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APPENDIX III
**NF-104A AEROSPACE
TRAINER EVALUATION**

CLENDON L. HENDRICKSON
Project Engineer

ROBERT W. SMITH, Major, USAF
Project Pilot

TECHNICAL REPORT No. 65-37

JANUARY 1966

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412TW-PA-16243

412TH TEST WING
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE

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APPENDIX III

NF-104A AEROSPACE TRAINER EVALUATION

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This appendix III to the NF-104A Aerospace Trainer Evaluation Report presents most of the data used in report preparation. Two of the references used in writing the report are also included to make them readily available.

Test day takeoff data, as obtained from the Askania phototheodolite cameras, are presented. Adequate information is included in the heading of each set of takeoff data to correct that data to sea level standard day conditions.

Instrument corrected aircraft data are presented for the subsonic climb, acceleration, and level flight speed-power flights. The weather data used to correct this data to standard day conditions can be found after the data that pertains to each flight. The test day J79 engine fuel flow data can be found at the end of each section.

Instrument corrected aircraft data are also presented for some of the zoom climb maneuvers conducted during the test program. In addition, data obtained from the Askania tracking cameras and the Nike radar are presented for some of the zoom climb maneuvers. Due to difficulties in tracking, the Askania and Nike radar data did not always include the entire zoom maneuver. The weather data used to "standardize" this data can be found at the end of the instrument corrected data for each flight. Occasionally the weather data and the Nike radar data are included on the same page as the instrument corrected data. The test day J79 engine fuel flow data can be found at the end of the zoom climb data.

TABLE OF CONTENTS

LIST OF SYMBOLS	V
TAKEOFF DATA	1
SUBSONIC CLIMB DATA	12
SPEED POWER DATA	14
ACCELERATION DATA	16
ZOOM CLIMB MANEUVER DATA	25
NF-104A LATERAL-DIRECTIONAL STABILITY ANALYSIS	87
NF-104A AND F-104A ANALOG SIMULATION SUPPORT	110

LIST OF SYMBOLS

Symbol	Definition	Units
A/CD	object flight path heading clockwise from true north	deg
C/N	counter number	sec
EGT	J79 exhaust gas temperature	deg C
H	altitude in feet above mean sea level for spherical earth	ft
MT	Mach number	dimensionless
PA	ambient pressure	lb per sq ft
Q	impact pressure = $P_a \times [(1+0.2M_{ct}^2)^{3.5}-1]$	lb per sq ft
RC	down range distance as an geocentric arc length. (From origin toward heading is positive.)	ft
rpm	J79 engine rotor speed	pct
T	time	sec
TA	ambient temperature	deg Rankine
TIC	indicated temperature corrected for instrument error	deg C
VRC	velocity for RC	fps
VT	speed along the flight path referenced to a fixed point on the surface of the earth	fps
VTW	wind corrected speed along the flight path referenced to a fixed point on the surface of the earth	fps
VXR	velocity for XR	fps
WD	wind source direction from true north at point altitude	deg
WF H2O2	rocket engine oxidizer flow	lb per sec
WF JP4	rocket engine fuel flow	lb per sec
WF TOT J79	J79 engine and afterburner fuel flow	lb per hr
XR	cross range distance perpendicular to the range headings (left is positive)	ft

TAKEOFF DATA

TAKE-OFF AND LANDING DATA

TAKE-OFF TWO STATION SOLUTION

ASKANIA ONE
 163-516 TAKEOFF 12 Nov 1963 1204 NF104-76
 FLIGHT 2
 DATE 12-11-63
 GROUND SPEED AT 400 FT/SEC
 GROUND SPEED AT 50 FT 552 FT/SEC
 AVG PT 7 IN HG
 WIND 0 KNOTS AT 0 DEGREES
 RUNWAY 22

GROUND ROLL 7440 FT
 AIR DISTANCE 6380 FT
 GROSS WEIGHT 21890 LBS
 AMBIENT PRES 27.75 IN HG
 AMBIENT TEMP 22.4 DEG C
 FLAP SETTING T.O.
 POWER USED Maximum Power

TIME	DISTANCE	HEIGHT	GROUND	ACCELERATION
HR MM SEC	FT, ZEROED	FEET	VELOCITY FT/SEC	FT/SEC/SEC
00 00 00	0	0	13.36	13.35
00 00 10.00	18.53	0	26.71	13.36
00 00 20.00	54.49	0	40.07	13.37
00 00 30.00	99.57	0	53.43	13.38
00 00 40.00	159.43	0	66.90	13.38
00 00 50.00	233.72	0	80.12	13.35
00 00 60.00	320.20	0	93.65	13.29
00 00 70.00	421.08	0	106.99	13.19
00 00 80.00	534.31	0	120.05	13.09
00 00 90.00	661.23	0	133.11	12.95
00 01 00.00	801.66	0	145.88	12.83
00 01 10.00	953.21	0	158.73	12.73
00 01 20.00	1118.67	0	171.51	12.78
00 01 30.00	1295.73	0	184.33	12.74
00 01 40.00	1487.12	0	197.09	12.66
00 01 50.00	1690.85	0	209.72	12.56
00 01 60.00	1907.53	0	222.27	12.43
00 01 70.00	2135.09	0	234.62	12.26
00 01 80.00	2376.37	0	246.35	12.04
00 01 90.00	2629.31	0	257.83	11.79
00 02 00.00	2894.94	0	270.57	11.51
00 02 10.00	3171.76	0	281.35	11.23
00 02 20.00	3459.31	0	292.39	10.91
00 02 30.00	3757.65	0	303.57	10.55
00 02 40.00	4066.66	0	314.20	10.19
00 02 50.00	4387.24	0	324.62	9.84
00 03 00.00	4725.25	0	334.94	10.02
00 03 10.00	5081.67	0	321.66	9.63
00 03 20.00	5455.21	0	324.25	9.73
00 03 30.00	5845.95	0	326.55	9.82
00 03 40.00	6254.45	0	328.96	9.74
00 03 50.00	6682.09	0	331.47	9.34
00 04 00.00	7129.69	0	333.88	10.17
00 04 10.00	7598.39	0	336.32	10.50
00 04 20.00	8083.06	0	339.05	10.73
00 04 30.00	8583.16	0	341.93	10.91

TIME	DISTANCE	HEIGHT	GROUND	ACCELERATION
HR MM SEC	FT, ZEROED	FEET	VELOCITY FT/SEC	FT/SEC/SEC
00 00 27.00	505.02	0	344.77	10.41
00 00 27.25	5140.40	0	347.39	10.43
00 00 27.50	5227.52	0	350.05	10.79
00 00 27.75	5315.78	0	352.41	9.77
00 00 28.00	5406.05	0	354.76	9.66
00 00 28.25	5493.12	0	357.15	9.64
00 00 28.50	5582.31	0	359.48	9.79
00 00 28.75	5672.54	0	362.06	9.86
00 00 29.00	5763.61	0	364.52	9.94
00 00 29.25	5855.05	0	367.10	10.26
00 00 29.50	5947.13	0	369.64	10.22
00 00 29.75	6039.62	0	372.03	10.48
00 00 30.00	6132.97	0	374.67	10.66
00 00 30.25	6226.81	0	377.50	10.46
00 00 30.50	6321.89	0	380.31	9.70
00 00 30.75	6417.06	0	382.89	9.26
00 00 31.00	6512.00	0	384.73	8.63
00 00 31.25	6610.00	0	386.62	8.43
00 00 31.50	6707.09	0	388.73	8.62
00 00 31.75	6803.39	0	390.90	9.12
00 00 32.00	6901.87	0	393.31	9.43
00 00 32.25	7000.62	0	395.96	9.52
00 00 32.50	7100.12	0	398.45	9.18
00 00 32.75	7199.96	0	400.50	9.46
00 00 33.00	7300.29	-0.09	402.83	9.47
00 00 33.25	7401.04	0.09	405.12	9.65
00 00 33.50	7502.67	0.72	407.75	10.11
00 00 33.75	7605.15	1.36	410.22	10.25
00 00 34.00	7707.81	1.93	412.85	10.47
00 00 34.25	7811.66	2.51	415.47	10.44
00 00 34.50	7915.36	3.21	418.15	10.42
00 00 34.75	8020.40	3.56	420.88	9.78
00 00 35.00	8126.79	4.13	423.34	9.14
00 00 35.25	8232.38	4.72	425.75	9.14
00 00 35.50	8339.13	6.09	427.55	7.11
00 00 35.75	8446.28	7.30	428.91	6.26
00 00 36.00	8553.85	8.17	430.38	6.26
00 00 36.25	8661.56	8.33	431.73	6.32
00 00 36.50	8769.21	9.43	433.39	7.94
00 00 36.75	8878.13	9.80	435.46	9.35
00 00 37.00	8988.91	9.99	438.04	10.13
00 00 37.25	9096.68	10.47	441.04	10.74
00 00 37.50	9207.36	10.91	443.74	11.31
00 00 37.75	9319.75	11.62	446.72	11.36
00 00 38.00	9431.02	12.34	449.55	11.23
00 00 38.25	9543.34	13.13	452.34	11.33
00 00 38.50	9656.84	13.77	455.11	11.27
00 00 38.75	9771.12	14.15	457.94	11.23
00 00 39.00	9886.00	15.55	460.34	11.13
00 00 39.25	10001.47	16.58	462.62	11.11
00 00 39.50	10117.73	16.83	464.43	11.40
00 00 39.75	10234.59	17.46	466.33	11.33
00 00 40.00	10352.39	18.16	472.27	11.32
00 00 40.25	10470.82	19.23	477.02	11.21
00 00 40.50	10589.98	20.06	477.84	11.17

TAKE-OFF AND LANDING DATA

TAKE-OFF TWO STATION SOLUTION

ASKANIA ONE
 163-552 TAKEOFF 4 DEC 1963 9279 F104760
 FLIGHT 5
 DATE 4-12-63
 GROUND SPEED AT 400 FT/SEC
 GROUND SPEED AT 50 FT 470 FT/SEC
 AVG PT 7 IN HG
 WIND 0 KNOTS AT 0 DEGREES
 RUNWAY 22

