TL.113-1957

AVRO C-105

DATA ON L/D_{max} AND PITCH-UP

March, 1957.

L/D_{max}

The maximum value of the ratio of lift to drag is one of the best criteria of aerodynamic efficiency. In Figure 1, this ratio is plotted vs Mach number for the Avro C-105. Because of certain special circumstances, it was felt necessary to give more than one curve and to explain the meaning of each curve, so that it would be possible to get a true appreciation of the significance of the data.

The first point to be considered is that in designing the C-105 to R.C.A.F. specification AIR 7-4, there appeared to be very little incentive for getting exceptionally good subsonic performance. This, however, does not mean that if more attention were directed to this aspect of the design that a great deal could not be done without extensive changes to the basic configuration. Accordingly, the maximum subsonic L/D that it is believed could be obtained by optimizing the leading edge camber for subsonic flight has been shown in Figure 1 for reference.

Another factor that must be borne in mind is that the performance of this aircraft has been the subject of considerable controversy. As a result of this only those figures that can be considered as proven by tests are actually claimed. However, it has been possible to calculate some quite substantial improvements in these figures without being able to amass sufficient evidence at the present time to prove them.

Accordingly the expected calculated values of L/D_{max} are given in Figure 1 along with those that are claimed for the purpose of performance estimates. The expected drag reduction is mainly due to the present conservative method of estimating the drag of the boat-tail in front of the propelling nozzles. Some improvement is also expected by a 2% aft c.g. movement under combat conditions.

A further complication is introduced into the presentation of supersonic drag figure by the definition of spillage drag. The practice followed at Avro is that the spillage for critical intake flows is chargeable to the airframe, while that due to subcritical flow is chargeable to the propulsion system. For comparison, values are given in Figure 1 with the whole spillage charged to the propulsion system.

Pitch-up

Several configurations of notches and leading edge extensions were tested so as to find the one most successful in alleviating the pitch-up tendencies of the basic wing. The improvement obtained by the final configuration is shown by Figures 2 and 3 which give the C_M vs C_L curves for Mach numbers of .5 and .9 respectively. Although data at the lower Mach number extends up to stalling incidences, tunnel limitations prevented exceeding approximately 12^o at the higher Mach number. These

curves show that the improvement due to the notch and leading edge extension is considerable, but that there is a reduction in stability of about 6% MAC for C_Ls greater than .4.

In evaluating these data, there are two factors which must be borne in mind. The first is that the wing loading is of the order of 40 lb./sq.ft. so that high lift coefficients are not necessary for most manoeuvres. The second factor is that the stick command system is based on a comparison of stick force with normal acceleration. This will ensure a steady stick force gradient with g and hence will eliminate at least part of the pitch-up problem.

