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Arbeitskreis Luft- und Raumfahrt

Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

The Royal Aeronautical Society Hamburg Branch presents

Concorde - Souvenirs of Supersonic Transport Design and Development

Dudley Collard, former aerodynamicist & designer Concorde project

Concorde

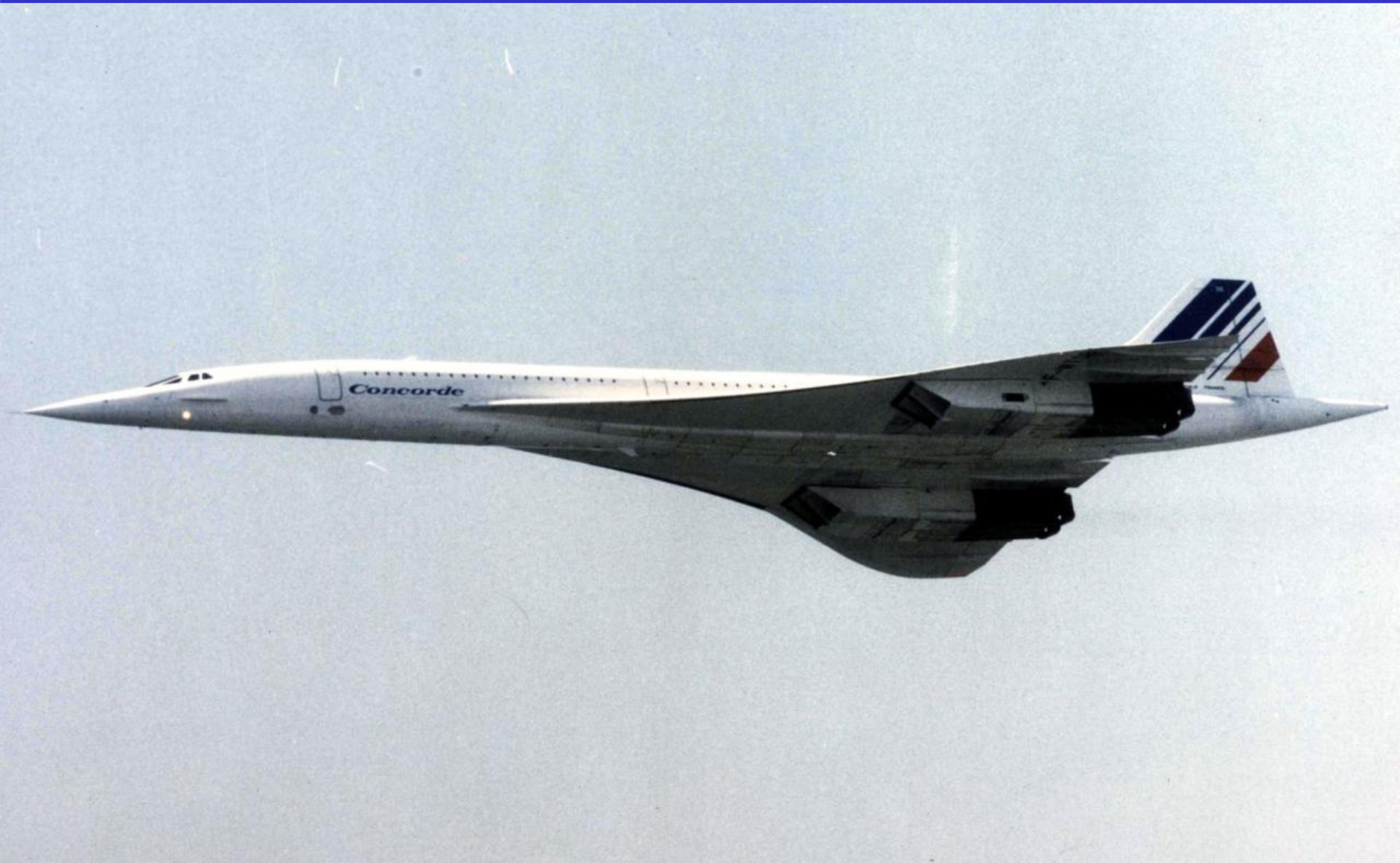
Souvenirs of SST Design and Development

Mr Dudley Collard MRAeS

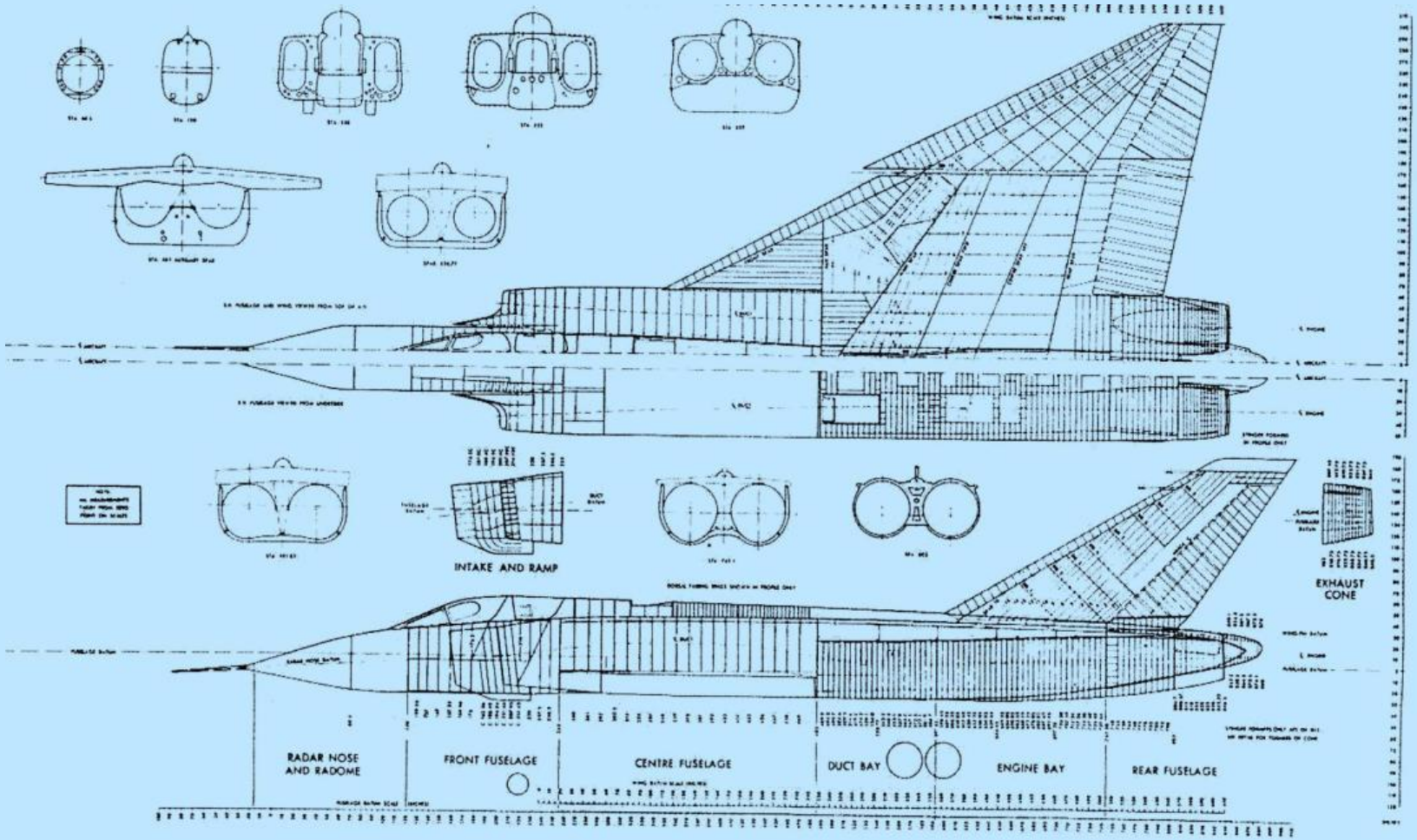
Gästehaus Universität Hamburg

11 April 2007

CONCORDE
Souvenirs of SST
Design and Development



CONCORDE
Souvenirs of SST Design and Development



AVRO ARROW CF 105 (P&W J75)

Fig. 1

CONCORDE
Souvenirs of SST Design and Development

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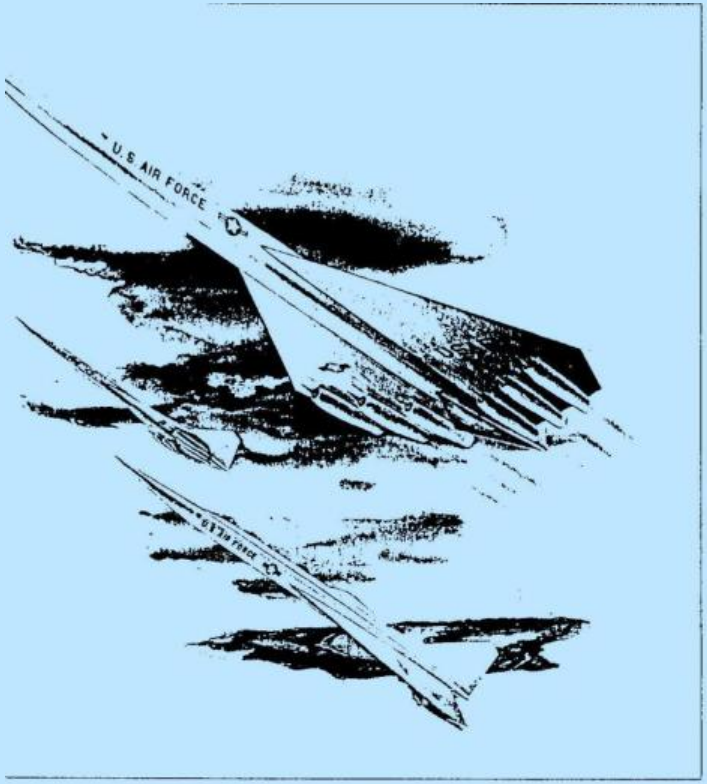
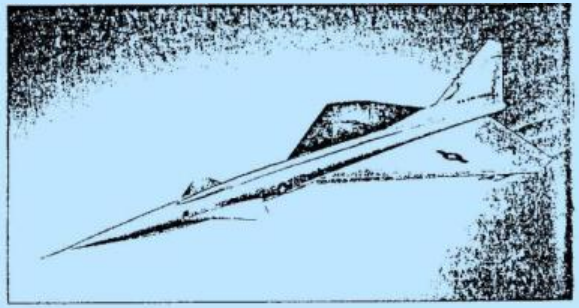


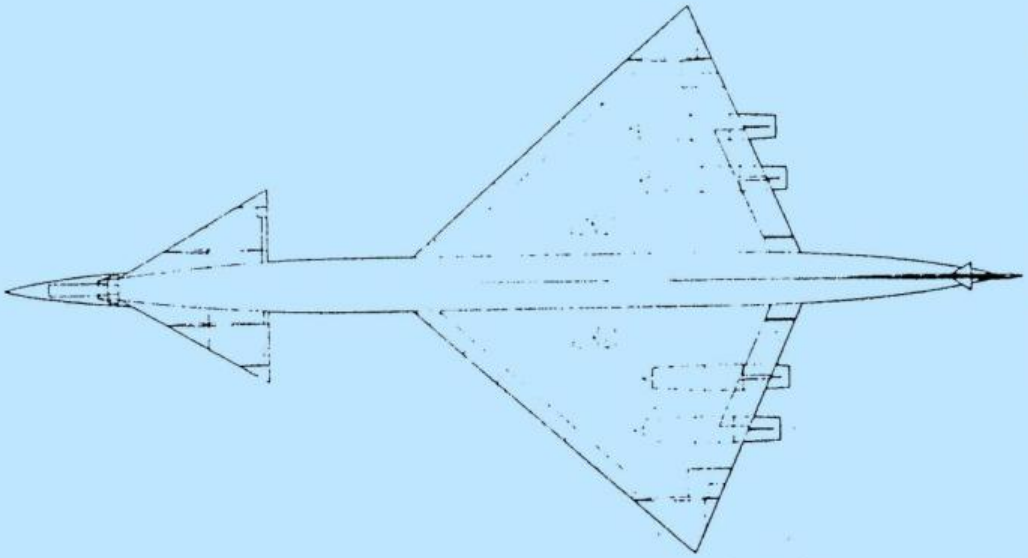


Fuselage length: 63 m.
Span: 29 m.
Cruise Mach Number: 3
Range: 7600 n.m. (14000 Km.)
6 General Electric J.93 (+ afterburner)
Fuel: Kerosene (JP.6) doped with boron

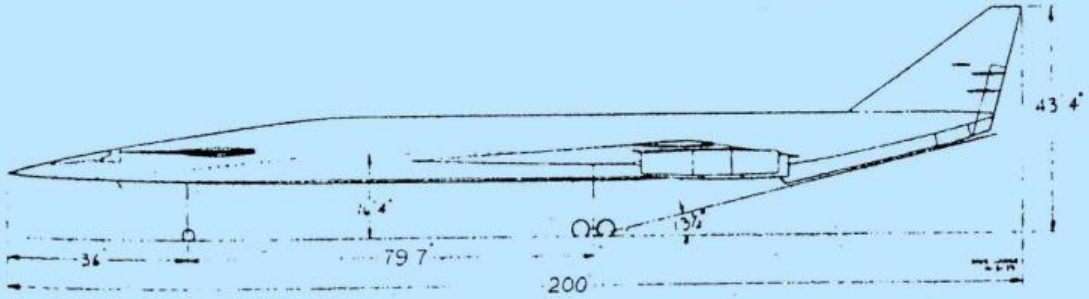
Boeing WS 110A Intercontinental Supersonic Bomber Study

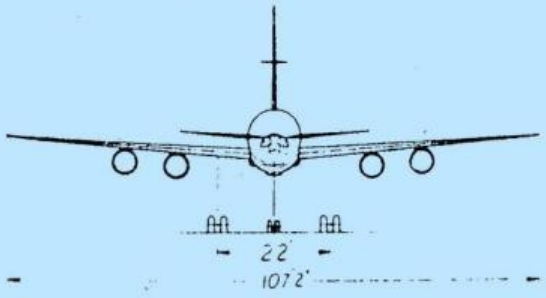
fig 2

CONCORDE
Souvenirs of SST Design and Development



Fuselage length: 61 m.
Span: 32.66 m.
Maximum Take Off Weight: 176 tonnes
Payload: 11.3 tonnes
Range: 3800 n.m.
4 Pratt & Whitney J.91 turbojets (non A/B)
Fuel: Kerosene (JP.1)

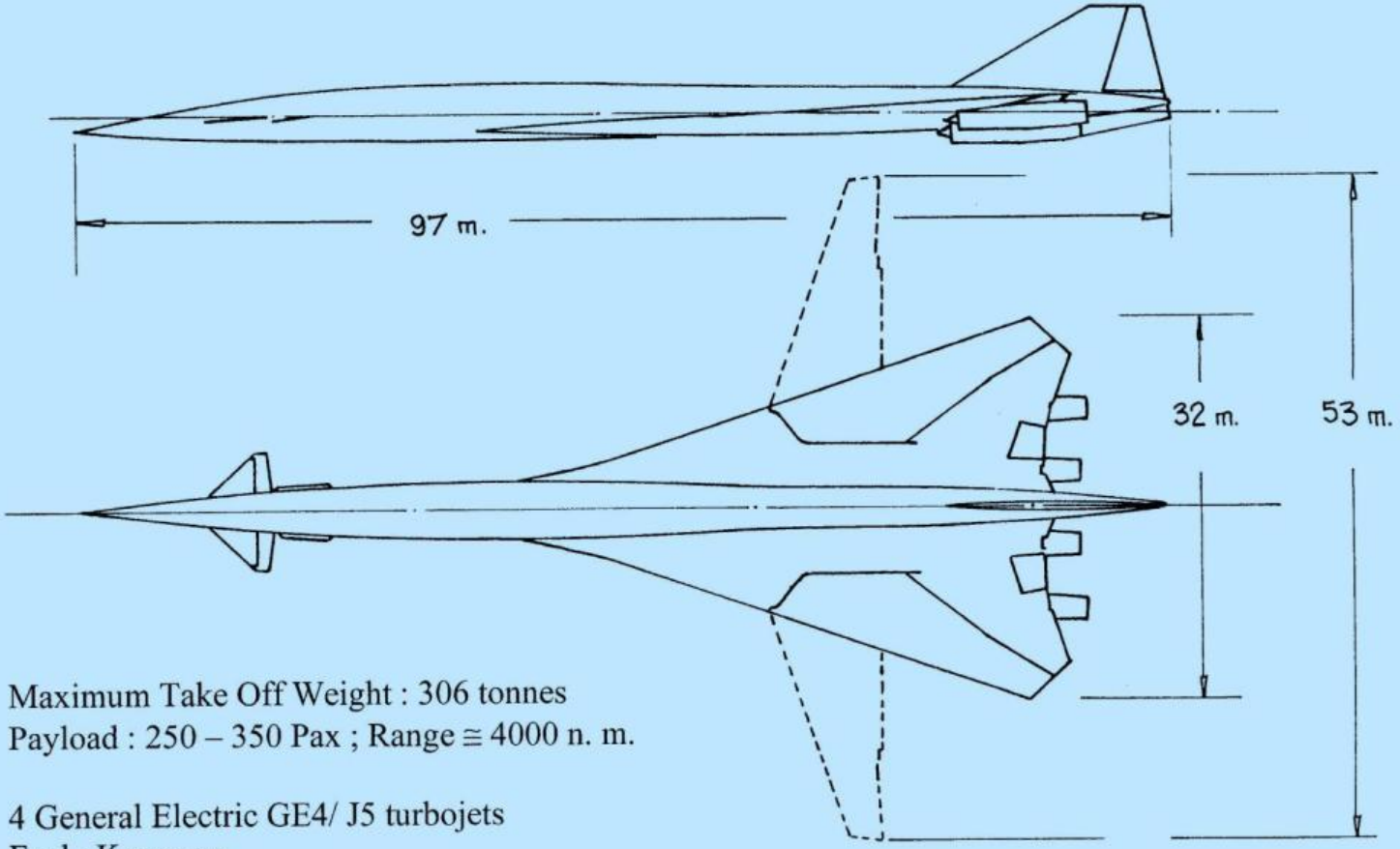




Boeing B 733-94 Mach 2 Supersonic Transport

fig 3

CONCORDE
Souvenirs of SST Design and Development



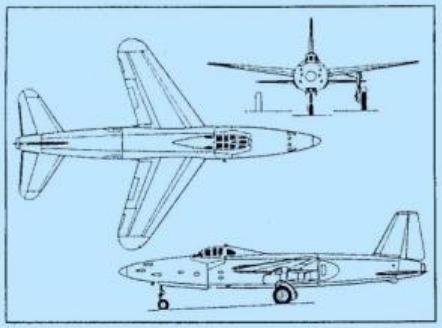
Maximum Take Off Weight : 306 tonnes
Payload : 250 – 350 Pax ; Range ≅ 4000 n. m.

