COURSE No. ....

EMPIRE TEST PILOTS' SCHOOL

STUDENT'S REPORT

on

MANOEUVRE STABILITY

LIGHTNING T MK 5 XS 422

*

RANK & NAME CAPT RIDZWAN
CAPT CALWER
FLT LT BROWN

CIRCULATION

Passed to	On (Date)	Actioned (Initials)
C.G.I.	CGI 12.6.78	[signature]
Tutor	14.6.78	[signature]
Student	16.6.78	[signature]
C.I.	5-8-78 1.8.78	[signature]
S.T.F.T. ιding	2.8.78	[signature]
C.G.I.	2.8.78	[signature]
Tutor	3.8.78	[signature]
Student	7-8-78	

GRAPHICAL REPORT

FLIGHT REPORT

AIRCRAFT Lightning T Mk5 XS 422

TEST EXERCISE Manoeuvre stability

DATE OF TEST Refer Annex A

COMMENTS ON RESULTS

1 INTRODUCTION The purpose of the tests was to assess the Lightning T Mk 5 longitudinal manoeuvrability characteristics in relation to its future role as high altitude interceptor and air superiority fighter and against AvP 970 memos.

2 CONDITIONS RELEVANT TO THE TEST

a WEATHER, TIME AND PLACE Three days sorties were flown from Boscombe Down, one sortie by each syndicate pilot as shown at Annex A.

b WEIGHT, LOADING AND CONFIGURATION For all tests the take off weight was 35,753 lbs. and the c.g. position 7.843 feet aft of datum. The aircraft was fitted with a 1975 lbs. content ventral tank. All tests were flown in clean configuration.

c POWER SETTING For the 2.0 g wind up turn, maximum dry power was used and minimum reheat was selected for the 2.5 g and 3.0 g wind up turns.

d INSTRUMENTATION The A-13 recorder was used for all sorties and the following data were taken from the traces for the analysis:

- altitude coarse and fine
- IAS coarse and fine

- elevator angle
- normal acceleration

Apart from the A-13 recorder, standard cockpit instrumentation was used.

3 TESTS MADE, RESULTS AND COMMENTS

a ACCELERATION

(1) PRESSURE ERROR A level acceleration from 0.9 to 1.4 IMN was carried out at FL 360, using maximum reheat power. The acceleration run was interrupted at IMN 1.3 for a SPO excitement. The altimeter PE increased from Δhp = +700 feet at IMN = 0.9 to Δhp = +1800 feet at IMN = 1.0, unlike in the ETPS aircraft data file, where a PE of Δhp = 1250 feet at IMN = 1.0 was specified. Beyond IMN = 1.0, there was no PE present. A further test should be made to get more accurate information on the PE in the transonic range.

(2) HANDLING The altimeter descent from 35,300 feet at IMN 0.9 to 34200 feet at IMN 1.0 in order to maintain true altitude was easy to fly.[2] As the aircraft accelerated through IMN 1.14 at 36,000 feet, the stick had to be moved back slowly but progressively to maintain level flight.[3] This result is confirmed by a plot of elevator angle versus IMN at Annex C where the data from 3 level accelerations (taken from the reduction proforma Annexes B1-3) were combined. Since the aircraft acceleration was fairly slow, it was easy to maintain constant altitude. However, the aircraft possessed negative stick fixed static stability beyond IMN 1.14. This was unsatisfactory and did not meet the requirements of AvP 970 chapter 601 para 1.1.3. However, the instability was mild, the rate of change of pitch trim required with increasing IMN was slow and the stick movements were small with comfortable light stick forces (2-3 lbf.).[4] Therefore, the negative stick fixed

longitudinal static stability was acceptable.

b DECELERATION

(1) DATA REDUCTION Data reduction proforma Q5 for the 3 sorties (Annex B1-3) was completed using the following technique to find accurate na values for 1, 1.5 and 2 g. The actual g values flown from the 3 flights were plotted against the corresponding η-values from IMN 0.9 to IMN 1.4 with 0.05 M intervals as shown at Annex D1-3. A best line was then fitted and the required η-values corresponding to the 2, 2.5 and 3 g values were taken from these graphs and used for the reduction in column 11 of the Q5 proforma.

1. (2) HANDLING Annex C shows the plots of elevator angle versus IMN for the 3 specified n_a values. For the $n_a = 2.0$ and $n_a = 1.5$ plots the stick had to be moved forward from IMN 1.4 to IMN 1.1 to maintain constant g. The $n_a = 1.0$ plot shows a decrease in elevator angle from IMN 1.4 to IMN 1.2 which indicates an increase in manoeuvre stability with decreasing normal acceleration between IMN 1.1 and 1.2. The stick pull forces became lighter during the acceleration phases which could lead to overstressing the aircraft in a combat environment, where maximum normal accelerations are likely to occur. A 'caution note' should be made in the Pilot's Notes, warning pilots of lightening stick forces during manoeuvres at supersonic speeds between IMN 1.4 and 1.1. Flying the aircraft level with bank control did not cause piloting difficulties since the aircraft response to aileron inputs was good. Below IMN = 1.0 it was difficult to compensate for the large altimeter P.E..

2.

c MANOEUVRE MARGIN The actual stick fixed manoeuvre margin of the aircraft could not be found since only one C.G. position was used for all tests. The C.G. movement with fuel usage was only 0.005 inches during the deceleration phases where 400 lbs. of fuel (mean value) were used. The mean test C.G. was taken at 7.856 feet aft of datum as shown in Annex E. The $\Delta\eta/n_a Cl$ values calculated in Annex B1-3 were plotted against IMN as shown in Annex F. A $\Delta\eta/n_a Cl$ versus IMN graph which would be expected if a more aft C.G. flight test had been carried out is also shown at Annex F. For this plot a C.G. of 8.3 feet aft of datum was chosen. Annex G shows how the stick fixed manoeuvre margin would be derived. At a selected IMN = 1.15 the distances A and B were measured, indicating 2 different C.G. positions as shown in Annex F. These distances were plotted on the $\Delta\eta/n_a Cl$ versus C.G. position graph using the actual C.G. value from the test (7.856 feet) and the imaginary C.G. value of 8.3 feet. A line was then drawn through A and B and the intercept of this line with the abscissa shows hm (stick fixed manoeuvre point) for the selected IMN. This procedure can be repeated for all IMN values. The stick fixed manoeuvre margin Hm is the calculated by subracting the C.G. position (h) from the stick fixed manoeuvre point (hm):

$$H_m = h_m - h$$

d SUITABILITY Annex C shows that with speed reduction the stick had to be moved forward to maintain a constant g value which indicates a decreasing static margin with decreasing supersonic speeds. The static margin varied in the transonic speed range from stable between IMN 1.1 to 1.0 to unstable between IMN 1.0 to 0.95. This was acceptable since it did not cause piloting difficulties and the AvP 970 ch. 601 para 1.1.3 allowed for relaxation in the transonic speed range. Further test should be made to investigate the static margin and manoeuvre stability in the combat configuration (ie. the aircraft loaded with missiles and guns).

e LONGITUDINAL TRIMMING The trim switch on top of the stick was easy to operate. The trim speed, however, was too slow for easy trimming and should be increased. — 1.

f DIRECTIONAL TRIMMING During the acceleration and deceleration from IMN 0.9 to 1.4 and vice versa, the aircraft wandered about the yaw axis and constant rudder trimming was necessary to maintain coordinated flight. This was unsatisfactory, because when using the aircraft as gun platform, it was difficult to track a (simulated) target, observe the slip indicator (ball) and operate the rudder trim control at the same time. Better directional stability should be introduced. /.

g SHORT PERIOD OSCILLATIONS (SPOs) The short period oscillatory characteristics of the aircraft in the clean configuration were investigated at 0·9 M and 1.3 M at 36,000 feet and at 250 K, 400 K and 500 K at 5000 feet although weather forced one pilot to complete the latter at 10,000 feet. Double spike or single spike inputs were used to obtain an approximate incremental 0·5 g and in all cases the results were compared with the autostabilisation system in and with it out.

(1) QUANTITATIVE DATA Annex H contains a numerical presentation of all the SPOs carried out on all 3 sorties while Annex J contains Hussenot traces of IAS, altitude, normal g, AOA and elevator angle. Only one representative trace of each altitude, speed and autostabilise condition has been included. AvP 970 memo 31/A, Leaflet 601/4, paragraph 2.3 sets out the damping ratios required in the short period mode as follow.

SHORT PERIOD DAMPING RATIO LIMITS

Flight Phase Category	Level 1		Level 2		Level 3	
	Min	Max	Min	Max	Min	Max
A	0·35	1·30	0·25	2·00	0·10*	-
B	0·30	2·00	0·20	2·00	0·10*	-
C	0·50	1·30	0·35	2·00	0·25	-

* These values may be reduced for altitudes greater than 6000 m (20000 ft) if approved by the Aeroplane Project Director (see also para.3.3.3 below)

No SPOs were carried out in the take off and landing configurations and consequently the aircraft could not be assessed against the Flight Phase Category C requirements; further tests will be required in this configuration. The results in Annex H show that with the autostabilisation system in, the relative damping of most of the SPOs performed was within the Level 1 limits for Flight Phase Categories A and B and those relative damping values which were outside level 1 were within level 2 limits. In most cases, in fact, no clearly definable SPO was demonstrated, the motion following neutralisation of the controls being either a deadbeat oscillation or an aperiodic subsidence. With the autostabilisation out, however, the relative damping at very few points was within the level 1 limits, the bulk being within the level 2 band and a small number in the level 3 band. Thus, following a pitch autostabilisation failure, the aircraft exhibited unsatisfactory SPO damping at 1.3 M at 36,000 feet and in one case at 0.9 M at 36,000 feet. In Annex K, the short period undamped natural frequency was compared with the limits set out in the AvP 970 Memo 31/A Leaflet 601/4 Fig. 1 and 2; all frequencies lay within the level 1 bands in both categories A and B and were thus satisfactory.

(2) QUALITATIVE ASSESSMENT Although the relative damping values obtained by analysis of the Hussenot traces were sometimes outside the requirement levels which would normally be acceptable, the results were subject to the following potential errors:

(a) The resolution of the traces was in the order of 1mm. and thus the trace thickness was equivalent to the amplitude of the oscillation in heavily damped cases; possible errors of 50% were therefore introduced in such cases.