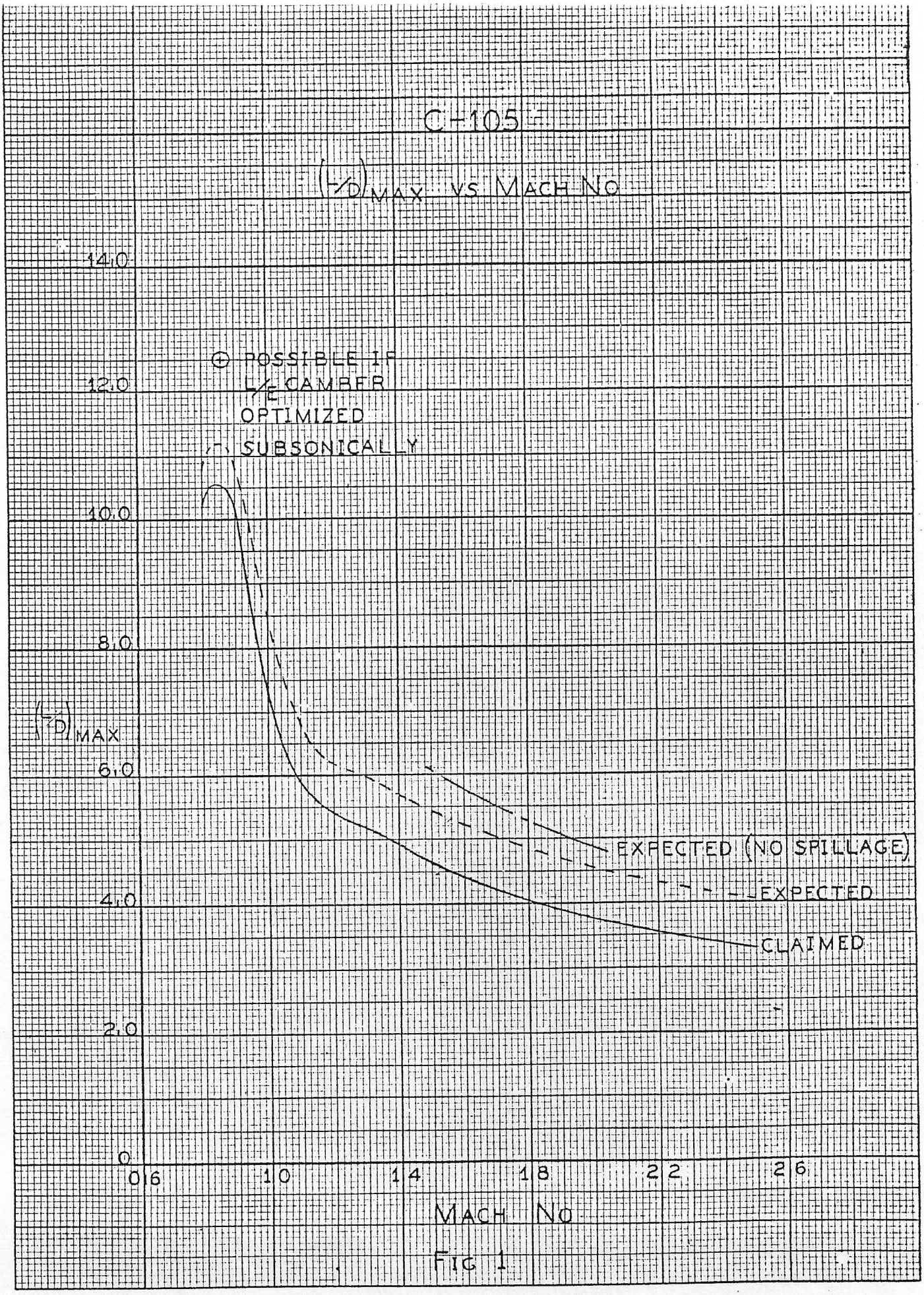
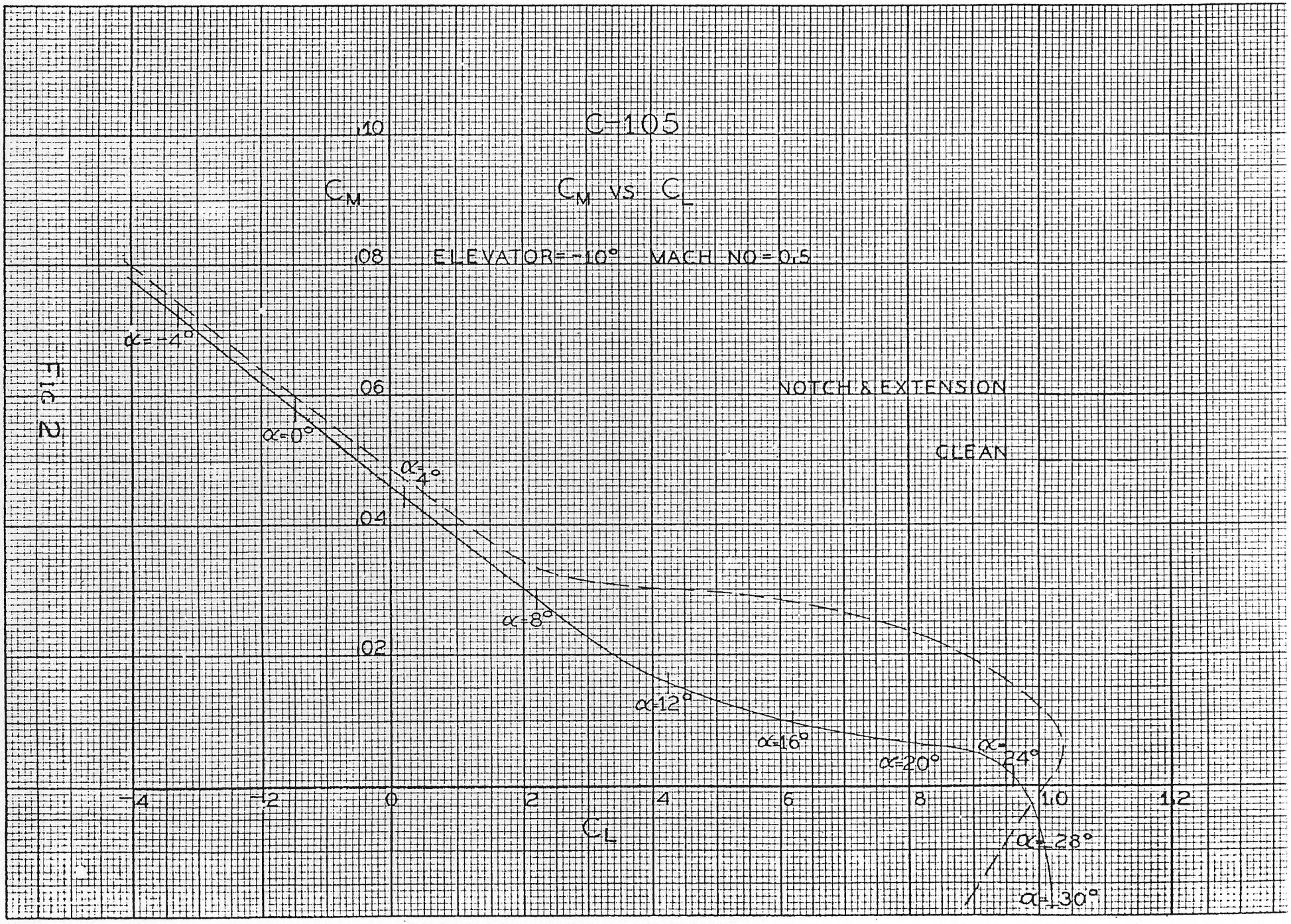
