APPENDIX II

AIRSPEED SYSTEM TESTS

LP-15, N-1, N6LS

725 Pounds at 34% m.a.c.

Figure 1 of this Appendix shows the location of a series of paired static orifices which were installed in the nose and one pair in the tail cone during construction of the sailplane so they could be used during initial flight tests to determine the best static source for later production sailplanes. The total pressure source used for most of the tests was a stub tube projecting from the front of the fuselage nose as shown in Figure 1. Also shown is the location of the T.E. Venturi on top of the fuselage, 51 inches aft of the wing trailing edge. The basic system used for early testing was with the airspeed indicator connected to the nose total pressure and the paired statics on the tail cone.

This tail cone static airspeed system was carefully calibrated in flight by comparison with a test swivel head system mounted on the left wing as shown in Figure 2. The zero error of the test boom system had been verified (Figure 3) with the test boom system mounted on another sailplane which had an extensively calibrated system from other tests. The airspeed position error for the tail cone statics on the Nugget as determined from comparisons with the test boom system mounted on the left wing is shown in Figure 4. This was later cross checked in side-by-side pacer runs with the calibrated T-6; these points are also shown in Figure 4 and are in good agreement with the test boom points. The system error for the tail cone statics is acceptable for a production system but does show a 1 knot error at speeds up to 70-80 knots with the error increasing to 2 knots at 100 knots. This system was used as a reference to calibrate the nose static systems in a search for a system with even less error and one which would not require running static lines back to the tail cone.

Calibrations to determine the position errors for each of the five paired static orifices in the nose were made in this manner using the position error in Figure 4 as a reference system and, of course, correcting all readings for instrument errors. The instrument calibration for one of the test airspeed indicators is plotted in Figure 5 to illustrate the carefull calibrations and consistent readings obtainable with these test instruments. All pressure lines were leak-tight and dynamically balanced for lag and leak checks were made before each flight. Airspeed system position errors determined for each of the nose static systems are plotted in Figures 6 and 7 and summarized in Figure 8. The position error curves shift in a logical fashion with change in nose static location and the holes 15" and 17"

aft of the nose showing less than 1 knot error at all speeds except right at the stall where the system makes the airspeed readings about 1 knot low. The holes 15" aft of the nose were selected as the test system for the remainder of the N-1 test program.

Calibrations of all systems showed a greater sensitivity to yaw than was considered normal for systems of this type. Tests using a shielded total pressure head (good for $\pm 30^{\circ}$) as a reference showed that the problem was caused by the stub total pressure pick up on the nose which showed 100% total pressure recovery at low side slip angles but dropped in pressure sooner than normal as side slip was increased. At the same time it was necessary to find a good source of air for cockpit ventilation. The nose was modified by installing a 1.9 inch inside diameter duct and the total pressure pick up was submerged in this duct as shown in the sketch on Figure 9. Tests with the shielded total pressure pick as a reference for the new installation showed that the yaw sensitivity was greatly reduced. The final airspeed system selected for the N-1 Nugget tests was with the airspeed indicator connected to the new nose total pressure pick up and to the S-15 nose static sources. This system was recalibrated using the tail cone system as a reference and also flight checked later in the program with flights over a ground speed course. The final position error curve is plotted in Figure 9 and again the error is less than 1 knot at all speeds; the slight difference in values from those shown for the earlier S-15 system are less than 1/2 knot and within the test accuracy. It appears that later production systems might be even better if located at S-17.

There is little change in position error with different flap settings, 75° down flap only shifted the curve by about 1/2 knot.