(b) The zero line of many of the oscillations was ill defined introducing further potential errors into the measurement of oscillation amplitude. Little time was available to stabilise the aircraft on the short, busy sortie and this resulted in rather rushed SPOs.

(c) Because most of the oscillations were heavily damped, only the inherently inaccurate analytical method available for such oscillations could be used.

(d) The pilot's inexperience of the aircraft and of the excitement of SPOs probably led to some inconsistency in inputs and therefore in the SPOs obtained.

The acceptability of the aircraft's characteristics was not based on the numerical limit alone, therefore, and the final judgement was made largely on the pilot's opinions of the aircraft's behaviour. All the SPOs except those performed at 250 K at 5000 ft. and 10,000 ft. had periods in the 1 - 3 seconds band and it is this order of period which, experience shows, could result in pilot induced oscillations (PIOs). In all but the 1.3 M, autostabilisation out case, the damping was so high that PIOs were extremely unlikely to occur. Even at 1.3 M the damping was high enough to make PIO unlikely, but higher Mach Numbers or the more forward C.G. which would probably result from the fitment of missiles or guns might reduce the damping to a level where PIOs would occur. Further tests should, therefore, be carried out in the operational configuration up to the maximum operational aircraft speed. Rapid level-offs at approx. 0.9 M at 20,000 feet and 400 Kts. at 10,000 feet and a simulated tracking task at 0.9 M at 36,000 feet were carried out both with and without autostabilisation. With autostabilisation in, the aircraft was satisfactory in both types of manoeuvre. There was no noticeable difference between the level-offs with autostabilisation and those without and minor pilot compensation produced a satisfactory result in the tracking tasks performed with autostabilisation out. The pilots' overall opinion, therefore, was that, although some of the values of relative damping were outside the levels which would normally be acceptable, in practical terms the SPO was sufficiently damped to prevent piloting difficulties even following a failure of the pitch autostabiliser. The aircraft's SPO characteristics were, therefore, satisfactory.

4 RECOMMENDATIONS The Lightning T Mk 5 was acceptable for the high interceptor and air superiority fighter role in the configuration tested. Desirable recommendations are made to improve aircraft's performance in its role:

a P.E. MEASUREMENT A further flight test should be made to get more accurate information on the altimeter P.E. in the transonic range.

b PILOTS' NOTES Pilots should be warned of the stick force lightening with decreasing supersonic speed.

c LONGITUDINAL TRIM The elevator trim rate should be increased.

d WANDER IN YAW The wander in yaw with changes in speed should be reduced.

e FURTHER TESTS Further tests should be carried out in a typical combat configuration (ie. aircraft loaded with missiles and guns).

1.

R. CALWER	J. BROWN	A. RIDZWAN
Captain	Flight Lieutenant	Captain (Air)

ETPS
9 JUNE 78

2.

ANNEX A TO
LONGITUDINAL
MANOEUVRE STABILITY
LIGHTNING T MK5
DATED 9 JUN 78

TEST CONDITIONS

SERIAL (a)	DATE (b)	DURATION (hrs) (c)	TEST HEIGHT (feet) (d)	NORMAL ACCELERATION FOR WIND-UP TURN ("g") (e)	PILOT (f)	CONDITIONS (g)
1	4 MAY 78	0:40	36000 / 5000	2.5	CALWER	Good, no clear horizon below 10000 feet
2	4 MAY 78	0:35	36000 / 5000	3.0	RIDZWAN	clouds between 2000 and 9000 feet, clear above
3	10 MAY 78	0:35	36000 / 5000	2.0	BROWN	good

LONGITUDINAL MANOEUVRABILITY

DETERMINATION OF $\frac{-\eta}{n_a C_L}$ FROM WIND-UP TURNS

ETPS Proforma G5 (Revised April 1976)

Aircraft: LIGHTNING Mk No: T5 No: XS 422 Pilot: R. CALWER Date: 4 May 78

TO Weight: 35,753 lbf: Wing Area: 458.5 ft^2

CG Position 33.47 % $\bar{c}$

ACCELERATION DECELERATION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
												SUPER	SUBSONIC					
n	η deg	V_R knots	Height ft	M	n_a	η deg	V_R knots	M	M	$\frac{-\eta}{n_a}$ deg ($\eta_0 = 1.5$)	Height ft	p	$-h_p$ ft	h_p ft	p	ΔW lbf	C_L	$\frac{-\eta}{n_a C_L}$ deg
0.94	-1.5	283	35100	0.87	1.1	-3.75	493	1.39	0.9	-1.63	34625	—	+700	35325	0.232	4561	0.244	-6.68
1.00	-1.5	295	34950	0.91	1.8	-6.75	484	1.35	0.95	-1.78	34500	—	+900	35400	0.231	4526	0.221	-8.05
1.00	-1.5	320	34400	0.97	1.7	-6.0	465	1.30	1.0	-2.11	34100	—	+1250	35350	0.23	4486	0.2	-10.55
1.00	-0.8	356	35500	1.05	1.8	-5.75	442	1.26	1.05	-2.11	35600	0.229				4441	0.183	-11.53
1.20	-1.5	377	35650	1.09	1.9	-5.75	420	1.20	1.1	-2.33	35575	0.229				4406	0.167	-13.95
1.00	-0.6	394	35750	1.14	1.9	-5.25	400	1.15	1.15	-2.49	35550	0.229				4361		
1.00	-1.0	417	35800	1.21	2.1	-5.25	368	1.06	1.2	-2.30	35450	0.230				4321		
1.00	-1.5	430	35800	1.24	1.9	-5.00	337	1.02	1.25	-2.28	35000	0.235				4284		
1.00	-1.5	453	35800	1.31	1.9	-4.75	308	0.94	1.3	-2.45	34600	0.240				4239		
1.00	-1.5	473	35700	1.36	0.7	-1.25	298	0.91	1.35	-2.72	34450	0.241				4200		
0.80	-1.5	495	35800	1.41	0.5	-1.25	292	0.89	1.4	-3.09	35650	0.228				4161		

ANNEX B TO
LONGITUDINAL
MANOEUVRE STABILITY
LIGHTNING T MK 5
DATED 9 JUN 78

LONGITUDINAL MANOEUVRABILITY

DETERMINATION OF $\frac{-\eta}{n_a C_L}$ FROM WIND-UP TURNS

ETPS Proforma G5 (Revised April 1976)

Aircraft: LIGHTNING Mk No: T5 No: XS 422 Pilot: RIDZWAN Date: 4 MAY 78

TO Weight: 35,753 lbf: Wing Area: 456.5 ft^2

CG Position 33.47 % $\bar{c}$ (7.843 ft. aft of datum)

ACCELERATION — DECELERATION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
												SUPER	SUBSONIC					
n	η deg	V_R knots	Height ft	M	n_a	η deg	V_R knots	M	M	$\frac{-\eta}{n_a}$ deg $n_a=2.0$	Height ft	p	$-h_p$ ft	h_p ft	p	$-W$ lbf	C_L	$\frac{-\eta}{n_a C_L}$ deg
1.0	-1.45	290	35050	0.90	2.3	-9.2	499	1.40	0.90	-1.86	33800	–	700	34500	0.240	3400	0.245	-7.59
1.0	-1.45	335	34100	1.00	2.3	-8.6	480	1.36	0.95	-1.81	33 500	–	950	34450	0.241	3360	0.219	-8.26
0.95	-0.55	370	35900	1.08	2.3	-7.8	460	1.31	1.00	-2.125	32 000	–	1300	34300	0.243	3320	0.197	-10.79
1.0	-0.70	390	36100	1.14	2.34	-7.4	440	1.25	1.05	-2.115	33300	–	1400	34700	0.238	3280	0.182	-11.62
0.95	-0.70	400	36100	1.17	2.3	-6.8	420	1.18	1.10	-2.265	34800	0.237				3240	0.167	-13.56
1.0	-1.30	410	36050	1.19	2.38	-5.8	390	1.10	1.15	-2.25	34800	0.237				3200	0.153	-14.71
1.0	-1.10	420	36000	1.22	2.23	-6.0	368	1.05	1.20	-2.445	34 750	0.238				3160	0.140	-17.46
1.0	-1.45	430	36000	1.24	2.15	-6.0	342	1.01	1.25	-2.485	34 750	0.238				3120	0.129	-19.26
0.95	-1.45	450	35950	1.30	2.42	-5.8	317	0.95	1.30	-2.635	34 750	0.238				3080	0.120	-21.96
1.1	-1.80	470	36250	1.35	2.30	-5.6	303	0.91	1.35	-2.88	34850	0.237				3040	0.112	-25.71
1.0	-1.80	490	35900	1.40	2.38	-5.6	290	0.88	1.40	-3.21	35000	0.235				3000	0.105	-30.57

LONGITUDINAL MANOEUVRABILITY

DETERMINATION OF $\frac{-\eta}{n_a C_L}$ FROM WIND-UP TURNS

ETPS Proforma G5 (Revised April 1976)