4 General Electric GE4/ J5 turbojets
Fuel : Kerosene

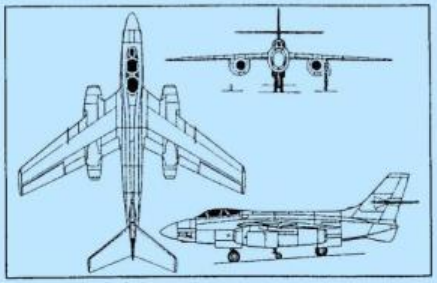
Boeing B 2707 Mach 2.7 Supersonic Transport

fig 4

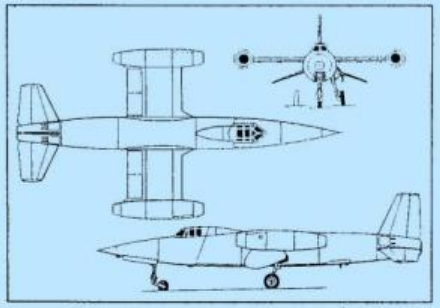
CONCORDE
Souvenirs of SST Design and Development



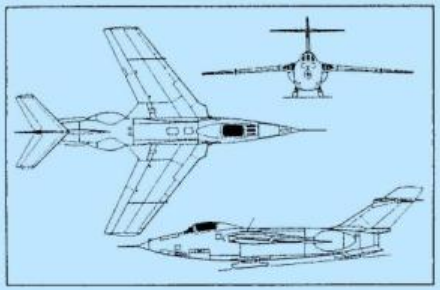
SO 6021 3 IX '50



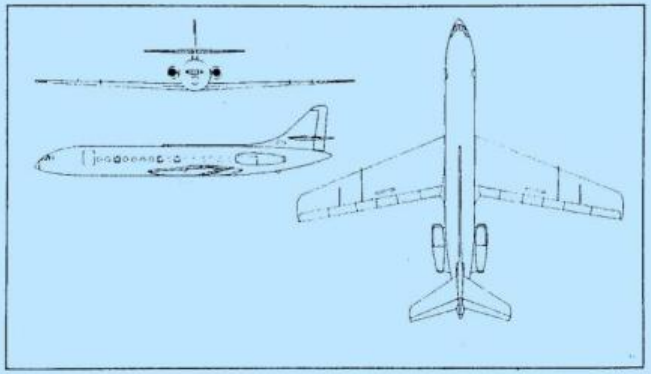
SO 4050 16 X '52



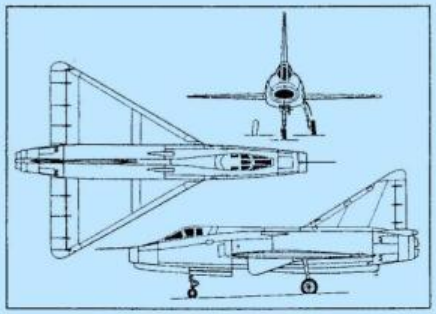
SO 9050 19 VII '55



SE 5003 12 V '54



SE 210 27 V '55



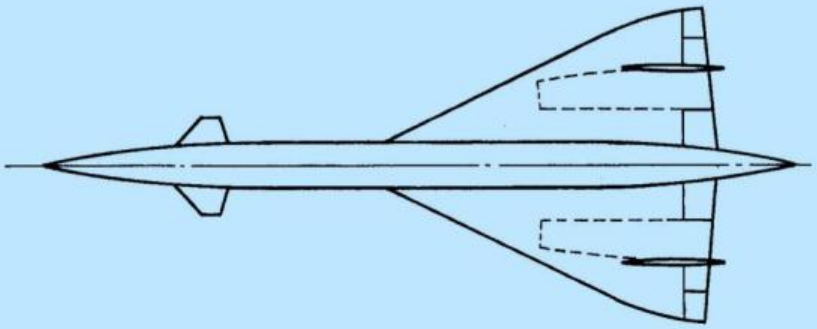
SE 212 20 IV '56

Sud Aviation Jet Aircraft Prior to Concorde Preliminary Design

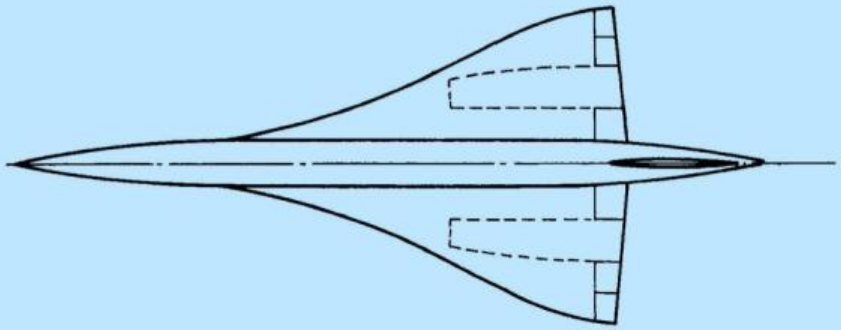
(with dates of first flight)

Fig. 5

CONCORDE
Souvenirs of SST Design and Development



CANARD : TWIN FIN

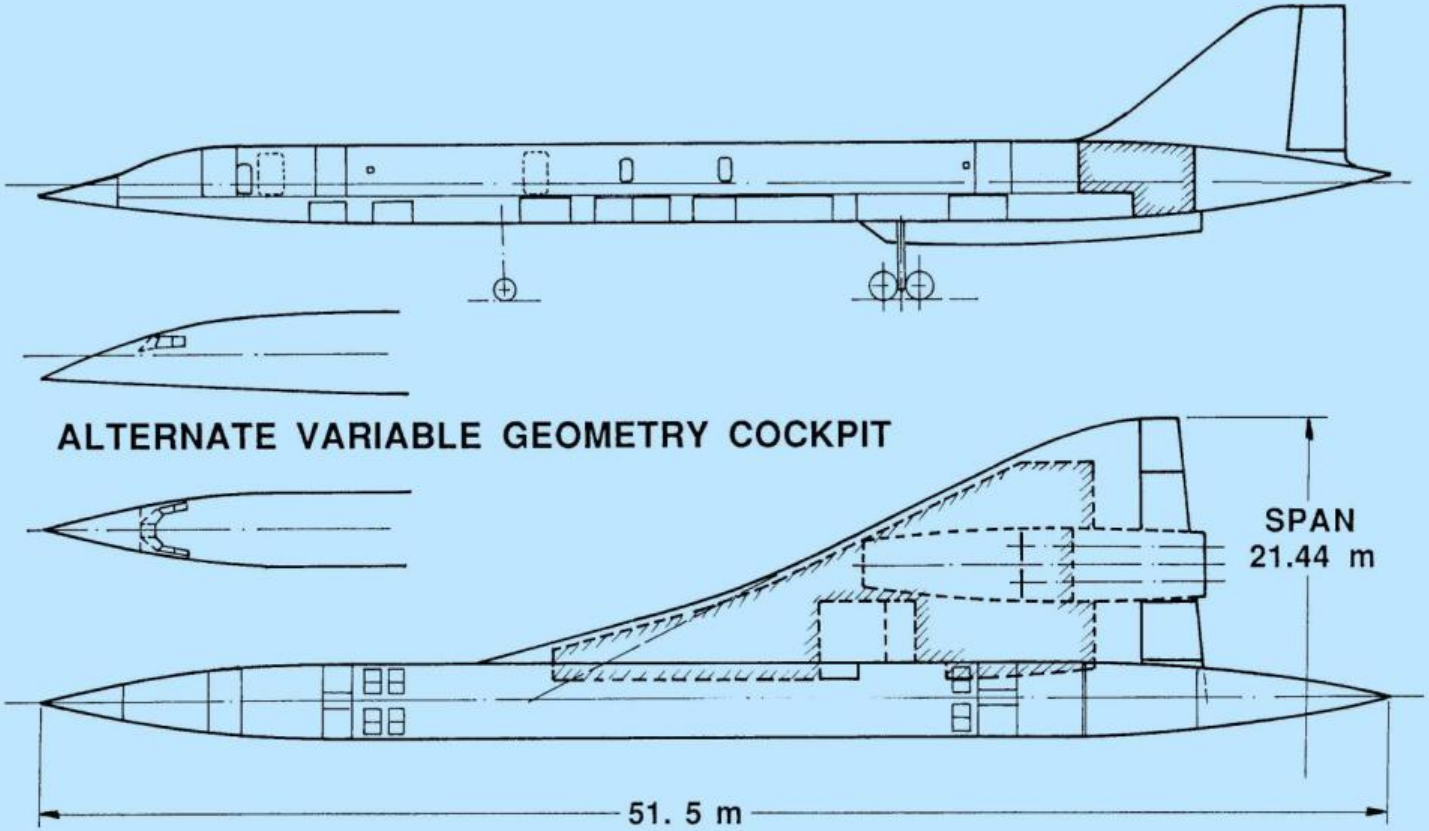


EXTENDED APEX : SINGLE FIN

Early Configuration Development

Fig. 6

CONCORDE
Souvenirs of SST Design and Development



BAC/SUD AVIATION Agreed Long Range SST - January 1962

Fig. 7

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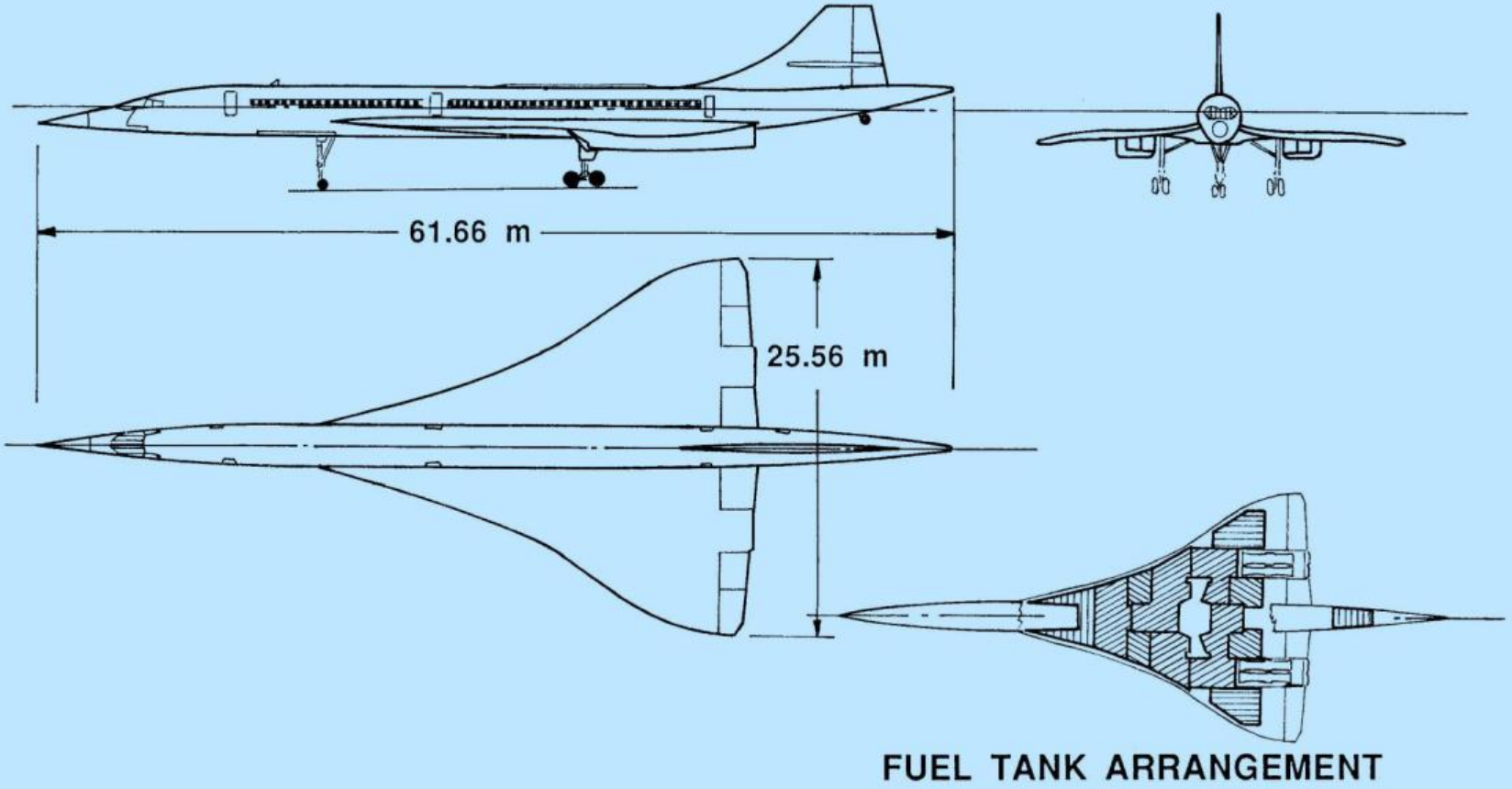
Design and Development

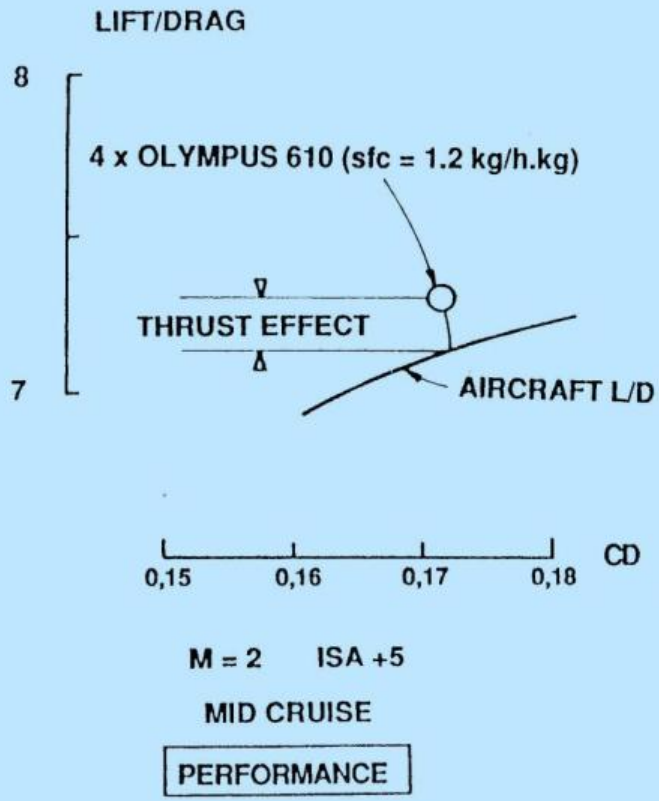


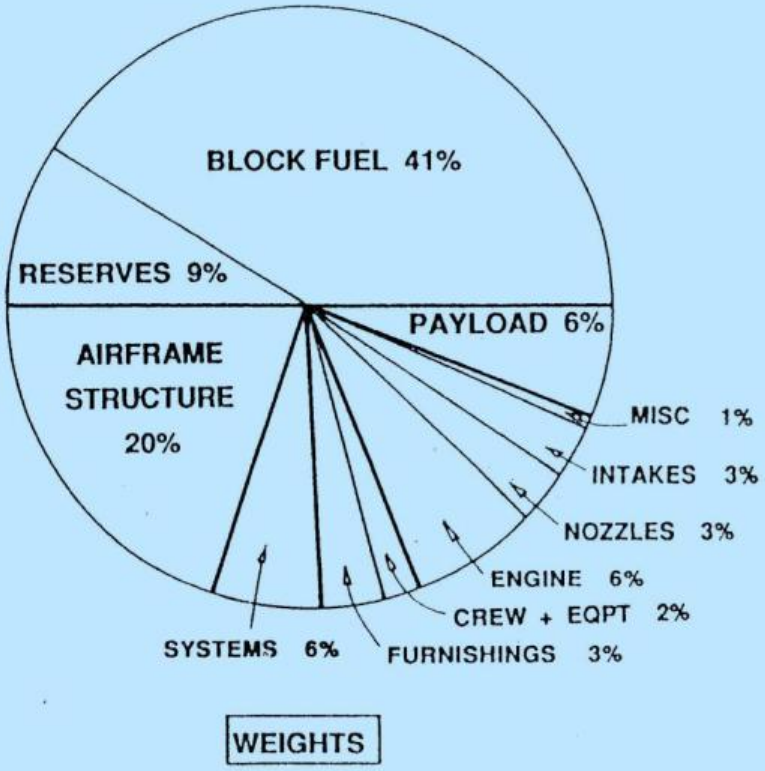
CONCORDE - General Arrangement

Fig. 8

CONCORDE
Souvenirs of SST Design and Development

CONCORDE
Souvenirs of SST Design and Development

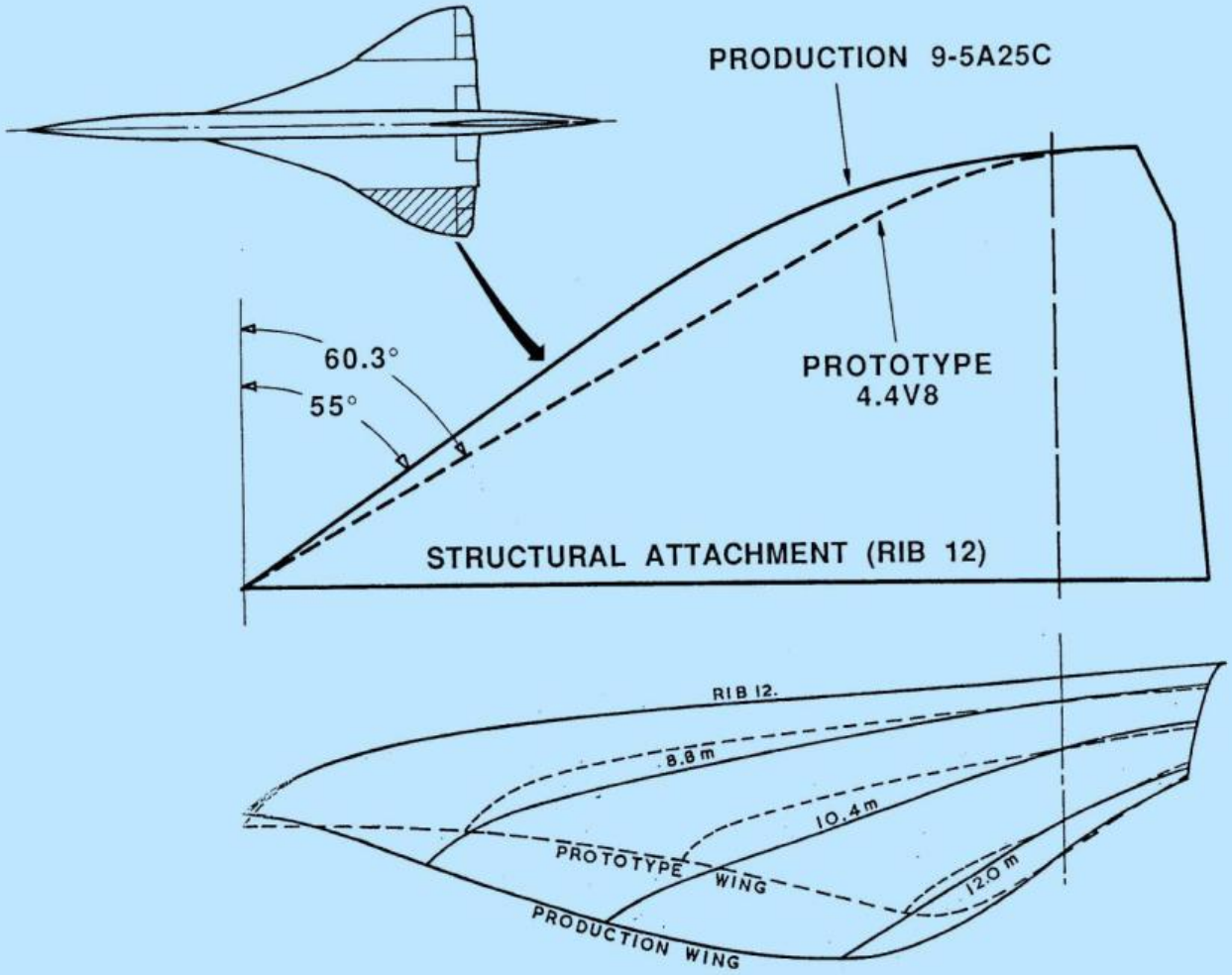




CONCORDE - CRUISE PERFORMANCE AND WEIGHT BREAKDOWN

Fig. 9

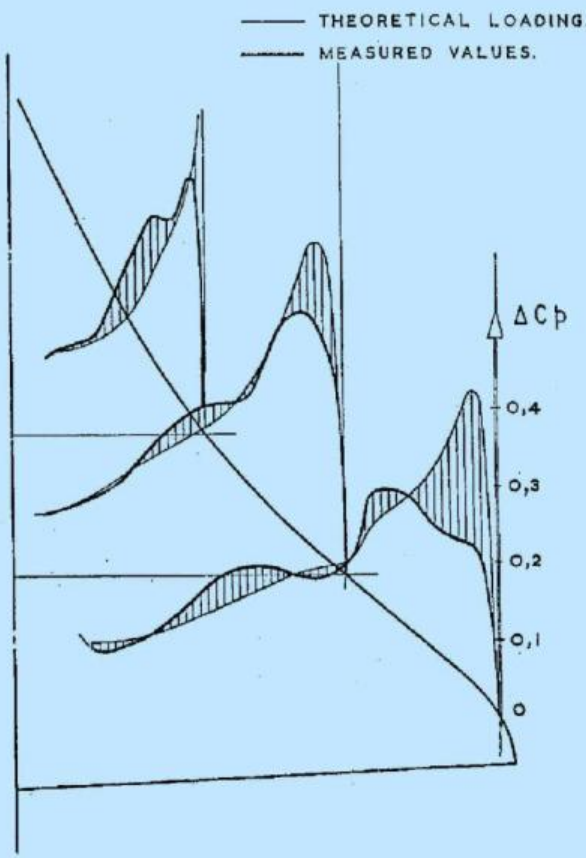
CONCORDE
Souvenirs of SST Design and Development