GROUND ROLL 5780
 AIR DISTANCE 1910
 GROSS WEIGHT 21876 LBS
 AMBIENT PRES 27.78 IN HG
 AMBIENT TEMP 13.2 DEG C
 FLAP SETTING T.O.
 POWER USED Maximum Power

TIME	DISTANCE	HEIGHT	GROUND	ACCELERATION
HR MM SEC	FT, ZEROED	FEET	VELOCITY FT/SEC	FT/SEC/SEC
00 00 10.00	27.44	0	22.29	12.29
00 00 20.00	72.29	0	44.47	11.54
00 00 30.00	127.13	0	67.92	13.27
00 00 40.00	196.92	0	78.55	13.44
00 00 50.00	280.49	0	89.98	13.44
00 01 00.00	378.99	0	102.42	13.33
00 01 10.00	487.61	0	116.76	13.28
00 01 20.00	610.78	0	130.00	13.11
00 01 30.00	747.40	0	143.18	13.11
00 01 40.00	897.45	0	156.12	12.89
00 01 50.00	1060.23	0	169.94	12.74
00 02 00.00	1236.02	0	181.58	12.57
00 02 10.00	1423.61	0	194.10	12.44
00 02 20.00	1623.88	0	206.50	12.29
00 02 30.00	1836.72	0	218.70	12.14
00 02 40.00	2069.06	0	230.78	11.99
00 02 50.00	2294.18	0	242.66	11.84
00 03 00.00	2547.44	0	254.40	11.70
00 03 10.00	2807.68	0	266.00	11.61
00 03 20.00	3079.62	0	277.51	11.52
00 03 30.00	3363.29	0	289.00	11.46
00 03 40.00	3657.48	0	300.44	11.41
00 03 50.00	3963.76	0	311.83	11.26
00 04 00.00	4281.26	0	323.15	11.02
00 04 10.00	4362.89	0	325.77	10.91
00 04 20.00	4527.10	0	331.25	10.87
00 04 30.00	4693.96	0	333.83	10.84
00 04 40.00	4693.86	0	336.36	11.14
00 04 50.00	4778.53	0	338.47	11.68
00 05 00.00	4863.37	0	342.29	10.71
00 05 10.00	4949.49	0	344.97	10.39
00 05 20.00	5036.27	0	347.31	10.11
00 05 30.00	5123.22	0	349.41	11.07
00 05 40.00	5211.17	0	352.24	10.23
00 05 50.00	5299.13	0	354.77	10.47

TAKE-OFF AND LANDING DATA

TAKI-OFF IMP STATION SOLUTION GROUND ROLL 4756 FT
 AIR DISTANCE 2804 FT
 ASKANIA ONE GROSS WEIGHT 21876 LBS
 T63-560 TAKEOFF 06 DEC 1963 0947 NF104-76 AMBIENT PRES 27.83 IN HG
 FLIGHT 0 AMBIENT TEMP 7.0 DEG C
 RUN 0 FLAP SETTING T.O.
 DAT 6-12-63 POWER USED MAXIMUM POWER
 GROUND SPEED AT MWP FT/SEC
 GROUND SPEED AT T0 346 FT/SEC
 GROUND SPEED AT 50 FT 406 FT/SEC
 AVG PIT 14.11 FT
 WIND 2.0 KNOTS AT 350.00 FEET MAGNETIC
 RUNWAY 22

TIME H:MM:SS	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC	TIME H:MM:SS	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 00	0	0	0.56	11.30	00 02 00	4.41	0	12.52	11.75
00 00 10	26.79	0	26.47	12.13	00 02 10	36.43	0	49.26	12.91
00 00 20	56.98	0	52.10	13.31	00 02 20	77.19	0	62.10	13.51
00 00 30	95.90	0	75.97	13.61	00 02 30	150.41	0	92.12	13.75
00 00 40	150.41	0	103.98	13.81	00 02 40	219.61	0	117.63	13.73
00 00 50	304.291	0	144.95	13.66	00 03 00	400.30	0	131.27	13.65
00 01 00	400.30	0	158.48	13.55	00 03 10	511.79	0	144.95	13.66
00 01 10	635.86	0	172.05	13.47	00 03 20	774.19	0	185.52	13.37
00 01 20	925.72	0	198.86	13.24	00 03 30	1019.73	0	212.01	13.08
00 01 30	1091.73	0	225.07	12.90	00 03 40	1269.89	0	237.87	12.57
00 01 40	1269.89	0	252.07	12.31	00 03 50	1462.43	0	259.52	12.39
00 01 50	1462.43	0	275.21	12.31	00 04 00	1668.13	0	302.83	12.30
00 02 00	2619.98	0	287.34	12.31	00 04 10	1887.23	0	306.08	12.16
00 02 10	2809.34	0	299.52	12.39	00 04 20	2116.63	0	309.00	11.98
00 02 20	3170.56	0	302.83	12.30	00 04 30	2361.03	0	311.95	11.53
00 02 30	3461.99	0	306.08	12.16	00 04 40	2619.98	0	314.79	11.29
00 02 40	3692.08	0	309.00	11.98	00 04 50	2889.34	0	323.11	11.21
00 02 50	3870.01	0	311.95	11.53	00 05 00	3174.56	0	325.89	11.30
00 03 00	4071.34	0	314.79	11.29	00 05 10	3374.56	0	328.74	11.16
00 03 10	4290.29	0	320.18	11.17	00 05 20	3574.56	0	331.94	11.34
00 03 20	4497.75	0	323.11	11.21	00 05 30	3762.08	0	337.24	11.52
00 03 30	4684.71	0	325.89	11.30					
00 03 40	4861.16	0	328.74	11.16					
00 03 50	5027.44	0	331.94	11.34					
00 04 00	5173.47	0	337.24	11.52					

TIME H:MM:SS	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 04 00	10297.00	344.83	499.38	7.24
00 04 05	10393.01	398.43	461.33	6.96
00 04 10	10468.29	372.74	467.46	7.24
00 04 15	10584.57	366.32	464.47	7.21
00 04 20	10701.00	403.09	466.44	6.43
00 04 25	10816.61	416.92	468.96	9.28
00 04 30	10935.09	432.93	471.17	9.51
00 04 35	11052.01	446.30	473.70	9.61
00 04 40	11172.32	467.00	476.39	9.30
00 04 45	11291.02	475.85	478.43	8.99
00 04 50	11410.96	470.68	480.81	8.14
00 04 55	11531.54	504.98	482.65	7.31
00 05 00	11652.74	519.45	484.71	7.08
00 05 05	11774.25	533.68	485.76	7.21
00 05 10	11895.74	548.22	487.26	7.99
00 05 15	12017.91	562.48	489.63	9.00
00 05 20	12139.15	575.59	492.12	9.99
00 05 25	12260.24	590.50	495.05	10.00
00 05 30	12380.24	603.90	497.90	9.21
00 05 35	12501.51	619.26	500.17	8.60
00 05 40	12638.10	633.22	501.64	8.44
00 05 45	12763.86	645.33	503.05	9.31
00 05 50	12889.31	660.44	505.61	11.34
00 05 55	13015.85	673.86	508.64	13.90
00 06 00	13142.88	688.19	512.66	16.21
00 06 05	13271.78	702.13	517.41	18.21
00 06 10	13401.71	716.44	522.16	20.21
00 06 15	13532.96	730.04	526.91	22.22

TAKE-OFF AND LANDING DATA

TAKI-OFF IMP STATION SOLUTION GROUND ROLL 5025 FT
 AIR DISTANCE 2800 FT
 ASKANIA ONE GROSS WEIGHT 21876 LBS
 T63-560 TAKEOFF 06 DEC 1963 1156 NF104 AMBIENT PRES 27.72 IN HG
 FLIGHT 0 AMBIENT TEMP 16.5 DEG C
 RUN 0 FLAP SETTING T.O.
 DAT 6-12-64 POWER USED MAXIMUM POWER
 GROUND SPEED AT MWP FT/SEC
 GROUND SPEED AT T0 346 FT/SEC
 GROUND SPEED AT 50 FT 411 FT/SEC
 AVG PIT 14.11 FT
 WIND 5 KNOTS AT 306.00 FEET MAGNETIC
 RUNWAY 22

TIME H:MM:SS	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 04 00	0	0	0.59	11.34
00 04 10	5.89	0	4.37	11.24
00 04 20	12.76	0	13.33	11.16
00 04 30	29.35	0	22.29	11.08
00 04 40	54.48	0	31.17	10.99
00 04 50	80.52	0	40.32	10.90
00 05 00	139.09	0	56.66	10.81
00 05 10	202.17	0	70.19	10.72
00 05 20	270.23	0	84.13	10.63
00 05 30	370.42	0	97.77	10.54
00 05 40	474.90	0	111.43	10.45
00 05 50	591.48	0	125.13	10.36
00 06 00	729.50	0	137.42	10.27
00 06 10	870.31	0	151.89	10.18
00 06 20	1029.42	0	165.17	10.09
00 06 30	1200.37	0	178.40	10.00
00 06 40	1386.66	0	191.62	9.91
00 06 50	1584.29	0	204.72	9.82
00 07 00	1799.53	0	217.74	9.73
00 07 10	2020.02	0	230.52	9.64
00 07 20	2257.44	0	243.28	9.55
00 07 30	2506.89	0	255.70	9.46
00 07 40	2769.14	0	267.88	9.37
00 07 50	3044.51	0	279.87	9.28
00 08 00	3332.18	0	291.76	9.19
00 08 10	3632.83	0	303.45	9.10
00 08 20	3946.26	0	315.06	9.01
00 08 30	4272.47	0	326.29	8.92
00 08 40	4338.99	0	328.96	8.83
00 08 50	4421.64	0	331.65	8.74
00 09 00	4508.78	0	334.17	8.65
00 09 10	4603.56	0	337.99	8.56
00 09 20	4696.73	0	342.99	8.47
00 09 30	4844.89	0	345.78	8.38
00 09 40	4931.58	0	348.41	8.29
00 09 50	5017.47	0	351.96	8.20

