NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

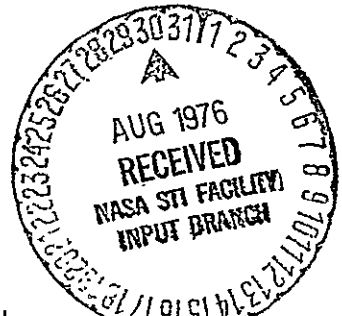
NASA CR-
147620

DMS-DR-2311
NASA CR-147,620

RESULTS FROM INVESTIGATIONS IN THREE NASA/LaRC HYPERSONIC WIND TUNNELS ON A .004 SCALE MODEL SPACE SHUTTLE ORBITER (MODEL 13P-O) TO DETERMINE REAL GAS EFFECTS (LA78, LA87, LA88)

SPACE SHUTTLE

AEROTHERMODYNAMIC DATA REPORT



JOHNSON SPACE CENTER

HOUSTON, TEXAS

DATA MANagement services

SPACE DIVISION CHRYSLER CORPORATION

July 1976

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Prepared under NASA Contract Number NAS9-13247

by

Data Management Services
Chrysler Corporation Space Division
New Orleans, La. 70189

for

Engineering Analysis Division

Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Numbers:	LaRC CF4 267, 268, 272, 273; LaRC 22" 446; LaRC 20" M6 6468
NASA Series Numbers:	LA78, LA87, LA88
Model Number:	13P-0
Test Dates:	May 21, 1975 through January 29, 1976
Occupancy Hours:	16, 36, 16

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ABSTRACT

Results from tests in the NASA/CF4, 20 inch Mach 6 and the 22 inch Helium Tunnel consist of pressure measurements on the lower surfaces of the Rockwell Space Shuttle Orbiter. All data are in absolute pressures.

Data were recorded with the model at a Mach number of 6 and 20 at angles of attack of 10° to 30°.

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NOMENCLATURE

PLOT SYMBOL	MNEMONIC	DEFINITION
A_b		base area, in.^{2}
b	BREF	reference span, in.
ℓ_{ref}	LREF	reference length, in.
M	MACH	Mach number
P_{local}	PL	static pressure, millimeters of mercury
P_O	PO, PTOT	total pressure, millimeters of mercury
q	Q(MMH)	dynamic pressure, millimeters of mercury
S_{ref}	SREF	reference area, ft.^{2}
T	TO, TTOT	temperature, ^oC
X	XO	longitudinal displacement along centerline, inches
Y	YO	lateral displacement from centerline, inches
Z	ZO	vertical displacement from centerline, inches
α	ALPHA	angle of attack, angle between the projection of the wind Z axis on the body X, Z plane and the body X axis, deg.
β	BETA	sideslip angle, angle between the wind Z axis and the projection of this axis on the body X, Z plane, deg.
RN	RN/L	Reynolds number; per m, per ft.
	ELEVON	elevon deflection angle, degrees
	SPDBRK	speedbrake deflection angle, degrees
	BDFLAP	body flap deflection angle, degrees

INTRODUCTION

A series of wind tunnel tests have been conducted to investigate real-gas effects. Pressures have been obtained on the windward surface of a .004 scale model space shuttle orbiter in three Langley Research Center facilities: the 20-Inch Hypersonic Tunnel (Mach 6), the 22-Inch Helium Tunnel, and the CF_4 Tunnel.

Data are presented at angles of attack from 10° to 30° as absolute pressures (mm of Hg) for Mach numbers of 6 and 20. The Rockwell designation of the model is 13P-O.

CONFIGURATIONS INVESTIGATED

The model used in this test is designated 13P-0. It is constructed to .004 scale Vehicle 2A (modified), with provisions for 19 pressure measurements. Elevon, aileron, rudder and speed brake deflections were all zero. The specific elements of the orbiter vehicle are:

Element	Identifier
Body	B58
Canopy	C5
Elevon	E18
Body Flap	F4
OMS Pods	M3
Rudder	R5
Vertical Tail	V5
Wing	W87

Modifications to the vehicle 2A configuration consisted of removal of the manipulator arm fairings (D7) and alteration of the nose forward of body station 300 to approximate vehicle 3 contours (Drawing VL70-000139B). Dimensional data for these elements are given in table III.

The arrangement and locations of the pressure orifices on the orbiter wing are shown in figure 2. The locations of the pressure orifices on the orbiter wing are given in terms of Full Scale Dimensions of the theoretical wing in figure 2.

TEST CONDITIONS

All data were recorded with the model at 10 to 30 degrees angle of attack and zero degree sideslip. The tunnel conditions during the tests are presented in table I.

TEST FACILITY DESCRIPTIONS

Langley 22-Inch Helium Tunnel;

The test medium is purified helium. Models are mounted on a vertical strut. The nozzle is contoured and the test section is 57.1 cm in diameter. The test core is 20 to 25 cm in diameter and the helium exhausts into a vacuum system. Nominal operating conditions are as follows:

Stagnation pressure, pascals	3.4×10^6 to 24.8×10^6
Stagnation temperature, °K	up to 477
Mach number	20
Reynolds number, per meter	1×10^6 to 4.7×10^6
Running time, sec	80

Langley 20-Inch Hypersonic Tunnel (Mach 6);

Test medium is air. Models are sting mounted on a model injection mechanism. Nozzle blocks are two dimensional and contoured. The test section is 50.8 by 50.8 cm. It exhausts through a movable second minimum into atmosphere with the aid of an annular ejector. Examples of operating conditions are as follows:

Stagnation pressure, pascals	1.4×10^6 to 3.4×10^6
Stagnation temperature, °K	up to 555
Mach number	6
Reynolds number, per meter	1×10^6 to 3.2×10^6
Running time, min	over 15

Langley CF_4 Tunnel;

Test medium is CF_4 (Tetraflouromethane). Models are sting mounted on a model injection mechanism. The tunnel has a contoured nozzle and an open jet test section. It exhausts to a vacuum sphere and is reclaimed and purified. Operational conditions are as follows:

Stagnation pressure, pascals	1.0×10^7 to 1.7×10^7
Stagnation temperature, °K	389 to 666
Mach number	6.1, 6.4
Reynolds number, per meter	$.10 \times 10^6$ to $.15 \times 10^6$
Running time, sec	90

DATA REDUCTION

Data were recorded on facility system and quantity program was used to reduce data to absolute pressure. There were no corrections to the data.

TABLE I

TEST : LA78, LA87, LA88 | DATE : APRIL 1976

TEST CONDITIONS

MACH NUMBER	REYNOLDS NUMBER (per foot)	DYNAMIC PRESSURE (pounds/sq. inch)	STAGNATION TEMPERATURE (degrees Fahrenheit)
6.04	0.36×10^6	1.10	820
5.94	1.00 "	0.87	350
20.30	4.40 "	1.59	83

BALANCE UTILIZED: _____

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF			
SF			
AF			
PM			
RM			
YM			

COMMENTS:

TABLE II

TEST : LA78, LA87, LA88 — DATA SET/RUN NUMBER COLLATION SUMMARY — DATE : 5-10-76

DATA SET IDENTIFIER	CONFIGURATION	SCHD. α	β	δe	δBF	PARAMETERS/VALUES δSB	MACH NUMBERS 5.94	6.0	20.3	TEST RUN NUMBERS
RJL001	Orbiter	A	0	0	0	0		1*		
RJ5001	"	B	↓	↓	↓	↓			2*	
RJV001	"	A	↓	↓	↓	↓	3*			
* 1 Run	1 consists of Runs	273,	268,	272	and	267 combined				
* 2 Run	2 consists of Runs	7	10	16	and	14 combined				
* 3 Run	3 consists of Runs	5	7	8	and	9 combined				

1 PL 7 13 19 25 31 37 43 49 55 61 MACH 67 ALPHA 73

α OR β SCHEDULES — COEFFICIENTS

A) α = 10, 18, 25, and 30°

B) α = 5, 10, 15 and 18°

IDVAR (1) IDVAR (2) NDV

Orbiter = $W_{87} B_{58} C_5 E_{18} F_4 M_3 R_5 V_5$

NASA-MSFC-MAF

TABLE III.

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Body B58

GENERAL DESCRIPTION : Double Delta Wing Fuselage Per Lines VL70-000093 except nose modified to conform to Vehicle 3 configuration forward of Station 300 (Station 338 on Lines VL70-000139)

DRAWING NUMBER : VL72-000061 VL70-000139 ~~VL70-000093~~

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length, in.	1328.3	5.313
Max Width X_o560 to X_o1307, in.	216.0	0.864
Max Depth, in.	239.0	0.956
Fineness Ratio	5.495	5.495
Area		
Max. Cross-Sectional	319.556	0.005
Planform		
Wetted		
Base		

TABLE III (Continued)

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Canopy - C5

GENERAL DESCRIPTION : 2A Configuration Per NR Lines VL70-000092

Scale Model= .004

DRAWING NUMBER : VL70-000092

DIMENSIONS :	FULL SCALE	MODEL SCALE
Sta. Fwd. Bulkhead	391.00	1.564
Sta. T. E.	560.0	2.240
Canopy Intersects Body ML	391.00	1.564
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE III - Continued
MODEL DIMENSIONAL DATA

MODEL COMPONENT : Elevon E-18

GENERAL DESCRIPTION : 2A Configuration Per W-87. NR Lines VL70-000093

Data for (1) of (2) Sides

Model Scale = .004

DRAWING NUMBER VL70-000093

DIMENSIONS	FULL SCALE	MODEL SCALE
Area, FT^2	205.517	0.0033
Span (equivalent), in.	353.34	1.413
Inb'd equivalent chord	114.78	0.459
Outb'd equivalent chord	55.00	0.220
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	.208	.208
At Outb'd equiv. chord	.400	.400
Sweep Back Angles, degrees		
Leading Edge	0.00	0.00
Trailing Edge	10.02	10.02
Hingeline	0.00	0.00
Area Moment (Normal to hinge line), FT^3	1548.07	0.00010
Product of area moment		

TABLE III (Continued)
MODEL DIMENSIONAL DATA

MODEL COMPONENT : F4 Body Flap

GENERAL DESCRIPTION : 2A Configuration Per NR Lines VL70-000094 "A"

Scale Model = .004

DRAWING NUMBER : VL70-000094A

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length ; in.	84.70	0.3388
Max Width, in.	265.00	1.060
Max Depth		
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform; ft.^{2}	142.63715	0.002282
Wetted		
Base		

TABLE III. (Continued)
MODEL DIMENSIONAL DATA

MODEL COMPONENT : OMS PODS-M3

GENERAL DESCRIPTION : 2A Light WT Configuration ; per MC120074

Per NR Lines VL70-000094

Scale Model = .004

DRAWING NUMBER : VL70-000094

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length, in.	346.0	1.384
Max Width , in.	108.0	0.432
Max Depth, in.	72.8	0.291
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

℄ of OMS POD

WP = 463.9 inches FS; 400.0 + 63.9 = 463.90 INFS
1.600 + .2556 = 1.8556 INMS

BP = 80.0 in. FS; 0.320 INMS

From Fuselage Station 1214.0 to 1560 INFS = 346.0 INFS
4.956 yo 6.240 = 1.384 INMS

TABLE III-(Continued)
MODEL DIMENSIONAL DATA

MODEL COMPONENT : Rudder R5

GENERAL DESCRIPTION 2A Configuration Per NR Lines VL70-000095

Scale Model— .004

DRAWING NUMBER VL70-000095

DIMENSIONS	FULL SCALE	MODEL SCALE
Area, FT^2	98.67	0.0016
Span (equivalent), in.	201.0	0.804
Inb'd equivalent chord	91.585	0.366
Outb'd equivalent chord	50.833	0.203
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	0.400
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	34.83314	34.83314
Trailing Edge	26.24915	26.24915
Hingeline	34.83314	34.83314
Area Moment (Normal to hinge line), FT^3 Product of area and mean chord	526.125	0.00003

TABLE III. MODEL COMPONENT DIMENSIONAL DATA (Continued)

MODEL COMPONENT: Vertical Tail V5 (Light Wt. Orbiter config)

GENERAL DESCRIPTION: Center Line Vertical Tail on the Double Delta Configuration with Double Wedge Airfoil and Rounded Leading Edge, Total Data Includes Void Area Listed Below Scale Model = .004

DRAWING NUMBER: VL70-000095

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area, FT^2	386.05	0.006
Void (included above), FT^2	13.17	0.0002
Blanketed included above, FT^2	12.67	0.0002
Span (equivalent), FT	24.37	0.097
Aspect Ratio	1.590	1.590
Rate of Taper	0.507	0.507
Taper Ratio	0.426	0.426
Dihedral Angle, degrees	--	--
Incidence Angle, degrees	--	--
Aerodynamic Twist, degrees	--	--
Toe-In Angle	0.0	0.0
Cant Angle	0.0	0.0
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	26.249	26.249
0.25 Element Line	41.130	41.130
Chords:		
Root (Wing Sta. 0.0)	257.99	1.032
Tip, (equivalent)	109.78	0.439
MAC	193.84	0.775
Fus. Sta. of .25 MAC	1473.64	5.895
W.P. of .25 MAC	647.31	2.589
B.L. of .25 MAC	0.0	0.0
Airfoil Section		
Root		
Tip		
EXPOSED DATA		
Area		
Span, (equivalent)		
Aspect Ratio		
Taper Ratio		
Chords		
Root		
Tip		
MAC		
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		

TABLE III. MODEL COMPONENT DIMENSIONAL DATA (Concluded)

MODEL COMPONENT:- Wing W 87-New Light Weight

GENERAL DESCRIPTION: Oribter Configuration per lines VL70-000093

Scale Model= .004

DRAWING NUMBER: VL70-000093

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area, FT^2 (W.R.P.)		
Planform	2689.38	0.043
Wetted		
Span (equivalent)	77.12	0.308
Aspect Ratio	2.214	2.214
Rate of Taper	1.176	1.176
Taper Ratio	0.209	0.209
Dihedral Angle, degrees @ 75.33% element line	3.860	3.860
Incidence Angle, degrees @ .425 b/2 to 1.00 b/2	3.000	3.000
Aerodynamic Twist, degrees	— —	— —
Toe-In Angle	— —	— —
Cant Angle	— —	— —
Sweep Back Angles, degrees		
Leading Edge	44.873	44.873
Trailing Edge	10.242	10.242
0.25 Element Line	35.050	35.050
Chords:		
Root (Wing Sta. 0.0)	690.19	2.761
Tip, (equivalent)	144.30	0.577
MAC	476.76	1.907
Fus. Sta. of .25 MAC	1136.12	4.544
W.P. of .25 MAC	289.44	1.158
B.L. of .25 MAC	181.03	0.724
Airfoil Section		
Root		
Tip		
EXPOSED DATA		
Area, FT^2	1746.87	.0279
Span, (equivalent)	59.16	0.237
Aspect Ratio	2.004	2.004
Taper Ratio	0.256	0.256
Chords		
Root	562.77	2.251
Tip	144.30	0.577
MAC	394.81	1.579
Fus. Sta. of .25 MAC	1185.17	4.741
W.P. of .25 MAC	291.56	1.166
B.L. of .25 MAC	250.54	1.002
LEADING EDGE CUFF(data for (1) side)		
Plan form area, FT^2 (BP 108.0)	120.333	0.0019
L.E. Intersect Fus ML STA	560.0	2.240
L.E. Intersects Wing STA	1035.0	4.140

Notes:

1. Positive directions of force coefficients, moment coefficients, and angles are indicated by arrows
2. For clarity, origins of wind and stability axes have been displaced from the center of gravity

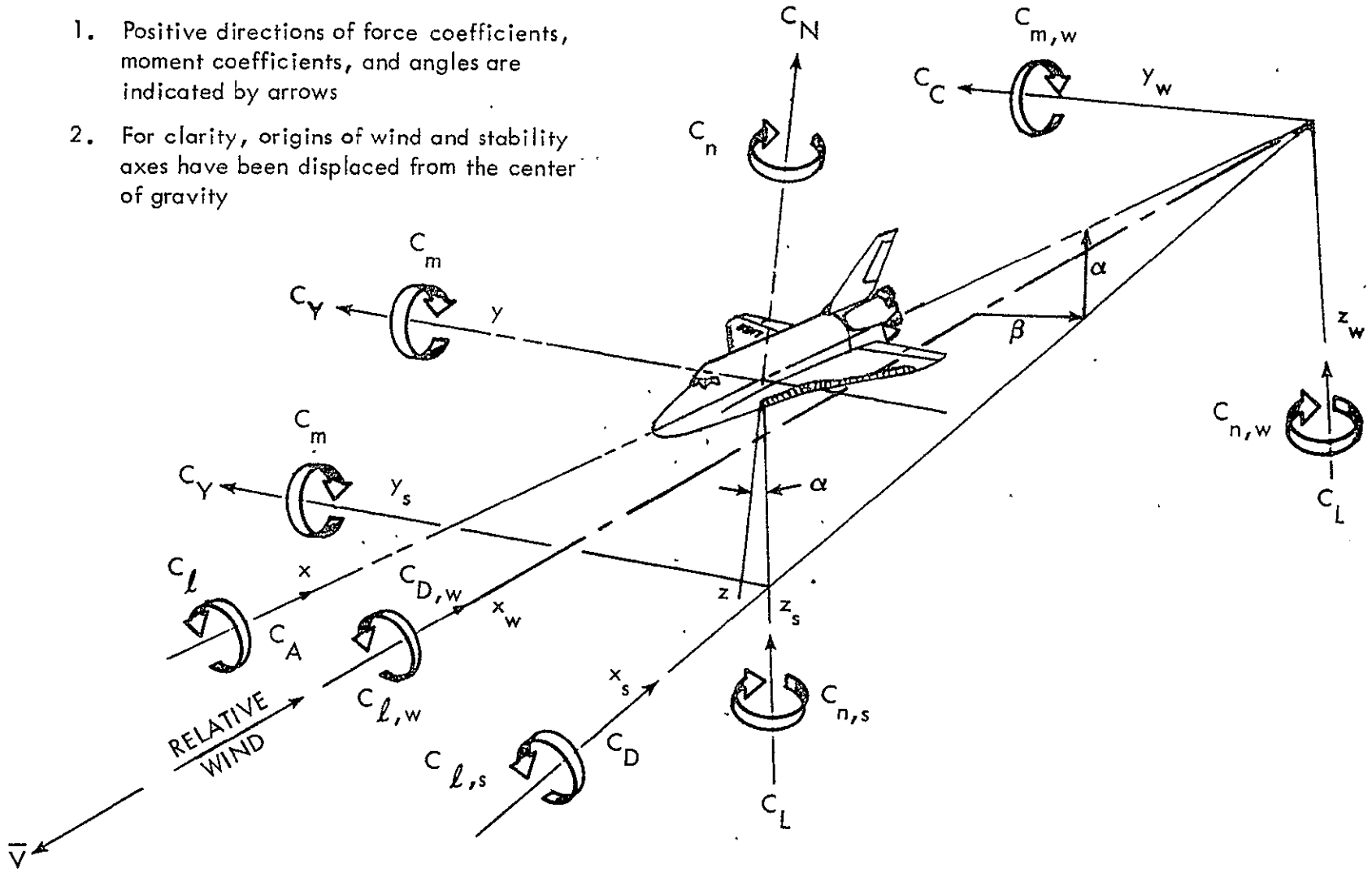
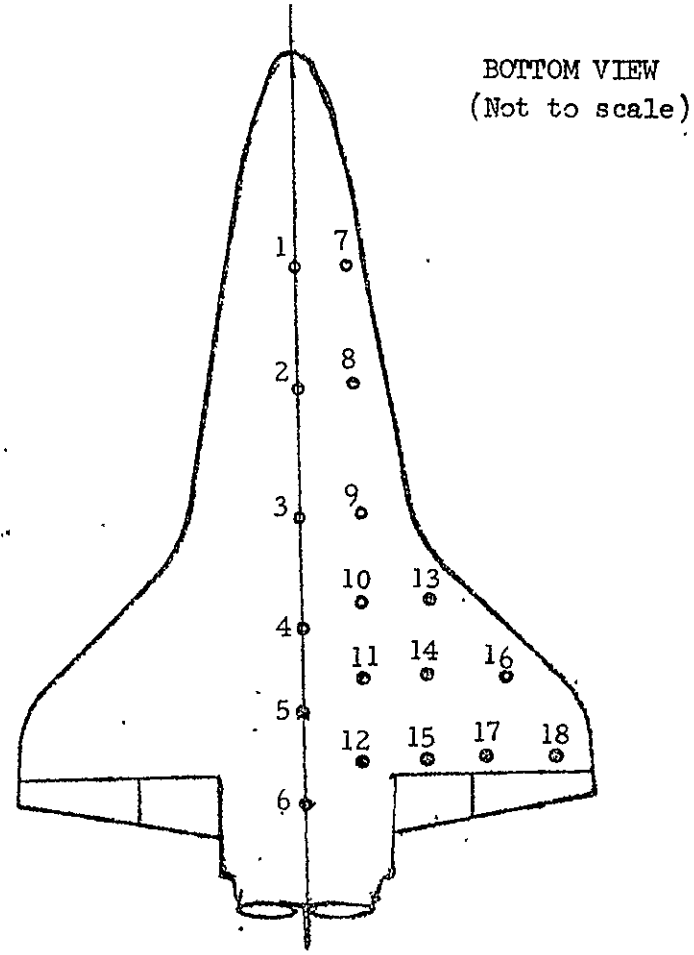