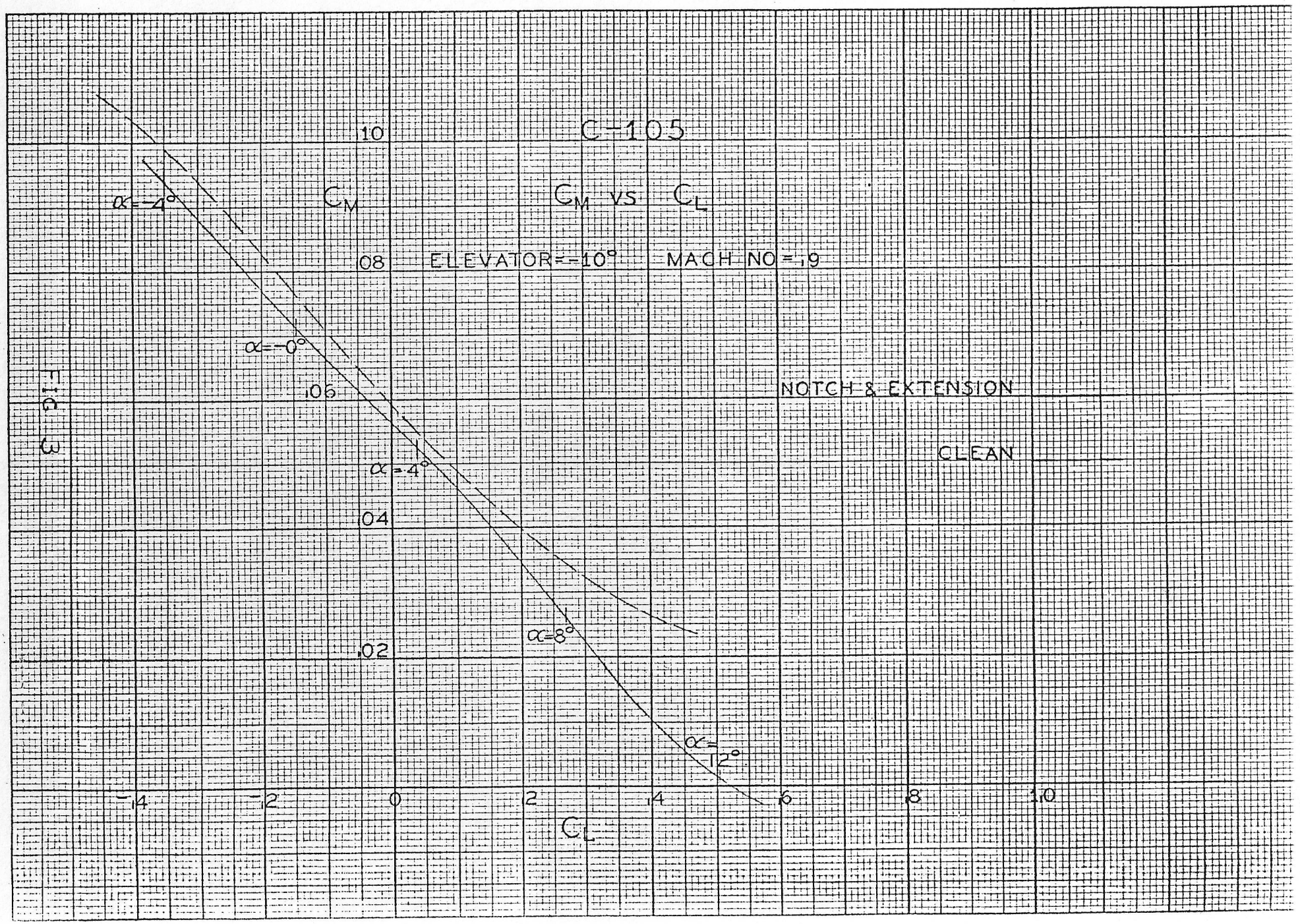