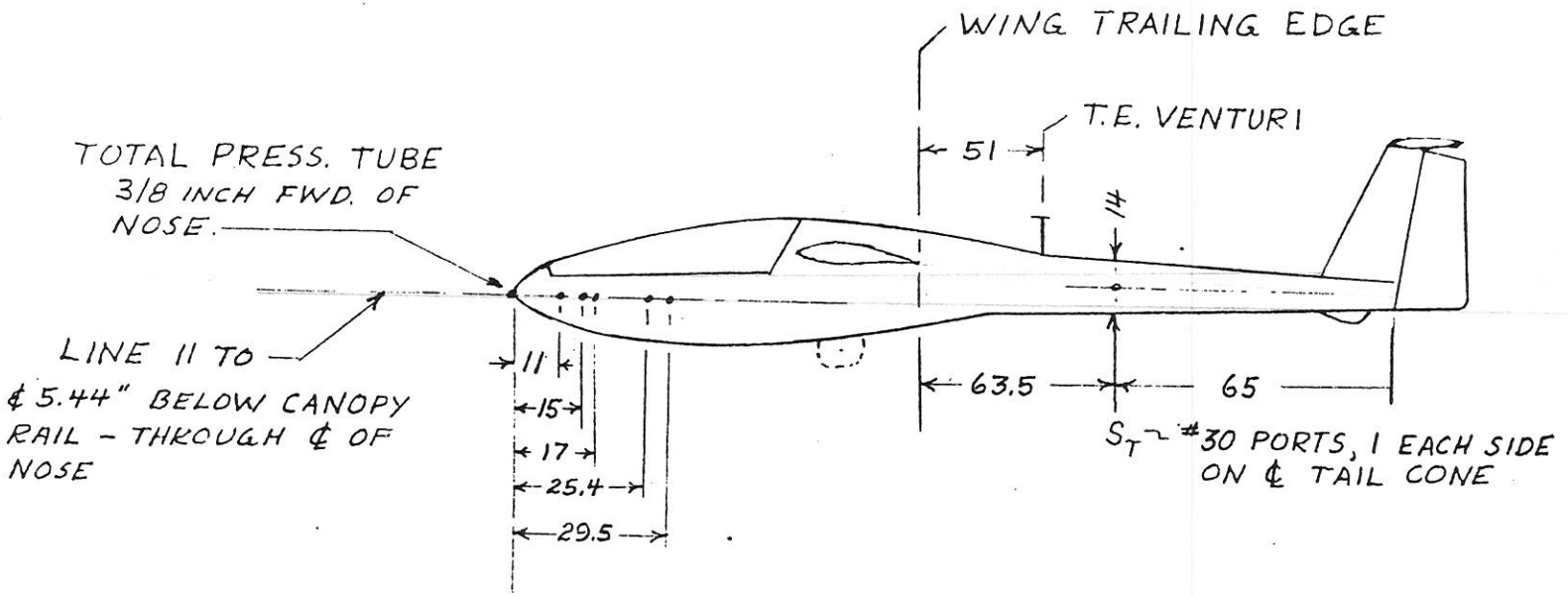


FIG. 1

ANGLE OF TANGENT AT ORIFICE TO FUSELAGE ℄ ~ (#40 HOLES)

