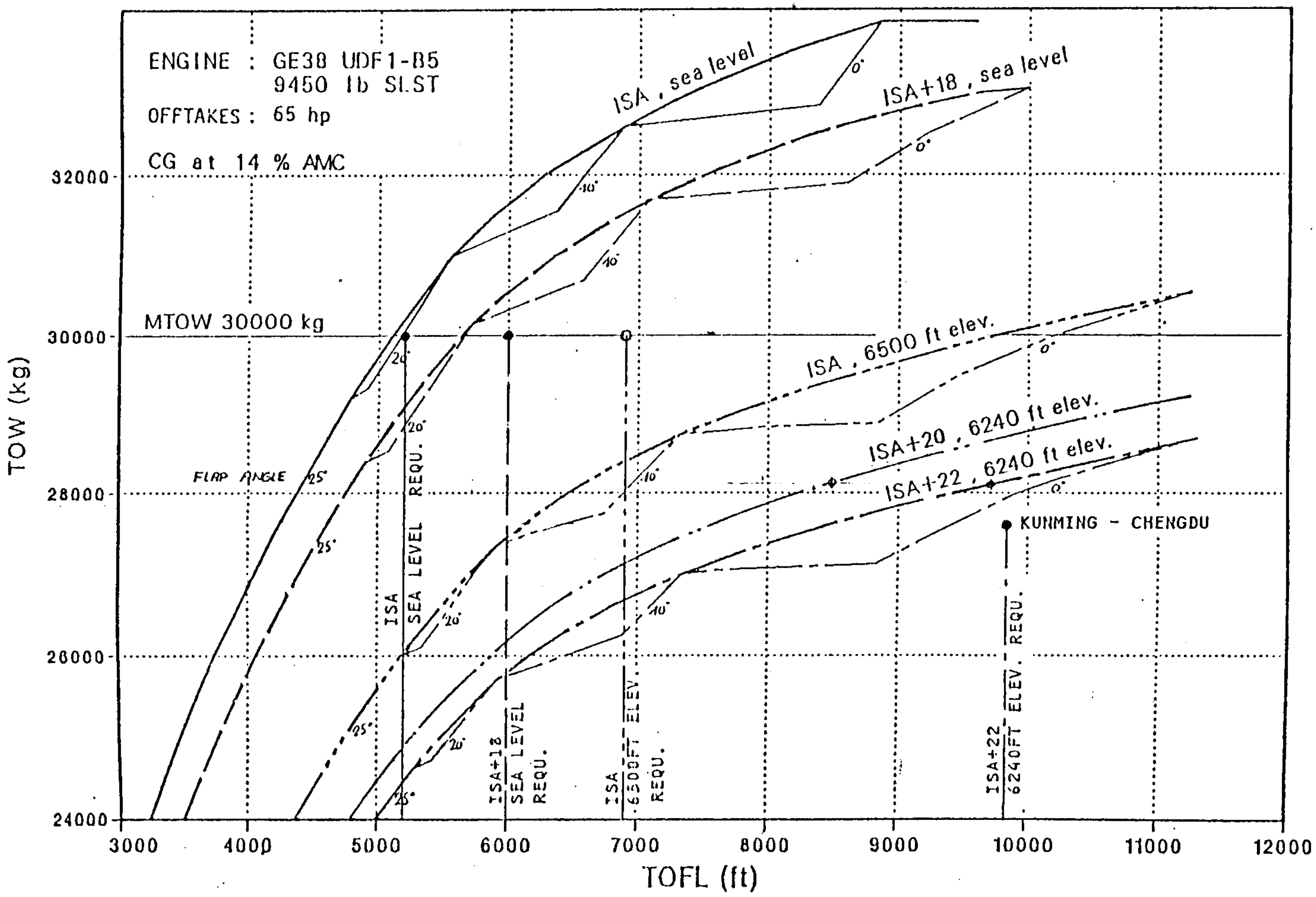
*If High Speed Protection is incorporated it would be possible to reduce VD.

3.6 PERFORMANCE SUMMARY

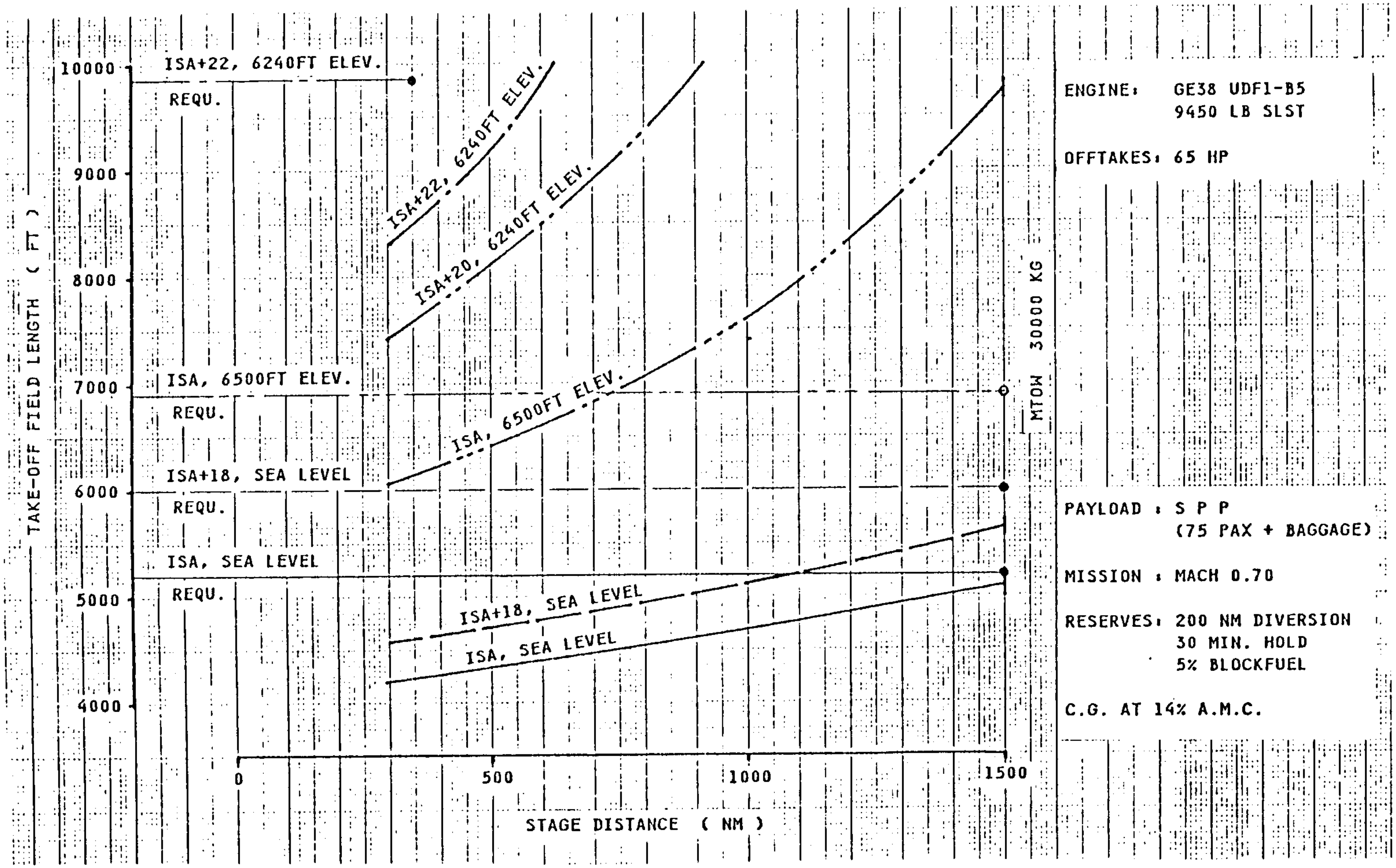
Range with full passengers		1500 nm
Range with max. fuel		2500 nm
FAR T-O field length	ISA,SL,MTOW	5100 ft.
	ISA+18deg.,SL,MTOW	5700 ft.
FAR Landing Field length (at typical mission LW)	SL, wet runway	4200 ft.
Associated Approach Speed		115 kts.
Initial cruise altitude (500ft./min., M=0.7)		36000 ft.
One engine inoperative ceiling (ISA + 10 deg.)		16500 ft.
Max. cruise Mach No.		0.76 Mach
Take-off speed (at Max.TOW, ISA, SL)		120 kts.

Note: Performance data has been calculated assuming engine bleed air supply for E.C.S.. Later studies assume E.C.S. is supplied by a mechanical compressor.

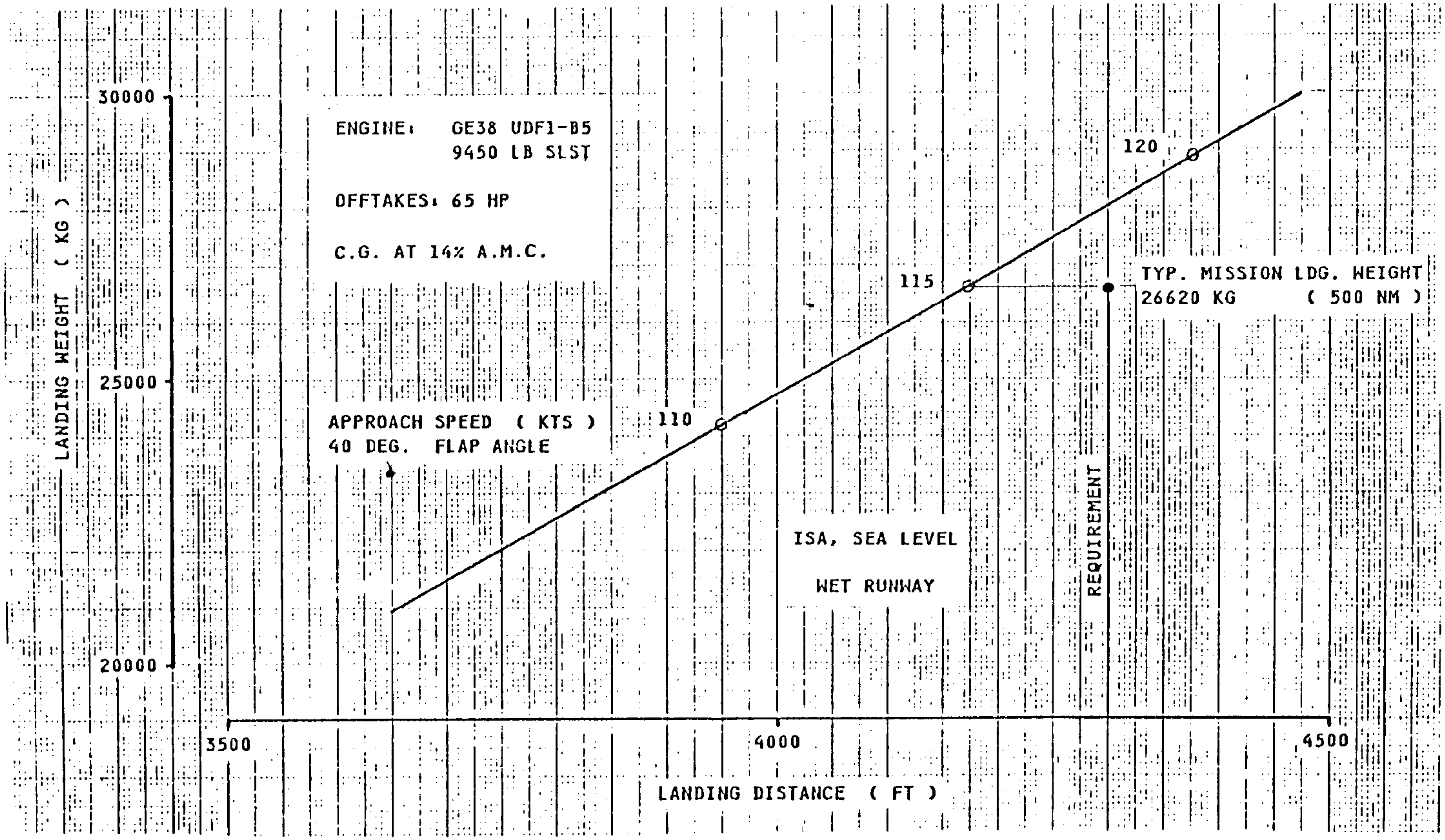
3.6.1 Take-off Weight vs. Take-Off Field Length



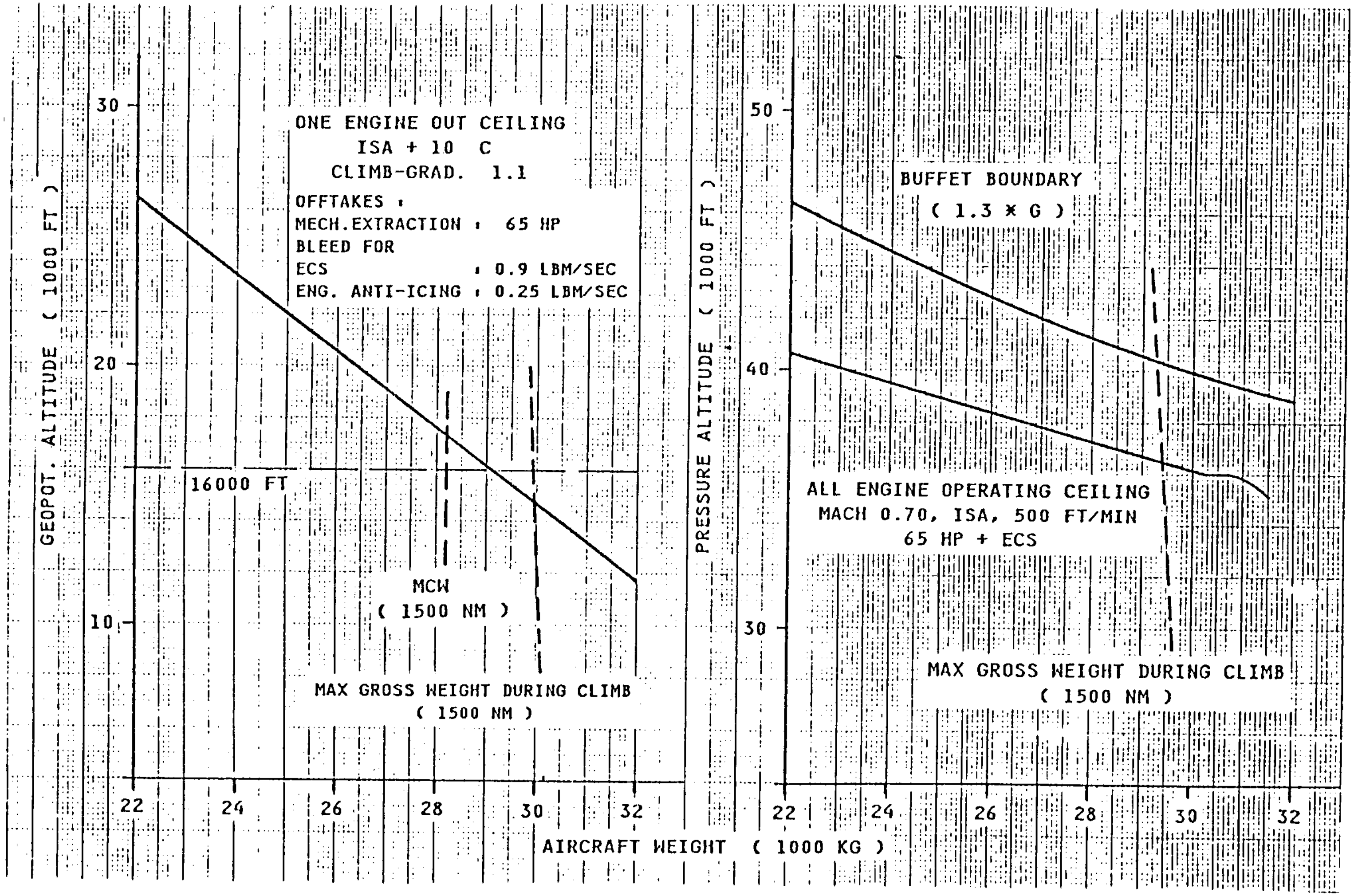
3.6.2 Take-Off Field Length vs. Stage Distance



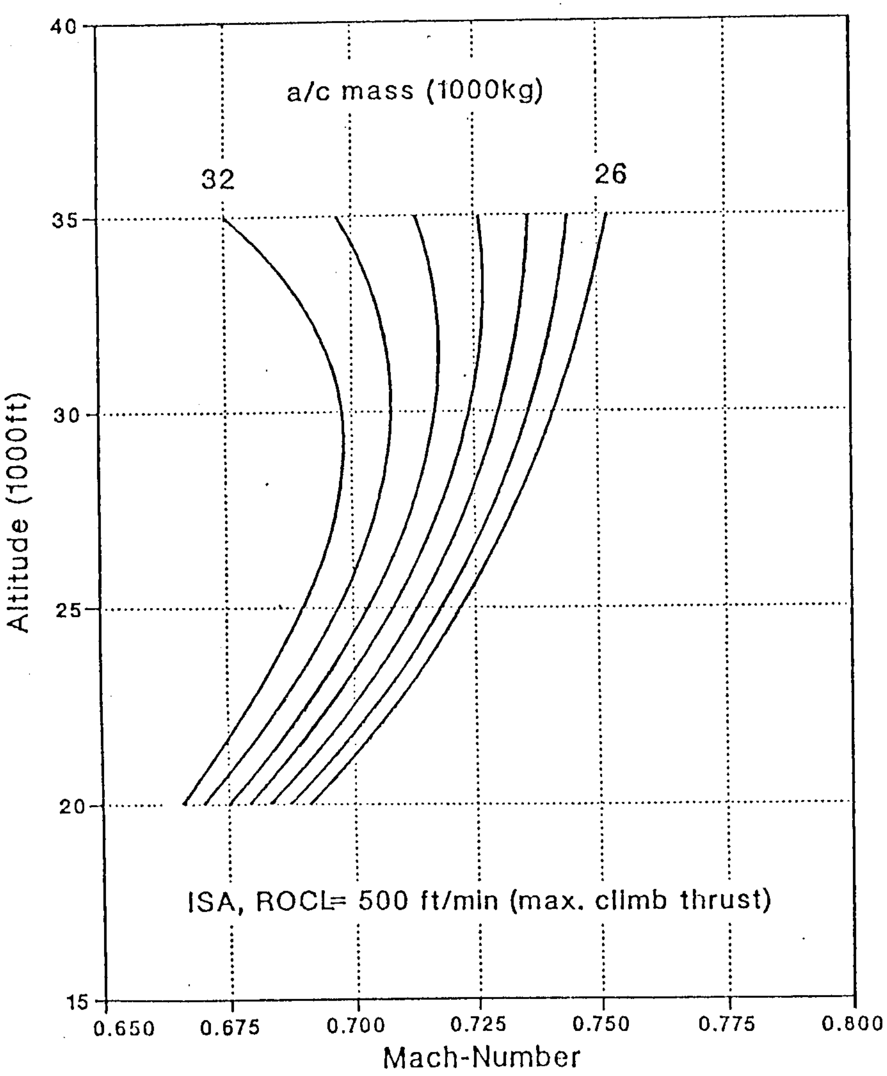
3.6.3 Landing Weight vs. Landing Distance