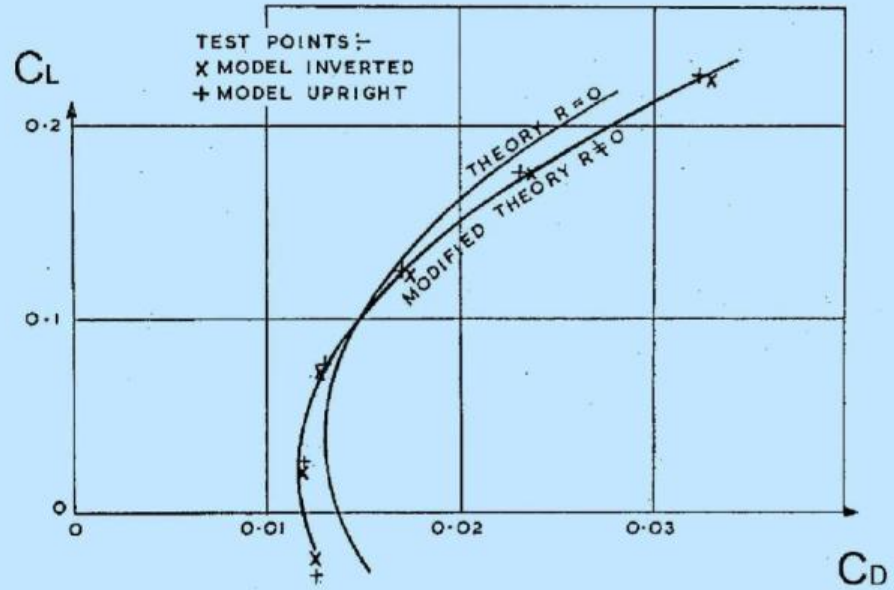
Wing Tip Development

Fig. 10

CONCORDE
Souvenirs of SST Design and Development



M = 2.2



M = 2

PROTOTYPE – MODEL SUPERSONIC WING LOADING AND DRAG

Fig. 11

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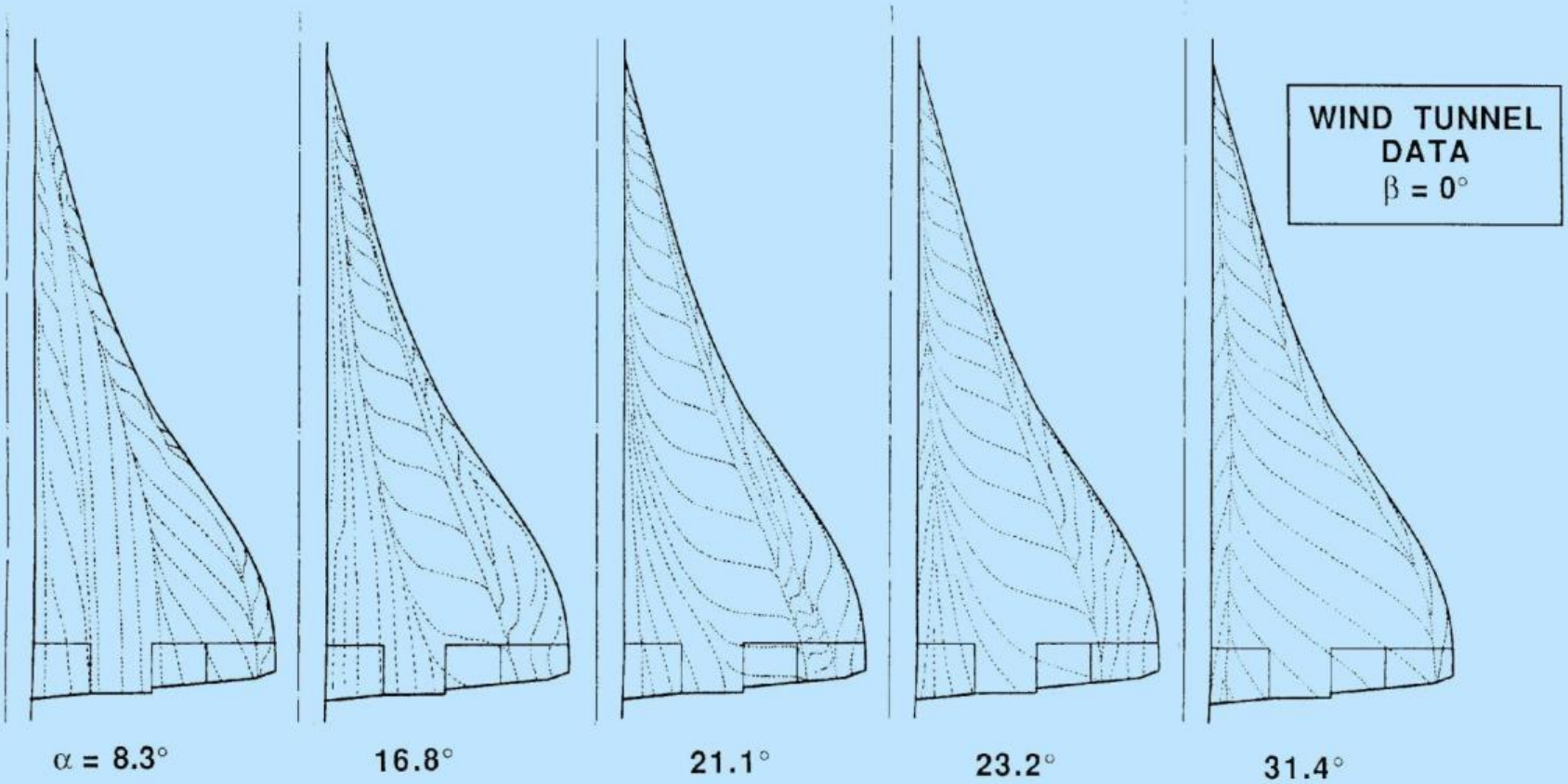
Souvenirs of SST Design and Development



PROTOTYPE - Flow Patterns on the Upper Wing

Fig. 12

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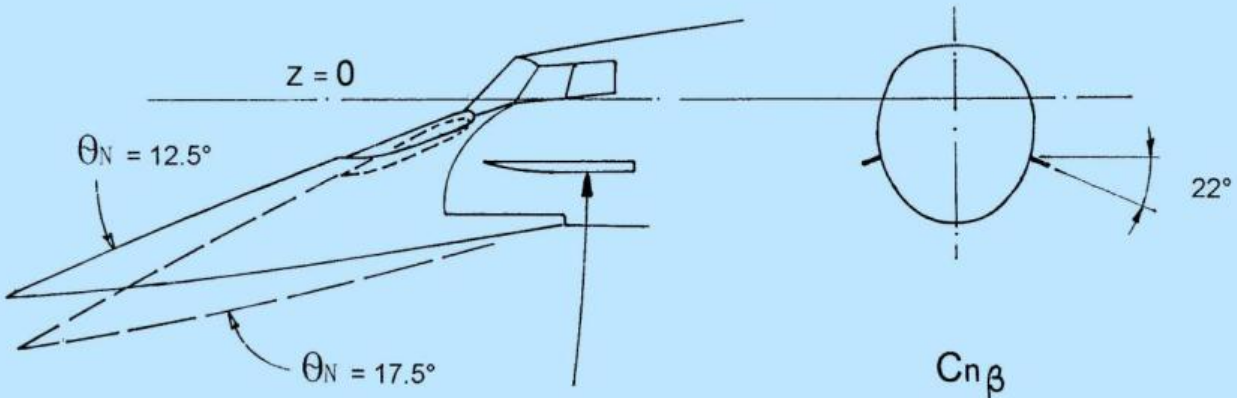
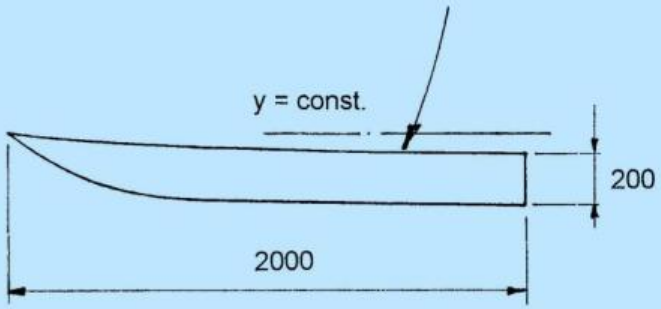
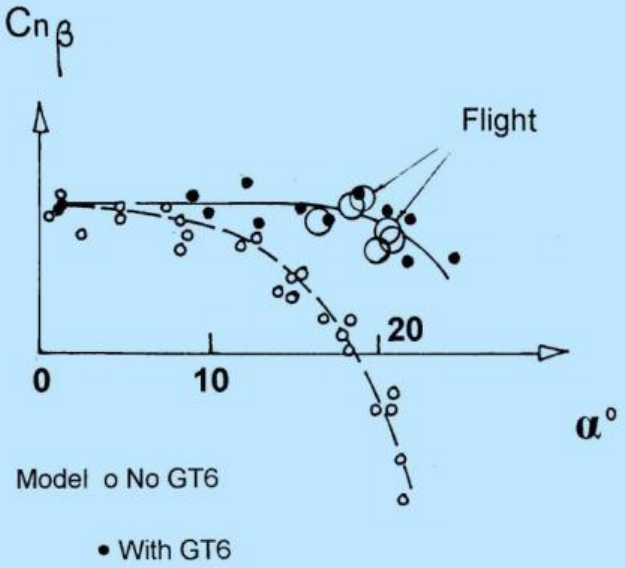




NOSE VORTEX GENERATOR

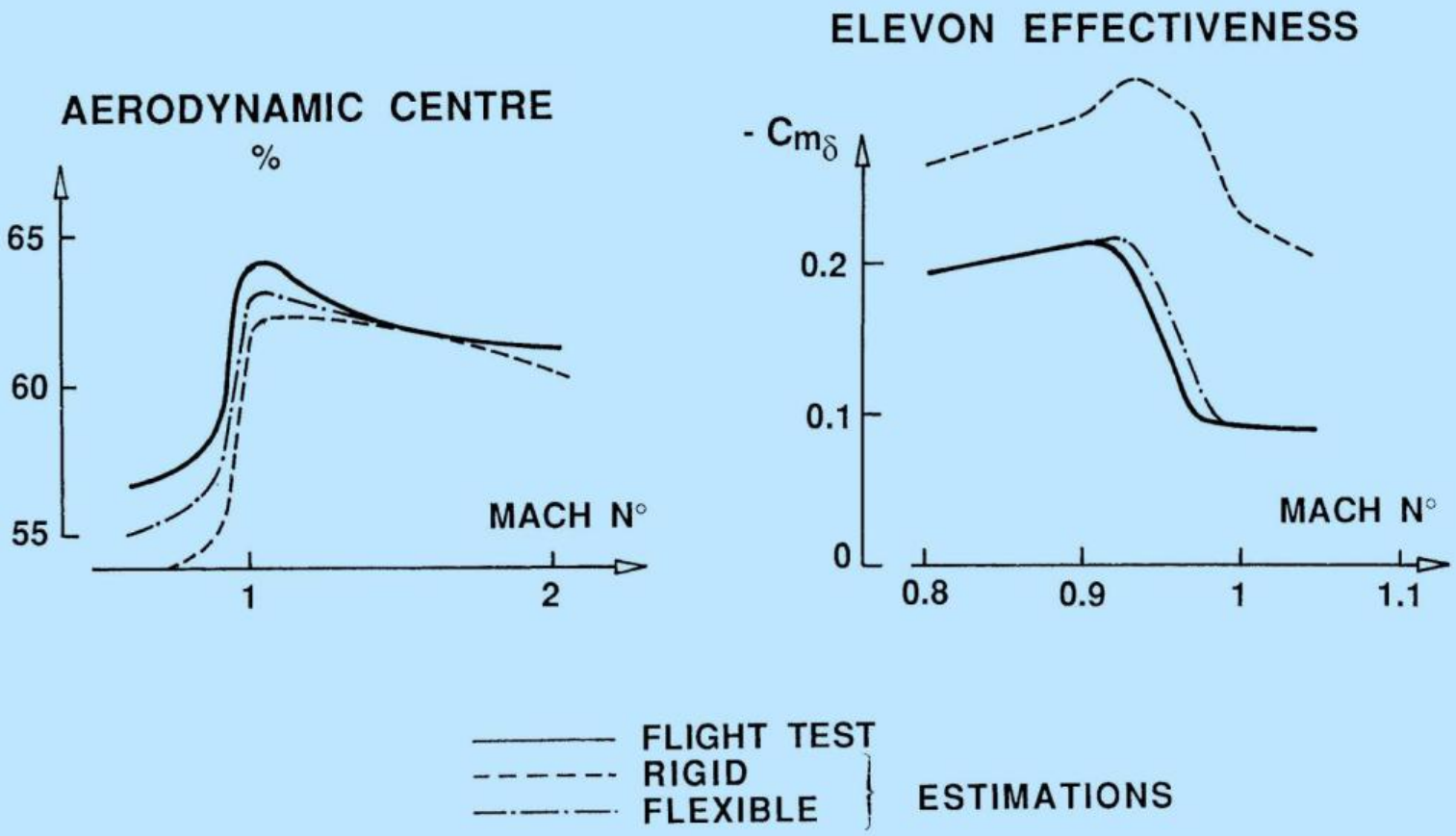


LATERAL STABILITY AT HIGH INCIDENCE

Fig. 13

CONCORDE
Souvenirs of SST Design and Development

CONCORDE
Souvenirs of SST Design and Development



Flexibility Effects on Longitudinal Aerodynamics

Fig. 14

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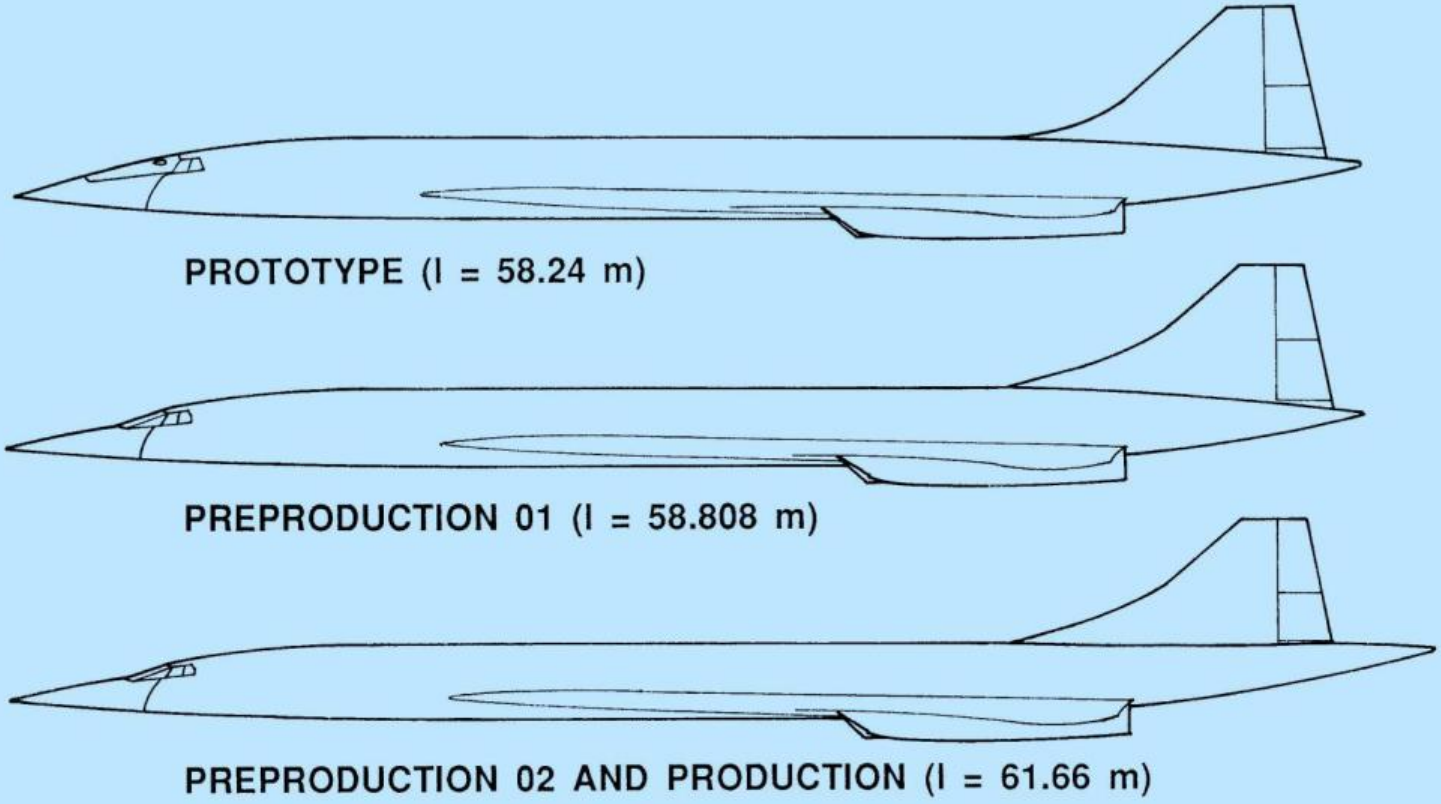
Souvenirs of SST Design and Development