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 29.50	5107.39	0.	393.70	10.81
00 00 29.75	5195.66	0.	396.34	11.15
00 00 30.00	5285.20	0.	399.07	11.32
00 00 30.25	5375.72	0.	402.05	11.30
00 00 30.50	5466.28	0.	405.15	11.19
00 00 30.75	5556.91	0.	408.83	10.77
00 00 31.00	5650.23	0.	410.23	10.28
00 00 31.25	5744.54	0.	412.91	9.81
00 00 31.50	5838.93	0.	415.20	9.73
00 00 31.75	5930.97	-0.	417.57	9.72
00 00 32.00	6025.57	0.38	419.96	9.74
00 00 32.25	6120.91	0.69	422.61	9.79
00 00 32.50	6216.75	1.32	425.01	9.77
00 00 32.75	6313.63	1.98	427.41	9.72
00 00 33.00	6410.89	2.89	429.77	9.57
00 00 33.25	6508.19	3.48	432.19	9.50
00 00 33.50	6606.55	4.62	434.66	9.13
00 00 33.75	6705.55	5.86	436.91	8.20
00 00 34.00	6805.95	7.45	439.21	8.81
00 00 34.25	6905.70	9.67	440.84	5.34
00 00 34.50	7005.69	12.25	441.62	4.35
00 00 34.75	7106.07	15.56	442.12	3.91
00 00 35.00	7207.52	19.70	442.89	4.54
00 00 35.25	7307.49	24.99	444.18	5.97
00 00 35.50	7408.50	29.45	445.69	7.32
00 00 35.75	7510.37	35.18	448.03	8.14
00 00 36.00	7612.79	33.72	449.58	8.41
00 00 36.25	7715.66	37.73	442.74	8.37
00 00 36.50	7819.36	42.46	444.51	8.11
00 00 36.75	7923.39	47.55	446.36	8.17
00 00 37.00	8027.35	53.43	448.38	8.80
00 00 37.25	8131.93	59.12	450.60	9.53
00 00 37.50	8237.47	65.99	453.20	9.95
00 00 37.75	8343.68	71.55	456.06	10.02
00 00 38.00	8450.55	78.07	458.67	9.76
00 00 38.25	8558.17	84.72	460.91	9.16
00 00 38.50	8666.31	91.86	463.07	8.55
00 00 38.75	8774.76	99.37	465.17	8.34
00 00 39.00	8883.99	106.95	467.03	8.41
00 00 39.25	8993.28	114.99	469.02	8.60
00 00 39.50	9103.45	122.19	471.49	8.93
00 00 39.75	9213.64	129.56	474.70	9.39
00 00 40.00	9324.81	137.76	476.71	9.45
00 00 40.25	9437.06	145.14	478.40	9.37
00 00 40.50	9549.24	152.42	480.94	9.37
00 00 40.75	9662.30	160.20	483.13	9.13
00 00 41.00	9775.79	170.78	485.32	8.79
00 00 41.25	9889.08	179.37	487.62	8.32
00 00 41.50	10004.57	189.32	489.70	8.00
00 00 41.75	10119.98	198.72	491.57	7.84
00 00 42.00	10235.64	207.55	493.26	7.89
00 00 42.25	10351.74	216.00	495.17	8.26
00 00 42.50	10468.00	224.22	497.53	8.83
00 00 42.75	10584.81	234.25	499.70	9.35
00 00 43.00	10702.63	244.19	472.18	9.52

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 43.25	10821.89	259.28	474.71	9.36
00 00 43.50	10940.22	270.10	477.12	9.09
00 00 43.75	11059.78	281.09	479.23	8.71
00 00 44.00	11179.83	292.03	481.23	8.37
00 00 44.25	11300.58	302.78	483.38	8.13
00 00 44.50	11421.62	316.42	485.35	8.15
00 00 44.75	11543.20	325.42	487.38	8.31
00 00 45.00	11665.23	337.87	489.29	8.42
00 00 45.25	11787.78	349.61	491.95	8.94
00 00 45.50	11911.02	362.37	493.85	8.54
00 00 45.75	12036.43	374.85	495.96	8.43
00 00 46.00	12161.18	388.35	498.03	8.06
00 00 46.25	12288.03	400.72	500.00	7.79
00 00 46.50	12408.98	413.39	501.94	7.71
00 00 46.75	12529.72	426.79	503.62	7.65
00 00 47.00	12648.91	440.39	505.61	7.75
00 00 47.25	12764.37	468.41	509.59	7.95
00 00 47.50	12882.39	482.99	511.58	8.04

TAKE-OFF AND LANDING DATA

TAKE-OFF TIME STATION SOLUTION GROUND ROLL 6002 FT
 AIR DISTANCE 5568 FT
 GROSS WEIGHT 21880 LBS
 AMBIENT PRESS 22.72 IN HG
 AMBIENT TEMP 18.5 DEG C
 FLAP SETTING TD
 POWER USED MAXIMUM POWER

ASKANIA ONE
 T63-561 TAKEOFF 06 DEC 1963 1402 NFIJ4-76
 FLIGHT 10
 NUM 6-12-63
 GRIND SPEED AT NW 0 FT/SEC
 GRIND SPEED AT TB 375 FT/SEC
 GRIND SPEED AT 50 FT 375 FT/SEC
 AVG PTT 14.80
 WIND 4.0 KNOTS AT 22 DEGREES MAGNETIC
 RUNWAY 22

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 23.35	5209.14	0.	358.83	9.54
00 00 23.50	5290.08	0.	361.35	9.44
00 00 24.25	5380.56	0.	363.60	9.41
00 00 24.50	5471.60	0.	365.93	9.43
00 00 24.75	5561.89	0.	368.17	9.39
00 00 25.00	5656.10	-0.	370.65	9.59
00 00 25.25	5748.85	0.08	373.04	9.93
00 00 25.50	5842.68	0.35	375.39	10.34
00 00 25.75	5936.44	0.60	378.11	10.86
00 00 26.00	6031.48	0.79	381.44	11.09
00 00 26.25	6127.01	1.42	383.80	11.11
00 00 26.50	6223.29	1.83	386.87	10.49
00 00 26.75	6320.61	2.33	389.33	10.17
00 00 27.00	6418.26	2.92	391.88	8.94
00 00 27.25	6516.75	3.31	394.47	7.79
00 00 27.50	6615.09	3.97	395.91	7.12
00 00 27.75	6714.81	4.22	397.01	6.64
00 00 28.00	6815.31	4.74	398.60	7.15
00 00 28.25	6913.68	5.10	400.63	8.64
00 00 28.50	7013.25	5.44	402.48	10.33
00 00 28.75	7115.08	6.19	405.56	11.16
00 00 29.00	7217.06	6.95	409.07	11.74
00 00 29.25	7318.95	7.17	412.49	11.87
00 00 29.50	7421.57	7.93	416.52	11.93
00 00 29.75	7526.73	8.61	417.68	10.18
00 00 30.00	7632.48	9.50	420.28	9.95
00 00 30.25	7736.08	10.14	422.09	10.49
00 00 30.50	7843.91	11.12	424.51	10.53
00 00 30.75	7949.56	11.82	427.59	11.04
00 00 31.00	8056.01	12.68	430.77	11.55
00 00 31.25	8163.73	13.59	433.42	11.27
00 00 31.50	8274.38	14.38	436.39	10.52
00 00 31.75	8382.84	15.07	439.17	10.17
00 00 32.00	8493.59	16.08	441.21	10.23
00 00 32.25	8601.05	17.35	443.26	10.53
00 00 32.50	8714.28	18.28	446.36	11.04
00 00 32.75	8826.20	18.90	449.29	11.52
00 00 33.00	8939.30	19.88	452.58	11.57
00 00 33.25	9052.73	20.86	455.33	11.30
00 00 33.50	9167.28	22.02	457.96	11.14
00 00 33.75	9281.89	23.25	460.44	11.12
00 00 34.00	9397.44	24.41	463.45	11.44
00 00 34.25	9512.97	25.66	466.33	11.75
00 00 34.50	9630.24	27.04	469.37	11.82
00 00 34.75	9748.44	28.46	472.47	11.52
00 00 35.00	9866.76	29.79	475.41	11.31
00 00 35.25	9985.34	31.09	478.04	11.09
00 00 35.50	10105.89	32.66	480.50	11.34
00 00 35.75	10226.08	35.07	483.43	11.35
00 00 36.00	10347.53	35.48	486.78	11.81
00 00 36.25	10468.98	36.53	489.20	12.37
00 00 36.50	10592.06	37.83	492.54	12.45
00 00 36.75	10715.25	39.41	495.64	12.20
00 00 37.00	10839.72	41.39	497.13	11.79
00 00 37.25	10965.11	43.17	501.76	11.4

TIME HR MN SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 037.50	1000.00	48.04	504.14	11.20
00 037.75	1000.00	48.06	506.94	11.10
00 038.00	1000.00	48.88	509.94	11.49
00 038.25	11471.08	51.43	512.85	11.80
00 038.50	11600.00	54.42	515.70	11.63
00 038.75	11730.52	57.01	518.88	11.36
00 039.00	11860.00	60.59	521.78	11.21
00 039.25	11990.16	64.30	524.17	10.96
00 039.50	12121.98	68.52	526.88	10.70
00 039.75	12254.39	71.67	529.78	10.75
00 040.00	12387.32	74.79	532.31	10.86
00 040.25	12520.50	79.90	534.95	11.20
00 040.50	12654.58	85.74	537.86	11.58
00 040.75	12789.04	87.02	540.48	11.99
00 041.00	12924.00	91.51	544.03	11.83
00 041.25	13061.63	96.37	547.16	11.38
00 041.50	13201.66	100.62	550.11	11.33
00 041.75	13343.99	105.06	552.17	10.84
00 042.00	13488.99	109.78	554.58	11.12
00 042.25	13636.96	114.29	558.20	11.82
00 042.50	13787.50	118.96	560.48	12.17
00 042.75	13940.51	123.38	564.17	12.28
00 043.00	14096.61	128.22	567.72	11.93
00 043.25	14255.89	147.97	578.50	11.37
00 043.50	14418.47	170.98	589.78	10.98
00 043.75	14584.30	195.94	600.20	10.82
00 044.00	14754.05	223.89	611.28	10.77
00 044.25	14927.33	255.10	621.93	10.70
00 044.50	15104.30	289.06	632.59	10.64
00 045.00	15277.24	319.96	643.24	10.57