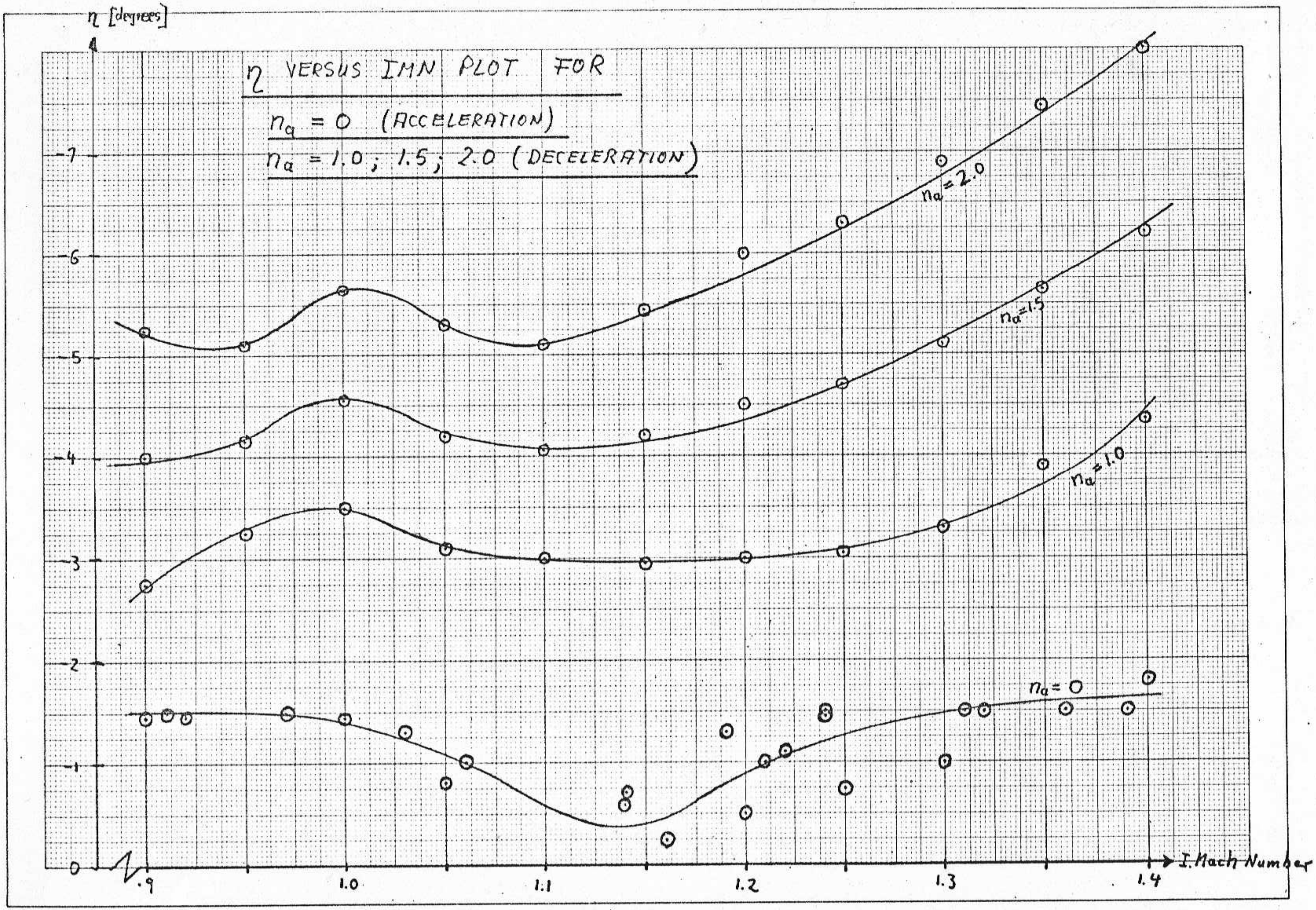
Aircraft: LIGHTNING Mk No: T5 No: XS 422 Pilot: J. BROWN Date: 10 May 78

TO Weight: 35,753 lbf: Wing Area: ft^2

CG Position 33.47 % $\bar{c}$

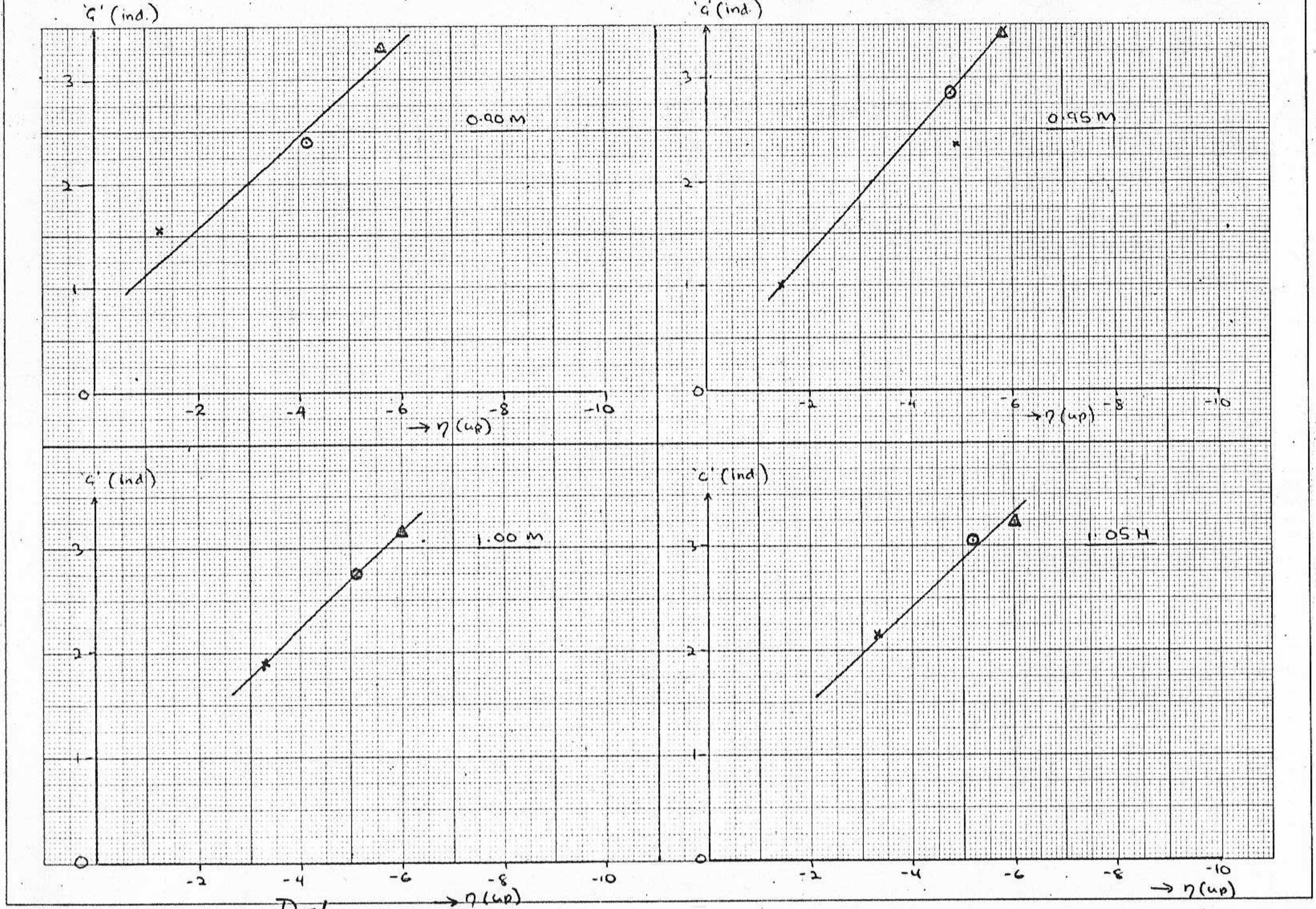
ACCELERATION / DECELERATION

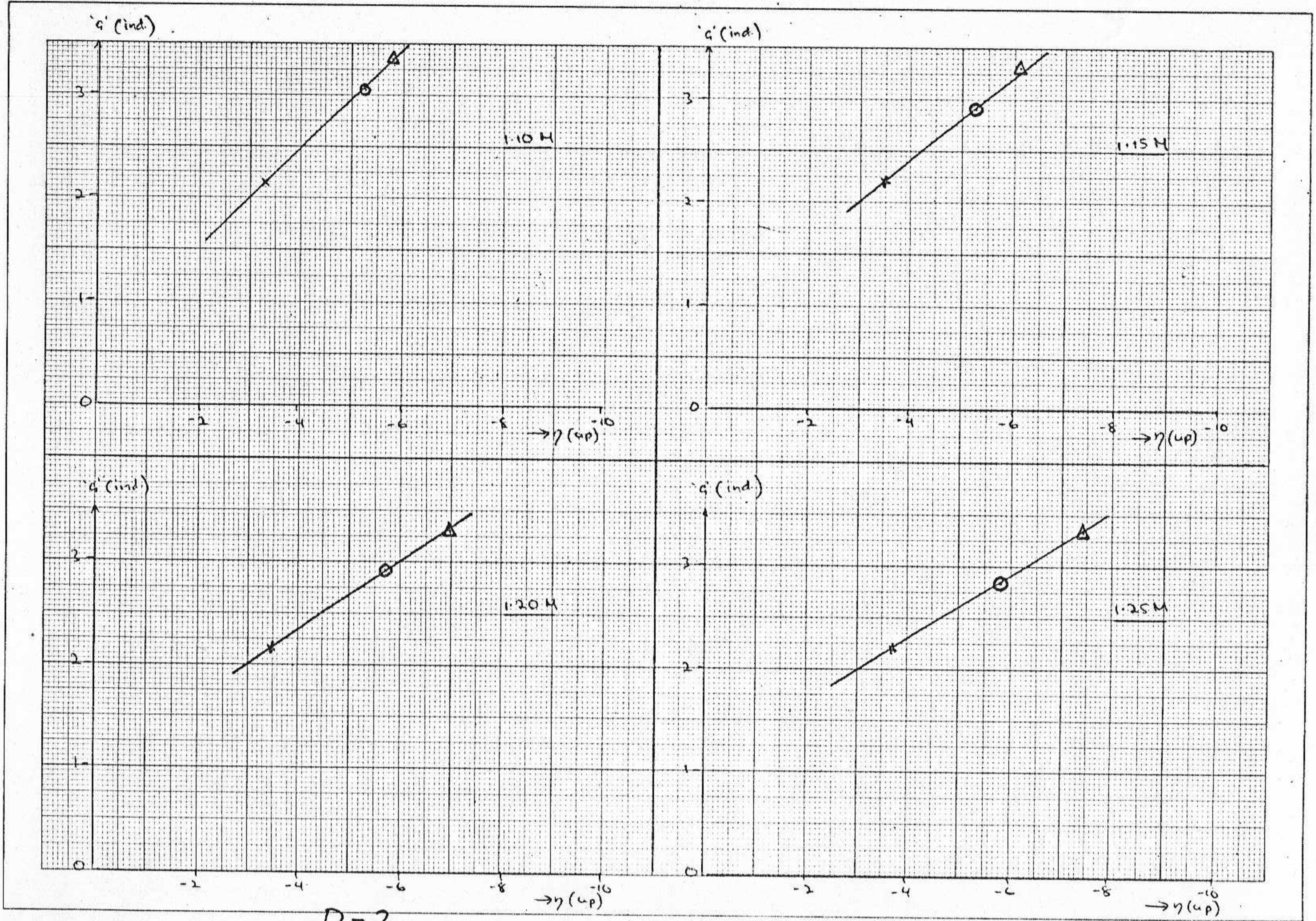
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
												SUPER	SUBSONIC					
n	η deg	V_R knots	Height ft	M	n_a	η deg	V_R knots	M	M	$\frac{-\eta}{n_a}$ deg $n_a = 1.0$	Height ft	p	$-h_p$ ft	h_p ft	p	ΔW lbf	C_L	$\frac{-\eta}{n_a C_L}$ deg
0.95	-1.2	317	35380	0.985	1.4	-4.1	276	0.9	0.9	-1.23	37700	—	+700	38400	0.20	4030	0.288	-4.27
0.9	-1.0	324	35100	1.0	1.35	-4.9	292	0.95	0.95	-1.8	37800	—	+925	38725	0.197	3986	0.263	-6.84
0.7	-1.25	359	36100	1.05	0.9	-3.3	311	1.0	1.0	-2.09	36900	—	+1275	38125	0.203	3942	0.231	-9.05
1.1	-0.6	377	35900	1.1	1.15	-3.3	342	1.05	1.05	-2.05	38050	0.202				3898	0.211	-9.72
0.95	+0.25	395	35950	1.15	1.15	-3.3	352	1.1	1.1	-2.41	37800	0.206				3854	0.189	-12.75
1.0	+0.5	412	35900	1.2	1.2	-3.5	392	1.15	1.15	-2.56	36700	0.217				3810	0.164	-15.61
1.0	-0.75	431	35900	1.25	1.15	-3.5	410	1.2	1.2	-2.1	36050	0.224				3766	0.146	-14.38
1.0	-1.0	449	35850	1.3	1.2	-3.7	431	1.25	1.25	-1.82	35500	0.23				3721	0.131	-13.89
0.9	-1.0	468	35650	1.34	1.05	-3.3	456	1.3	1.3	-1.84	35000	0.235				3676	0.119	-15.46
1.1	-1.5	480	35300	1.36	1.35	-5.0	478	1.35	1.35	-2.11	35430	0.231				3631	0.112	-18.84
0.9	-1.5	489	35750	1.4														