FIG 1

1.5 M. 37 deg sweep SP.
30 " " "





C-105

FLIGHT ENVELOPE LIMITATIONS

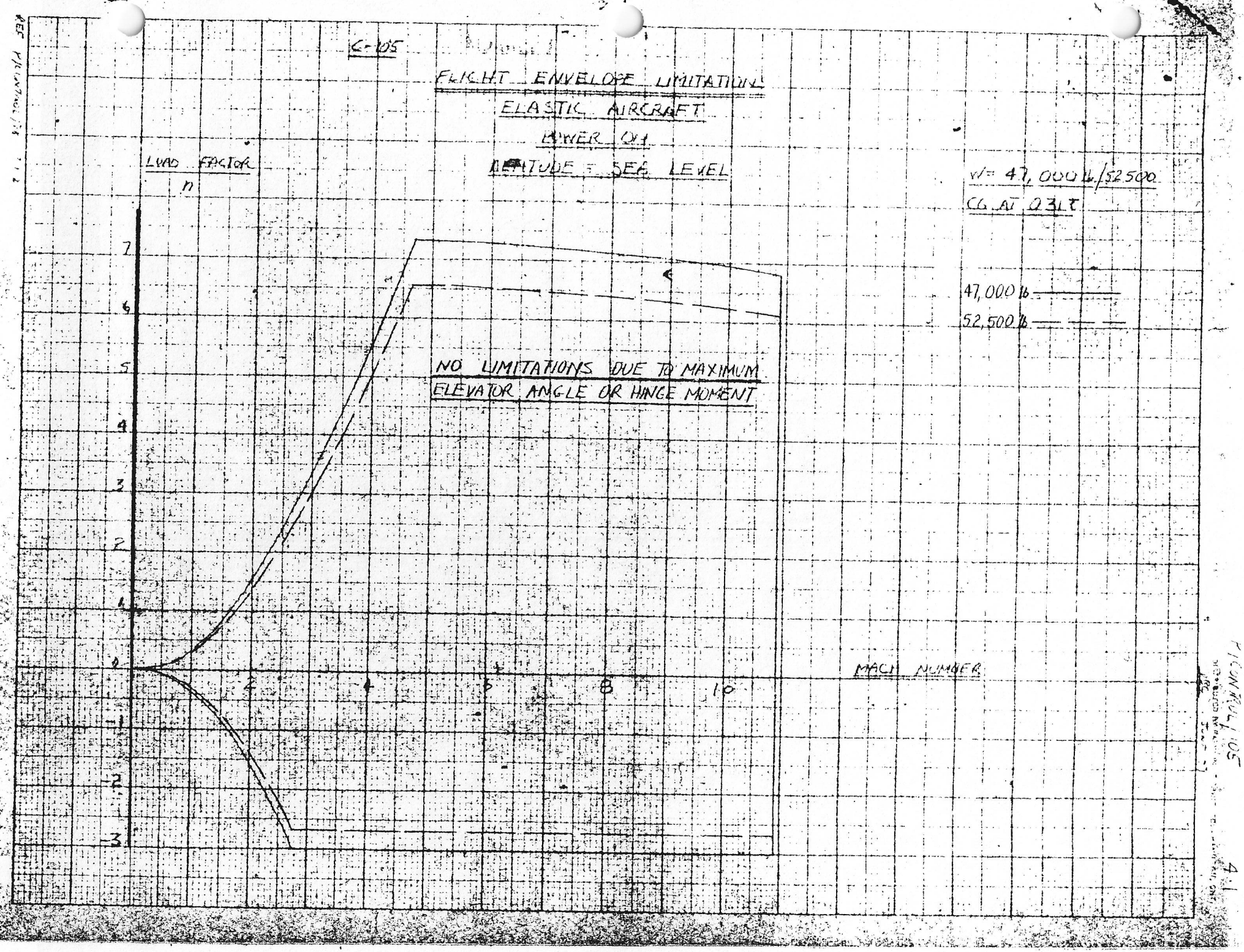
ELASTIC AIRCRAFT

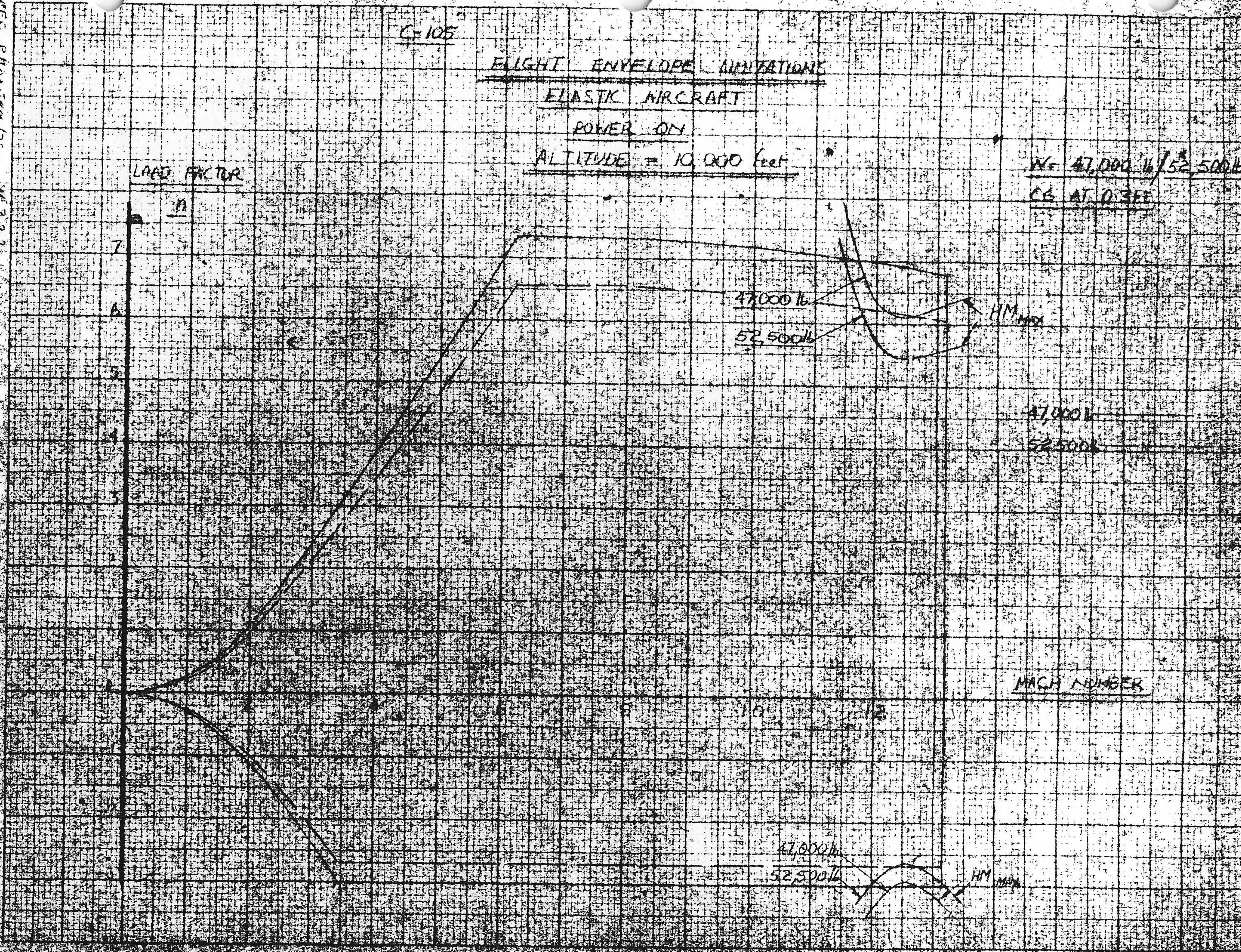
POWER ON

ALTITUDE = SEA LEVEL

W = 47,000 lb / 52500

CG AT 23%




C-105
FLIGHT ENVELOPE LIMITATIONS
ELASTIC AIRCRAFT
POWER ON
ALTITUDE = 10,000 feet
W = 47,000 lb / 52,500 lb
CG AT 0.3
LOAD FACTOR
n
7
6
5
4
3
2
1
MACH NUMBER
.4
.6
.8
1.0
1.2
47,000 lb
52,500 lb
HM MAX
47,000 lb
52,500 lb
47,000 lb
52,500 lb
HM MAX