TAKE-OFF AND LANDING DATA

TAKE-OFF TWA STATION SOLUTION

ASKANIA PNI
164-494 16104-760 TAKEOFF 08/04/64 0958
FLIGHT 20
RUN
DATE 08/05/64
GROUND SPEED AT VMP 322 FT/SEC
GROUND SPEED AT T 322 FT/SEC
GROUND SPEED AT 10.1 318 FT/SEC
AVG PT 1 IN HG
WIND 4.0 KNOTS AT 87.8 MAGNETIC
RUNWAY 22

CAPULO RYLL 4088 FT
AIR DISTANCE 7540 FT
GRASS HEIGHT 21644 LBS
AMPIENT PR 5 27.70 IN HG
AMPIENT TEMP 10.7 ING C
FLAP SETTING T.O.
POWER USED MAXIMUM POWER

TIME HR MN SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 0.00	0	0	0	0
00 00 1.00	20.60	0	46.87	13.73
00 00 2.00	57.17	0	60.59	13.72
00 00 3.00	120.67	0	74.24	13.71
00 00 4.00	197.73	0	89.07	13.67
00 00 5.00	290.51	0	101.65	13.59
00 00 6.00	402.72	0	115.02	13.49
00 00 7.00	431.56	0	128.28	13.40
00 00 8.00	544.93	0	141.46	13.33
00 00 9.00	729.83	0	154.60	13.20
00 01 0.00	77.64	0	167.80	13.27
00 01 1.00	100.41	0	181.49	13.20
00 01 2.00	121.35	0	194.71	13.14
00 01 3.00	140.27	0	207.40	13.04
00 01 4.00	148.27	0	220.43	12.94
00 01 5.00	205.53	0	233.62	12.73
00 01 6.00	225.72	0	246.40	12.71
00 01 7.00	243.30	0	258.15	12.61
00 01 8.00	254.15	0	271.73	12.41
00 01 9.00	302.17	0	284.15	12.15
00 02 0.00	315.48	0	297.13	12.07
00 02 1.00	325.42	0	309.62	12.11
00 02 2.00	429.77	0	321.43	12.07
00 02 3.00	537.29	0	332.11	12.11
00 02 4.00	646.44	0	342.23	11.99
00 02 5.00	741.91	0	351.24	11.59
00 02 6.00	834.01	0	359.13	11.38
00 02 7.00	924.81	0	367.83	11.21
00 02 8.00	1014.99	0	376.12	11.16
00 02 9.00	1104.99	0	384.29	11.20
00 03 0.00	1194.41	0	392.26	11.29
00 03 1.00	1283.09	0.14	400.08	11.16
00 03 2.00	1371.18	0.27	407.71	10.99
00 03 3.00	1458.43	0.41	415.23	10.69
00 03 4.00	1544.44	0.53	422.12	10.57

TIME HR MN SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 0.00	0	0	0	0
00 00 1.00	20.60	0	46.87	13.73
00 00 2.00	57.17	0	60.59	13.72
00 00 3.00	120.67	0	74.24	13.71
00 00 4.00	197.73	0	89.07	13.67
00 00 5.00	290.51	0	101.65	13.59
00 00 6.00	402.72	0	115.02	13.49
00 00 7.00	431.56	0	128.28	13.40
00 00 8.00	544.93	0	141.46	13.33
00 00 9.00	729.83	0	154.60	13.20
00 01 0.00	77.64	0	167.80	13.27
00 01 1.00	100.41	0	181.49	13.20
00 01 2.00	121.35	0	194.71	13.14
00 01 3.00	140.27	0	207.40	13.04
00 01 4.00	148.27	0	220.43	12.94
00 01 5.00	205.53	0	233.62	12.73
00 01 6.00	225.72	0	246.40	12.71
00 01 7.00	243.30	0	258.15	12.61
00 01 8.00	254.15	0	271.73	12.41
00 01 9.00	302.17	0	284.15	12.15
00 02 0.00	315.48	0	297.13	12.07
00 02 1.00	325.42	0	309.62	12.11
00 02 2.00	429.77	0	321.43	12.07
00 02 3.00	537.29	0	332.11	12.11
00 02 4.00	646.44	0	342.23	11.99
00 02 5.00	741.91	0	351.24	11.59
00 02 6.00	834.01	0	359.13	11.38
00 02 7.00	924.81	0	367.83	11.21
00 02 8.00	1014.99	0	376.12	11.16
00 02 9.00	1104.99	0	384.29	11.20
00 03 0.00	1194.41	0	392.26	11.29
00 03 1.00	1283.09	0.14	400.08	11.16
00 03 2.00	1371.18	0.27	407.71	10.99
00 03 3.00	1458.43	0.41	415.23	10.69
00 03 4.00	1544.44	0.53	422.12	10.57

TIME HR MN SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 0.00	0	0	0	0
00 00 1.00	20.60	0	46.87	13.73
00 00 2.00	57.17	0	60.59	13.72
00 00 3.00	120.67	0	74.24	13.71
00 00 4.00	197.73	0	89.07	13.67
00 00 5.00	290.51	0	101.65	13.59
00 00 6.00	402.72	0	115.02	13.49
00 00 7.00	431.56	0	128.28	13.40
00 00 8.00	544.93	0	141.46	13.33
00 00 9.00	729.83	0	154.60	13.20
00 01 0.00	77.64	0	167.80	13.27
00 01 1.00	100.41	0	181.49	13.20
00 01 2.00	121.35	0	194.71	13.14
00 01 3.00	140.27	0	207.40	13.04
00 01 4.00	148.27	0	220.43	12.94
00 01 5.00	205.53	0	233.62	12.73
00 01 6.00	225.72	0	246.40	12.71
00 01 7.00	243.30	0	258.15	12.61
00 01 8.00	254.15	0	271.73	12.41
00 01 9.00	302.17	0	284.15	12.15
00 02 0.00	315.48	0	297.13	12.07
00 02 1.00	325.42	0	309.62	12.11
00 02 2.00	429.77	0	321.43	12.07
00 02 3.00	537.29	0	332.11	12.11
00 02 4.00	646.44	0	342.23	11.99
00 02 5.00	741.91	0	351.24	11.59
00 02 6.00	834.01	0	359.13	11.38
00 02 7.00	924.81	0	367.83	11.21
00 02 8.00	1014.99	0	376.12	11.16
00 02 9.00	1104.99	0	384.29	11.20
00 03 0.00	1194.41	0	392.26	11.29
00 03 1.00	1283.09	0.14	400.08	11.16
00 03 2.00	1371.18	0.27	407.71	10.99
00 03 3.00	1458.43	0.41	415.23	10.69
00 03 4.00	1544.44	0.53	422.12	10.57

TAKE-OFF AND LANDING DATA

TIME HR MM SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SQC
00 00 45.25	11642.34	44.70	511.21	18.92
00 00 45.50	11771.56	46.28	505.75	11.16
00 00 46.00	11901.39	48.78	506.76	3.20
00 00 46.00	12033.06	51.04	505.44	-3.13
00 00 46.25	12161.65	52.62	502.75	-5.40
00 00 46.50	12287.40	54.63	500.36	-3.78
00 00 46.75	12414.39	56.83	500.99	-0.04
00 00 47.00	12541.20	58.23	500.11	4.35
00 00 47.25	12669.22	60.82	502.81	8.99
00 00 47.50	12797.35	62.69	505.98	12.59
00 00 47.75	12926.99	64.61	510.23	14.16
00 00 48.00	13056.84	67.01	520.31	14.55
00 00 48.25	13187.27	69.58	527.60	14.45
00 00 48.50	13318.54	72.14	536.95	15.70
00 00 48.75	13450.06	74.58	532.98	11.78
00 00 49.00	13588.47	77.58	536.82	10.65
00 00 49.25	13721.16	80.26	539.40	9.91
00 00 49.50	13854.56	83.83	540.87	8.75
00 00 49.75	13994.12	85.92	541.50	6.96
00 00 50.00	14129.73	90.24	545.17	6.49
00 00 50.25	14286.27	93.72	546.45	7.01
00 00 50.50	14401.51	97.26	546.91	7.85
00 00 50.75	14537.87	101.42	549.93	9.26
00 00 51.00	14676.53	105.92	552.83	10.10
00 00 51.25	14815.18	110.33	555.81	10.46
00 00 51.50	14954.35	114.97	559.63	10.72
00 00 51.75	15094.75	119.83	565.10	8.94
00 00 52.00	15236.94	124.38	562.26	8.74
00 00 52.25	15376.15	129.00	564.35	9.35
00 00 52.50	15516.07	133.66	566.60	10.81
00 00 52.75	15658.93	138.41	569.68	12.21
00 00 53.00	15801.27	143.31	572.75	13.58
00 00 53.25	15944.76	148.24	575.63	14.95
00 00 53.50	16099.18	153.04	580.31	16.32
00 00 53.75	16255.17	157.96	584.39	17.69

TAKE-OFF TIME STATION SOLUTION
 ASKANIA RNE
 780-1191 TAKEOFF NF104 20 OCT 1964
 FLIGHT 37
 DATE 20/10/64
 GROUND SPEED AT NMP FT/SEC
 GROUND SPEED AT 10 373 FT/SEC
 GROUND SPEED AT 50 FT 469 FT/SEC
 WIND 0 KNOTS AT 0 DEGREES
 TIME 1104 LIC 9279