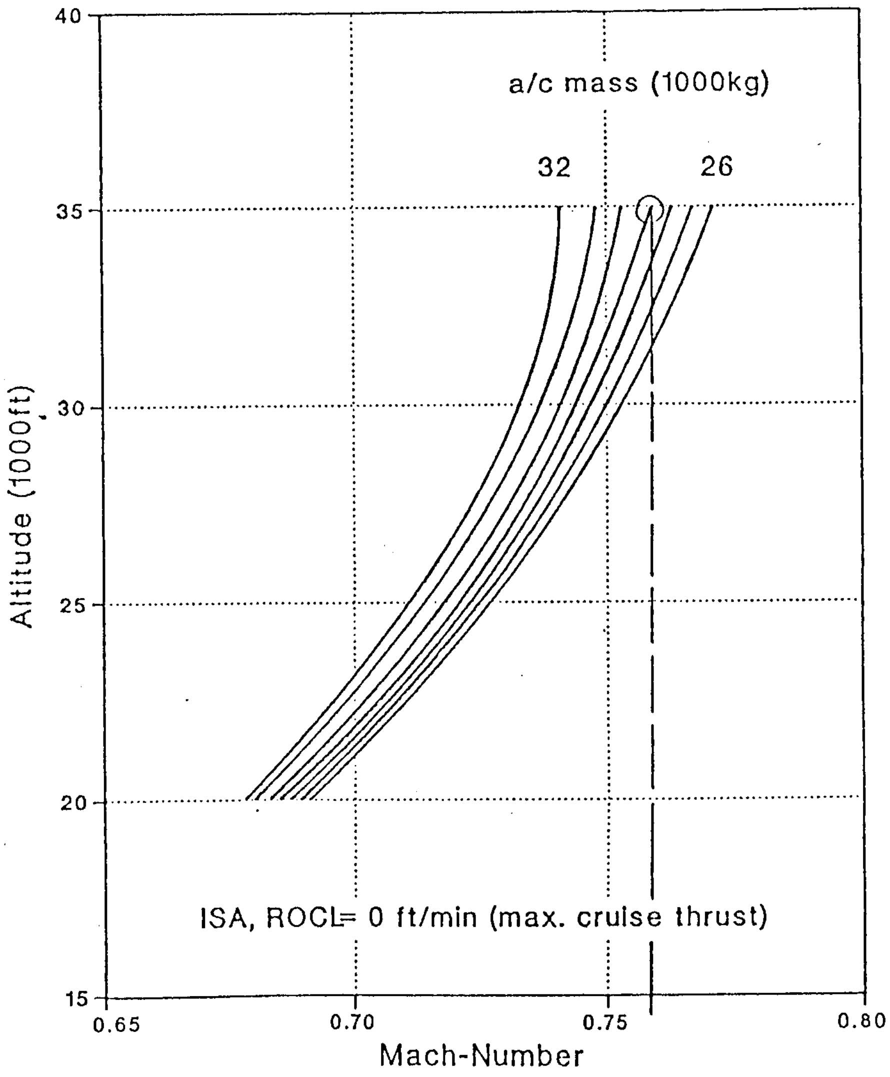


3.6.4 Aircraft Ceilings

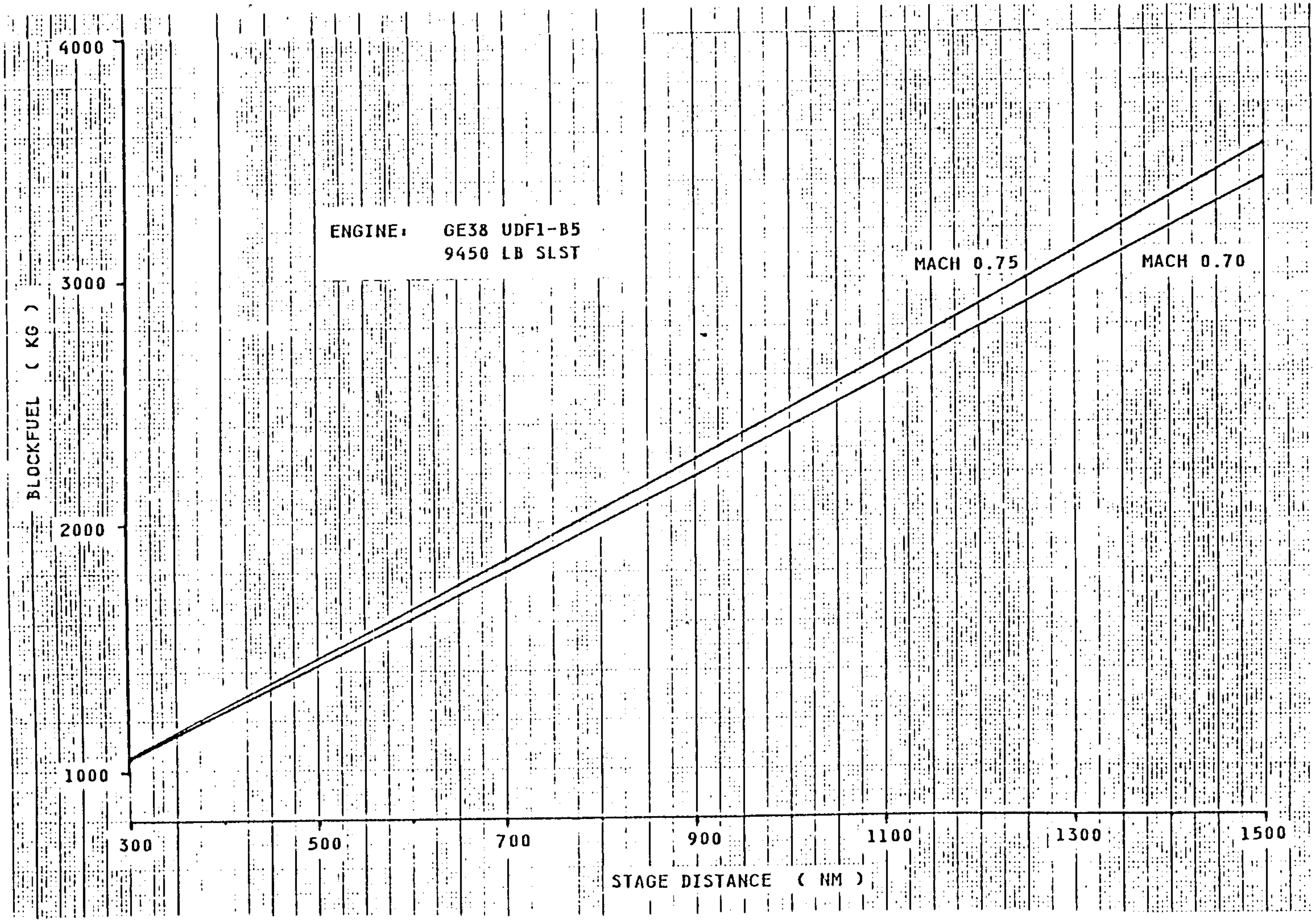


3.6.5 Climb & Cruise Mach Number vs. Altitude

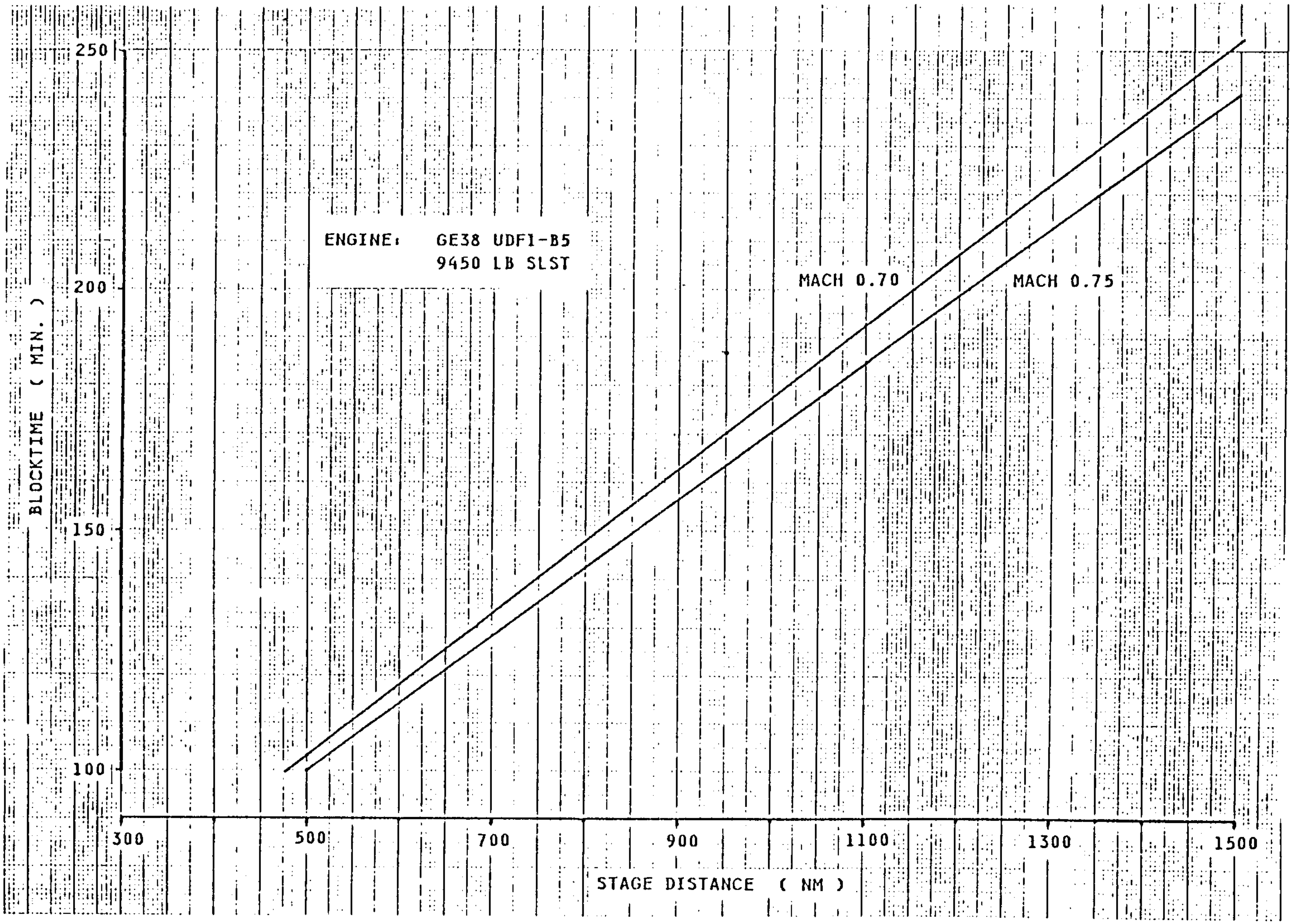




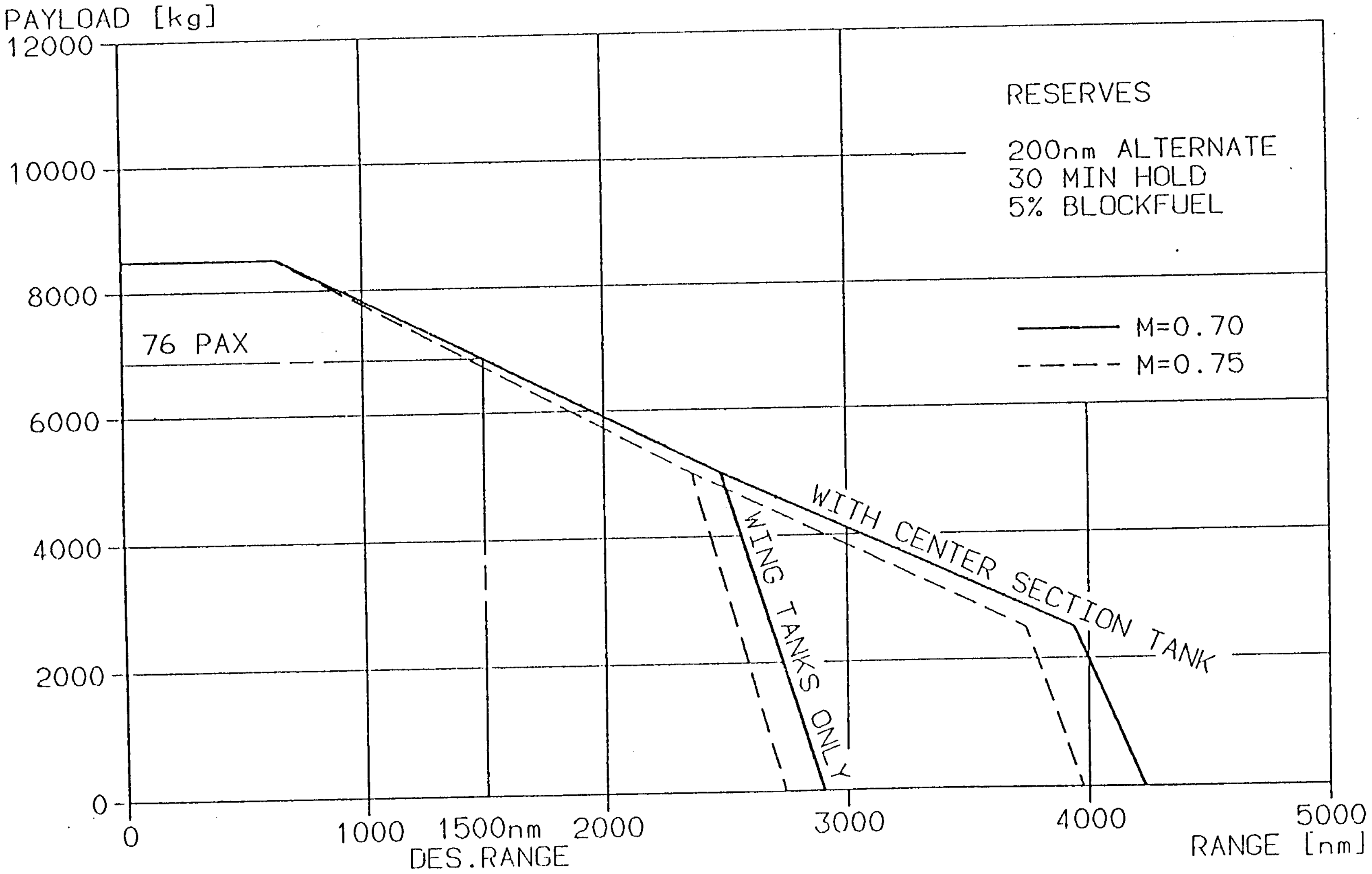
3.6.6 Block Fuel vs. Stage Distance



3.6.7 Block Time vs. Stage Distance



3.6.8 Payload/Range Diagram



4.0 AIRCRAFT DESCRIPTION

4.1 GENERAL ARRANGEMENT

The MPC 75 is a low wing aircraft with T-tail and two rear-mounted ultra high by-pass engines. The engine currently being studied in the baseline configuration is the GE 38 UDF/B5.(Other types of ultra high by-pass engines are under study)

The natural laminar flow wing is constructed of carbon fibre reinforced material with an integral fuel tank. Advanced aluminium and aluminium lithium materials are used in the fuselage structure and the fuselage skin has riblets to reduce aerodynamic drag. An advanced flight deck uses LCD display units and an advanced flight management system provides for optimization of flight control and navigation.

4.2 POWER PLANT

The MPC 75 is powered by the GE 38 UDF/B5 which is based on the GE27/GE 38 developed core and GE 36 UDF propulsor design technology. The engine is designed to meet FAR36 Stage 3 noise requirements. Up to 15% increase in thrust is obtainable without changing the fan diameter or engine envelope. SFC remains unchanged but engine weight increases by 5%.

Reverse thrust is controlled by a single lever and requires low power during normal landing because of the high drag of the flat disc.

4.2.1 Main Data

SLST(ISA)	9620 lb.
Bare engine weight (including UDF)	2395 lb.
Propulsion Pod complete (including accessories)	3050 lb.
Number of UDF blades	11/9
UDF diameter	2.1m
Horsepower extraction(max)	100 shp (increase to 335 shp possi

Bleed air extraction - max. 10% of total core mass flow
(max. 6.5% from 1. port(5. stage) or 2. port (compressor discharge)

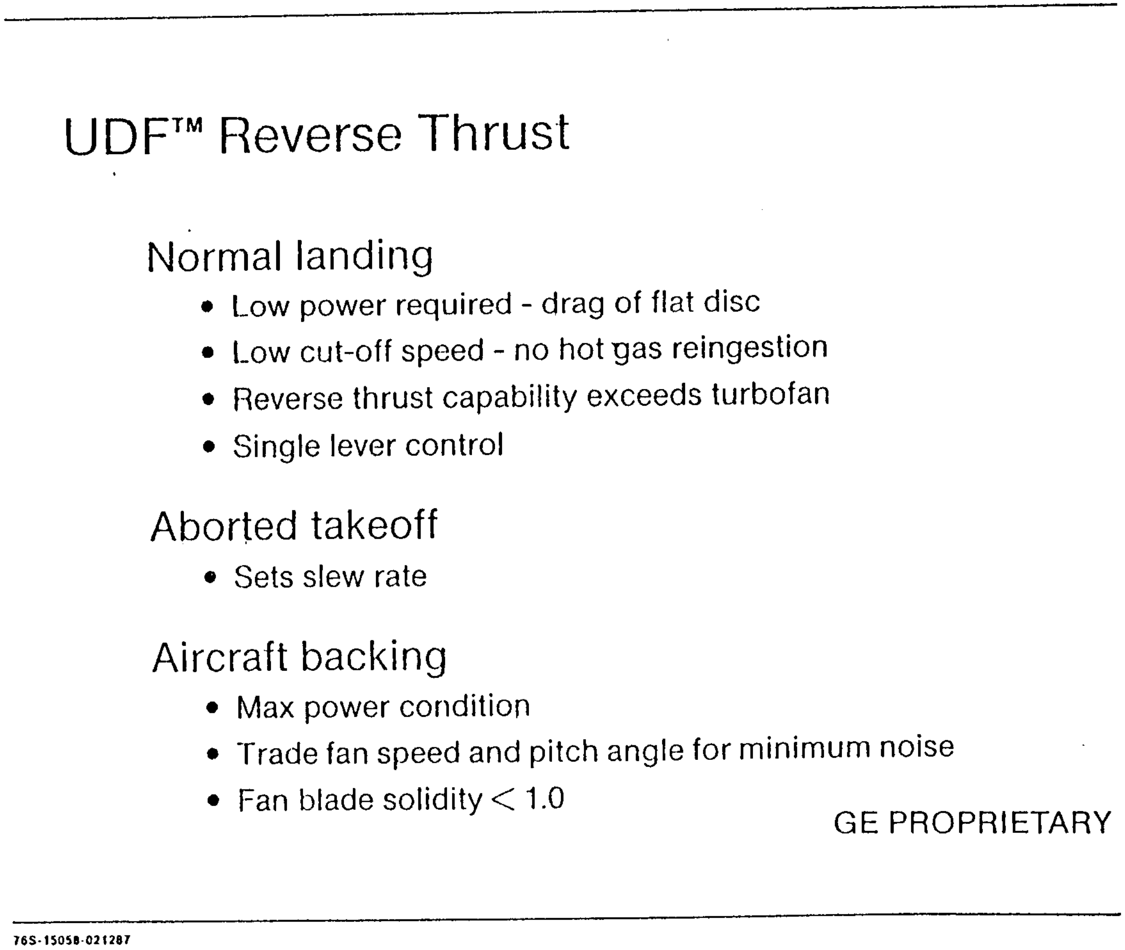
OVERALL PERFORMANCE

INLET RECOVERY = 0.998

NO BLEED OR POWER EXTRACTION

ALTITUDE, ft	35000	35000	0	0
MACH NUMBER	0.8	0.8	0.2	0
AMBIENT TEMPERATURE	ISA+10C	ISA	ISA+15C	ISA+15C
RATING	MAX CLIMB	MAX CRUISE	TAKEOFF	TAKEOFF
NET THRUST, lbf	2062	2190	7744	9644
TSFC, (lbm/hr)/lbf	0.536	0.519	0.302	0.240
FUEL FLOW, lbm/hr	1106	1137	2339	2316

Reverse Thrust



UDF™ Reverse Thrust

Normal landing

- Low power required - drag of flat disc
- Low cut-off speed - no hot gas reingestion
- Reverse thrust capability exceeds turbofan
- Single lever control

Aborted takeoff

- Sets slew rate

Aircraft backing

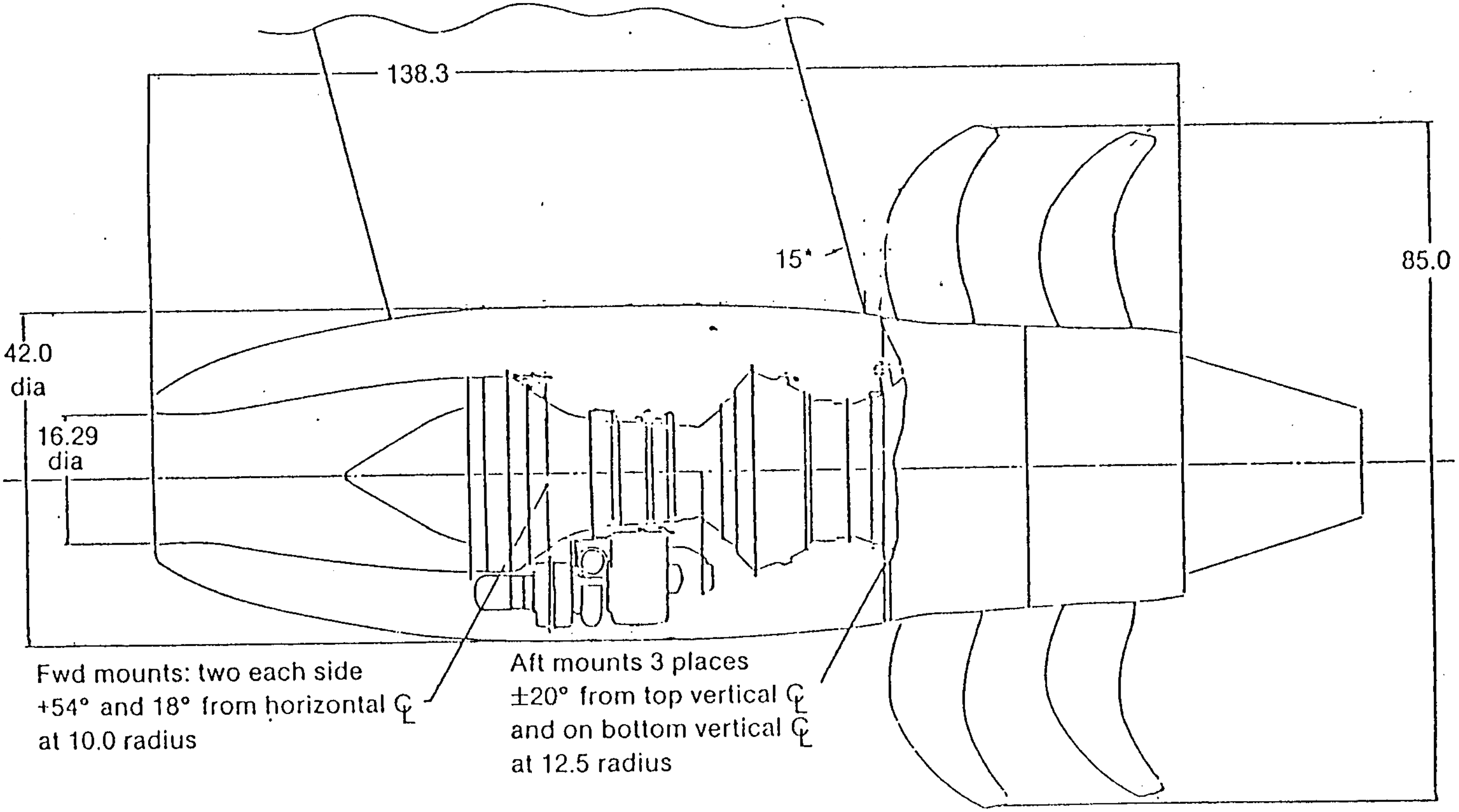
- Max power condition
- Trade fan speed and pitch angle for minimum noise
- Fan blade solidity < 1.0

GE PROPRIETARY

76S-15058-021287

Installation Outline

GE38/UDF™-1 Study B5 Installation Outline



Fwd mounts: two each side
+54° and 18° from horizontal ℄
at 10.0 radius

Aft mounts 3 places
±20° from top vertical ℄
and on bottom vertical ℄
at 12.5 radius

* Estimate, pylon chord will be determined by aircraft and engine requirements

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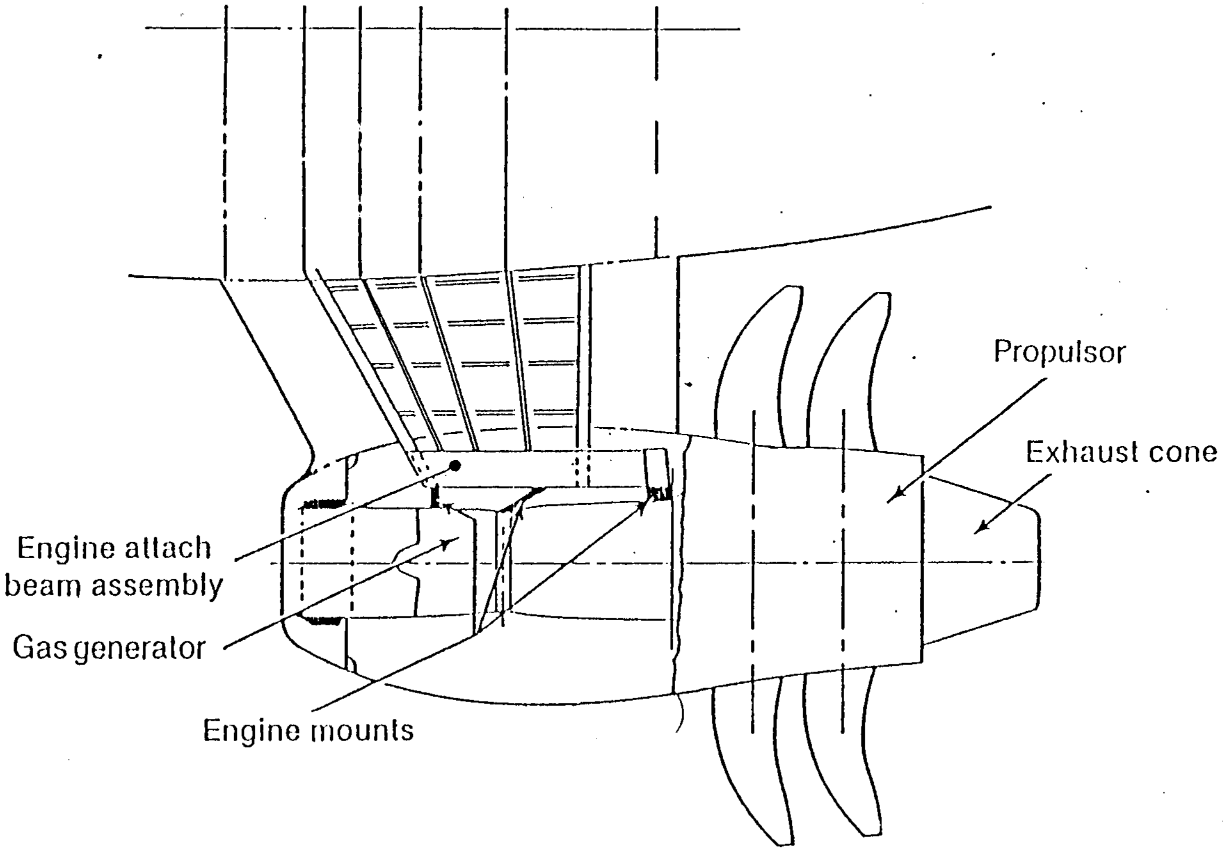
82S-16315-032387

Pylon Arrangement



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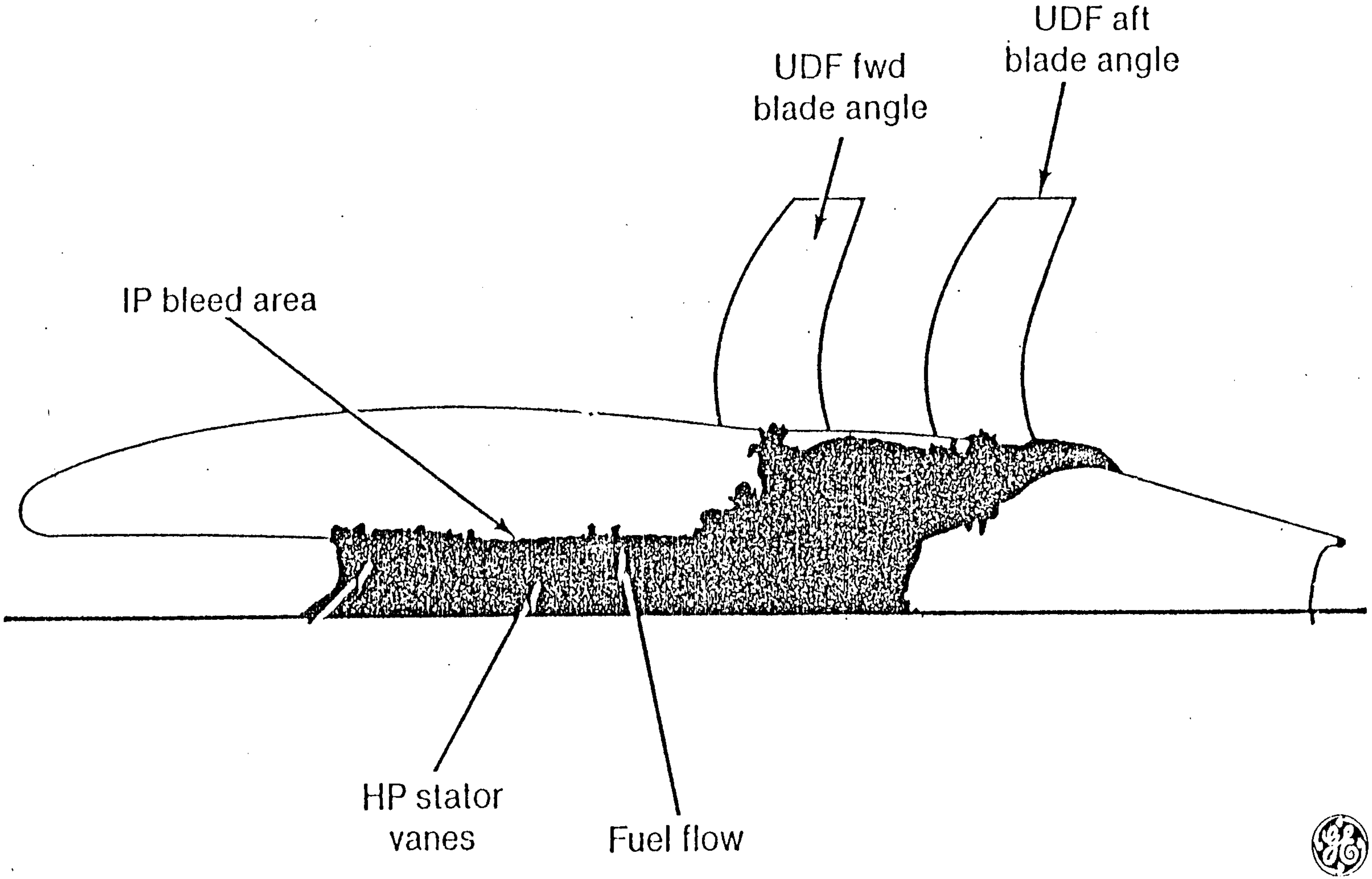
4.2.2 Engine Control

The engine is controlled by means of FADEC mounted on the engine in a single housing. FADEC uses engine alternator power and has self-test fault detection. Control strategy is shown below.