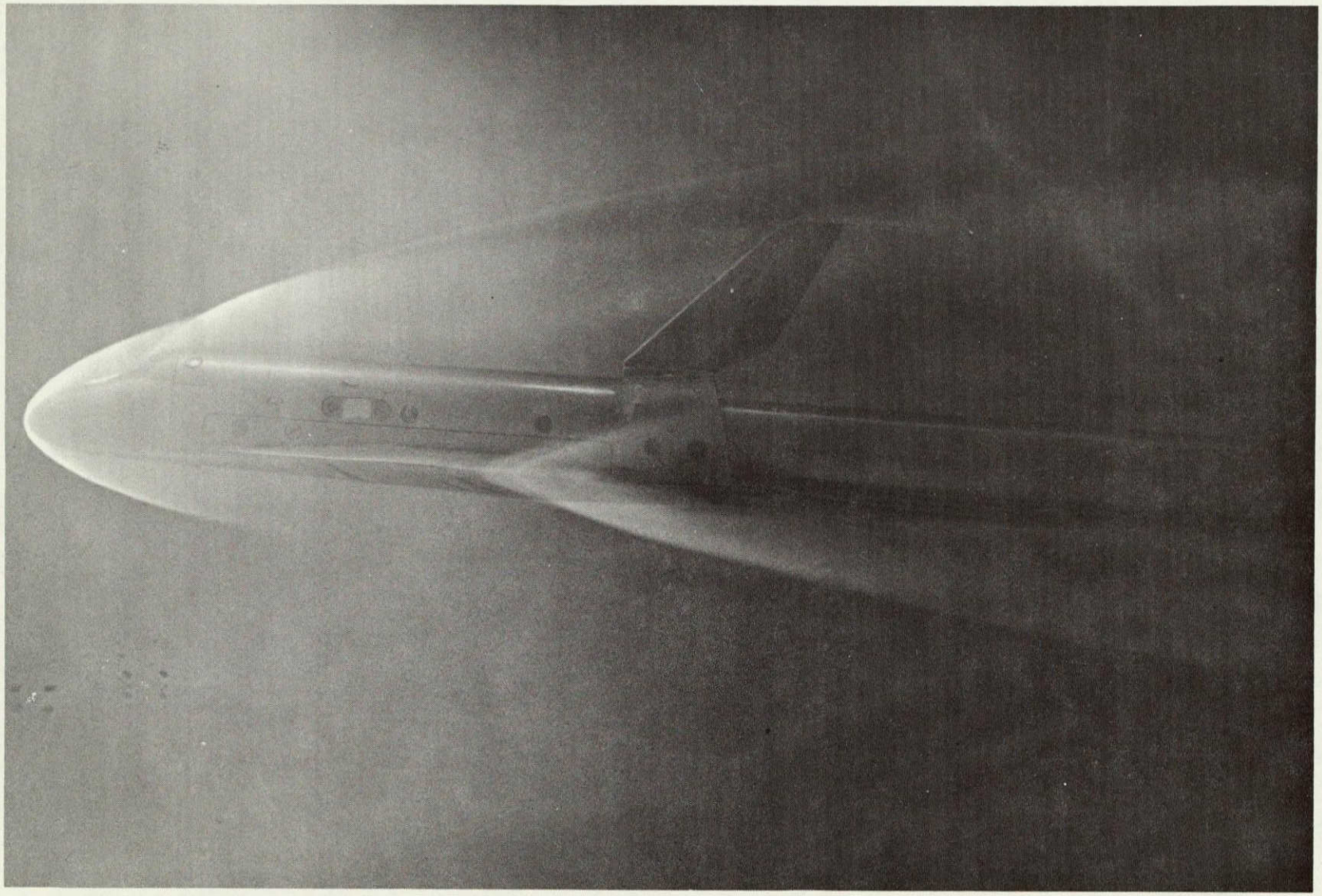
Figure 1. - Axis systems.

ORIFICE NUMBER	X_O, in. F.S.	Y_O, in. F.S.
1	361.0	0.0
2	527.0	0.0
3	782.0	0.0
4	982.0	0.0
5	1102.0	0.0
6	1282.0	0.0
7	364.0	93.0
8	530.0	100.0
9	784.0	107.0
10	911.0	114.0
11	1049.0	114.0
12	1200.0	114.0
13	913.0	236.0
14	1046.0	251.0
15	1200.0	202.0
16	1041.0	365.0
17	1200.0	317.0
18	1202.0	411.0



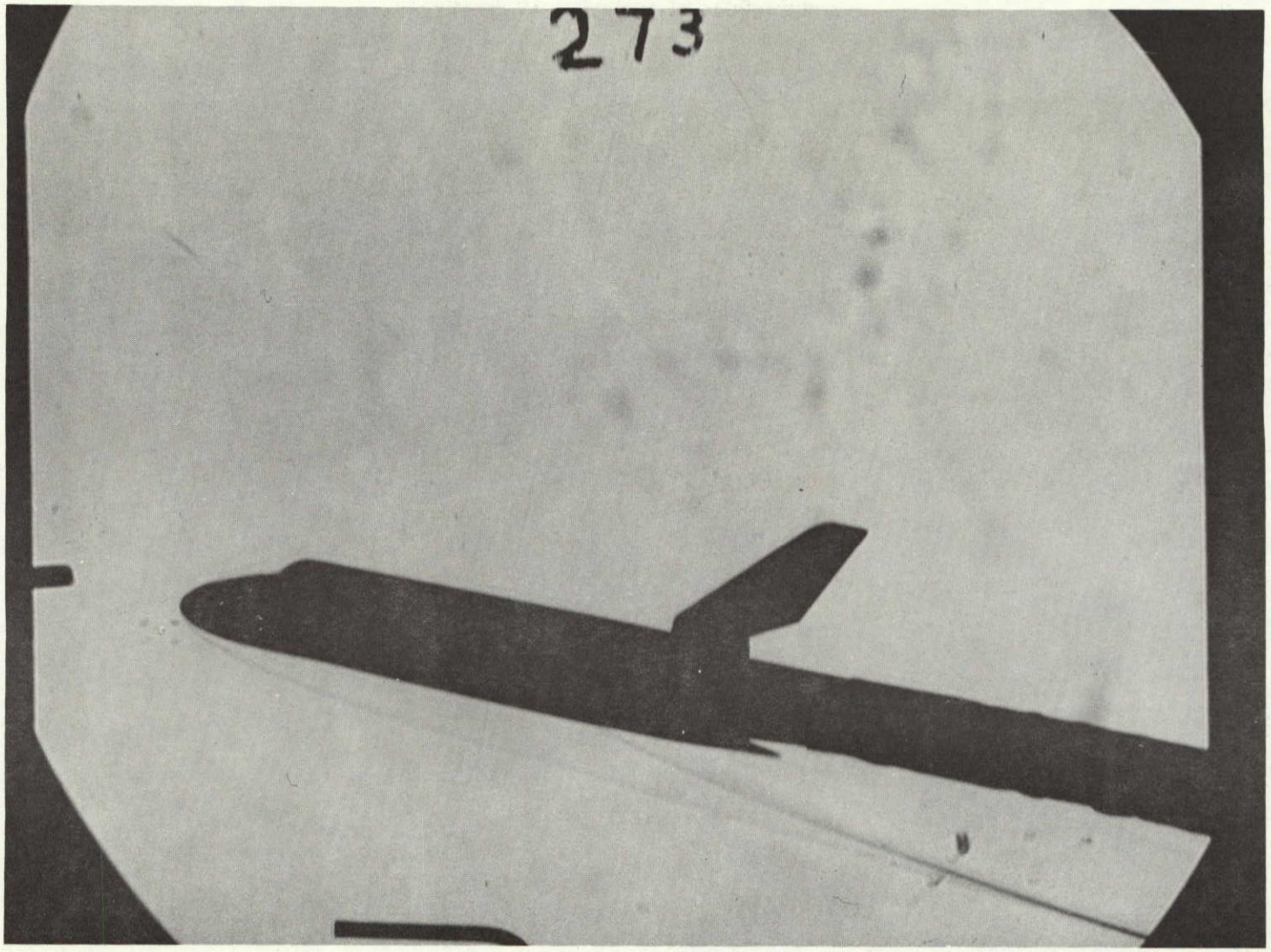
a. Pressure Tap Location

Figure 2. - Model Sketches

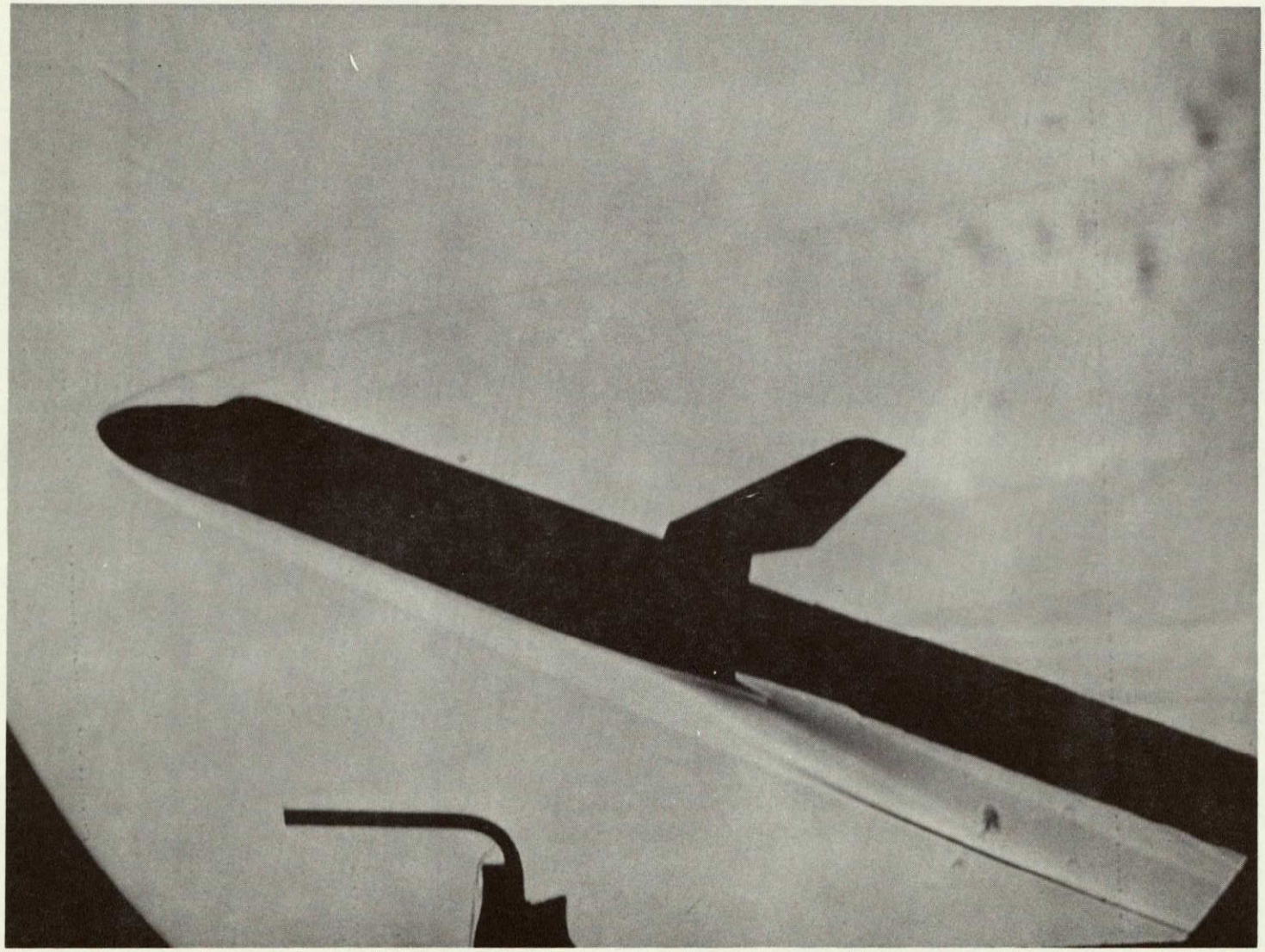


a. Electron Beam photograph, 22" Helium Tunnel, α=5°, M=20.3

Figure 3. - Model photographs



b. Schlieren photograph, CF4 Tunnel, α=10°, M=6.0
Figure 3. - Model photographs



c. Schlieren photograph, CF_4 Tunnel, α=18°, M=6.0

Figure 3. - Model photographs.

DATA FIGURES

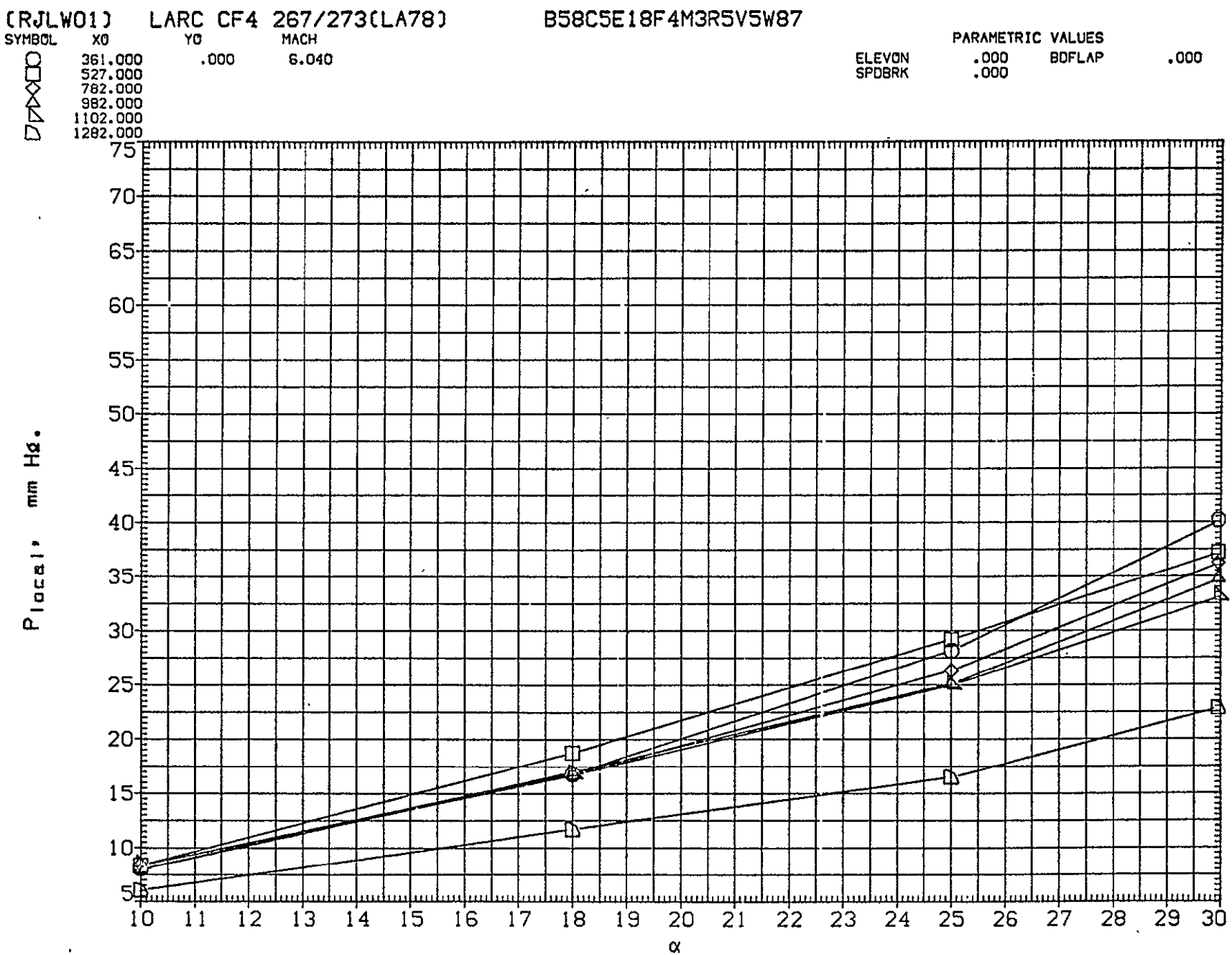


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	364.000	93.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

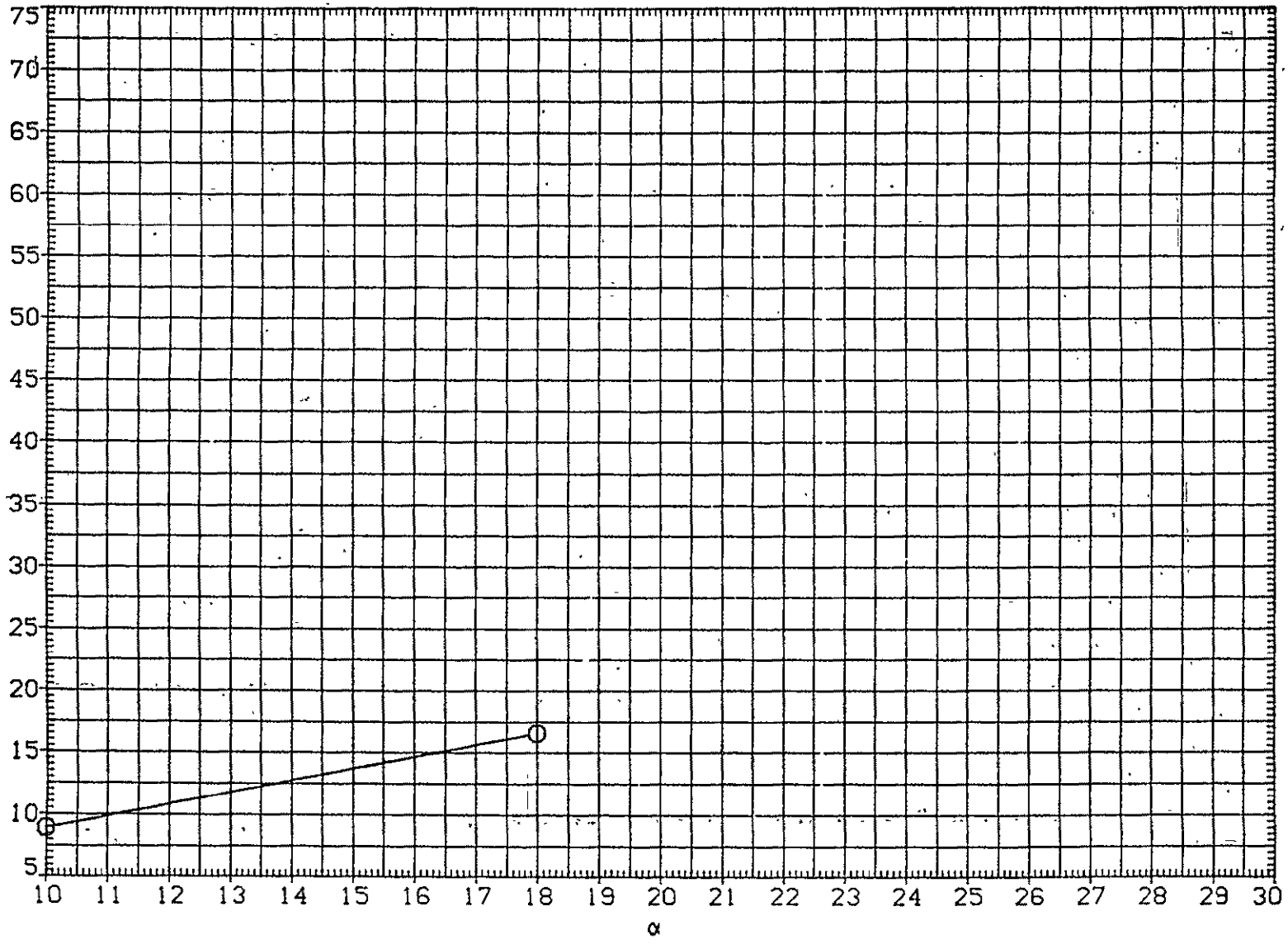


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	530.000	100.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BOFLAP	.000
SPDBRK	.000		