S-11	16.4°
S-15	14.4°
S-17	13.2°
S-25.4	10.1°
S-29.4	9.0°

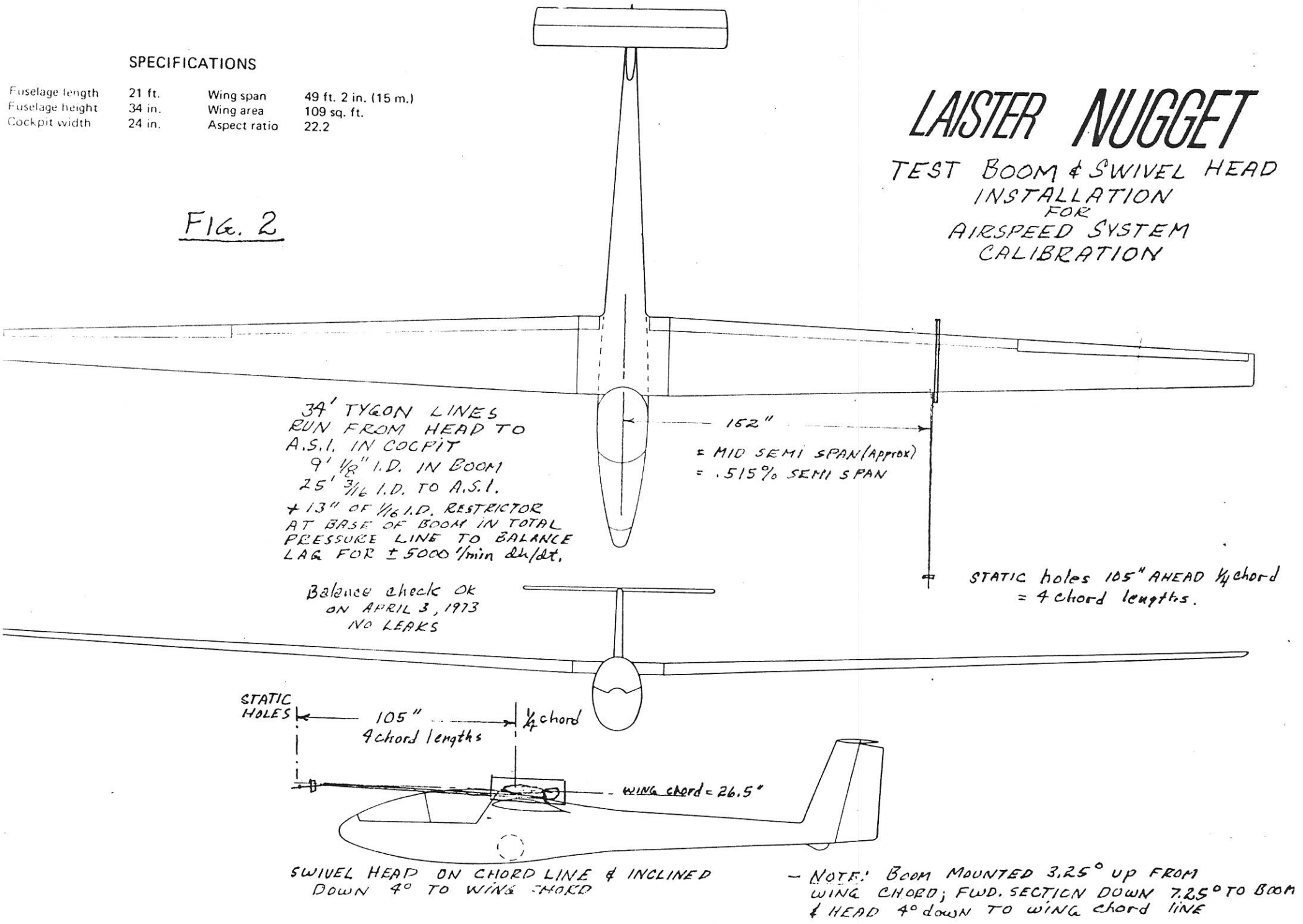
SPECIFICATIONS

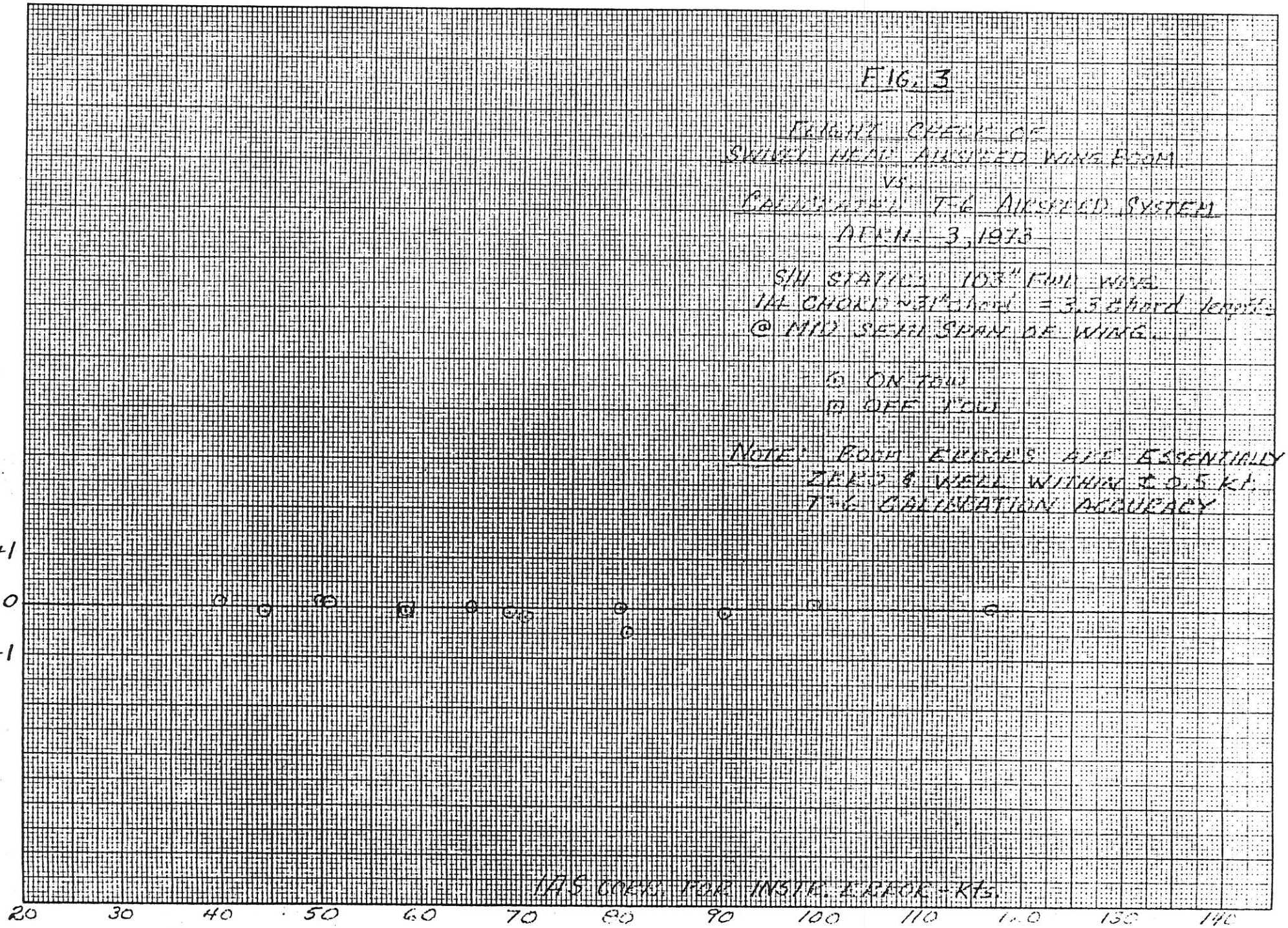
Fuselage length	21 ft.	Wing span	49 ft. 2 in. (15 m.)
Fuselage height	34 in.	Wing area	109 sq. ft.
Cockpit width	24 in.	Aspect ratio	22.2

