Deutsche Airbus

DOCUMENT NO.: E0 21-304/92

PROJECT: **REGIOLINER R92**

TITLE/SUBJECT: **AIRCRAFT DEFINITION NOTE**
- Project Status: RL100C01/095 -

SUMMARY: This note defines the revised Regioliner R92 configuration as jointly established during first half of 1992 by DASA/Aerospatiale/Alenia.

This new Baseline Configuration will serve as starting point for further refinement and optimization.

DATE: Hamburg, 22-07-92

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1. INTRODUCTION

DASA, Aerospatiale and Alenia have agreed to jointly prepare for a new aircraft family programme in the 80- to 130-seat category. Starting from a set of design requirements and objectives formulated in January 1991 (revised in February 1992), the basic technical features of the new aircraft family have been agreed between the partners.

This note describes the basic aircraft of the new family, i.e. the aircraft with the smallest capacity, which will be developed first. It is meant to serve as a new "baseline configuration", i.e.

- to be used as starting point and reference for further refinement and optimization;
- to provide a coherent set of aircraft data as required for a new sales brochure;
- to provide representative performance and economics data for comparison with anticipated competition aircraft;
- to offer input data for assessment of industrial and economic programme viability.

1.1 CONFIGURATION STATUS

The new configuration status RL100C01/095 is based on configuration status RL100A01/095 with modifications being included as follows:

- wing geometry according to revised wing design status "TC4-2L";
- tailplane area increased to 25 m^2, position redefined;
- fin area increased to 17.2 m^2, position redefined;
- aft pressure bulkhead shifted rearward by 359 mm;
- aft passenger / service doors shifted rearward by 5 inches;
- new door concept: LH: 32" x 72" / 32" x 72" ,
RH: 32" x 62" / 32" x 62" .

2. CONFIGURATION/STRUCTURES

2.0 Configuration-General

The airplane is designed as an advanced short-/medium-haul airliner to carry 95 passengers (nominal capacity) over stage lengths up to 1500 nm, flying at a cruise speed of M = 0.70 to 0.80. It is an all-new standard-body low-wing aircraft with a low tail and two wing-mounted high bypass-ratio turbofan engines.

The general arrangement is shown in fig. 2.1. For main dimensions, see chapter 3.0.

A summary of the metallic/non metallic materials used on the airframe is given in tables 2.1/2.2.

2.1 Wing

The wing planform geometry is shown in fig. 2.1 and geometric details are given in chapter 3.1.

The wing box is designed to carry fuel outboard the root rib. On developed versions the centre section will carry additional fuel.

The current aircraft definition assumes the wing box to be made up of three parts: Two swept outboard boxes and one straight center section buried in the fuselage. They are joined at the sides of the fuselage. The outboard boxes are built from CFRP, the center section is a metal design as advantages from a CFRP design turned out to be negligible.

The leading edge is equipped with slats made of aluminium.

On the trailing edge single slotted Fowler-type flaps are foreseen. They are constant percentage chord outboard the kink and constant chord from kink to fuselage side. The flap support system is of the linkage type.

There is one aileron per side. The ailerons are positioned outboard of the flaps and are of constant percentage chord.

There are four spoilers per side. Three of them, positioned outboard of the kink, are of constant percentage chord, the fourth spoiler, positioned inboard of the kink is of constant chord (equal to that at the kink).

Flaps, ailerons and spoilers are made of CFRP.

A principle scheme of the wing structure is shown in fig. 2.2.

2.2 Fuselage

The cross-section is a blended double-bubble, shown in fig. 2.3. For details of geometry, see chapter 3.2.

The fuselage structure is of conventional skin/stringer/frame construction. Selective use will be made of advanced metals.

Composite material is used for the cabin floor panels and the cargo hold floor panels. The fairings are made from composites as well.

The fuselage system is shown in fig. 2.4.

2.3 Cabin and Cargo Hold

The passenger compartment provides accommodation for up to 110 passengers (low comfort, high density) in 5-abreast seat arrangement. For example arrangements (all tourist, mixed class, high density) see fig. 2.5 a/b/c. For geometric data, see chapter 3.3.

Passenger boarding is through the left hand side doors (72" h x 32" w). For the forward door, airstairs of the underfloor foldable type is an option. For the aft passenger door, no optional airstairs of the underfloor foldable type are considered, but foldable stairs in the cabin are possible as a customer option at the expense of two seats.

On the right hand side of the fuselage there are two service doors, one forward and one aft in the cabin. Both are of same size (62" h x 32" w).

All doors are used as type C emergency exits and are equipped with inflatable slides (or optional slide rafts).

Total evacuation limit is 2 x 55 pax/door = 110 occupants, which equals the practical capacity of the cabin.

Hot and wet galleys as well as toilets can be arranged at the front end and at the rear end of the cabin.

Baggage and cargo is carried in the underfloor holds. There are two compartments with dedicated access door each (44" h x 56" w). The width of the cargo hold doors is designed for efficient ground handling, e.g.: "pushing-in" the conveyor belt for faster loading; allowing conveyor belt vehicles to stand in a slanted position, if necessary.

The forward cargo hold can be equipped optionally with a cargo ventilation and heating system. The aft hold is designed to accept a mechanical loading system of the "sliding carpet"-type. However, such system is considered to be optionally.

Layout, materials used, and structural design of all cabin/cargo hold equipment/furnishing have been selected in agreement with the latest applicable certification rules.

2.4 Vertical Tail

The planform and the position of the vertical tail are shown in fig. 2.1, and geometric data are summarized in chapter 3.4.

The swept fin box is a two-spar design which is joined to the aft unpressurized part of the fuselage. The fwd. fuselage attachment of the vertical tail is at the same location as the aft pressure bulkhead.

There is a single-piece rudder.

The fin is constructed of composites. Rudder and leading edges are of honeycomb construction covered with composite material.

The structural system is shown in fig. 2.6.

2.5 Horizontal Tail

The planform and the position of the horizontal tail are shown in fig. 2.1. For geometric data, see chapter 3.5.

The tailplane is of the trimmable type.

The box of the horizontal tail is a two spar design. It consists of two swept boxes which are joined at the centre line.

The tailplane is constructed of composites. Elevators and leading edges are of honeycomb construction covered with composite material.

The horizontal tail box is fitted through a cutout in the rear fuselage, and is attached to it by a hinge aft of the rear spar. The trim actuator is arranged forward of and attached to the front spar. The fuselage cutout will be covered by a rigid shield attached to the horizontal tail box. The shield (apron) will also be made of composite material.

The structural system is shown in fig. 2.7.

2.6 Landing Gear

There is a retractable tricycle type landing gear. For details see chapter 3.6 and figures 2.8 and 2.9.

It is of conventional telescopic type with twin wheels. The MLG is retracted sideways, and the NLG is retracted forward into the fuselage.

The main gear leg is attached to the wing by a skewed trunnion that is supported by the box rear spar (Airbus type attachment).

The primary structure of the LG will be manufactured from high tensile steel forgings or high strength aluminium alloy. The wheels are fabricated from aluminium alloy forgings. All tires are of radial type (or optional bias type). Each MLG wheel is equipped with hydraulically operated carbon disc brakes (or optional steel brakes). An antiskid system and an emergency extension system are installed.

Nose whel steering is electrically signalled.