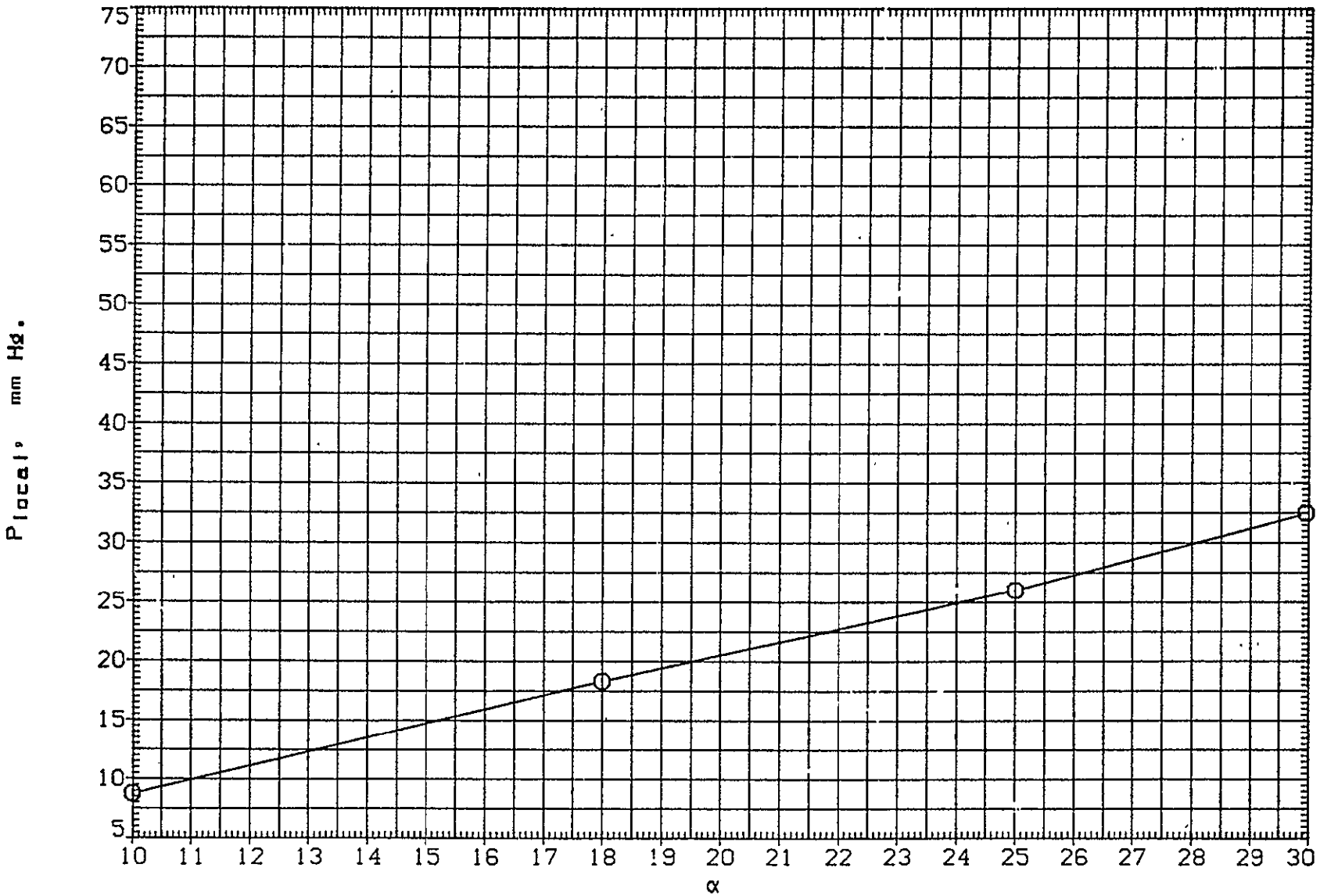


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	784.000	107.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPOBRK	.000		

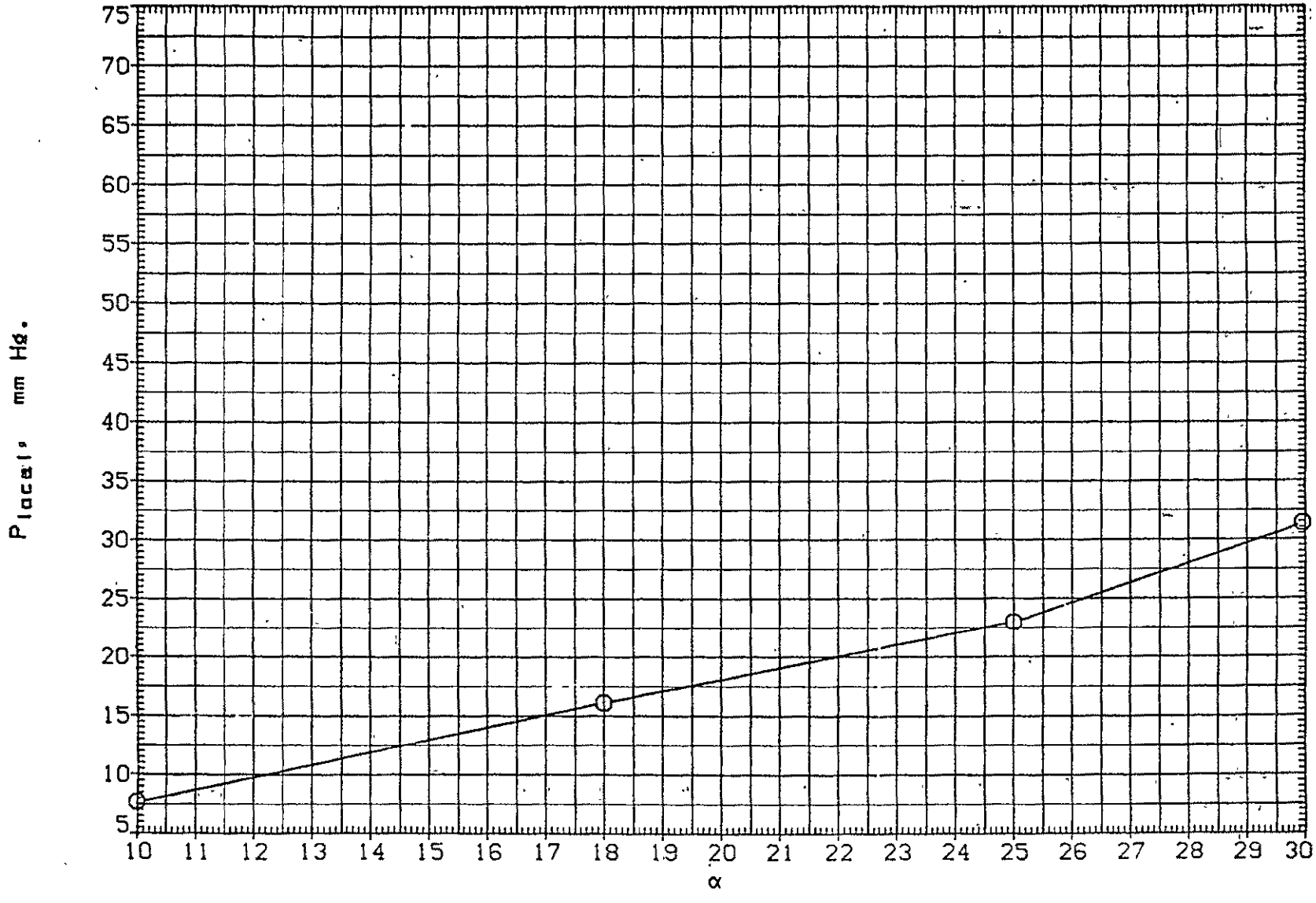


FIGURE 4. LARC CF4 267.268.272.273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XC	YC	MACH
○	911.000	114.000	6.040
□	1049.000		
◇	1200.000		

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

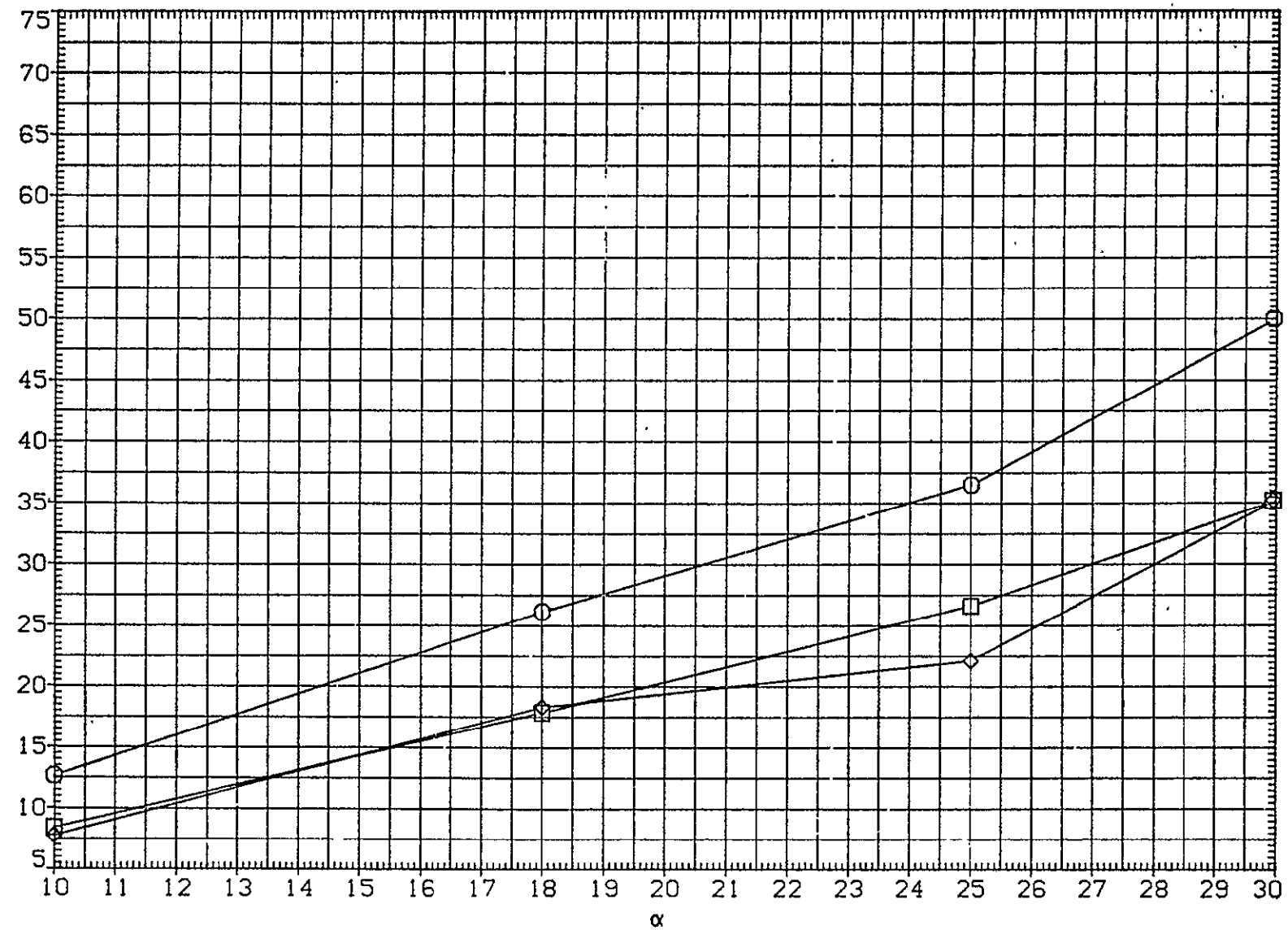


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1200.000	202.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

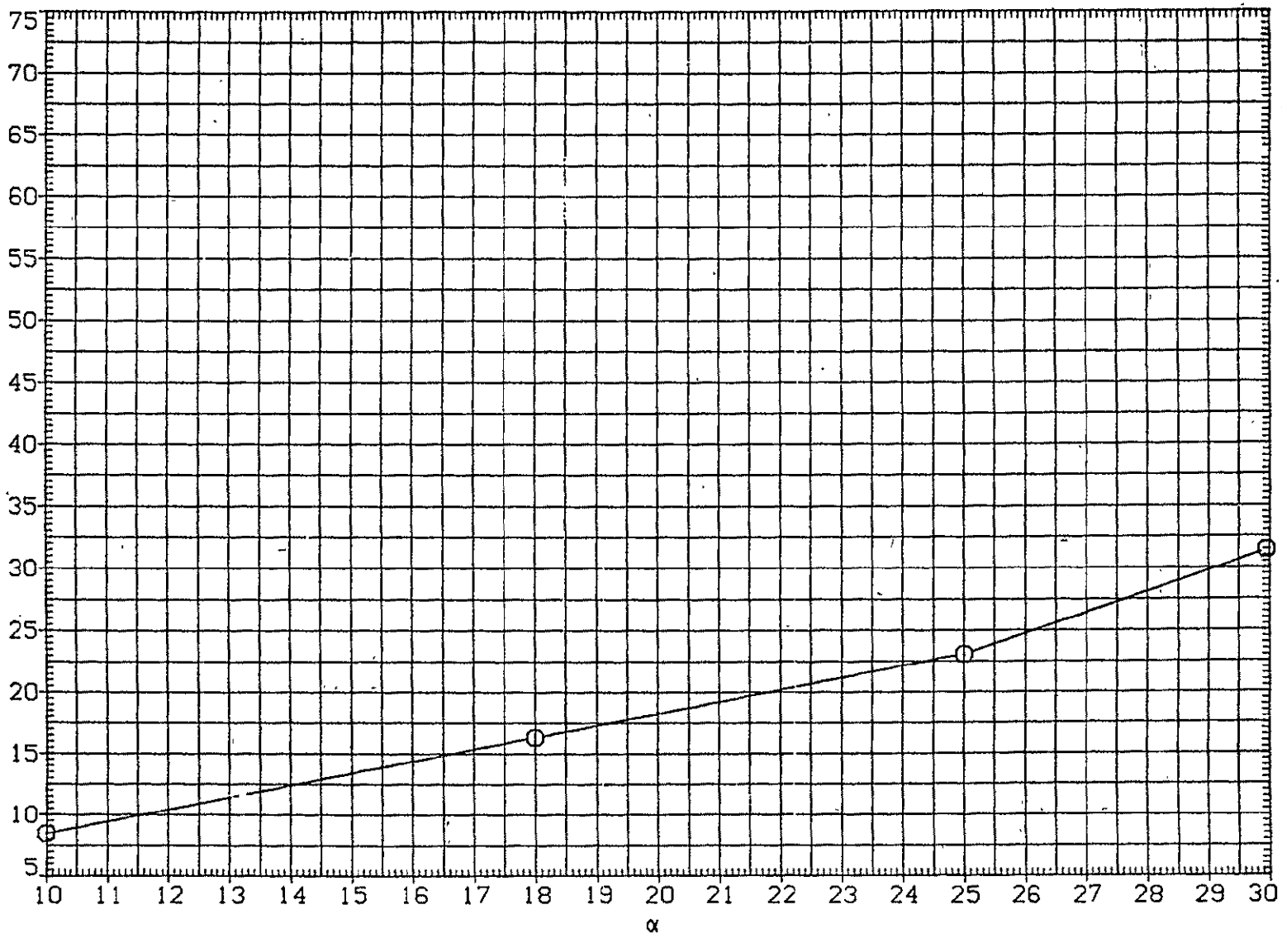


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	913.000	236.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

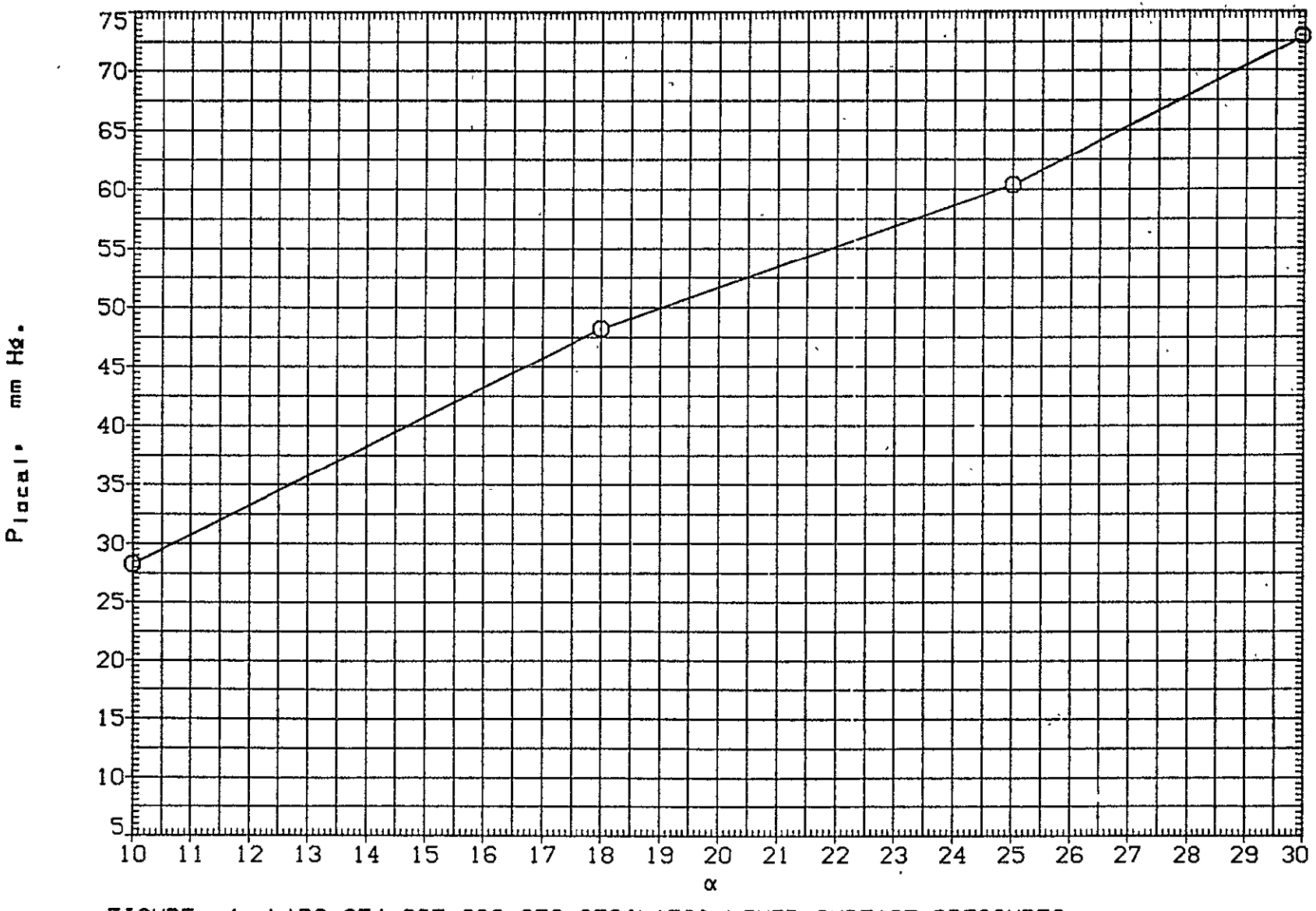


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1046.000	251.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

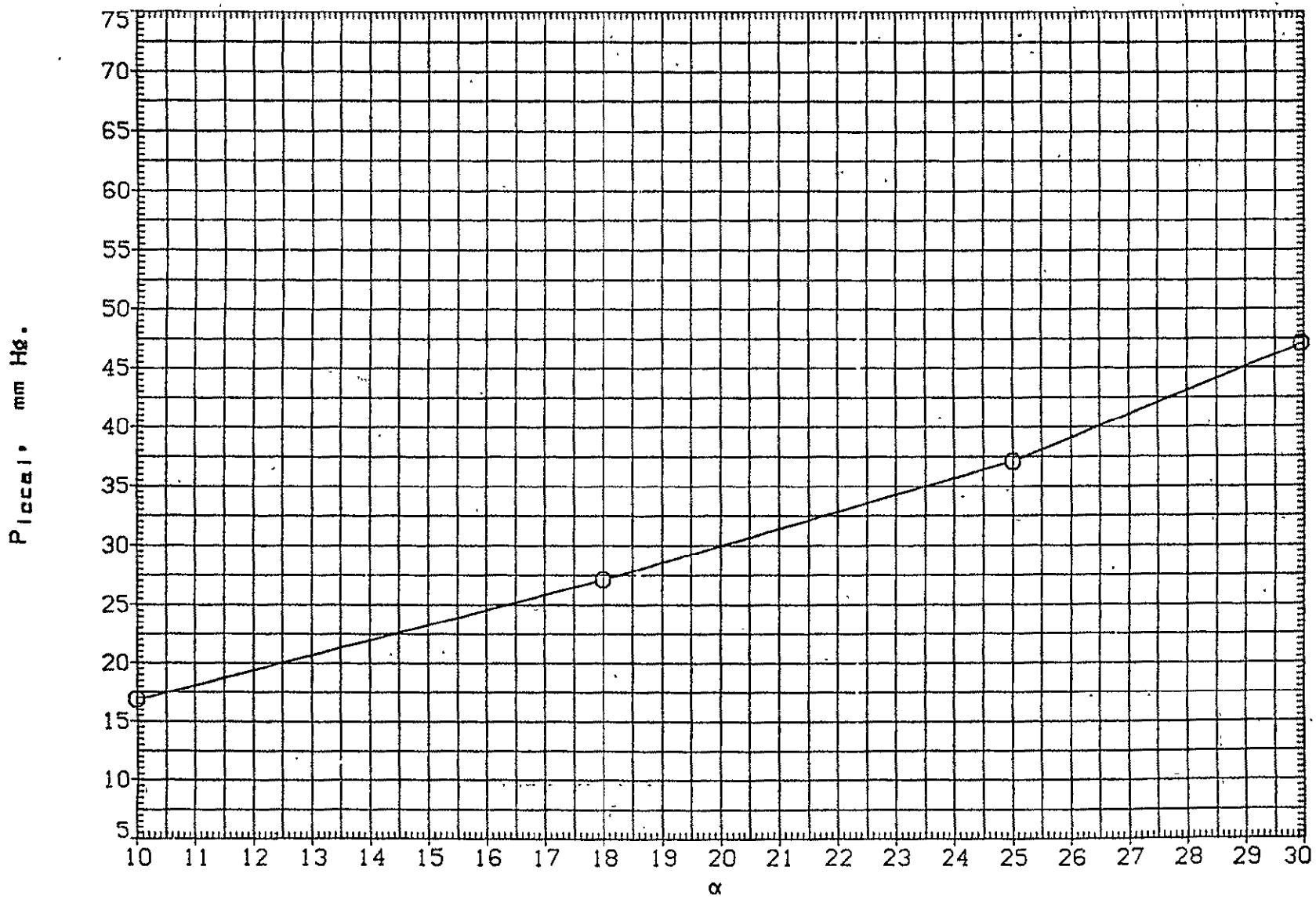


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1200.000	317.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