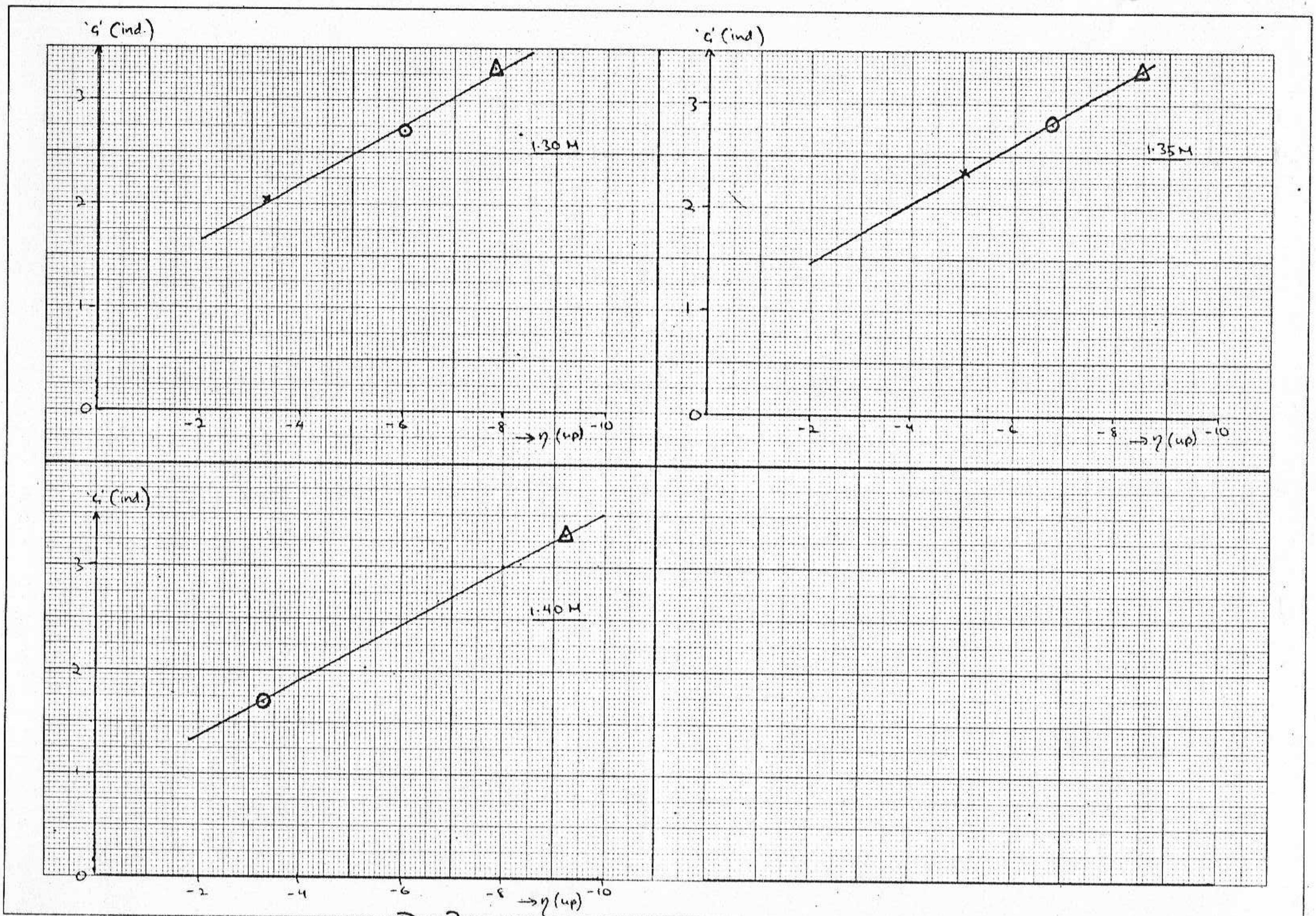
η VERSUS IMN PLOT FOR
n_a = 0 (ACCELERATION)
n_a = 1.0 ; 1.5 ; 2.0 (DECELERATION)
η [degrees]
-7
-6
-5
-4
-3
-2
-1
0
.9
1.0
1.1
1.2
1.3
1.4
I. Mach Number
n_a = 2.0
n_a = 1.5
n_a = 1.0
n_a = 0

PLOTS OF "G" VERSUS η FOR IMN 0.9 TO 1.4 (0.05 INCREMENTS)