FIG. 2

LAISTER NUGGET

TEST BOOM & SWIVEL HEAD INSTALLATION FOR AIRSPEED SYSTEM CALIBRATION





FLIGHT CHECK OF
SWEPT WING AIRSPEED FROM
VS.
CALIBRATED T-6 AIRSPEED SYSTEM
APR. 3, 1973

S/N STA. 103" (RW) WING
1/4 CHORD ~31° SWEEP = 3.5 chord length
@ MID SEMI SPAN OF WING

⊙ ON TAIL
⊡ OFF TAIL

NOTE: BOTH ERRORS ARE ESSENTIALLY
ZERO & WELL WITHIN ± 0.5 KT.
T-6 CALIBRATION ACCURACY

FIG. 4

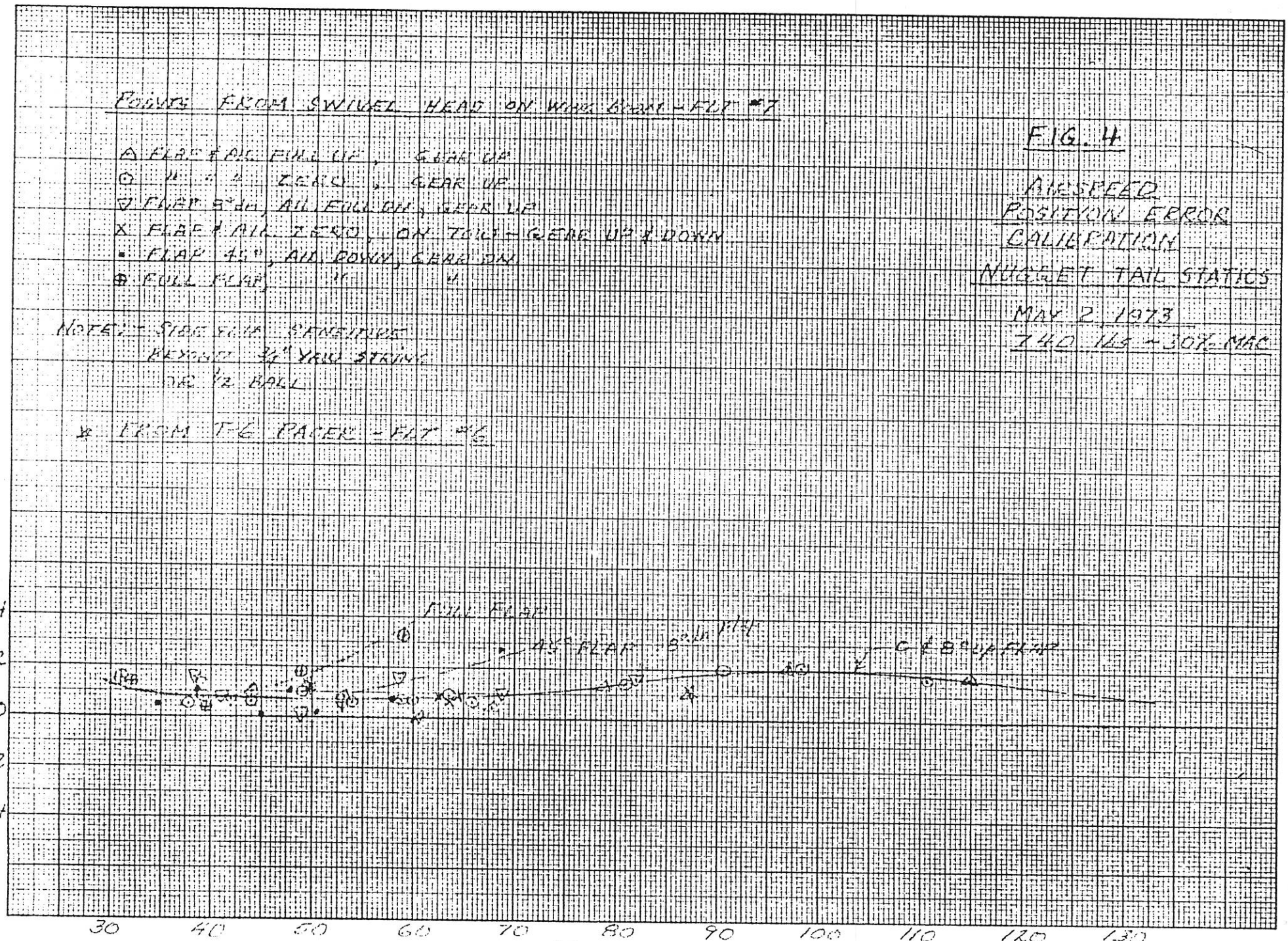
AIRSPEED POSITION ERROR CALIBRATION
NUGGET TAIL STATICS
MAY 2, 1973
7.40 KG +30% MAC