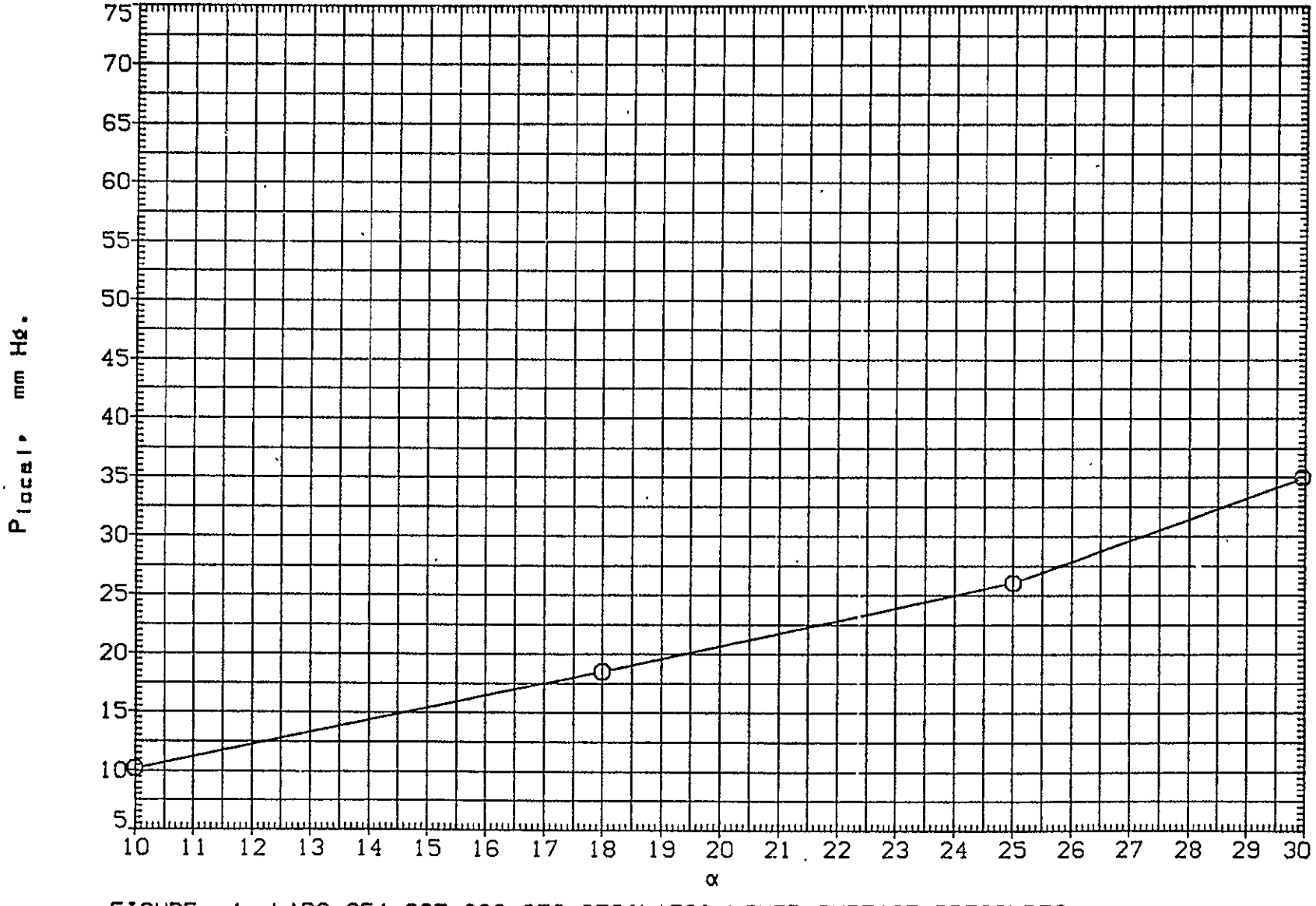


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XØ	YØ	MACH
○	1041.000	365.000	6.040

PARAMETRIC VALUES

ELEVØN	.000	BDFLAP	.000
SPDBRK	.000		

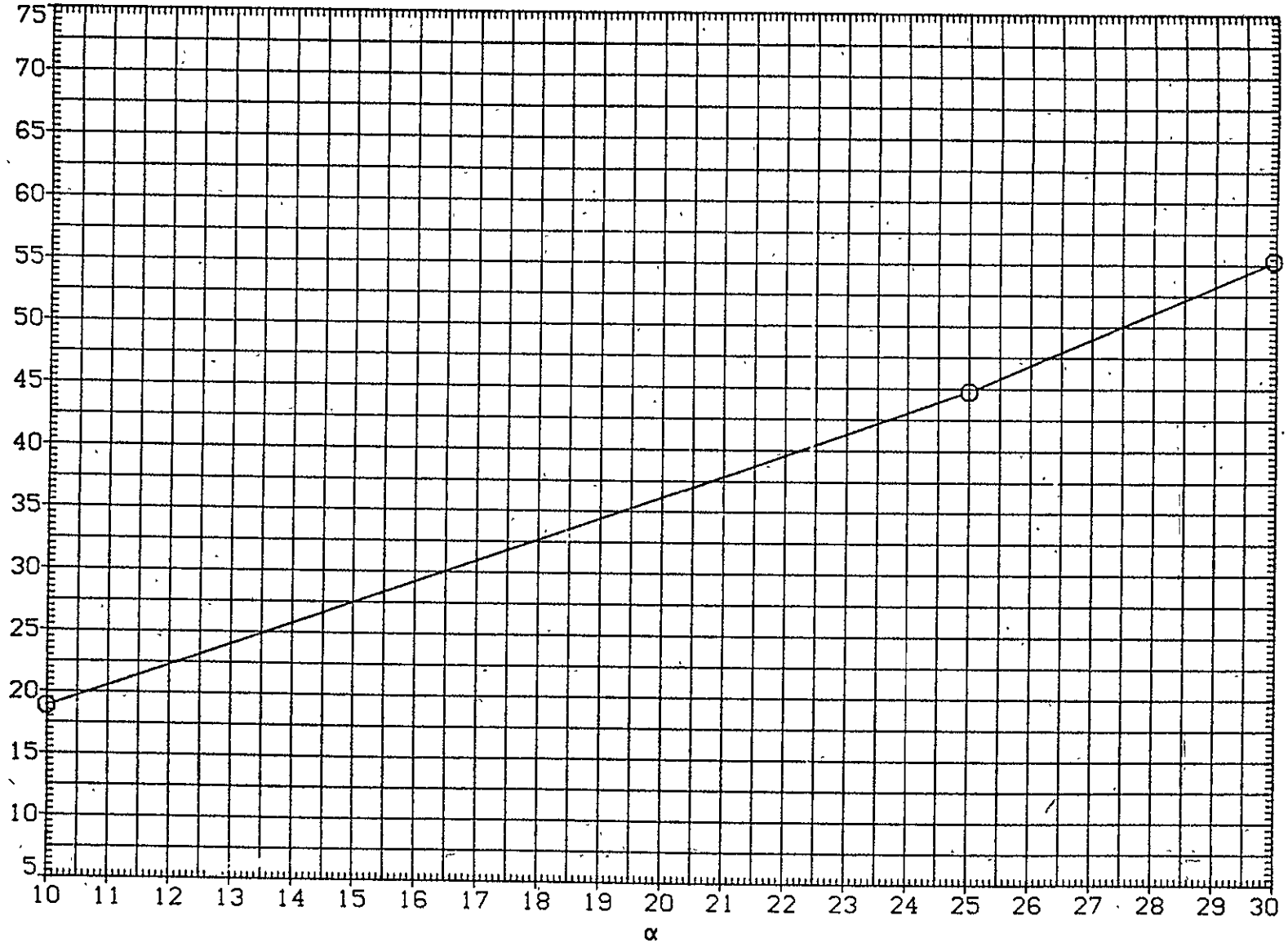


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJLW01) LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1202.000	411.000	6.040

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

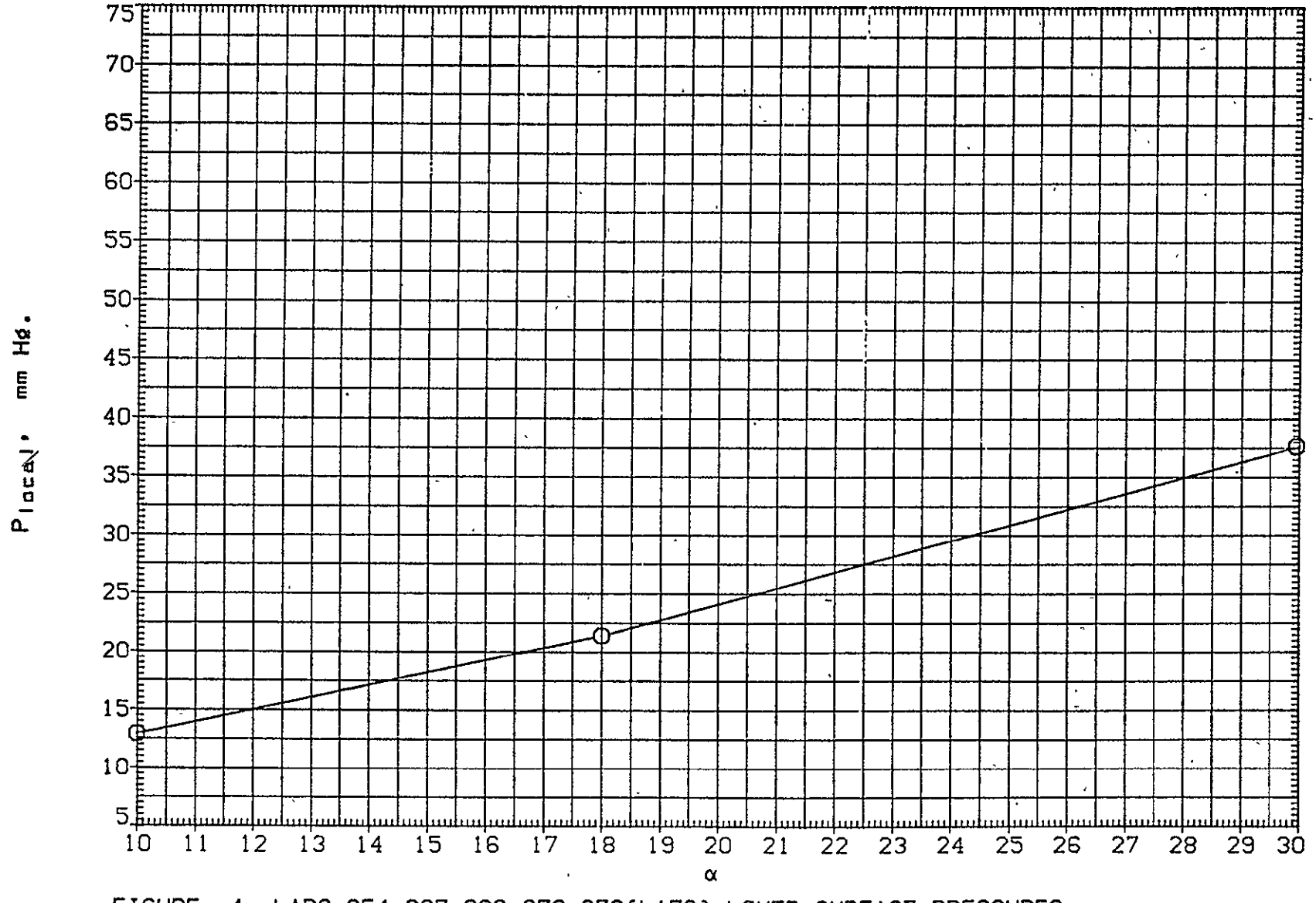


FIGURE 4. LARC CF4 267,268,272,273(LA78) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

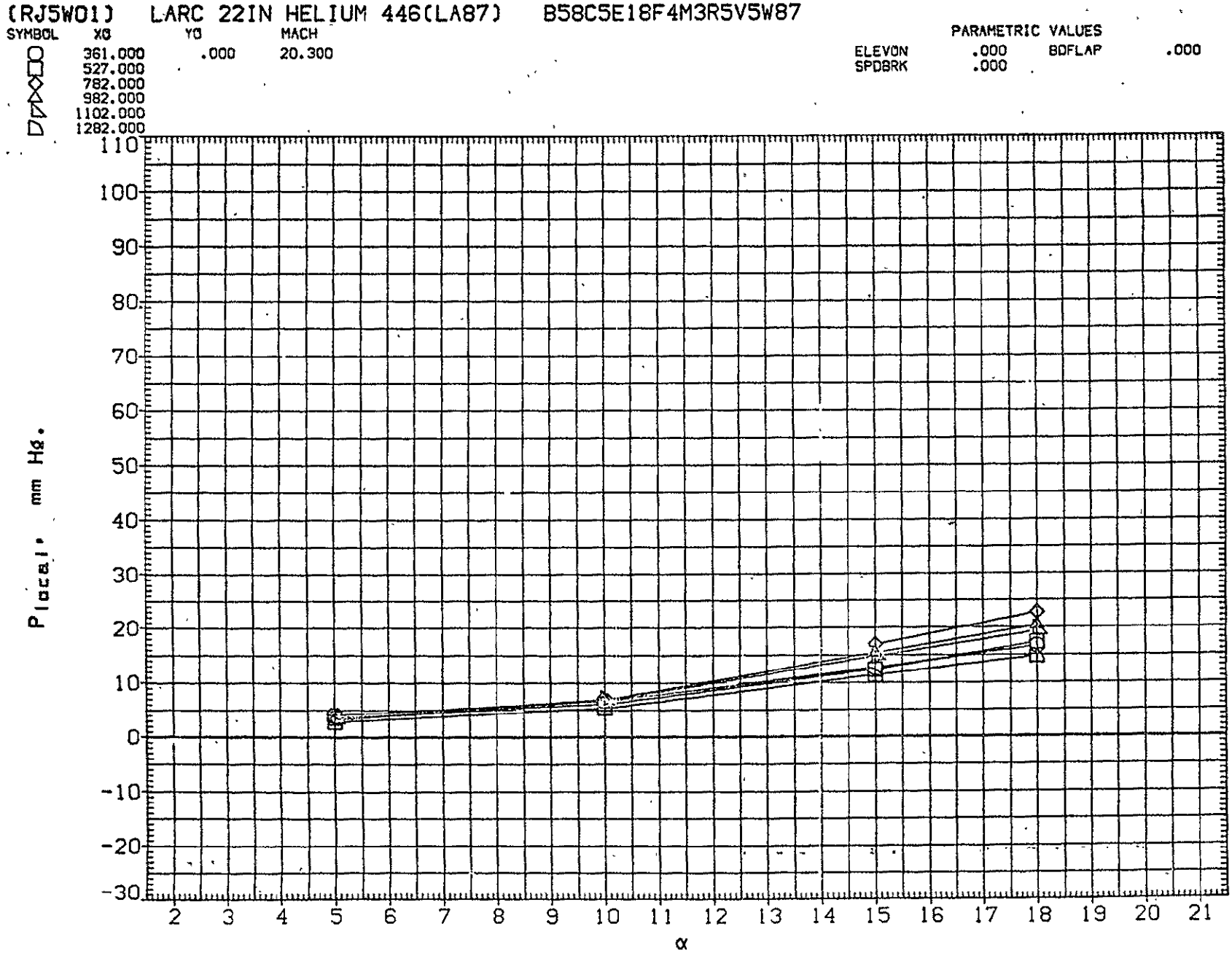


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XC	YC	MACH
○	364.000	93.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

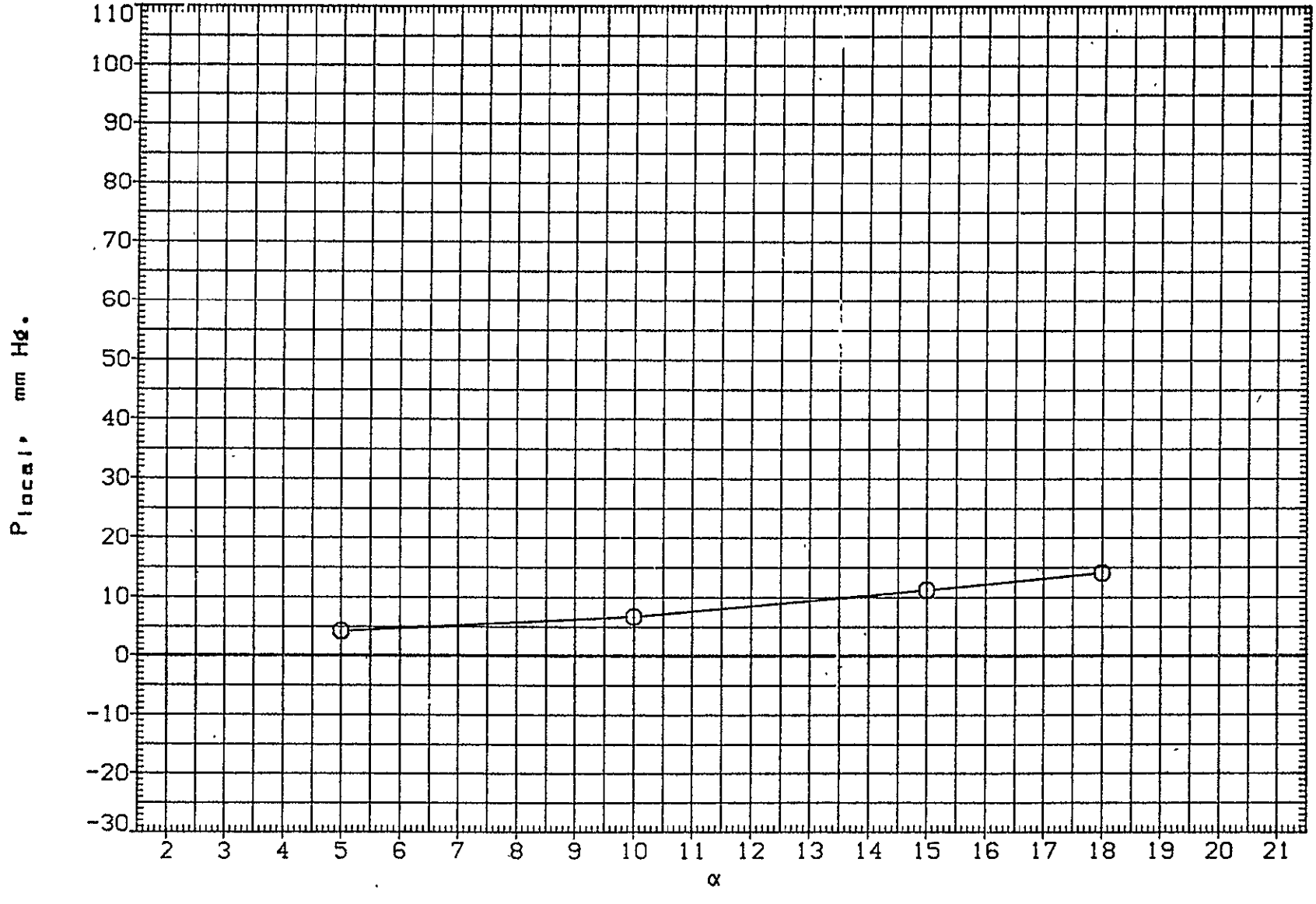


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

-47-

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	530.000	100.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BOFLAP	.000
SPDBRK	.000		