Development of the Fuselage Geometry

Fig. 15

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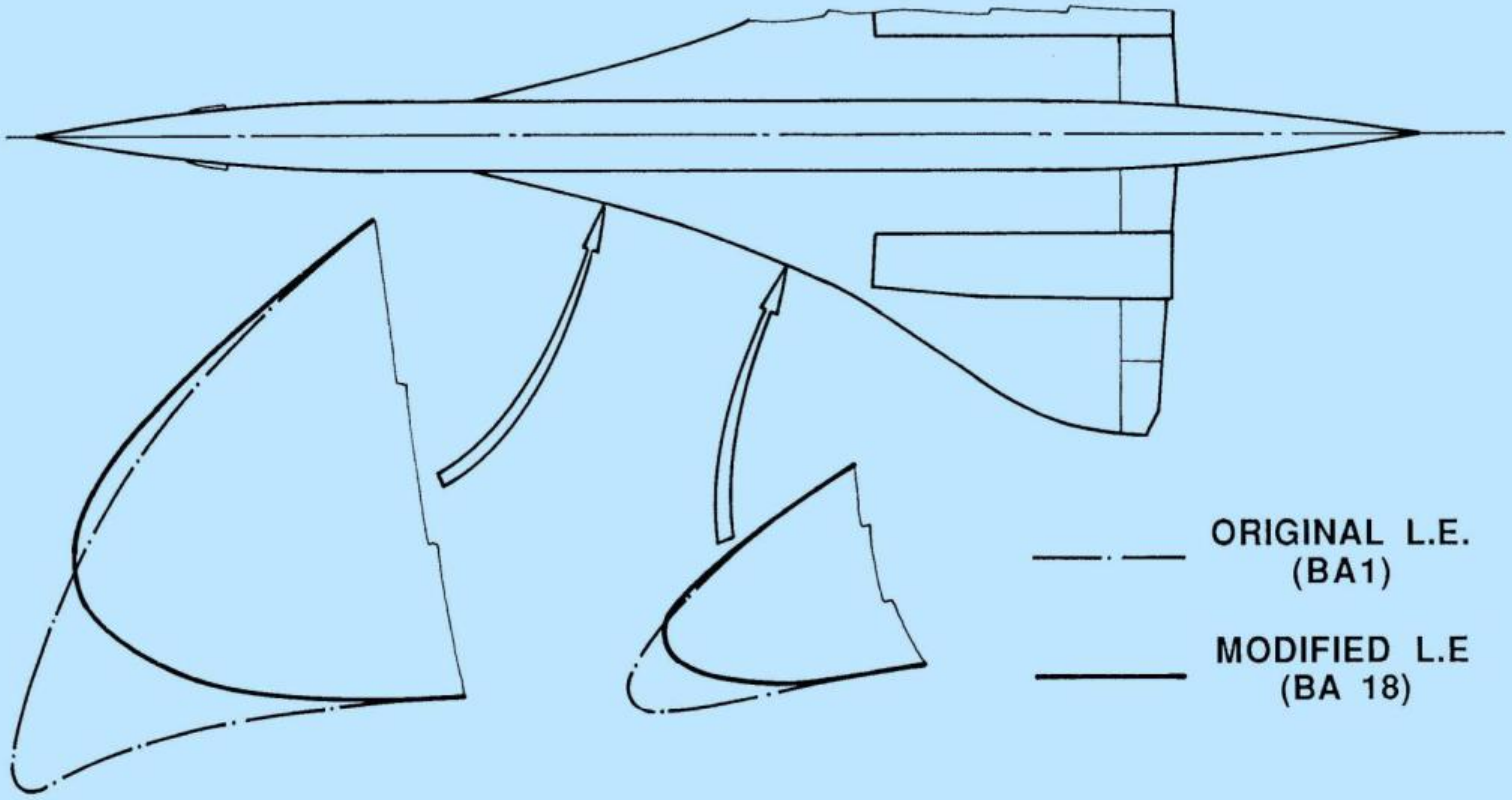

Leading Edge Modifications ahead of the Air Intakes

Fig. 16

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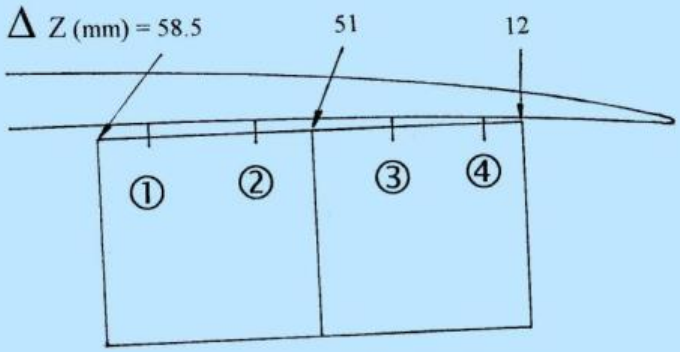
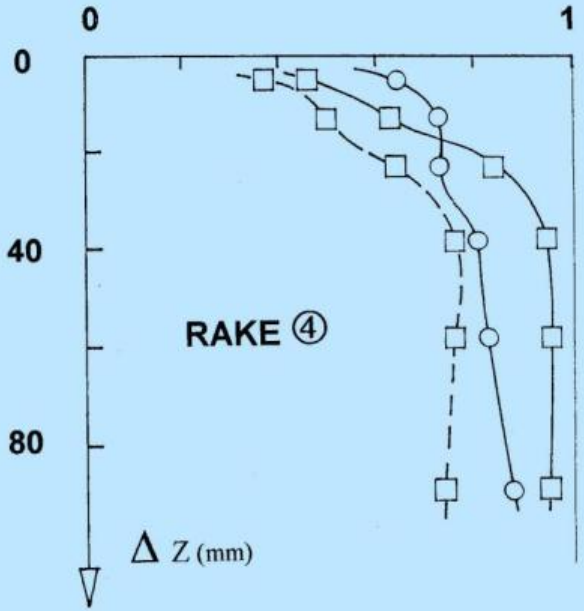
Souvenirs of SST Design and Development

Diverter Height



RAKE POSITIONS

Pressure Recovery η



PROTOTYPE FLIGHT TEST

BA 1 (M=1.91 α = 1.5°)

BA 18 (M=1.95 α = 1.1°)

BA 18 (M=2 α = -0.6°)

BOUNDARY LAYER SURVEY AHEAD OF AIR INTAKES

Fig. 17

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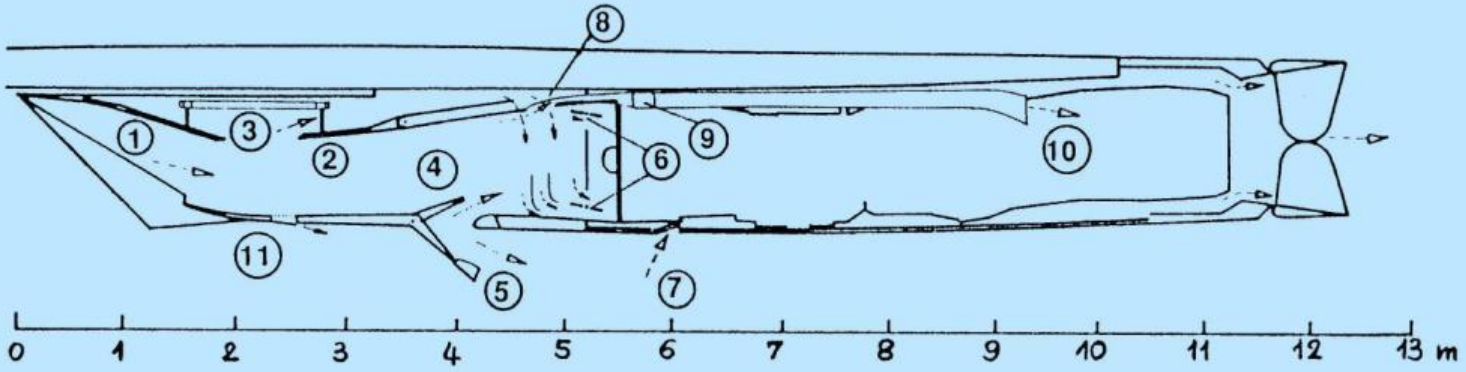
Souvenirs of SST Design and Development



① Front ramp

② Rear ramp

③ Ramp void

④ Auxiliary intake

⑤ Dump door

⑥ Secondary doors

⑦ Ground running door

⑧ Main intake

⑨ Auxiliary intake

⑩ Exit

} Heat exchanger cooling system

⑪ Cowl boundary layer bleed

NACELLE INTERNAL AIR FLOW - PRODUCTION AIRCRAFT

Fig. 18

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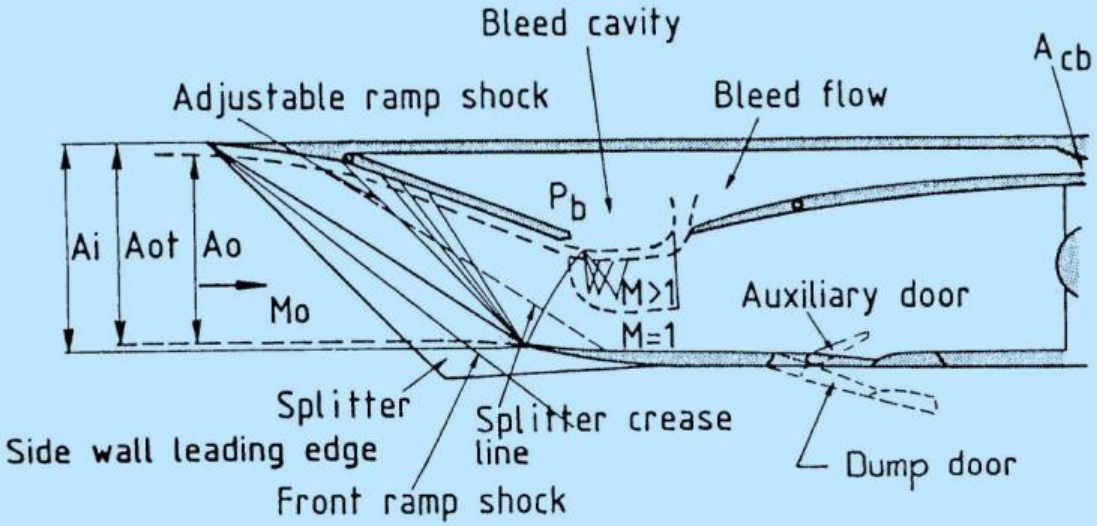
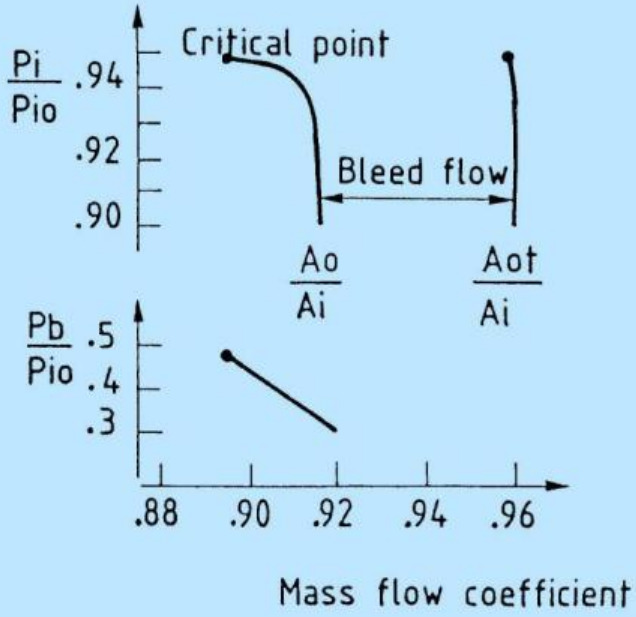
Souvenirs of SST Design and Development





INTERNAL FLOW AT Mo = 1.9

Fig. 19

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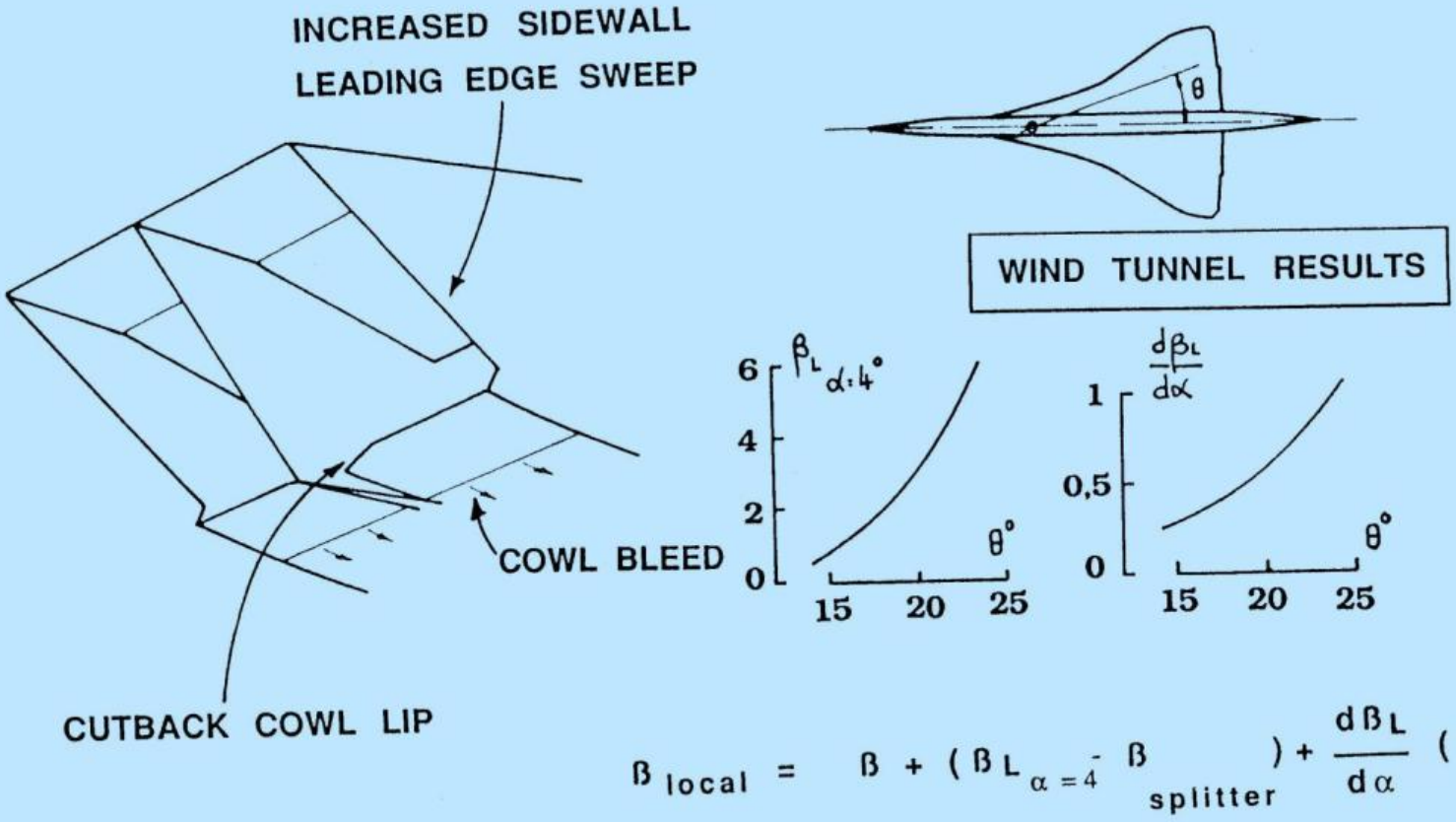
Souvenirs of SST Design and Development



$$\beta_{local} = \beta + (\beta L_{\alpha=4} - \beta_{splitter}) + \frac{d\beta_L}{d\alpha}(\alpha - 4°)$$

LOCAL SIDEWASH EFFECTS

Fig. 20

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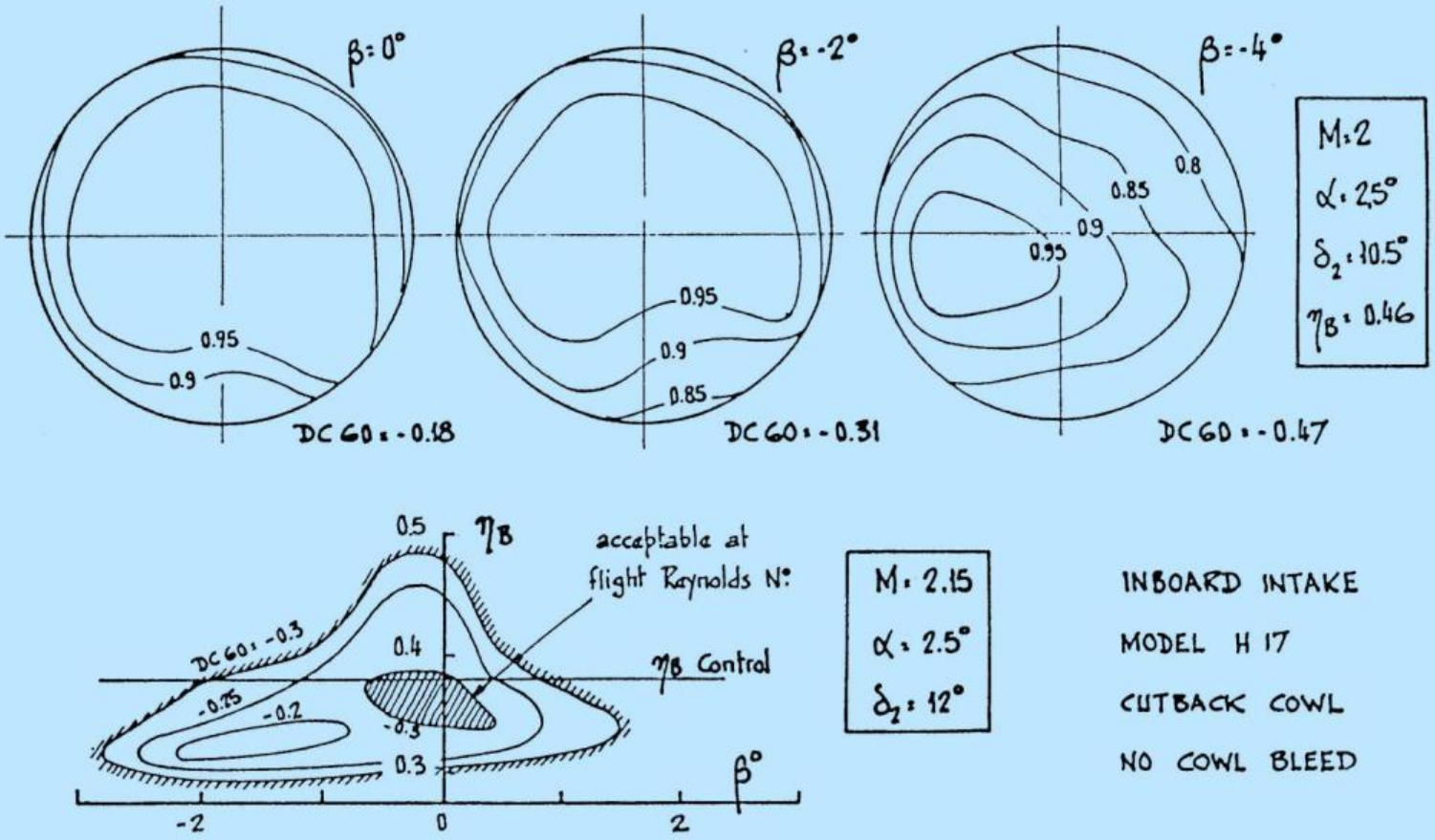
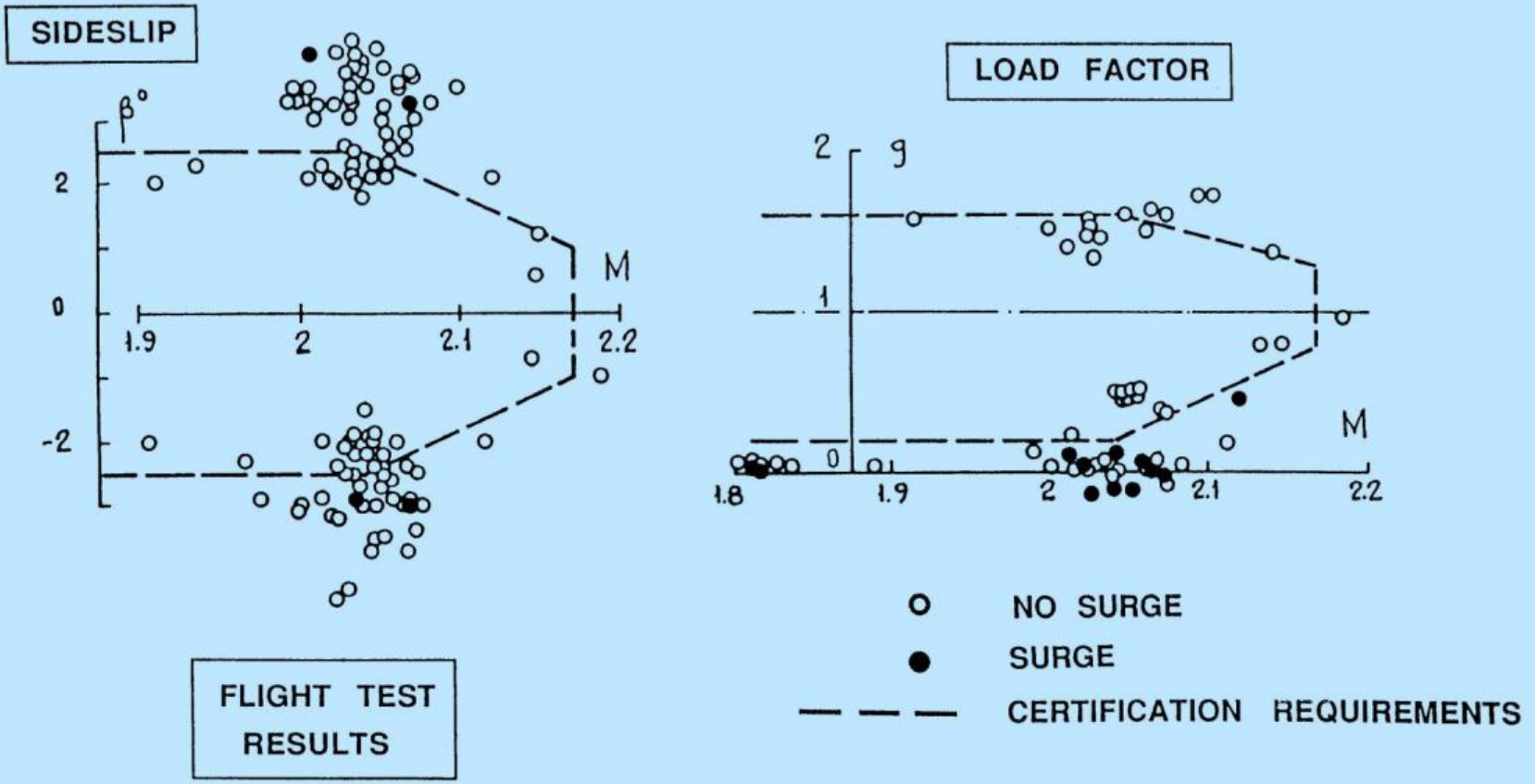
Souvenirs of SST Design and Development