EPR scheduled as function of PLA
Fuel flow modulated to control EPR
Forward fan RPM scheduled via EPR
Forward fan blade angle varied to control RPM
Aft fan blade angle modulated to synchronize/synchrophase with forward fan
Gas generator variable geometry adjusted for core RPM, temperature and pressure

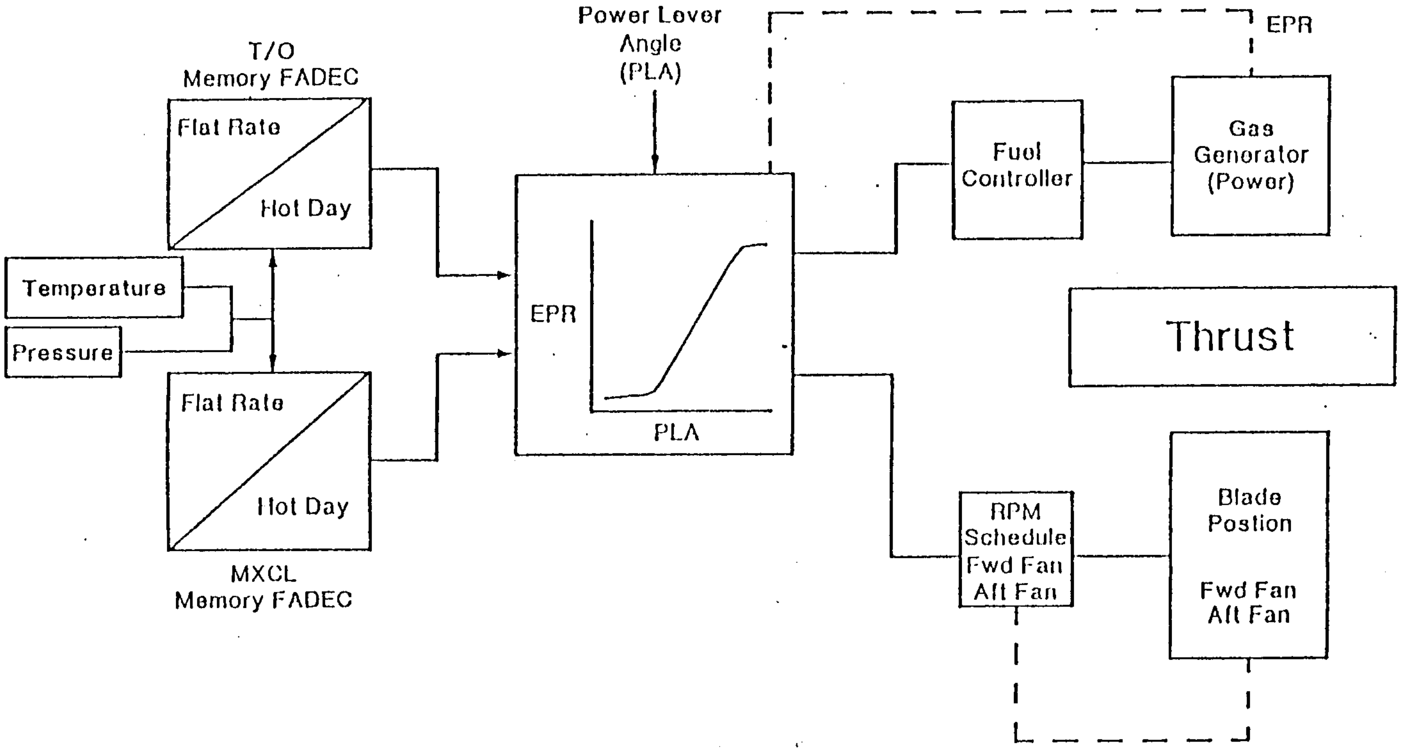
Schematic Control system and FADEC control are shown in diagrams.

FADEC Controls



PROPRIETARY

UDF Control System



PROPRIETARY

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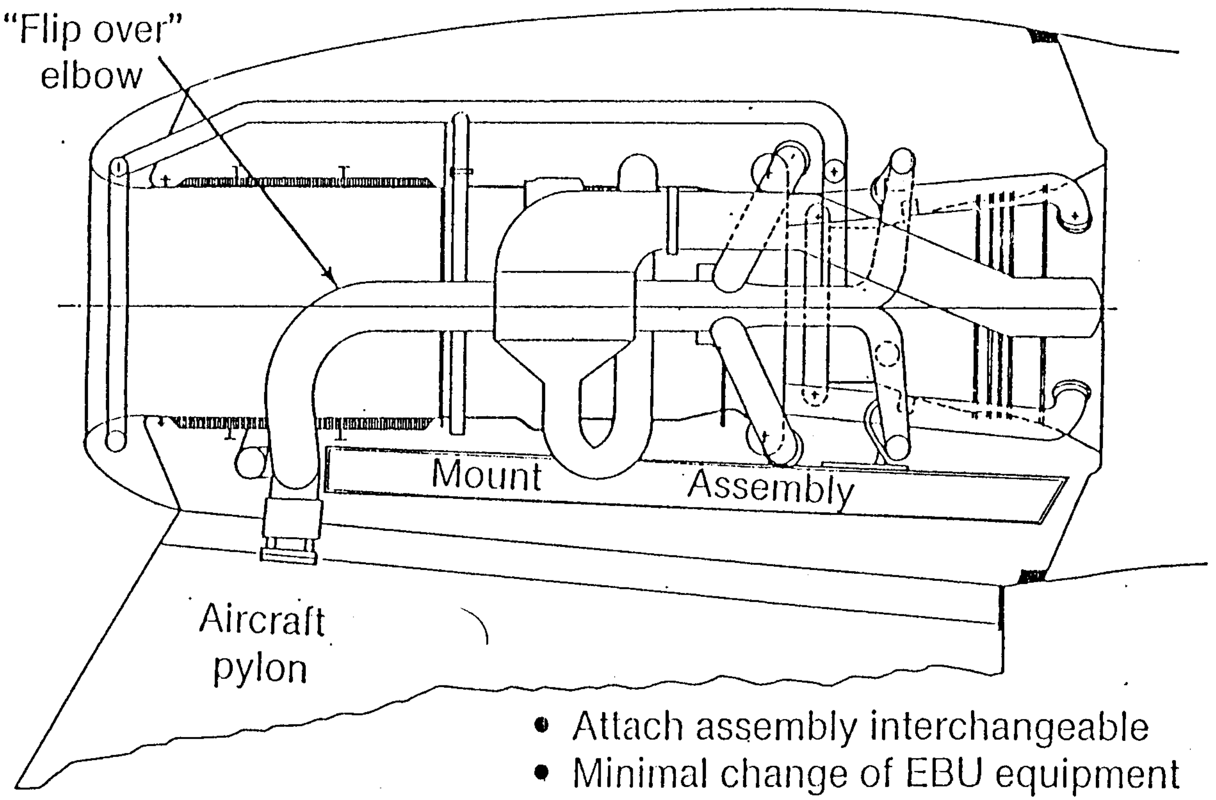
4.2.3 Engine Maintenance

The engine is connected to the pylon by an attachment beam and is easily removable after opening the cowls which remain on the pylon. The engine is interchangeable LH and RH side and is made up of modules as shown in diagrams.

Left Hand - Right Hand Installation Commonality
Typical Schematic



- Attach assembly interchangeable
- Minimal change of EBU equipment

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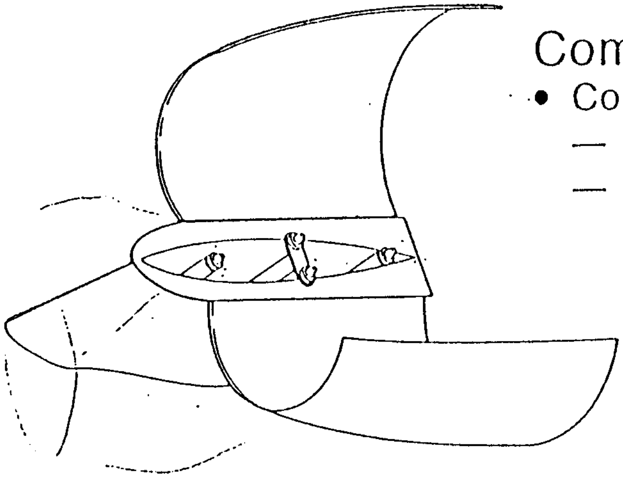
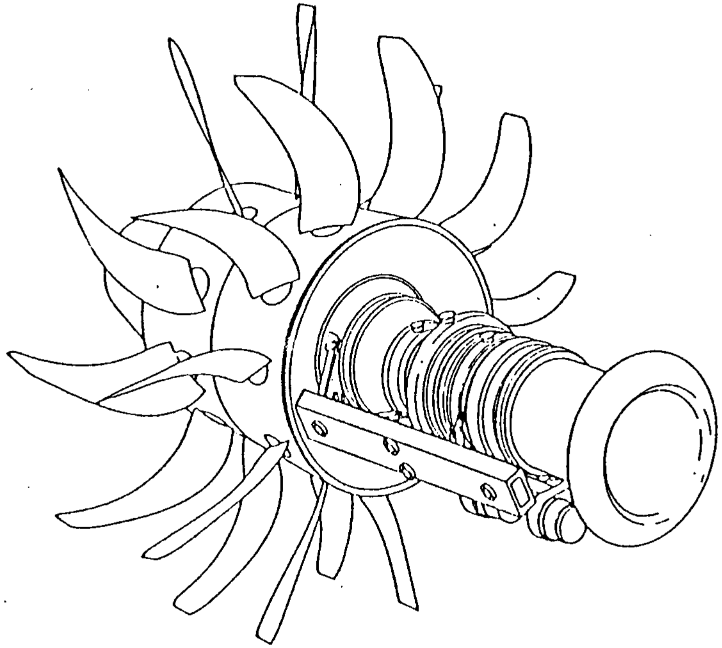
Easy Removal of the Propulsion System



Components remaining with aircraft

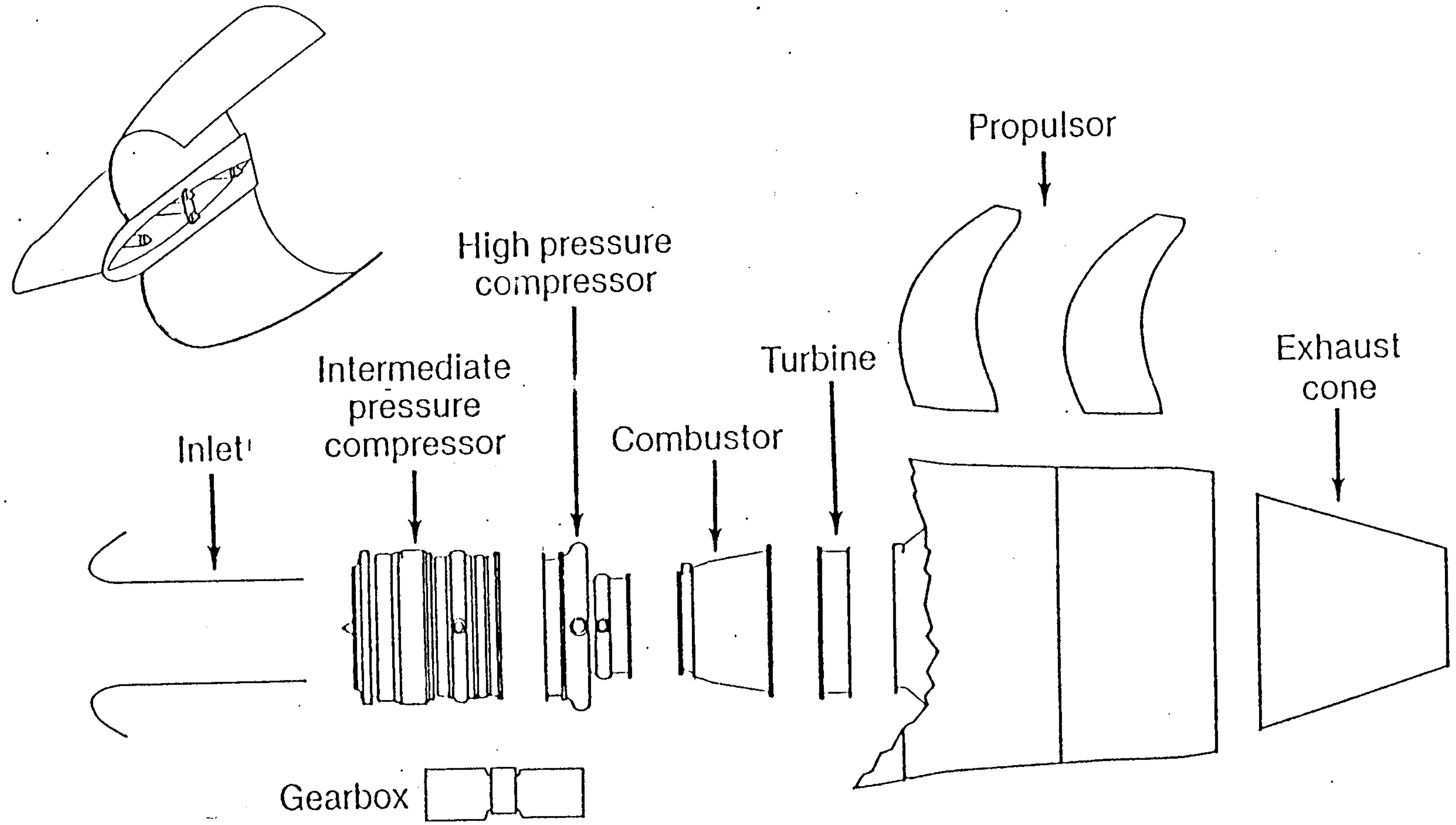
- Cowls
  - Upper
  - Lower



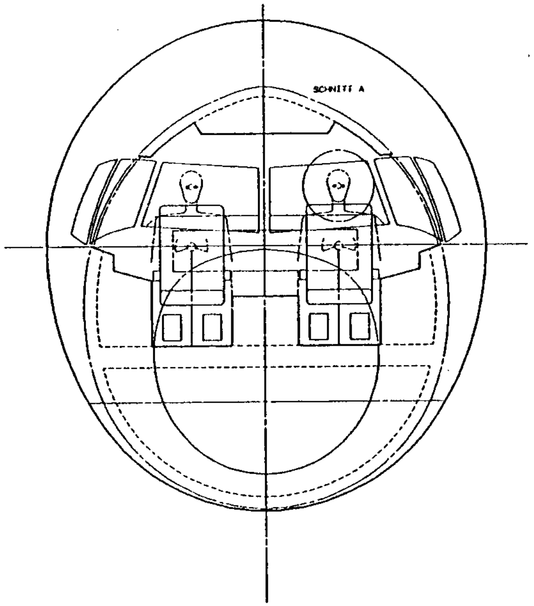
Demountable units

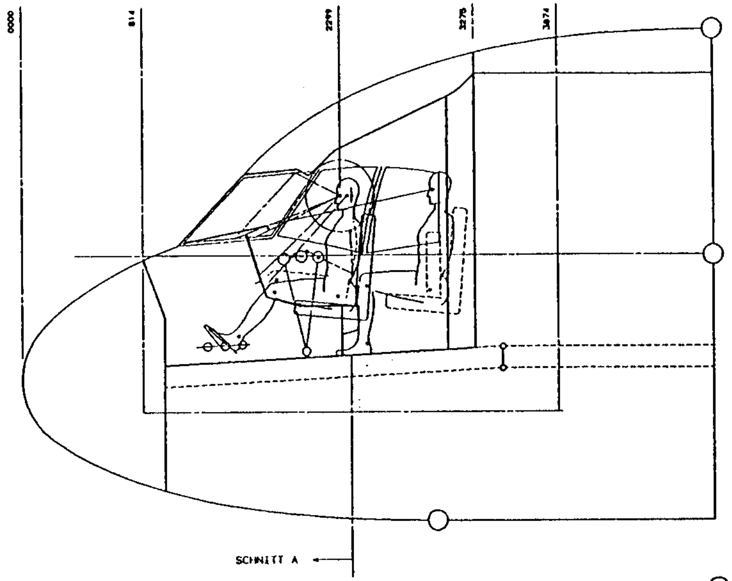
- Basic engine
- Inlet and duct
- Nacelle equipment
- Attach beam

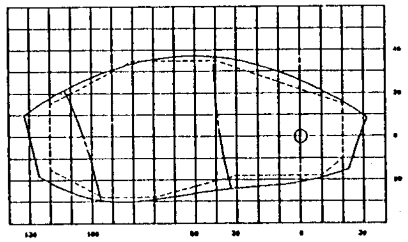
GE36 UDF Modularity permits Rapid Replacement
(Typical Schematic, GE38 will be similar)

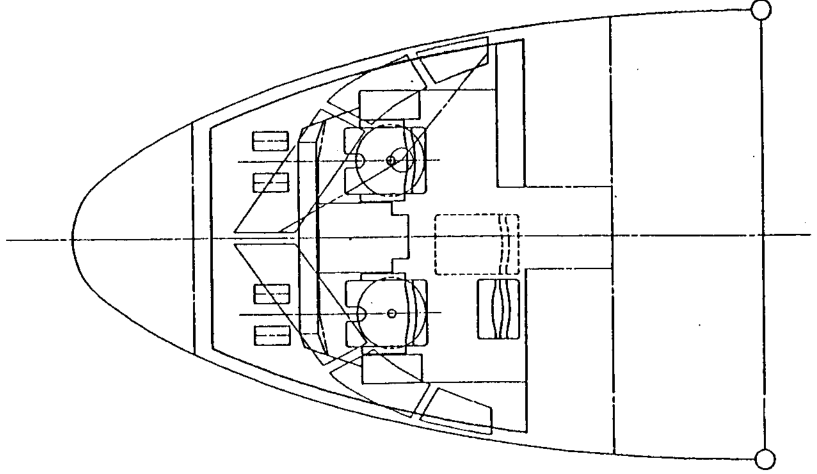


4.3 FLIGHT DECK









4.4 PASSENGER CABIN

The upper lobe of the fuselage is dimensioned to provide in a standard 4-abreast seating arrangement a more spacious and hence more comfortable cabin than any other aircraft of the class.

Cabin access is through passenger doors on the left hand side and service doors on the right hand side at both the front end and the rear end of the cabin. All entry doors are of the same size and serve as Type 1 emergency exits. According to the JAR and FAR proposed Rules these allow a maximum capacity of up to 90 - 110 passengers. (as long as distance between front and rear doors is no greater than 60ft.)

The basic seating arrangement is for 76 Tourist passengers at 32 inch pitch. There is also a 69 seat Mixed Class version with 36"/32" pitch and a high density version with 84 seats at 30" pitch. (See diagrams.) Seat rails permit changes in seating pitch in one inch increments.

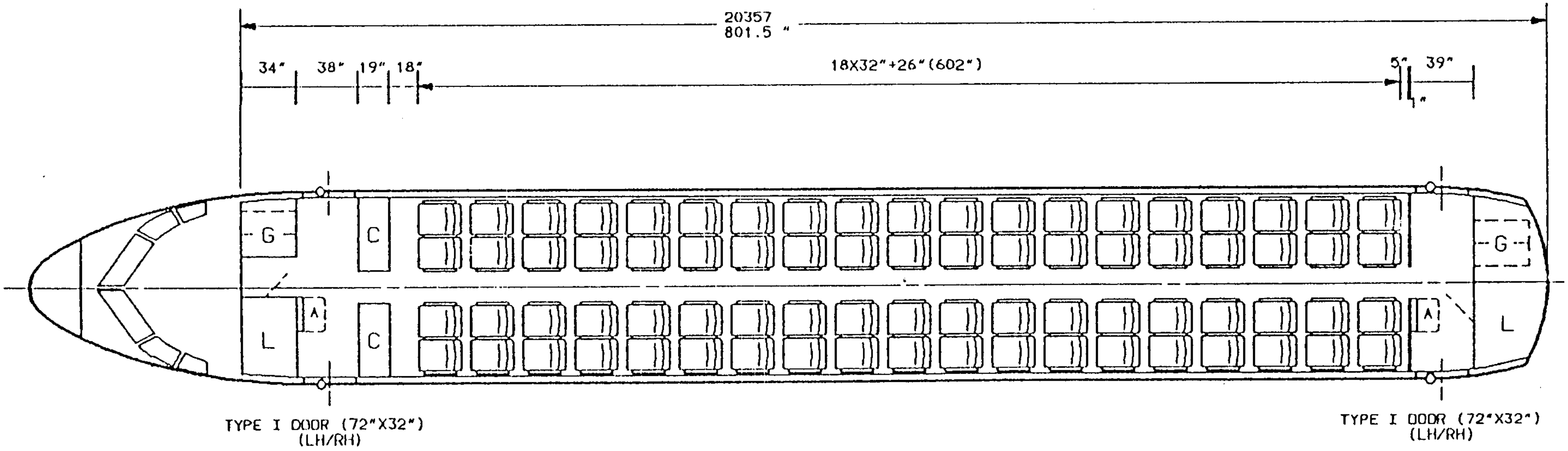
Galleys and lavatories can be arranged at both ends of the cabin. Overhead bins provide adequate capacity for carry-on baggage.