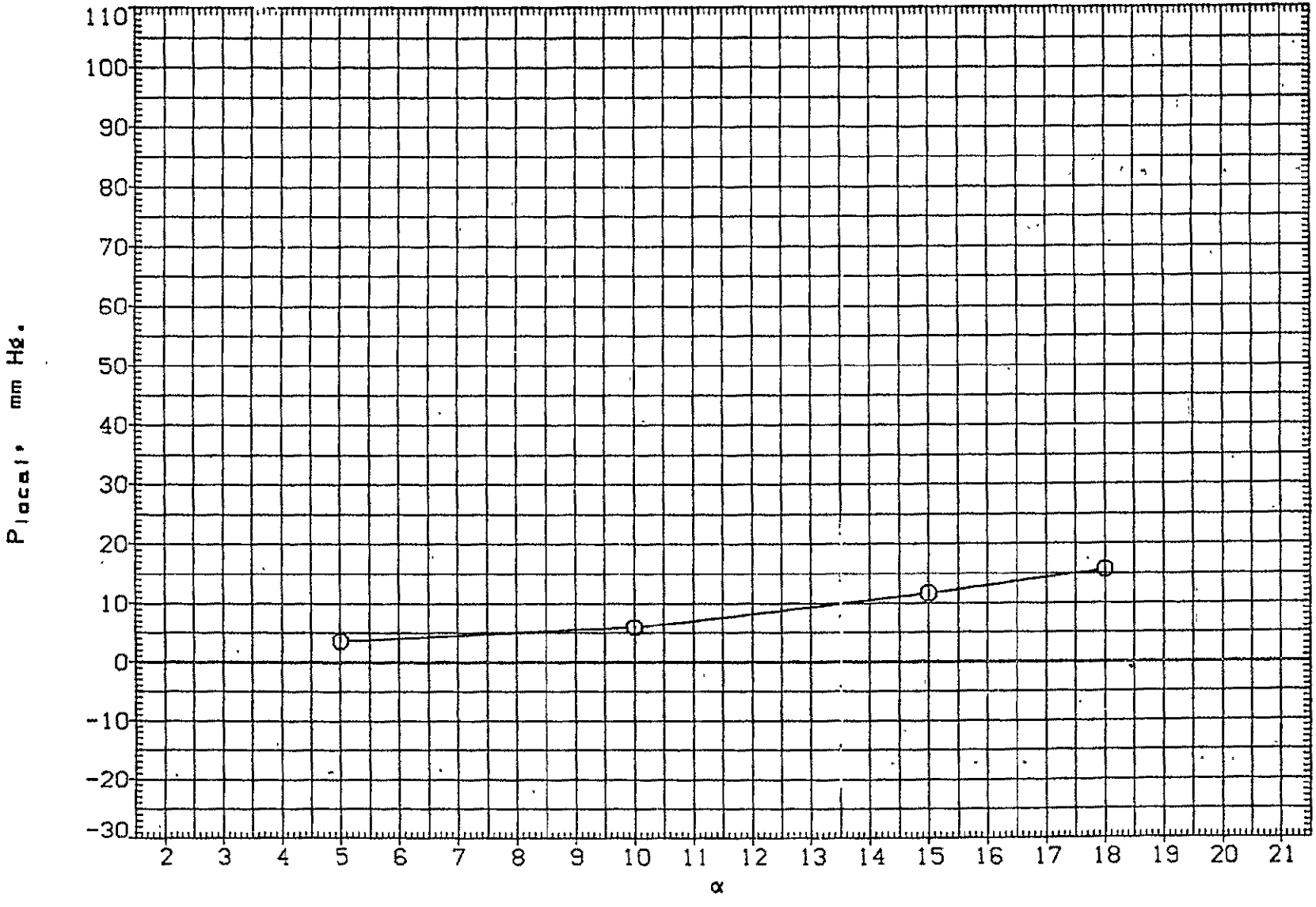


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	784.000	107.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

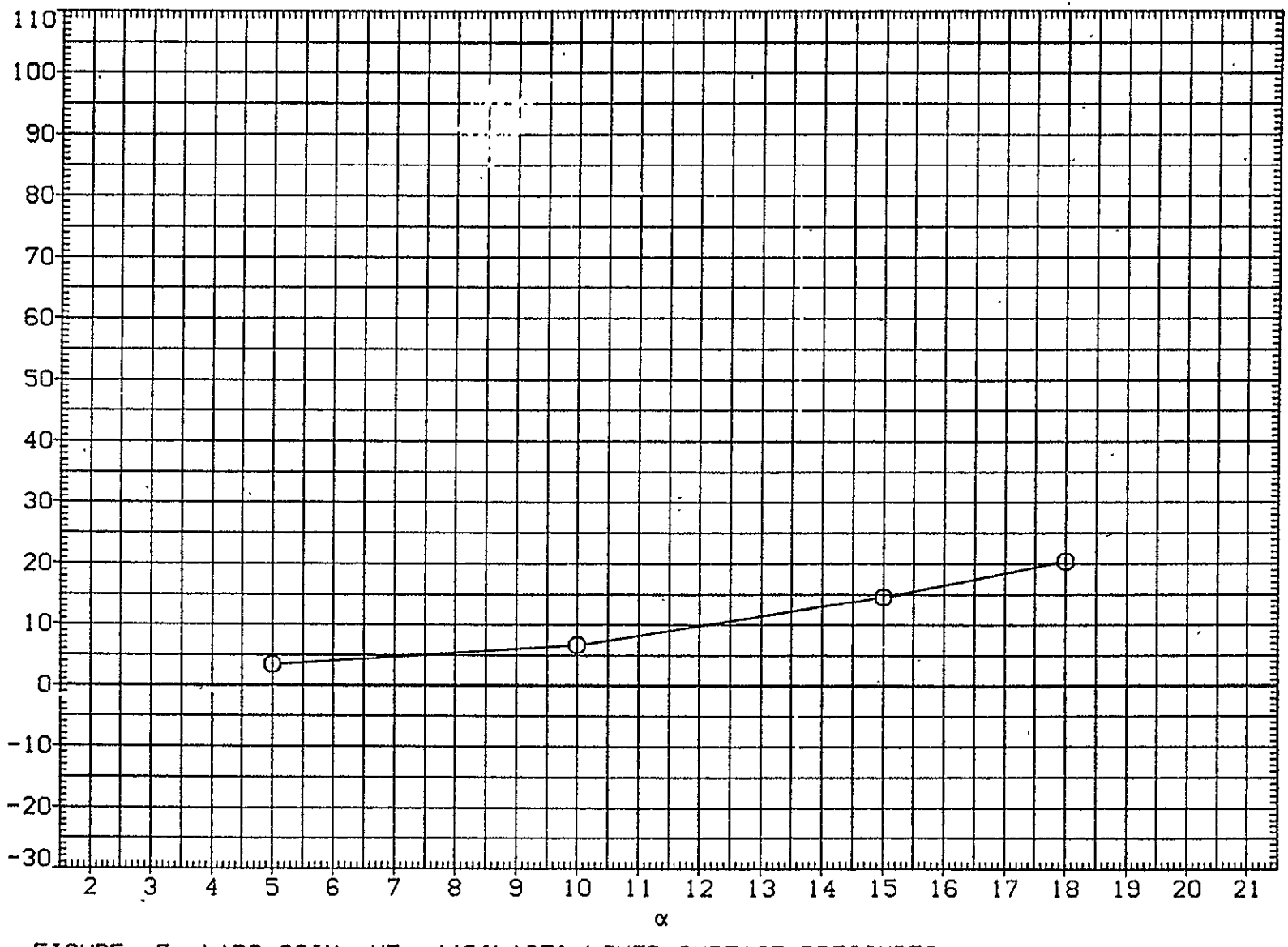


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	911.000	114.000	20.300
□	1049.000		
◇	1200.000		

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

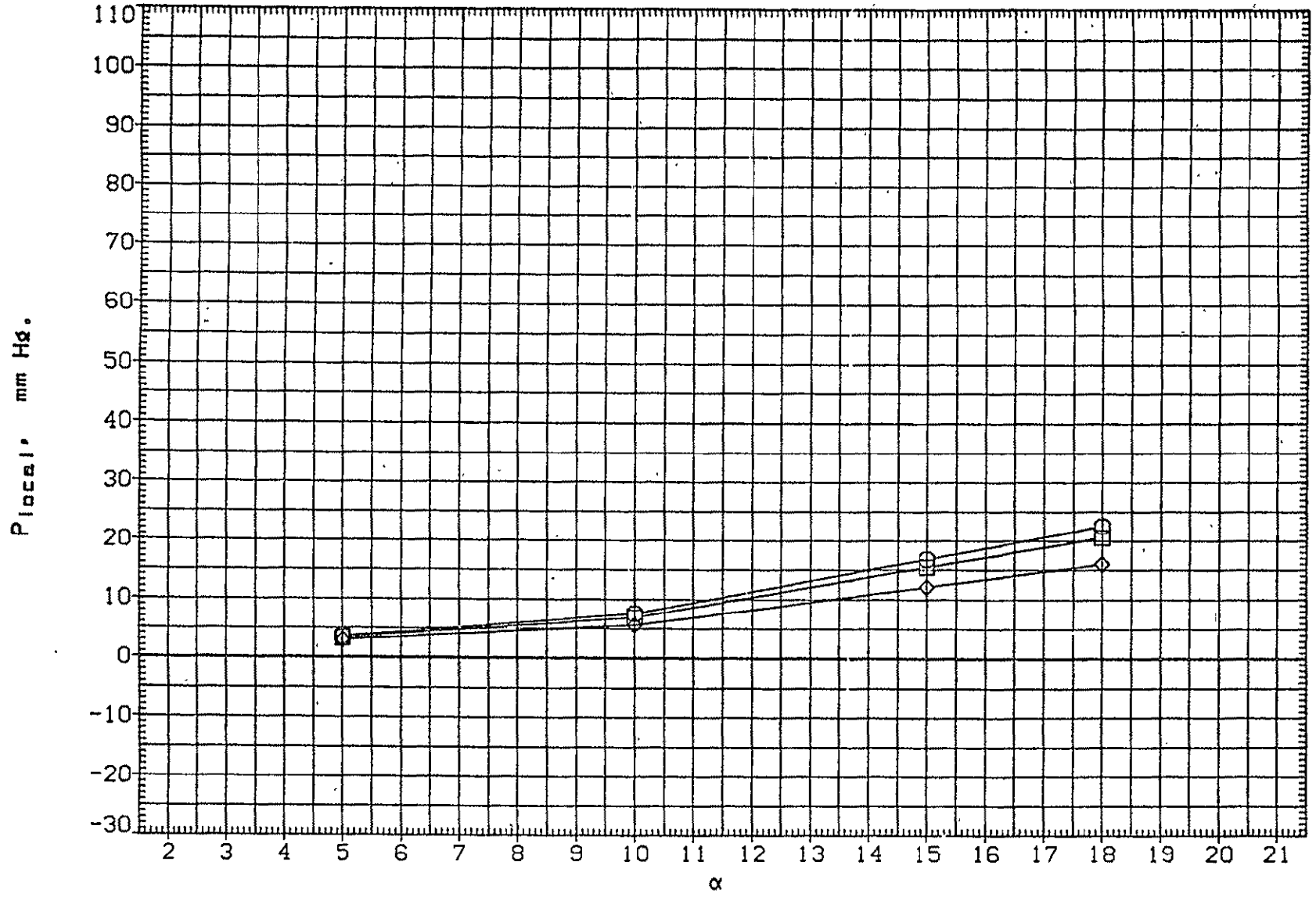


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XØ	YØ	MACH
○	1200.000	202.000	20.300

PARAMETRIC VALUES

ELEVØN	.000	BDFLAP	.000
SPDBRK	.000		

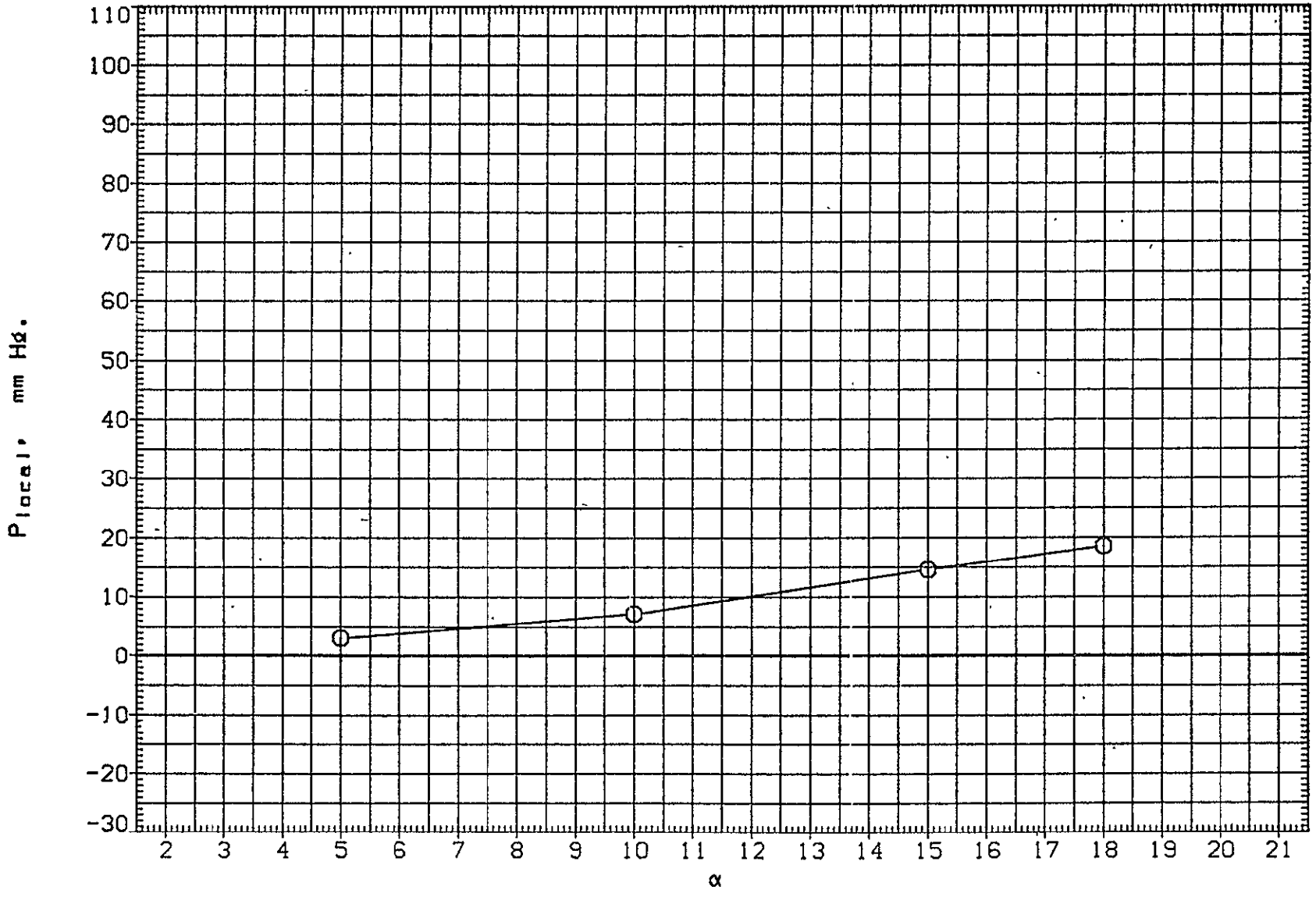


FIGURE 5. LARC 22IN. HE. 446(LA87) LØWER SURFACE PRESSURES
LØCAL PRESSURE ØN LØWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	913.000	236.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

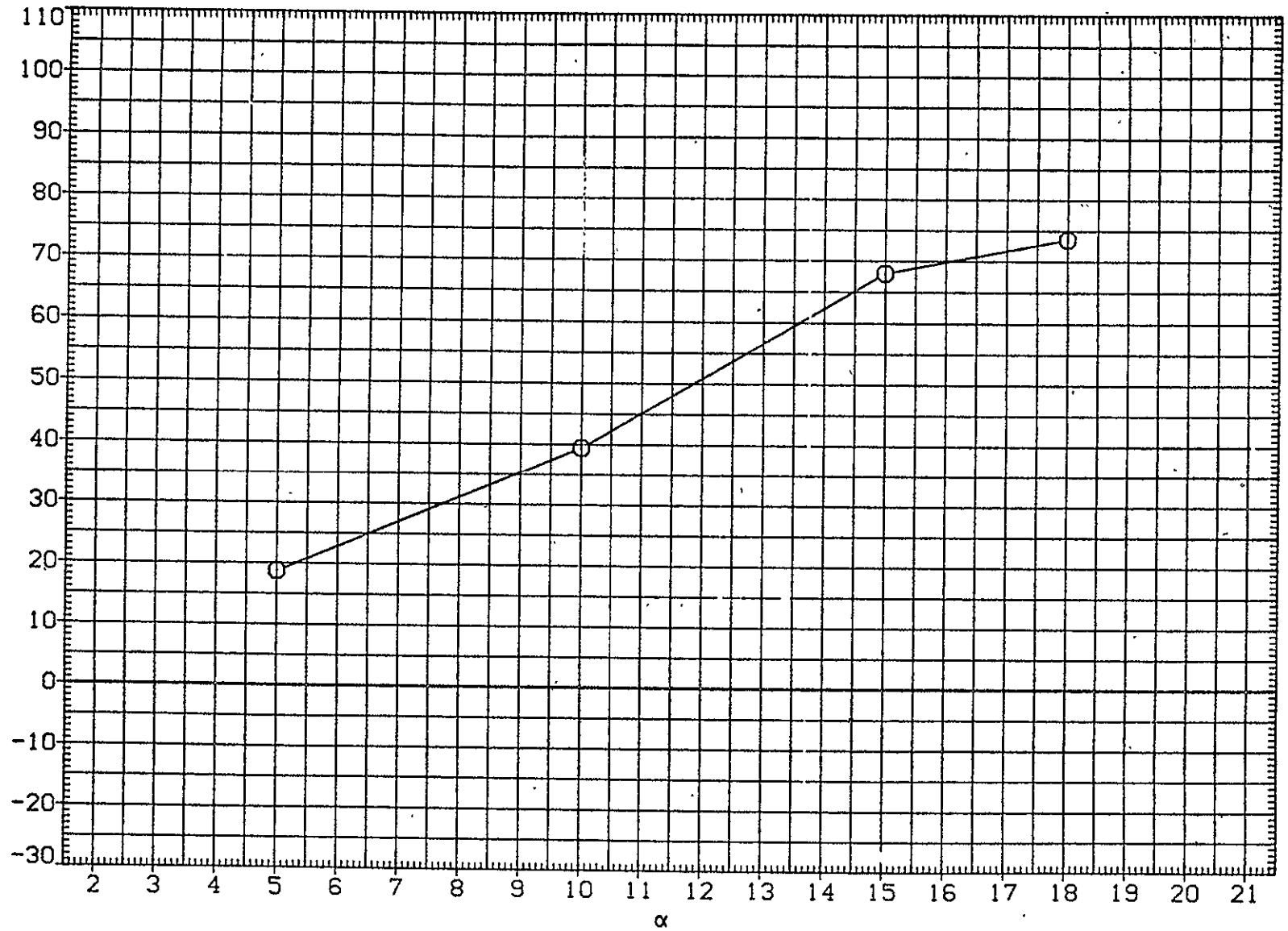


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1046.000	251.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPOBRK	.000		

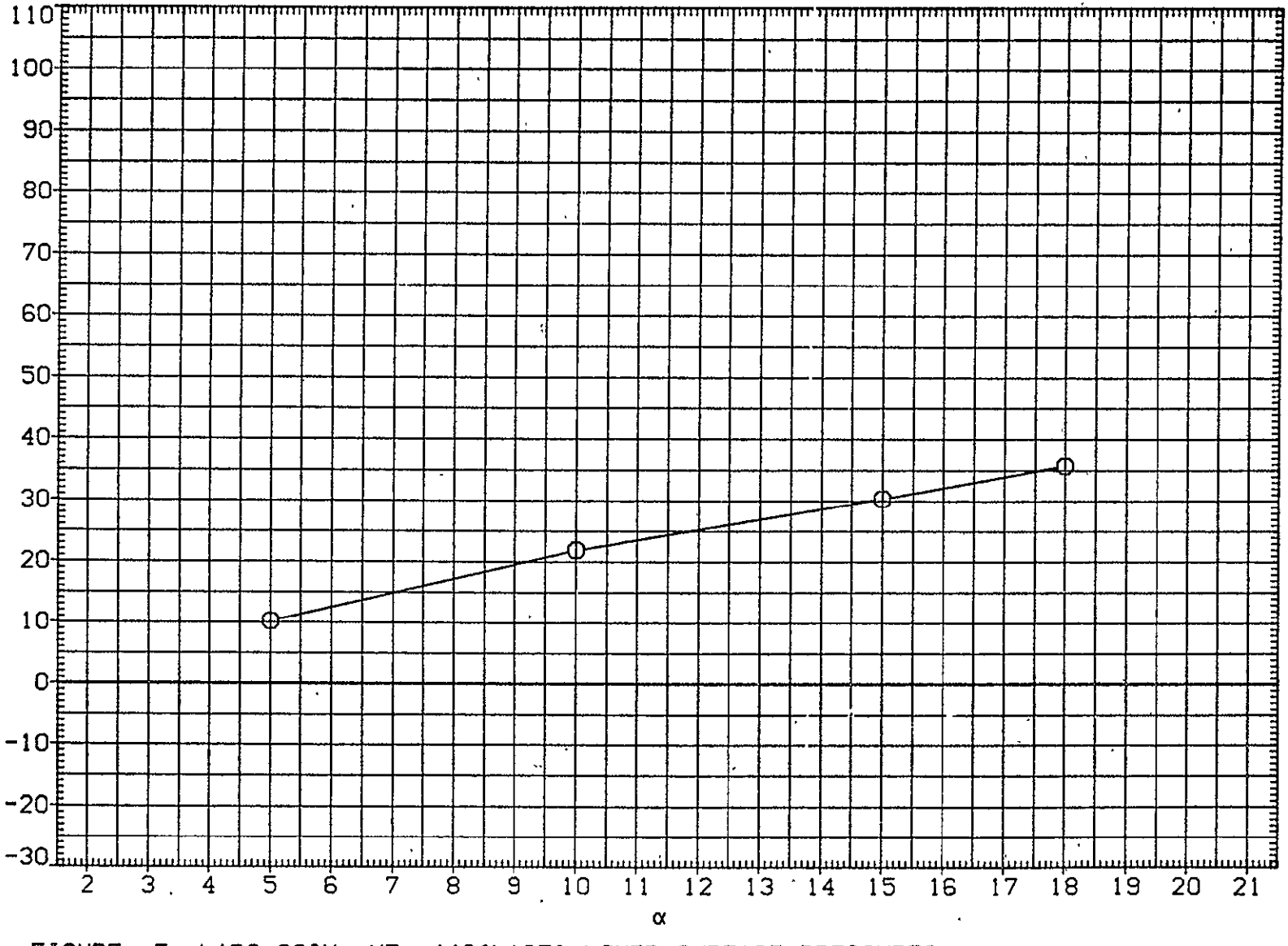


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1200.000	317.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