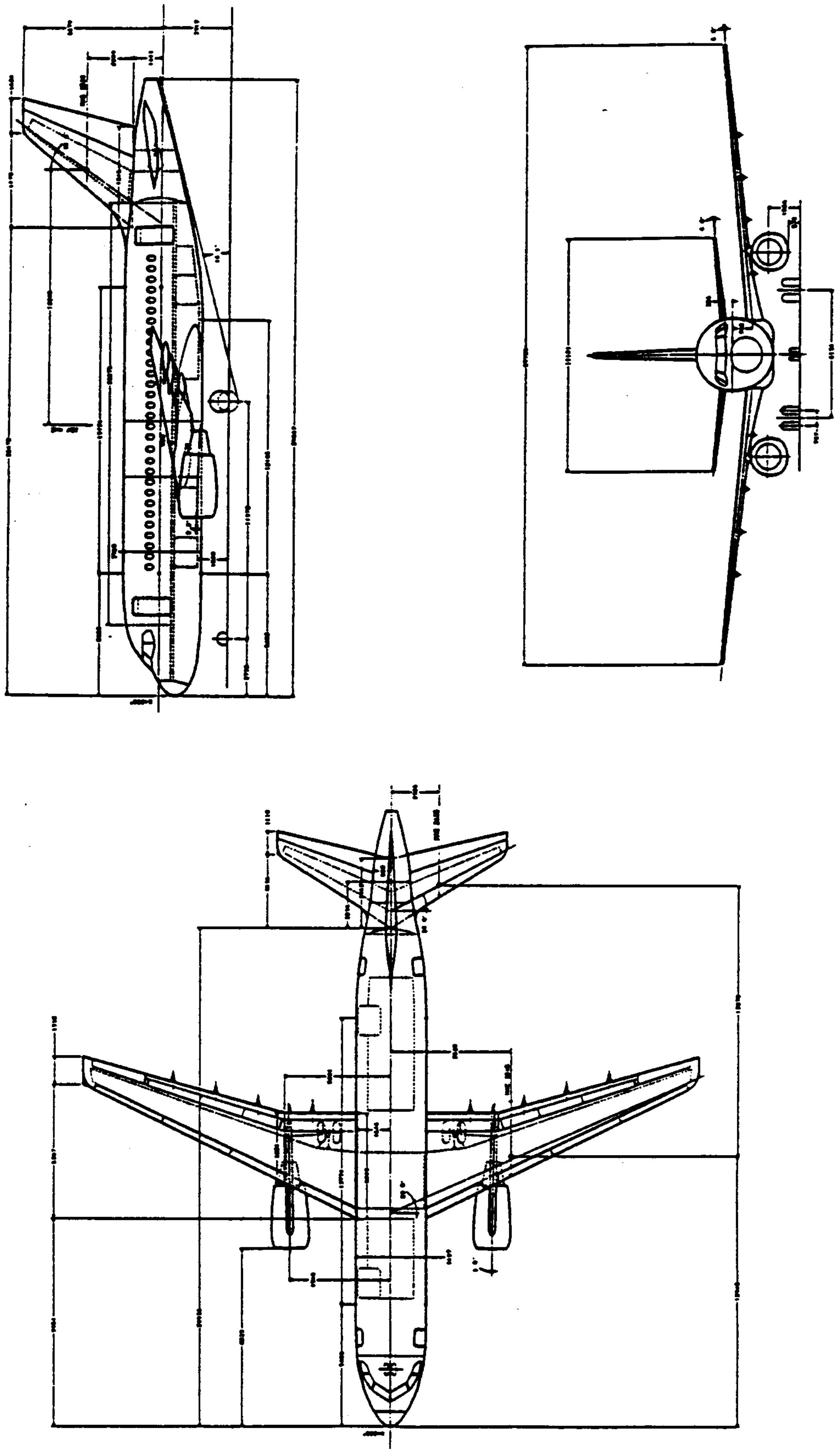

FIG. 2.1: GENERAL ARRANGEMENT - RL100C01/095

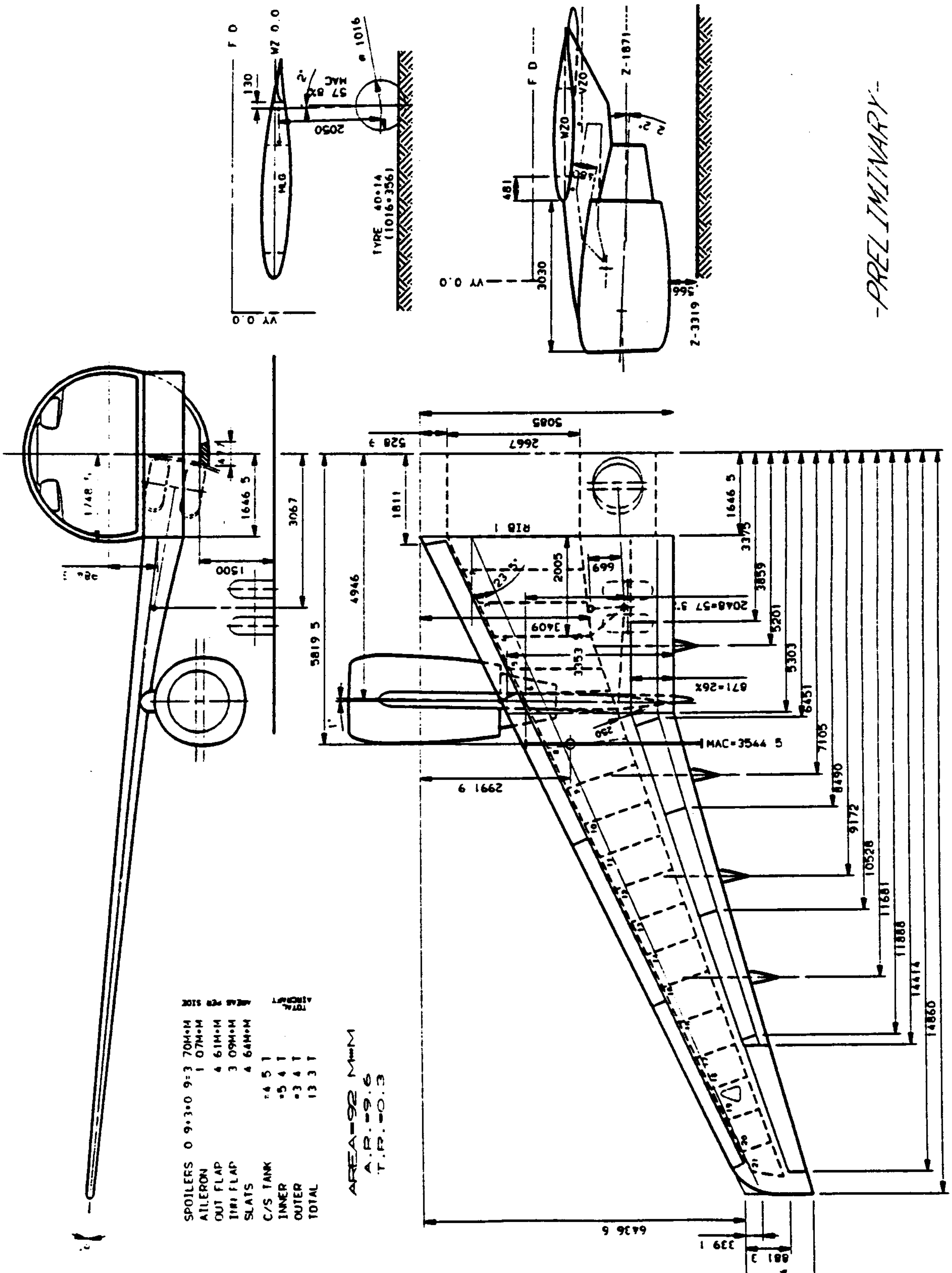

FIG. 2.2: WING SYSTEM - RL100C01/095

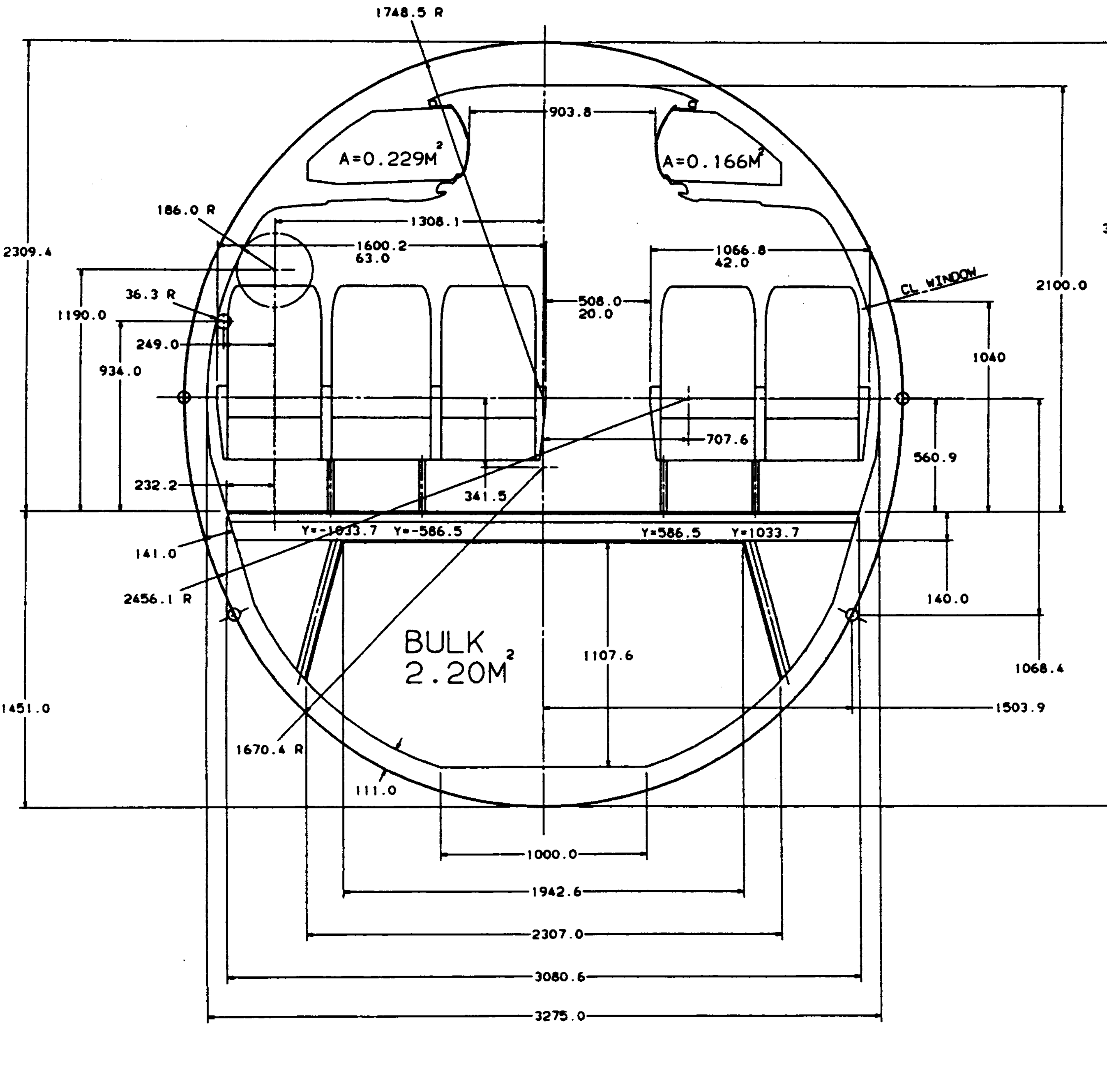

FIG. 2.3: FUSELAGE CROSS-SECTION - RL100C01/095

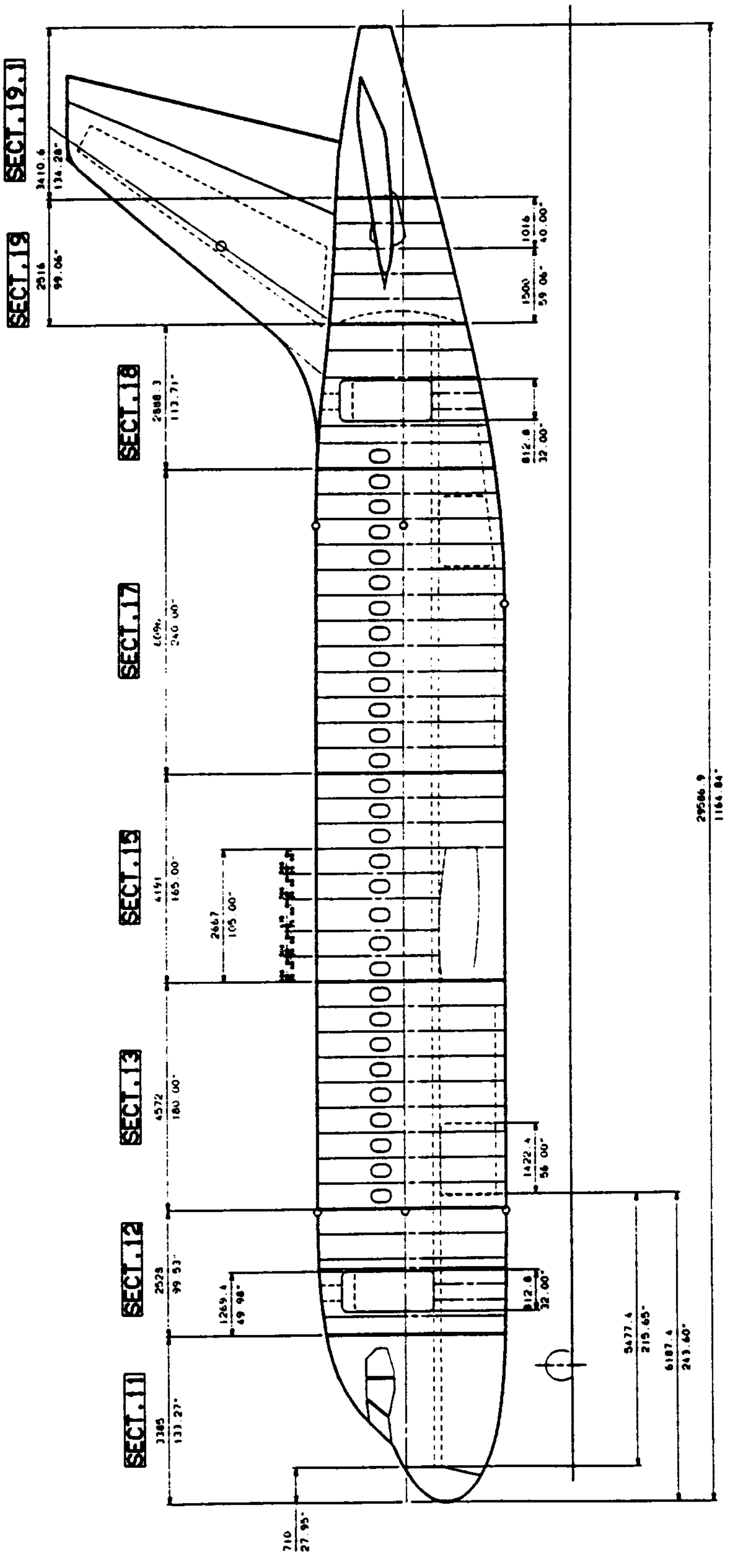

FIG. 2.4: FUSELAGE SYSTEM - RL100C01/095

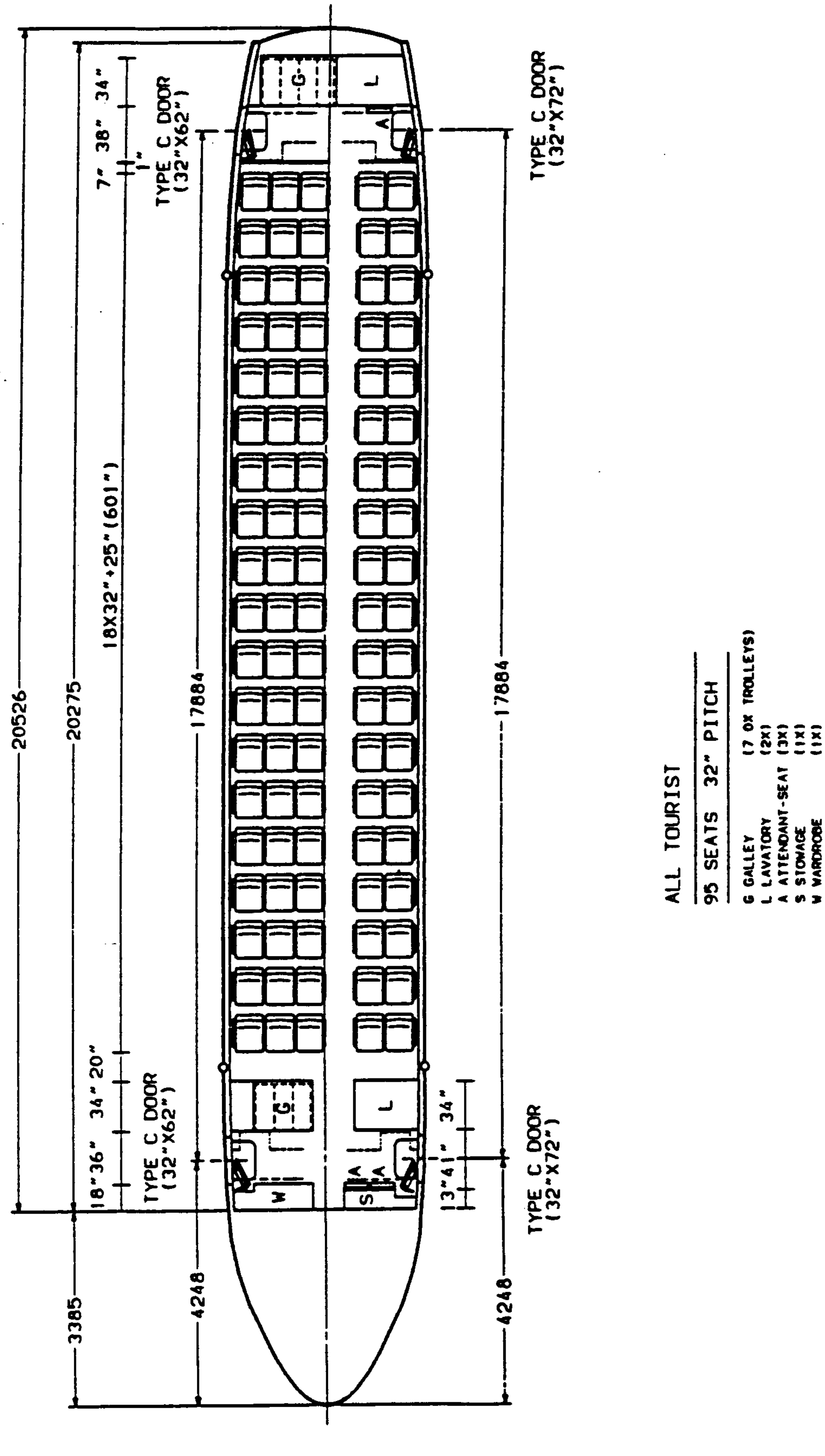

FIG. 2.5a: CABIN LAYOUT, ALL TOURIST - RL100C01/095

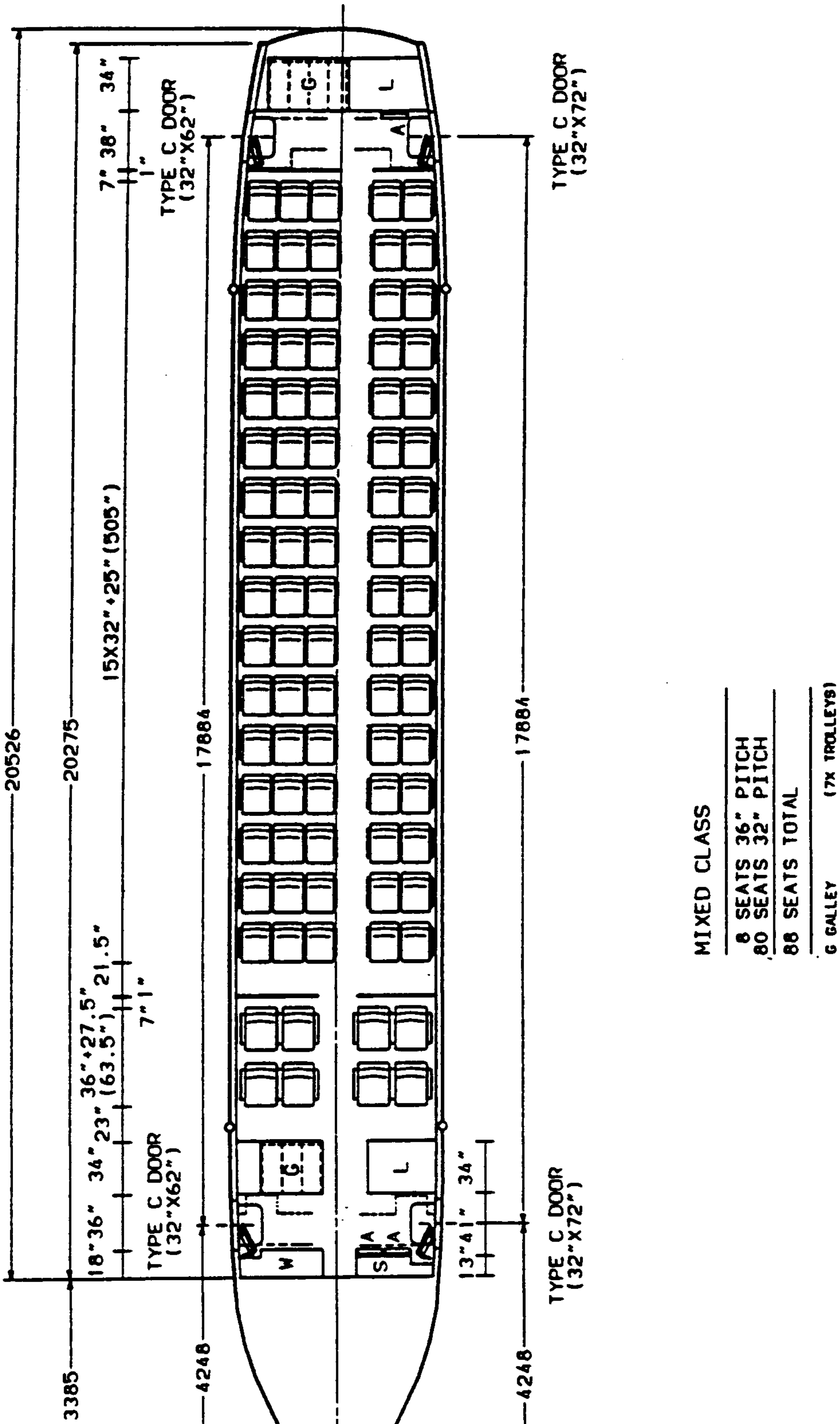

FIG. 2.5b: CABIN LAYOUT, MIXED CLASS - RL100C01/088

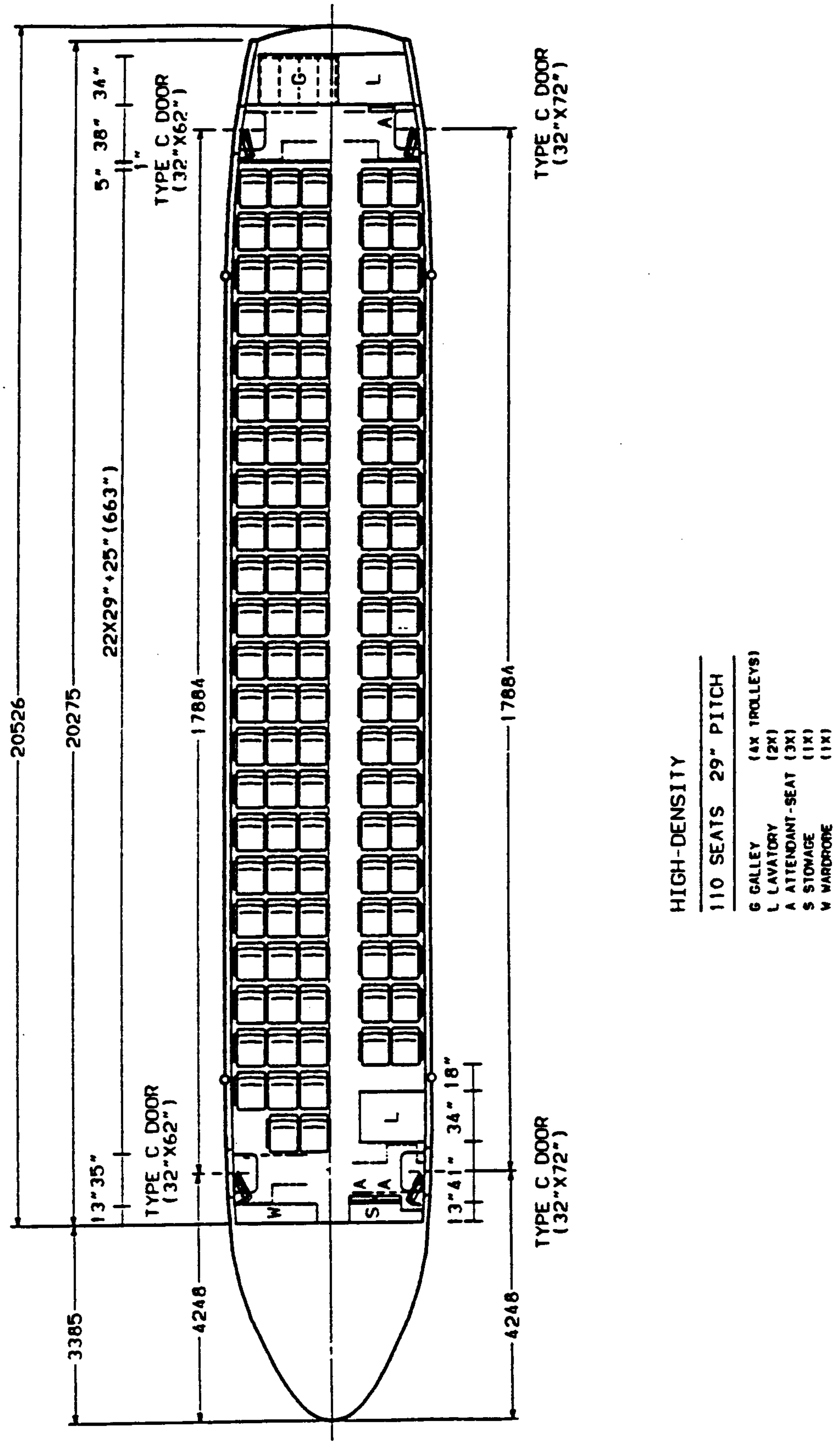

FIG. 2.5c: CABIN LAYOUT, HIGH DENSITY - RL100C01/110

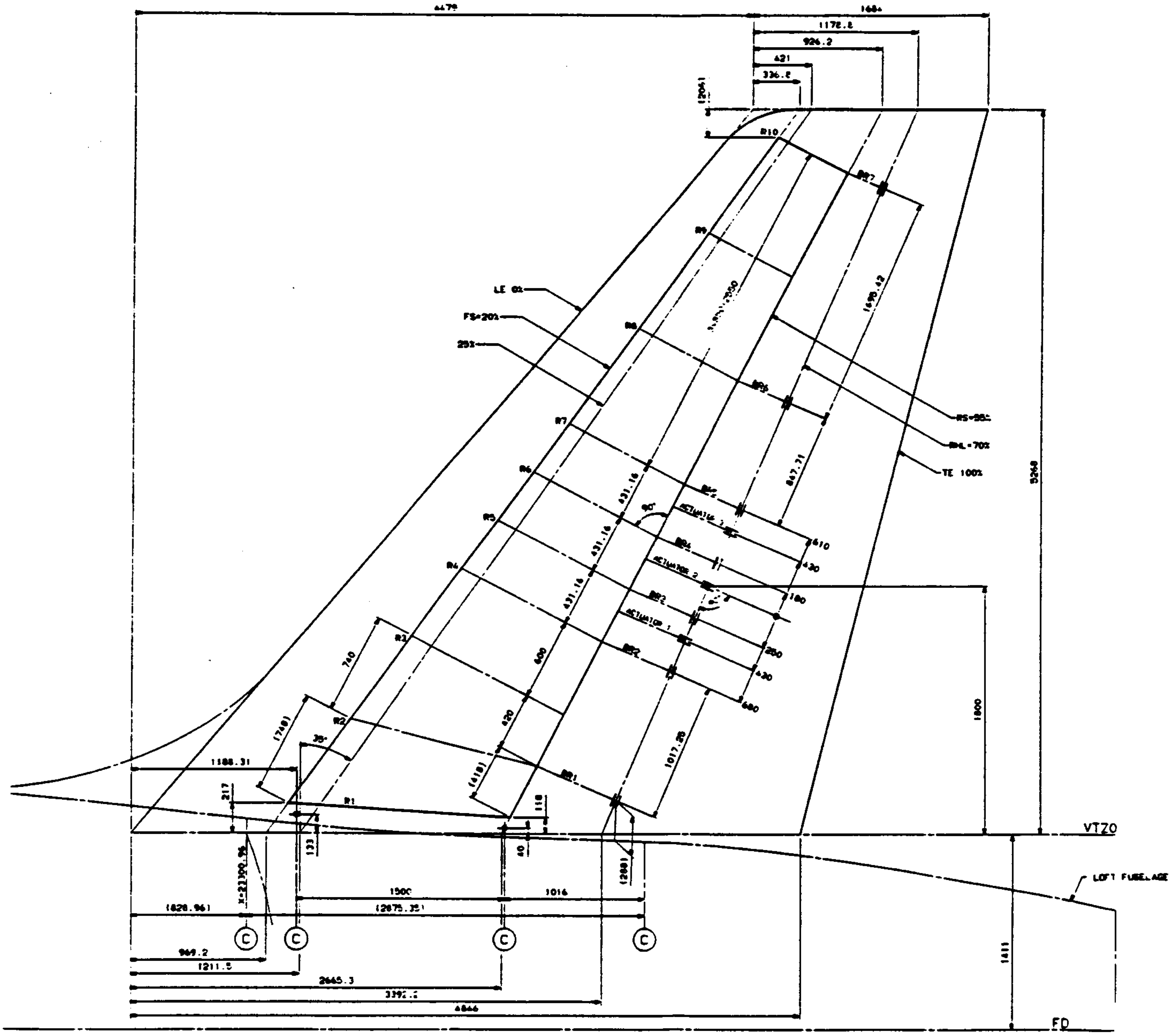

FIG. 2.6: VERTICAL TAILPLANE SCHEME - RL100C01/095

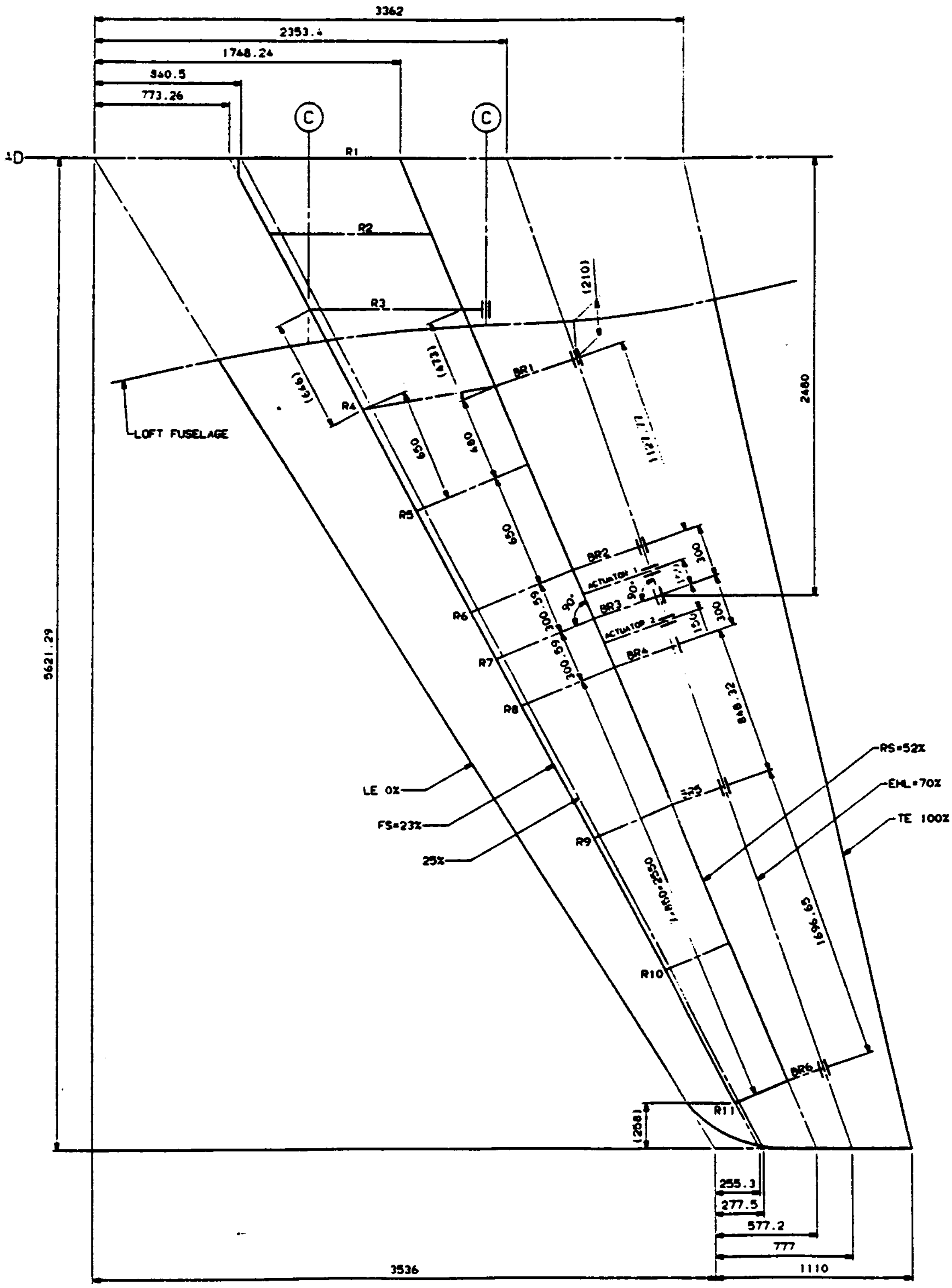

FIG. 2.7: HORIZONTAL TAILPLANE SCHEME - RL100C01/095

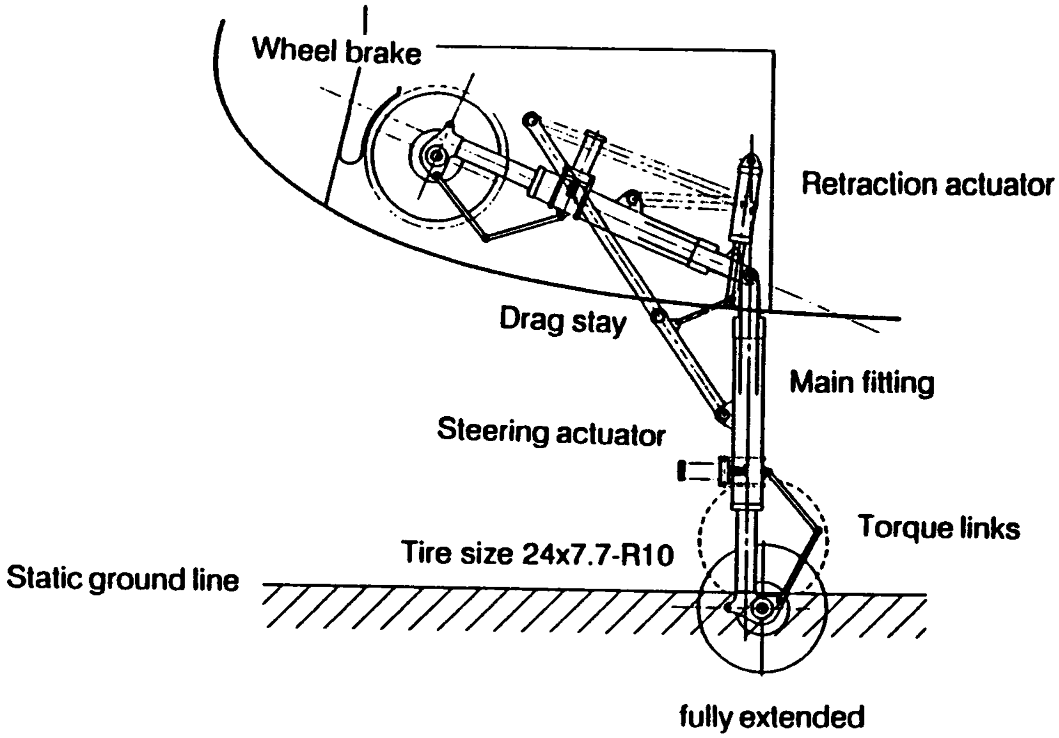

FIG. 2.8: NOSE LANDING GEAR - RL100C01/095

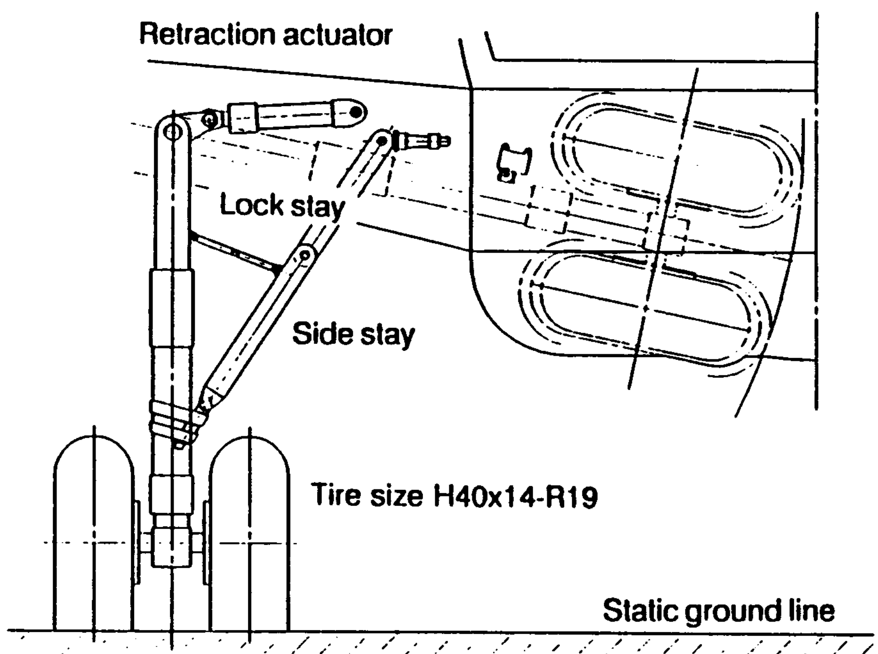

FIG. 2.9: MAIN LANDING GEAR - RL100C01/095

METALLIC MATERIALS

Component	Material
Fuselage	
Skin	2024
Stringers	2024/7075
Frames	2024/7175
Crack Retarders	Ti 6Al 4V
Seat Tracks	7075
Door Skins	2024
Cross beams	7175
Wing Centre Section	
Upper Panels	7010/7050