Cabin Layout (Basic - 76 seats)

ALL TOURIST

76 SEATS 32" PITCH

G GALLEY	(4X TROLLEYS)
L LAVATORY	(2X)
A ATTENDANT-SEAT	(2X)
C COAT STOWAGE	(2X)



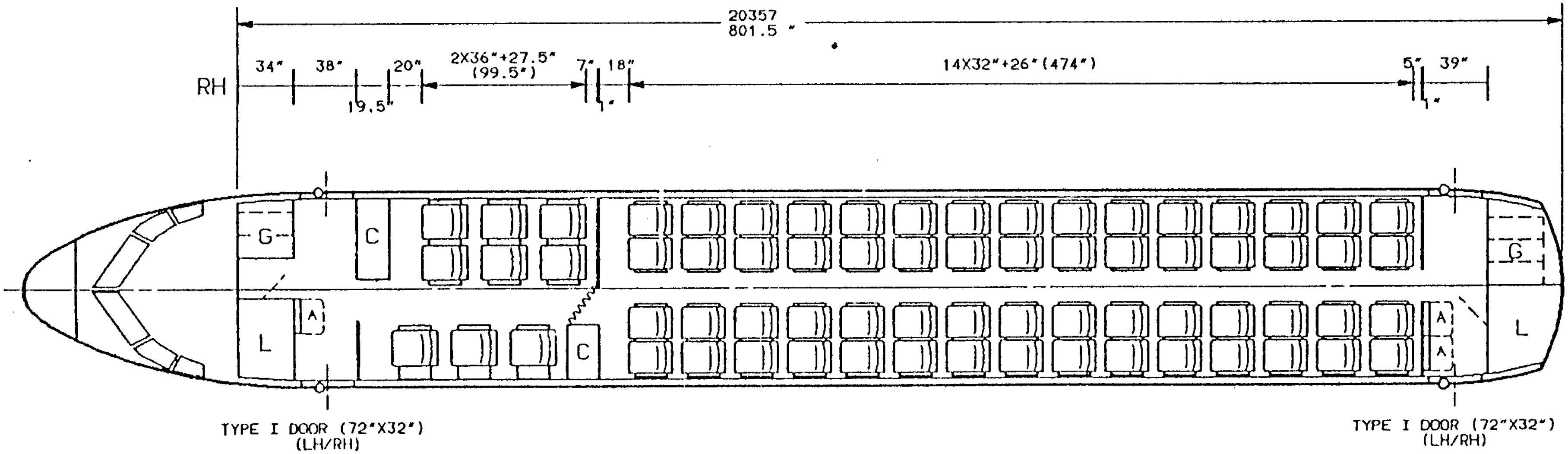
Cabin Layout (Mixed Class - 69 seats)

MIXED CLASS

9 SEATS 36" PITCH
60 SEATS 32" PITCH

69 SEATS TOTAL

G	GALLEY	(5X TROLLEYS)
L	LAVATORY	(2X)
A	ATTENDANT-SEAT	(3X)
C	COAT STOWAGE	(2X)

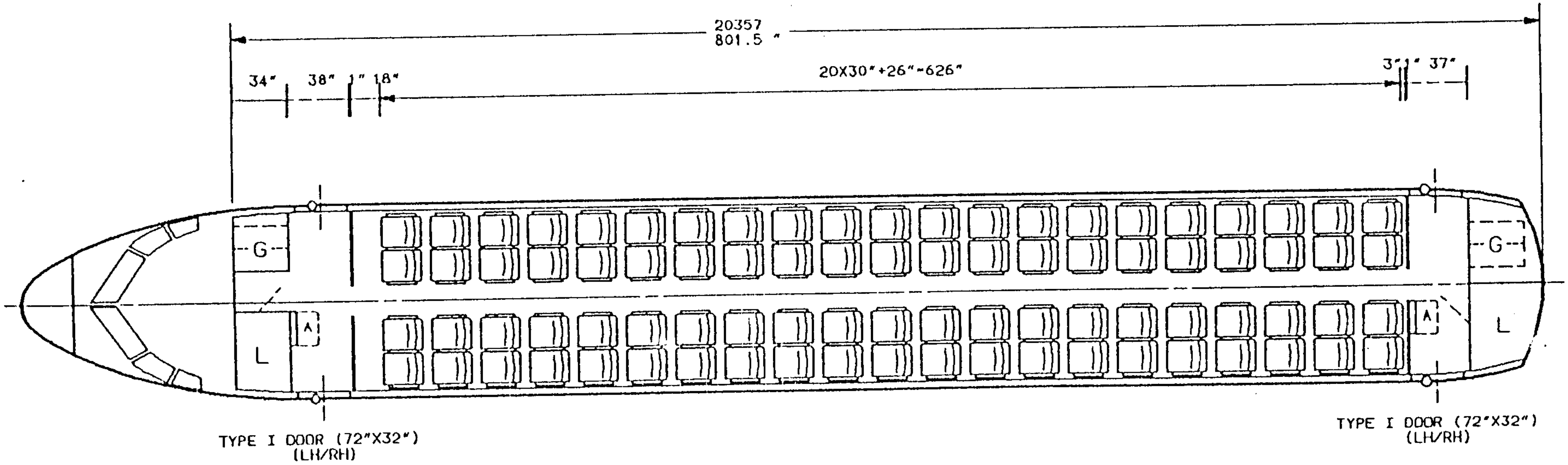


Cabin Layout (High Density - 80 seats)

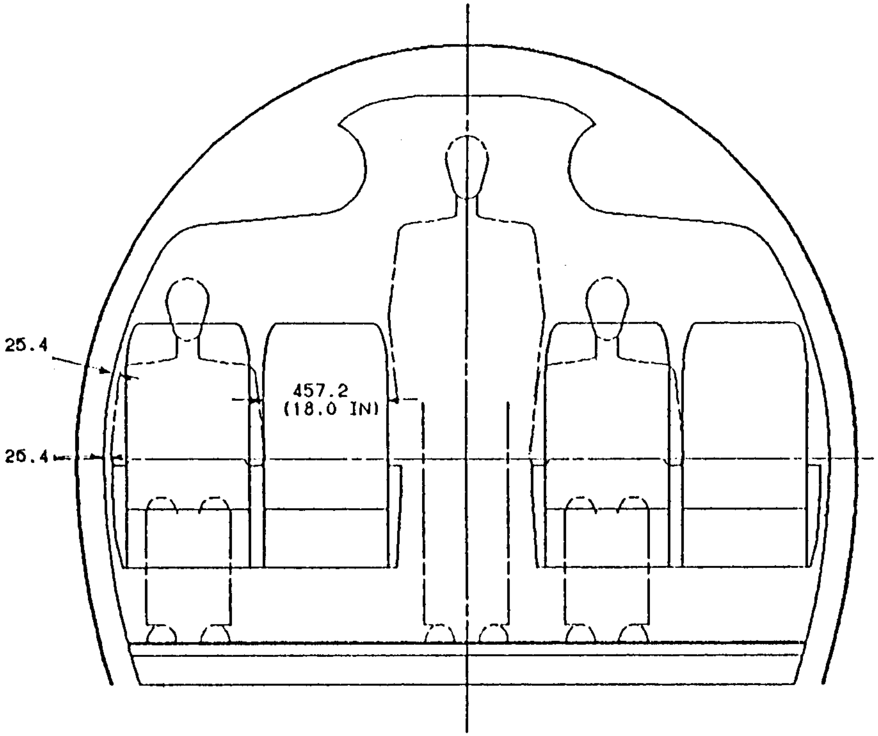
HIGH DENSITY

84 SEATS 30 PITCH

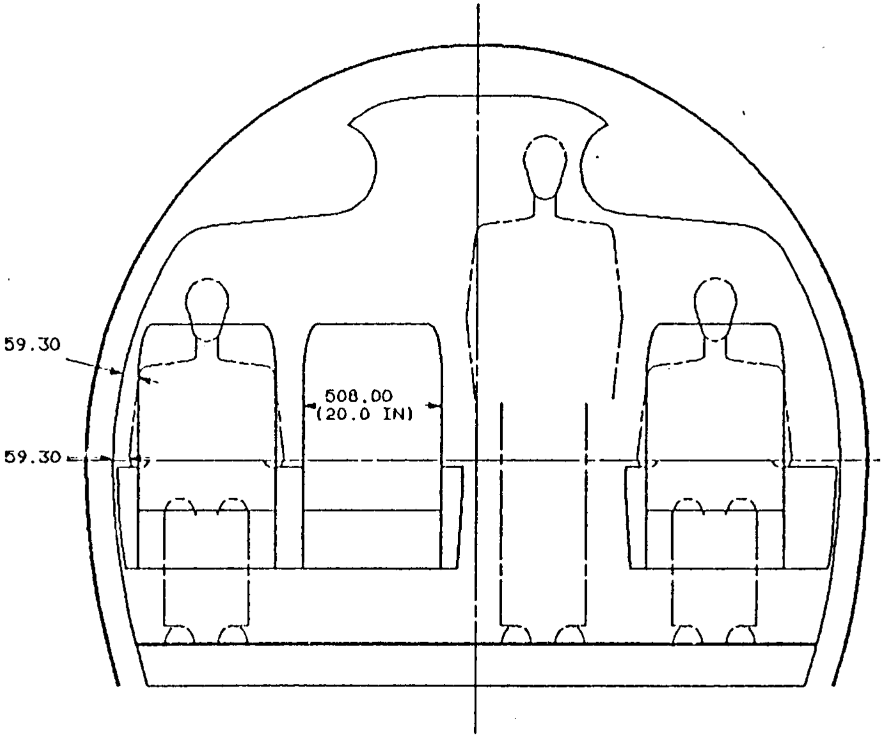
G	GALLEY	(4X TROLLEYS)
L	LAVATORY	(2X)
A	ATTENDANT-SEAT	(2X)
S	STOWAGE	(2X)



Cabin Cross Section



TOURIST CLASS
4 ABREAST
AISLE WIDTH 19"
NOMINAL SEAT WIDTH 42"



FIRST CLASS
3 ABREAST
AISLE WIDTH 23.7"
NOMINAL SEAT WIDTH 50"

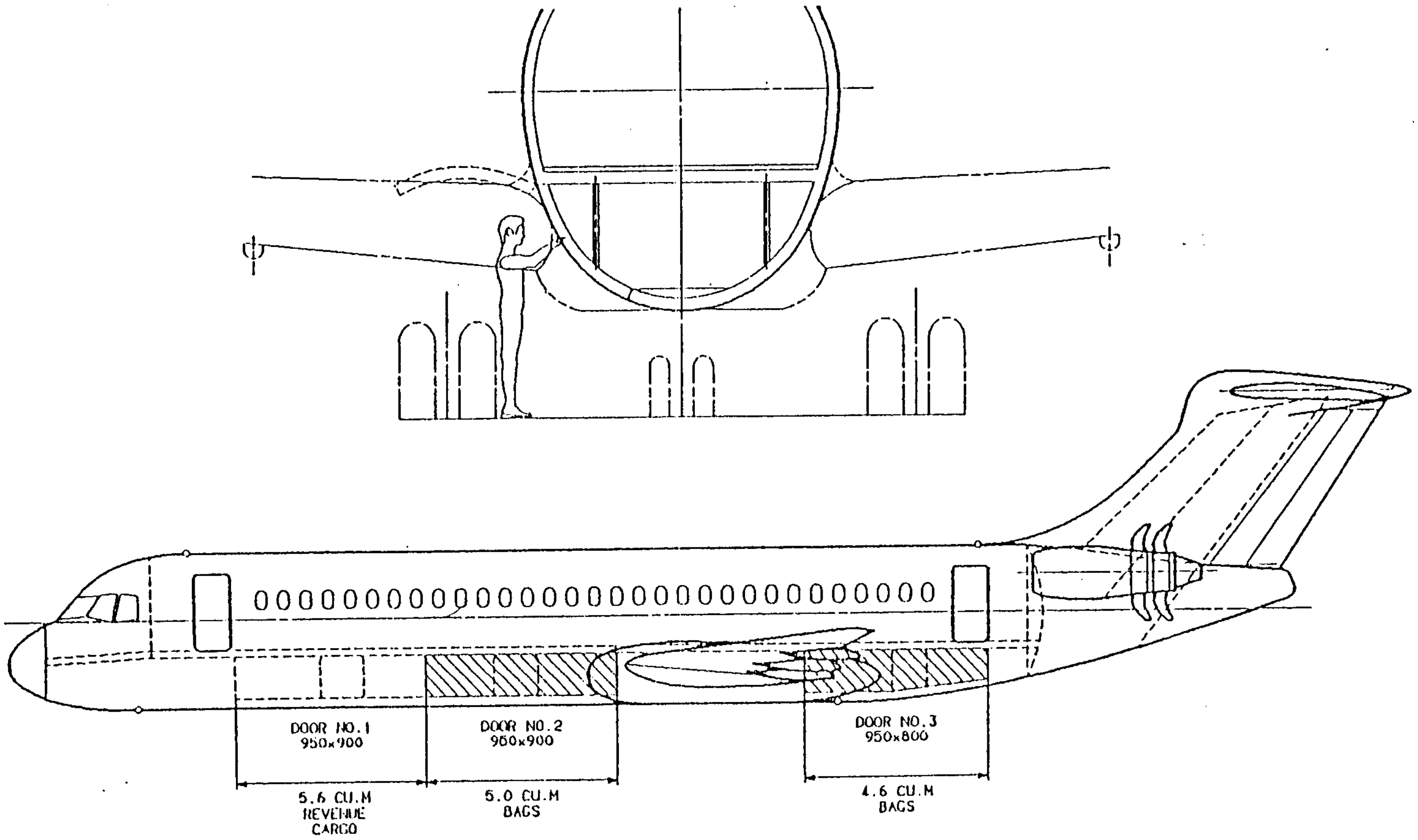
4.5 CARGO/BAGGAGE HOLDS

The underfloor cargo hold offers a capacity of 10.6 cu.m. in the forward hold and 4.6 cu.m. in the rear hold. The height of the cargo hold is 900 mm (i.e. 4 inches more than offered by the closest 5-abreast competitor).

Manual loading is assumed in the standard version. In order to simplify loading, two doors 1450 mm x 900 mm are provided in the forward hold. The rear hold has one door with the same dimensions. The cargo holds are equipped with tie-down points and door nets. The front hold has, in addition, a divider net.

As an option a telescopic bin system and a belt loading system may be considered for the forward hold. In this case only one door will be necessary in the forward hold.

Cargo Compartments



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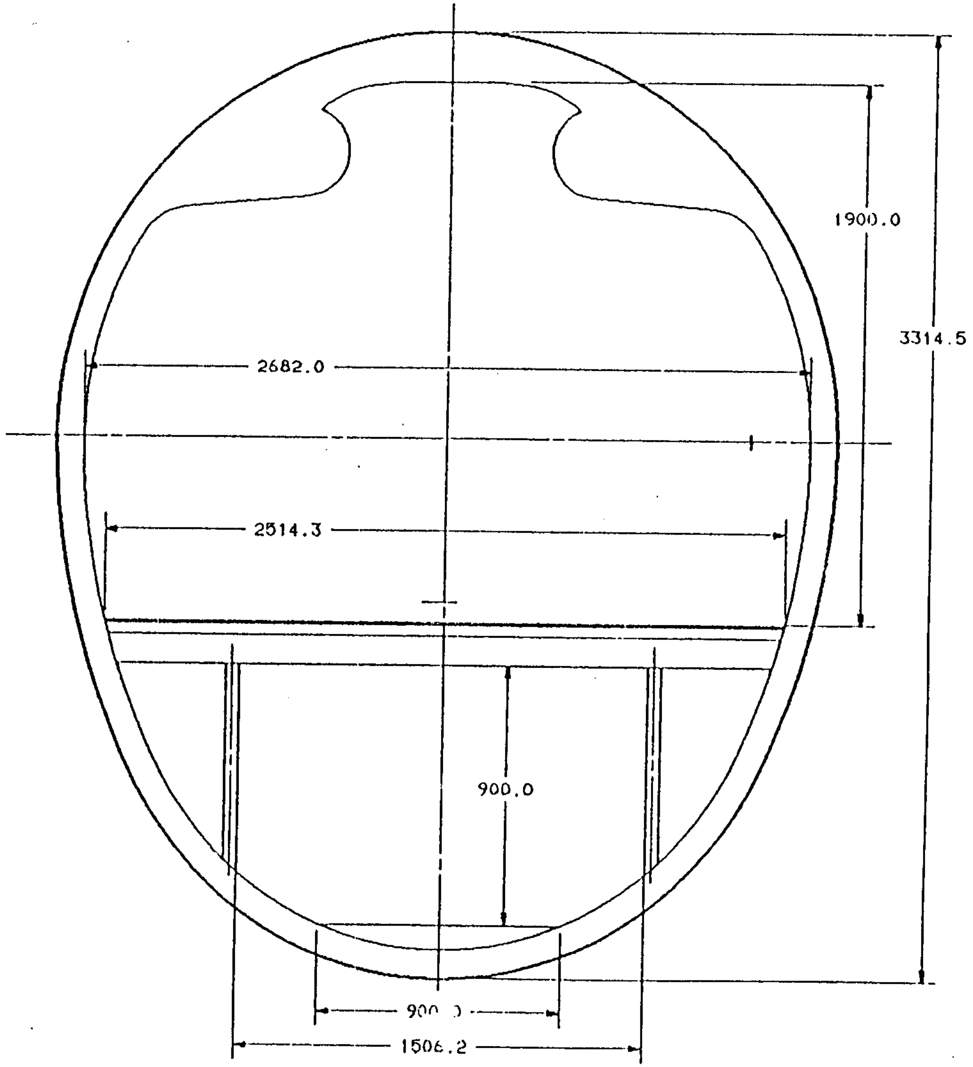
4.6 FUSELAGE

The constant-section fuselage has a blended double-bubble cross-section with 2+2 abreast seating and a single aisle and offers ample underfloor baggage/cargo volume. The fuselage construction is of conventional skin/stringer/frame construction with a typical frame pitch of 20 inches. The nose section has no stringers but a reduced frame pitch.

It is assumed that sandwich type structural elements will be integrated in the tail cone structure.The afterbody structural design will be determined by the noise fatigue requirements.

Further structural details remain to be defined. Materials have not yet been specified. Selective use will be made of advanced metals such as aluminium lithium for passenger and service doors, stringers, floor structure and window frames. Fairings and access doors and landing gear doors are in composite material. Floor panels consist of glass fibre.

Fuselage Cross Section



4.6.1 Engine Pylons.

The engine pylon structure continues through the rear end of the fuselage. Aluminium lithium is used for the structure and the fairings are of composite material. Quick attachment bolts connect with the engine attachment beam and permit rapid removal of the engine.

4.7 WING

The quarter chord of the wing MAC is positioned 16657 mm aft of the aircraft nose. The planform is matched to the needs of natural laminar flow, i.e. the leading edge sweep is limited to 20 degrees, the wing chords are kept short and aspect ratio is high.

From considerations of the landing gear installation, the wing trailing edge is kinked at approximately 34% semi-span.

The leading edge is fixed. The trailing edge flaps have about 30% chord outboard of the kink while inboard of the kink, flap chord remains constant equal to that at the kink. The ailerons are positioned outboard of the flaps and there are four spoilers per side, one inboard and three outboard of the kink.

The wing box is designed to carry fuel outboard of the root rib. Tank capacity is estimated to be approx. 3100 kg. per side. For developed versions, space is available for more fuel in the centre section. Potential additional capacity is estimated to be approx. 2500 kg.

It is assumed that the major components of the wing are arranged "geometrically conventional", i.e. an unswept centre-section box buried in the fuselage and two cantilever swept outboard wings attached to each side of the centre-section box. Both the centre-section box and the outboard wing box are of two-spar design. Outboard the kink, both the front and rear spars run at constant chord percentages whereas inboard the kink the spar positions are at varying chords resulting in a straight front spar and a kinked rear spar.

To ensure natural laminar flow, the fixed leading edge structure will be integrated with the wing box structure in such a way that a smooth surface can be maintained under all conditions. The leading edge thus becomes a part of the primary wing structure. It is designed to carry part of the wing loads as well as to improve the torsional stiffness of the wing and to withstand bird impact and damage from hail. Provision is made for the installation of an efficient anti-icing system.

The wing structure is manufactured of carbon fibre reinforced material and, where appropriate, of advanced metals. Details are to be defined.

To provide protection from lightning strikes the composite wing box is covered with a wire mesh system and solid metallic conductors to facilitate current flow. These metallic conductors are combined as far as possible with such structural necessities as the rear spar and lower flange. As a further precaution, rivetting through the skin panels is to be avoided as far as possible.

As a precaution against corrosion a design target is that all metallic parts inside the fuel compartment shall be of either titanium or stainless steel.

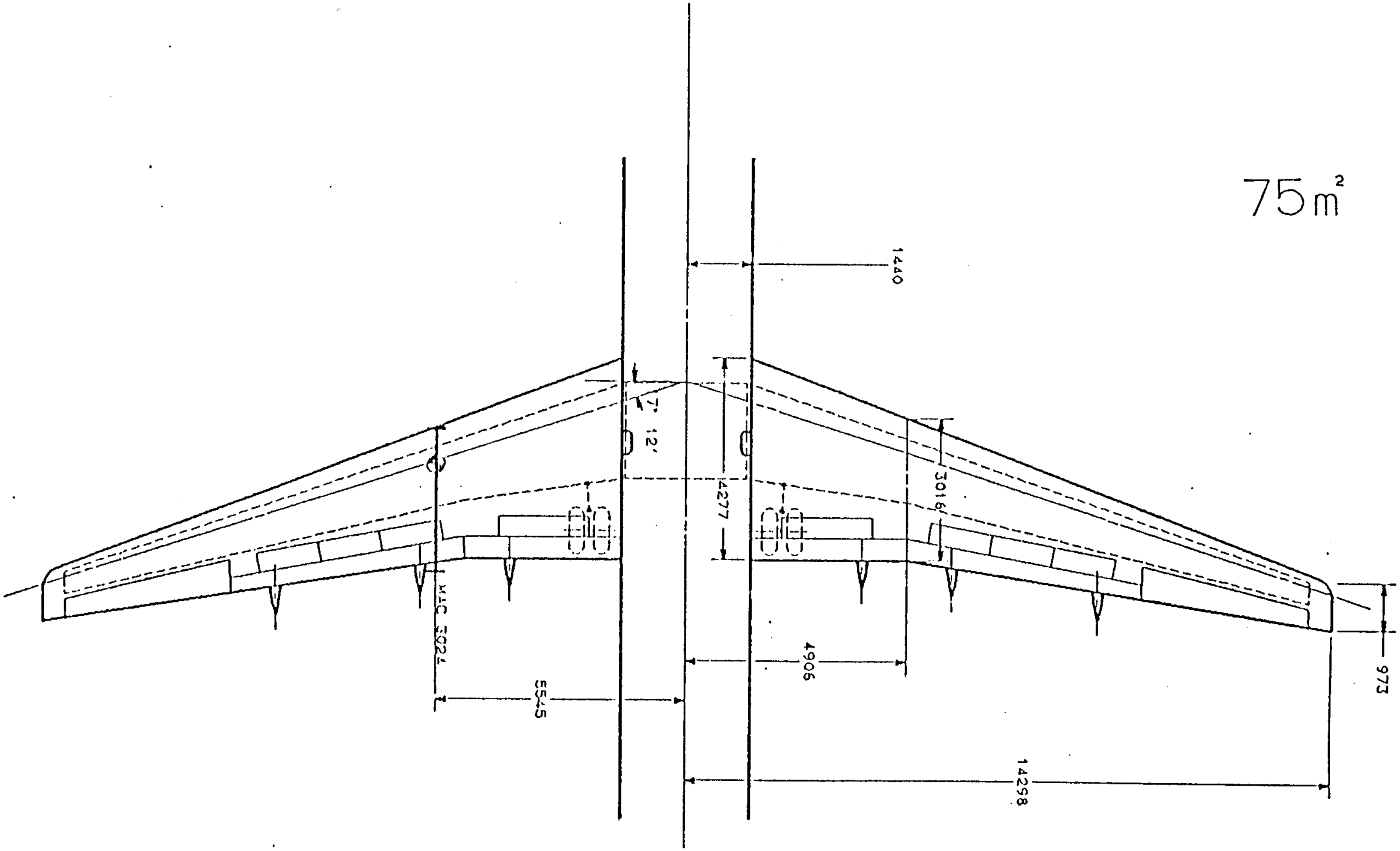
Type and location of the root panel joints are not yet finally decided. One design under study provides for only one skin joint located at the fuselage centre line. In all cases the skin joints are of double-spliced shear-loaded design.

The main landing gear attachment area is not yet decided. Under consideration is a separate metal beam located behind the rear spar designed and integrated into the rear spar in such a way that it is capable of withstanding the high loads sustained by the landing gear in the crash case. The beam box is a single component running through the fuselage.