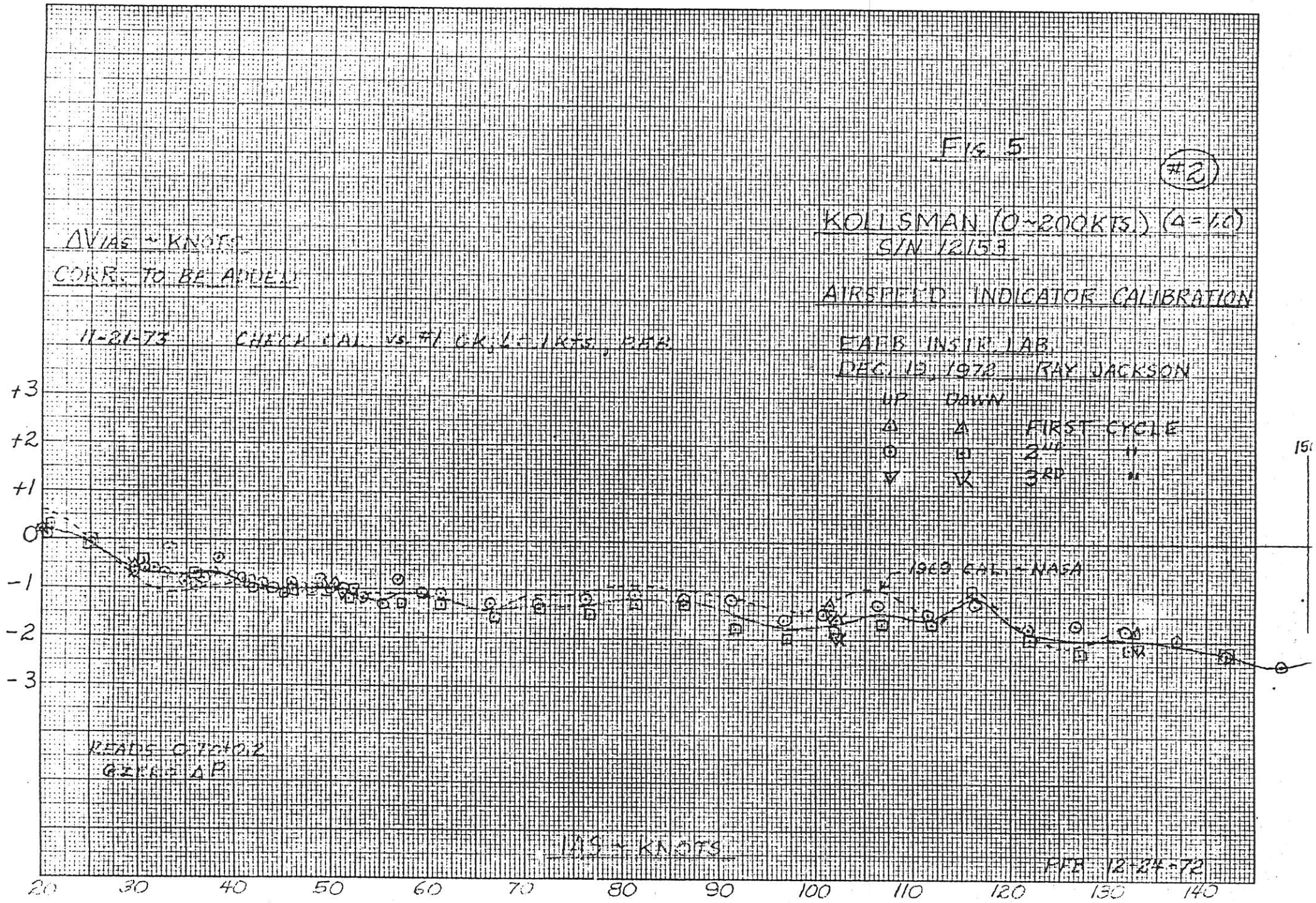
POINTS FROM SWIVEL HEAD ON WING STRUT - FLT #7

△ FLAPS FULL UP, GEAR UP
⊙ " " ZERO " GEAR UP
▽ FLAPS 5°, AIL FOLLOW ON, GEAR UP
X FLAPS AIL ZERO, ON TAIL - GEAR UP & DOWN
▪ FLAP 45°, AIL DOWN, GEAR DOWN
⊕ FULL FLAP " "

NOTE: SIDE SLIP CALIBRATION
REVEALED ½° YAW STRING
OR ½ BALL

* FROM T-6 PACER - FLT #6





LP-15 NO. 1
GROSS WT = 7241bs
C.G. @ 30.5 to 34% MAC

FIG 6
AIRSPEED SYSTEM
STATIC ORIFICE SURVEY

⊙ ~ 0° FLAP, 2° UP AILERON
△ ~ 6.1 UP FLAP, 2° UP AILERON
▽ ~ 35° DN. FLAP, 2° UP AILERON
◇ ~ 60° DN. FLAP, 0° AILERON
(☼, ☆) ~ CALIBRATED ON TOM

NOTE:- POSITION ERROR CORRECTION, ΔV_{PE}, FROM REF. TO CALIBRATED TAIL CONE SYSTEM @ (-) POINTS FROM T-6 PACER.