GROUND BALL 6319 FT
 AIR DISTANCE 4361 FT
 GROSS WEIGHT 21992 LBS
 AMBIENT PRESS 27.80 I. HG
 AMBIENT TEMP 21.6 DEG C
 FLAP SETTING T.O
 POWER USED MAXIMUM POWER

TIME HR MM SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SQC
00 00 00.00	0.	0.	31.52	12.73
00 00 1.00	99.252	0.	96.19	12.71
00 00 2.00	191.283	0.	108.87	12.69
00 00 3.00	307.281	0.	121.55	12.67
00 00 4.00	435.231	0.	134.32	12.64
00 00 5.00	575.204	0.	146.92	12.59
00 00 6.00	729.203	0.10	159.46	12.51
00 00 7.00	895.69	0.	171.96	12.43
00 00 8.00	1073.223	0.	184.36	12.36
00 00 9.00	1264.19	0.	196.63	12.28
00 00 10.00	1466.69	0.35	208.91	12.17
00 00 11.00	1682.202	0.	221.12	12.11
00 00 12.00	1908.200	0.	233.10	11.94
00 00 13.00	2149.13	0.	244.85	11.55
00 00 14.00	2399.68	0.	256.27	11.26
00 00 15.00	2662.06	0.	267.38	10.99
00 00 16.00	2934.98	0.	278.11	10.75
00 00 17.00	3218.284	0.	288.74	10.55
00 00 18.00	3512.286	0.	299.14	10.38
00 00 20.00	4132.60	0.	319.52	10.24
00 00 21.00	4496.247	0.	329.70	10.24
00 00 22.00	4791.10	0.	339.77	10.24
00 00 22.25	4876.261	0.	342.78	9.97
00 00 22.50	4963.211	0.	345.07	9.54
00 00 22.75	5049.224	0.	347.54	9.30
00 00 23.00	5136.260	0.	349.88	8.91
00 00 23.25	5224.13	0.	351.77	8.93
00 00 23.50	5312.51	0.	354.07	9.06
00 00 23.75	5401.30	0.	356.16	9.35
00 00 24.00	5490.56	0.	358.70	9.66
00 00 24.25	5580.38	0.	361.21	9.82
00 00 24.50	5670.78	0.	363.68	9.99
00 00 24.75	5762.56	0.	366.23	9.66
00 00 25.00	5854.42	0.	368.62	9.77
00 00 25.25	5946.59	0.	370.94	9.06
00 00 25.50	6039.74	-0.	373.10	8.64

TIME HR MM SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SQC
00 00 25.75	6133.19	0.16	375.23	17.80
00 00 26.00	6227.45	0.45	377.32	9.02
00 00 26.25	6322.22	1.13	379.13	7.87
00 00 26.50	6416.96	1.88	380.99	7.93
00 00 26.75	6512.51	2.58	383.03	8.07
00 00 27.00	6608.42	2.99	385.02	8.29
00 00 27.25	6704.99	3.95	387.11	8.34
00 00 27.50	6802.15	4.88	389.00	8.44
00 00 27.75	6899.65	5.95	390.59	8.59
00 00 28.00	7096.75	8.19	395.88	9.00
00 00 28.50	7195.264	9.37	397.22	9.27
00 00 28.75	7295.19	10.40	400.47	8.93
00 00 29.00	7395.40	11.53	402.87	8.21
00 00 29.25	7496.66	12.81	405.22	7.08
00 00 29.50	7598.75	14.14	406.32	5.13
00 00 29.75	7700.78	15.53	407.39	5.88
00 00 30.00	7802.96	16.98	408.56	6.36
00 00 30.25	7903.52	18.40	410.24	7.59
00 00 30.50	8006.65	19.39	412.45	6.70
00 00 30.75	8110.44	20.60	416.01	9.23
00 00 31.00	8214.97	21.49	417.89	9.36
00 00 31.25	8319.53	22.44	419.86	9.40
00 00 31.50	8424.55	23.50	421.86	9.52
00 00 31.75	8530.31	24.72	424.19	9.76
00 00 32.00	8636.56	25.73	426.94	10.29
00 00 32.25	8743.49	27.20	429.74	10.59
00 00 32.50	8851.45	28.46	432.33	10.51
00 00 32.75	8960.08	29.66	435.02	10.20
00 00 33.00	9069.15	30.63	437.54	9.96
00 00 33.25	9178.49	31.95	439.89	9.06
00 00 33.50	9289.02	33.60	442.23	10.62
00 00 33.75	9399.87	34.83	444.75	10.21
00 00 34.00	9511.37	36.30	447.52	10.48
00 00 34.25	9623.39	37.44	450.12	10.61
00 00 34.50	9736.19	39.37	452.79	10.57
00 00 34.75	9850.09	41.04	455.59	10.47
00 00 35.00	9964.21	42.32	458.06	10.49
00 00 35.25	10078.92	44.08	460.60	10.70
00 00 35.50	10194.60	45.95	463.08	10.92
00 00 35.75	10310.31	47.82	466.069	11.16
00 00 36.00	10427.30	50.16	469.074	11.06
00 00 36.25	10544.78	51.57	471.867	10.92
00 00 36.50	10663.49	53.35	474.546	10.55
00 00 36.75	10782.67	54.81	476.83	10.31
00 00 37.00	10901.96	56.82	479.568	10.60
00 00 37.25	11021.84	56.50	481.996	10.63
00 00 37.50	11142.36	37.77	484.699	10.85
00 00 37.75	11264.78	61.21	487.649	10.86
00 00 38.00	11386.59	62.62	490.428	11.15
00 00 38.25	11509.26	64.32	493.012	11.33
00 00 38.50	11633.24	66.82	495.641	11.41
00 00 38.75	11757.41	68.22	498.93	11.45
00 00 39.00	11882.16	69.58	501.87	11.27
00 00 39.25	12008.32	70.82	504.667	11.03
00 00 39.50	12135.28	72.11	507.306	10.50

TAKE-OFF AND LANDING DATA

TAKE-OFF TWO STATION SOLUTION
 ASKANIA RME
 T041266 TAKEOFF 19 NOV 1964 TIME 1213
 FLIGHT 45
 RUN
 DAY 19/11/64
 CABIN SPEED AT NHP FT/SEC
 GROUND SPEED AT TR 360 FT/SEC
 GROUND SPEED AT 50 FT 436 FT/SEC
 AVG P17 IN MG
 WIND 15 KNOTS AT 100 DEGREES MAGNETIC
 MFL 4760 LIC 9279
 RUNWAY 22 L

GROUND ROLL 5252 FT
 AIR DISTANCE 2080 FT
 GROSS WEIGHT 2170 LBS
 AMBIENT PRES 27.66 IN HG
 AMBIENT TEMP 2.0 DEG C
 FLAP SETTING T.O.
 POWER USED MAXIMUM POWER

TIME M. MN SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00:00:00	0	0	0	0
00:00:10	64.50	0	10.85	10.85
00:00:20	22.92	0	21.47	10.78
00:00:30	49.05	0	32.09	11.26
00:00:40	85.95	0	43.29	11.07
00:00:50	132.82	0	55.39	12.60
00:01:00	194.25	0	68.50	13.34
00:01:10	268.55	0	82.55	13.94
00:01:20	357.88	0	97.04	14.33
00:01:30	462.42	0	111.66	14.52
00:01:40	582.34	0	126.34	14.53
00:01:50	715.29	0	140.92	14.46
00:02:00	857.40	0	155.29	14.34
00:02:10	1008.15	0	169.58	14.20
00:02:20	1207.39	0	185.70	14.05
00:02:30	1394.04	0	197.70	13.88
00:02:40	1594.22	0	211.56	13.70
00:02:50	1810.90	0	225.15	13.51
00:03:00	2049.82	0	235.54	13.29
00:03:10	2215.41	0	245.74	13.09
00:03:20	2355.62	0	254.87	12.87
00:03:30	2474.86	0	271.41	12.67
00:03:40	2609.05	0	290.03	12.46
00:03:50	2745.11	0	307.42	12.33
00:04:00	2875.77	0	324.55	12.27
00:04:10	2995.05	0	341.56	12.34
00:04:20	3172.82	0	326.87	12.47
00:04:30	3355.95	0	321.94	12.85
00:04:40	3474.50	0	327.63	12.40
00:04:50	3617.02	0	344.17	12.18
00:05:00	3794.74	0	331.15	12.03
00:05:10	4211.51	0	336.23	11.84
00:05:20	4367.91	0	349.66	11.66
00:05:30	4535.02	0	341.99	11.61
00:05:40	4644.50	0	344.30	11.62
00:05:50	4675.53	0	347.69	11.74

TAKE-OFF AND LANDING DATA

TAKE-OFF TWO STATION SOLUTION
 ASKANIA RME
 T041269 TAKEOFF 19 NOV 1964 TIME 1207
 FLIGHT 47
 RUN
 DAY 19/11/64
 CABIN SPEED AT NHP FT/SEC
 GROUND SPEED AT TR 371 FT/SEC
 GROUND SPEED AT 50 FT 452 FT/SEC
 AVG P17 IN MG
 WIND 0 KNOTS AT 0 DEGREES
 MFL 4760 LIC 9279

GROUND ROLL 5286 FT
 AIR DISTANCE 3374 FT
 GROSS WEIGHT 2160 LBS
 AMBIENT PRES 27.83 IN HG
 AMBIENT TEMP 2.6 DEG C
 FLAP SETTING T.O.
 POWER USED MAXIMUM POWER