Lower Panels	2124
Front Spar Web	2024
Rear Spar	7010
L.E. Slats	
Skins, Ribs, Spars	2024

TABLE 2.1

COMPOSITE MATERIALS

Component	Material	%	Cur. Temp.
Radome	GFRP		125°C
Leading Edge Root Fillet	GFRP		125°C
Pylon Parts	GFRP		125°C
Wing Flaps	CFRP		175°C
Main Landing Gear Wing Bay Top Panel	CFRP		175°C
Wing Box, outboard	CFRP		175°C
Dorsal Fin	GFRP		125°C
Vertical Stabilizer Leading Edge	GFRP		125°C
Vertical Stabilizer Tip	GFRP		125°C
Vertical Stabilizer Box	GFRP,CFRP	10/90	125°C
Rudder	GFRP,CFRP	10/90	125°C
Vertical Stabilizer Trailing Edge	GFRP,CFRP	80/20	125°C
Horizontal Stabilizer Trailing Edge			
Access Panels	GFRP,CFRP	80/20	125°C
Elevator	GFRP,CFRP	10/90	175°C
Horizontal Stabilizer Box, inc. Apron	GFRP,CFRP	10/90	175°C
Horizontal Stabilizer Leading Edge and Tip	GFRP		175°C
Aft Fairing	GFRP		125°C
Upper Wing Fairing	GFRP		125°C
Main Landing Gear Door/Leg Fairing/ Hinged Door	CFRP		125°C
Spoiler/Airbrakes	CFRP		175°C
Fixed Wing Trailing Edge, Aileron	CFRP		175°C
Flap Track Fairing	GFRP		125°C
Main Landing Gear Door	CFRP		125°C
Fan Cowl	CFRP		175°C
Belly Fairing, incl. Lower Wing Fairing	GFRP		125°C
Nose Landing Gear Doors	CFRP		125°C
Passenger/Cargo Compartment Floor Panels	GRFP		125°C