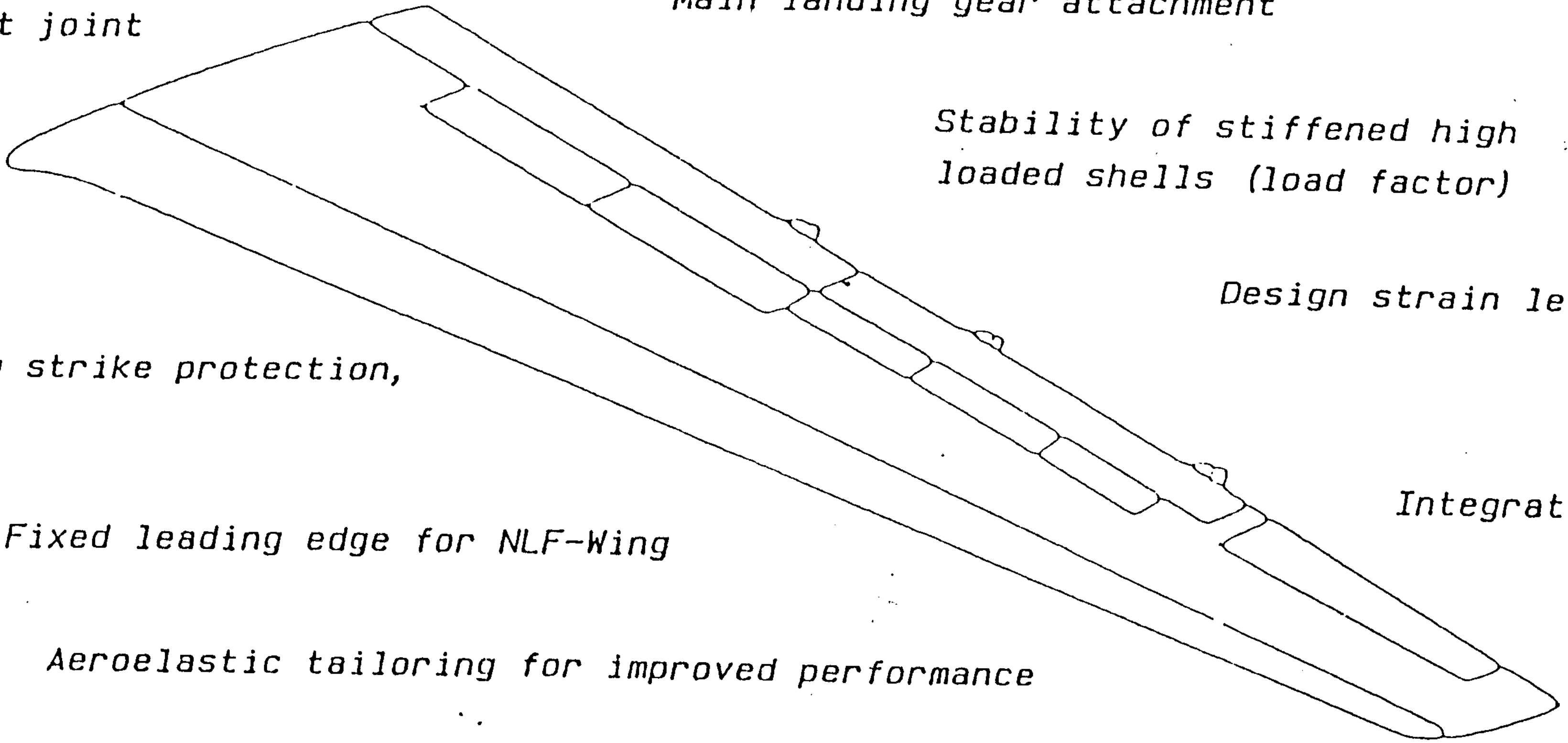
The wing skins are designed and manufactured as stringer stiffened integrally monolithic shells. The integrally stiffened front spar web is rivetted to the flanges integrated in the upper and lower skins during assembly. The rear spar is also designed as an integrally stiffened web containing one flange for the connection with the lower skin panel.

Three types of ribs will be installed: heavily loaded ribs at load introduction stations e.g. flap track positions, undercarriage pick-up, etc., supporting ribs and sealing ribs in connection with the fuel tank and venting system. Design and manufacturing technique of the ribs will be chosen in accordance with the local requirements.

Wing Geometry



Key Points for Wing Development



nel root joint

Main landing gear attachment

Stability of stiffened high loaded shells (load factor)

Design strain level

ightning strike protection,
MC

Integrated fuel tan

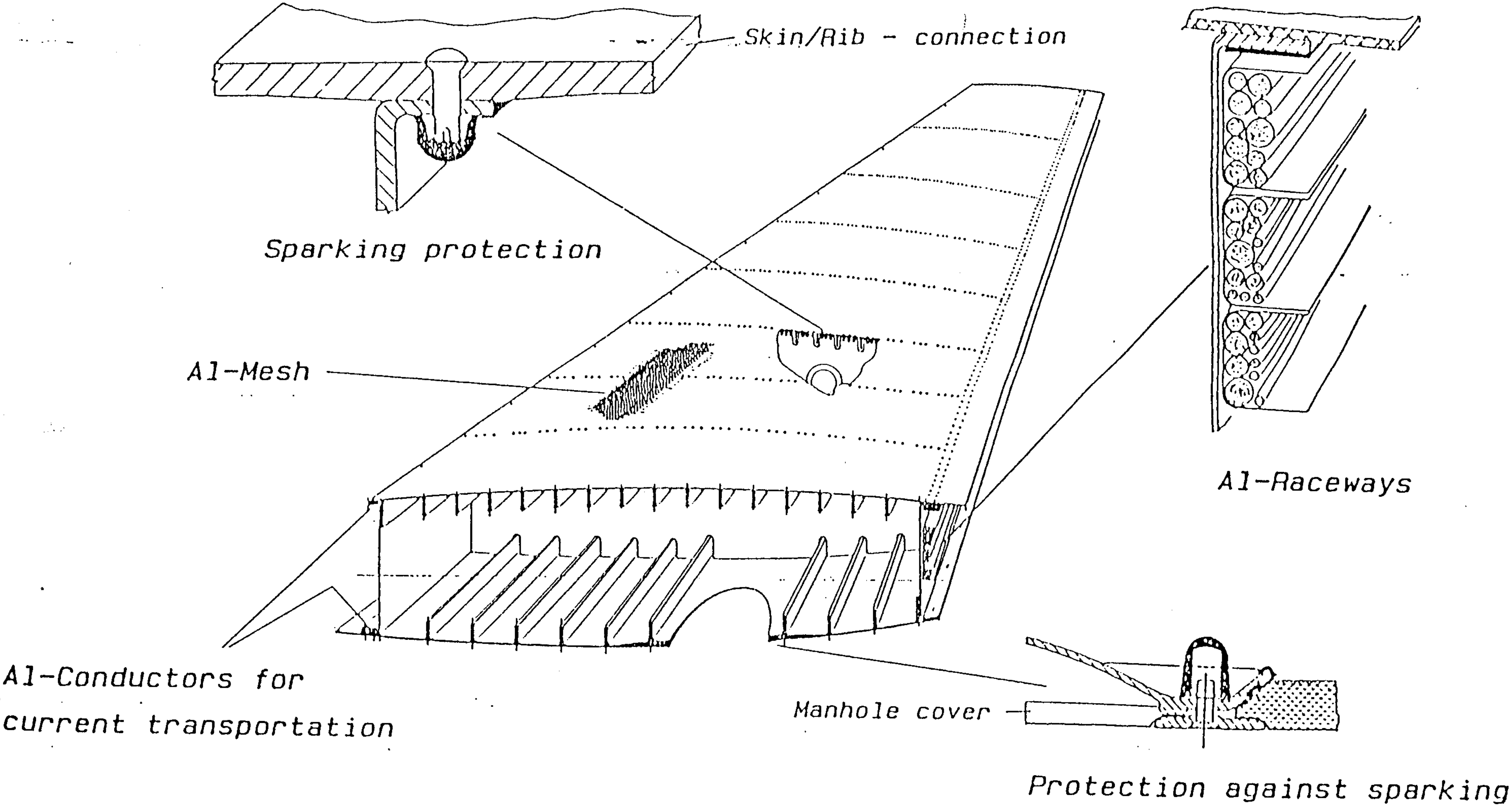
Fixed leading edge for NLF-Wing

Aeroelastic tailoring for improved performance

Impact tolerant design (I T D)

Advanced CFRP material

Preventive Measures against Lightning Strikes.



4.8 TAIL

4.8.1 Fin and Rudder

The MAC quarter chord of the vertical stabilizer is positioned 26803 mm aft of the aircraft nose and 10146 mm aft of the wing MAC quarter chord respectively.

The vertical tail is moderately tapered from consideration of the installation of the horizontal tail at the top. The fin box is of three-spar design with the spars running at constant chord.

The rudder is split and double hinged at approx. 70% and 85% respectively.

Structurally the fin is integrated with the aft fuselage structure. The fin and rudder are constructed of carbon fibre reinforced material. Leading edges are of honeycomb construction covered with composite material.

4.8.2 Horizontal tail

The MAC quarter chord of the horizontal stabilizer is positioned 29539 mm aft of the aircraft nose and 12882 mm aft of the wing MAC quarter chord respectively. It is of trimming type with a travel ranging up to -14 deg.

The main box is a two-spar design with both spars running constant chord. It comprises of two swept boxes joined at the centre line. The elevators are hinged at approx. 70% chord.

Structurally the horizontal tail box is attached to the top of the fin box by a hinge aft of the rear spar and the trim actuator attachmment forward of the front spar. The horizontal tail is constructed of carbon fibre reinforced material. Leading edges are of honeycomb construction covered with composite material.

4.9 LANDING GEAR

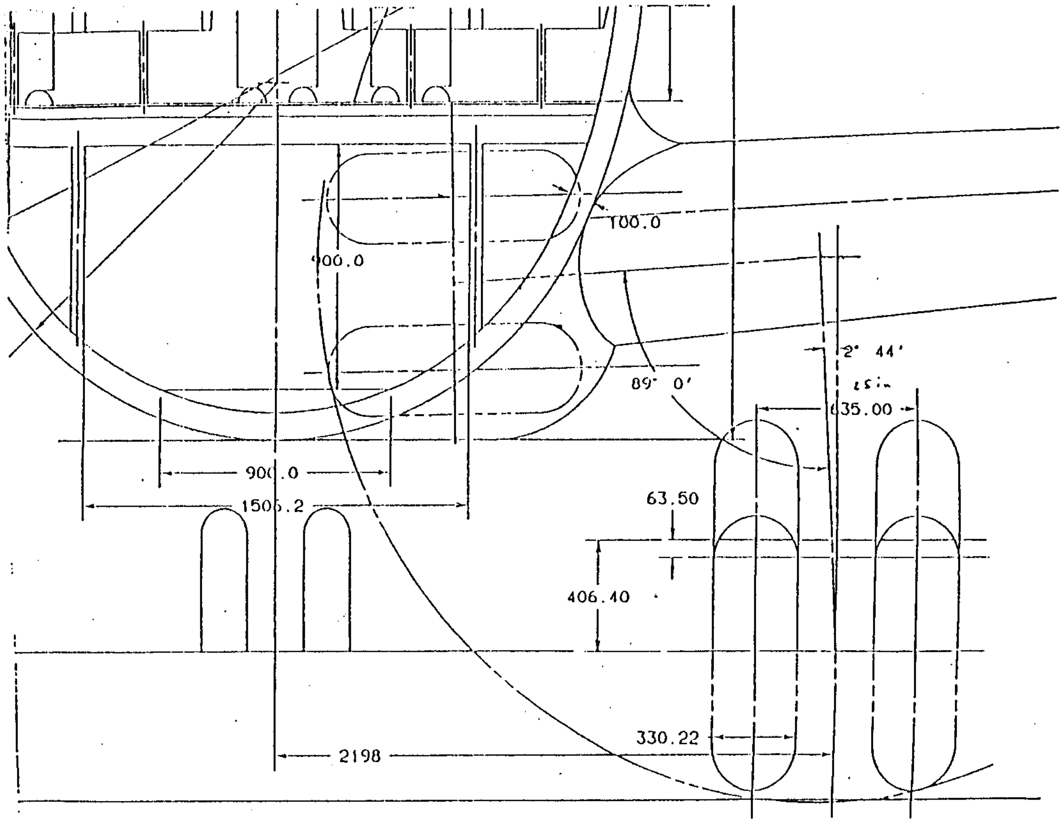
The MPC 75 aircraft configuration calls for a main landing gear at 71% AMC on the ground with sideways retraction and dual wheels. A slight inboard inclination angle of the main landing gear leg and skewed trunnions supported by structure aft of the rear wing spar permits stowage of the main landing gear with a wheel spacing of up to 25 in. and tyre sizes of 39 in. x 13 in. into the landing gear bay situated in the lower lobe of the fuselage aft of the wing centre-section.

The landing gear is of steel construction with carbon fibre, anti-skid brakes and radial tyres. Consideration will be given to the use of high strength aluminium alloys or powder metallurgy aluminium if fatigue/corrosion problems can be overcome.

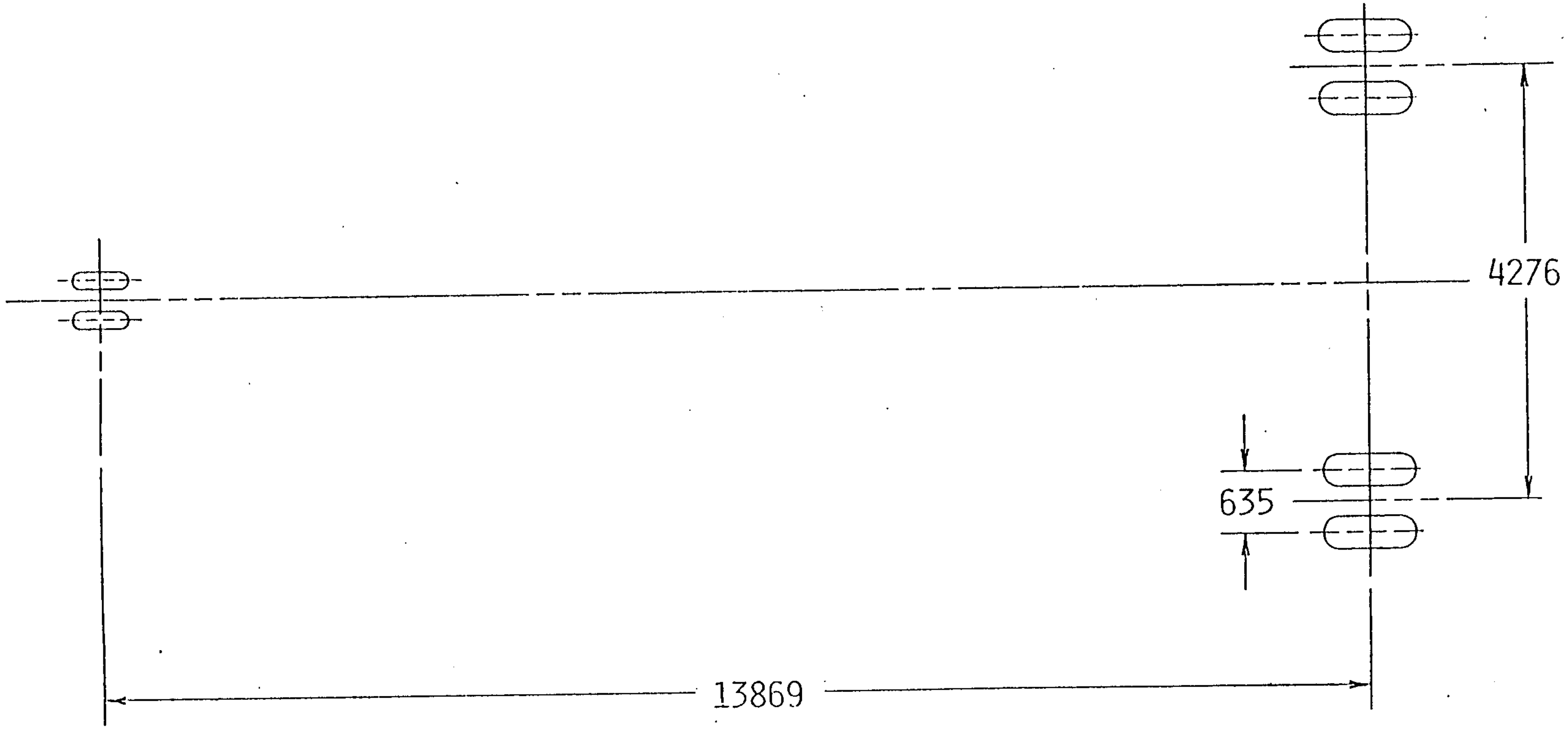
The main landing gear track of 4276 mm. and the total compression travel of 16 in. give sufficient aircraft ground stability. The wheel spacing ranging between 21 in. and 25 in. and the tyre sizes of 38 in x 11 in and 39 in x 13 in and actual tyre pressures between 104 - 140 psi result in suitable ACN values in the range of 16 to 18 for rigid as well as flexible runway surfaces.

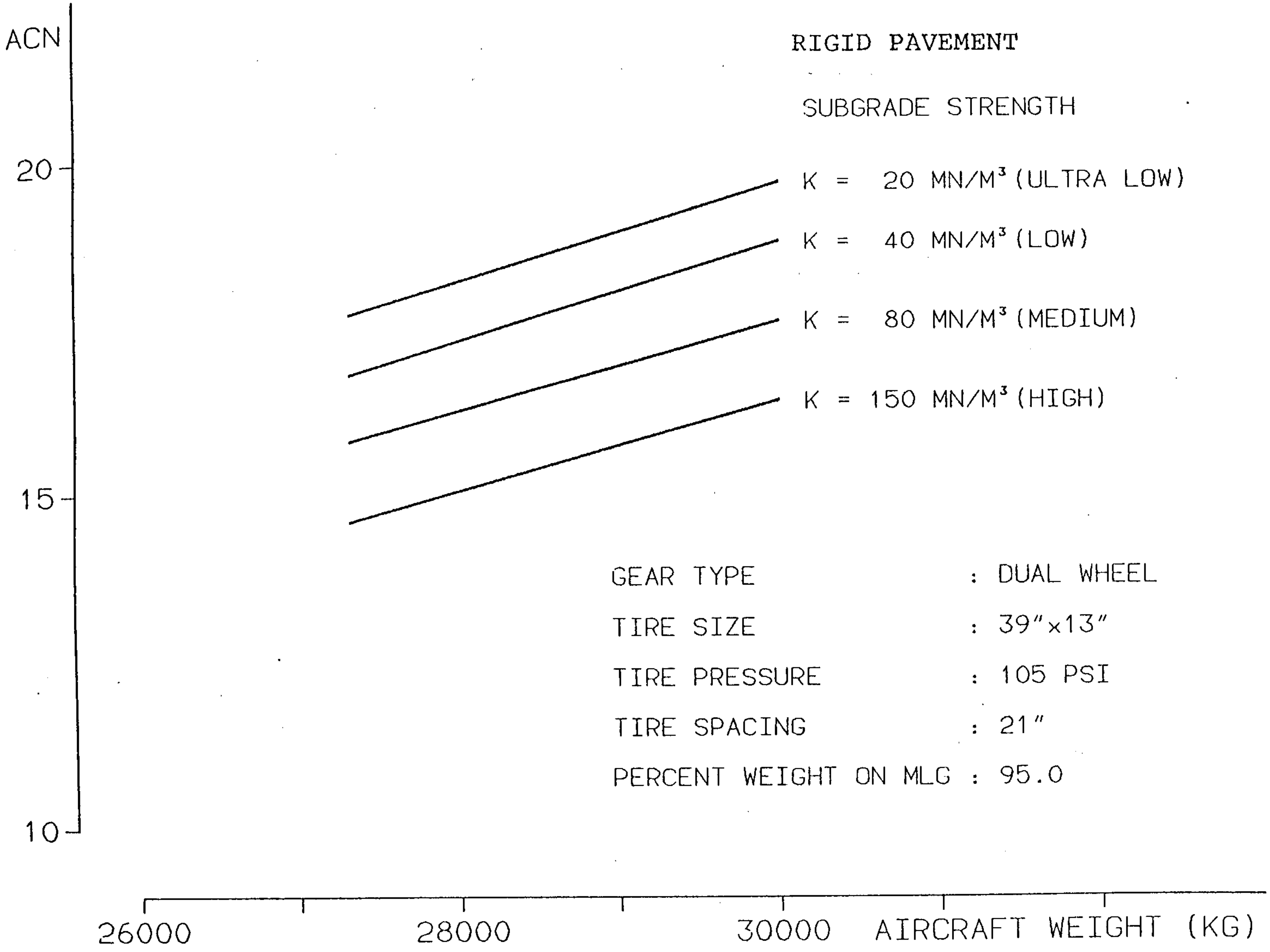
Further information on the landing gear is given under Systems (ATA Chapter 32).