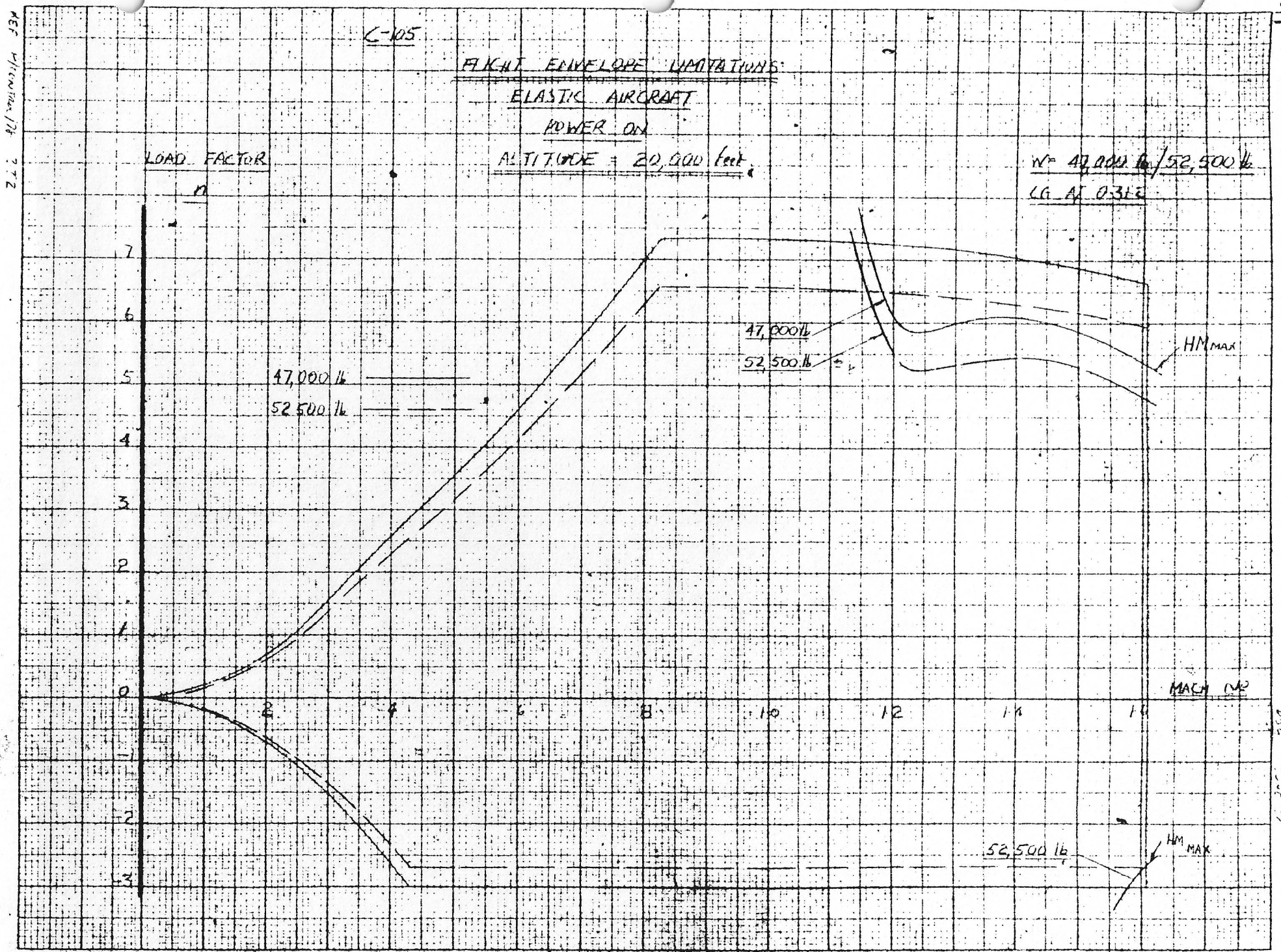
C-105

FLIGHT ENVELOPE LIMITATIONS:

ELASTIC AIRCRAFT

POWER ON

ALTITUDE = 20,000 feet



CG 10%

FLIGHT ENVELOPE LIMITATIONS

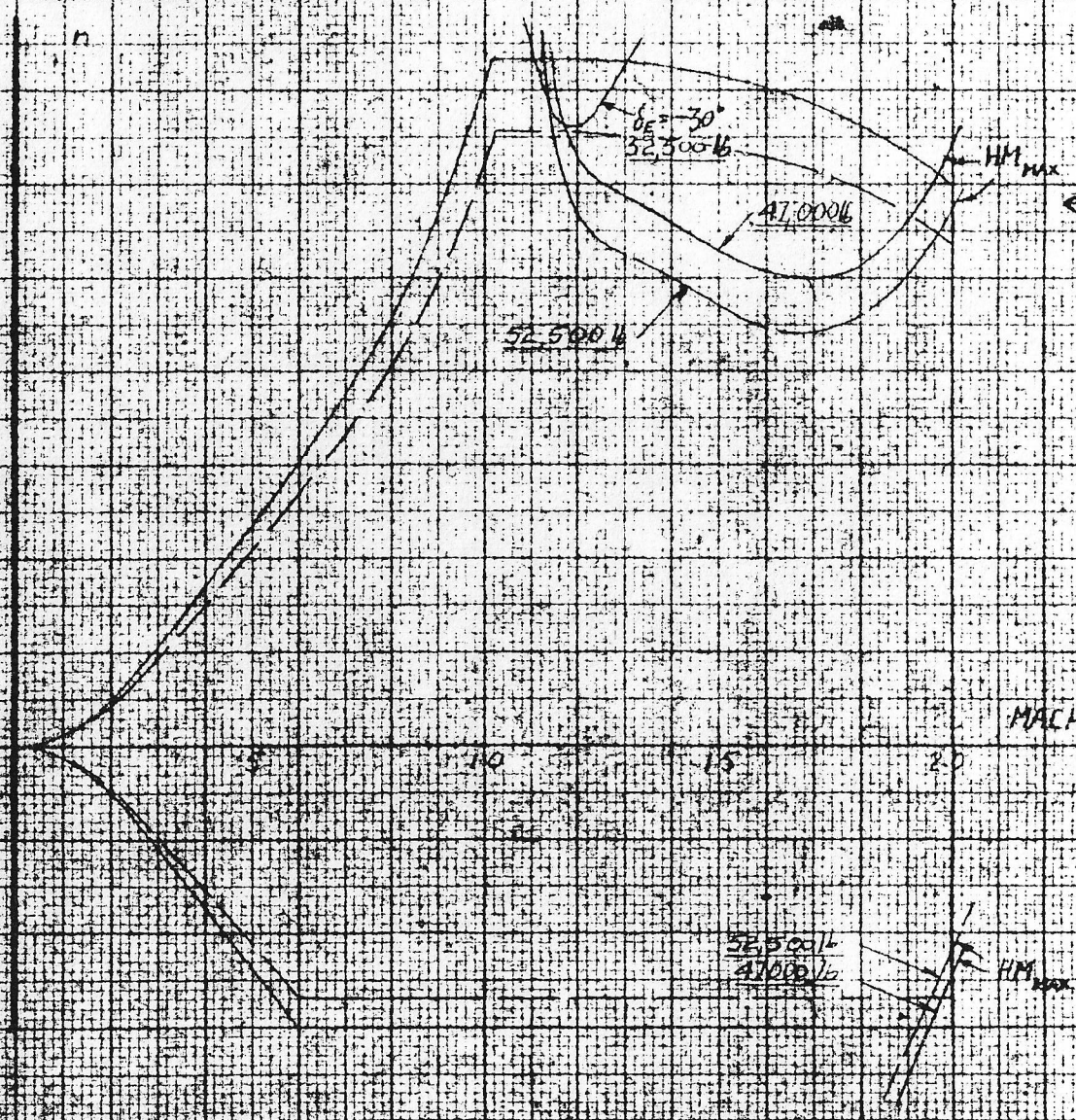
ELASTIC AIRCRAFT

POWER ON

ALTITUDE = 30,000 feet

W = 47,000 lb / 52,500 lb

CG at 0.3 $\bar{c}$



47,000 lb ———

52,500 lb — — —

C-105

FLIGHT ENVELOPE LIMITATIONS

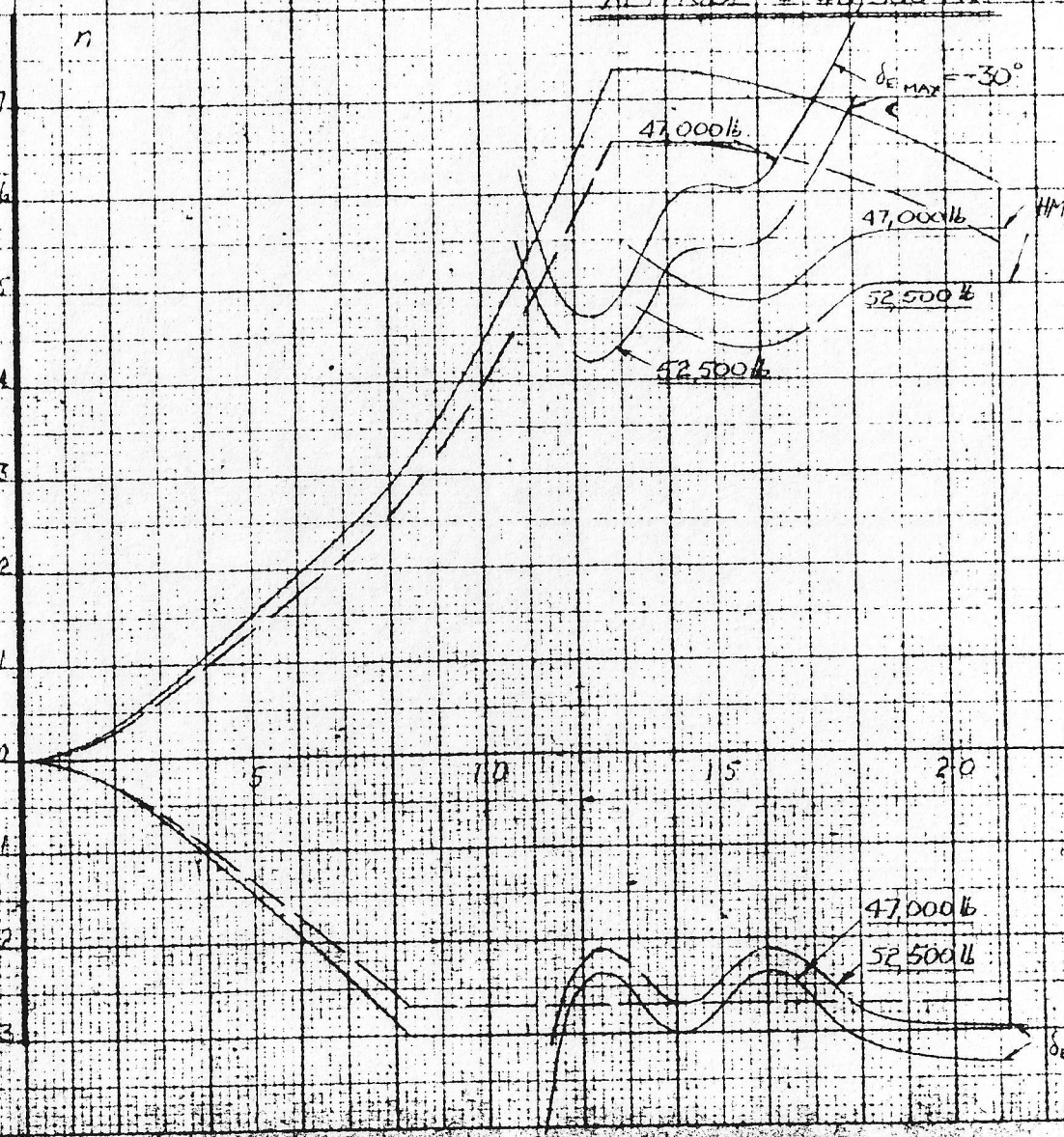
ELASTIC AIRCRAFT

POWER ON

ALTITUDE = 40,000 feet

W = 47,000 lb / 52,500 lb

CG AT 0.31 $\bar{c}$



47,000 lb ————