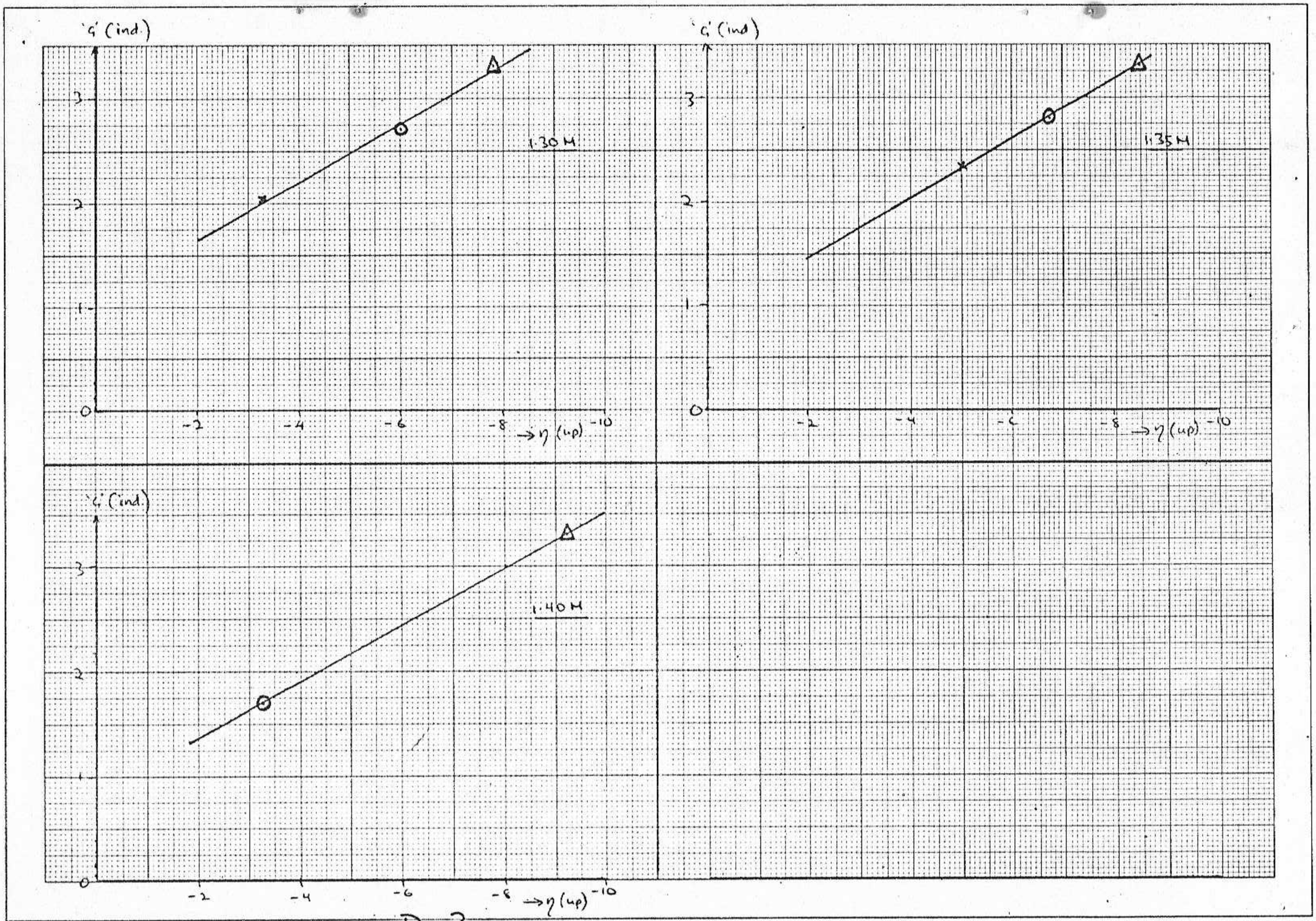




D-2

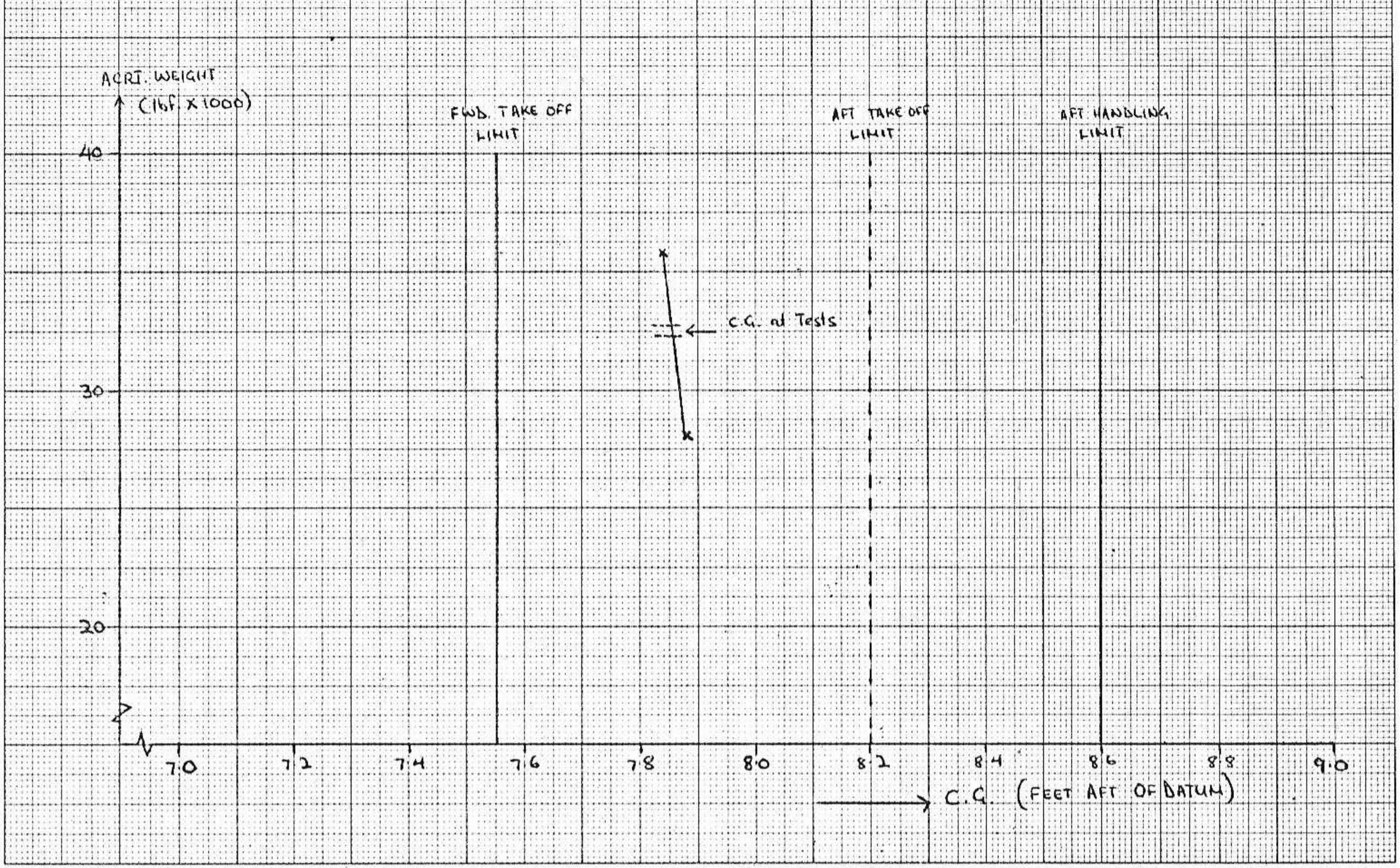


D-3

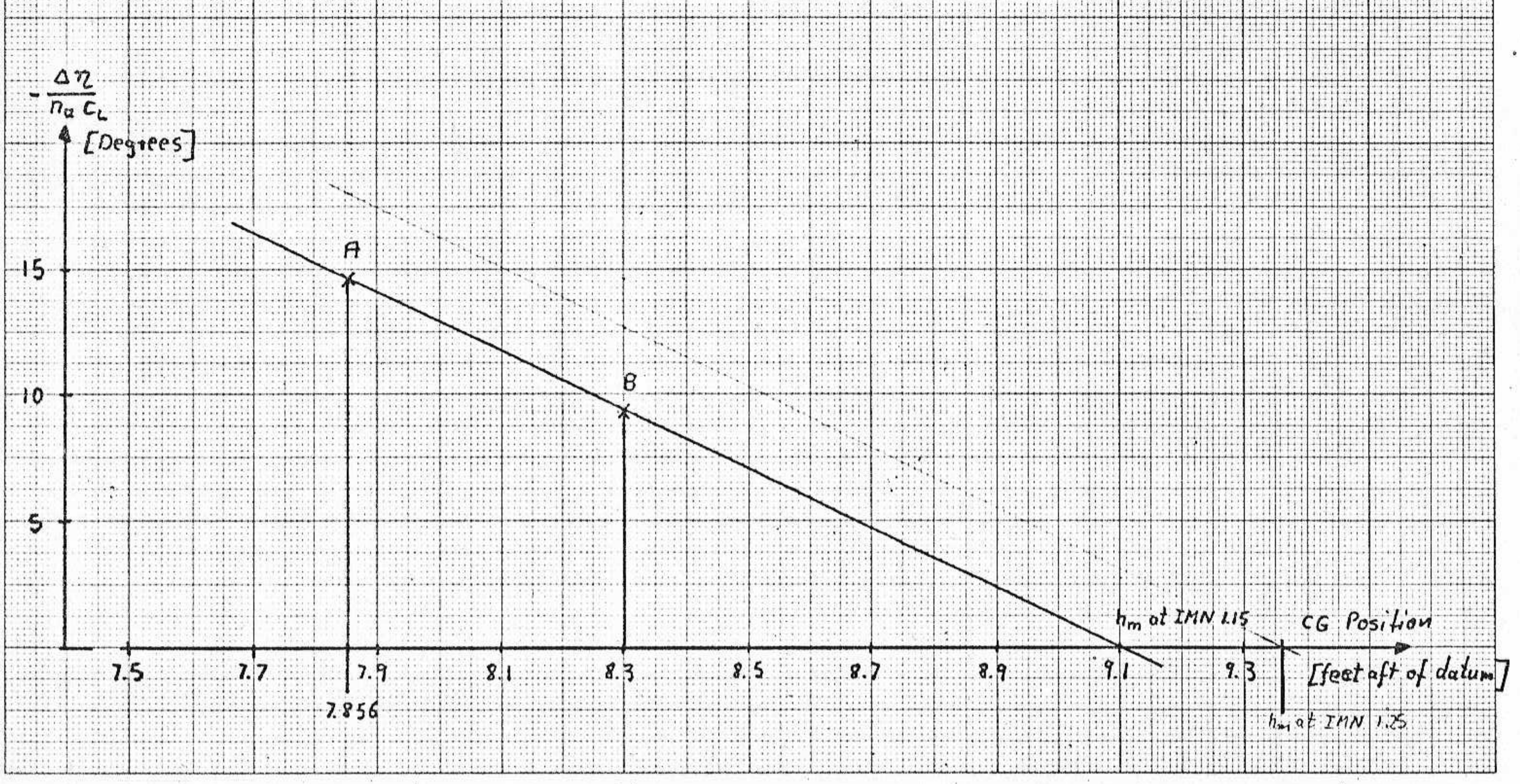


D-3

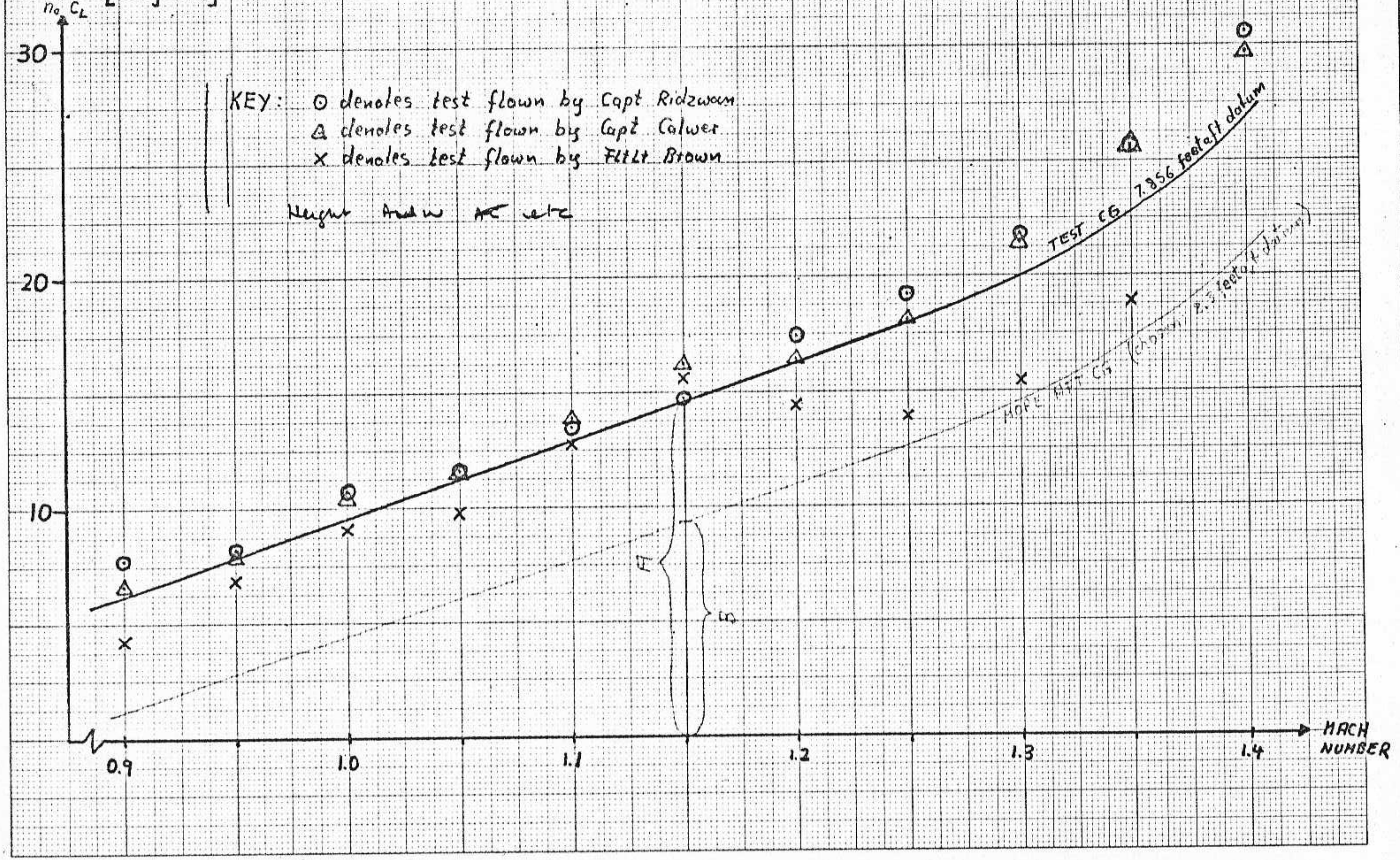
PLOT OF AC WEIGHT VERSUS CG POSITION



$\frac{\Delta\eta}{n_a C_L}$ VERSUS CG POSITION PLOT



$\frac{\Delta\eta}{n_a C_L}$ VERSUS IMN PLOT



EMPIRE TEST PILOTS' SCHOOL.

FLIGHT TEST REPORT.

TEST:- SHORT PERIOD OSCILLATIONS DATE OF TEST:- MAY 78 AIRCRAFT:- LIGHTNING T MK 5 No.:- XS 422 PILOT:- BROWN

C.G.:- 33.47% SMC on start WEIGHT:- 35753lbf on start CONFIGURATION:- CLEAN

AUTOSTABILIZATION (a)	IAS K (b)	INDICATED ALTITUDE ft (c)	ALTIMETER PEC ft (d)	TRUE ALTITUDE ft (e)	TRUE MACH NO (f)	OSCILLATORY PERIOD T sec (g)	$t_{1/2}$ sec (h)	DAMPING RATIO (i)	OSCILLATORY FREQUENCY Hz (j)	
IN	297	35950	+875	36825	0.94	/	0.6	≃ 1	/	
OUT	302	35550	+900	36450	0.945	2.5	0.8	0.32	0.4	
IN	473	35450	0	35450	1.35	1.25	0.29	0.43	0.8	
OUT	478	35250	0	35250	1.35	1.3	0.72	0.19	0.77	
IN	503	4750	+810	5560	0.855	/	0.2	≃ 1	/	
OUT	502	4800	+810	5610	0.855	1.6	0.43	0.375	0.625	
IN	417	4850	+475	5325	0.71	/	0.4	≃ 1	/	
OUT	403	5050	+475	5525	0.69	2.0	1.06	0.195	0.5	POOR OSCILLATION (PERIOD GOOD DAMPING POOR)
IN	285	5050	+180	5230	0.49	/	0.5	≃ 1	/	
OUT	275	4900	+175	5075	0.47	3.6	0.6	0.57	0.28	

PILOTS' SIGNATURE:- J. Brown

ANNEX H
No 80
LONGITUDINAL MANOEUVRE STABILITY
LIGHTNING T5
XS 422
DATED 9 JUN 78

EMPIRE TEST PILOTS' SCHOOL.

FLIGHT TEST REPORT.