Landing Gear Installation

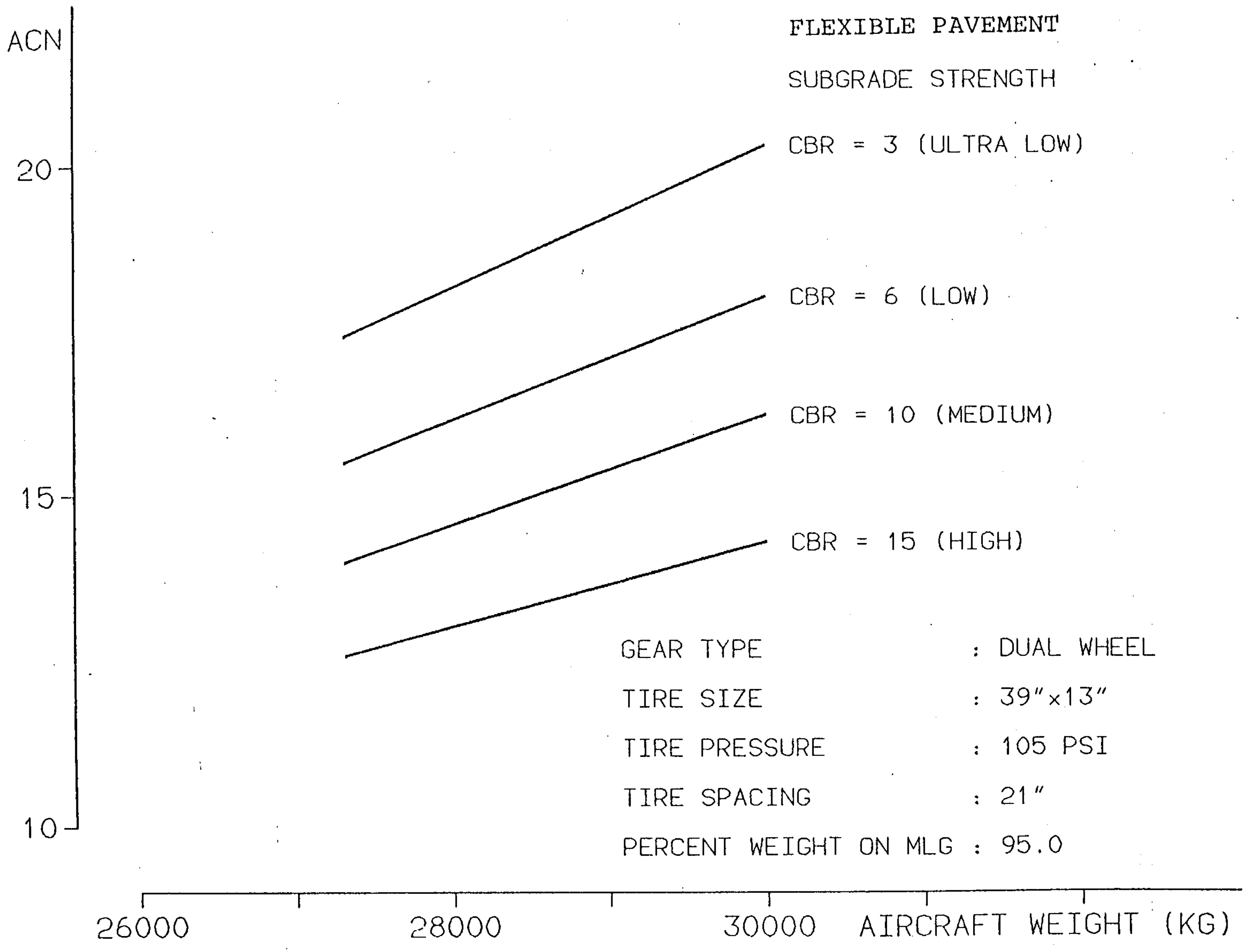


Landing Gear Geometry





GEAR TYPE : DUAL WHEEL
TIRE SIZE : 39″x13″
TIRE PRESSURE : 105 PSI
TIRE SPACING : 21″
PERCENT WEIGHT ON MLG : 95.0

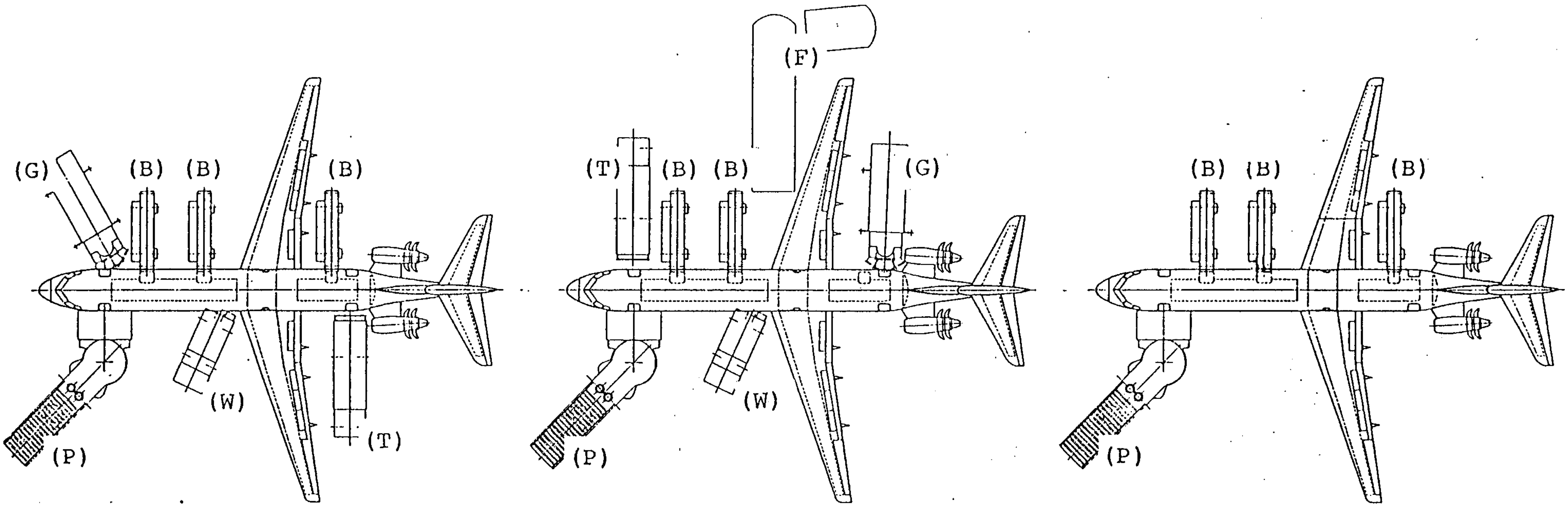


GEAR TYPE : DUAL WHEEL
TIRE SIZE : 39″x13″
TIRE PRESSURE : 105 PSI
TIRE SPACING : 21″
PERCENT WEIGHT ON MLG : 95.0

4.10 GROUND HANDLING

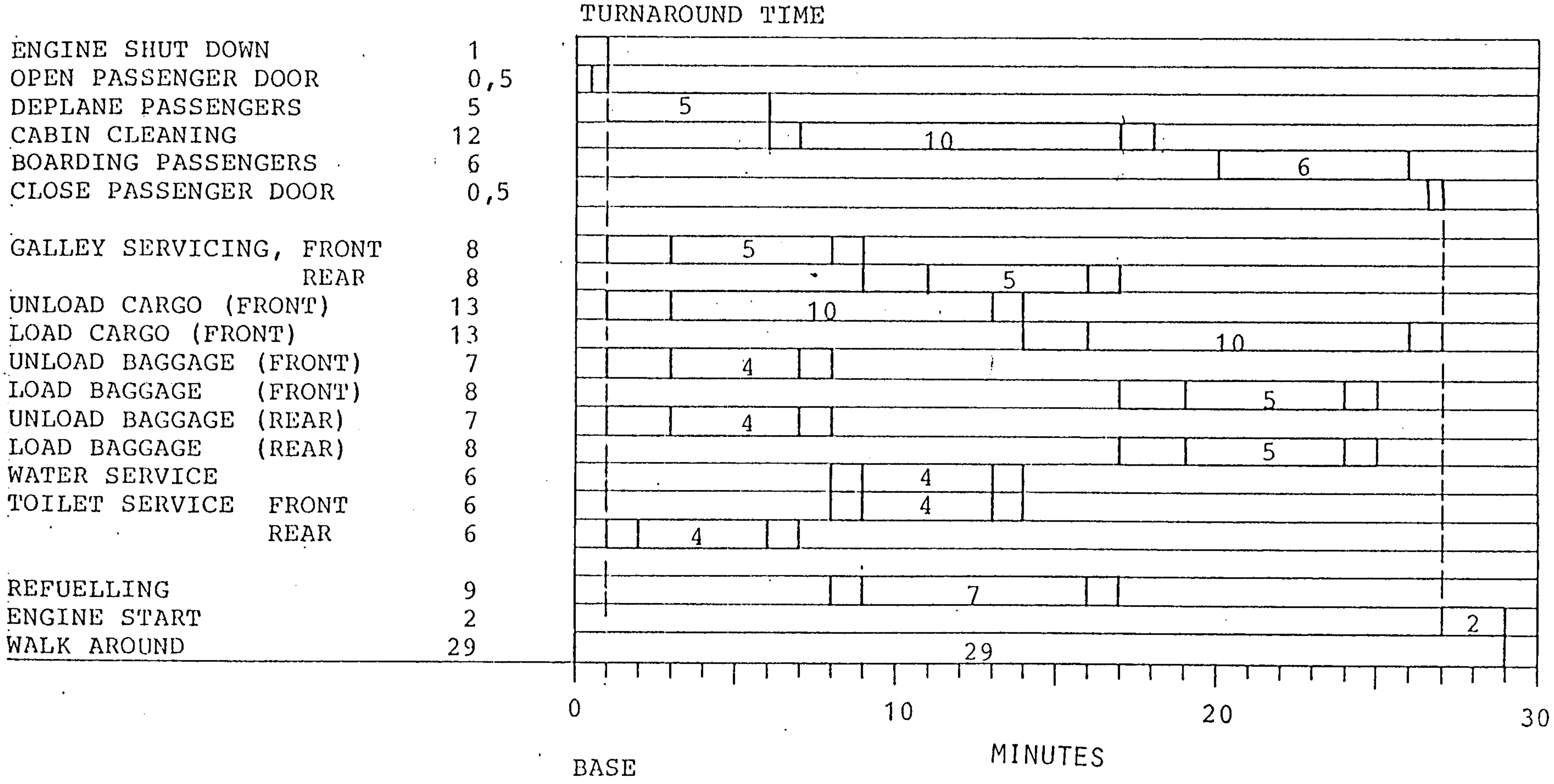
The aircraft is easily accessible to ground service vehicles (see Diagram).

Turn-around times of less than 30 minutes are possible. Times for individual phases are shown in diagram. Critical time is the unloading and loading of the bulk cargo compartments.



(T) TOILET SERVICE
(G) GALLEY SERVICE
(W) WATER SERVICE
(F) FUEL VEHICLE
(B) BULK/CARGO LOADER
(P) PASSENGER BRIDGE

Turnaround Time



5.0 SYSTEMS (IN ATA CHAPTER ORDER)

5.1 AIR CONDITIONING SYSTEM (ATA21)

GENERAL

Air conditioning shall be provided by two vapour cycle packs using air from main engine shaft driven compressors. Pressurization will be achieved by controlling the outflow of cabin air.

PERFORMANCE

Minimum fresh airflow requirements

Total 0,554 kg/s at S. L. and 0,411 kg/s at 8.000 ft cabin
Loss of one air source: 0,37 kg/s at S. L. and
0,275 kg/s at 8.000 ft cabin.

CABIN TEMPERATURE

In flight with two packs, flight deck and cabin temperature shall be selectable in the range 18° C - 30° C.

On ground with two packs, flight deck and cabin temperature of 21° C (cold day) or 27° C (hot day) shall be achieved within 30 minutes of system start.

Ground and flight operation with one pack shall ensure acceptable temperature in flight deck and cabin.

CABIN PRESSURE

Maximum differential pressure shall be 8,0 psi. At 35.000 ft cruise, cabin altitude will be 7.000 ft.
(Note that Δp = 8,0 psi gives theoretical ECS capability up to 38.500 ft.)

AIR CONDITIONING SYSTEM

The main engine shaft driven compressor shall provide the necessary speed control and airflow regulation.

The air/air heat exchanger is used to reduce cooling load of the evaporator at conditions of high compressor supply temperature. Temperature control is achieved by varying the vapour cycle circuit control and the position of the ram air exit door.

The refrigerant compressor is driven by electric motor. The motor and expansion valve are controlled automatically.

The water being drained from the evaporator is injected into the condenser cooling air inlet to increase cooling efficiency. The ground fan provides condenser cooling air during ground operation.

The evaporator is located inside the pressure fuselage with the refrigerant pipes passing through the pressure bulkhead to the main part of the pack.

Recirculation air must be introduced upstream of the evaporator inside the pressure fuselage. The recirculation fan shall have variable speed to meet cabin cooling/heating requirements particularly during ground cooling/heating mode (cooling/heating can be achieved with recirculation air only).

The electric heater is installed in the duct downstream of each pack primarily for use in cold day ground operation. The smaller heater in the flight deck supply duct provides a higher flight deck supply temperature when required.

The overall system will be controlled by an airborne computer.

PRESSURIZATION SYSTEM

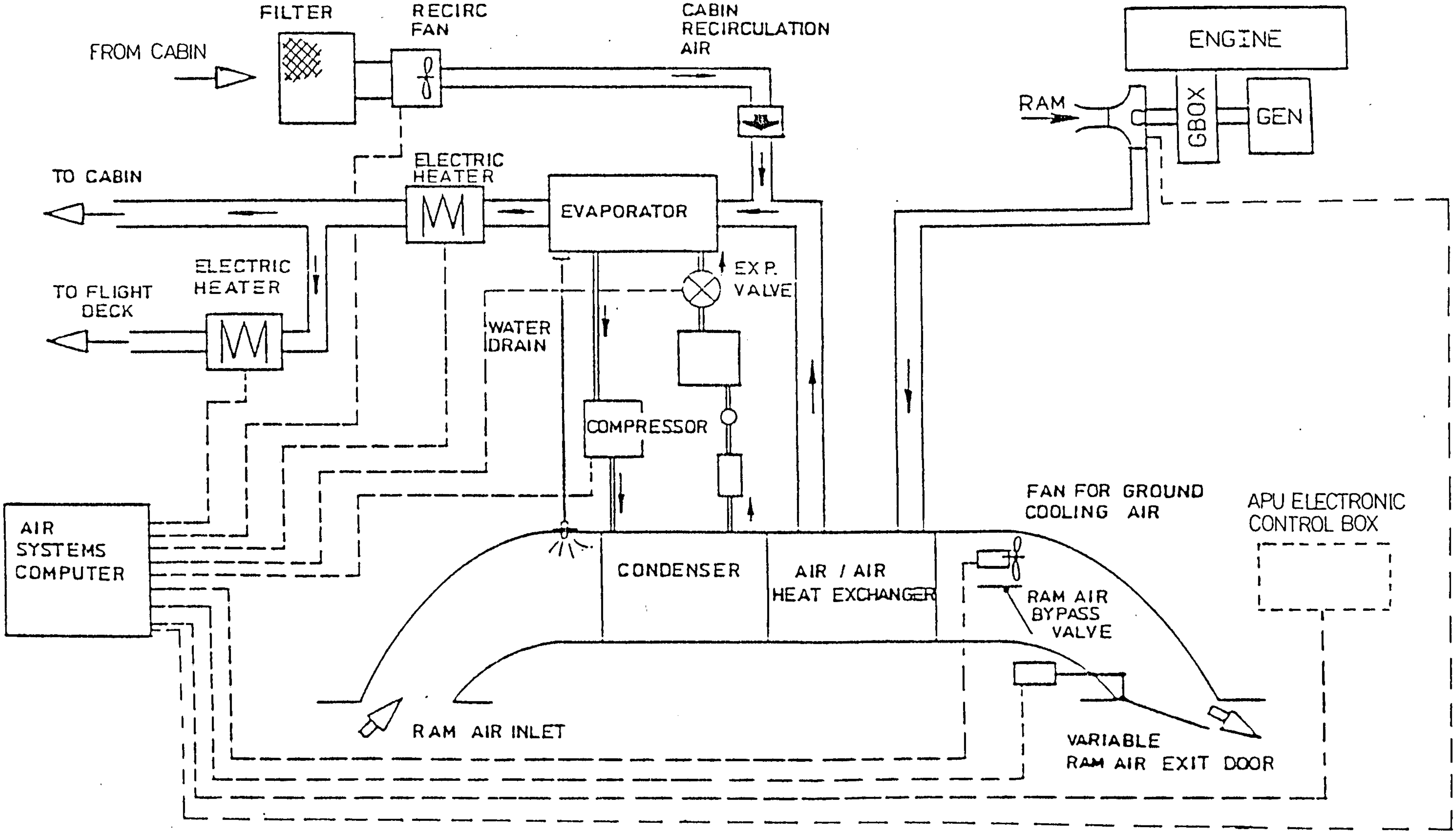
The cabin shall be pressurised up to a nominal pressure of 8,0 psi by restricting the outflow of the cabin air via an outflow valve. The outflow valve shall be designed to provide thrust recovery.

The system shall automatically control the cabin pressure rate of change and cabin altitude.

Two identical, independent, pneumatically operated safety valves shall be installed to provide positive and negative cabin pressure relief.

Loss of one air source shall not significantly affect cabin pressure control.

Environmental Control System Schematic Diagram



5.2 AUTOMATIC FLIGHT CONTROL SYSTEM - AFCS (ATA 22)

PREMISE

A fail operational fly by wire flight control system with mechanical manual backup will be available to fulfill manoeuver demand control functions (pilot input and stabilisation for all axes), flight envelope protection, turn coordination and auto trim functions. In addition full authority digital engine control (FADEC) will be used with engine protection functions.

AUTO FLIGHT SYSTEM (AFS)

In the basic configuration a fail passive autoflight/flight director system with category II approach capability will be installed (AFS 1) to transmit commands to the fly by wire system and the FADECs.

The basic modes of the system will be

- longitudinal: vertical speed hold, altitude hold, level change,
- lateral: heading hold/heading select, VOR/LOC mode,
- approach mode (ILS beam) to minimum use height,
- speed/mach mode.

There are provisions for

- land, go around mode, take off,
- ILS roll guidance.

There are provisions for a 2nd autoflight system for improved system integrity needed for CAT III landing capability. The above mentioned provisional modes can be activated with the 2nd AFS installed only.

FLIGHT MANAGEMENT SYSTEM

Optional Flight Management Capability (FMS 1) will be available in two levels of performance by add on hardware

level 1: lateral, vertical and speed (4D-)guidance based on flight plan conditions and navigation sensor information,

level 2: flight path/flight plan optimization based on airframe and engine models airline cost index and actual flight conditions (ATC, weather);

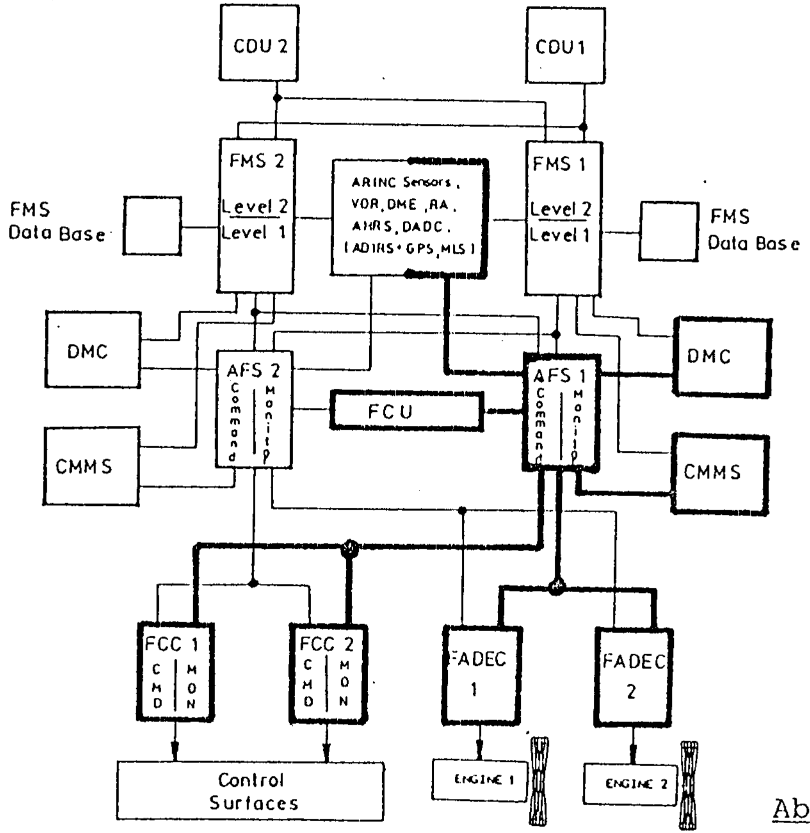
For increased dispatchability there are provisions for a 2nd flight management system (FMS 2).

CREW INDICATION AND CONTROL

Informations for indications (selected targets, modes, system status) will be transmitted to DMCs, system failures and disconnects are transmitted to CMMS; pilot inputs are provided for

AFS on a dedicated flight control unit (FCU, glare shield controller),
FMS on a multipurpose control and display unit (CDU, central pedestal).

Automatic Flight Control Schematic Diagram



━ Basic System

— Options

Abbreviations

FMS	Flight Management System
FCU	Flight Control Unit
AFS	Automatic Flight System
FCC	Flight Control Computer
CDU	Control and Display Unit
FADEC	Full Authority Digital Engine Control
DMC	Data Management Computer
CMMS	Centralized Monitoring and Maintenance System

5.3 COMMUNICATIONS (ATA23)

The aircraft will be equipped with the following communication systems:

- two VHF-radio systems,
- two HF-radio systems (structural provisions),
- two RMP (Radio Management Panel),
- an audio integration system (incorporating flight interphone amplifier and SELCAL decoding) and ground crew call system,
- a cockpit voice recorder (CVR),
- a cabin intercommunication data system (CIDS), incorporating passenger address (PA) system, cabin and flight crew interphone and service interphone system and
- portable megaphone.

Adequate space is provided to allow for systems growth and development during the operational life of the aircraft.

Static dischargers are installed on the wing and tail unit trailing edges to minimize corona discharge interference.

All of the communication systems except CIDS use solutions according to the state of the art.

An advanced technology system design is used for CIDS based on a microprocessor controlled data bus to provide improved passenger comfort, reduced crew workload and increased flexibility to customer desires.

5.4 ELECTRICAL POWER (ATA 24)

The main electrical power generation consists of a variable speed constant frequency (VSCF) system with two engine driven generators and their associated multiple-output converters. According to the electrical load estimate each generator has a capacity of max. 75 KVA. The generators deliver 115/200 V wild frequency AC power to the electrical distribution system, where one part of it is used to feed the heating equipment whilst the other part shall be converted to 115/200 V 400 Hz AC and to 28 V DC power.

The auxiliary generator driven by the APU is mainly used for ground service purposes. This generator with 115/200 V 400 Hz AC power output and a power of 90 KVA can also substitute an engine driven generator if the engine or the associated generator has failed. In case that the APU generator is feeding the electrical system with AC power, the associated DC busses will be fed via a transformer rectifier unit (TRU).

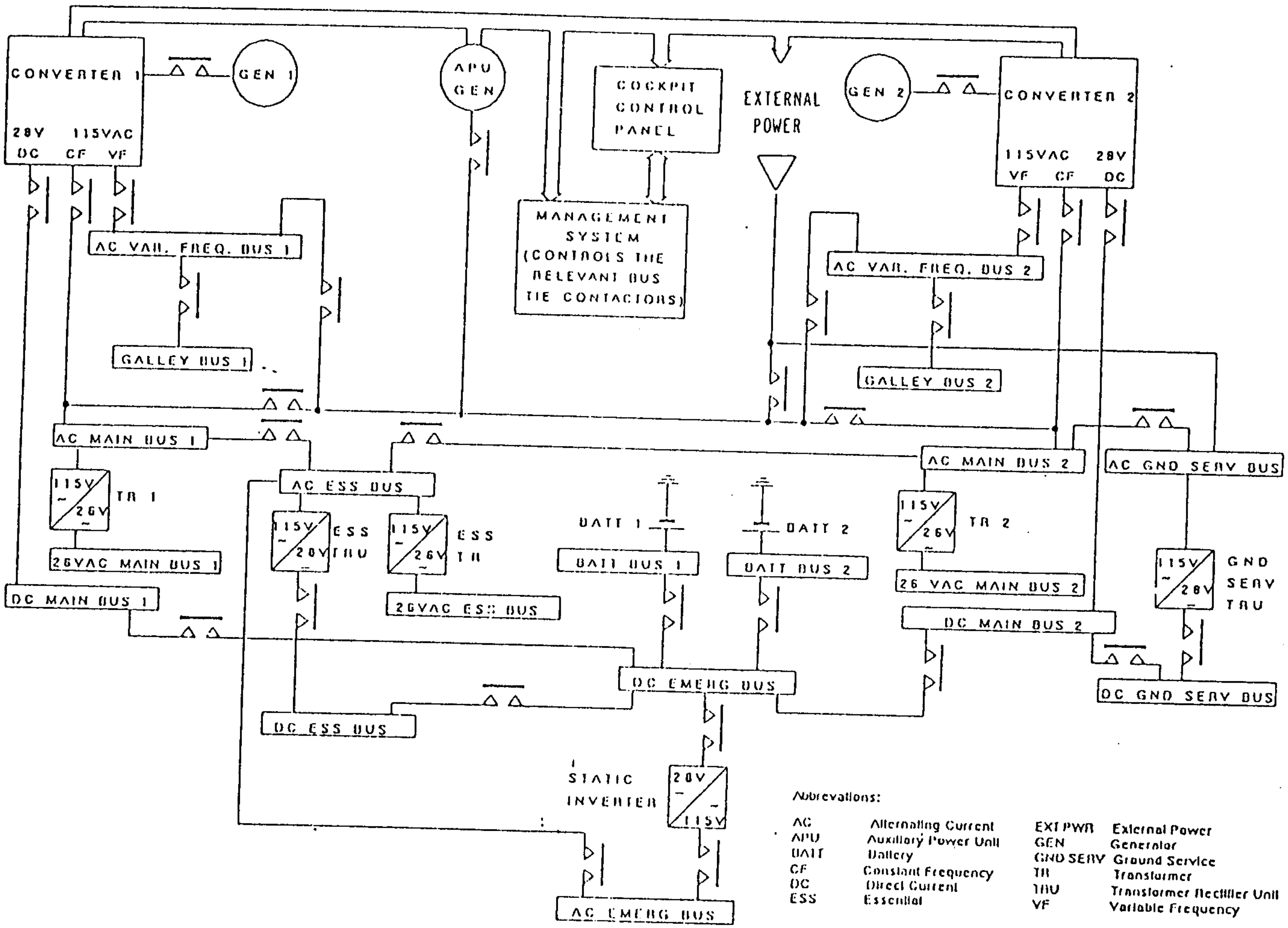
Two batteries and one single phase static inverter provide emergency power. The batteries can also start the APU. A 115/200 V 400 Hz AC ground power source can be used for ground service purposes via the EXT PWR connector.

An advanced power distribution management system will be implied to achieve

o failure management, remote circuit breaker and bus tie contactor control,
o load monitoring and priority administration,
o system status data processing for indication and maintenance purposes

thus minimising generator power and wiring complexity and weight.