INTAKE DISTORTION & BLEED PRESSURE

Fig. 21

CONCORDE
Souvenirs of SST Design and Development



SIDESLIP AND LOAD FACTOR CAPABILITY AT HIGH MACH NUMBER

Fig. 22

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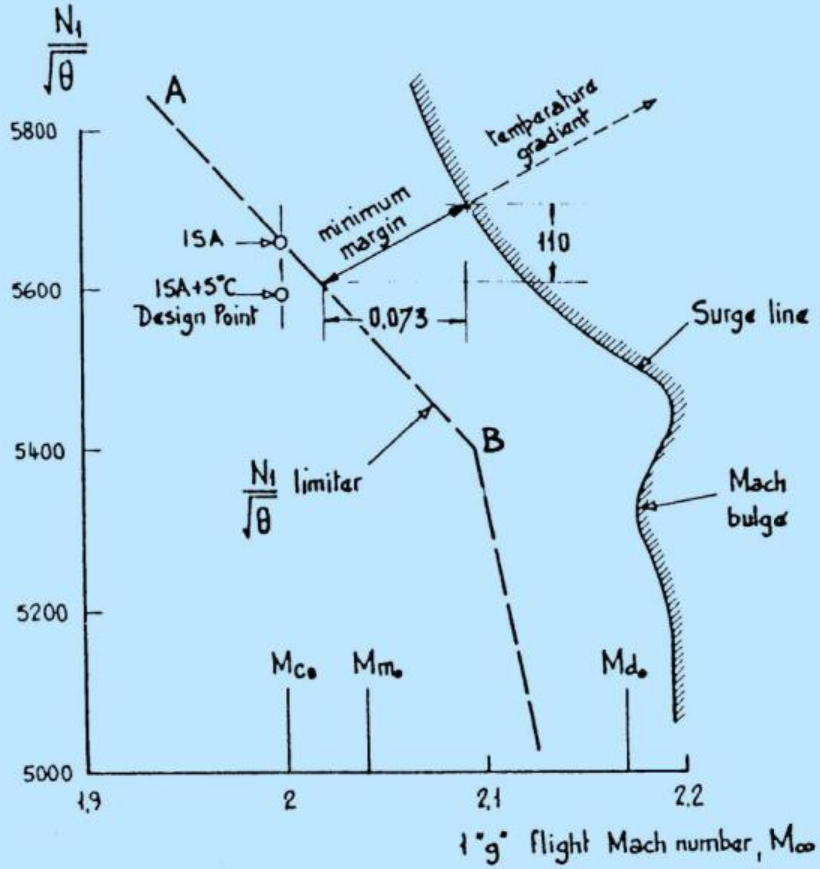
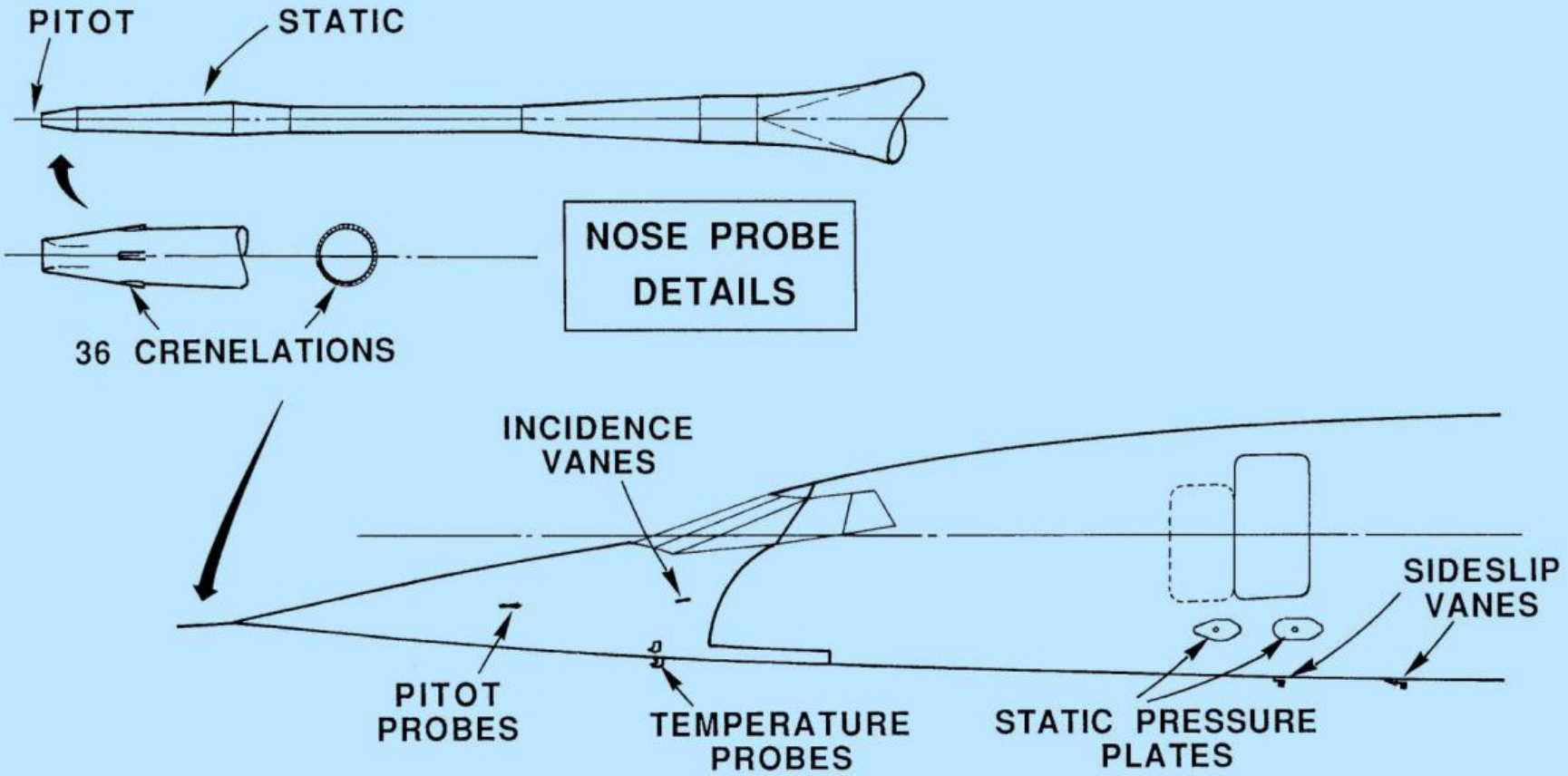
Souvenirs of SST
Design and Development



OLYMPUS L. P. COMPRESSOR LIMITER

Fig. 23

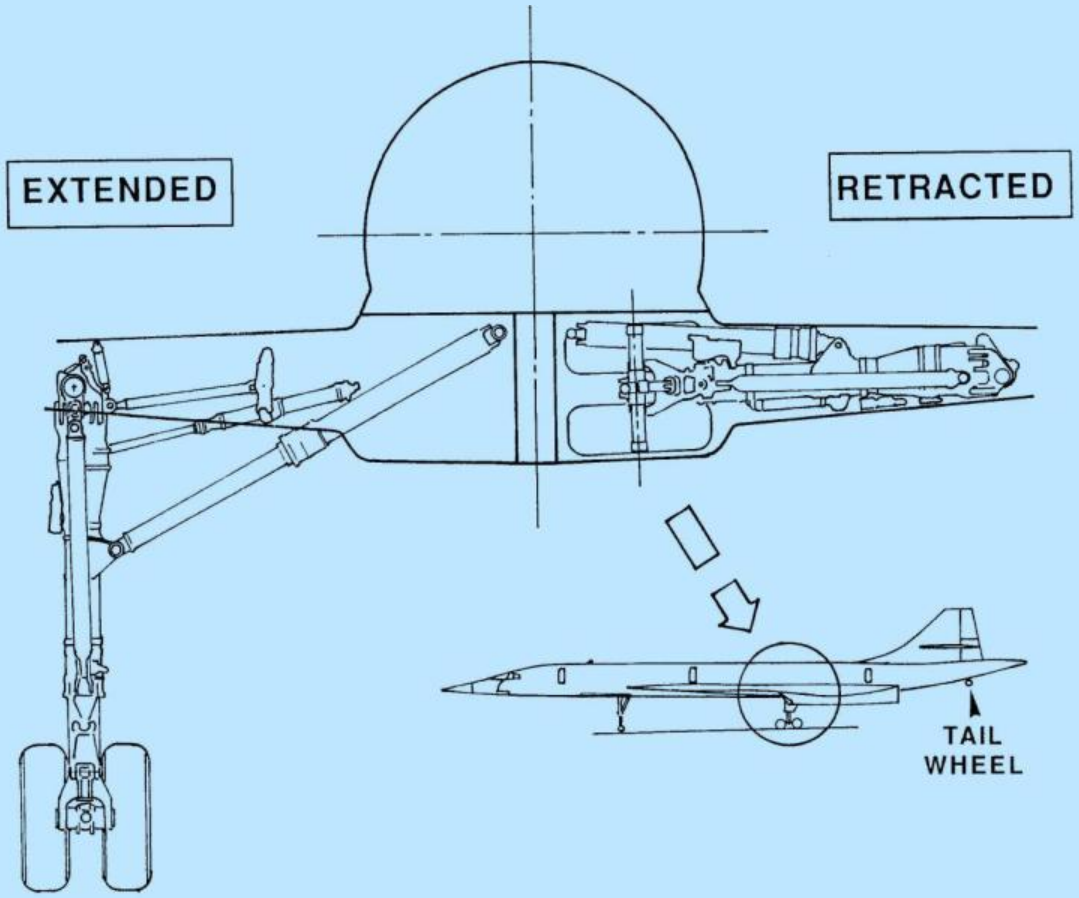
CONCORDE
Souvenirs of SST Design and Development



Air Data Measurement

Fig. 24

CONCORDE
Souvenirs of SST Design and Development



Main Wheel Landing Gear

Fig. 25

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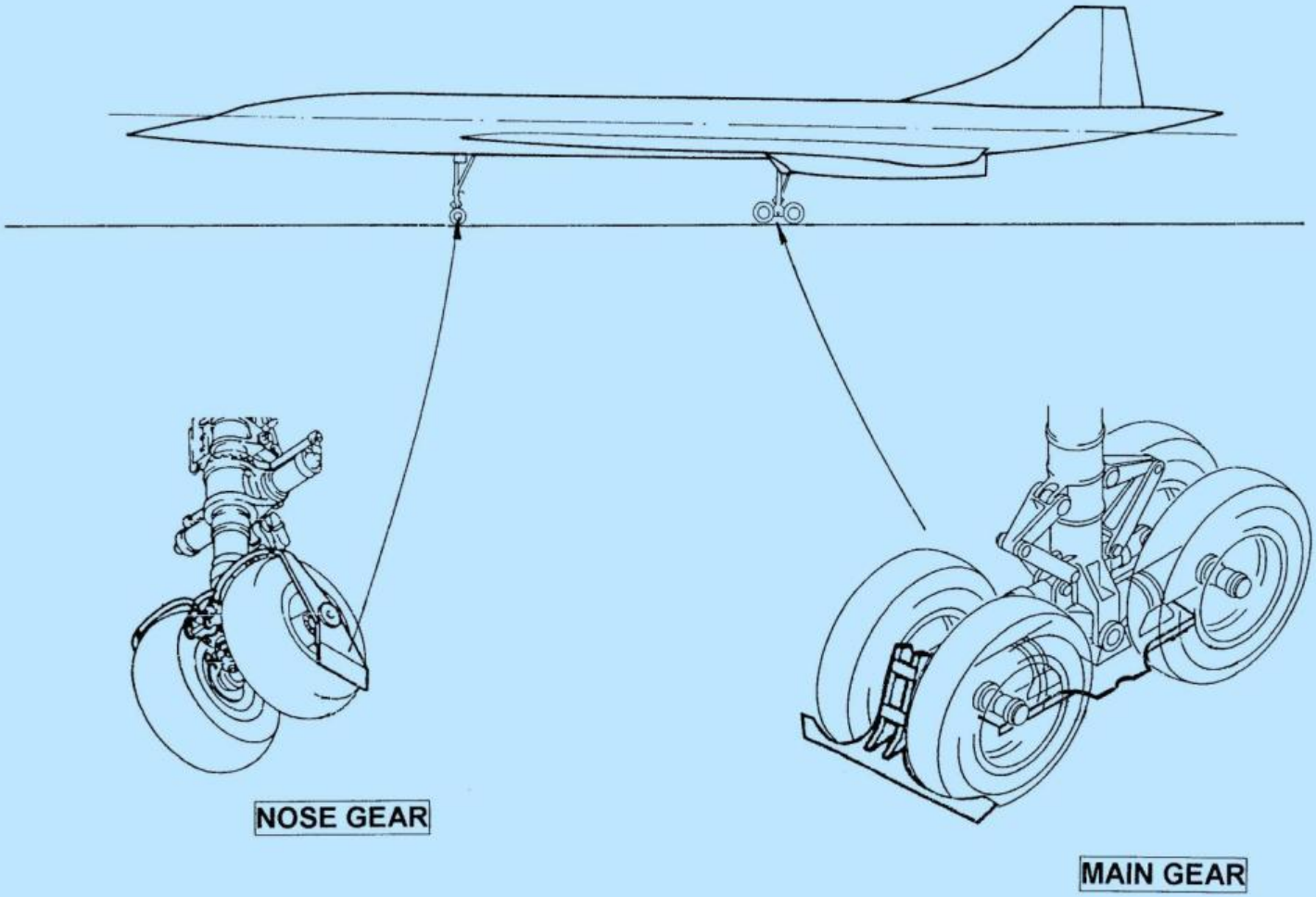
CONCORDE
Souvenirs of SST
Design and Development