TEST:- SHORT PERIOD OSCILLATIONS DATE OF TEST:- MAY 78 AIRCRAFT:- LIGHTNING T MK 5 Nº:- XS 422 PILOT:- RIDZWAN

C.G:- 33.47% SMC on start WEIGHT:- 35753 on start CONFIGURATION:- CLEAN

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
IN	297	34300	700	35000	0.9	—	0.67	1.06	—	
OUT	301	34600	700	35300	0.9	2.66	1.01	0.27	0.38	
IN	452	35900	0	35900	1.3	1.28	0.4	0.33	0.78	
OUT	432	36100	0	36100	1.25	1.42	0.81	0.18	0.7	
IN	507	9850	1200	11,050	0.94	—	0.29	1.22	—	
OUT	498	9800	1100	10,900	0.92	1.28	0.55	0.32	0.78	
IN	398	9300	550	9850	0.74	—	APERIODIC BUT TRACE TOO POOR TO BE ANALYSED			
OUT	400	9400	550	9950	0.74	1.82	0.76	0.26	0.55	
IN	257	10500	0	10,500	0.48	—	0.97	1.32	—	
OUT	260	10500	0	10,500	0.48	3.4	1.19	0.29	0.29	

PILOTS' SIGNATURE:-

M.Nº 8

EMPIRE TEST PILOTS' SCHOOL.

FLIGHT TEST REPORT.

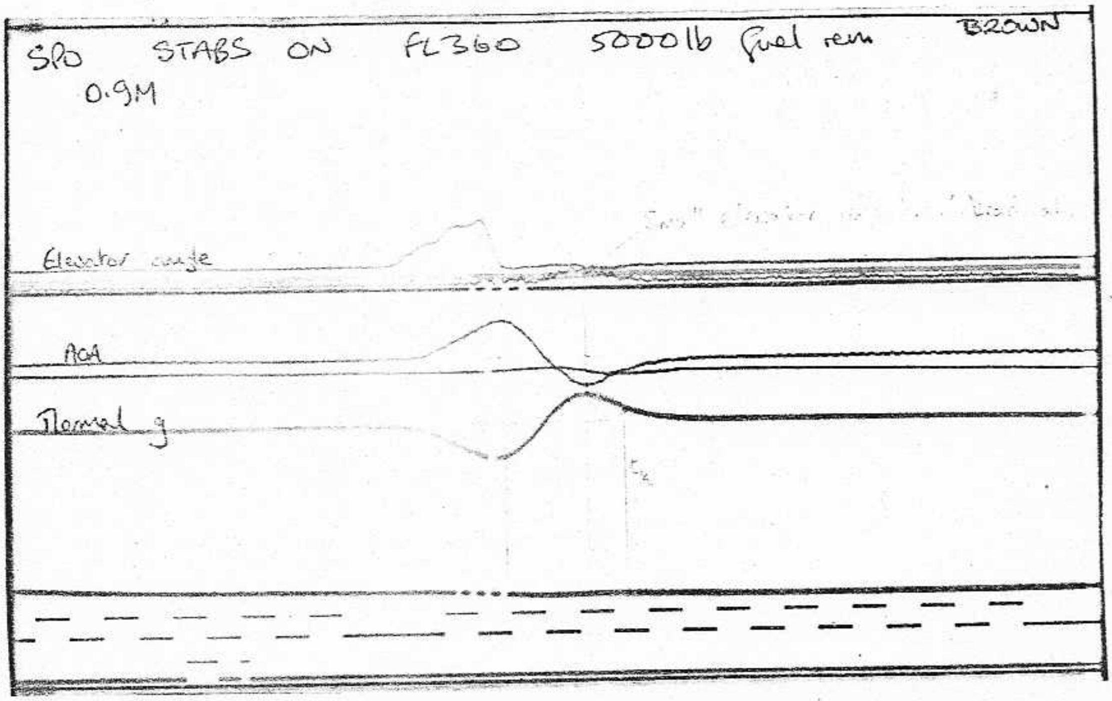
TEST:- SHORT PERIOD OSCILLATIONS DATE OF TEST:- MAY 78 AIRCRAFT:- LIGHTNING T MK 5. Nº:- XS 422 PILOT:- CALWER

C.G:- 33.47% SMC on start WEIGHT:- 35753 lbf on start CONFIGURATION:- CLEAN

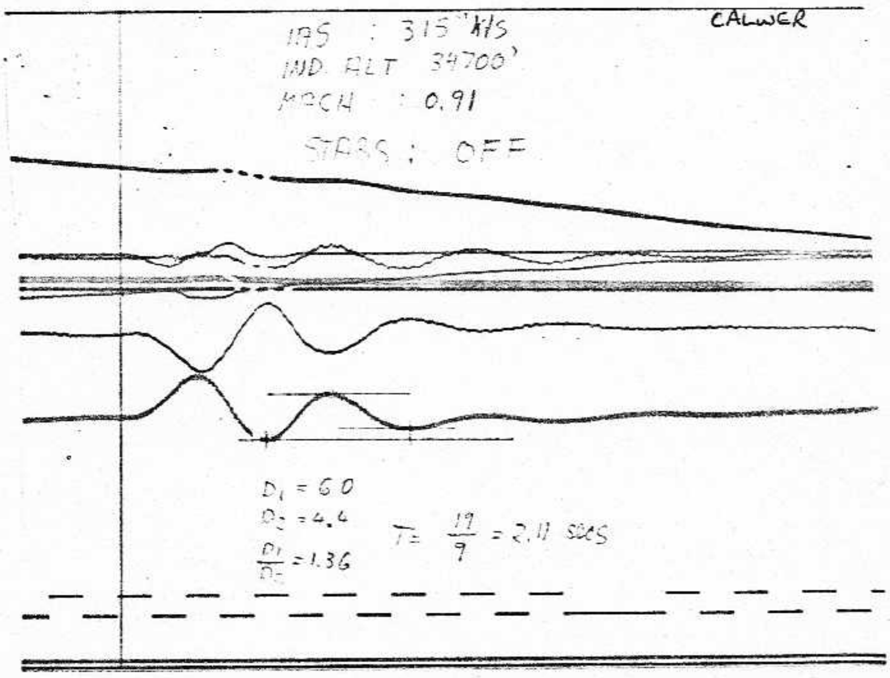
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
IN									
OUT	315	34700	+750	35950	0.91	2.11	2.11	0.1	0.47
IN									
OUT	451	35750	0	35750	1.3	1.34	0.79	0.18	0.75
IN	505	4650	+810	5460	0.855	/	0.44	1.19	/
OUT	505	4800	+810	5410	0.855	1.5	0.41	0.37	0.67
IN									
OUT	398	5250	+450	5700	0,675	2.22	0.44	0.48	0.45
IN	257	4900	+150	5150	0.425				
OUT	248	5100	+150	5250	0.42	3.39	1.08	0.32	0.295