TABLE 2.2

3. GEOMETRY

3.0 Main Dimensions

Wing Span	(m)	29.720
Wing Area	(m^2)	92.00
Length, Overall	(m)	29.587
Length of Fuselage	(m)	29.587
Height of Fuselage	(m)	3.760
at Belly Fairing	(m)	3.760
Width of Fuselage	(m)	3.497
Height, Overall	(m)	9.998
Wheel Track	(m)	6.134
Wheel Base	(m)	11.372

3.1 Wing

3.1.1 Wing Main Data

Wing Reference Area	(m^2)	92.00
Aerodynamic Mean Chord (A.M.C.)	(m)	3.545
Geometric Mean Chord (G.M.C.)	(m)	TBD
Span	(m)	29.720
Aspect Ratio	(-)	9.6
Taper Ratio (Tip Chord/Root Chord)	(-)	0.26
Root Chord*	(m)	5.085
Kink Chord	(m)	3.354
Tip Chord (Nominal)	(m)	1.332
Sweep Angle (25 %)	(°)	23.5
Relative Thickness (Root*/Kink/Tip)	(%)	15.0/11.3/10.8
Root*-Wing-Setting	(°)	2.7
Dihedral of Wing Reference Area	(°)	6.0
Dihedral of Trailing Edge at Wing Root*	(°)	TBD
Dihedral of Trailing Edge at Kink	(°)	TBD

* Here, root is taken at fuselage side, i.e. max. width

3.1.2 Wing, Movable Parts

Flaps

Type:		Single slotted, Fowler/Linkage	
Projected Area	inboard, per side	(m^2)	3.1
	outboard, per side	(m^2)	4.6
Span	inboard section	(mm)	3555
	outboard section	(mm)	6687
Chord	inboard section	(mm)	871
	outboard section		
	- root	(mm)	871
	- tip	(mm)	508
	- relative	(%)	26
Max. Deflection, High Lift Mode		(°)	35

Slats

Number per side	(-)	4
Area per side	(m^2)	4.356

Aileron

Area (aft of hinge line) per side		(m^2)	1.07
Span (aft of hinge line)		(mm)	2526
Chord (aft of hinge line)	- root	(mm)	489
	- tip	(mm)	356

Spoiler

Number	per side		4
Area	outboard, per side	(m^2)	2.69
	inboard, per side	(m^2)	0.98
	total, per side	(m^2)	3.67
Span	each spoiler, }	(mm)	1826
	inboard }	(mm)	1880
	to }	(mm)	2156
	outboard }	(mm)	2617

3.2 Fuselage

3.2.1 Main Dimensions

Fuselage Length	(m)	29.587
Length of Cylindrical Part	(m)	12.186
Width/Height of Cylindrical Part	(m)	3.497/3.760
Distance from Nose to 25 % AMC Wing	(m)	12.945

3.3 Cabin and Cargo Hold

3.3.1 Doors

Location	Dimension[1] (height x width) (in x in)	Sill Height (@ MTOW) (mm)
Cabin Forward LH	72 x 32	2758
Cabin Forward RH	62 x 32	2758
Cabin Rear LH	72 x 32	2758
Cabin Rear RH	62 x 32	2758
Cargo Hold Forward RH	44 x 56	1500
Cargo Hold Rear RH	44 x 56	1586

[1] Clear Opening

3.3.2 Cabin

Cabin Length (excl. Cockpit)	(mm)	20275
Max. Length Seating Area	(mm)	16967
Max. Height	(mm)	2100
Max. Width	(mm)	3275
Floor Width	(mm)	3080
Hatrack Volume		
- per m	(m^3)	0.367
- total (all Y example layout)	(m^3)	5.83

3.3.3 Cargo Hold

<u>Forward Hold</u>

Length	(mm)	3816
Height	(mm)	1108
Floor Area	(m^2)	3.816
Total/Usable Volume	(m^3)	8.40/7.61

<u>Rear Hold</u>

Length	(mm)	6415
Max. Height	(mm)	1108
Floor Area	(m^2)	6.20
Total/Usable Volume	(m^3)	13.1/12.31

3.4 Vertical Tail

Vertical Tail Area	(m^2)	17.2
A.M.C.	(m)	3.52
G.M.C.	(m)	TBD
Span	(m)	5.268
Aspect Ratio	(-)	1.614
Taper Ratio (Tip Chord/Root Chord)	(-)	0.348
Root Chord (Nominal)	(m)	4.846
Tip Chord (Nominal)	(m)	1.684
Sweep Angle (25 %)	(°)	35
Relative Thickness	(%)	11
Distance Fuselage Reference Line/		
Root Chord (Nominal)	(m)	1.411
Rudder Area	(m^2)	5.30
Rudder Span in % Total Span	(%)	100
Hinge Line at % of AMC	(%)	70
Rudder Chord - root	(m)	1.471
- tip	(m)	0.505
Rudder Movement (Operation)	(°)	± 30
Rudder Movement (for Structure Possibilities)	(°)	TBD
Area Ratio Vertical/Wing		0.187
Distance 25 % AMC Wing to 25 % AMC Fin	(m)	12.285
Tail Volume		0.648

3.5 Horizontal Tail

Tailplane Reference Area	(m^2)	25.0
Net Area		TBD
A.M.C.	(m)	2.425
G.M.C.	(m)	TBD
Span	(m)	11.181
Aspect Ratio	(-)	5.0
Taper Ratio (Tip Chord/C/L Chord)	(-)	0.330
Centre Line Chord (Aircraft C/L)	(m)	3.362
Tip Chord	(m)	1.110
Sweep Angle (25 %)	(°)	28
Dihedral	(°)	6
Relative Thickness (Root/Tip)	(%)	10/10
Elevator Reference Area (total)	(m^2)	5.85
Elevator Span per side	(m)	4.731
Elevator Hinge Line at % AMC	(%)	70
Elevator Chord - root	(m)	0.905
- tip	(m)	0.333
Stabilizer Movement	(°)	+ 3 / - 13
Elevator Movement	(°)	+ 15 / - 30
Distance 25 % AMC Wing to 25 % AMC Tailplane	(m)	13.070
Area Ratio Tailplane/Wing		0.27
Tail Volume		1.002

3.6 Landing Gear

Wheelbase	(mm)	11372
Track	(mm)	6134

Main Landing Gear

Total compression travel	(mm)	450
Static compression travel (MTOW)	(mm)	390
Wheel/Ground contact point at % AMC (Static Compression)	(%)	57.8
Standard tyre size	(in)	H 40 x 14.0-R19
Standard tyre pressure	(psi)	135
Max. tyre size (optional)	(in)	H 40 x 14.5-R19
Associated tyre pressure	(psi)	145

Nose Landing Gear

Total compression travel	(mm)	400
Static compression travel	(mm)	320
Standard tyre size	(in)	24 x 7.7-R10
Standard tyre pressure	(psi)	115
Max. tyre size (optional)	(in)	-
Associated tyre pressure	(psi)	-
Max. steering angle	(°)	±75

4. PROPULSION

4.1 General

The aircraft will be powered by two high-bypass ratio turbofans rated at 15500 lb SL static thrust each. This thrust level is necessary to achieve the performance level envisaged, and is subject to further confirmation by detailed performance analysis.

The Propulsion system will not be equipped with thrust reverser. However, full provisions are made to integrate a fan stream thrust reverser (door type) as a standard option.

Engine control will be by an advanced dual channel Full Authority Digital Engine Control System (FADEC). It will be accomodated in a single unit mounted on the fan case no additional interface unit will be needed between the aircraft and the propulsion system. In addition to the compulsory engine control and indication, will comprise features such as:

- Automatic engine starting
- Power managment
- Vibration monitoring (incl. on-wing fan balancing)
- Interface for expanded condition monitoring.

The engines are core mounted to pylons attached to the lower side of the wing box. Pylon skin panels and spars are of high-strength aluminum combined with composite materials.

The engine will be member of an all new engine family of sufficient thrust potential to power the whole aircraft family as envisaged today. The engine will be sized basically to power the stretched 125 seat aircraft version, and will be derated for application to the basic 95 seat aircraft. Hence, there will be maximum commonality between the propulsion system for the basic aircraft and for the stretched aircraft. Differences in the nacelle are limited to the thrust reverser section.

Each engine will be equipped with three ports for customer bleed offtakes located at:

- fan duct
- intermediate compressor stage
- compressor exit.

Fan duct bleed will be utilized for the pre-cooler, compressor bleed is for ECS and Anti-Icing usage.

The accessory gearbox accomodates drive pads for the installation of BFE: one generator and one hydraulic pump.The engine will be equipped with an airturbine starter. Air supply will be from ground supply, APU or the opposite engine. An inflight starting envelope will be certified to an altitude of 30,000 ft including restarts without starter assistance at speeds above 220 knots CAS.

Four engine candidates are under consideration:

- BMW Rolls Royce .... BR 715
- CFM International .... CFM 88
- General Motors Allison .... GMA 3014ADV
- MTU / Pratt & Whitney .... RTF 180

All designs are based on established advanced technologies; within each engine family the same basic core will be used. Within the overall thrust range the adaption to specific thrust classes will be done by configuring the low pressure spool.

Particular attention will be paid in the engine design process to achieve:

- low Direct Operating Cost
- high noise margins to current rules
- low gaseous emission
- low propulsion system weight

The General Arrangement (Fig. 2.1) shows a representative generic type of propulsion system, not to indicate any preference for one of the actual engines under discussion before an engine finally has been selected. The following characteristics have been assigned to this reference propulsion system:

- fan diameter 1346 mm (53")
- max. nacelle height 1821 mm
- short duct, separate flow nacelle
- propulsion system weight 2278 kg.

The reference installation is governed by the follwing parameter (Fig. 4.1):

- maximum forward position of air area: .... 3030 mm[1]
- minimum gully hight betwéen wing and nacelle: . . 480mm
- minimum ground clearance .... 520 mm
- primary nozzle boattail angle .... < 13°
- fan nozzle boattail angle .... < 10°

[1] relativ to wing leading edge

4.2 Description of the Engine Contenders

The proposed propulsion systems cover short duct/separate flow as well as long duct/mixed flow nacelle configurations. The final selection will be based on results of in-depth studies considering parameters such as performance, weight, noise and cost.
Engine architecture and main data of the various contenders are presented in Table 4.1.

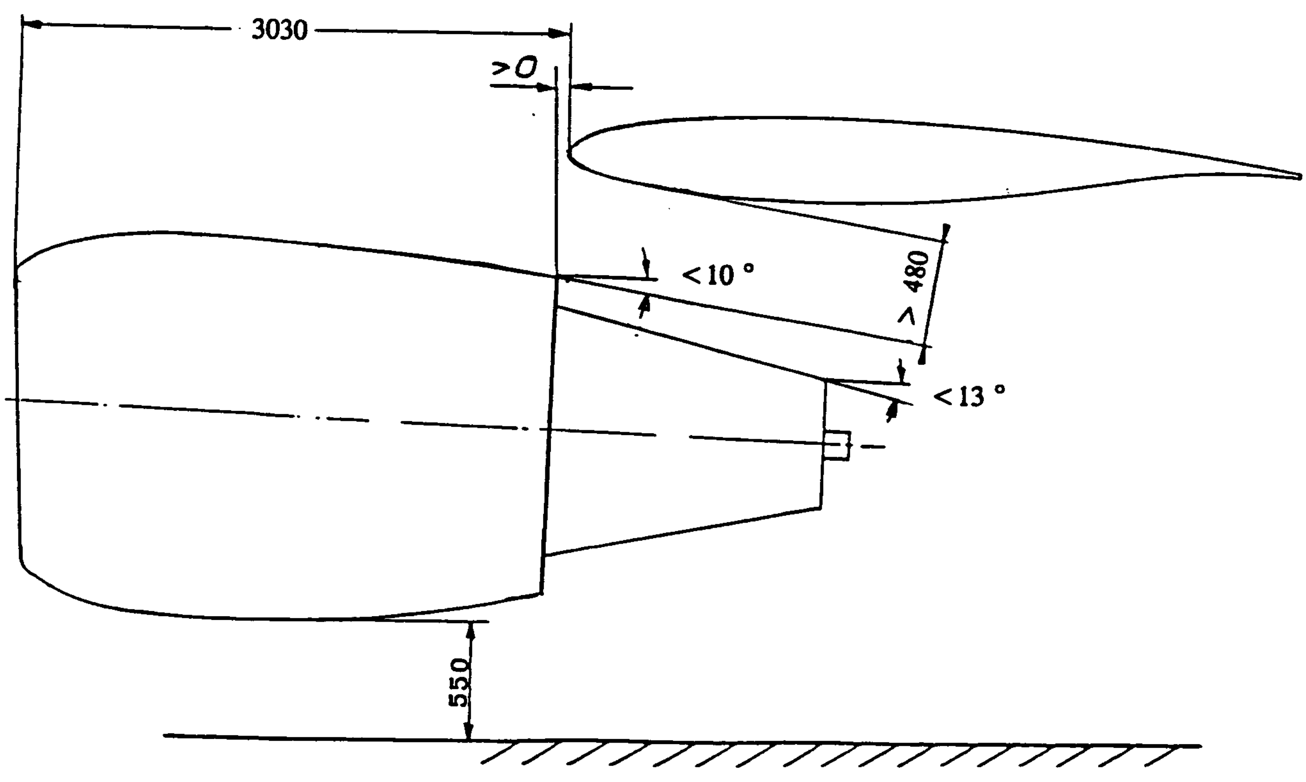

FIG. 4.1: INSTALLATION OF REFERENCE PROPULSION SYSTEM

4.2.1 BMW Rolls Royce BR 715

BMW Rolls Royce will develop the BR 700 turbofan family covering the thrust range from 10 to 22+ klb; it shall take over the TAY market. The design benefits from the extensive RR experience as aero-engine manufacturer in the short haul market.

The BR 715 member (Fig. 4.2) will be sized for the 14 to 22 klb take-off thrust, the proposed nacelle configuration is of the separate flow type.

BR 715 Design Features:

Fan:	Wide chord 53" fan; technology based on extensive RR technology, solid titanium blades. Good noise characteristics, robust blades with improved FOD resistance and core protection, high integrity, no RR fan blade ever lost, steel casing.
LP-Compressor:	Two stages, design to match fan exit profile to HPC inlet requirements, bleed handling valve to ensure adequate surge margin, based on TAY booster technology.
HP-Compressor:	Ten stages, utilizes RR technology from V2500 with reduced design complexity, first 4 stages variable vanes to ensure good handling qualities.
Combustor:	Conventional low emission combustor. Provision for retrofitting of advanced combustor from ongoing programme.
HP-Turbine:	Two stage, shrouded design for low tip leakage and high performence eliminating need for active clearance control, simplified RB211 cooling system, high life blades. Design and materials selected for low maintenance cost.
LP-Turbine:	three stages, solid blading, 3D aerodynamics,thermally-matched tip control, vane to blade ratio selected to achieve tone cut-off.
Control:	FADEC, built-in capabilities for fault isolation and engine monitoring.