52,500 lb — — —

C-105

FLIGHT ENVELOPE LIMITATIONS

ELASTIC AIRCRAFT

POWER ON

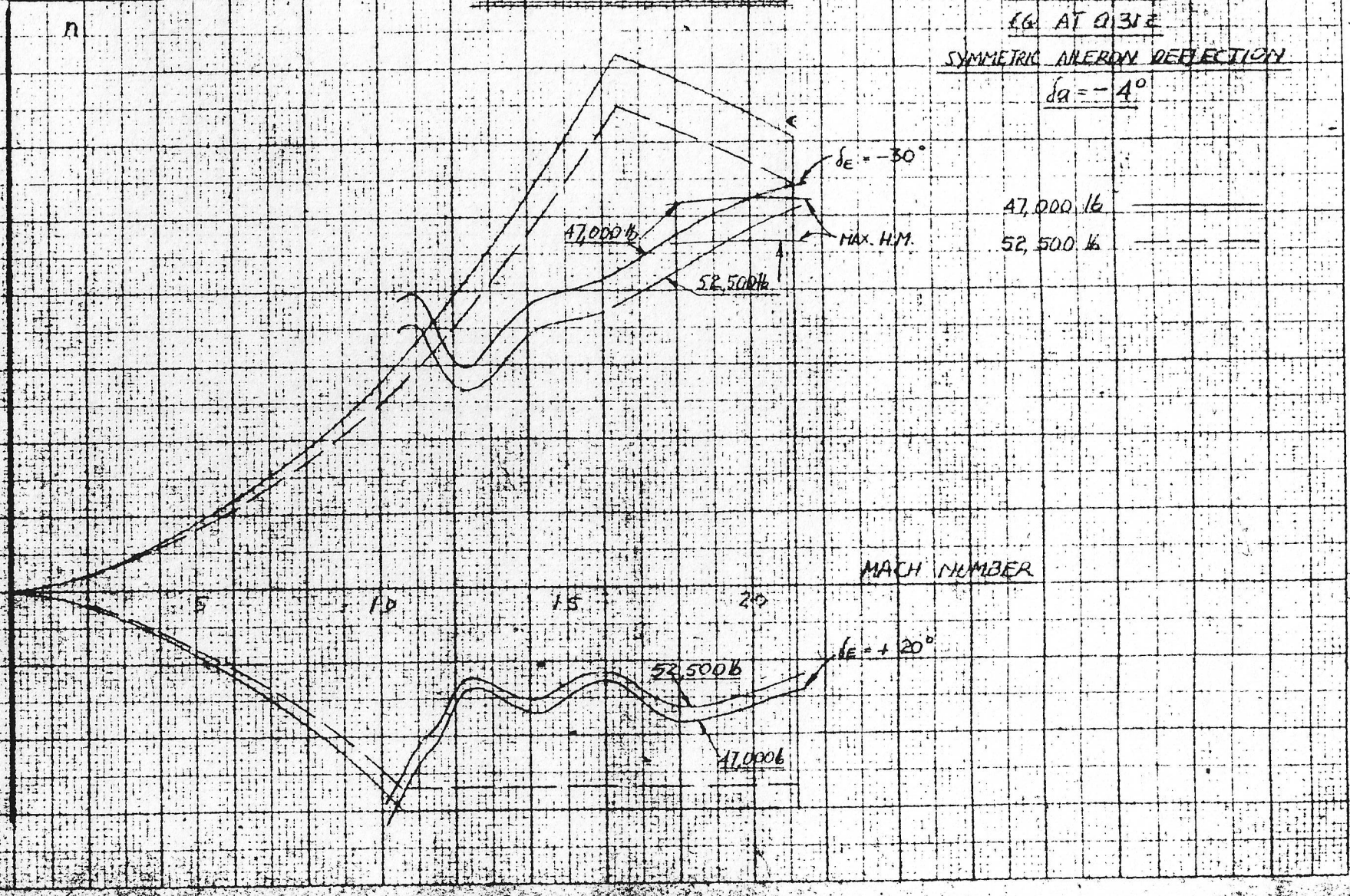
ALTITUDE = 50,000 feet

W = 47,000 lb / 52,500 lb

CG AT 0.31 c̄

SYMMETRIC AILERON DEFLECTION

$\delta_a = -4°$

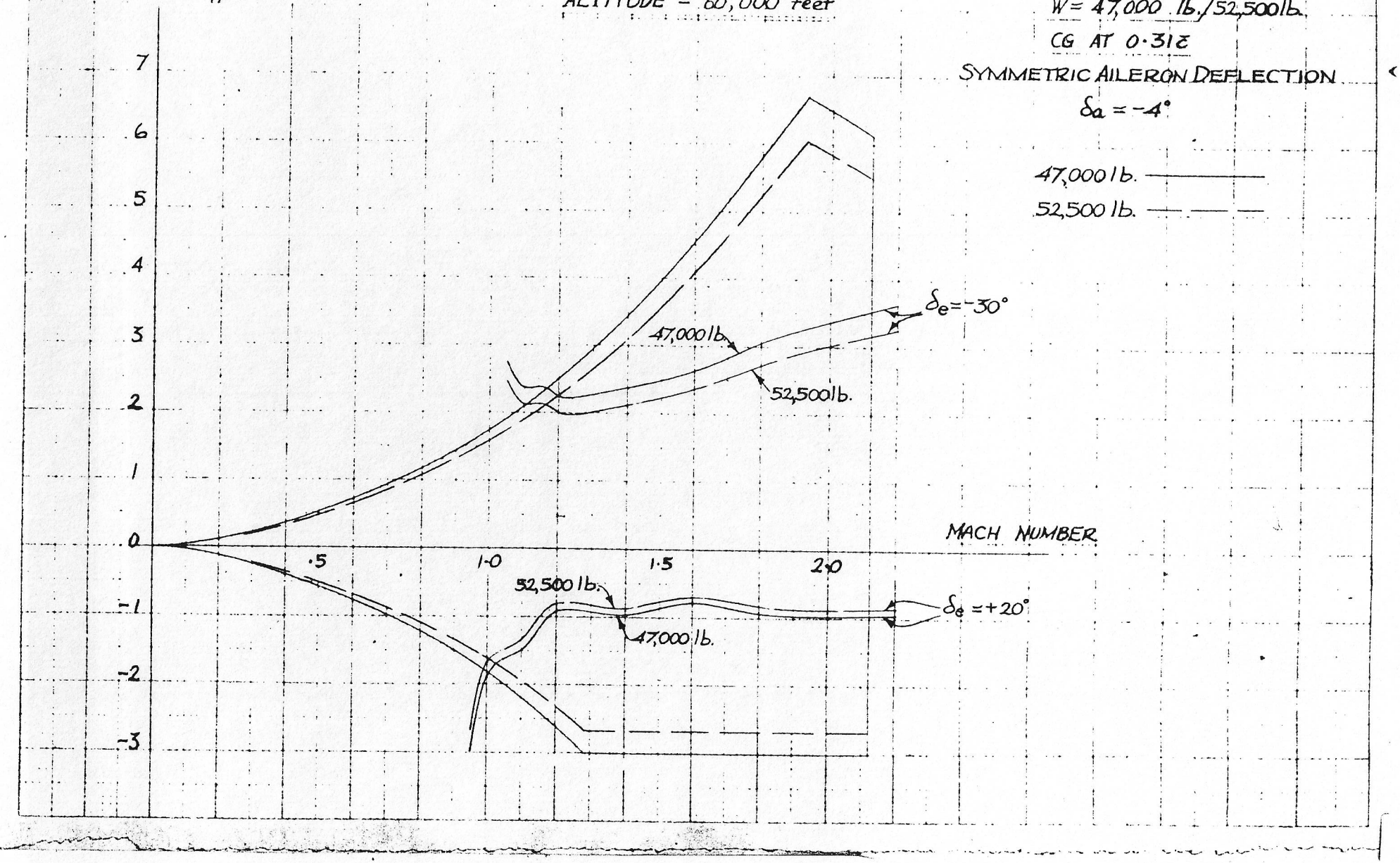


C-105

FLIGHT ENVELOPE LIMITATIONS
ELASTIC AIRCRAFT
POWER - ON
ALTITUDE = 60,000 feet

W = 47,000 lb./52,500 lb.
CG AT 0.31 $\bar{c}$
SYMMETRIC AILERON DEFLECTION
$\delta_a = -4°$