TIME M. MN SEC	DISTANCE FT. ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00:00:00	0	0	0	0
00:00:10	64.59	0	10.85	10.85
00:00:20	22.92	0	21.47	10.78
00:00:30	49.05	0	32.09	11.26
00:00:40	85.95	0	43.29	11.07
00:00:50	132.82	0	55.39	12.60
00:01:00	194.25	0	68.50	13.34
00:01:10	268.55	0	82.55	13.94
00:01:20	357.88	0	97.04	14.33
00:01:30	462.42	0	111.66	14.52
00:01:40	582.34	0	126.34	14.53
00:01:50	715.29	0	140.92	14.46
00:02:00	857.40	0	155.29	14.34
00:02:10	1008.15	0	169.58	14.20
00:02:20	1207.39	0	185.70	14.05
00:02:30	1394.04	0	197.70	13.88
00:02:40	1594.22	0	211.56	13.70
00:02:50	1810.90	0	225.15	13.51
00:03:00	2049.82	0	235.54	13.29
00:03:10	2215.41	0	245.74	13.09
00:03:20	2355.62	0	254.87	12.87
00:03:30	2474.86	0	271.41	12.67
00:03:40	2609.05	0	290.03	12.46
00:03:50	2745.11	0	307.42	12.33
00:04:00	2875.77	0	324.55	12.27
00:04:10	2995.05	0	341.56	12.34
00:04:20	3172.82	0	326.87	12.47
00:04:30	3355.95	0	321.94	12.85
00:04:40	3474.50	0	327.63	12.40
00:04:50	3617.02	0	344.17	12.18
00:05:00	3794.74	0	331.15	12.03
00:05:10	4211.51	0	336.23	11.84
00:05:20	4367.91	0	349.66	11.66
00:05:30	4535.02	0	341.99	11.61
00:05:40	4644.50	0	344.30	11.62
00:05:50	4675.53	0	347.69	11.74

TAKE-OFF AND LANDING DATA

TAK-OFF TW9 STATION SOLUTION
ASKANIA ONE
TAK-1271 TAKEOFF NF104-760 19N06V64
FLIGHT 49
RUN
DATE 19/11/64
GROUND SPEED AT 10 351 FT/SEC
GROUND SPEED AT 50 FT 507 FT/SEC
AVG PIT IN HG
WIND 0 KNOTS AT 0 DEGREES
LIC 9279 TYP 1472 02

GROUND ROLL 4726 FT
AIR DISTANCE 5020 FT
GROSS WEIGHT 21000 LBS
AMBIENT PRES 27.70 IN HG
AMBIENT TEMP 4.6 DEG C
FLAP SETTING T.O.
POWER USED MAXIMUM POWER

Table with columns: TIME MR PN SEC, DISTANCE FT, HEIGHT FEET, GROUND VELOCITY FT/SEC, ACCELERATION FT/SEC/SEC. Data points from 00:00:00 to 00:00:50.

Table with columns: TIME MR PN SEC, DISTANCE FT, HEIGHT FEET, GROUND VELOCITY FT/SEC, ACCELERATION FT/SEC/SEC. Data points from 00:00:00 to 00:00:50.

TAKE-OFF AND LANDING DATA

TAK-OFF TW9 STATION SOLUTION
ASKANIA ONE
TAK-1290 TAKEOFF NF104-760 23N06V64
FLIGHT 49
RUN
DATE 23/11/64
GROUND SPEED AT 10 365 FT/SEC
GROUND SPEED AT 50 FT 519 FT/SEC
AVG PIT IN HG
WIND 0 KNOTS AT 0 DEGREES
LIC 9279 TIME 1259
RUNWAY 04

GROUND ROLL 5525 FT
AIR DISTANCE 5732 FT
GROSS WEIGHT 21700 LBS
AMBIENT PRES 27.95 IN HG
AMBIENT TEMP 6.9 DEG C
FLAP SETTING T.O.
POWER USED MAXIMUM POWER

Table with columns: TIME MR PN SEC, DISTANCE FT, HEIGHT FEET, GROUND VELOCITY FT/SEC, ACCELERATION FT/SEC/SEC. Data points from 00:00:00 to 00:00:50.

Table with columns: TIME MR PN SEC, DISTANCE FT, HEIGHT FEET, GROUND VELOCITY FT/SEC, ACCELERATION FT/SEC/SEC. Data points from 00:00:00 to 00:00:50.

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 00	0	0	0	0
00 00 05	117.4	15.27	512.87	11.95
00 00 10	117.4	15.90	515.21	11.98
00 00 15	117.4	16.65	517.65	12.04
00 00 20	117.4	17.37	520.58	12.57
00 00 25	117.4	18.01	524.09	13.11
00 00 30	117.4	18.75	528.01	12.51
00 00 35	117.4	19.59	531.14	13.89
00 00 40	117.4	21.22	534.36	13.20
00 00 45	121.7	22.78	537.60	12.84
00 00 50	121.7	24.48	540.90	13.06
00 00 55	122.9	26.24	544.09	12.89
00 01 00	124.9	28.19	547.23	12.60
00 01 05	126.6	30.45	550.37	11.94
00 01 10	127.4	32.57	553.73	11.29
00 01 15	128.4	34.69	556.36	11.01
00 01 20	129.5	37.02	558.48	11.89
00 01 25	131.3	39.00	561.07	12.92
00 01 30	133.4	41.94	563.79	15.12
00 01 35	134.2	44.81	566.75	17.66
00 01 40	135.6	47.20	571.99	19.76
00 01 45	136.9	50.00	574.37	21.57
00 01 50	136.7	53.19	580.85	23.39
00 01 55	139.5	56.62	590.22	25.20

TAKE-OFF AND LANDING DATA

TAKE-OFF TWO STATION SOLUTION

GROUND ROLL 6117 FT
AIR DISTANCE 8383 FT
GROSS WEIGHT 21700 LBS
ASBEST PRESS 27.58 IN HG
AMBIENT TEMP 15.4 DEG C
FLAP SETTING T.O.
POWER USED MAXIMUM POWER

ASKANIA 8NF
T04 11:04 TAKEOFF NR104760 25 NOV 54
FLIGHT 53
RUN
DATE 25/11/54
GRIND SPEED AT NWC FT/SEC
GRIND SPEED AT 10 374 FT/SEC
GRIND SPEED AT 0 FT 484 FT/SEC
AVG PTV IN HG
WIND 0 KNOTS AT 0 DEGREES
LIC 9275 TIM 1124 02
RUNWAY 04

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 00	0	0	0	0
00 00 1.00	7.90	0	15.66	16.37
00 00 2.00	24.41	0	21.83	10.92
00 00 3.00	51.04	0	32.21	11.87
00 00 4.00	84.77	0	44.78	12.62
00 00 5.00	123.40	0	56.70	12.54
00 00 6.00	167.38	0	69.7	12.89
00 00 7.00	217.71	0	84.99	13.21
00 00 8.00	263.11	0	95.10	13.24
00 00 9.00	306.11	0	109.86	13.17
00 010.00	342.04	0	122.34	13.65
00 011.00	371.25	0	135.55	12.97
00 012.00	401.00	0	147.86	12.99
00 013.00	430.59	0	161.32	12.31
00 014.00	476.01	0	174.11	12.71
00 015.00	516.67	0	186.81	12.50
00 016.00	554.99	0	199.76	12.82
00 017.00	597.60	0	211.74	12.22
00 018.00	634.56	0	222.87	12.31
00 019.00	675.86	0	235.76	13.0
00 020.00	714.96	0	247.9	11.61
00 021.00	769.50	0	258.88	11.45
00 022.00	794.11	0	270.26	11.74
00 023.00	790.00	0	281.44	11.27
00 024.00	857.11	0	292.67	11.97
00 025.00	895.71	0	304.26	11.29
00 026.00	930.50	0	316.31	11.01
00 027.00	978.68	0	329.67	10.77
00 028.00	1026.87	0	342.29	10.87
00 029.00	1134.95	0	354.91	10.17
00 030.00	1214.07	0	377.16	10.25
00 031.00	1295.41	0	399.37	10.16
00 032.00	1374.51	0	422.99	10.71
00 033.00	1454.41	0	444.99	10.71
00 034.00	1534.11	0	472.58	10.96
00 035.00	1618.86	0	504.41	11.12

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 00	0	0	0	0
00 00 1.00	7.90	0	15.66	16.37
00 00 2.00	24.41	0	21.83	10.92
00 00 3.00	51.04	0	32.21	11.87
00 00 4.00	84.77	0	44.78	12.62
00 00 5.00	123.40	0	56.70	12.54
00 00 6.00	167.38	0	69.7	12.89
00 00 7.00	217.71	0	84.99	13.21
00 00 8.00	263.11	0	95.10	13.24
00 00 9.00	306.11	0	109.86	13.17
00 010.00	342.04	0	122.34	13.65
00 011.00	371.25	0	135.55	12.97
00 012.00	401.00	0	147.86	12.99
00 013.00	430.59	0	161.32	12.31
00 014.00	476.01	0	174.11	12.71
00 015.00	516.67	0	186.81	12.50
00 016.00	554.99	0	199.76	12.82
00 017.00	597.60	0	211.74	12.22
00 018.00	634.56	0	222.87	12.31
00 019.00	675.86	0	235.76	13.0
00 020.00	714.96	0	247.9	11.61
00 021.00	769.50	0	258.88	11.45
00 022.00	794.11	0	270.26	11.74
00 023.00	790.00	0	281.44	11.27
00 024.00	857.11	0	292.67	11.97
00 025.00	895.71	0	304.26	11.29
00 026.00	930.50	0	316.31	11.01
00 027.00	978.68	0	329.67	10.77
00 028.00	1026.87	0	342.29	10.87
00 029.00	1134.95	0	354.91	10.17
00 030.00	1214.07	0	377.16	10.25
00 031.00	1295.41	0	399.37	10.16
00 032.00	1374.51	0	422.99	10.71
00 033.00	1454.41	0	444.99	10.71
00 034.00	1534.11	0	472.58	10.96
00 035.00	1618.86	0	504.41	11.12