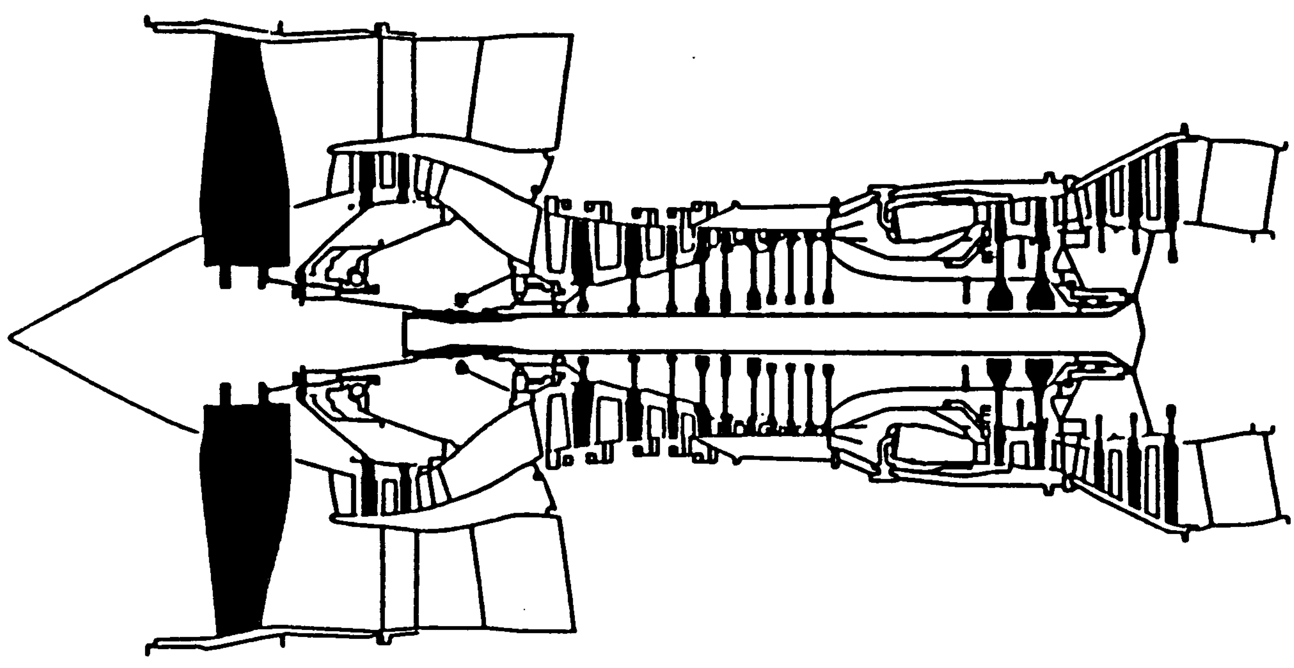

FIG. 4.2: LAYOUT OF BR 715 ENGINE

4.2.2 CFM International CFM 88

The CFM 88 engine family will adopt the successful CFM 56 architecture and technology around a new core, which is derived from the existing SNECMA military engine M 88. The core features a short and rugged design for high performance retention, low vibration, low weight and low maintenance cost.

The CFM 88 with a 55" fan (Fig. 4.3) will be sized for the 15 to 22 klb thrust bracket. It comprises a short duct, separate flow nacelle.

CFM 88 Design Features:

Fan:	New fan technology with advanced 3D aerodynamic shroudless wide chord fan, solid titanium blades. Outlet guidevanes from composite, struts shaped to limit aero distortion.
LP-Compressor:	Three stages, variable bleed vane system optimized for hail/dust extraction.
HP-Compressor:	Seven stages, short and stiff construction, erosion coatings on rear stages, rugged blading, moderate stage loading, bleed location optimized, bleed collector for customized bleed port location. Based on CFM 56/GE 38 design.
Combustor:	Short combustor with advanced cooling for low NOx emission, based on CFM 56/GE 38 technology .
HP-Turbine:	single stage - moderate rotor inlet temperature, active clearance control. Technology based on M 88/CFM 56.
LP-Turbine:	four stages, similar to CFM 56 design.
Control:	FADEC, built-in capabilities for fault isolation and engine monitoring.

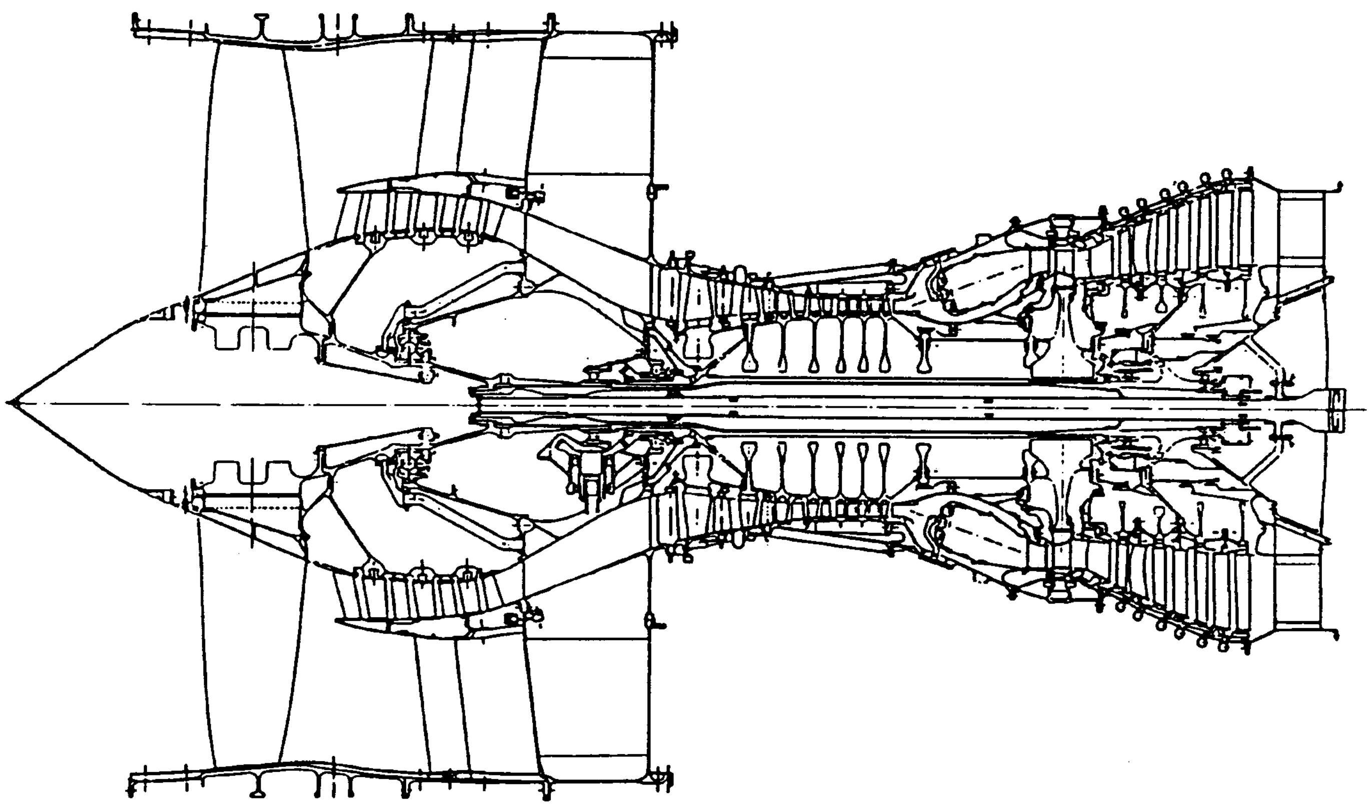

Fig. 4.3: Layout of CFM 88 Engine

4.2.3 General Motors Allison GMA 3014ADV

This engine is a new, advanced technology turbofan family and part of Allison's commercial engine strategic initiative. The core will incorporatdesign components based on the GMA 101 military programme. The engine design will utilize company's experience with the T56/501 engine family and the GMA 3007 turbofan development.

The GMA 3014ADV is designed with a 55" fan, a short duct, separate flow nacelle and will cover the thrust range of 14 to 20 klb.

GMA 3014 Design Features:

Fan:	Wide chord fan, hollow titanium blades, lightweight aluminium fan case with KEVLAR bandage. Based on TF41, GMA 3007 and technology demonstrators
LP-Compressor:	Two stages, lightly loaded, high efficiency, ample surge margin based on 587-DX LP compressor
HP-Compressor:	Advanced multi application cpmpressor based on full scale devolopment for US Navy, 8 stages, 3-D viscous design analysis for high efficiency.
Combustor:	staged combustor for low NO_x Emission, low cost effusion cooling for improved durability
HP-Turbine:	2 stage unshrouded, advanced 3D aero design with evolutionary advanced materials and cooling. High temperature capability, one piece cast, LAMILLOY 'CASTCOOL' airfoils, single crystal material, passive clearance control.
LP-Turbine:	4 stages, designed for cruise efficiency, based on GMA 3007.
Control:	FADEC, built-in capabilities for fault isolation and engine monitoring.

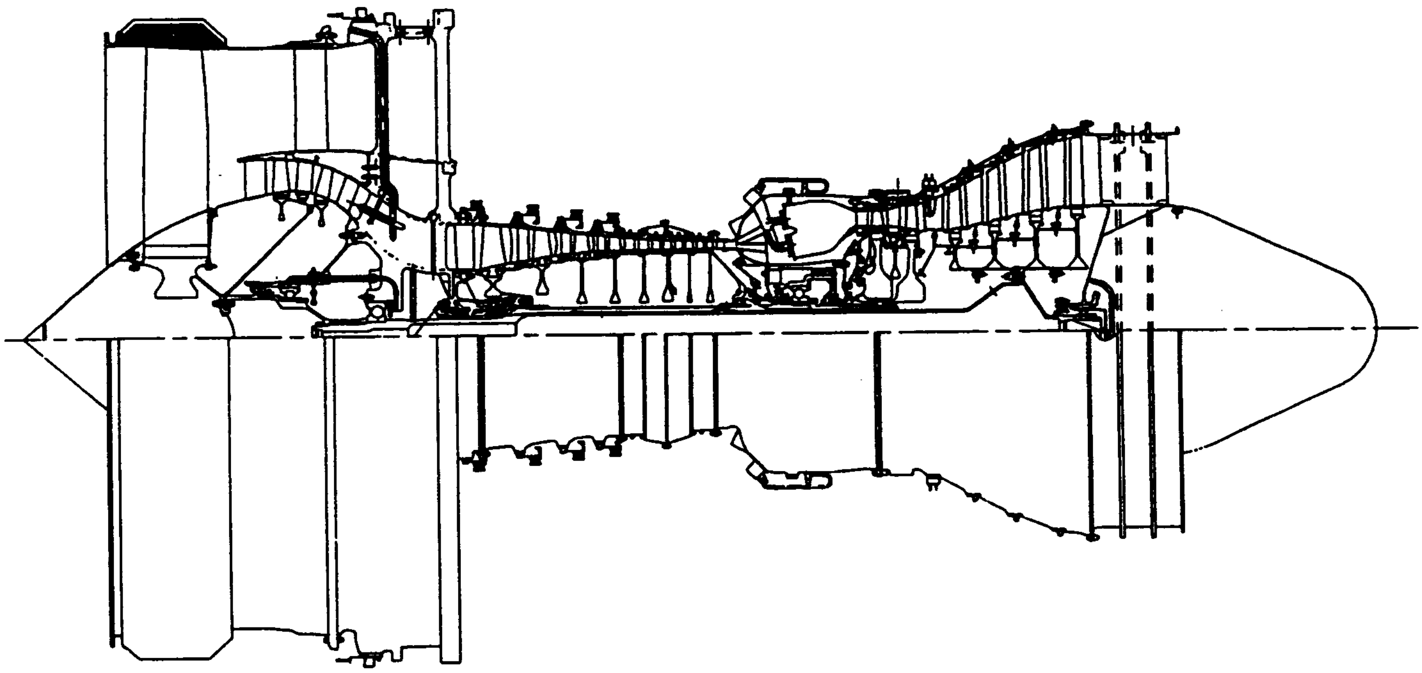

FIG. 4.4: LAYOUT OF THE GMA 3014ADV ENGINE

4.2.4 MTU/Pratt & Whitney RTF 180

The RTF 180 trubofan family is based on the existing military EJ 200 high pressure compressor technology and combines available and affordable technology from PW and MTU.

The RTF 180 in the R 92/R 122 application comprises a 52" fan and a long duct nacelle with a forced mixer and covers the thrust range 14 to 20 klb.

RTF 180 Design Features:

Fan:	Wide chord fan, optimised for high performance and low weight. Based on new PW technology of PW4000 programs. High root aspect ratio patterned after PW 4084 design.
LP-Compressor:	Two stages, low aspect ratio blading, annular stability bleed valve integrated.Aerodynamic based on PW4000 and PWC technology
HP-Compressor:	Advanced design, 6 stages optimized for short lenght, low parts count and low weight, low aspect ratio blading with little sensitivity to erosion and clearance, good surge margin. Aerodynamic and mechanic design based on EJ200.
Combustor:	Annular double dome combustor for low NO_xemission, PW 'Floatwall' liner for high durability. Based on PW technology currently under development for V2500.
HP-Turbine:	single stage cooled turbine, advanced 3D aero design with moderate temperature levels relative to MTU/PW's advanced HPT experience. CAST I cooling philosophy, active clearance control. Derived from E^3 program with modified airfoil shapes.
LP-Turbine:	3 stages, low aspect ratio blading designed for low weight, airfoil count and maintenance cost. Based on proven MTU experience on V2500. PW 2000, PW300.
Control:	FADEC, built-in capabilities for fault isolation and engine monitoring.

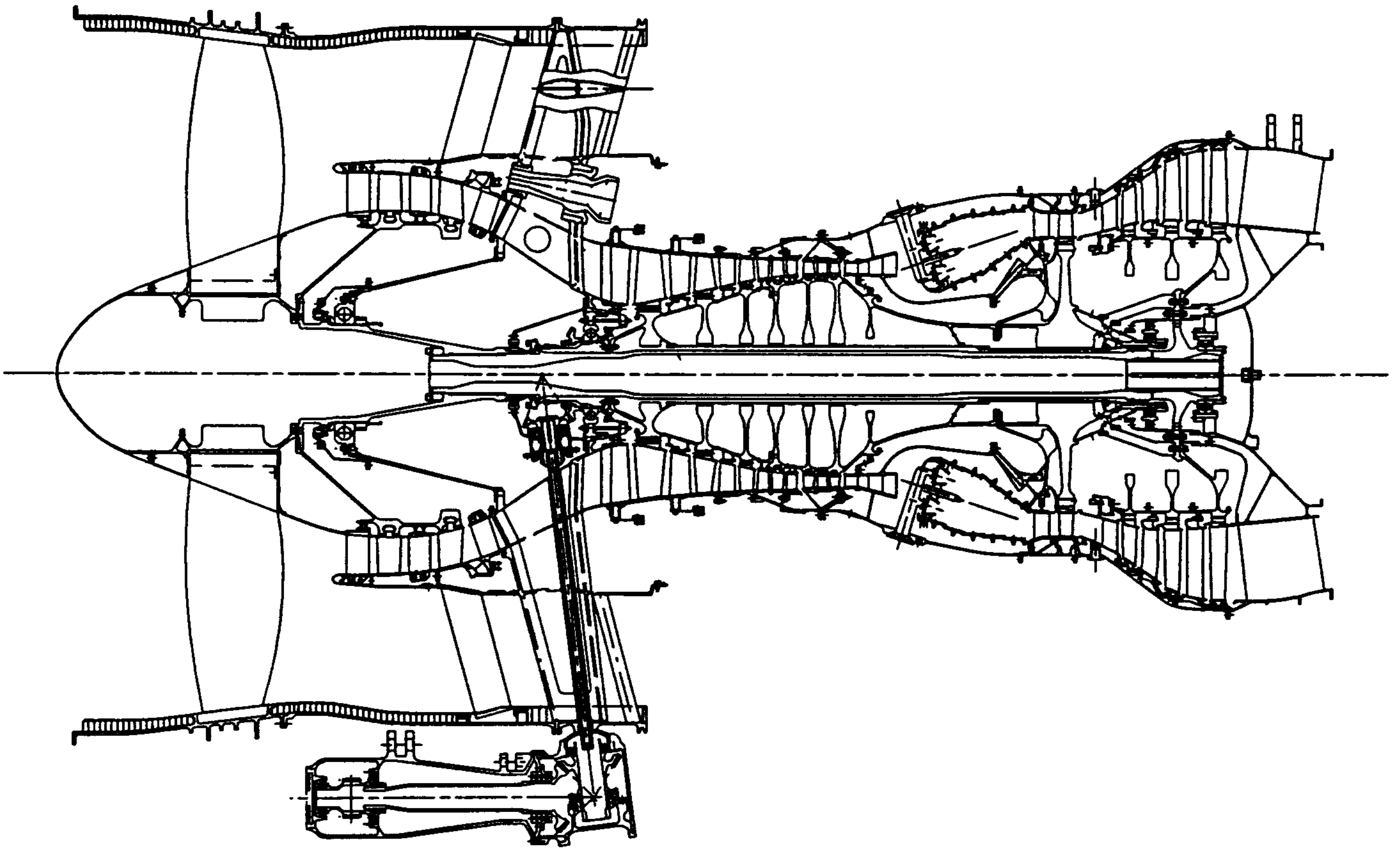

FIG. 4.5: LAYOUT OF THE RTF 180 ENGINE

4.3 Noise and Emission

4.3.1 Community Noise

With the perspective of more stringent noise certification rules to be issued , it is anticipated to achieve safe noise margins relative to FAR 36, stage 3 rule.