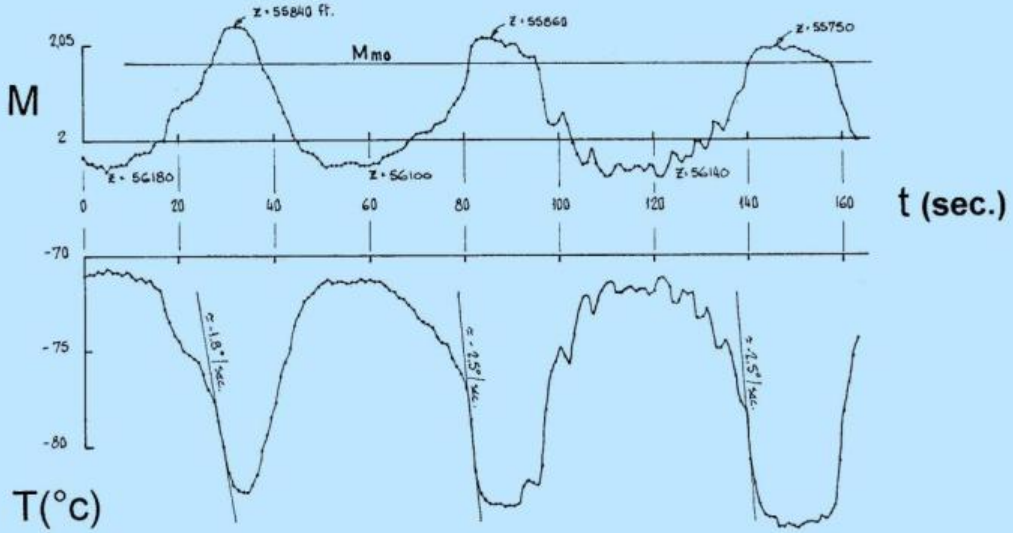
LANDING GEAR SPRAY DEFLECTORS

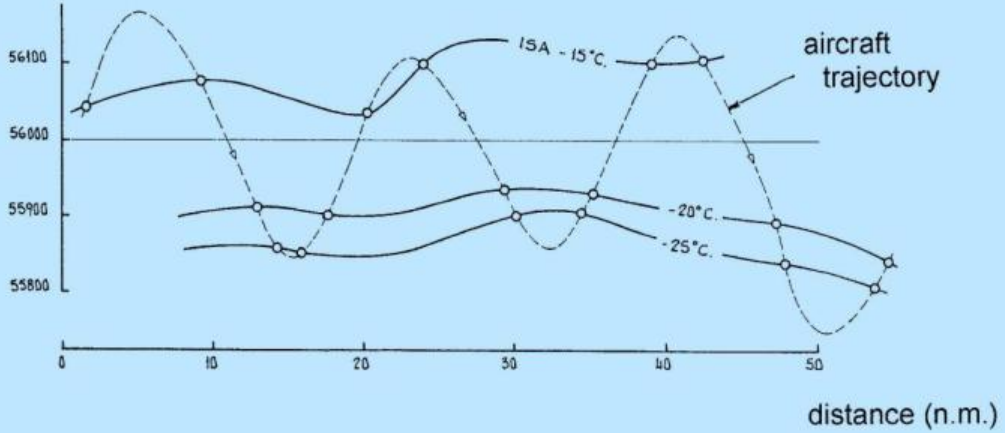
Fig. 26

CONCORDE
Souvenirs of SST Design and Development

CONCORDE
Souvenirs of SST Design and Development

CONCORDE
Souvenirs of SST Design and Development



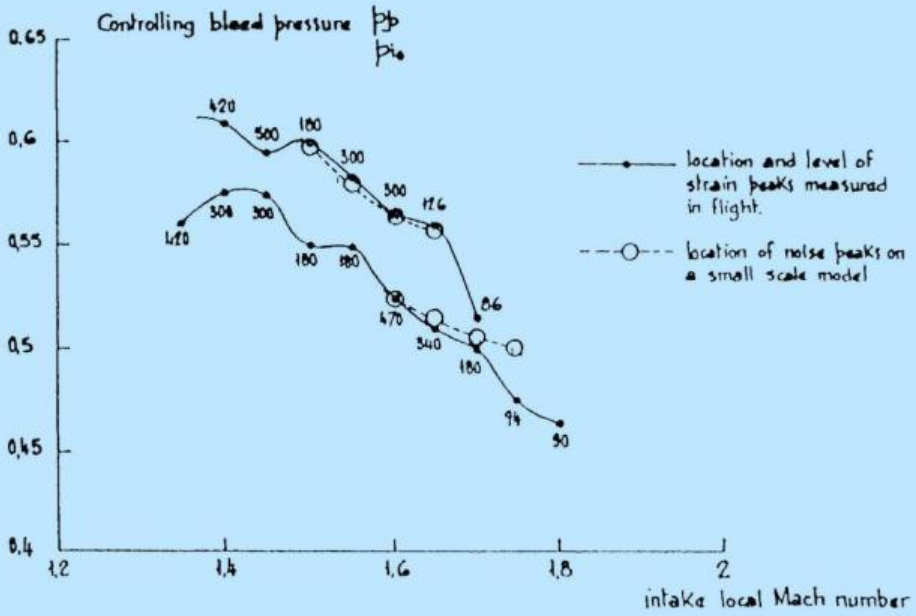


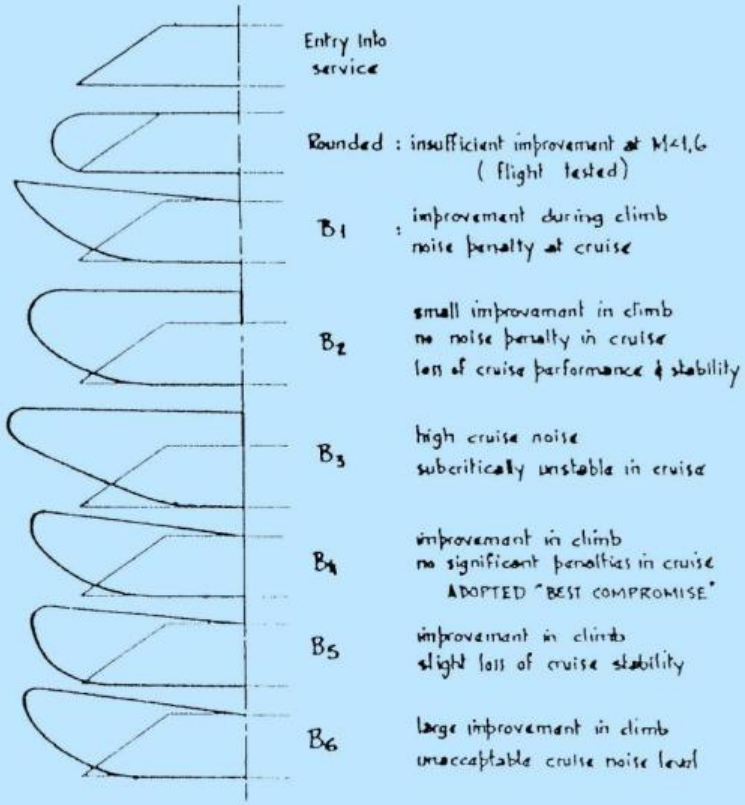
(Rolls Royce Bristol data 2.3.92)

UPPER ATMOSPHERE TEMPERATURES – G. BOAG BHH/BKK 29 oct. 1991

Fig. 27

CONCORDE
Souvenirs of SST Design and Development

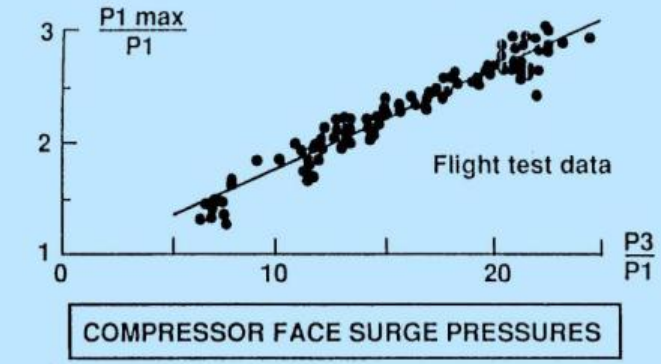




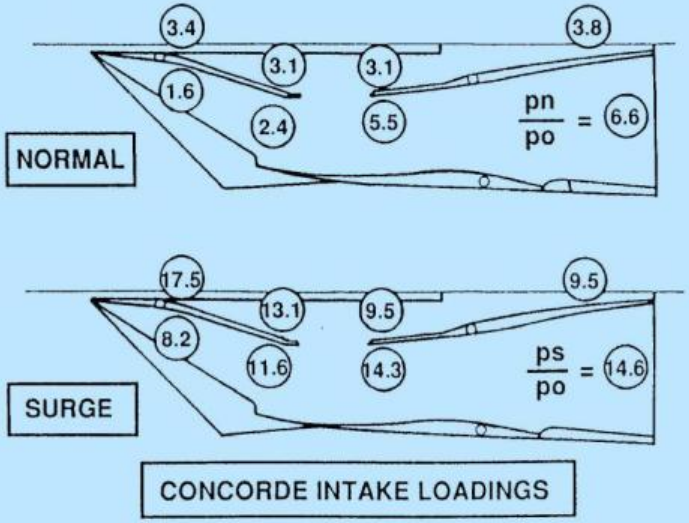
REAR RAMP LEADING EDGE MODIFICATIONS

Fig. 28

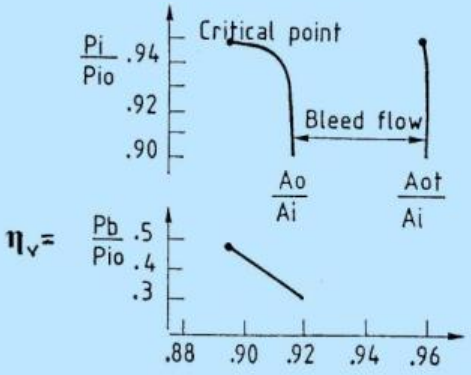
CONCORDE
Souvenirs of SST Design and Development



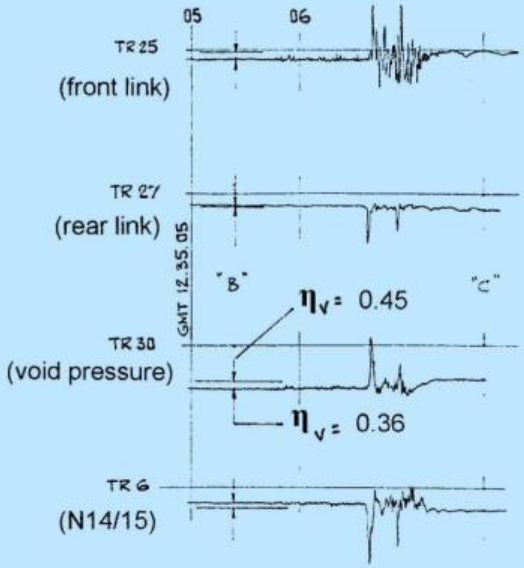
COMPRESSOR FACE SURGE PRESSURES



CONCORDE INTAKE LOADINGS



TYPICAL CRUISE INTAKE CHARACTERISTICS

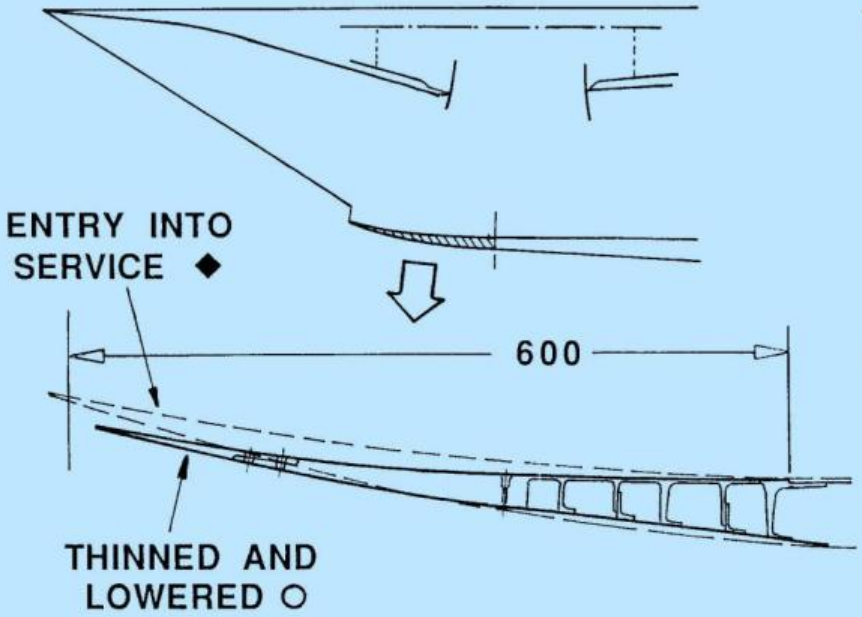


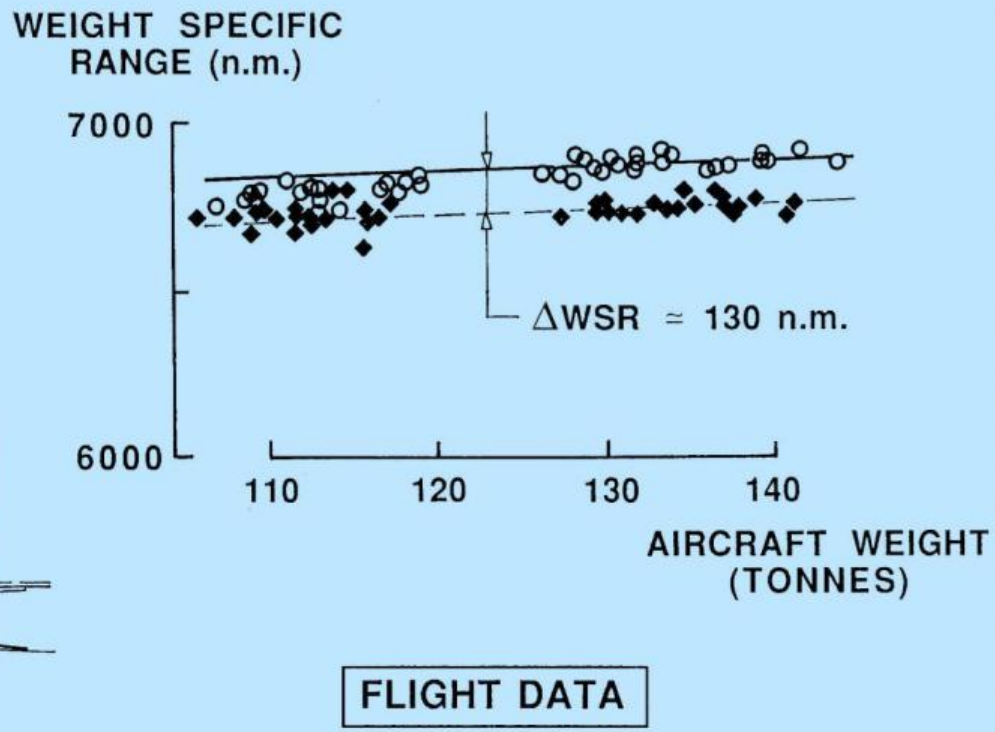
FLIGHT 537 WING STRAINS DURING SUPERCRITICAL SURGE AT M = 2

AIRCRAFT 202 – INTAKE SURGE TEST RESULTS

Fig. 29

CONCORDE
Souvenirs of SST Design and Development



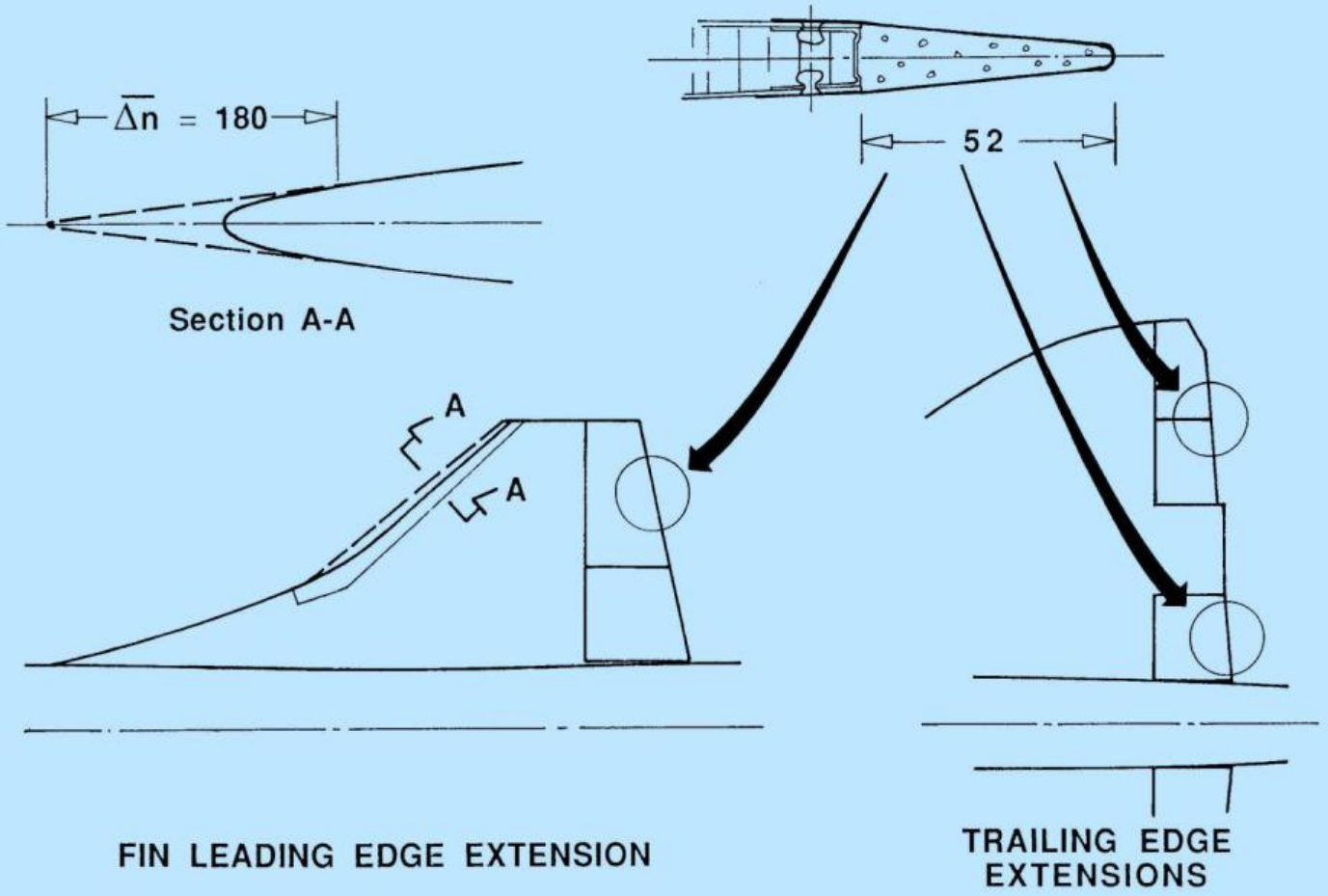


FLIGHT DATA

Thinned and Lowered Air Intake Cowl Lip

Fig. 30

CONCORDE
Souvenirs of SST Design and Development



Fin, Rudder and Elevon Modifications

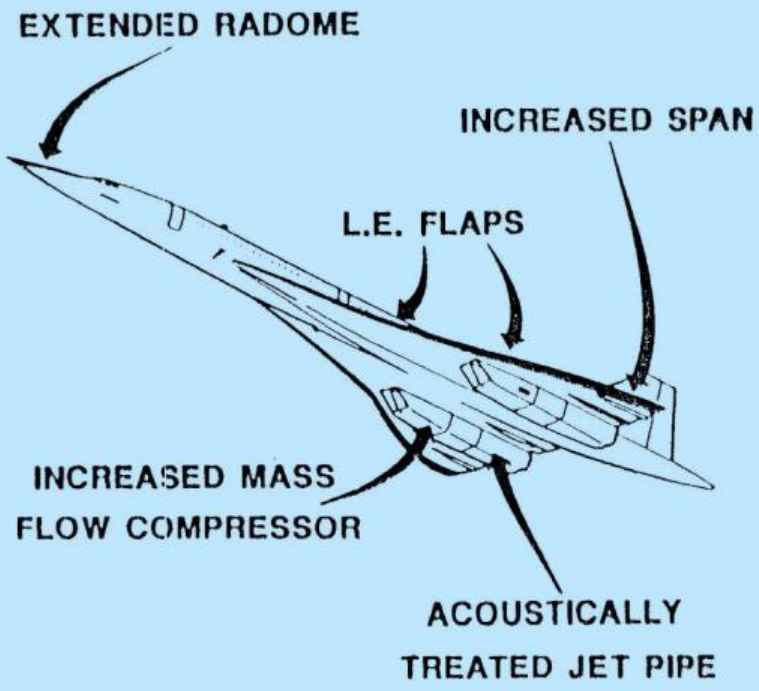
Fig. 31

CONCORDE
Souvenirs of SST Design and Development

AIRCRAFT L/D

		CONCORDE A OLYMPUS 610	CONCORDE B OLYMPUS 622
TAKE OFF	ZERO RATE OF CLIMB SPEED	3,94	4,24
	SECOND SEGMENT	5,0	5,6
	FLY OVER	6,0	7,4
APPROACH		4,4	4,8
HOLD (250 Kt 10000ft)		9,3	13,1
SUBSONIC CRUISE M=0,93		11,5	12,9
SUPERSONIC CRUISE M=2 ISA+5°C		7,3	7,70