TIME H MN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SEC
00 00 00	0	0	0	0
00 00 1.00	7.90	0	15.66	16.37
00 00 2.00	24.41	0	21.83	10.92
00 00 3.00	51.04	0	32.21	11.87
00 00 4.00	84.77	0	44.78	12.62
00 00 5.00	123.40	0	56.70	12.54
00 00 6.00	167.38	0	69.7	12.89
00 00 7.00	217.71	0	84.99	13.21
00 00 8.00	263.11	0	95.10	13.24
00 00 9.00	306.11	0	109.86	13.17
00 010.00	342.04	0	122.34	13.65
00 011.00	371.25	0	135.55	12.97
00 012.00	401.00	0	147.86	12.99
00 013.00	430.59	0	161.32	12.31
00 014.00	476.01	0	174.11	12.71
00 015.00	516.67	0	186.81	12.50
00 016.00	554.99	0	199.76	12.82
00 017.00	597.60	0	211.74	12.22
00 018.00	634.56	0	222.87	12.31
00 019.00	675.86	0	235.76	13.0
00 020.00	714.96	0	247.9	11.61
00 021.00	769.50	0	258.88	11.45
00 022.00	794.11	0	270.26	11.74
00 023.00	790.00	0	281.44	11.27
00 024.00	857.11	0	292.67	11.97
00 025.00	895.71	0	304.26	11.29
00 026.00	930.50	0	316.31	11.01
00 027.00	978.68	0	329.67	10.77
00 028.00	1026.87	0	342.29	10.87
00 029.00	1134.95	0	354.91	10.17
00 030.00	1214.07	0	377.16	10.25
00 031.00	1295.41	0	399.37	10.16
00 032.00	1374.51	0	422.99	10.71
00 033.00	1454.41	0	444.99	10.71
00 034.00	1534.11	0	472.58	10.96
00 035.00	1618.86	0	504.41	11.12

TAKE-OFF AND LANDING DATA

TAK-07FF TWO STATION SOLUTION
 CRUND KELL 5538 FT
 AIR DISTANCE 13379 FT
 GROSS WEIGHT 21779 LBS
 AMBIENT PR 27.53 IN HG
 AMBIENT TEMP 16.5 DEG C
 FLAP SETTING T.O.
 PPMHP USED MAXIMUM POWER

ASKANIA ONE
 T69-1708 TAKEOFF NPTON-760 25 NOV 64
 FLIGHT 54
 RUN

DATE 05/11/64
 DRGINS SPEED AT 100 FT/SEC
 DRGINS SPEED AT 12 358 FT/SEC
 DRGINS SPEED AT 10 FT 676 FT/SEC
 AVG P17 IN HG
 WIND 1.0 KNOTS AT 230, DEGREES MAGNETIC
 TIME 1957 110 9279
 RUNWAY 04

TIME M: NN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SFC
04 5.00	0.0	0.0	7.71	14.19
04 5.00	77.57	0.0	87.78	14.17
04 5.00	174.20	0.0	101.77	17.96
04 6.00	214.72	0.0	115.79	17.75
04 7.00	466.29	0.0	129.66	12.55
04 8.00	547.97	0.0	142.98	12.28
04 9.00	697.09	0.0	155.99	13.01
04 10.00	855.56	0.0	168.89	12.77
04 11.00	1040.70	0.0	181.52	12.58
04 12.00	1219.19	0.0	193.95	12.33
04 13.00	1419.24	0.0	206.24	12.18
04 14.00	1651.77	0.0	219.47	11.99
04 15.00	1915.15	0.0	232.22	11.81
04 16.00	2202.79	0.0	244.91	11.65
04 17.00	2511.64	0.0	257.45	11.45
04 18.00	2846.82	0.0	269.84	11.23
04 19.00	3210.17	0.0	282.07	11.19
04 20.00	3602.34	0.0	294.13	11.05
04 21.00	4022.22	0.0	299.26	10.90
04 22.00	4469.04	0.0	309.01	10.72
04 23.00	4943.40	0.0	319.70	10.49
04 23.25	4943.69	0.0	322.23	10.49
04 23.50	4943.77	0.0	324.84	10.50
04 23.75	4943.81	0.0	327.46	10.51
04 24.00	4943.80	0.0	330.13	10.52
04 24.25	4943.80	0.0	332.79	10.79
04 24.50	4943.81	0.0	335.49	10.84
04 24.75	4943.82	0.0	338.23	10.83
04 25.00	4943.87	0.0	341.04	10.73
04 25.25	4943.90	0.0	343.87	10.49
04 25.50	4943.95	0.0	346.29	10.17
04 25.75	4943.98	0.0	348.81	9.84
04 26.00	5070.10	0.0	351.17	9.64
04 26.25	5196.28	0.0	353.50	9.52
04 26.50	5246.88	0.0	355.81	9.48
04 26.75	5316.13	-0.0	358.25	9.48

TIME M: NN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SFC
04 27.00	5405.80	0.29	360.67	9.44
04 27.25	5516.39	0.54	361.01	9.47
04 27.50	5607.65	0.79	365.32	9.44
04 27.75	5699.25	1.04	367.64	9.68
04 28.00	5791.22	1.29	370.10	10.04
04 28.25	5883.97	1.53	372.44	10.29
04 28.50	5977.38	1.78	375.29	10.55
04 28.75	6071.90	2.02	378.12	10.51
04 29.00	6166.19	2.31	380.81	9.96
04 29.25	6262.53	2.62	383.24	9.89
04 29.50	6358.19	2.90	385.61	7.89
04 29.75	6455.12	3.20	387.16	7.10
04 30.00	6552.11	3.61	388.50	6.41
04 30.25	6650.16	4.07	390.11	7.11
04 30.50	6748.48	4.54	391.83	8.51
04 30.75	6846.14	4.84	393.99	9.41
04 31.00	6943.64	5.22	396.71	10.44
04 31.25	7043.40	5.67	400.24	11.56
04 31.50	7143.56	5.96	403.06	11.54
04 31.75	7245.97	6.22	405.89	11.19
04 32.00	7349.13	6.51	408.49	10.74
04 32.25	7454.40	7.02	411.19	10.75
04 32.50	7552.18	7.63	413.70	10.84
04 32.75	7652.00	8.12	416.42	10.97
04 33.00	7760.67	8.67	419.37	11.39
04 33.25	7865.74	9.11	422.22	12.04
04 33.50	7971.71	9.65	424.84	12.56
04 33.75	8078.32	10.39	428.41	12.49
04 34.00	8185.46	10.96	431.97	12.67
04 34.25	8293.25	11.49	435.26	12.00
04 34.50	8404.00	11.70	438.79	10.60
04 34.75	8513.82	11.95	440.38	9.70
04 35.00	8624.12	12.64	442.72	9.12
04 35.25	8735.25	12.86	444.27	9.97
04 35.50	8846.99	13.04	447.15	11.07
04 35.75	8958.48	13.51	450.33	11.79
04 36.00	9070.62	13.86	453.69	12.52
04 36.25	9183.10	14.24	457.01	12.57
04 36.50	9299.79	14.44	459.62	12.54
04 36.75	9414.66	14.72	462.94	12.62
04 37.00	9530.85	15.01	466.04	12.53
04 37.25	9647.79	15.04	469.25	12.44
04 37.50	9765.47	15.28	472.63	12.12
04 37.75	9884.42	15.50	475.40	11.87
04 38.00	10003.32	15.62	478.15	11.75
04 38.25	10123.52	16.00	481.09	11.95
04 38.50	10244.55	16.52	484.99	12.44
04 38.75	10366.86	16.86	487.20	12.61
04 39.00	10489.66	17.41	490.71	12.44
04 39.25	10610.41	17.90	494.06	12.20
04 39.50	10734.15	18.07	496.71	12.07
04 39.75	10859.59	19.44	499.47	11.77
04 40.00	10984.70	18.64	502.44	12.41
04 40.25	11109.69	19.15	505.65	11.76
04 40.50	11226.52	19.15	508.87	11.75

TIME M: NN SEC	DISTANCE FT, ZEROED	HEIGHT FEET	GROUND VELOCITY FT/SEC	ACCELERATION FT/SEC/SFC
04 40.75	11344.47	19.67	512.78	12.77
04 41.00	11463.75	19.90	516.56	13.42
04 41.25	11622.69	20.22	519.67	13.05
04 41.50	11753.22	20.41	522.66	12.52
04 41.75	11894.52	20.86	525.48	12.35
04 42.00	12047.81	20.31	528.83	12.65
04 42.25	12188.37	20.82	531.67	12.97
04 42.50	12218.48	21.21	535.19	12.04
04 42.75	12416.50	21.37	538.69	12.48
04 43.00	12551.05	21.61	541.76	12.40
04 43.25	12687.11	21.91	544.78	12.44
04 43.50	12833.75	22.14	547.40	12.97
04 43.75	12980.77	22.45	550.65	14.00
04 44.00	13098.89	22.53	554.36	14.98
04 44.25	13237.32	22.84	558.51	15.52
04 44.50	13377.41	23.06	562.96	14.73
04 44.75	13519.32	23.46	566.73	13.15
04 45.00	13661.72	23.71	570.02	11.42
04 45.25	13805.10	24.01	571.84	10.22
04 45.50	13947.98	24.80	573.76	10.01
04 45.75	14091.77	24.95	576.25	11.58
04 46.00	14234.67	24.37	579.22	13.96
04 46.25	14340.57	24.30	582.49	15.83
04 46.50	14574.10	25.26	584.11	16.18
04 46.75	14674.24	25.01	587.76	15.77
04 47.00	14821.32	25.06	594.72	14.17
04 47.25	14975.01	25.73	598.92	11.69
04 47.50	15123.41	26.05	602.20	11.30
04 47.75	15275.13	25.65	604.12	12.14
04 48.00	15423.29	25.58	606.00	14.15
04 48.25	15578.01	25.55	611.21	14.47
04 48.50	15738.97	25.64	615.58	15.11
04 48.75	15894.74	25.44	620.65	12.92
04 49.00	16048.57	25.68	621.75	10.09
04 49.25	16197.22	25.91	623.74	7.25
04 49.50	16344.49	26.75	624.40	5.97
04 49.75	16487.46	26.72	627.19	7.44
04 50.00	16649.79	27.39	627.27	9.71
04 50.25	16819.36	28.26	627.42	14.79
04 50.50	16985.24	29.44	625.02	17.40
04 50.75	17136.45	0.68	640.23	20.64
04 51.00	17300.47	22.12	647.61	20.58
04 51.25	17462.46	23.50	650.93	19.34
04 51.50	17629.23	25.02	657.86	17.39
04 51.75	17792.49	6.62	659.55	15.64
04 52.00	17977.24	8.68	661.86	14.52
04 52.25	18147.09	41.24	667.02	12.01
04 52.50	18300.77	43.61	671.36	10.39
04 52.75	18463.27	46.21	675.27	7.94
04 53.00	18629.24	48.96	674.18	5.10
04 53.25	18794.67	11.31	677.12	2.25
04 53.50	18944.96	54.77	676.06	-0.60