As a design goal, the community noise level of the aircraft at each of the three certification measuring points shall be at least 4 EPNdB below current rule. This will apply to the stretched (R 122) aircraft with respectively higher margins for the derated engine application on this aircraft.

Based on actual flight path data, community noise values have been assessed by the engine manufacturers for their proposed engine. The margins relative to stage 3 rule are shown in Fig. 4.6.

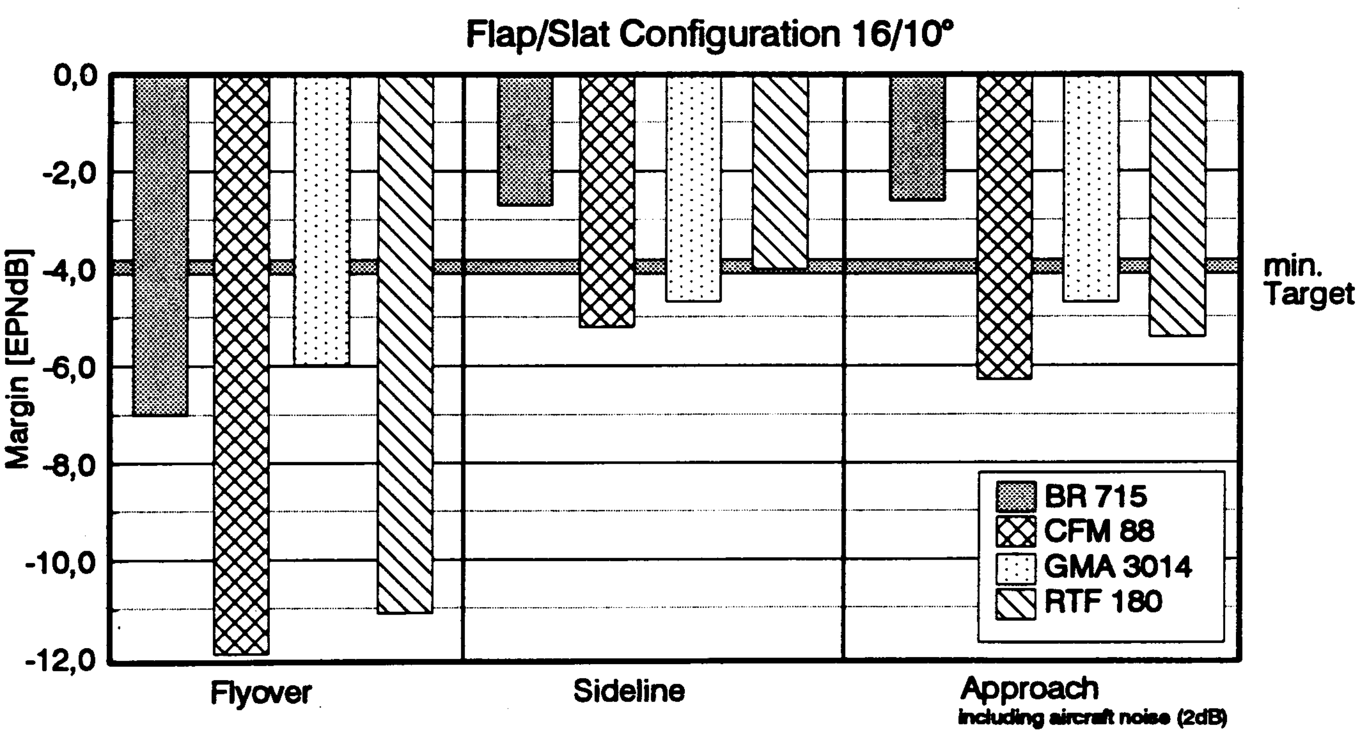

FIG. 4.6: NOISE MARGINS OF ENG. OPTIONS RELATIVE TO FAR 36, STAGE 3

4.3.2 Gaseous Emissions

Requirements for the four main pollutants (NO_x, CO, HC, Smoke) of this aircraft are based on the levels of existing modern turbofans which are already performing well below current ICAO recommendations.
Further reductions in NO_x by additional 30% will only be achievable with advanced combustor technologies. Such are proposed for two engine options, whereas the other have space provision for later retrofitting. Final selection of the combustor feature will, amongst other criteria, depend on technology readiness at entry into service.

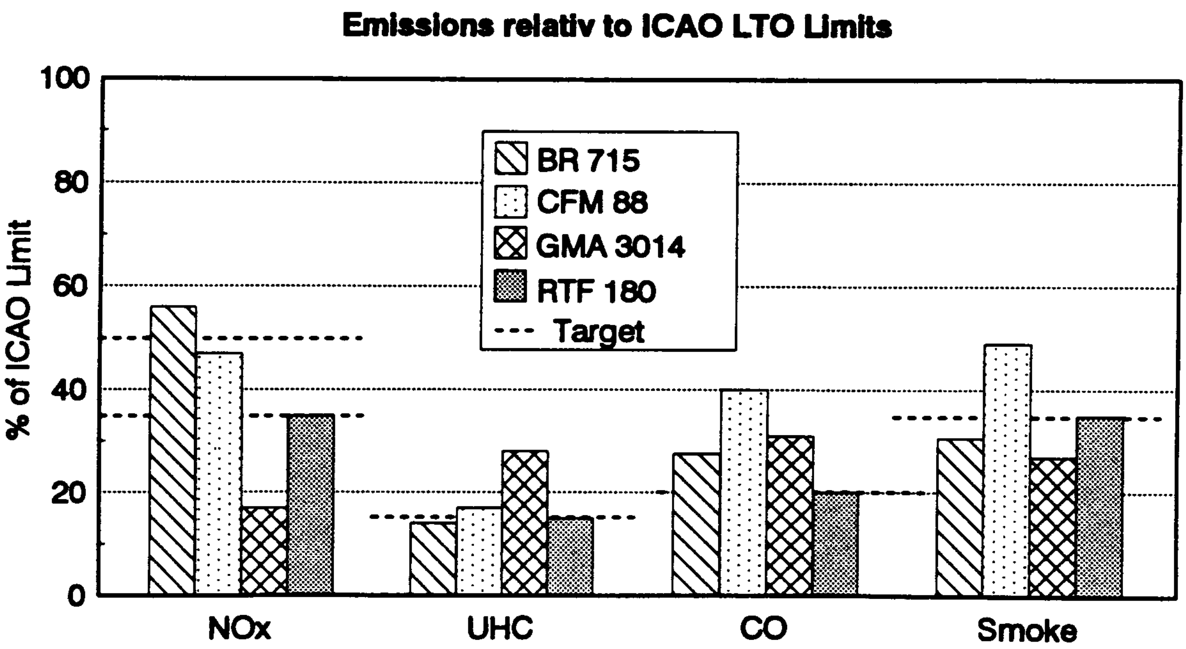

FIG. 4.7: EMISSIONS OF ENGINE OPTIONS RELATIVE TO ICAO LTO CYCLE

Item	BR 715	CFM 88	GMA 3014	RTF 180
Fan	1 stage, 53", wide chord solid titanium	1 stage, 55", wide chord solid titanium	1 stage, 55", wide chord hollow titanium	1 stage, 52", wide chord solid titanium
LP Compressor	2 stages	3 stages	2 stages	2 stages
HP Compressor	10 stages, 4 variable	7 stages, 3 variable	8 stages, 4 variable	6 stages, 2 variable
Combustor	conventional	conventional	fuel stagingl	fuel staging
HP Turbine	2 stages	1 stage	2 stages	1 stage
ACC	no	yes	no	yes
LP Turbine	3 stages	4 stages	4 stages	3 stages
Bleed offtakes				
LP	Fan duct	Fan duct	Fan duct	LPC exit
IP	HPC, stage 5	HPC, stage 4	HPC, stage 4	HPC, stage 4
HP	HPC, stage 8	HPC exit	HPC exit	HPC exit
Bypass- Ratio (SLS)	5.1	5.75	4.6	5.0
SFC (35000ft, M 0.77,inst.) [lb/h/lb]	0.632	0.625	0.657	0.648
Nacelle Configuration length / height [mm]	short duct 4196/1816	short duct 4213/1984	short duct 4033/2023	long duct, mixed 4132 / 1864
Thrust reverser (optional)	4 door pivot type	4 door pivot type	4 door pivot type	cascade
Weight				
dressed engine	3964	3869	3228	3740
propulsion system	5140	5167	4468	5245

TABLE 4.1: ENGINE ARCHITECTURE AND MAIN DATA

5. SYSTEMS

5.0 Introductory Remarks

5.0.1 Not in all cases systems have been discussed, let alone agreed by partners.

5.0.2 There has been no joint agreement among the partners whether Airline avionics type (ARINC/IMA) or General Aviation avionics type shall be used for the Regioliner. For weight reasons the "Joint Company" decided to use the lighter General Aviation standard avionics for this design status. There will be no cockpit commonality to the Airbus design. Therefore, but without any anticipation of decision which type of avionics will be selected finally, General Aviation standard avionics is included in the weight breakdown (chapter 7.2).

5.0.3 There will be full commonality of the systems between R 92 and R 122 except:

- Changes caused by stretching the fuselage, higher pax capacity.
- Introduction of center section tank for the R 122 (to meet the 1500 nm range requirement, the R 122 needs the center tank basically).
- higher design weights

5.0.4 As a target no equipment (e.g. fans, hydraulic pumps, actuator) shall exceed the cabin noise limitation in normal operation.

5.1 Systems Descriptions

ATA 21 Air Conditioning

Air supply will be bleed air from the main engines.

The air will pass through two air cycle packs including air/air heat exchangers, will be mixed with filtered recirculated air from the cabin, and finally will enter the distributing system to the cabin.

The cabin will be pressurized up to a nominal value of 8.06 psi by restricting the outflow of the cabin air via an outflow valve. The system will automatically control the cabin pressure rate of change and the cabin pressure.

The passenger compartment will be supplied with conditioned air via quasi continuous slots along the sidewalls and adjustable air outlets for each passenger.

For sufficient air conditioning on the ground, pressurized air will be provided by the APU or an external source (LP ground connector).

ATA 22 Automatic Flight Control

In the basic configuration a fail passive Autoflight/Flight Director system with CAT II A approach capability will be installed, transmitting commands to the flight control surfaces and the FADEC's. Operating modes of this basic system will be conventional including Autoland modes. There are provisions for an improved system integrity as needed for CAT III A landing capability.

There will be a single Flight Management function with two CDU's. Optionally, a second Fight Management function can be installed.

ATA 23 Communication

The basic equipment will be:

2 VHF Transceiver
1 CVR

2 Radio Management Panels
1 Audio Management System with integrated SELCAL function and
  2 Audio Management Panels
1 Cabin integrated data system with the following functions:
  Cabin interphone with 2 handsets in the cabin and one in the cockpit
  Service Interphone
  Public Address
  Cabin Lighting Control
  Steward Call
  Interface for optional entertainment systems

Optional equipment will be:

a third Audio Management Panel
a third Radio Management Panel
a third VHF Transceiver
1 ACARS
1 Pre-recorded announcement and boarding music system
1 Passenger audio entertainment
2 HF Transceiver

ATA 24 Electrical Power

Power will be generated by two engine-driven 60 KVA generators (one per engine). The generators supply 115/200 V AC, wild frequency power to the converter which supplies the distribution system with 400 Hz constant frequency power.

An auxiliary generator driven by the APU is mainly used for ground operation, but can also substitute an engine-driven generator in case of failure. The auxiliary generator will produce 115/200 V 400 Hz AC power; DC busses will be fed via TRU's (transformer-rectifier unit).

Emergency power is provided by two batteries and one single phase static inverter. Batteries can start the APU.

In case of double engine failure, a RAT (Ram Air Turbine), being located in the a/c nose, will be extended automatically. It provides electric power to supply essential AC power and, via a TRU, essential DC power and also via an electric driven pump hydraulic power to the respective subsystems in the blue circuit.

ATA 25 Equipment/Furnishing

SEE 2.3

ATA 26 Fire Protection

Conventional fire detection and extinguishing systems will be used.

ATA 27 Flight Controls

The flight control system comprises the following surfaces:

Directional Control	1 rudder
Roll Control	1 aileron on each wing, complemented by spoilers
Pitch Control	trimmable horizontal stabilizer with an elevator on each side
Airbrakes	symmetrical operation of spoilers on each wing
Lift Dumping	symmetrical operation of all spoilers on each wing
Slats	4 segments on each wing
Flaps	2 segments on each wing

All control surfaces are fully hydraulically powered and electrically signalled in normal operation.

The trimmable horizontal stabilizer and the rudder are also mechanically signalled.

Pilot controls consist of two side-stick controllers one on each side console. Rudder pedals, pitch trim wheels, etc. are of conventional design.

The computer system for flight control will comprise two computer systems with internal dissimilarity for hardware and software in charge of primary and secondary flight control functions.

ATA 28 Fuel System

There is a conventional fuel system with fuel storage in both outer wing boxes and for fuel capacity enlargement in the center section wing box optionally.

ATA 29 Hydraulic Power

Hydraulic power is used to operate primary and secondary flight controls and the landing gear system.

There are three independent hydraulic systems among which the users are shared in order to ensure safe aircraft control in the event of loss of any two systems. Hydraulic power is generated by two engine-mounted variable displacement piston pumps for two systems and one electrical pump for the third system. In case of loss of hydraulic power due to engine failure, there are electrically driven hydraulic pumps in each system.

Emergency power is provided by an electric pump to supply the respective subsystems in the blue circuit (see also chapter ATA 24) in case of double engine failure.

ATA 30 Ice and Rain Protection

The leading edge (slats) outward of the engine pylons will be protected by a conventional system using hot bleed air from the engines.

An ice protection system for the empennage is not required (Note: This assumption must be verified!).

Windshields and miscellaneous probes and other items (e. g. drain mast) will be protected by electric heating.

ATA 31 Cockpit and Instruments

The cockpit will be designed for operation by a 2-men-crew, with a third seat for a flight observer. Push-button technology will be applied wherever possible with the "dark cockpit concept".

There will be an electronic instrument system with 6 interchangeable display units with a primary flight display and a navigation display on each side, an engine-warning and a systems display in the center of the main instrument panel. There will be the necessary stand-by instrumentation. There will by a flight warning system.

There will be a centralized maintenance system for failure detection in flight and line maintenance support on ground via a dedicated CDU. Optionally, an aircraft condition and monitoring system for engines, APU and ECS can be installed.

The standard digital recording system will be designed and installed according to latest certification requirements.

ATA 32 Landing Gear

SEE 2.6

ATA 33 Lights

State-of-the-art technology will be applied.

ATA 34 Navigation

The aircraft will be equipped with three attitude and Heading Reference Systems (AHRS) and two Air Data Computer (ADC) or optionally with 3 ADIRS. Three smart air data probes (combined pitot-static AOA probe with direct mounted air data module) without pitot-static tubing in the fuselage are under consideration.

Dual conventional radio nav-aids (VOR/MKR, ILS ADF, ATC with TCAS option, DME, MLS option), weather radar, two radio altimeters, and a ground proximity warning system will be installed.