(S-11)
P_T, 3/8" TUBE ON NOSE
P_S, STATIC HOLES 11" AFT NOSE

(S-25.4)
3/8" P_T TUBE
P_S, 25.4" AFT NOSE

(S-29.5)
P_T, 3/8" TUBE ON NOSE
P_S, STATIC HOLES 29.5" AFT NOSE

ΔV_{PE} ~ KTS.
CORR. TO BE ADDED

+2, 0, -2, -4, -6, -8

60°6f
35°δf
δf = 6.1° UP
δf = 0°
60°
34°
δf = 0°

30 40 50 60 70 80 90 100 110 120 130
I.A.S. CORR. FOR INST ERROR ~ KNOTS

PFP ~ 6-2-73

FIG. 7

AIRSPEED SYSTEM STATIC ORIFICE SURVEY

P_T ~ 3/8" TUBE ON NOSE

LP-15 NO. 1

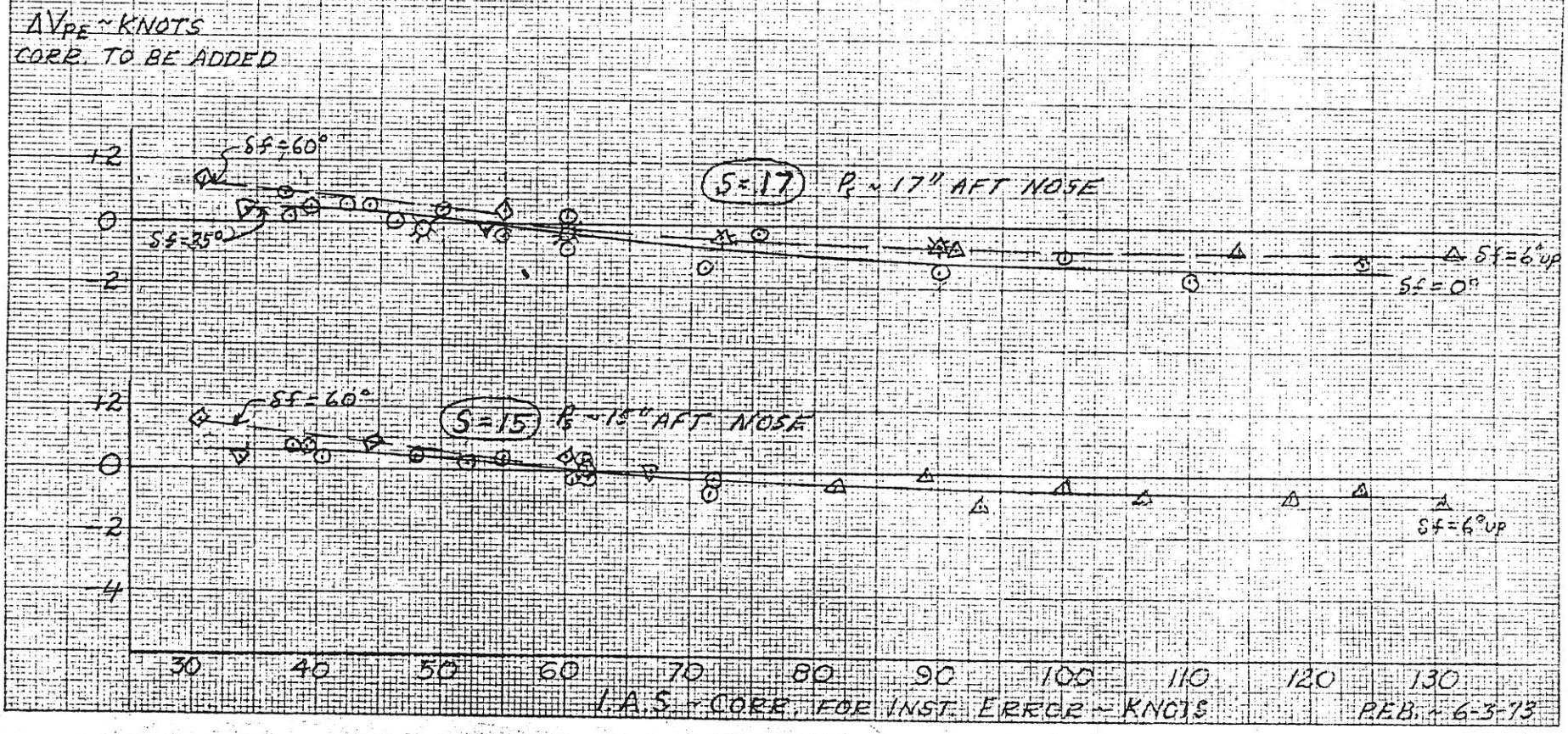
GROSS WEIGHT = 721 lbs.