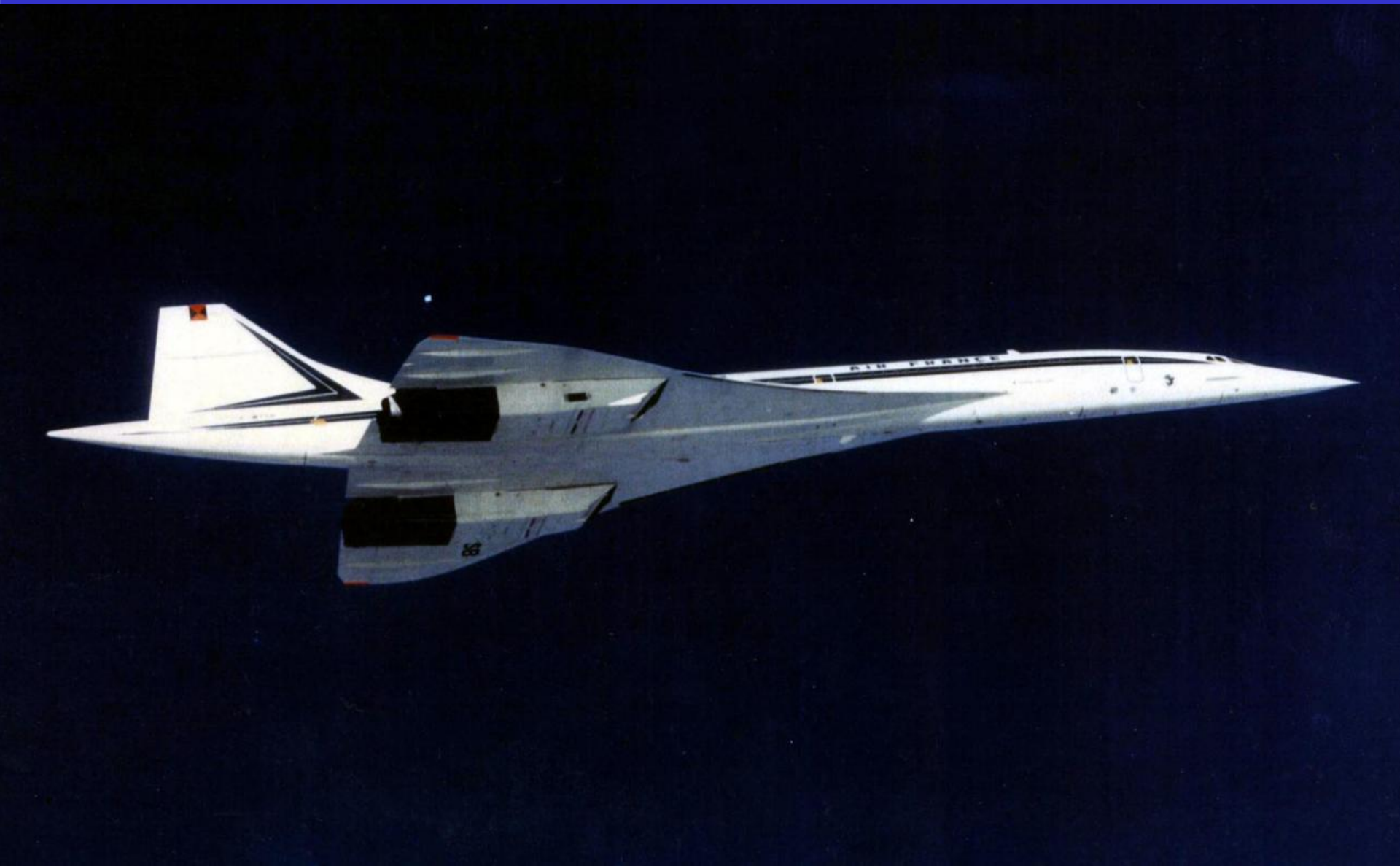
PRINCIPAL MODIFICATIONS



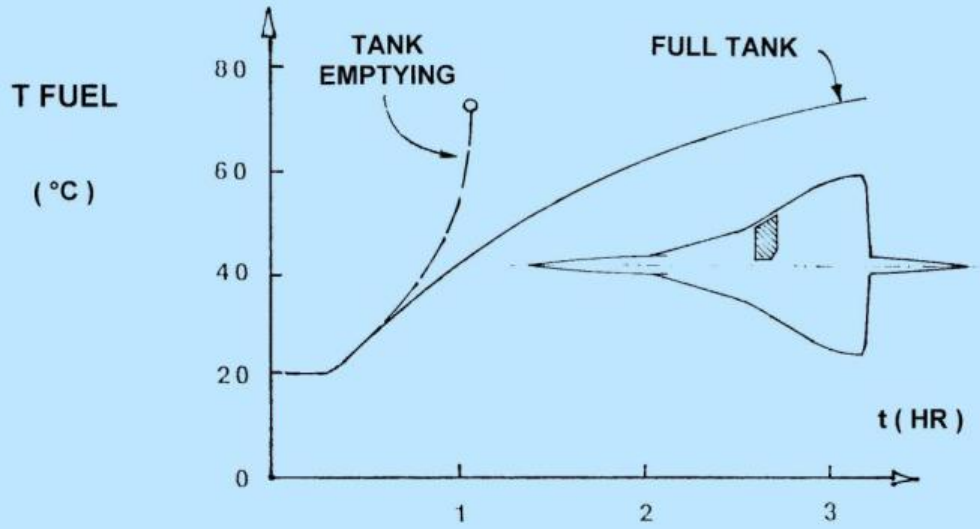
CONCORDE "B" Developed Aircraft

Fig. 32

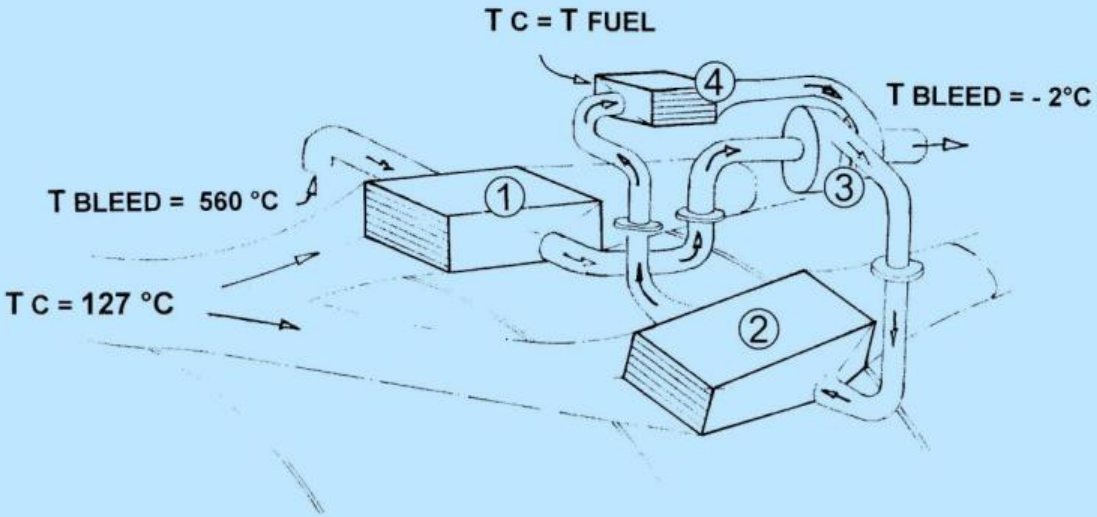
CONCORDE
Souvenirs of SST Design and Development



CONCORDE
Souvenirs of SST Design and Development



M = 2



Engine bleed (1.3 Kg / Sec.)

① Primary Exchanger (- 470 Kw)

② Secondary Exchanger (- 130 Kw)

④ Fuel Exchanger (- 130 Kw)

Duct Heating (+ 5 Kw)

Passengers (+ 9 Kw)

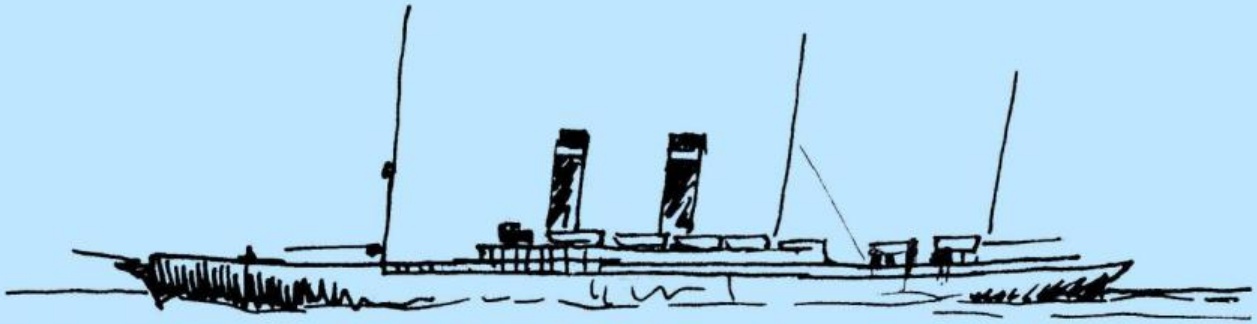
Aerodynamic Heating (+ 17 Kw)

Equipment (+ 21 Kw)

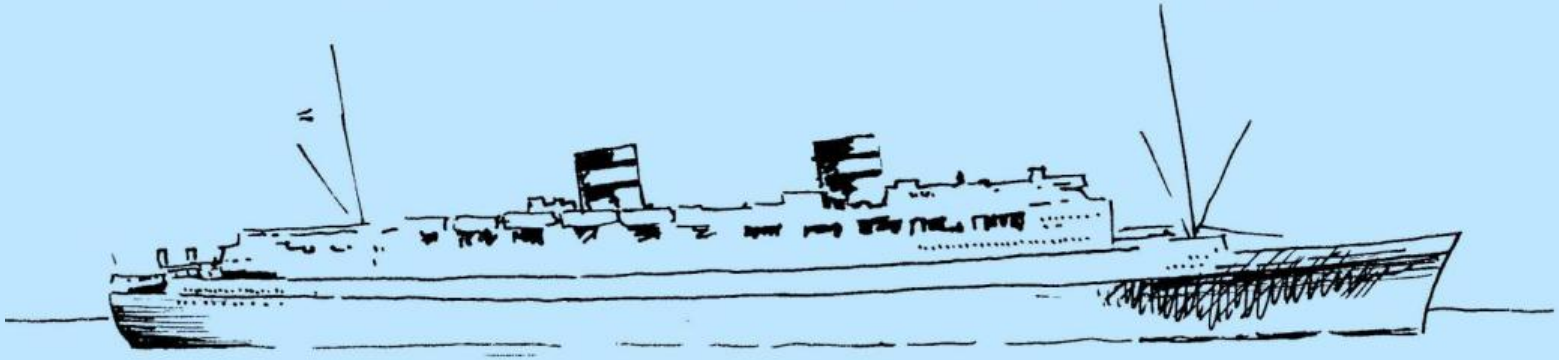
Dump through thrust recovery valves at T ≈ 60°C

CONCORDE AIR CONDITIONNING AND THERMAL MANAGEMENT Fig. 31

CONCORDE
Souvenirs of SST Design and Development



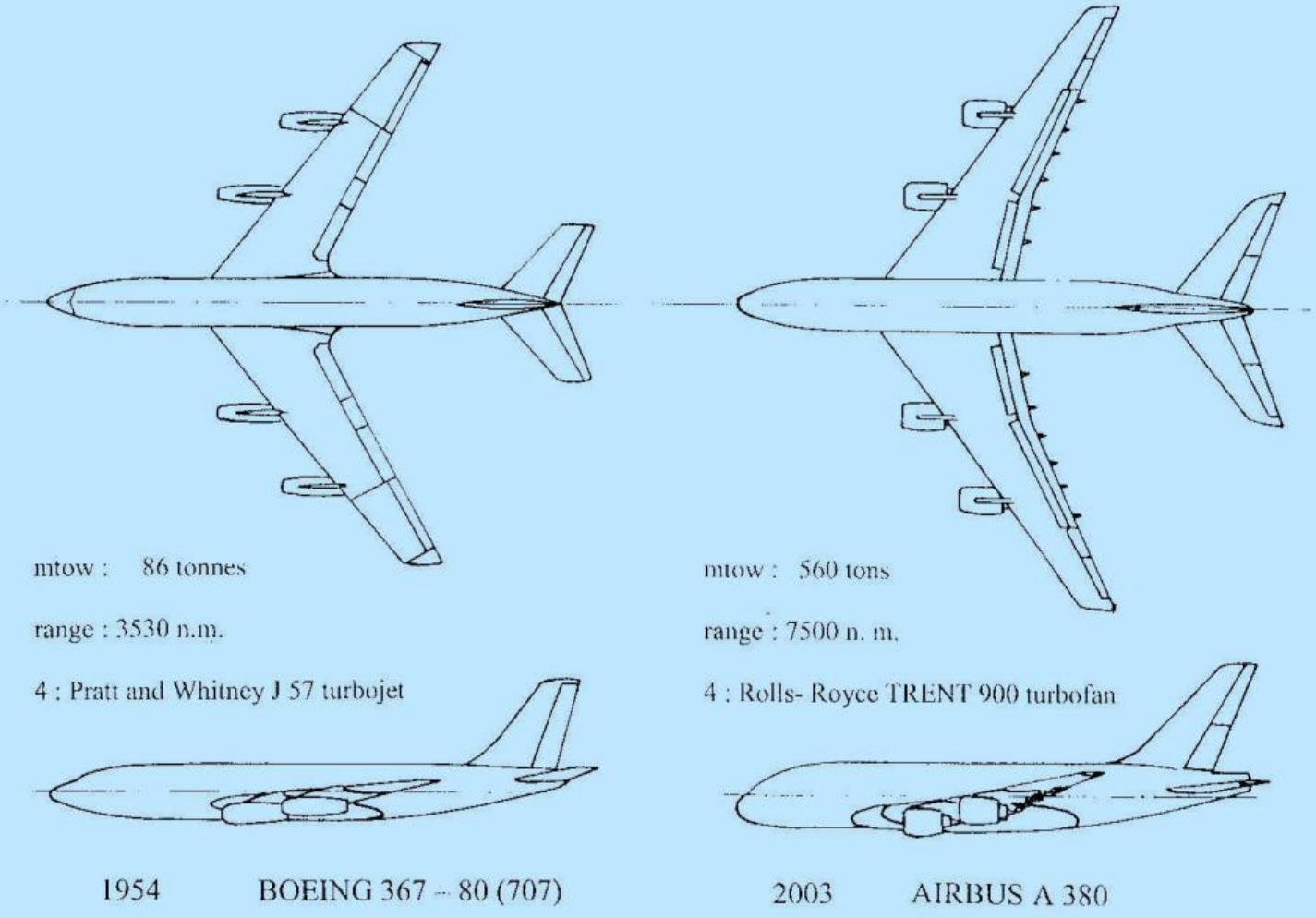
S.S. " Philadelphia" 10500 tons, length 171 m., 21 kt. (1889)
540 IST. CLASS, 200 2 ND CLASS, 1000 3 RD CLASS.



S.S. " Nieuw Amsterdam" 36982 tons, length 231 m., 21 kt. (1938)
556 IST. CLASS, 455 2 ND CLASS, 209 3 RD CLASS.

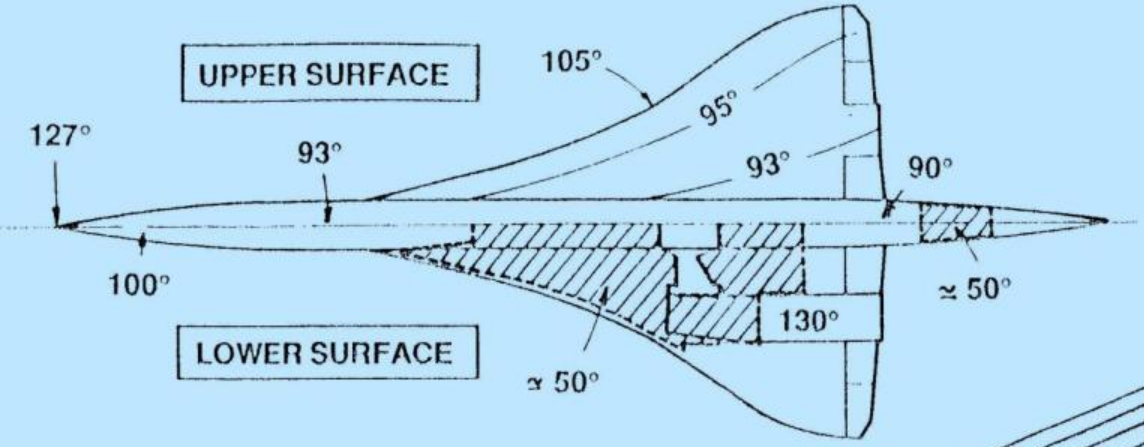
TECHNICAL DEVELOPMENT AT CONSTANT SPEED (I) **Fig. 37**