The equipment will fulfil the requirements for CAT II up to CAT III A.

Two optional GPS receivers can be integrated to cover areas with insufficient radio nav-aids.

ATA 35 Oxygen

Conventional technology will be applied.

ATA 36 Pneumatics

The function of this system shall be to supply air to the following user:

- air conditioning system
- wing ice protection
- engine starting system
- water system
- hydraulic system

The air sources are:

- air bleed from various stages of the engine compressors
- the APU
- an equivalent HP ground supply

ATA 38 Water/Waste

System layout will be state-of-the-art. The toilet waste system will be of the recirculation type. A vacuum toilet waste system can be installed as an option.

ATA 49 Airborne Auxiliary Power

The APU will be operable in flight, and will be capable of providing electrical power, e. g. in the event of engine or generator failure. However, it is a design objective that the APU will not be on the Minimum Equipment List.

The APU is located aft of the pressure bulkhead in the tail cone.

An APU Control Unit will be installed. Controls and indications necessary to operate, monitor, and assist maintenance of the APU will be accommodated in the flight deck.

The APU noise levels are targeted at latest recommendations according to ICAO Annex 16, chapter 9.

The APU types currently under consideration are the Garrett GTCP 36-250, BMW/Rolls Royce T 218, and the APIC APS2000.

6. DESIGN CRITERIA AND LIMITATIONS

6.1 Speeds

V_A (Manoeuvering)	kts CAS	TBD
V_B (Gust)	kts CAS	TBD
V_{MO}	kts CAS	320
M_{MO}	-	0.81
V_D	kts CAS	350 (with overspeed protection system)
M_D	-	0.88

6.2 Manoeuvre Loads

Manoeuvre Load Factor + 2.5
- 1

6.3 Max. Flight Level

Max. Flight Level ft 39000

6.4 Cabin Pressure Altitude

Design Pressure Differential psi 8.06

6.5 Fatigue Life Design

Crack-free life: 25000 FC/HRS

Structural endurance under normal operating conditions allowing for minor repairs, but not for replacement of major structural parts:

60000 FC/HRS

7. WEIGHT AND BALANCE

7.0 Introductory Remark

7.0.1 Starting from individual companies' weight estimates, weights were discussed between the partners and agreed.

Weight breakdown and center of gravity estimation include effects of all configuration changes featuring the new configuration status (see chapter 1.1).

Design weights have been established according to new, jointly agreed MZFW/MLW - definitions. MTOW increase due to guaranteed range requirements has not been included so far.

The weights assume a generic "brochure engine" as shown in the 3-view General Arrangement.

7.0.2 Weight estimates have been based upon the following assumptions about the development strategy:

Regioliner R92 will be designed allowing for future stretch in terms of external geometry but without any special reserves in structures and systems beyond normal design practice. Regioliner R122 will utilize all structural reserves which become apparent in tests of the R92. Prerequisite for this is a suitable timing of the two aircraft development schedules.

7.0.3 Weights assume a three box wing design with metal wing center box as described in chapter 2.1.

7.0.4 Weights assume General Aviation standard avionics. Airline standard avionics may cause a weight increase of up to 110 kg depending on definition.

7.1 Design Weights

Max. Take-off Weight	43280	kg
Max. Landing Weight	40250	kg
Max. Zero Fuel Weight	37700	kg
Manufacturer's Weight Empty	23723	kg
Operator's Items [1]	2711	kg
Operating Weight Empty	26434	kg
Standard Passenger Payload	9050	kg
Max. Payload (MZFW - OWE)	11266	kg
Max. Fuel (wing only)	8750	kg

7.2 Weight Breakdown

See table next page!

7.3 Center of Gravity

7.3.1 CG at OWE for example all tourist layout:
at 20 % MAC (± 2 %)

7.3.2 Center of Gravity Limits

Forward CG Limit	TO, LDG: 11 % MAC	
	Flight: 9 % MAC	
Rear CG Limit	TO, LDG: 39 % MAC	(tbc)
	Flight: 41 % MAC	(tbc)

---

1) Operator's Items reflect requirements formulated by Market Group, and can be considered to represent "typical airline" status.

7.2 Weight Breakdown (kg)

WC	DESCRIPTION	RL100C01/095
10	Wing	4516
11	Fuselage	5811
13	Tailplane	488
14	Fin	380
15	Landing gear	1539
16	Pylons	700
	STRUCTURE	**13434**
20	Equipped engines	4662
21	Bleed air system	185
22	Engine control	20
23	Engine instrumentation	0
25	Fuel system	170
	POWER UNIT	**5037**
30	APU	164
31	Hydraulic generators	375
32	Hydraulic distribution	203
33	Air conditioning	460
34	De-icing	32
35	Fire protection	75
36	Flight controls	610
37	Instruments	67
38	Auto flight system	40
39	Navigation	270
40	Communication	131
41	Electric generators	262
42	Electric distribution	698
	SYSTEMS	**3387**
50	Furnishing	1590
51	Oxygen	65
52	Lighting	150
53	Water installation	60
	FURNISHINGS	**1865**
	MWE	**23723**
90	Contingency	0
61	**OPERATOR ITEMS**	**2711**
	OWE	**26434**

8. PERFORMANCE

8.1 Design Requirements and Objectives

Table 8.1 summarizes the pertinent DR&O, originally defined by the Market Group, as they were modified and interpreted by dialogue between Marketing and Technical Group, or changed by top management.

8.2 Performance Predictions

8.2.1 Assumptions

Performance predictions are based upon the MTU/PW RTF 180 engine characteristics (mod. perf. deck status: MTU-DA1014, 24-01-92; off-takes as specified in the RFP), but with propulsion system weight and nacelle shape as assumed for the generic "brochure engine" (featuring project status: RL100C01/095).
The aerodynamic standard being used is based on Aero Data Base dated August 1, 1991 (DA-Note: EF-T-1/009) including modifications for current configuration status.
Weights have been used as shown in chapter 7.1.
Design mission profile definition is given in figure 8.6.

Results of the performance calculations can be considered to be representative for the performance level of the Regioliner R92. However, exact numbers can and will change in accordance with

- characteristics of alternative engines
- in-depth analysis of aerodynamics ("Base de Calcul").

8.2.2 Performance Summary

Table 8.2 summarizes the results of the performance "spot point" calculations.

8.2.3 Payload - Range

Fig. 8.1 shows the payload vs. range capability considering OWE for Standard Passenger Payload.

8.2.4 Range - Take-off Field Length

Fig. 8.2 shows the range vs. take-off field length for "ISA, SL" and "Denver" conditions.

8.2.5 Blockfuel / Blocktime - Stage Distance

Fig. 8.3 and fig. 8.4 show blockfuel and blocktime vs. stage distance, respectively.

8.2.6 AEO / OEI Ceiling - Weight

Fig. 8.5 shows all-engine-operative and one-engine-inoperative ceiling vs. weight.

SELECTED DESIGN REQUIREMENTS AND OBJECTIVES - PERFORMANCE

<u>Range (SPP, 0.77 Mach)</u>

Both basic aircraft	1500 nm
Extended Range, Stretched Aircraft	2300 nm
Extended Range, Initial Aircraft	not defined

<u>Take-off</u>

SL ISA, MTOW

Initial Aircraft	5000 ft
Stretched Aircraft	5250 ft
ER-versions	not defined

Denver (5330 ft elev., ISA + 31° C) SPP, 1000 nm mission	12000 ft

<u>One Engine Out Net Ceiling</u>

Engine failure 30 minutes after T.O., SPP, 500 nm mission, ISA + 10° C, Anti-icing off	19000 ft
Engine failure at T.O., SPP, 500 nm mission, ISA + 10° C, Anti-icing on	12000 ft

<u>AEO</u>

ISA + 10°C, MTOW	35000 ft

<u>Speed</u>

M_{MO}	0.81
V_{MO}	320 kts CAS
M_{Cruise}	0.77
$V_{appr.}$ (MLW)	≤ 130 kts CAS

TABLE 8.1

PERFORMANCE SUMMARY - RL100C01/095

Range (SPP, Mach .77, 35000 ft)	1500	nm
Take-off (SL ISA, MTOW)	4840	ft
Take-off (Denver: 5330 ft elev., ISA + 31° C) (SPP, 1000 nm mission)	11780	ft
One Engine Out Net Ceiling, (Engine failure 30 min after T.O.) (SPP, 500 nm mission, ISA + 10° C, Anti-icing off)	19200	ft
One Engine Out Net Ceiling 12000 ft (SPP, 500 nm mission, ISA + 10° C, Anti-icing on)	after 145	nm
AEO Ceiling (500 ft/min rate of climb at M=.75, ISA +10°C, ICW for 1500 nm)	36350	ft
Approach Speed (MLW)	122kts	CAS
Landing Field Length (SL ISA, dry runway, MLW)	4150	ft
Approach Speed (typ. mission landing weight)	117kts	CAS
Landing Field Length (SL ISA, dry runway, typical mission landing weight)	3900	ft