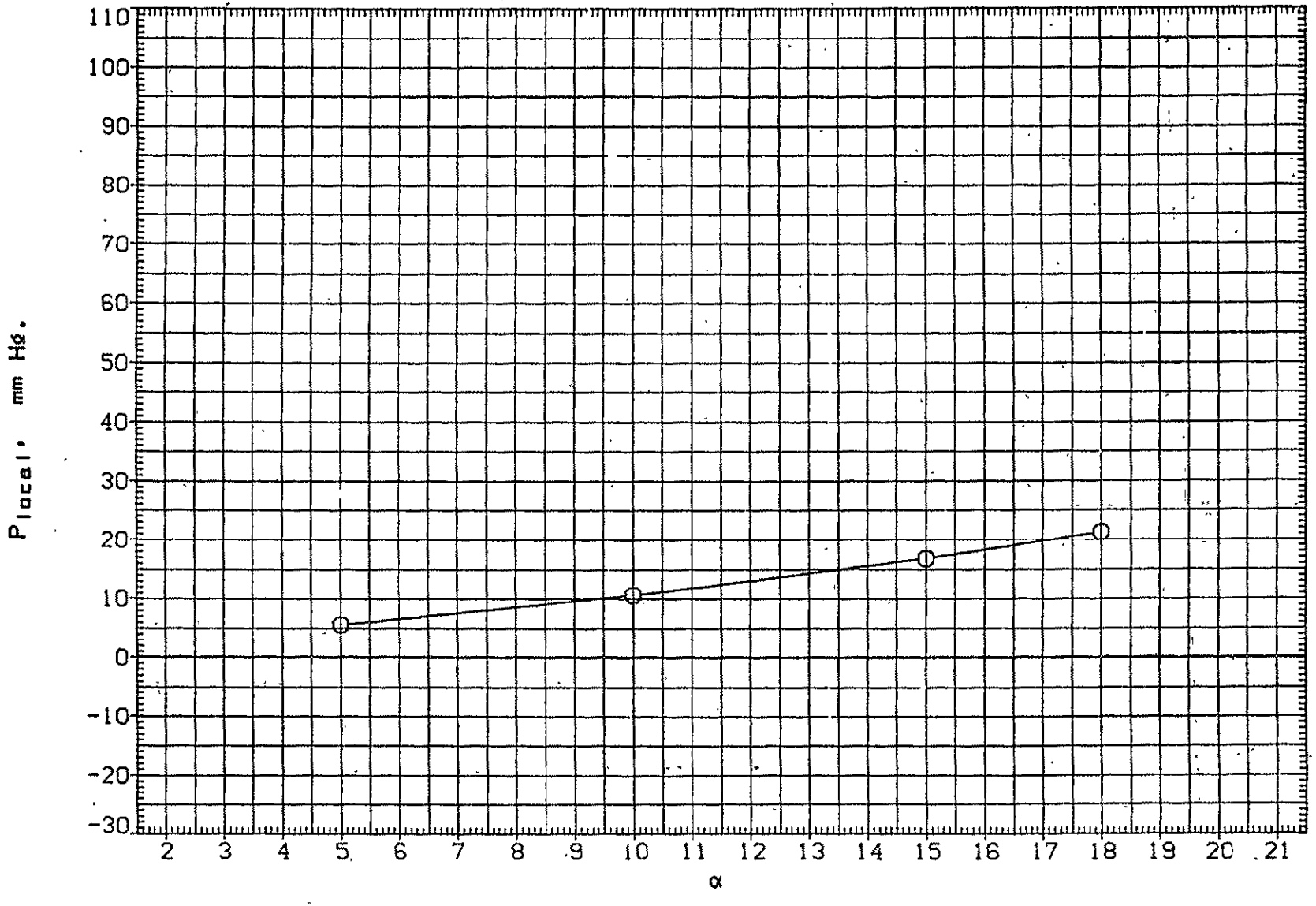


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1041.000	365.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

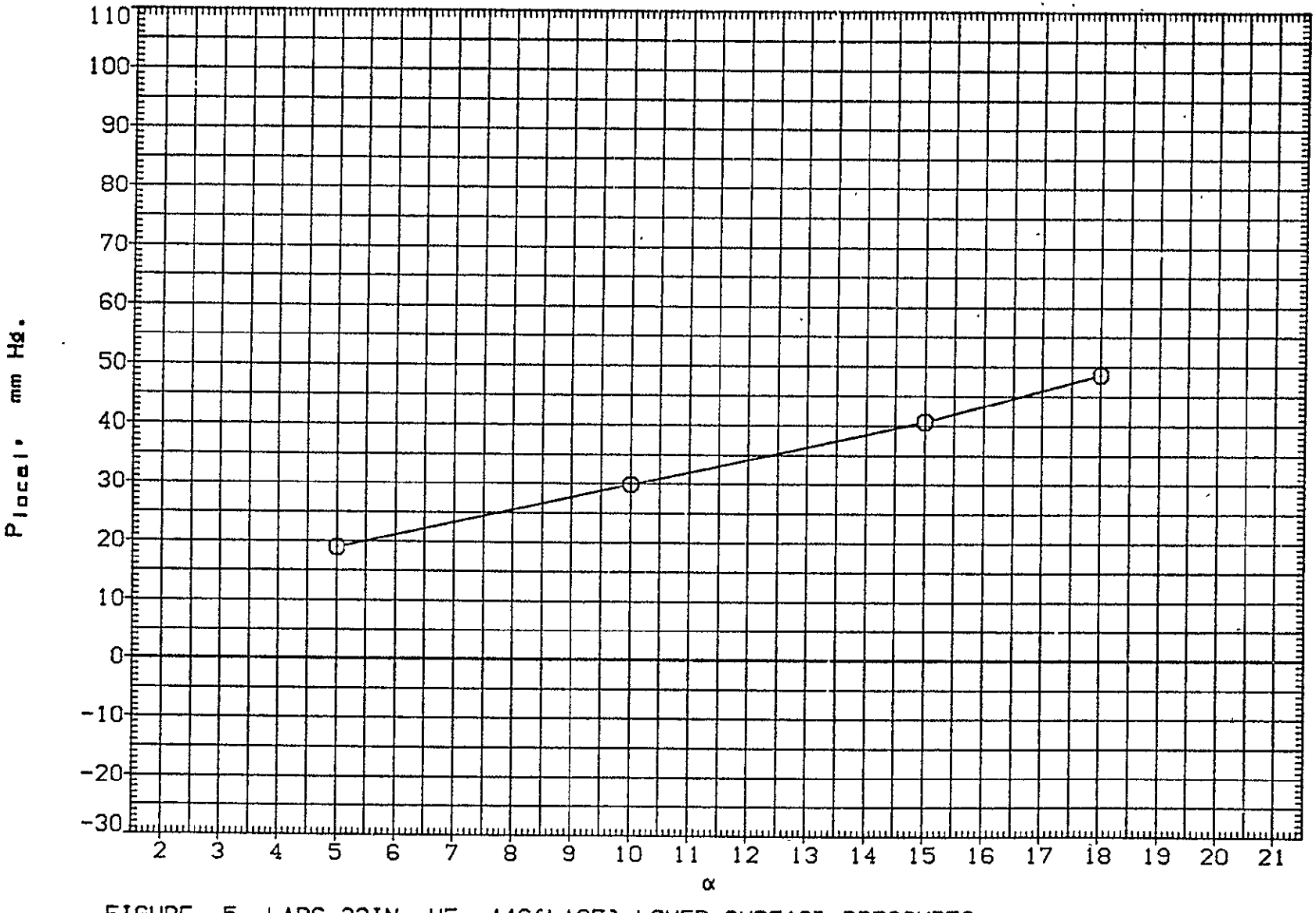


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJ5W01) LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87

SYMBOL	XB	YB	MACH
○	1202.000	411.000	20.300

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

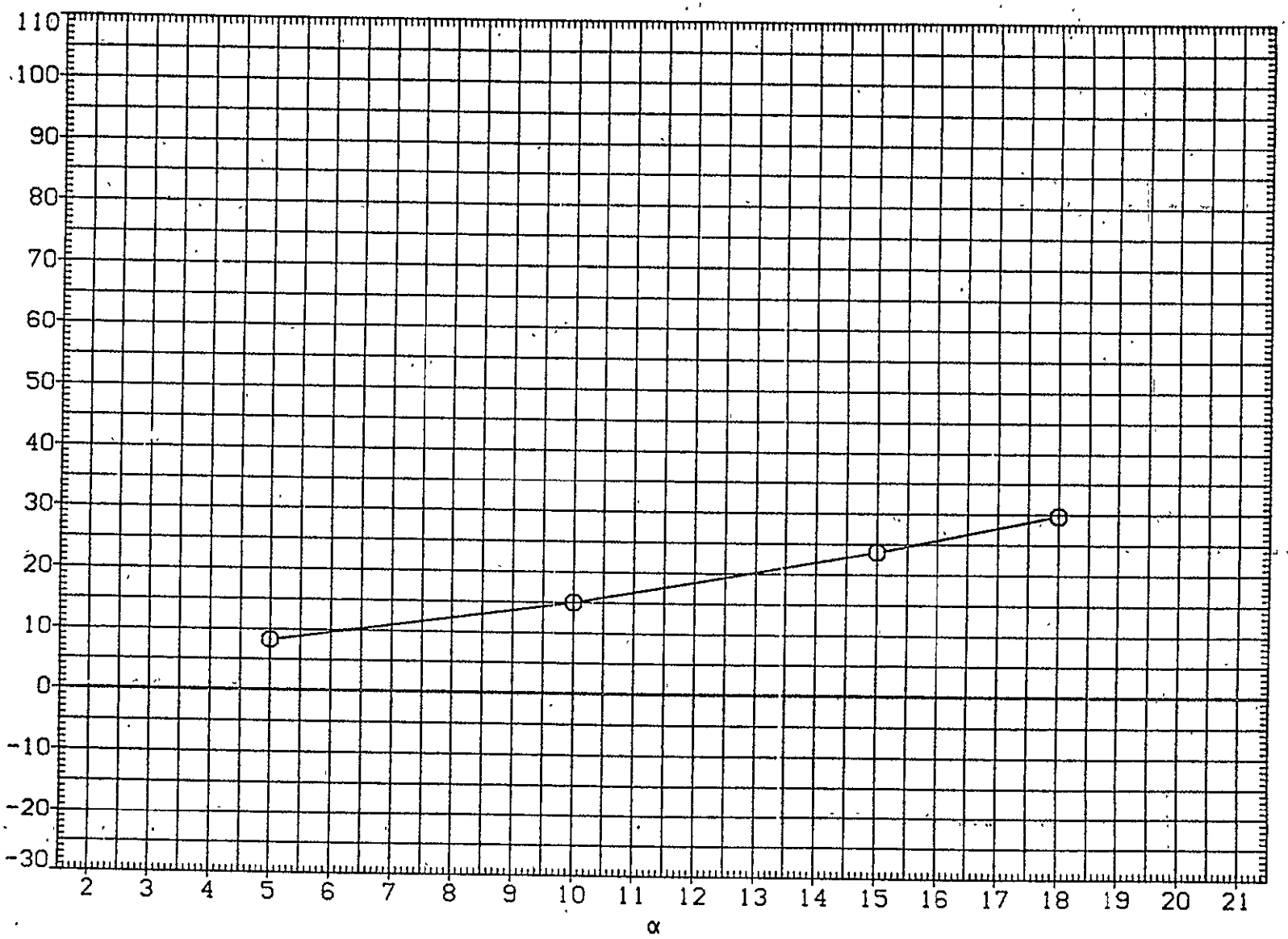


FIGURE 5. LARC 22IN. HE. 446(LA87) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

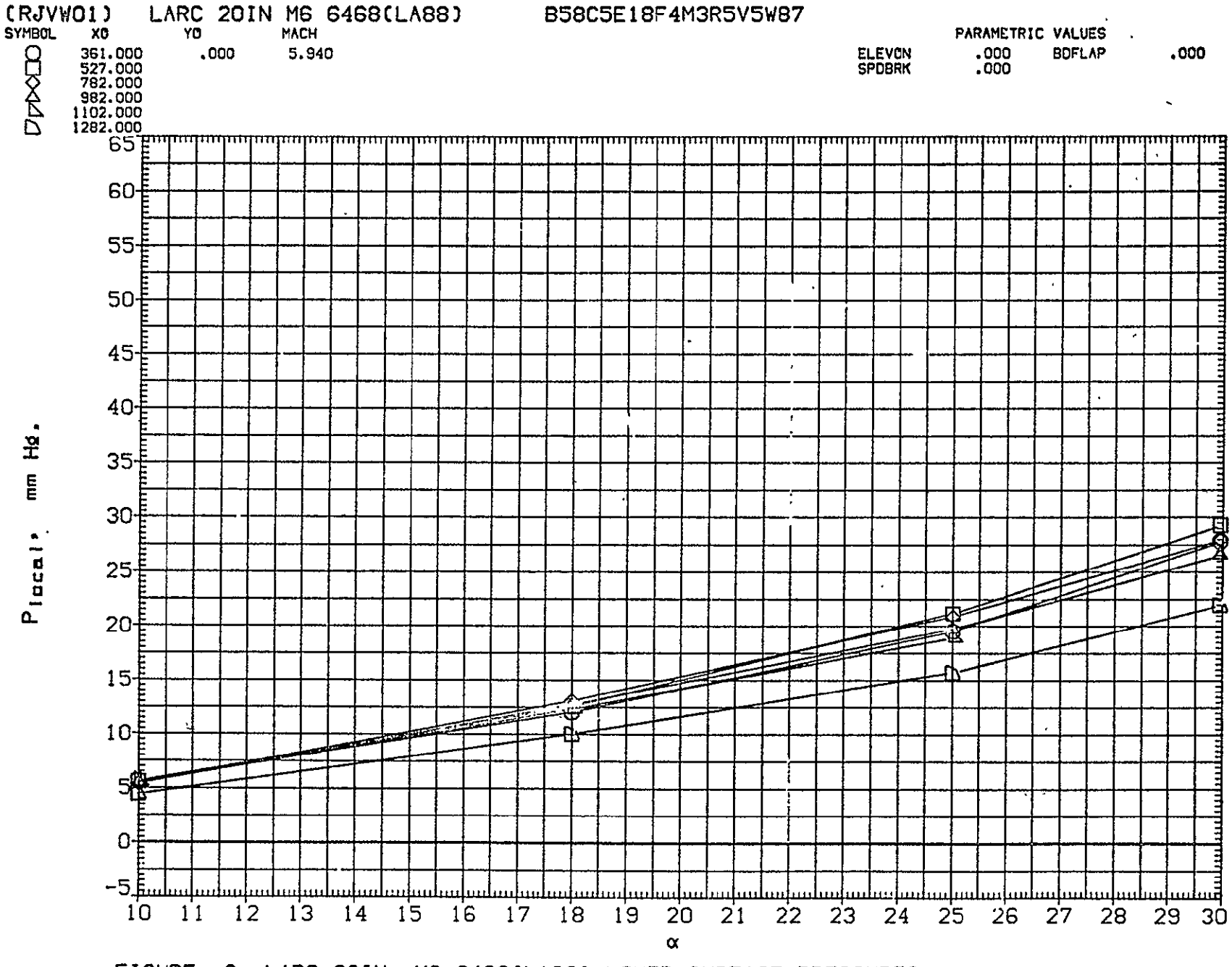


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XC	YC	MACH
○	364.000	93.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

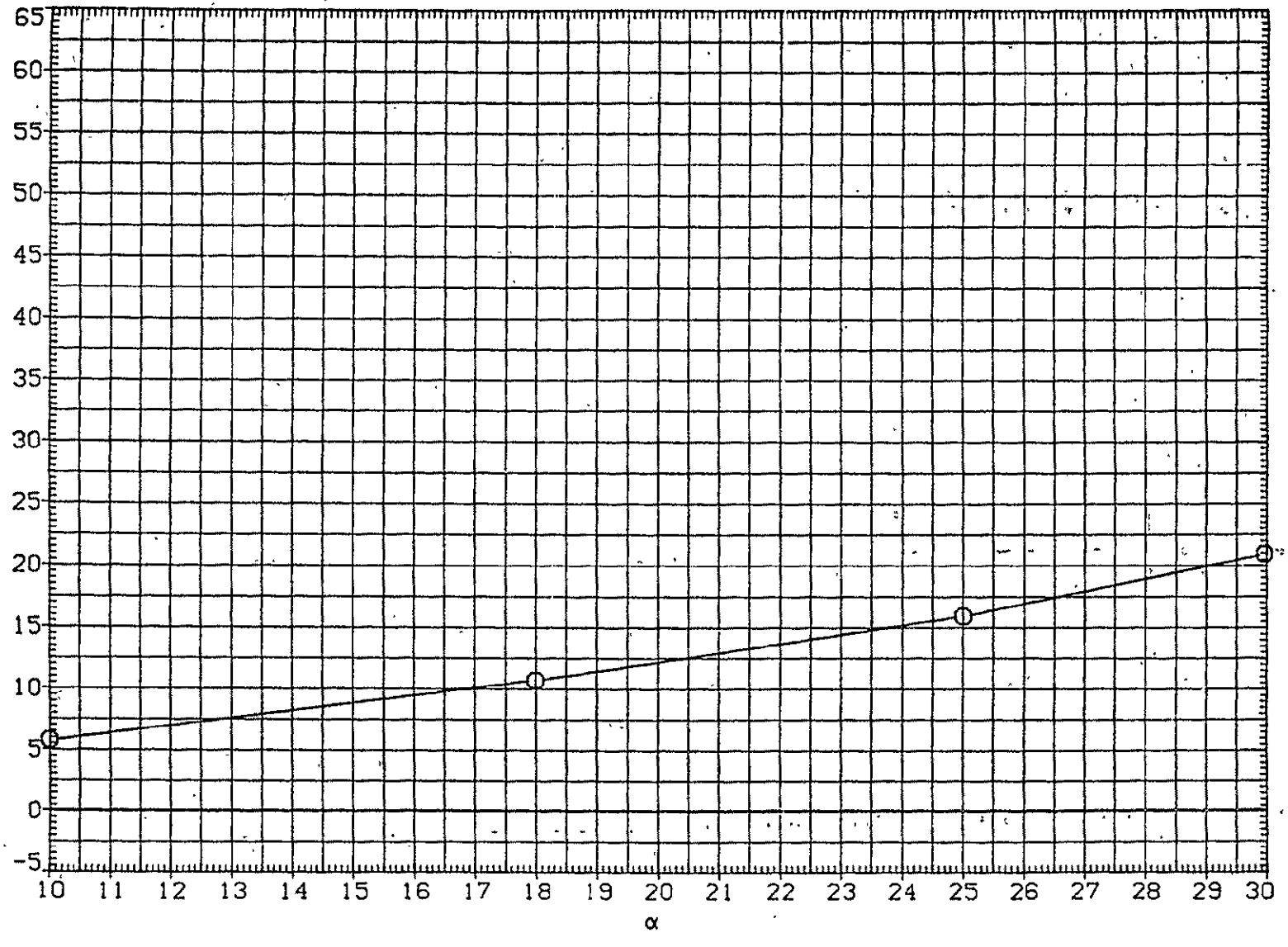


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XØ	YØ	MACH
○	530.000	100.000	5.940