Electrical Power Schematic Diagram



Abbreviations:

AC	Alternating Current	EXT PWR	External Power
APU	Auxiliary Power Unit	GEN	Generator
BATT	Battery	GND SERV	Ground Service
CF	Constant Frequency	TR	Transformer
DC	Direct Current	TRU	Transformer Rectifier Unit
ESS	Essential	VF	Variable Frequency

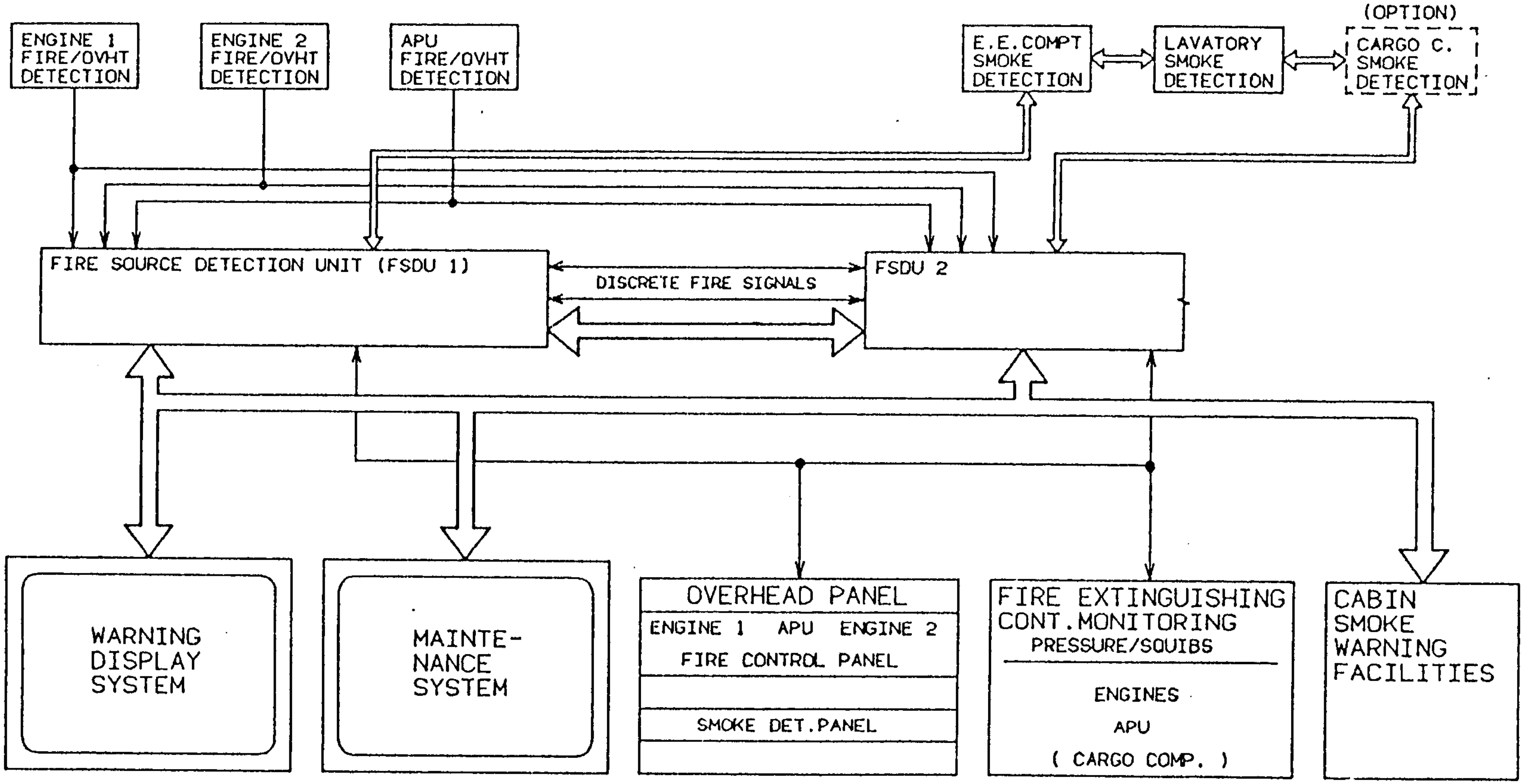
5.5 FIRE PROTECTION (ATA 26)

Aircraft fire protection systems with appropriate redundancy are provided for:

- engines and APU, comprising fire detection and extinguishing system,
- electronic bay with a smoke detection system,
- lower deck holds comprising an optional smoke detection system and if desired an optional fire extinguishing system,
- an automatic waste bin fire extinguishing system and smoke detectors in lavatories.

Additionally portable fire extinguishers are installed in the flight compartment and the passenger cabin.

Fire Protection Schematic Diagram



5.6 FLIGHT CONTROLS (ATA 27)

Primary and secondary flight control electrical signalling is integrated into the flight control computers (FCC), which include command shaping, flight augmentation, speed depending output limitation and sensor and computer failure monitoring functions.

Each primary control axis (roll, yaw and pitch) is supplied by two independent hydraulic systems and at least two independent electric power systems.

Each primary control axis is operated by duplicated electrohydraulic servo actuators with failure monitoring of each channel or alternatively (back up) by a single mechanical link from the pilot's control stations.

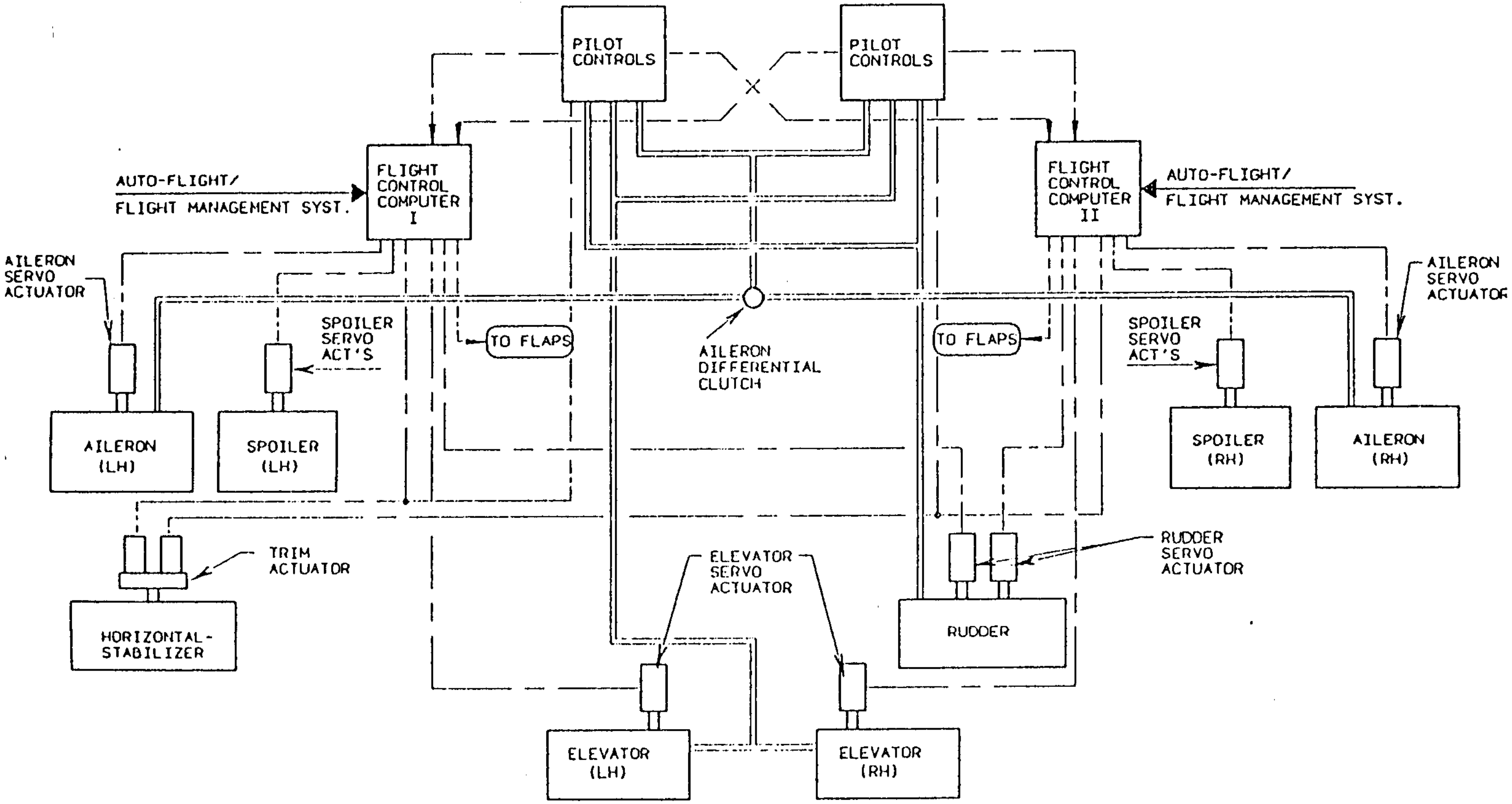
The electrohydraulic servo actuators are signalled from sensors located at the pilot's control stations or from the auto-flight system via duplicated flight control computers (FCC's) with failure monitoring of each channel.

The trimmable horizontal stabilizer is operated by a fail-safe designed electro-mechanical actuator which is driven by two independent electromotors via a differential gear box. The two motors are independently controlled by the pilot's control switches or by the autotrim-modes of the autoflight-system.

The flaps are operated by a mechanical transmission system driven by a centralized dual motor power drive unit and controlled by the pilot's control lever via the flight control computers (FCC's). The monitoring is provided by the FCC's.

The spoilers provide roll, airbrake and lift dump functions. Each spoiler is actuated by an electrohydraulic actuator and controlled by the pilot's roll controls, airbrake lever and/or auto-flight/land system via the two flight control computers (FCC's).

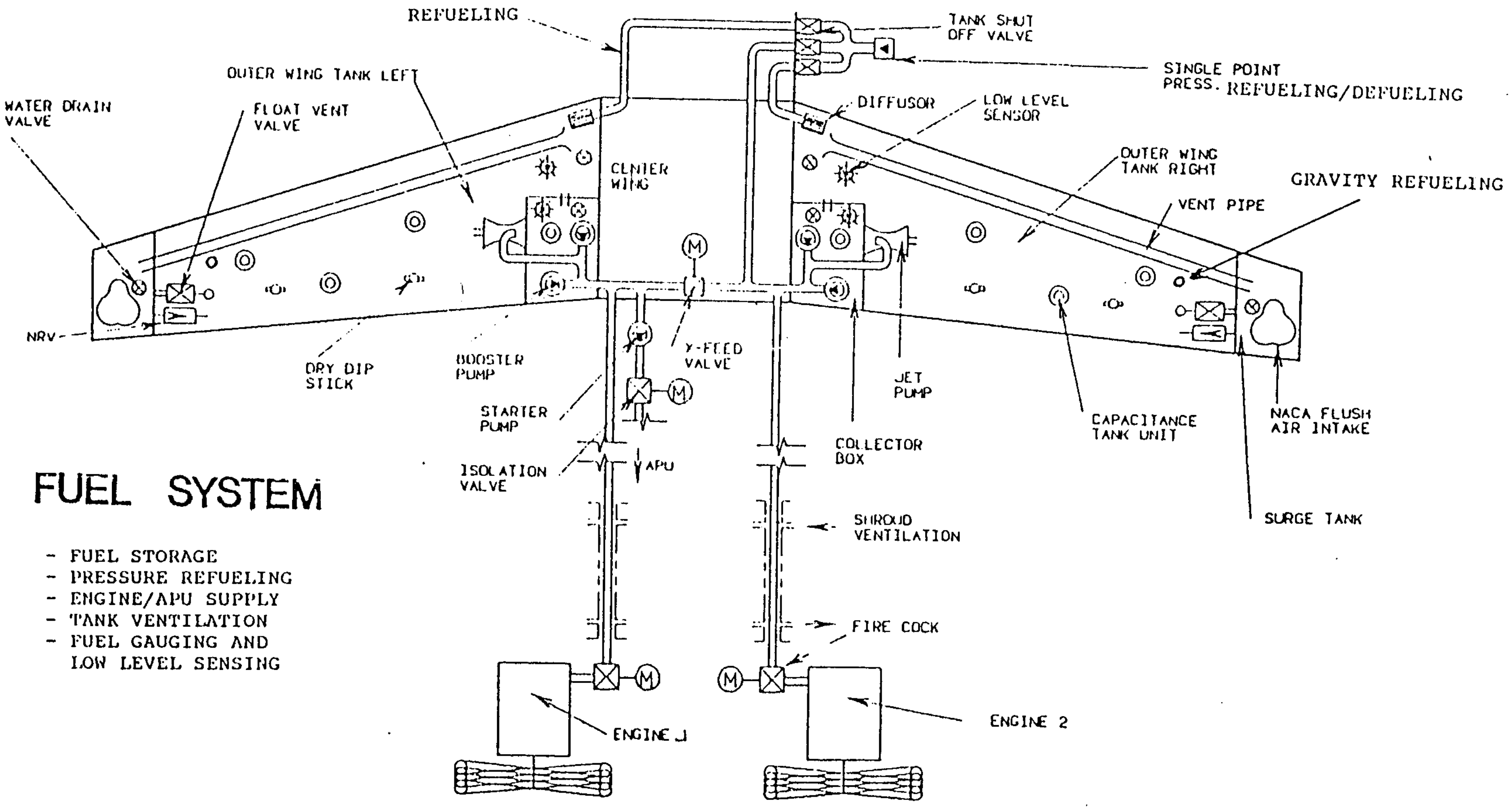
Flight Control System Schematic Diagram



5.7 FUEL SYSTEM (ATA 28)

- Fuel storage in both outer wing spar boxes (max. 6.150 kg total) (center wing box free for fuel capacity enlargement).
- A single pressure refueling/defueling point is located in the fuselage wing fairing within easy reach from the ground.
- Water drain valves at each low point of the tank.
- System segregation for each engine (left hand wing/right hand wing).
- X-feed connection between both fuel systems via X-feed valve.
- AC-driven canister type booster pumps, two in each wing tank installed in a collector box.
- Collector boxes filled up by jet pump to allow continuous operation also at negative "g" conditions.
- APU supply via X-feed duct, for starting the APU, a DC-driven in-line-pump to prime the system is used.
- Open tank ventilation system via surge tanks in each wing tip having flush type NACA air intakes.
- Ducts outside fuel tanks are double walled when installed in pressurized areas.
- Capacitance fuel gauging system as the main system with digital cockpit indication, using a fuel quantity indication computer.
- Independent low level sensing system to give a warning to the crew.
- Independent dry dip stick measuring device for on ground use only.

Fuel System Schematic Diagram



5.8 HYDRAULIC POWER (ATA 29)

Hydraulic power is used to operate high power demand services i. e. primary and secondary flight controls and landing gear systems.

The necessary degree of safety and reliability is achieved by application of the following principles:

- Redundancy of power supply and actuating components leading to adoption of two fully independent systems, each being pressurized by at least two independent means.
- Isolation
  - of the two systems from each other,
  - of unused, jammed or damaged users,
  - of large power consumers (landing gear and flaps) from the flight controls, which have priority in the event of pressure drops.
- Monitoring
  - Permanent monitoring with warnings in case of failures,
  - periodic monitoring by pre-flight checks.

The main functions and components are:

- The aircraft is provided with two independent hydraulic systems identified by the colours green and yellow, between which the users are shared in order to ensure aircraft control in the event of loss of one system. In the event of losing both systems, aircraft control is ensured by mechanical back up systems for flight controls and landing gear. In this case emergency braking is powered by a hydraulic brake accumulator in the yellow system.
- Each of two systems includes a reservoir which is air pressurized and compensates for variations in fluid volume due to user operation and which provides a reserve supply of fluid.

- The power generation consists of identical variable displacement pumps each driven by the related engine accessory gearbox.

- Each system is pressurized to 206 bars (3.000 psi).

- Hydraulic fluid shall be fire resistant and of the phosphate ester low density type IV.

- The auxiliary power generation includes:
  - Green system
    Bidirectional power transfer unit (PTU) pressurized by the yellow system, used in failure cases or on ground.

  - Yellow system
    Bidirectional power transfer unit pressurized by the green system, used in failure cases.

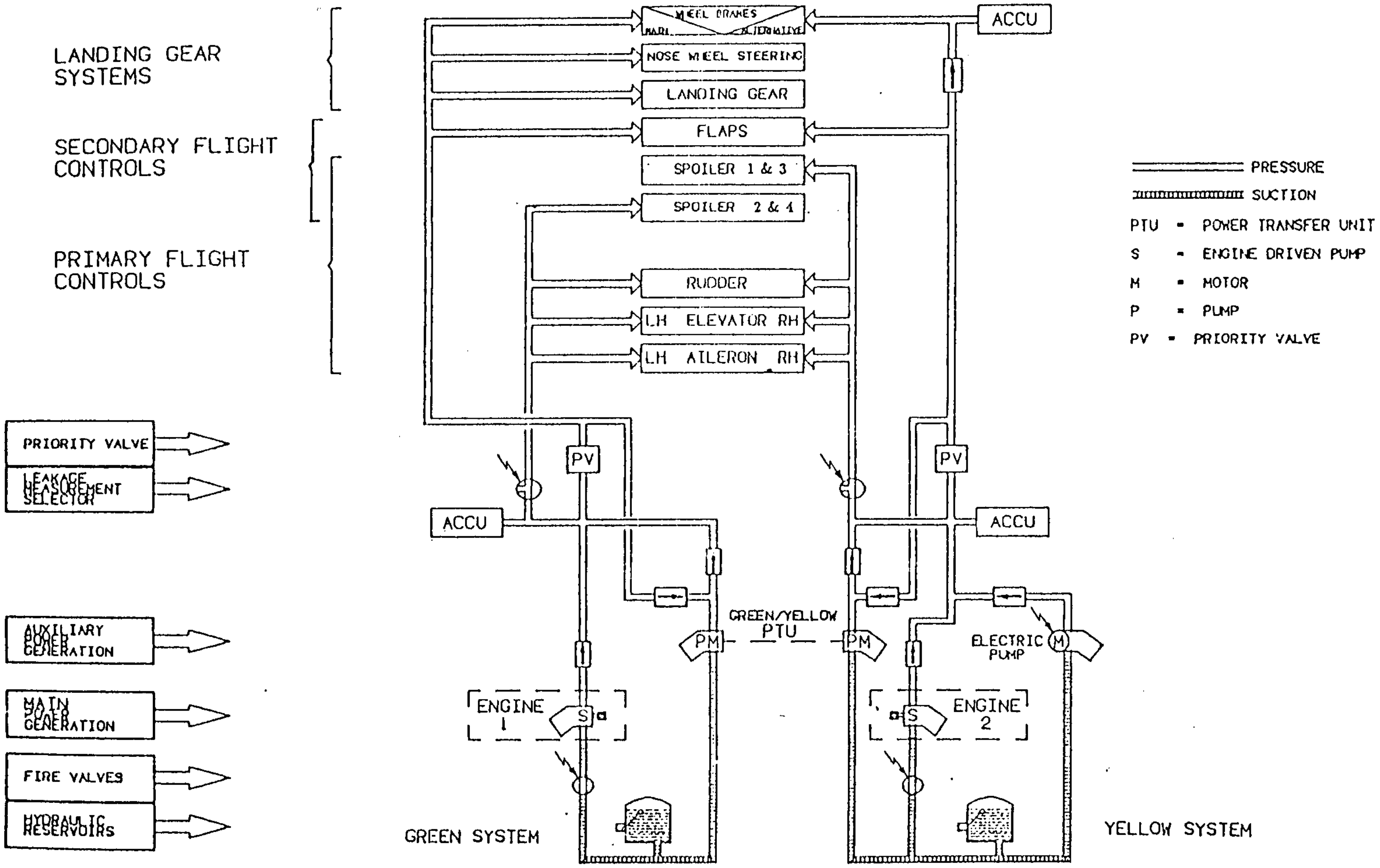
  - One electric pump, used on ground.

- The flight control servos are protected against high flow consumers by priority valves.

- The suction lines to the two engine driven pumps are equipped with fire shut-off valves which close when the fire handle of the respective engine is operated.

- Each of the two systems can be pressurized by a ground power unit. A handpump is located inside the fuselage on the green ground service panel to fill the selected reservoir from a standard container.

Hydraulic System Schematic Diagram



5.9 ICE AND RAIN PROTECTION INCL. CLEANING (ATA 30)

The aircraft will be certified for flights in icing conditions as defined by the Airworthiness Requirements without limitation.

The engines will be protected by the use of hot air from the engines.

Sensors, probes, windows and other parts, where necessary, will be protected by electrical heating.

The aircraft performance and handling will not be affected beyond reasonable limits by ice accumulation on unprotected areas.

Warning indications will be provided in the flight compartment for failures of important equipment.

Controls and indications will be provided in the flight compartment to enable the systems to be operated satisfactorily.

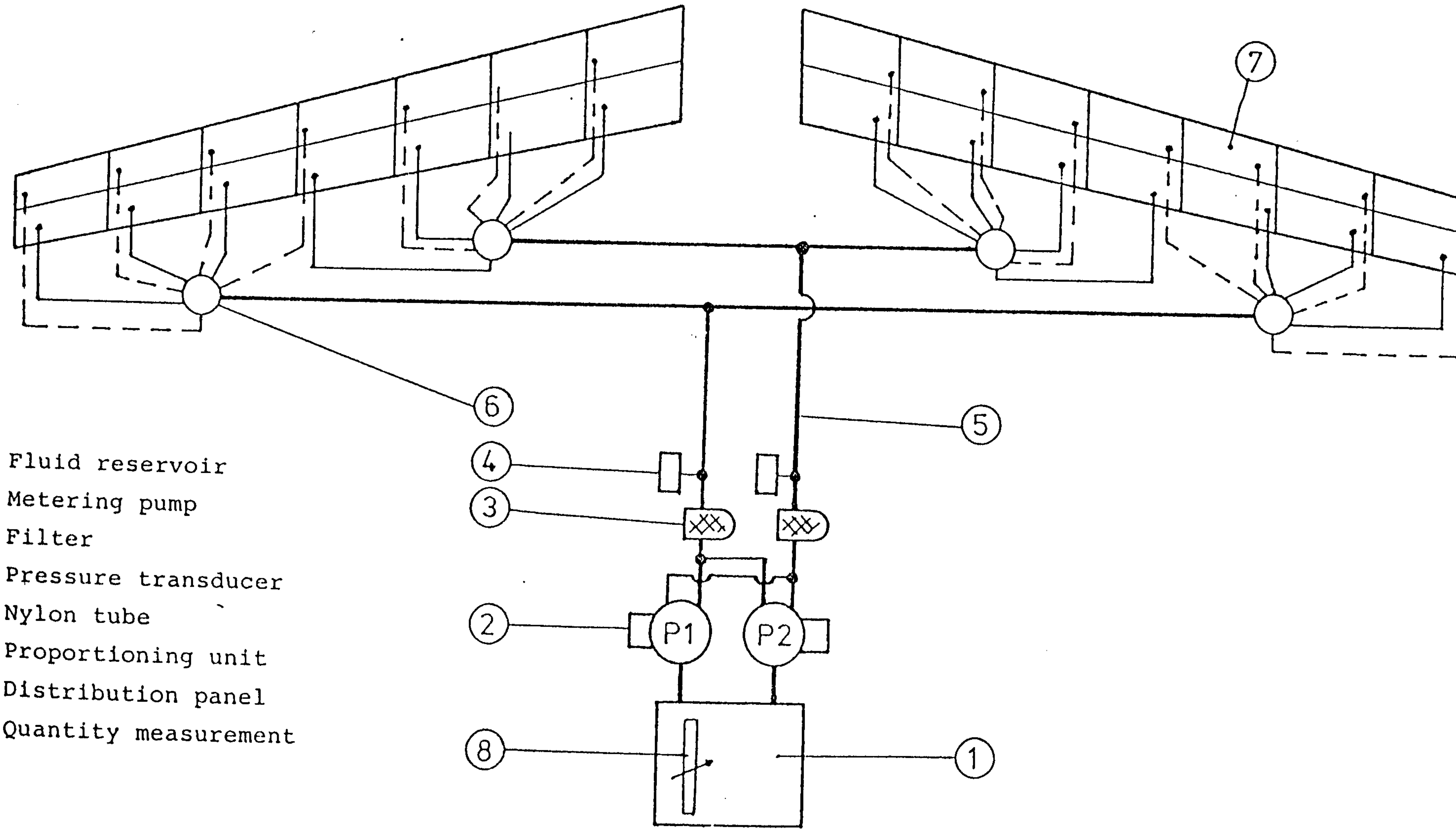
The system currently selected is a fluid ice protection system using perforated metal sheets which can be operated during all flight conditions from take off to landing.

The protected wing surfaces will be compatible with aerodynamic requirements.

The system promises to cover the cleaning aspects regarding insect contamination protection.

An ice protection system for the stabilizers is not required.

Ice Protection System Schematic Diagram



①	Fluid reservoir
②	Metering pump
③	Filter
④	Pressure transducer
⑤	Nylon tube
⑥	Proportioning unit
⑦	Distribution panel
⑧	Quantity measurement

5.10 COCKPIT AND INSTRUMENTS (ATA 31)

The cockpit will be a two men cockpit with all control panels within easy reach of the two crew members and a third seat for a flight observer.

The general arrangement of the instruments and controls is given in the main panel, central pedestal and overhead panel schematics.

An electronic instrument system (EIS) consisting of 6 interchangeable display units for primary flight displays (PFD) and navigation displays (ND) at each side and central engines and systems displays (CMMS) is provided. The EIS will have reconfiguration capability to select function priorities in case of display or symbol generator failures. Flat panel displays will be used as soon as available.

A minimum stand-by instrumentation will allow safe flight home in case of loss of EIS due to full loss of electrical power.

A centralized maintenance and monitoring system is provided using engines and systems displays and incorporating all centralized warnings.