C.G. = 34% M.A.C.

○ ~ 0° FLAP, 2° up aileron
△ ~ 6.1° UP FLAP, 2° up aileron
▽ ~ 35° dn Flap, 2° up aileron
◇ ~ 60° dn Flap, 0° aileron

(☼, ☆) ~ POINTS ON TOW

NOTE:- CALIBRATION VS REF. TO TAIL CONE STATIC SYSTEM

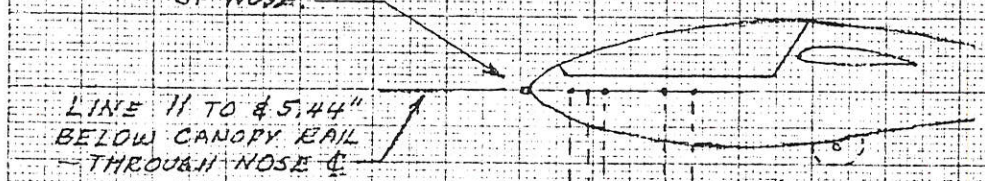


REB. - 6-3-73

FIG. 8
LP-15 NO. 1

SUMMARY OF AIRSPEED SYSTEM STATIC ORIFICE SURVEY

GROSS WEIGHT = 724 lbs
C.G. ≈ 30.5 TO 34% mac



29.5" AFT NOSE, S-29.5, ∠ OF NOSE SURFACE TO FUS. ℄ = 9.0°
25.4" AFT NOSE, S-25.4, ∠ " " " " " " = 10.1°
17" AFT NOSE, S-17, ∠ = 13.2°
15" AFT NOSE, S-15, ∠ = 14.4°
11" AFT NOSE, S-11, ∠ = 16.4°

NOTE: 2 STATIC ORIFICES, ONE EACH SIDE, AT EACH STATION

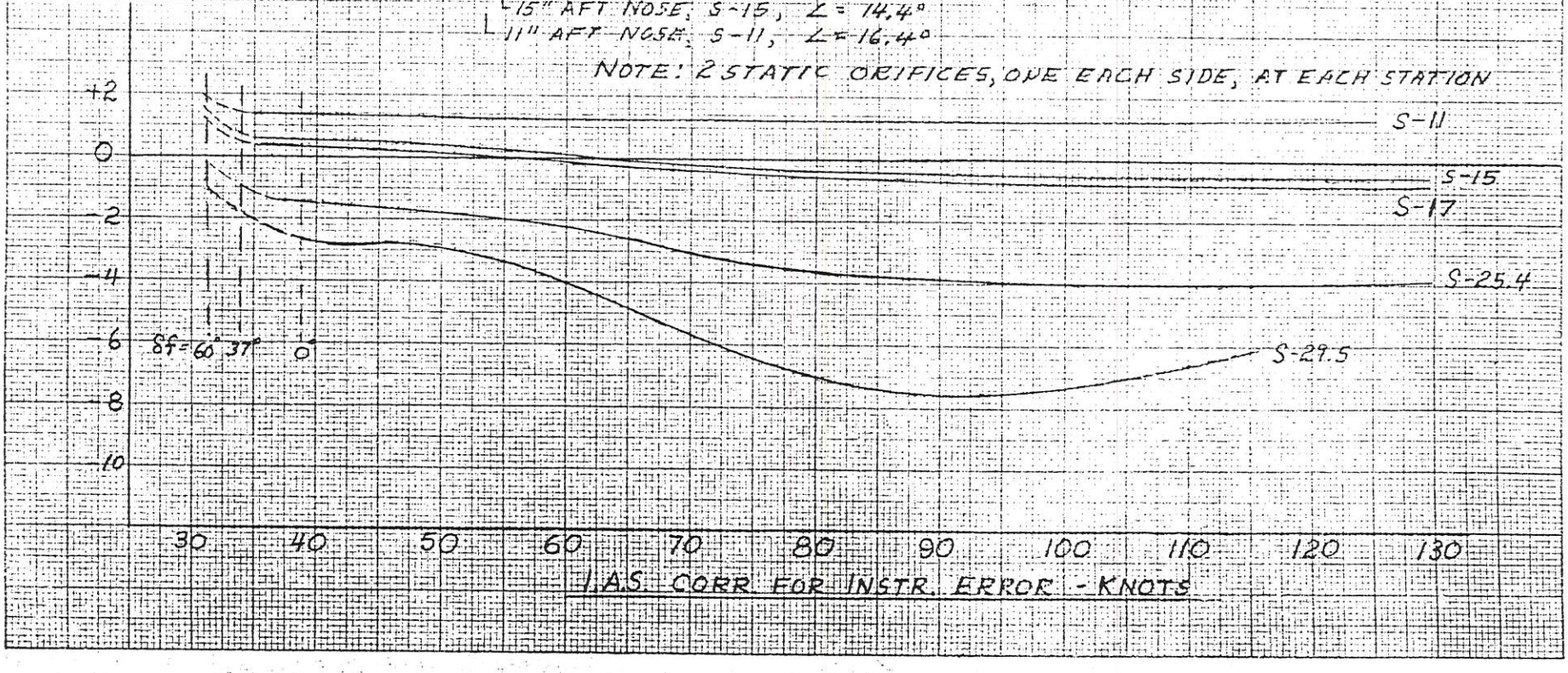
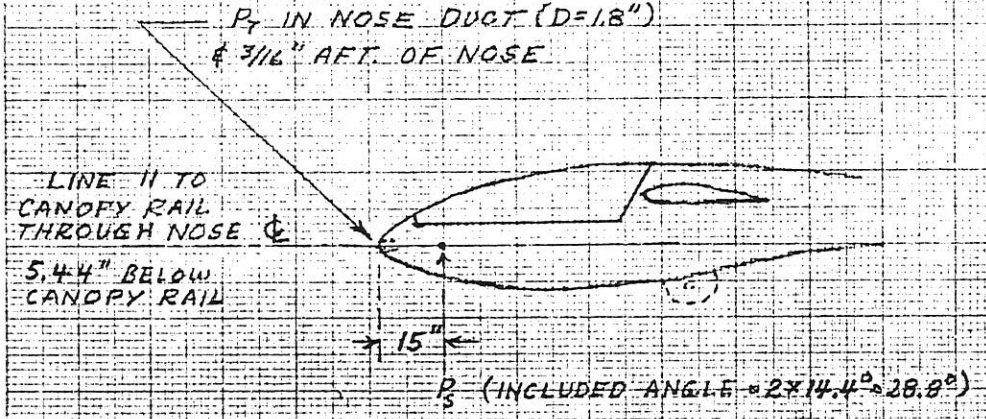