PARAMETRIC VALUES

ELEVØN	.000	BØFLAP	.000
SPØBRK	.000		

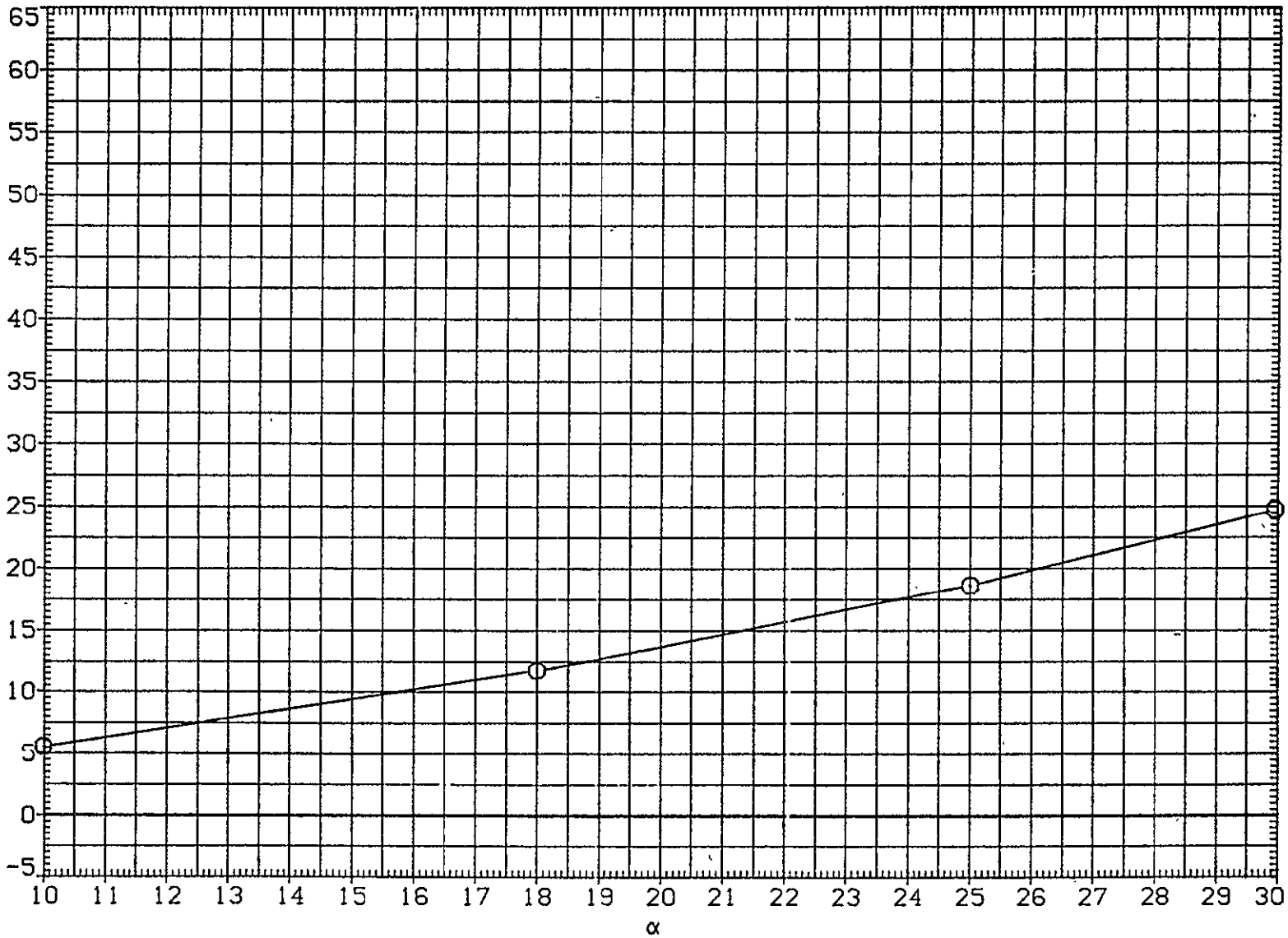


FIGURE 6. LARC 20IN. M6 6468(LA88) LØWER SURFACE PRESSURES
LØCAL PRESSURE ØN LØWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XC	YC	MACH
O	784.000	107.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

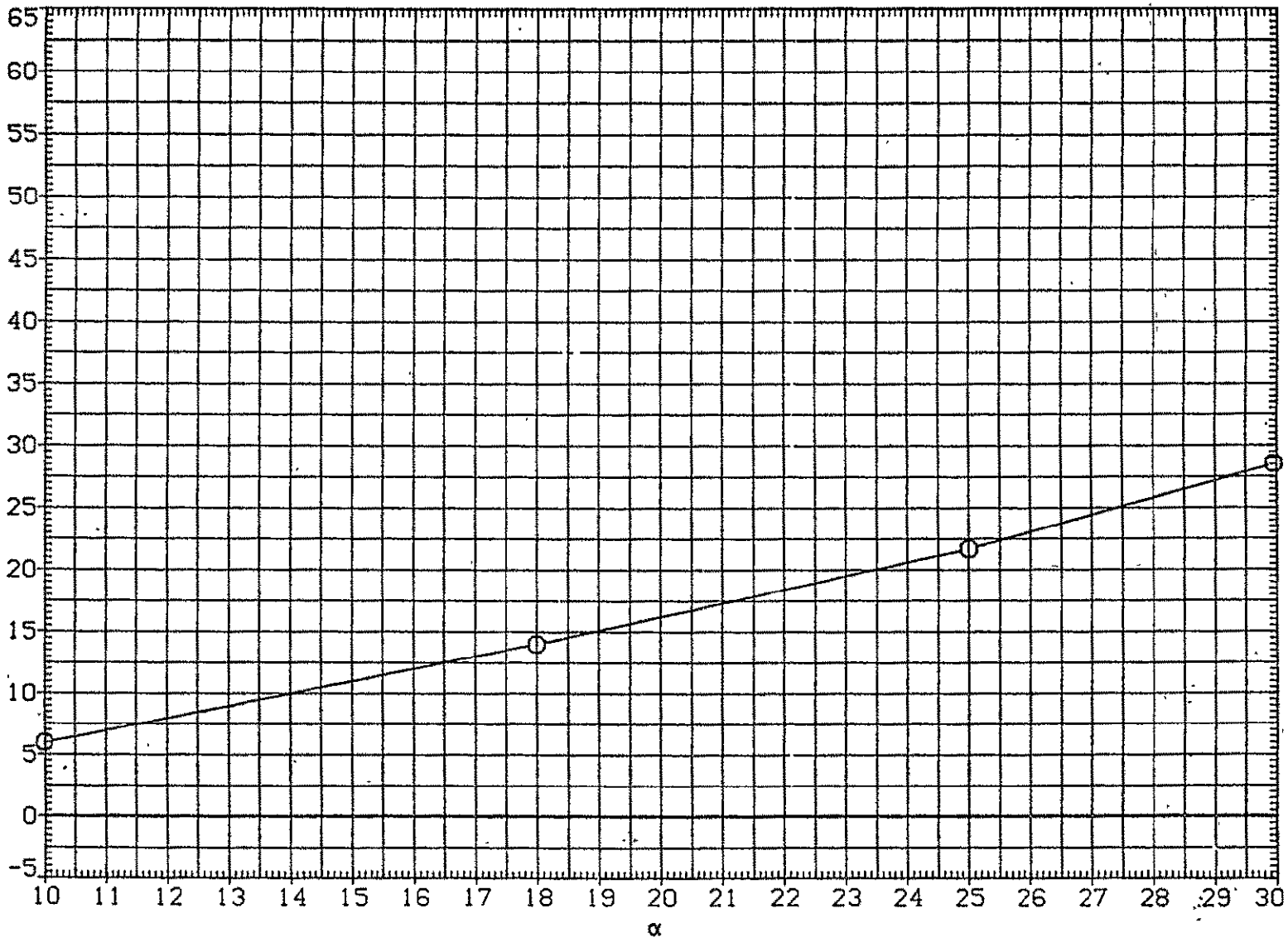


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XØ	YØ	MACH
○	911.000	114.000	5.940
□	1049.000		
◇	1200.000		

PARAMETRIC VALUES

ELEVØN	.000	BDFLAP	.000
SPDBRK	.000		

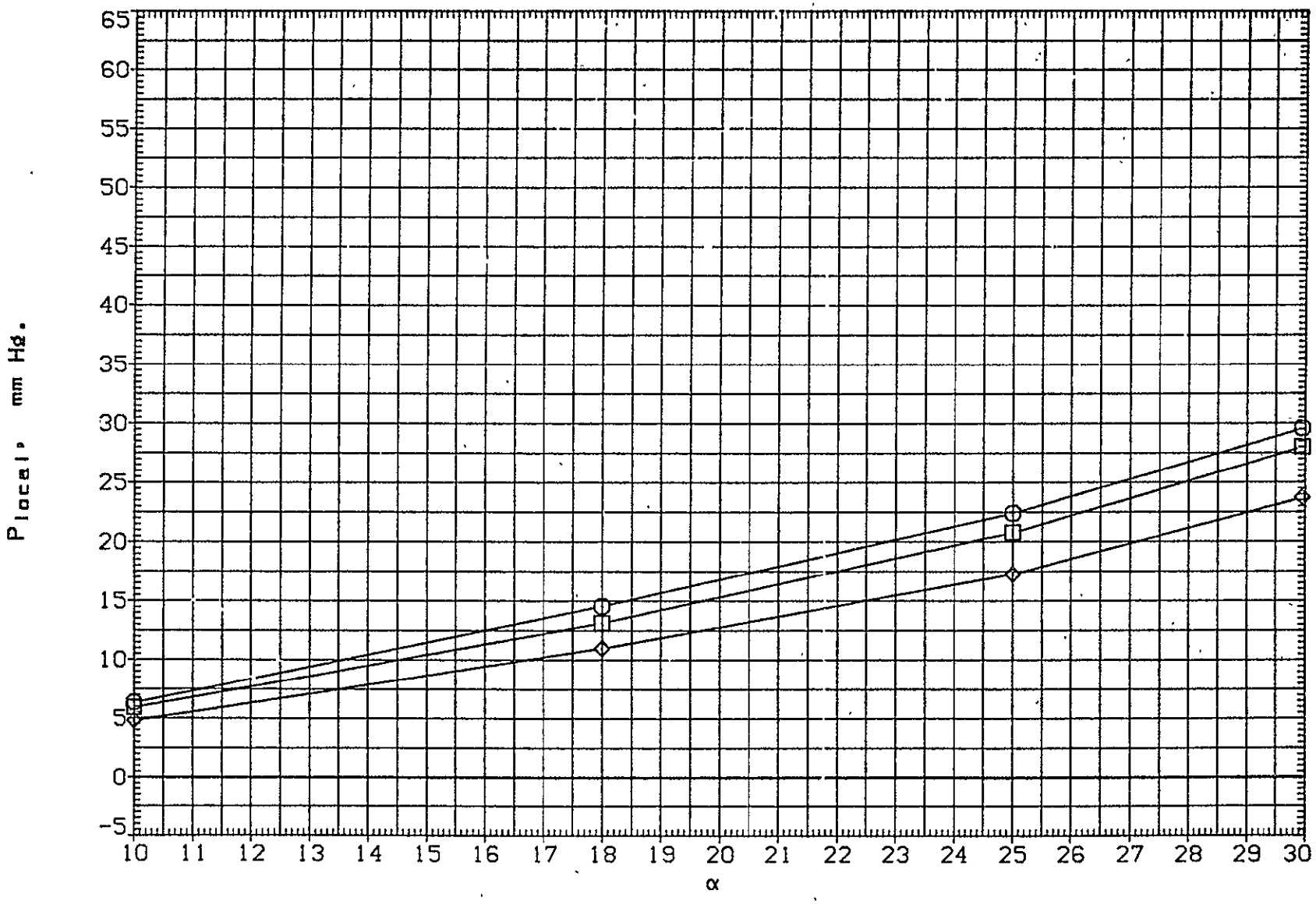


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ØN LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XC	YC	MACH
○	1200.000	202.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

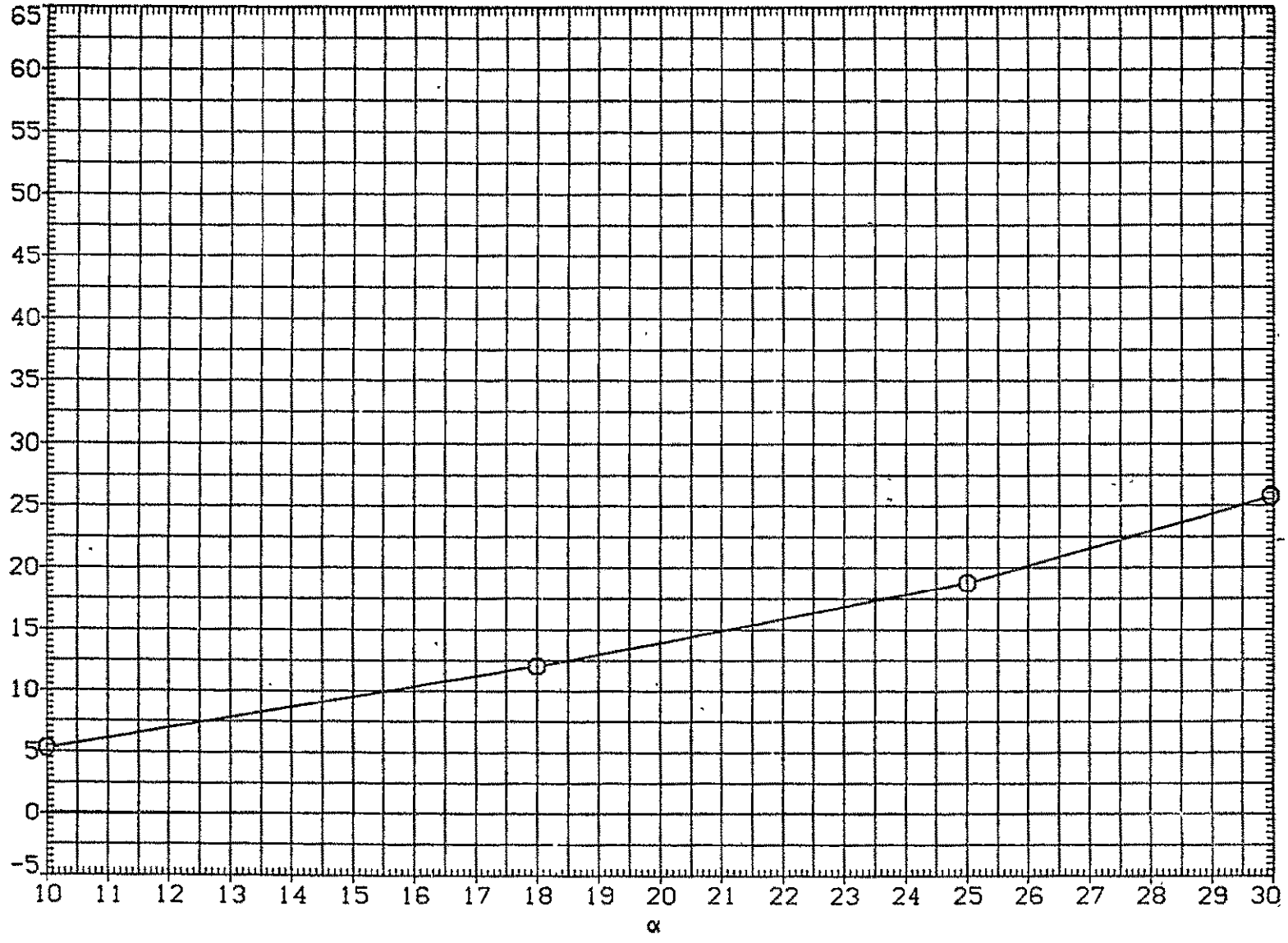


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XØ	YØ	MACH
○	913.000	236.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

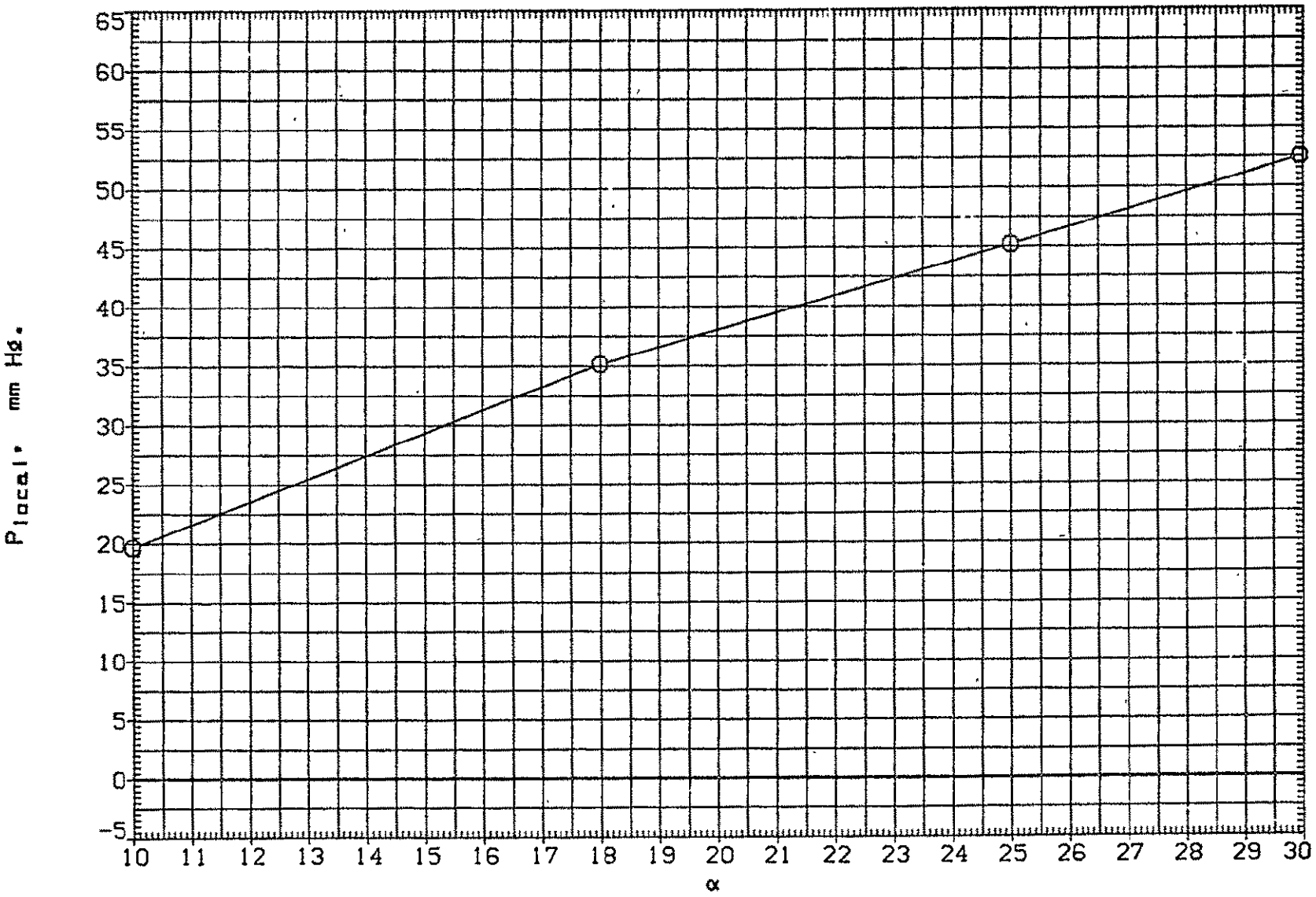


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1046.000	251.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

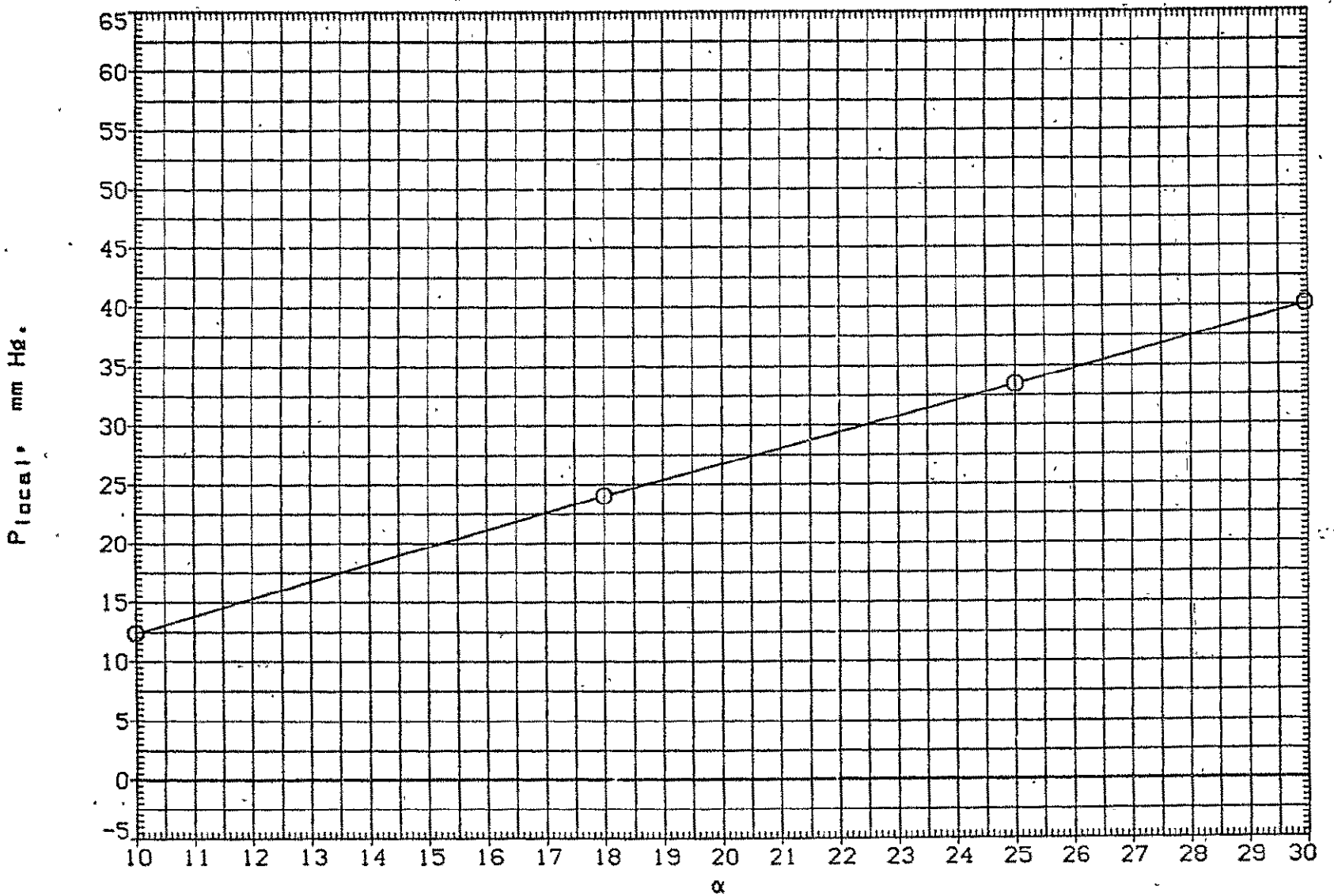


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XC	YC	MACH
○	1200.000	317.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