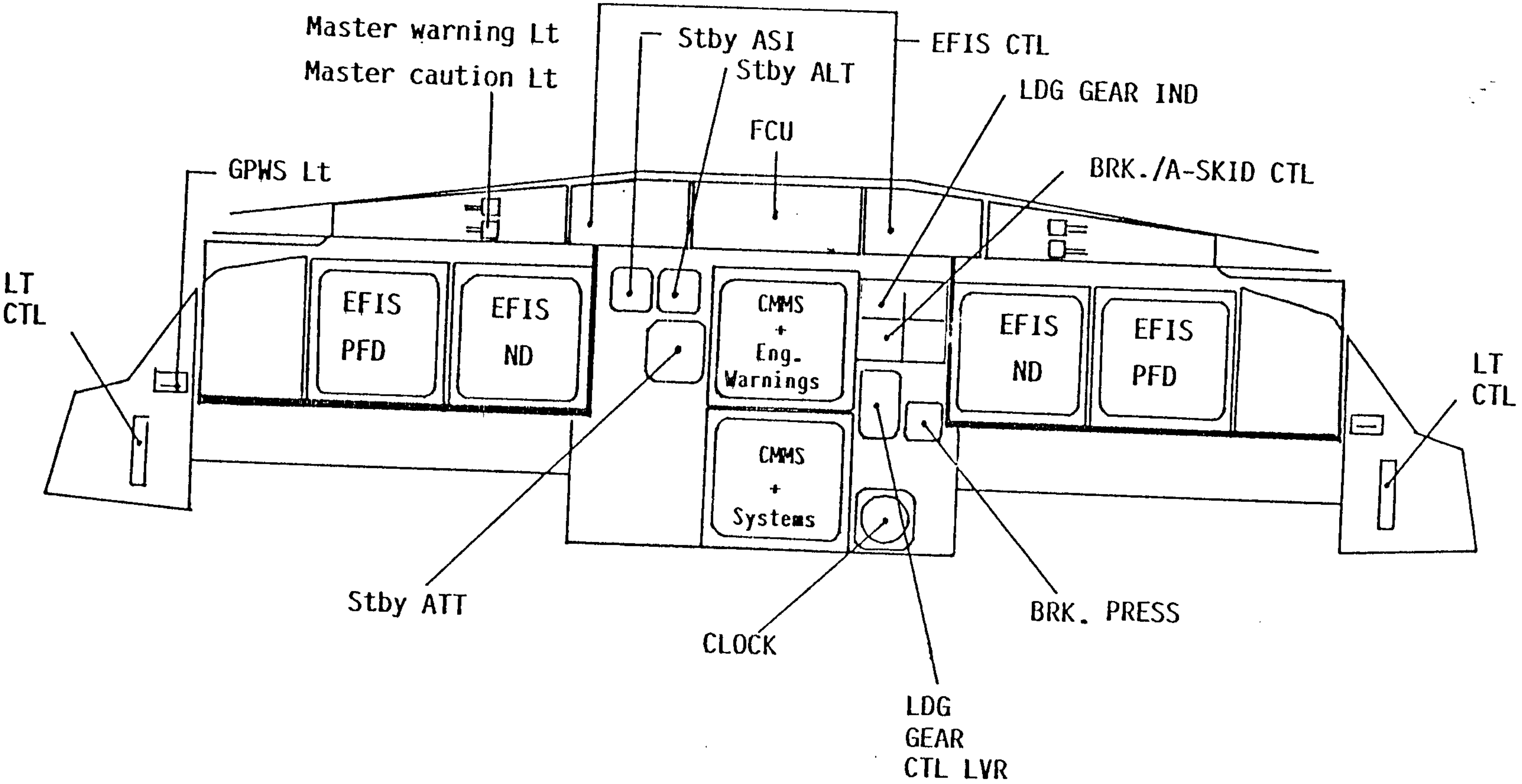
Push button technology will be applied - wherever possible - instead of switches; function and warning lights will only appear depending on pilots need to know or if it is required.

The intercommunication standard between avionic equipment will be ARINC 429. Depending on hardware availability, system maturity and data rate necessities ARINC 629-standards will be applied, if useful in mixed versions with ARINC 429.

The new racking concept replacing ARINC NIC600 will be applied depending on systems availability and maturity and customer requirements.

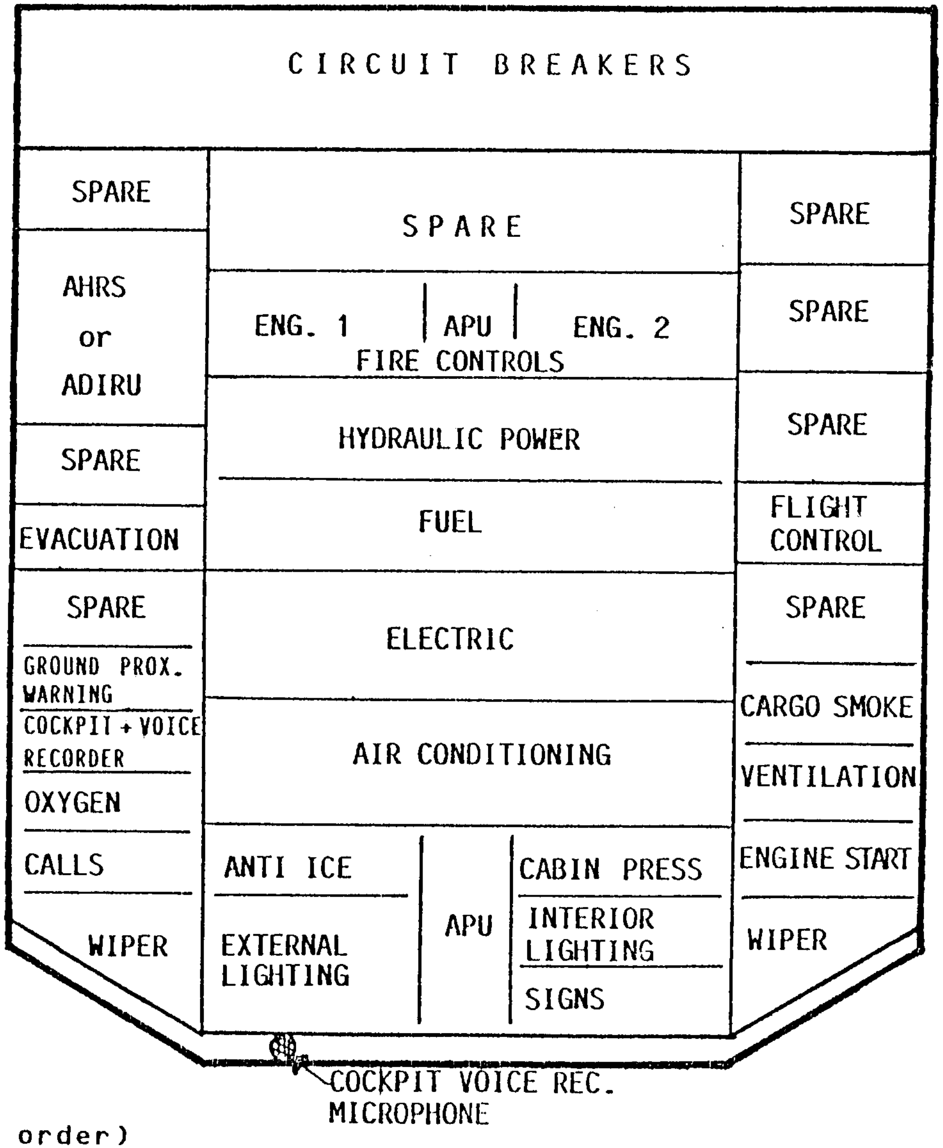
Fibre optics will be used for crosscommunication between lanes in redundant computer systems to reduce EMI and lightning strike interferences, to achieve decoupling of voltage potential.

Cockpit - Main Panel/Glare Shield

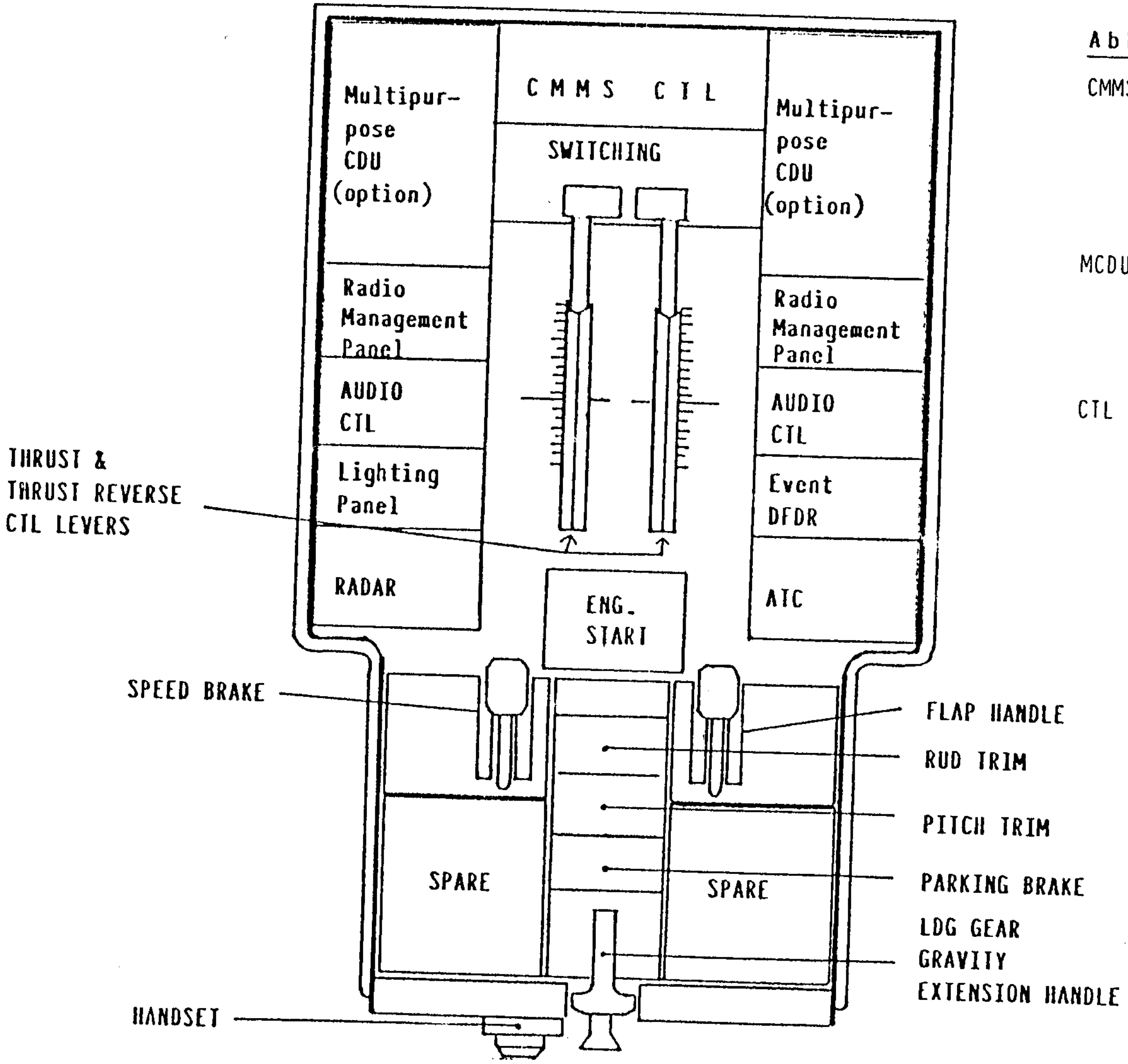


ystems (in ATA Chapter order)

Cockpit - Overhead Panel



Cockpit - Pedestal



Abbreviations:

CMMS	CENTRALIZED MAINTENANCE AND MONITORING SYSTEM
MCDU	MULTIPURPOSE CONTROL AND DISPLAY UNIT
CTL	CONTROL PANEL

5.11 LANDING GEAR (ATA 32)

The MPC-75 landing gear is of the conventional retractable tricycle type with direct-action shock absorbers. The main twin wheel landing gears are located under the wings and retract sideways towards the fuselage centreline. The nose landing gear retracts forward into the fuselage. The gears and gear doors are actuated hydraulically, the sequencing being electrically achieved with the use of proximity detectors and associated logic controls. The four wheels of the main landing gear are provided with a multi-disc carbon brake system incorporating the normal anti-skid braking system. Radial and conventional tyres in various sizes shall be available as standard options. Features for the attachment of towing and debogging means are provided besides jacking points. External lugs are mounted on the wheel axles for the installation of sensors for an optional weight and balance system. An electrically controlled, hydraulically powered nose gear steering system shall be provided.

In case of emergency the gear uplock and door lock mechanisms can be manually released, followed by free fall extension and locking down of the gears with spring assistance.

5.12 NAVIGATION (ATA 34)

The aircraft will be equipped with the following navigation systems according to CAT II requirements:

1. AIR DATA SYSTEM

- Two DIGITAL AIR DATA COMPUTERS (DADC) with space provision for a third unit.
- Three AIR DATA MODULES (ADM) linked to pitot probes.
- Five ADM's linked to static ports.
- One TOTAL AIR TEMPERATURE (TAT) probes.
- Two ANGLE OF ATTACK (AOA) vanes.
- One stand-by airspeed indicator connected to the stand-by-pitot source.
- One stand-by altitude indicator connected to the stand-by-static source.

2. ATTITUDE AND HEADING SYSTEM/INERTIAL REFERENCE

- Two ATTITUDE/HEADING REFERENCE SYSTEMS (AHRS) or optional, two inertial reference systems (IRS) with space provision for a third unit.
- One stand-by-attitude reference given by a self contained gyro-horizon.
- One stand-by-magnetic compass.
- One ADIRS Control and display unit.

DADC and AHRS/IRS may be integrated into the ADIRU.

Space Provision in the ADIRU allow the integration of Global Position System (GPS) to a combined system.

3. LANDING AID INFORMATION SYSTEM

- One Marker Beacon System (MKR) included in the VOR-receiver 1.
- Two ILS-receivers (localizer and glide slope) or equivalent MLS (Microwave Landing System) if operational.

4. INDEPENDENT POSITION INFORMATION SYSTEM

- One Weather Radar System (WXR).
- One Radio Altimeter System (RALT), with space provision for a second RALT.
- One Ground Proximity Warning System (GPWS).

5. DEPENDENT POSITION INFORMATION SYSTEM

- Two VOR receivers.
- Two DME Interrogators.
- One ATC transponder, with space provision for a second ATC and future systems such as ATC Mode S.
- One ADF system with space provision for a second ADF.

6. INSTRUMENT MONITORING

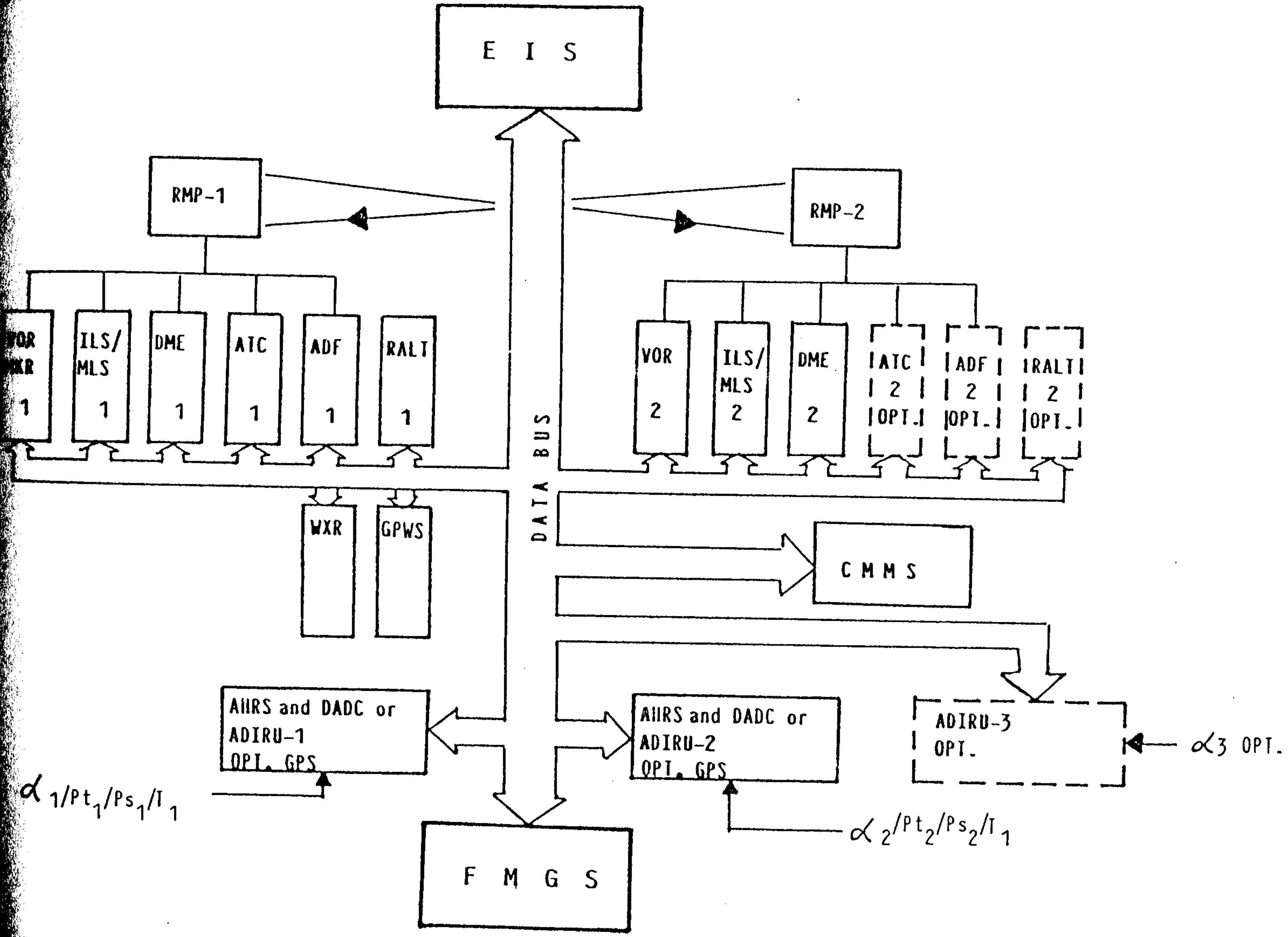
The navigation data presentation is displayed on the Electronic Instrument Systems (EIS), PFD (Primary Flight Display) and ND (Navigation Display) of each pilot.

7. NAVIGATION CONTROL

- Two Radio Management Panels (RMP) at the Captain's and First Officer's positions.

  If the optional Flight Management System (FMS) is installed as part of the Flight Management and Guidance System (FMGS), the NAV-radios are controlled by the FMGS.

Navigation System Schematic Diagram



Abbreviations:

EIS	Electronic Instrument System
MLD	Microware Landing Syster
RALT	Radio Altimeter System
ADIRU	Air Data/Inertial Reference Unit
DADC	Digital Air Data Unit
RMP	Radio Management Panel
AHRS	Attitude/Heading Reference System
FMGS	Flight Management Guidance System
CMMS	Centralized Monitoring a Maintenance System
WXR	Weather Radar Transmitter/Receiver
GPS	Global Positioning Satellite Nav. System
ADF	Automatic Direction Finde
GPWS	Ground Proximity Warning System
DME	Distance Measuring Equipment

5.13 PNEUMATIC SYSTEM (ATA 36)

Pressurized air is needed for
- Environmental Control System (ECS),
- Main Engine Starting (MES),
- Service Air to
  - Water System (ATA 38),
  - Hydraulic System (ATA 29),
  - Rain Repellent (ATA 30).

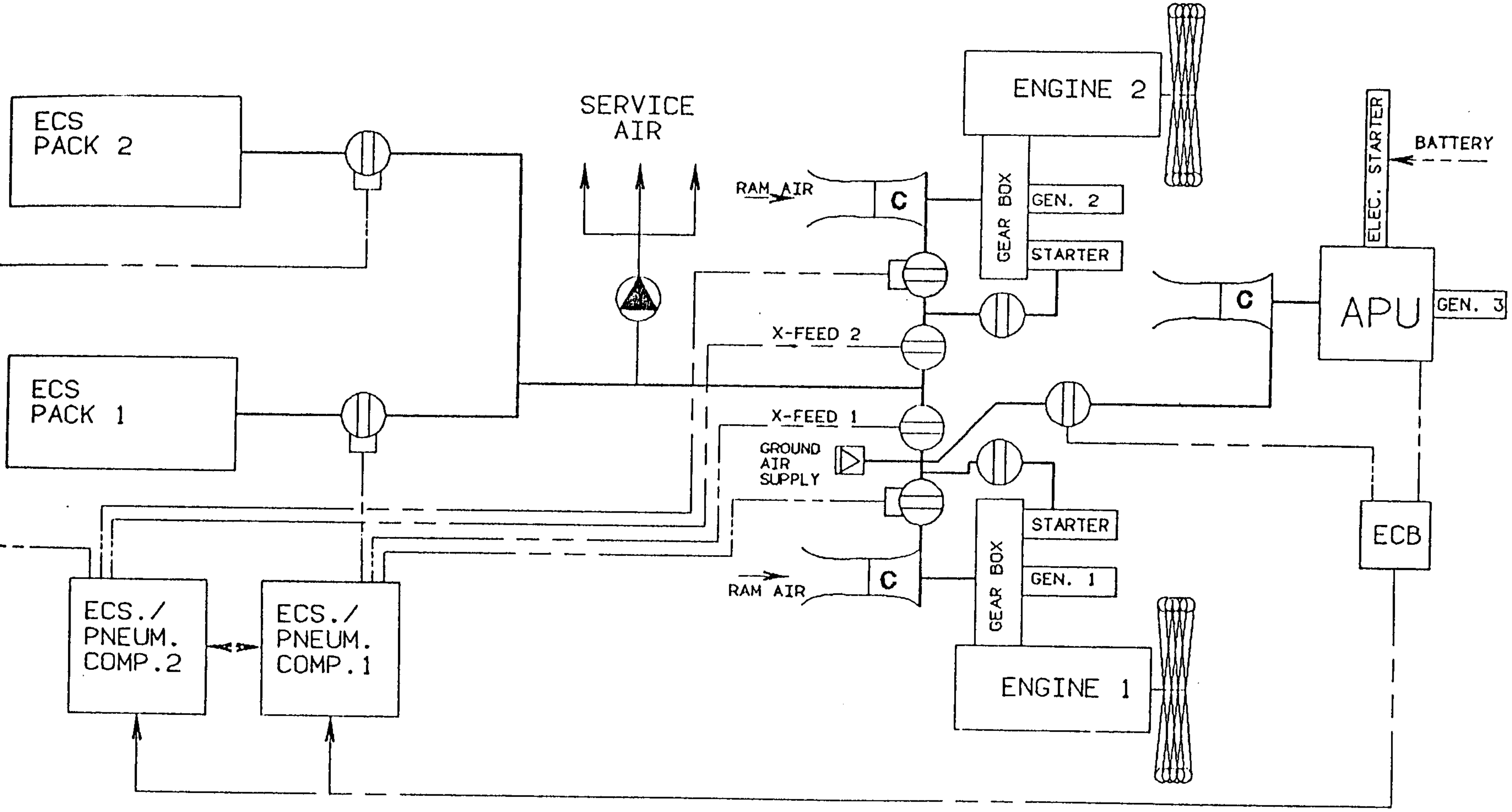
Pressurized air is generated by:
- APU load compressor,
- Engine shaft driven compressor at each main engine,
- Ground air supply from an external air source.

All air supply sources are connected to a distribution system which allows the individual functions mentioned above.

The APU is controlled by its own computer (ECB, electronic control box) including compressor control and valve shut-off function.

The ECS Packs and the Pneumatic System including engine driven compressors are controlled by two separate computers (ECS/PNEUM. COMP. 1 + 2) having integrated functions for both systems as primary and secondary control source. Interface between ECB and ECS/Pneum. Computer is provided to cater for integrity between both air supply systems.

Pneumatic System Schematic Diagram



5.14 AIRBORNE AUXILIARY POWER (ATA 49)

The AUXILIARY POWER UNIT (APU) for MPC-75 shall be capable of main engine starting and providing air-condition power and electrical energy while on the ground. The APU shall also be capable of providing electrical power in-flight, e. g. in the event of engine or generator failure. APU is located aft of the pressure bulkhead in the tail body. It will be located and the installation designed so as to permit easy maintenance and accessibility. The installation design will incorporate noise attenuation features so that noise will not exceed 85 DBA at the nearest service or passenger entrance.

An APU Monitoring System (AMS) will be implied into the Centralized Maintenance and Monitoring System (CMMS). The purpose of AMS is to monitor secondary power system health including the APU related aircraft bleed air system supply. AMS will acquire, analyse and store APU performance data and will alert the airline of any eminent system problems via alert reports.

An Electronic Control Box (ECB) will be accommodated in the pressurized compartment of the aircraft, and all controls and indications necessary to operate monitor and assist maintenance of the APU will be accommodated in the flight deck.