PILOTS' SIGNATURE:-

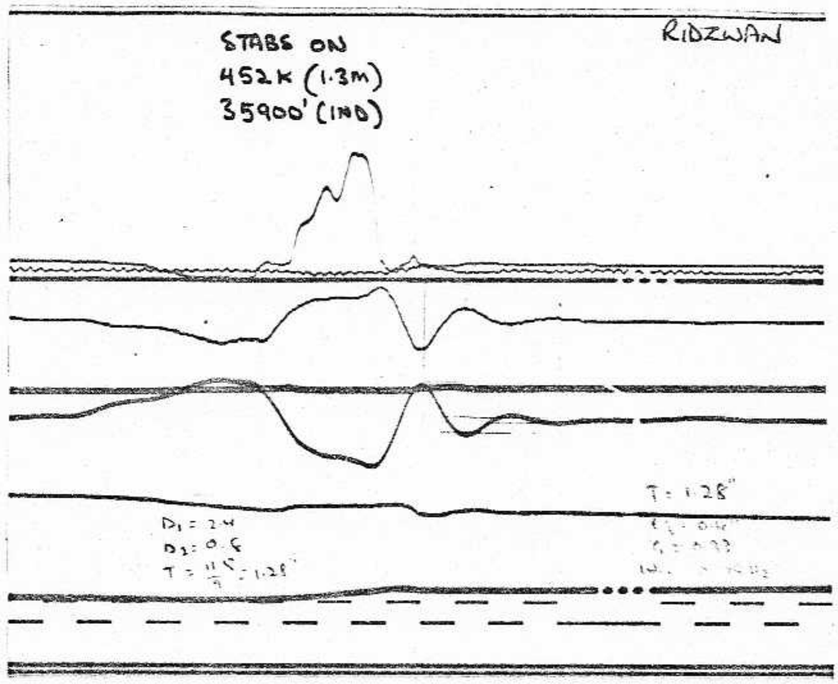
M.Nº



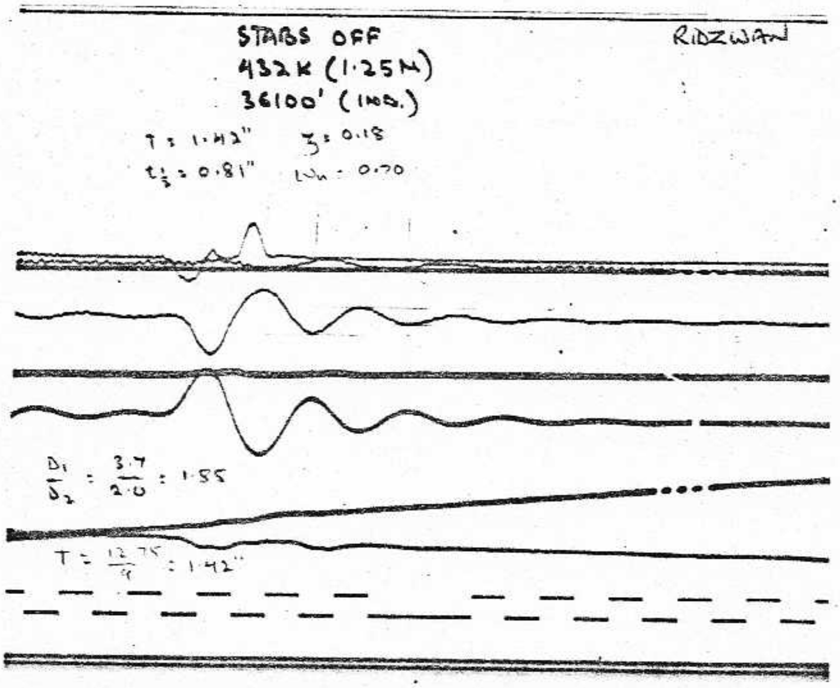
SPO, 0.94M, 36,825ft, AUTOSTABILIZATION ~~OUT~~ IN



SPO, 0.91M, 34,700ft, AUTOSTABILIZATION ~~IN~~ OUT



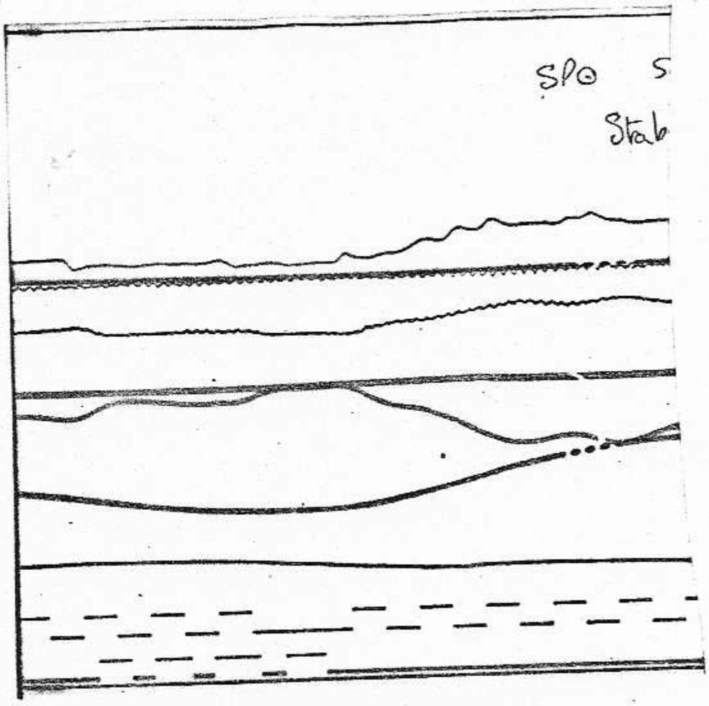
SPO, 1.3M, 36,100ft, AUTOSTABILIZATION IN



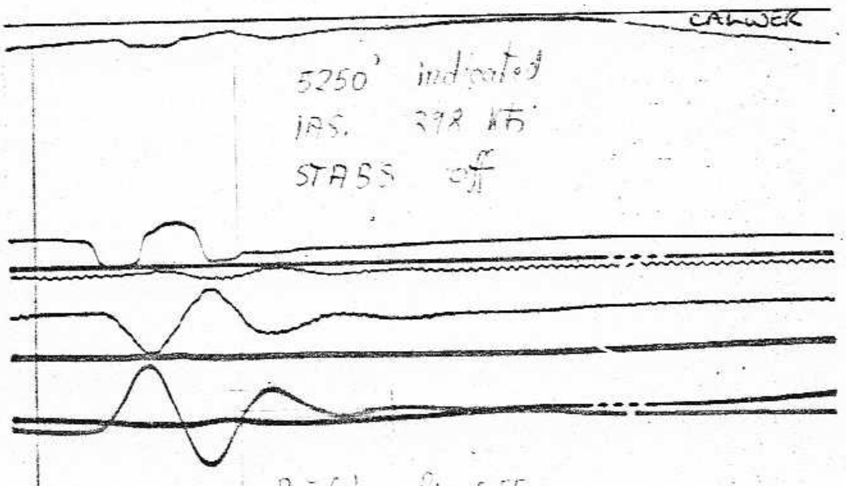
SPO, 1.25M, 35,900ft, AUTOSTABILIZATION OUT

LEFT : SPO 503K 5560ft AUTOSTABILIZATION IN

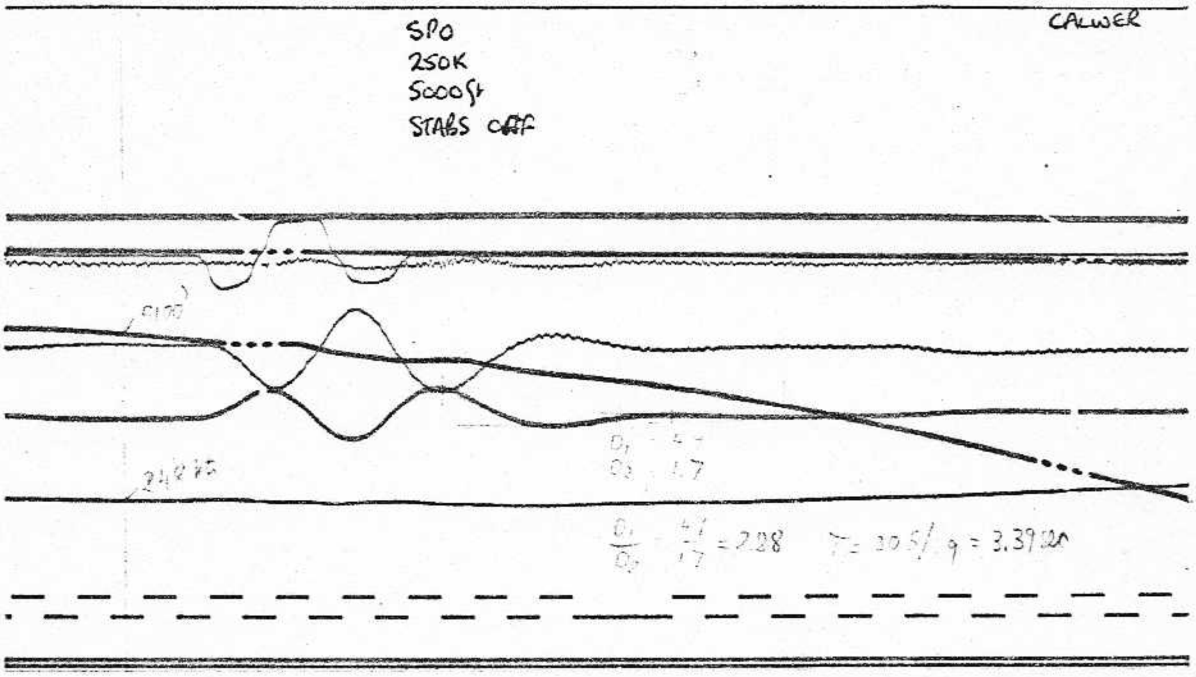
RIGHT : SPO 502K 5610ft AUTOSTABILIZATION OUT