FIG. 9
LP-15 NO. 1
AIRSPEED SYSTEM CALIBRATION

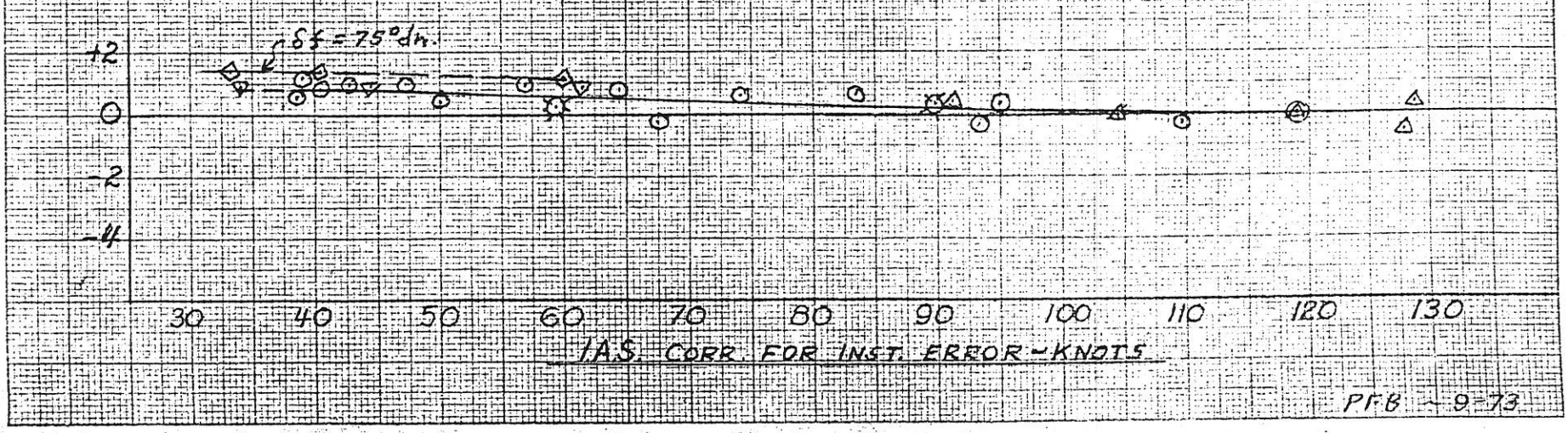


MODIFIED NOSE
P_T - IN NOSE DUCT INLET
P_S - ORIFICES 15" AFT. NOSE

GROSS WEIGHT ~ 728 lbs.
C.G. @ 34 % m.a.c.

- ○ 0° FLAP, 2° UP AILERON
- △ 6.0° UP FLAP, 2° UP AILERON
- ▽ 37° dN FLAP, 0° AILERON
- ◇ 75° dN FLAP, 0° AILERON

NOTE:- CALIBRATED VS. TAIL CONE SYSTEM - MAY 1973
- ✡ - CALIBRATION ON TDW OVER 2 MILE SPEED COURSE - AUG. 1973



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