47,000 lb. ————
52,500 lb. — — —



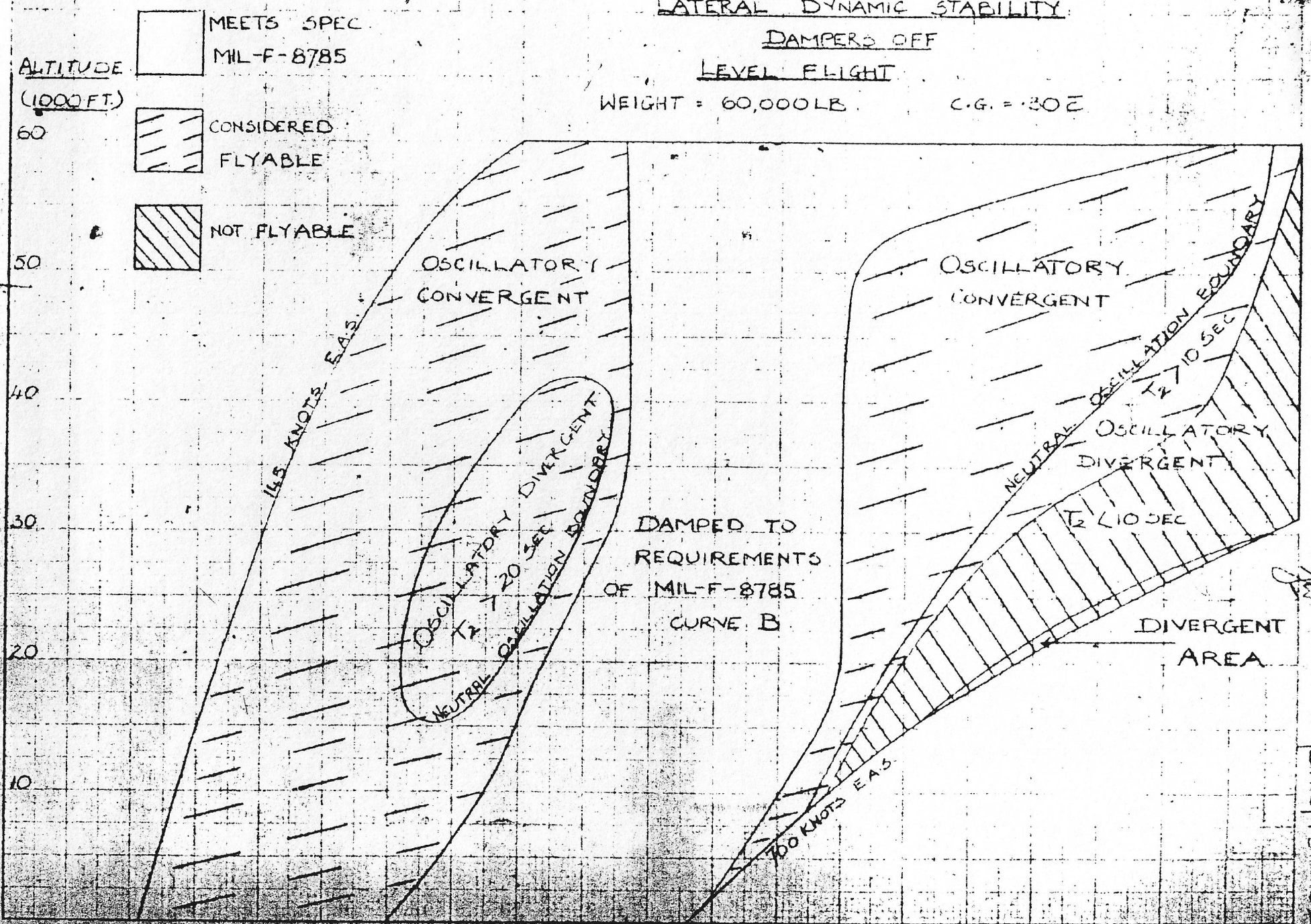
ARROW

LATERAL DYNAMIC STABILITY

DAMPERS OFF

LEVEL FLIGHT

WEIGHT = 60,000 LB C.G. = .30 $\bar{c}$



ARROW

LATERAL DYNAMIC STABILITY

DAMPERS OFF

LEVEL FLIGHT

WEIGHT = 60,000 LB C.G. = .30 E

MEETS SPEC MIL-F-8785

CONSIDERED FLYABLE

NOT FLYABLE

ALTITUDE (1000 FT.)

60

50

40

30

20

10

0

OSCILLATORY CONVERGENT

OSCILLATORY CONVERGENT

145 KNOTS E.A.S.

OSCILLATORY DIVERGENT

T_2 20 SEC

NEUTRAL OSCILLATION EQUIVOCABLY

DAMPED TO REQUIREMENTS OF MIL-F-8785 CURVE B

NEUTRAL OSCILLATION EQUIVOCABLY

T_2 10 SEC

OSCILLATORY DIVERGENT

T_2 < 10 SEC

DIVERGENT AREA

100 KNOTS E.A.S.

2 4 6 8 10 12 14 16 18 20

JULY 58 70/STAB/42

ARROW

LATERAL DYNAMIC STABILITY

DAMPER OFF

LEVEL FLIGHT

WEIGHT = 60,000 LB C.G. = .30 $\bar{c}$