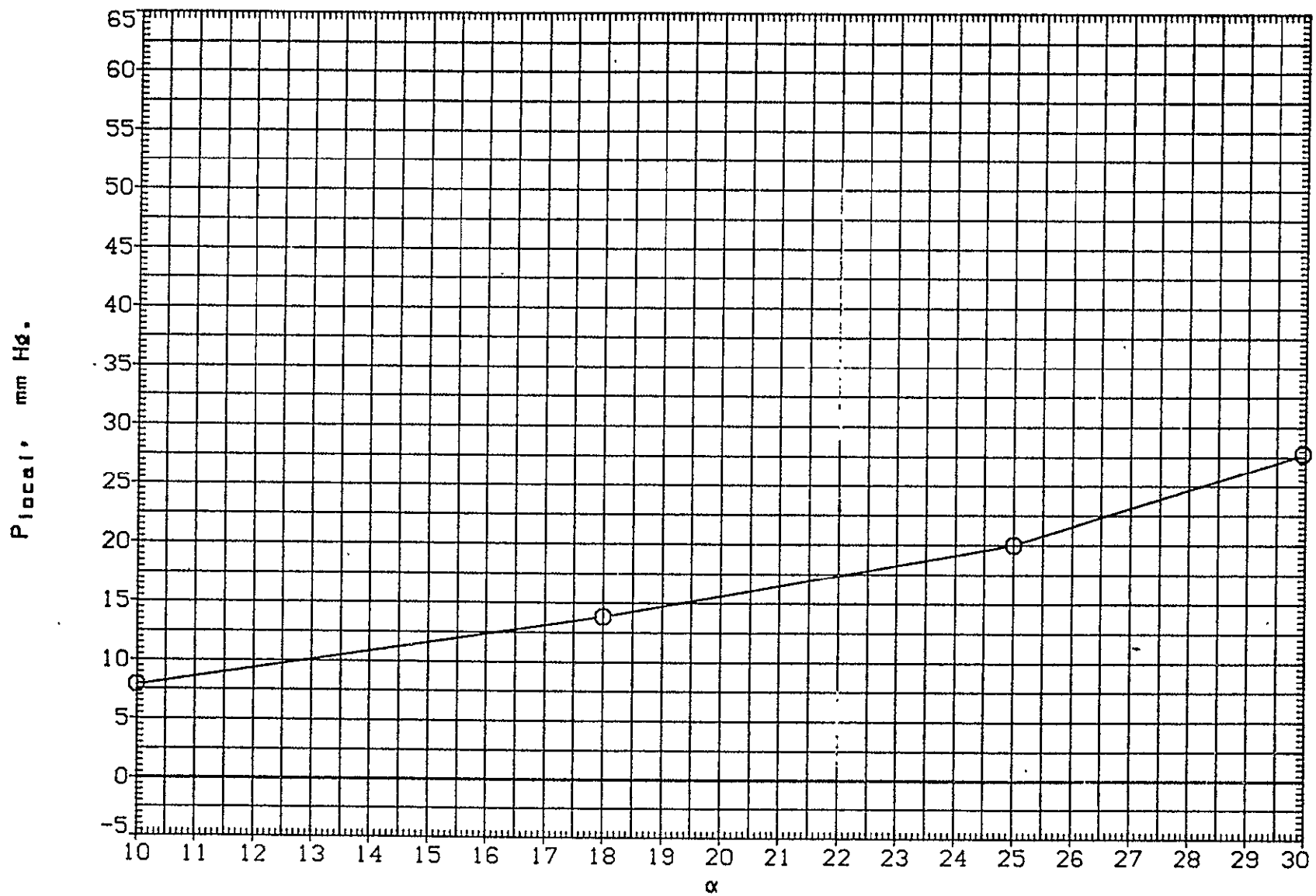


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1041.000	365.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BDFLAP	.000
SPDBRK	.000		

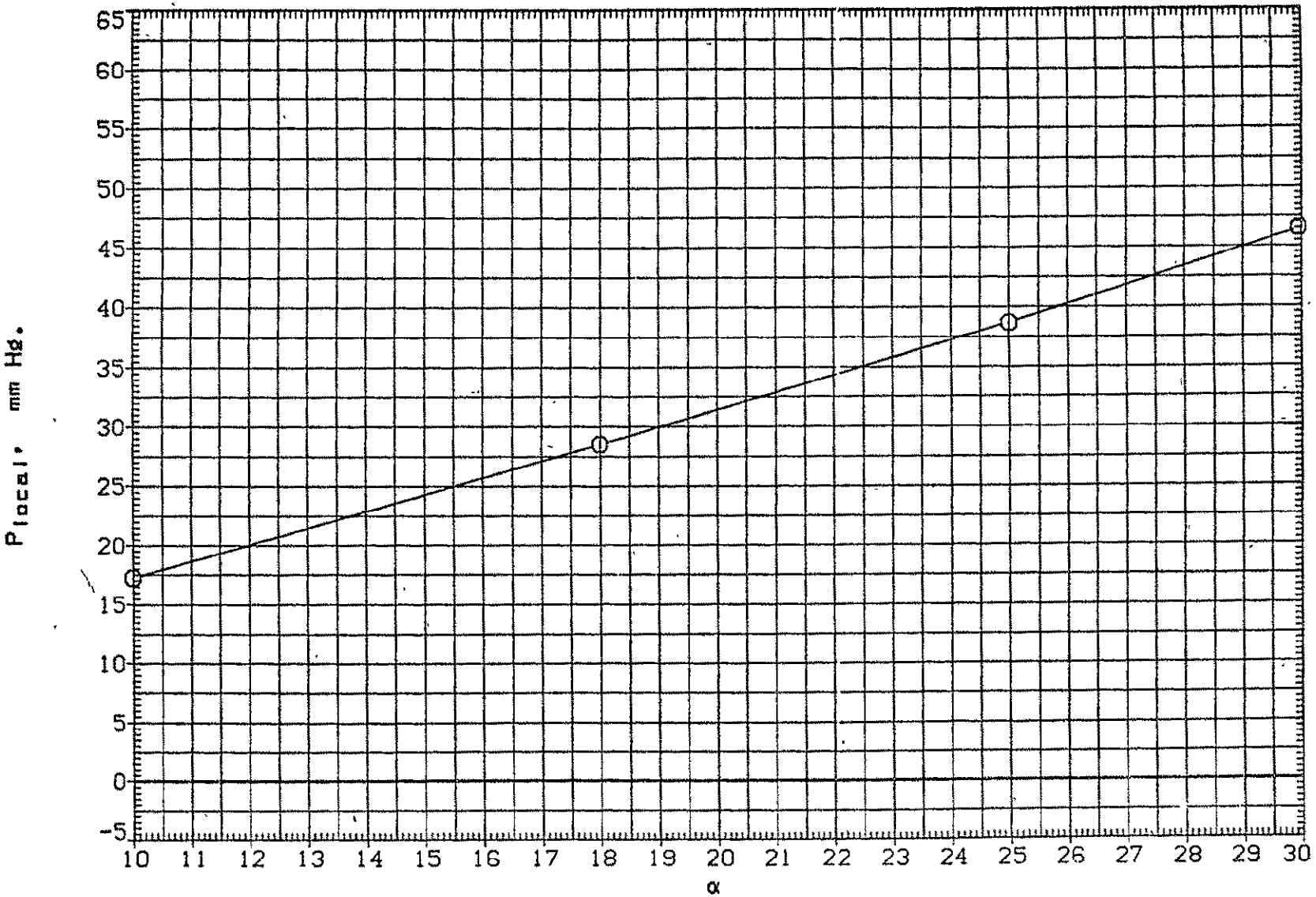


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

(RJVW01) LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87

SYMBOL	XO	YO	MACH
○	1202.000	411.000	5.940

PARAMETRIC VALUES

ELEVON	.000	BOFLAP	.000
SPDBRK	.000		

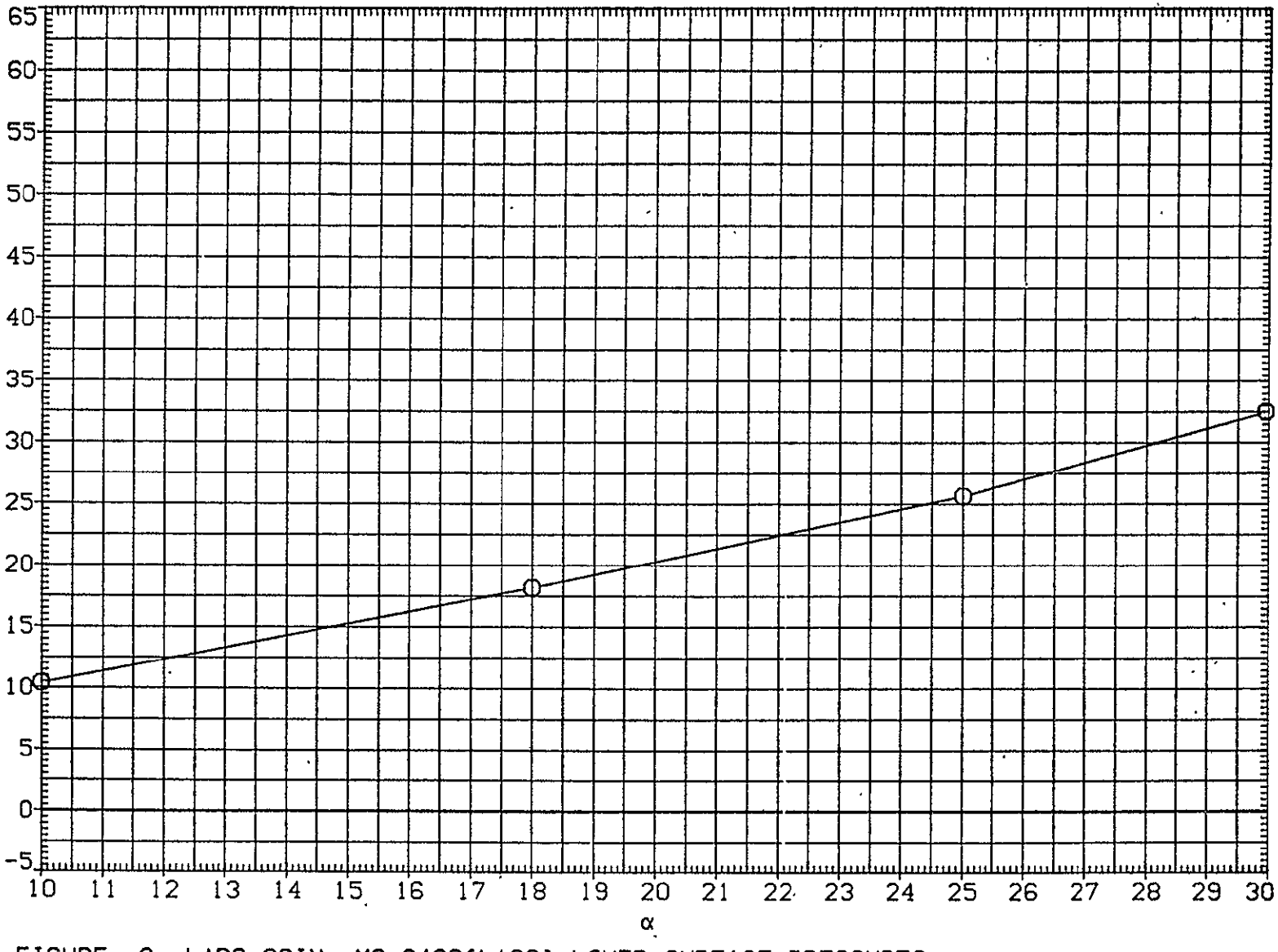


FIGURE 6. LARC 20IN. M6 6468(LA88) LOWER SURFACE PRESSURES
LOCAL PRESSURE ON LOWER WING SURFACE

APPENDIX

TABULATED SOURCE DATA

Tabulations of plotted data are available on request from Data Management Services.

LARC CF4 267/273(LA78) 858C5E18F4M3R5V5W87 (RJLW01) (27 APR 76)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.6800 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0040

PARAMETRIC DATA

ELEVON = .000 BDFLAP = .000
SPDBRK = .000

MACH (1) = 6.040 ALPHA (1) = 10.000 PTOT = 96868. TTOT = 438.52 Q(MMH) = 58.955

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	8.0789										
364.000		8.9332									
527.000	8.3714										
530.000			8.7826								
782.000	8.4024										
784.000				7.7019							
911.000					12.6530						
913.000							28.2400				
982.000	7.9859										
1041.000									18.8480		
1046.000								16.8530			
1049.000					8.4361						
1102.000	8.3811										
1200.000					7.7811	8.4716			10.2050		
1202.000										12.9010	
1282.000	6.0819										

MACH (1) = 6.040 ALPHA (2) = 18.000 PTOT = 96868. TTOT = 438.52 Q(MMH) = 58.955

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	16.8110										
364.000		16.5750									
527.000	18.7900										
530.000			18.3340								
782.000	16.6940										
784.000				16.1370							
911.000					26.1690						
913.000							48.2040				
982.000	17.0280										
1041.000									.0000		
1046.000								27.1180			
1049.000					17.9010						
1102.000	16.7340										
1200.000					18.3350	16.3480			18.5130		

LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87 (RJLW01)

MACH (1) = 6.040 ALPHA (2) = 18.000

SECTION (1)WING DEPENDENT VAR.ABLE PL

YO .0000 93.0000100.0000107.0000114.0000202.0000236.0000251.0000317.0000365.0000411.0000

XO
1202.000
1282.000 11.7360 21.4270

MACH (1) = 6.040 ALPHA (3) = 25.000 PTOT = 96868. TTOT = 438.52 Q(MMH) = 58.955

SECTION (1)WING DEPENDENT VARIABLE PL

YO .0000 93.0000100.0000107.0000114.0000202.0000236.0000251.0000317.0000365.0000411.0000

XO
361.000 28.1750
364.000 .0000
527.000 29.1930
530.000 26.0140
782.000 26.3260
784.000 23.0280
911.000 36.5350
913.000 60.3620
982.000 25.0840
1041.000 44.7660
1046.000 37.1100
1049.000 26.6530
1102.000 24.9600
1200.000 22.1380 23.1060 26.0630
1202.000 .0000
1282.000 16.5050

MACH (1) = 6.040 ALPHA (4) = 30.000 PTOT = 96868. TTOT = 438.52 Q(MMH) = 58.955

SECTION (1)WING DEPENDENT VARIABLE PL

YO .0000 93.0000100.0000107.0000114.0000202.0000236.0000251.0000317.0000365.0000411.0000

XO
361.000 40.1670
364.000 .0000
527.000 37.2020
530.000 32.4930
782.000 36.2290
784.000 31.3800
911.000 9.9990
913.000 72.9080
982.000 34.7610
1041.000 55.3140
1046.000 47.0780

LARC CF4 267/273(LA78) B58C5E18F4M3R5V5W87 (RJLW01)

MACH (1) = 6.040 ALPHA (4) = 30.000

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
1049.000					35.2090						
1102.000	33.0970										
1200.000					35.2420	31.4160			35.0050		
1202.000											37.6410
1282.000	22.8600										

LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87 (RJVW01) (27 APR 76)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.6800 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0040

PARAMETRIC DATA

ELEVON = .000 BDFLAP = .000
SPDBRK = .000

MACH (1) = 5.940 ALPHA (1) = 10.000 PTOT = 2678.5 TTOT = 176.87 Q(MMH) = 44.545

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	5.6602										
364.000		5.7872									
527.000	5.5917										
530.000			5.5693								
782.000	5.4472										
784.000				5.9996							
911.000					6.3425						
913.000						19.6900					
982.000	5.4740										
1041.000									17.2290		
1046.000								12.4010			
1049.000					5.9329						
1102.000	5.4908										
1200.000					4.7944	5.2864			7.9183		
1202.000										10.4290	
1282.000	4.4555										

MACH (1) = 5.940 ALPHA (2) = 18.000 PTOT = 2678.5 TTOT = 176.87 Q(MMH) = 44.545

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	12.0670										
364.000		10.7350									
527.000	12.6010										
530.000			11.7850								
782.000	13.1380										
784.000				14.0540							
911.000					14.5720						
913.000						35.1780					
982.000	12.7920										
1041.000									28.5090		
1046.000								24.0550			
1049.000					13.1430						
1102.000	12.3610										
1200.000					11.0180	12.0350			13.8540		

LARC 20IN M6 6468(LA88) B58C5E18F4M3R5V5W87 (RJVW01)

MACH (1) = 5.940 ALPHA (2) = 18.000

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
1202.000										18.1910	
1282.000	10.0560										

MACH (1) = 5.940 ALPHA (3) = 25.000 PTOT = 2678.5 TTOT = 176.87 Q(MMH) = 44.545

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	19.5370										
364.000		15.9530									
527.000	21.2070										
530.000			18.6700								
782.000	20.9300										
784.000				21.7460							
911.000					22.4250						
913.000						45.2250					
982.000	19.7530										
1041.000									38.6970		
1046.000								33.4580			
1049.000					20.7720						
1102.000	18.9320										
1200.000					17.2630	18.7680			20.0230		
1202.000										25.6780	
1282.000	15.7460										

MACH (1) = 5.940 ALPHA (4) = 30.000 PTOT = 2678.5 TTOT = 176.87 Q(MMH) = 44.545

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	27.8540										
364.000		20.9650									
527.000	29.2990										
530.000			24.7380								
782.000	27.9920										
784.000				28.5730							
911.000					29.5850						
913.000						52.5440					
982.000	26.5890										
1041.000									46.5340		
1046.000								40.1420			

LARC 201N M6 6468(LA88) B58C5E18F4M3R5V5W87 (RJVW01)

MACH (1) = 5.940 ALPHA (4) = 30.000

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
1049.000					28.0290						
1102.000	.0000										
1200.000					23.7470	25.7250		27.7800			
1202.000										32.5450	
1282.000	21.9820										

LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87 (RJ5W01) (27 APR 76)

REFERENCE DATA PARAMETRIC DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO ELEVON = .000 BDFLAP = .000
LREF = 474.8000 INCHES YMRP = .0000 IN. YO SPDBRK = .000
BREF = 936.6800 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0040

MACH (1) = 20.300 ALPHA (1) = 5.000 PTOT = 51598. TTOT = 28.725 Q(MMH) = 81.010

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	4.1104										
364.000		4.2987									
527.000	3.6135										
530.000			3.6034								
782.000	.0000										
784.000				3.4969							
911.000					3.6032						
913.000						18.7360					
982.000	3.4116										
1041.000									18.9960		
1046.000								10.2320			
1049.000					3.3989						
1102.000	3.2757										
1200.000					3.0627	3.1373			5.6288		
1202.000										8.3321	
1282.000	2.8504										

MACH (1) = 20.300 ALPHA (2) = 10.000 PTOT = 51598. TTOT = 28.725 Q(MMH) = 81.010

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	6.7102										
364.000		6.7650									
527.000	6.1979										
530.000			5.9933								
782.000	.0000										
784.000				6.7221							
911.000					7.5815						
913.000						39.4650					
982.000	6.9740										
1041.000									29.8720		
1046.000								21.9780			
1049.000					7.0116						
1102.000	6.7452										
1200.000					5.6711	7.1529			10.7120		

LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87 (RJ5W01)

MACH (1) = 20.300 ALPHA (2) = 10.000

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
1202.000											
1282.000	5.4312										15.0540

MACH (1) = 20.300 ALPHA (3) = 15.000 PTOT = 51598. TTOT = 28.725 Q(MMH) = 81.010

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	12.7310										
364.000		11.2270									
527.000	12.3610										
530.000			11.6390								
782.000	16.9310										
784.000				14.6000							
911.000					16.8990						
913.000							67.9810				
982.000	15.4170										
1041.000										40.6540	
1046.000								30.3810			
1049.000					15.5440						
1102.000	14.7980										
1200.000					12.1380	14.5750			16.8330		
1202.000										23.7710	
1282.000	11.4290										

MACH (1) = 20.300 ALPHA (4) = 18.000 PTOT = 51598. TTOT = 28.725 Q(MMH) = 81.010

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
361.000	16.6780										
364.000		14.0660									
527.000	17.2740										
530.000			15.6720								
782.000	22.7600										
784.000				20.4120							
911.000					22.5930						
913.000							73.6050				
982.000	20.3350										
1041.000										48.6530	
1046.000								35.7930			

LARC 22IN HELIUM 446(LA87) B58C5E18F4M3R5V5W87 (RJ5W01)

MACH (1) = 20.300 ALPHA (4) = 18.000

SECTION (1)WING DEPENDENT VARIABLE PL

YO	.0000	93.0000	100.0000	107.0000	114.0000	202.0000	236.0000	251.0000	317.0000	365.0000	411.0000
XO											
1049.000					20.6080						
1102.000	19.2970										
1200.000					16.0460	18.6080			21.3000		
1202.000										29.8100	
1282.000	14.8220										

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SPACE SHUTTLE

AEROTHERMODYNAMIC DATA REPORT

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