TABLE 8.2

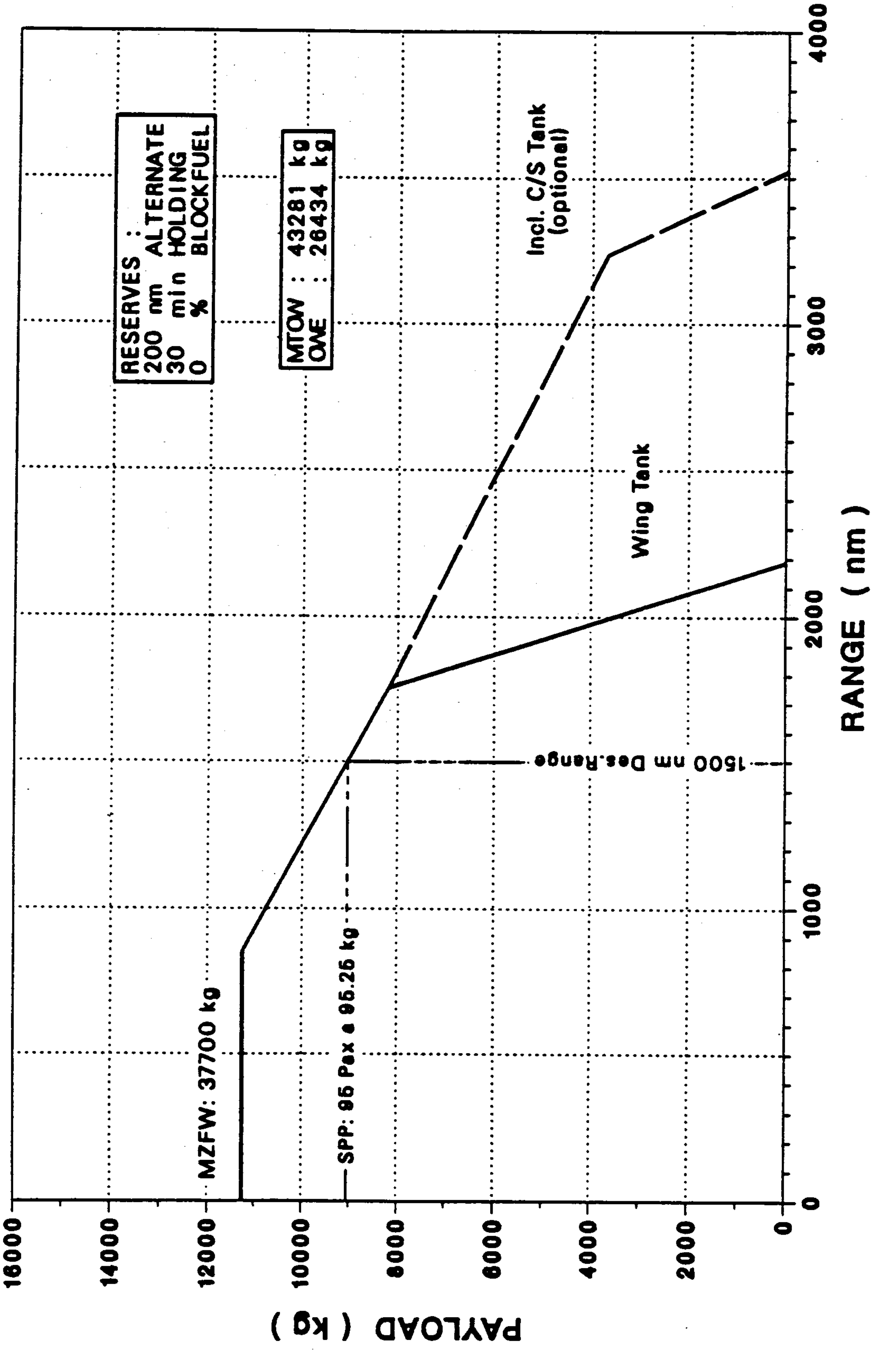

FIG. 8.1: PAYLOAD vs. RANGE - RL100C01/095

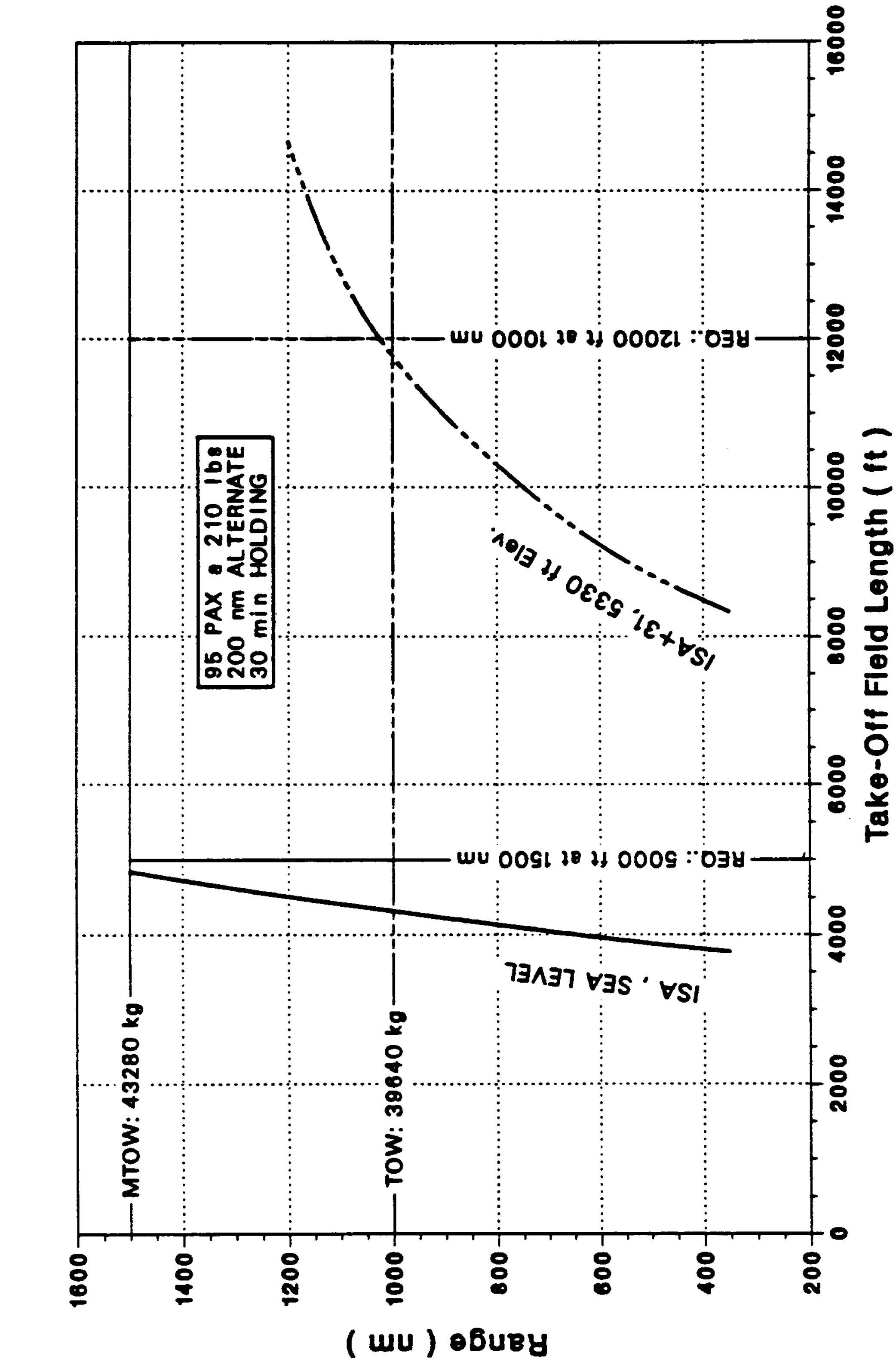

FIG. 8.2: RANGE vs. TAKE-OFF FIELD LENGTH - RL100C01/095

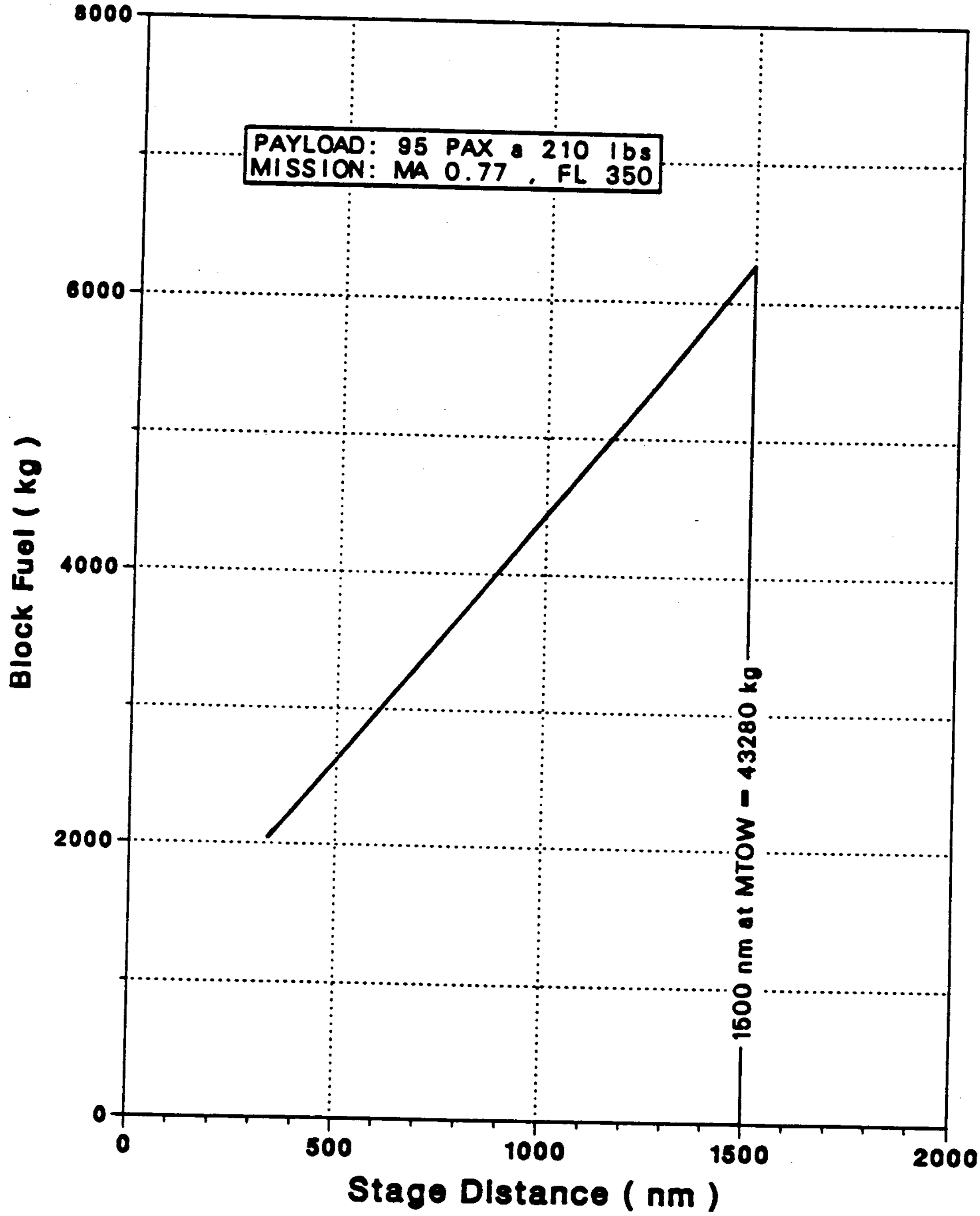

FIG. 8.3: BLOCKFUEL vs. STAGE DISTANCE - RL100C01/095

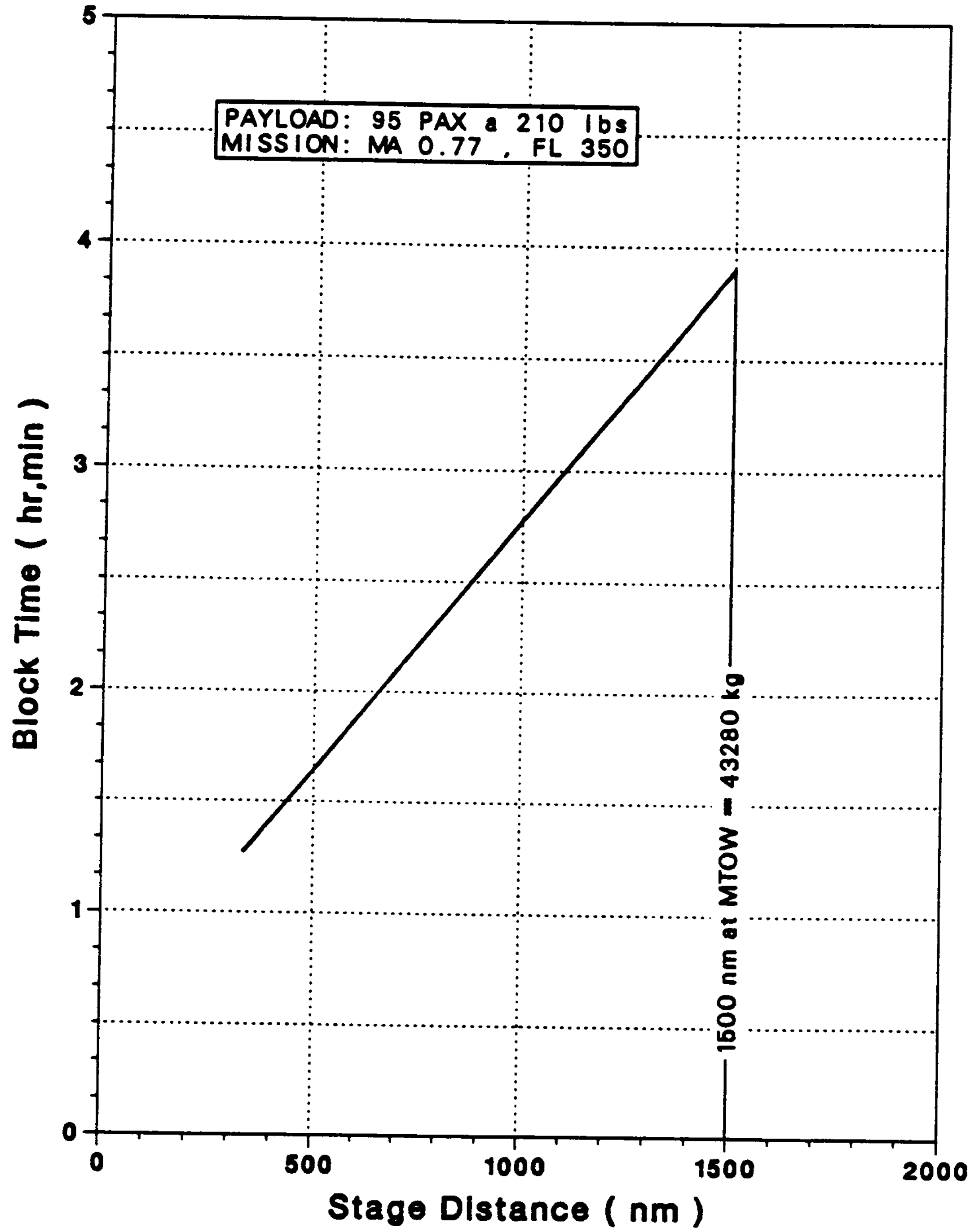

FIG. 8.4: BLOCKTIME vs. STAGE DISTANCE - RL100C01/095

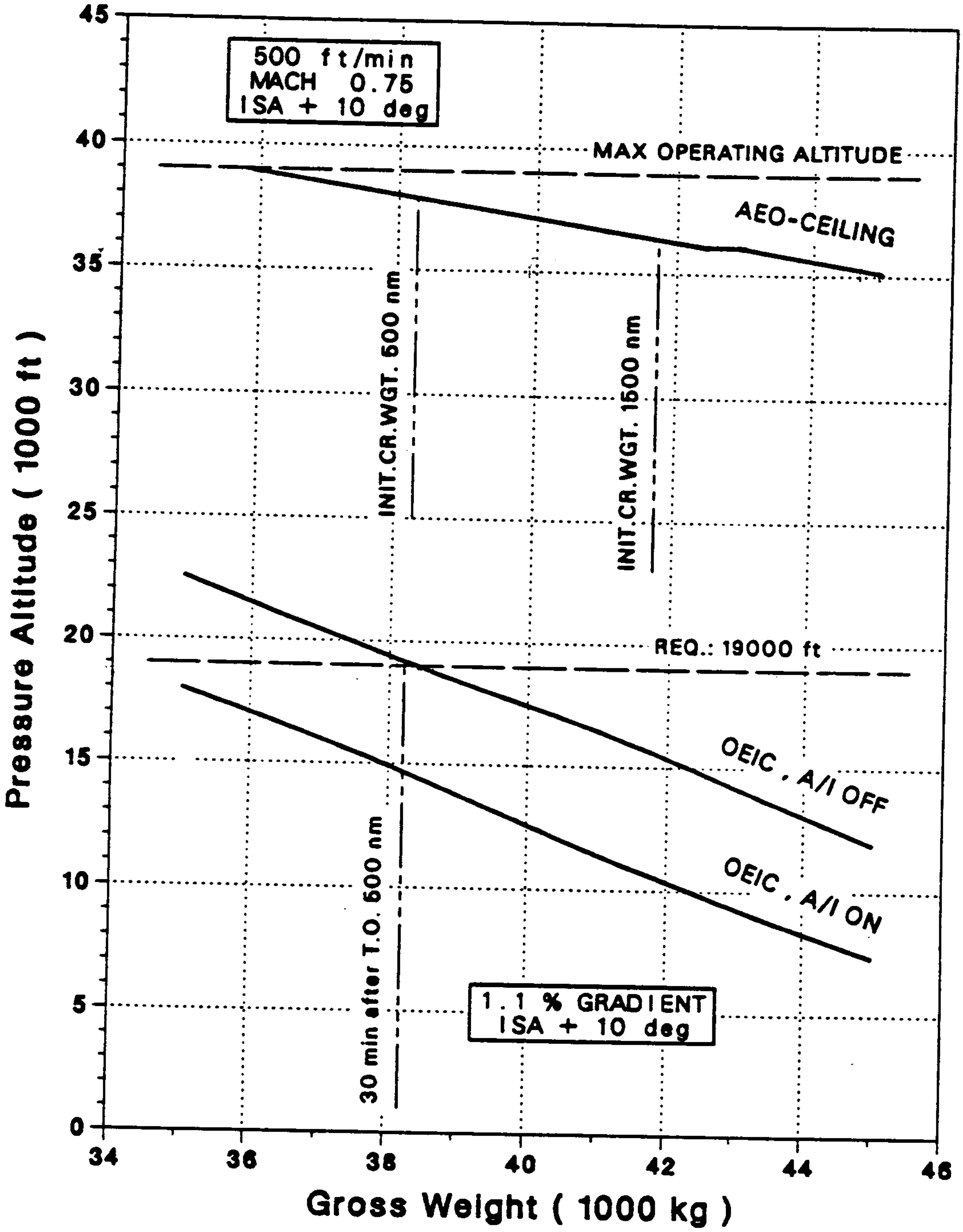

FIG. 8.5: AEO / OEI CEILING vs. WEIGHT - RL100C01/095

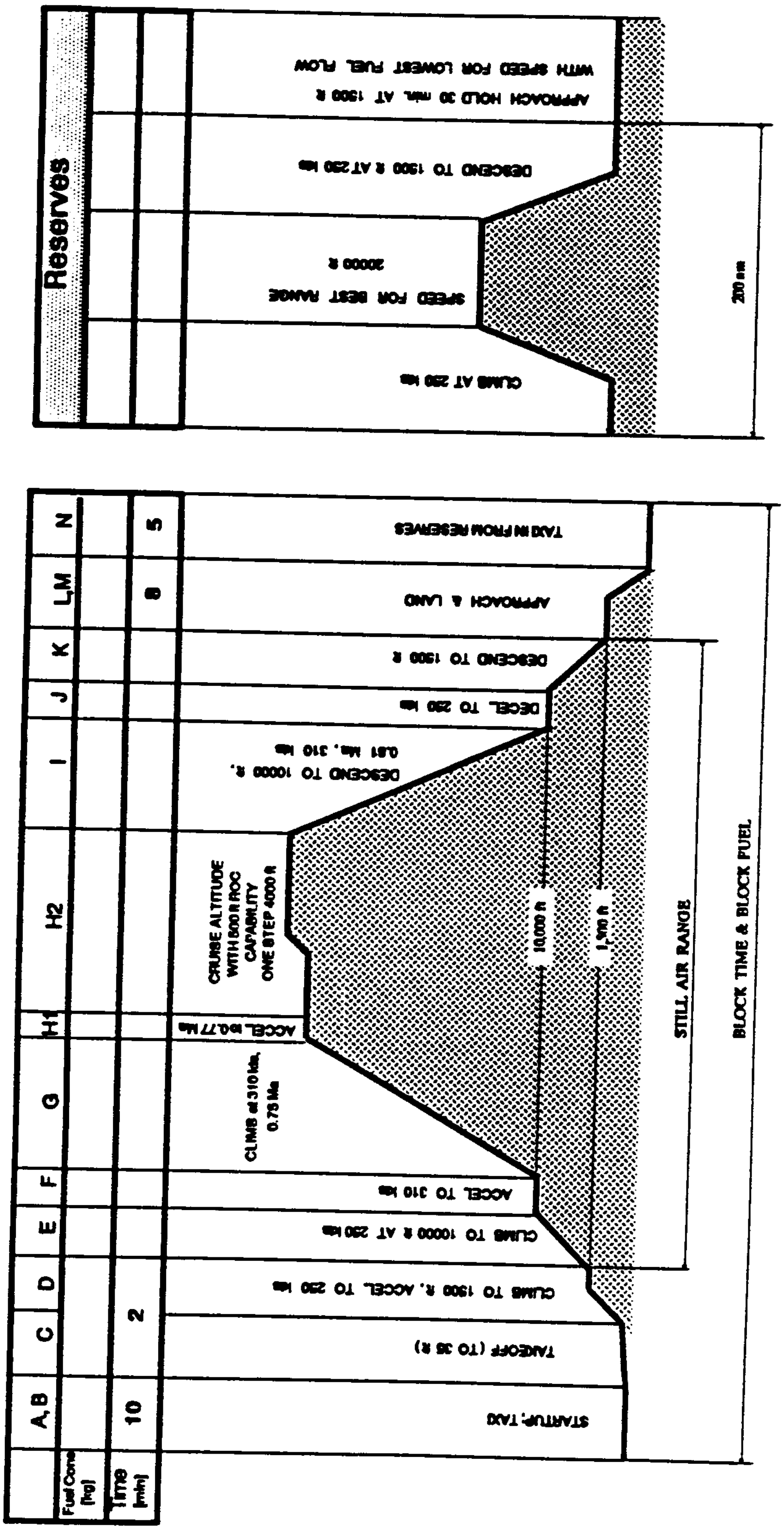

FIG. 8.6: DESIGN MISSION PROFILE