CONCORDE
Souvenirs of SST
Design and Development

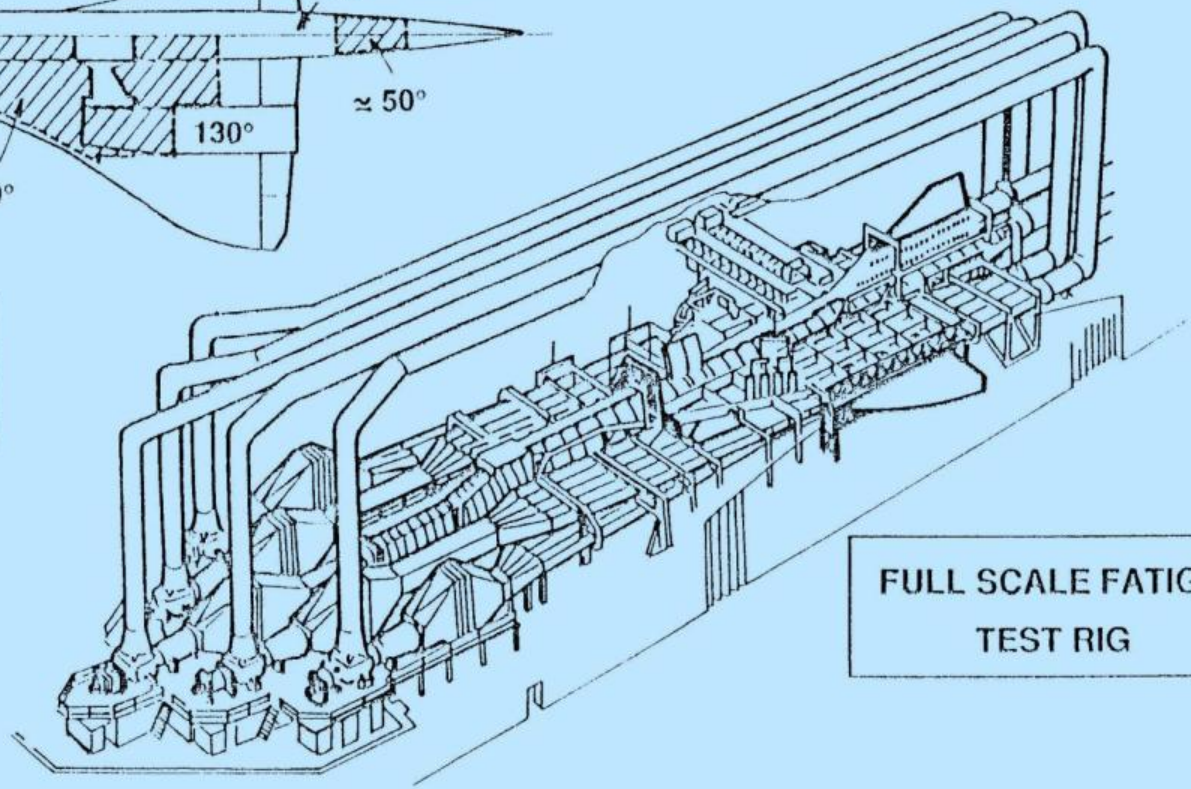


TECHNICAL DEVELOPMENT AT CONSTANT SPEED (II) **Fig. 38**

CONCORDE
Souvenirs of SST Design and Development



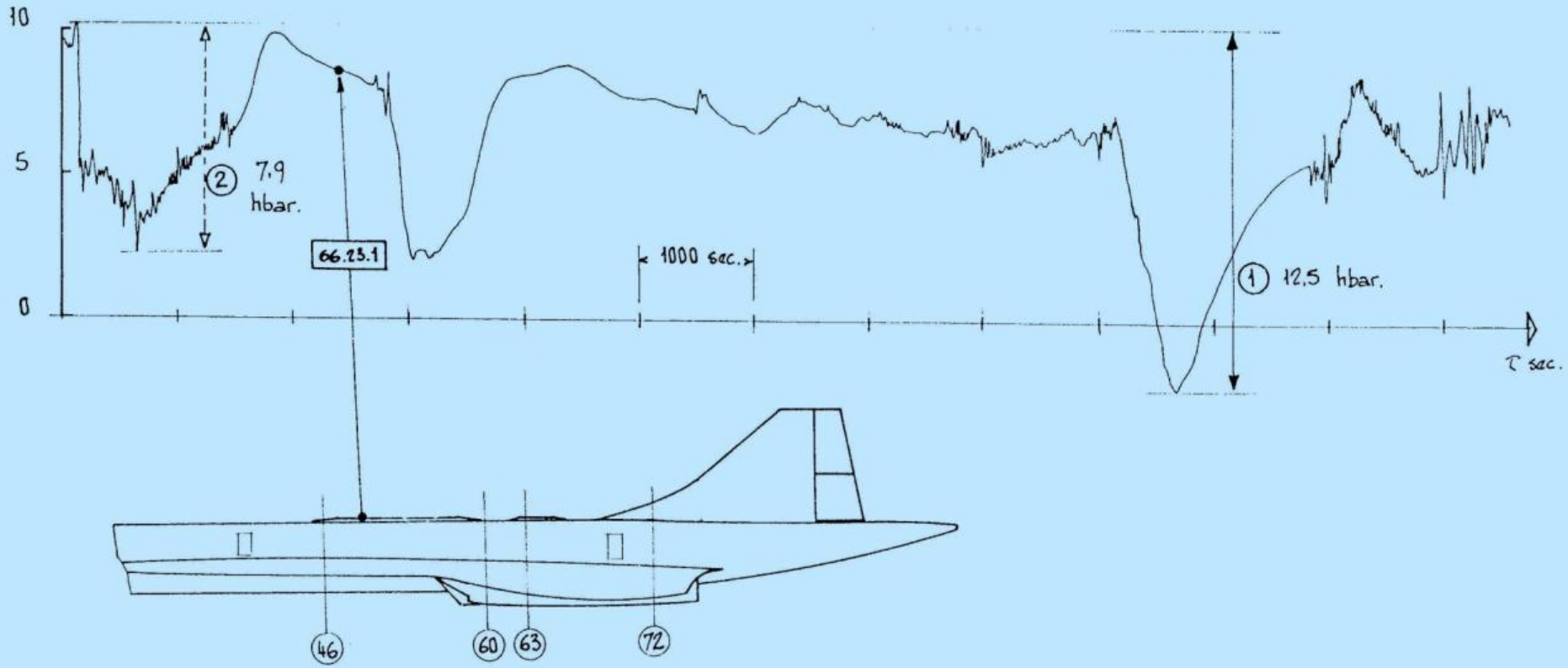
CRUISE TEMPERATURES
M = 2 ISA + 5°C



FULL SCALE FATIGUE TEST RIG

CONCORDE - The Need for Hot Fatigue Testing

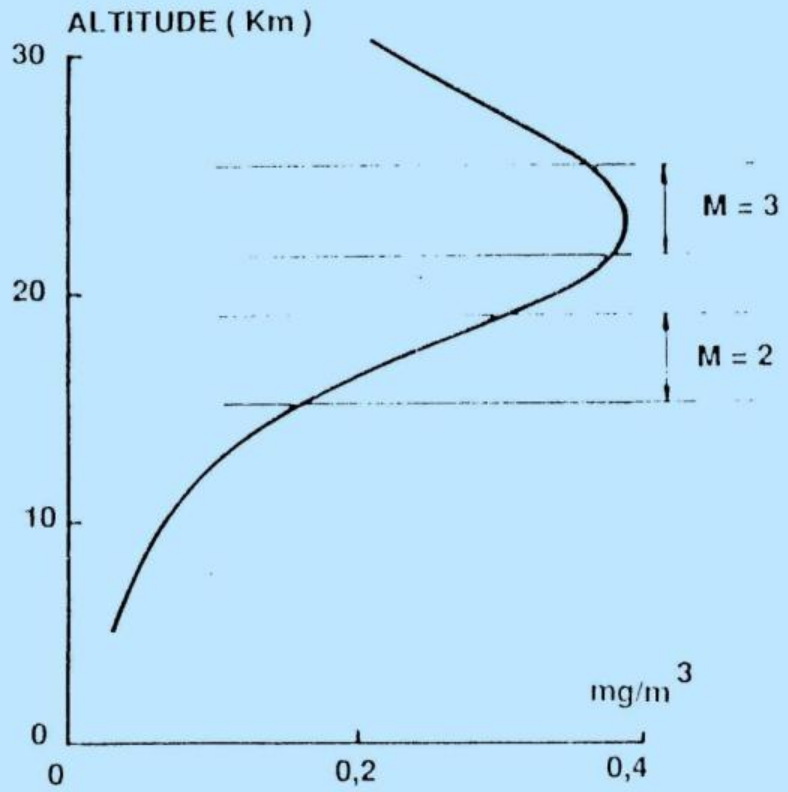
CONCORDE
Souvenirs of SST Design and Development



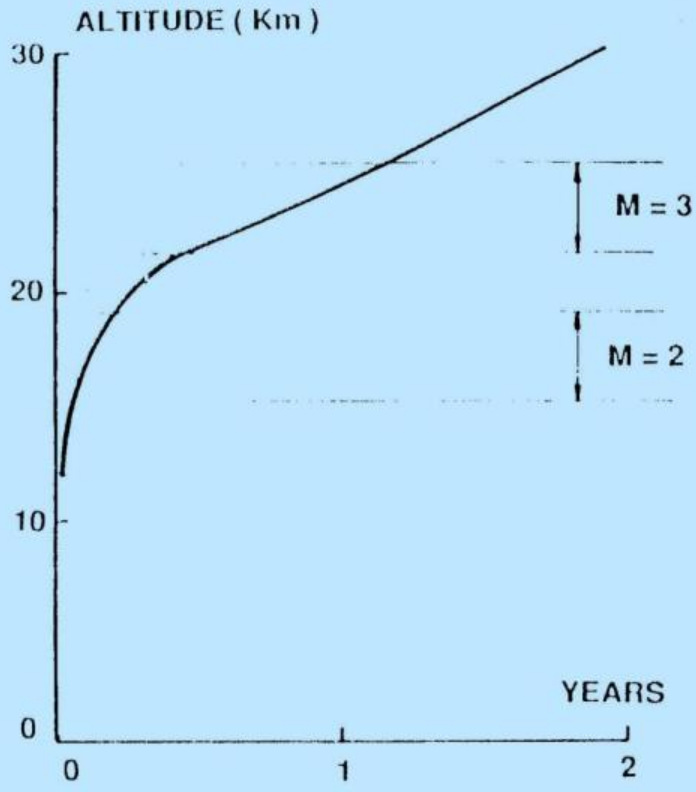
CONCORDE - Aircraft 201 Flight 427 Stress Levels under the ADF Antenna

fig. 16

CONCORDE
Souvenirs of SST Design and Development



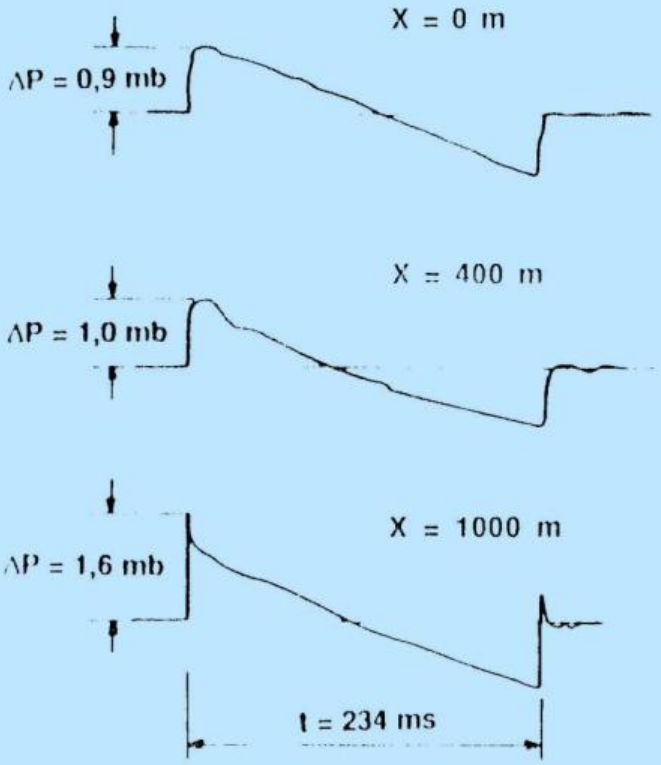
OZONE CONCENTRATION



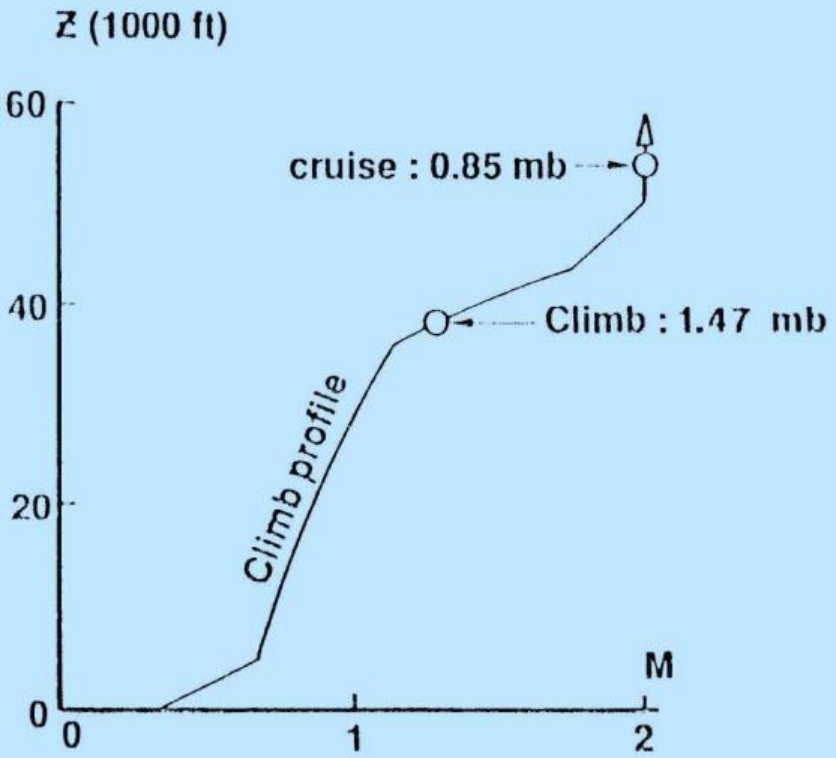
RESIDENTIAL TIME

FUTURE SST - Atmospheric Characteristics

CONCORDE
Souvenirs of SST Design and Development



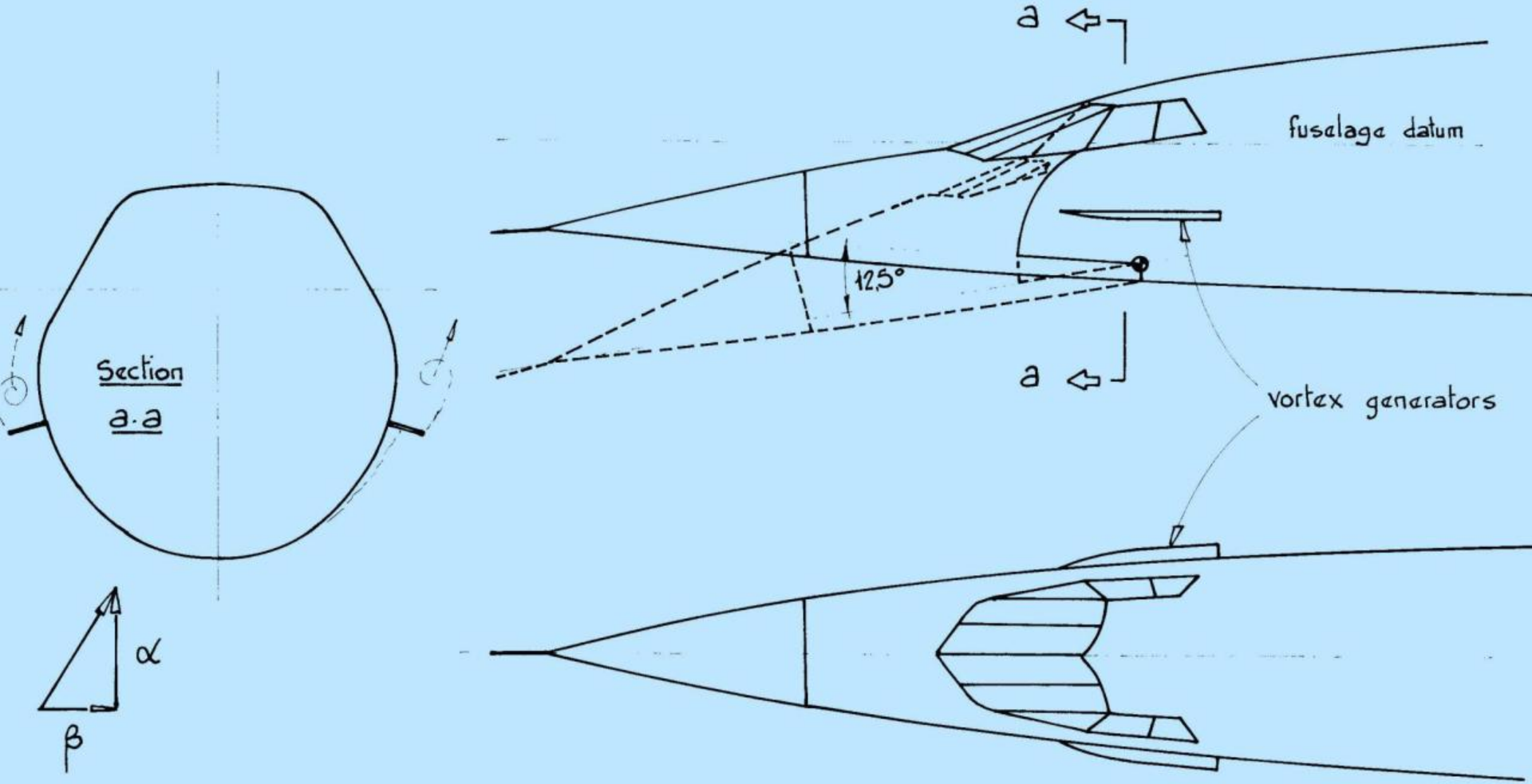
PROTOTYPE CONCORDE
M =2 RESULTS



FUTURE SST - TYPICAL OVERPRESSURES

FUTURE SST - Sonic Boom

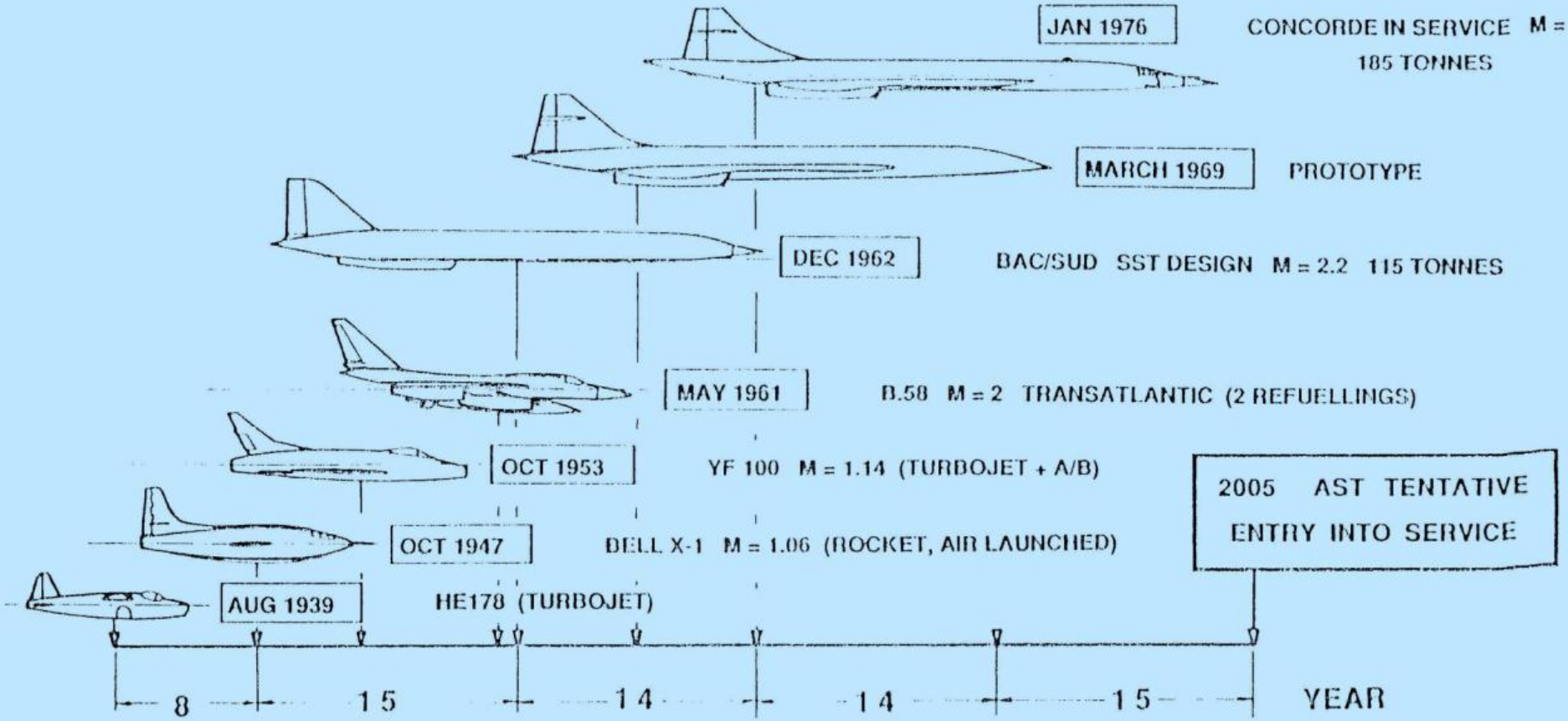
CONCORDE
Souvenirs of SST
Design and Development



CONCORDE DROOP NOSE AND VORTEX GENERATORS

fig.

CONCORDE
Souvenirs of SST Design and Development



Major Events leading to Civil Supersonic Flight

fig. 3

CONCORDE
Souvenirs of SST Design and Development