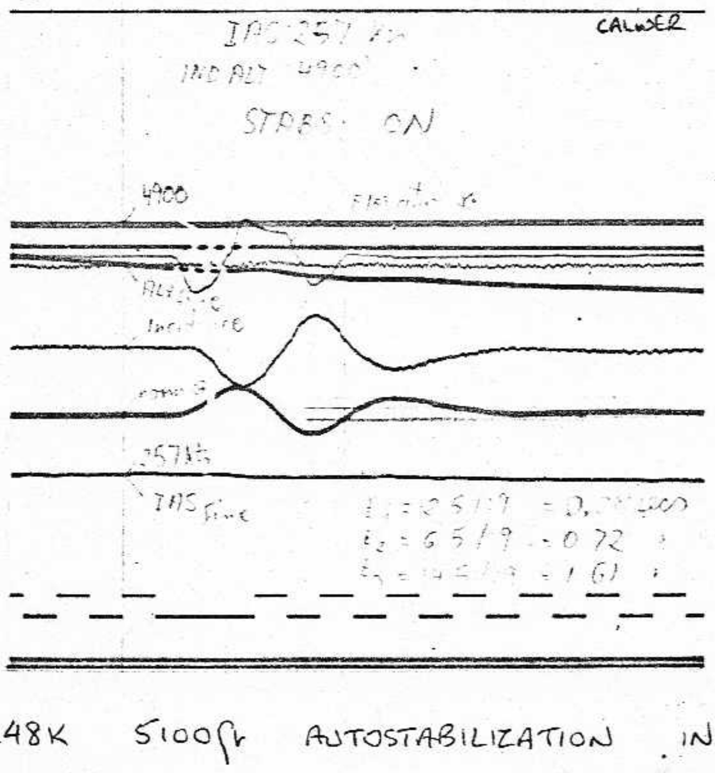
SPO, 417K, 5325ft, AUTOSTABILIZATION IN



SPO, 398K, 5250ft, AUTOSTABILIZATION OUT

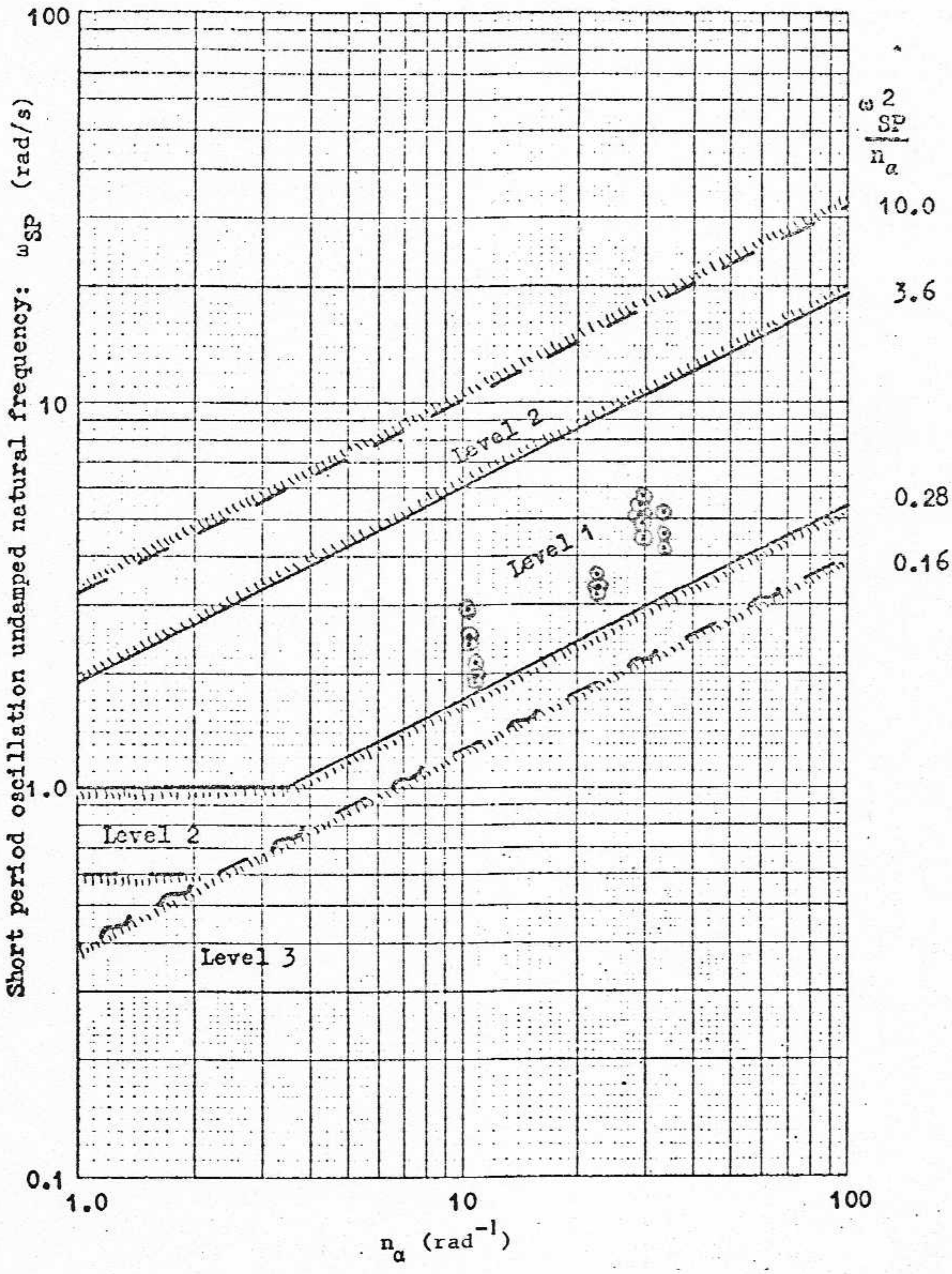


SPO 257K 4900ft AUTOSTABILIZATION OUT



SPO 248K 5100ft AUTOSTABILIZATION IN

ANNEX K TO
LONGITUDINAL
MANOEUVRE
STABILITY
LIGHTNING T MKS
XS 422
DATED 9 JUN 78

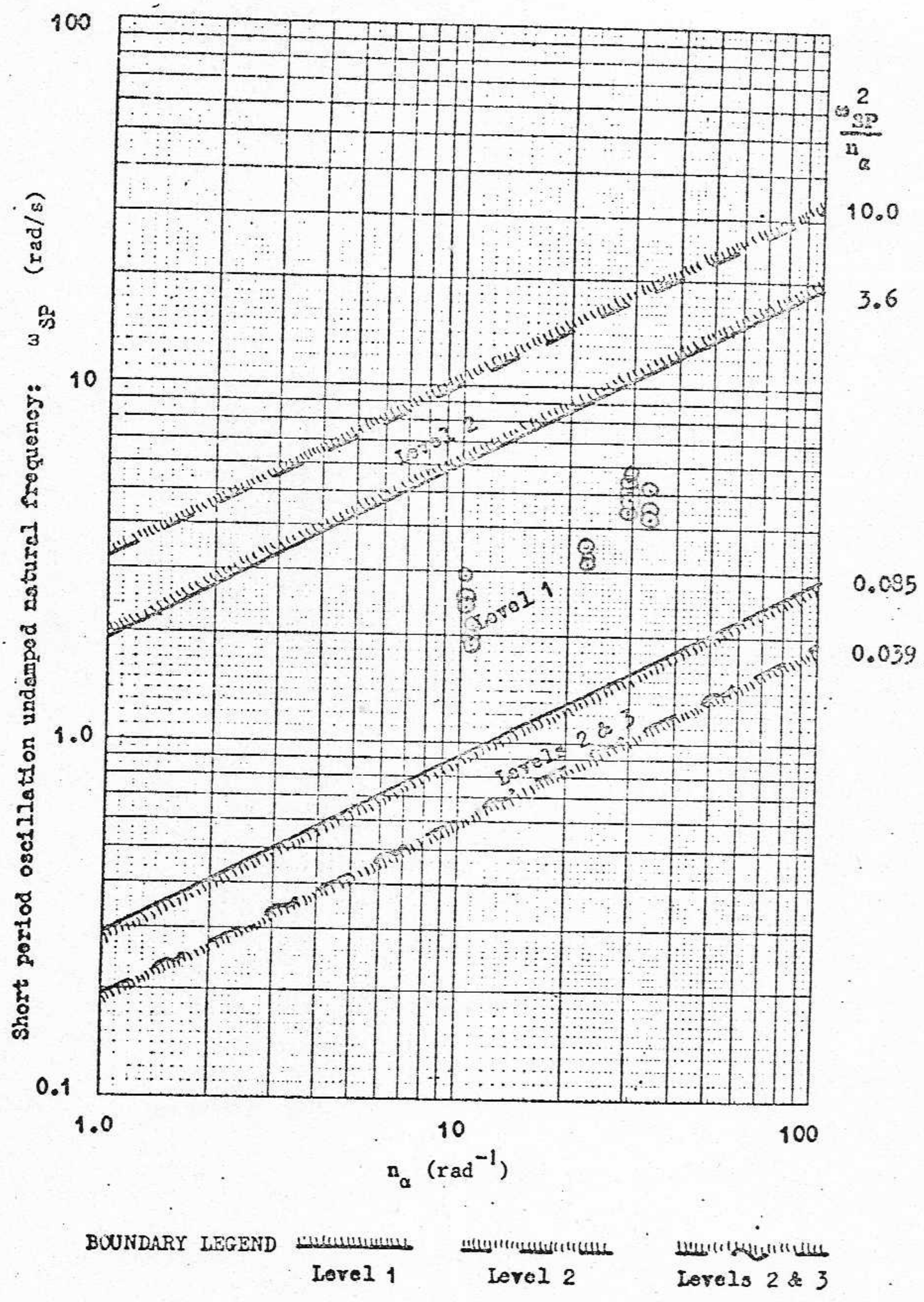


BOUNDARY LEGEND Level 1 Level 2 Level 3 Levels 2 & 3

NOTE The boundaries for values of n_α outside the range shown are defined by straight line extensions

Fig.1 Short Period Frequency Requirements - Category A Flight Phases

MEMO 31/A



NOTE The boundaries for values of n_α outside the range shown are defined by straight line extensions

Fig.2 Short Period Frequency Requirements - Category B Flight Phases