WEATHER TABLE

PRESSURE PSI	TEMPERATURE DEG F	WIND VELOCITY KNOTS	TASSELLE ALT. FEET	WIND DIRECTION DEGREES TRUE	A/C HEADING DEGREES TRUE
1310.40000	31.00000	0.00000	217.00000	372.00000	02.00000
1310.40000	31.00000	0.00000	245.00000	372.00000	02.00000
1410.40000	27.00000	13.00000	1810.00000	240.00000	02.00000
1720.50000	18.00000	17.00000	1580.00000	242.00000	02.00000
1870.70000	11.00000	16.00000	1460.00000	240.00000	02.00000
1970.80000	7.00000	22.00000	1040.00000	242.00000	02.00000
2070.90000	3.00000	27.00000	1310.00000	240.00000	02.00000
2170.90000	-1.00000	32.00000	1367.00000	240.00000	02.00000
2270.90000	-5.00000	37.00000	1070.00000	238.00000	02.00000
2370.90000	-9.00000	42.00000	2310.00000	240.00000	02.00000
2470.90000	-13.00000	47.00000	2080.00000	240.00000	02.00000
2570.90000	-17.00000	52.00000	2082.00000	242.00000	02.00000
2670.90000	-21.00000	57.00000	2082.00000	240.00000	02.00000
2770.90000	-25.00000	62.00000	1840.00000	244.00000	02.00000
2870.90000	-29.00000	67.00000	1550.00000	244.00000	02.00000
2970.90000	-33.00000	72.00000	1310.00000	241.00000	02.00000
3070.90000	-37.00000	77.00000	1000.00000	241.00000	02.00000

FLIGHT NO. 43 RUN NO. 1
DATE OF FLIGHT: 2/11/22
ENGINE START CONDITIONS
FUEL SPECIFIC WEIGHT 8.23 LB/GAL
FUEL TEMPERATURE 25.0 DEG C
HYDROGEN PERSEDE SPECIFIC WEIGHT 11.87 LB/GAL
HYDROGEN PERSEDE TEMPERATURE 25.0 DEG C
CRUISE HEIGHT 27130.1 IN
TEST - SUBSONIC CLIMB

AIR-CRAFT DATA

COUNTER NUMBER	TIME	AIRPEED	ALTITUDE (IC-19)	ALTITUDE (PENDING)	TEMP ENG	TEMP A/R	RPM
340	353	373	390	400	410	420	430
350	353	373	390	400	410	420	430
360	353	373	390	400	410	420	430

AIR-CRAFT DATA

COUNTER NUMBER	TIME	AIRPEED	ALTITUDE (IC-19)	ALTITUDE (PENDING)	TEMP ENG	TEMP A/R	RPM
491	491	502	510	520	530	540	550
501	491	502	510	520	530	540	550
511	491	502	510	520	530	540	550

AIR-CRAFT DATA

COUNTER NUMBER	TIME	AIRPEED	ALTITUDE (IC-19)	ALTITUDE (PENDING)	TEMP ENG	TEMP A/R	RPM
612	627	646	671	688	705	710	710
627	627	646	671	688	705	710	710
637	627	646	671	688	705	710	710

WEATHER TABLE

PRESSURE PSI	TEMPERATURE DEG F	WIND VELOCITY KNOTS	TASSELLE ALT. FEET	WIND DIRECTION DEGREES TRUE	A/C HEADING DEGREES TRUE
1000.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1100.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1200.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1300.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1400.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1500.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1600.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1700.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1800.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
1900.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2000.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2100.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2200.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2300.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2400.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2500.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2600.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2700.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2800.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
2900.00000	10.00000	10.00000	2770.00000	380.00000	02.00000
3000.00000	10.00000	10.00000	2770.00000	380.00000	02.00000

SUBMIT TOTAL 27130.10 FUEL PUM

FLIGHT 19		FLIGHT 24		FLIGHT 26		FLIGHT 42		FLIGHT 43	
C/N	WEIGHT LBS	C/N	WEIGHT LBS	C/N	WEIGHT LBS	C/N	WEIGHT LBS	C/N	WEIGHT LBS
370	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
380	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
411	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
420	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
427	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
430	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
440	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
450	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
491	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
510	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
520	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
530	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
540	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
550	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
560	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
570	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
580	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
590	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
600	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
610	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
620	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
630	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
640	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
650	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
660	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
670	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
680	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
690	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
700	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
710	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
720	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
730	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
740	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
750	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
760	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
770	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
780	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
790	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
800	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
810	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
820	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
830	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
840	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
850	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
860	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
870	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
880	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
890	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
900	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
910	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
920	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
930	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
940	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
950	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
960	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
970	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
980	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0
990	4595.0	570	7210.0	490	7000.0	480	5200.0	167	8120.0



FLIGHT NO 22 RUN NO 2
 DATE OF FLIGHT 8/5/64
 ENGINE START CONDITIONS
 FUEL SPECIFIC WEIGHT 6.47 LB/GAL
 FUEL TEMPERATURE 24.0 DEG C
 HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.65 LB/GAL
 HYDROGEN PEROXIDE TEMPERATURE 11.6 DEG C
 GROSS WEIGHT 21870 LBS

TEST - LEVEL FLIGHT SPEED POWER DATA

ON-BOARD DATA

AIRCRAFT DATA		1	2	3	4	5
POINT NUMBER						
COUNTER NUMBER		1475	1700	2043	2337	2810
AIR SPEED	KNOTS	316.5	294.5	276.5	256.	315.5
ALTITUDE (C-19)	FEET	34820.	34985.	35610.	35610.	36080.
TIC	DEG C	-11.5	-15.6	+20.0	-23.0	-10.0
WEIGHT	LB	17346.	17197.	16955.	16772.	16336.
FUEL FLOW	LB/HR	2998.	2445.	2360.	2360.	3459.

FLIGHT NO 23 RUN NO 2
 DATE OF FLIGHT 14/5/64
 ENGINE START CONDITIONS
 FUEL SPECIFIC WEIGHT 6.44 LB/GAL
 FUEL TEMPERATURE 23.0 DEG C
 HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.70 LB/GAL
 HYDROGEN PEROXIDE TEMPERATURE 14.3 DEG C
 GROSS WEIGHT 22050 LBS

TEST - LEVEL FLIGHT SPEED POWER DATA

ON-BOARD DATA

AIRCRAFT DATA		1	2
POINT NUMBER			
COUNTER NUMBER		1890	2250
AIR SPEED	KNOTS	296.5	315.5
ALTITUDE (C-19)	FEET	36360.	34580.
TIC	DEG C	-15.7	-13.5
WEIGHT	LB	16045.	15782.
FUEL FLOW	LB/HR	2487.	2642.

FLIGHT NO 32 RUN NO 2
 DATE OF FLIGHT 18/9/64
 ENGINE START CONDITIONS
 FUEL SPECIFIC WEIGHT 6.43 LB/GAL
 FUEL TEMPERATURE 23.5 DEG C
 HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.7 LB/GAL
 HYDROGEN PEROXIDE TEMPERATURE 15.7 DEG C
 GROSS WEIGHT 21850 LBS

TEST - LEVEL FLIGHT SPEED POWER DATA

ON-BOARD DATA

AIRCRAFT DATA		1	2	3	4
POINT NUMBER					
COUNTER NUMBER		1675	2270	2570	2875
AIR SPEED	KNOTS	261.0	276.5	295.5	317.3
ALTITUDE (C-19)	FEET	34295.	34500	35075.	35195
TIC	DEG C	-21.0	-18.0	-12.	-8.0
WEIGHT	LB	17115.	16836.	16625.	16255
FUEL FLOW	LB/HR	2350.	2306.	2421.	2883.

FLIGHT NO 51 RUN NO 2
 DATE OF FLIGHT 24/11/64
 ENGINE START CONDITIONS
 FUEL SPECIFIC WEIGHT 6.52 LB/GAL
 FUEL TEMPERATURE 12.0 DEG C
 HYDROGEN PEROXIDE SPECIFIC WEIGHT - LB/GAL
 HYDROGEN PEROXIDE TEMPERATURE - DEG C
 GROSS WEIGHT 19350 LBS

TEST - LEVEL FLIGHT SPEED POWER DATA

ON BOARD DATA

AIRCRAFT DATA		1	2	3	4	5	6	7	8
POINT NUMBER									
COUNTER NUMBER		235	468	639	735	855	895	976	1067
AIR SPEED	KNOTS	345.6	328.6	289.2	268.2	301.5	322.4	289.0	298.0
ALTITUDE (C-19)	FEET	32450	32855	33140	33539.	33870.	34172.	34329.	34642
TIC	DEG C	-11.0	-17.5	-23.5	-29.0	-23.2	-19.9	-26.5	-23.4
WEIGHT	LB	17674.	17384.	17104.	16907.	16613.	16342.	16033.	15775.
FUEL FLOW	LB/HR	4100.	2781.	2301.	2265.	2364.	2755.	2257.	2431.

ACCELERATION DATA

Flight Number

Rocket Engine Operating Mach Numbers

10	2.03 to 2.28
12	1.66 to 1.83
17	1.68 to 1.92
18	1.64 to 1.88
19	-----
21	-----
22	1.04 to 2.02
24	1.13 to 1.45, 1.87 to 2.00
25	1.12 to 1.43, 1.89 to 2.02
26	1.12 to 1.47, 1.88 to 2.08
29	1.13 to 1.46, 1.96 to 2.08
30	1.16 to 1.44, 1.90 to 2.15
36	1.13 to 1.44, 1.89 to 2.03
61	1.13 to 1.44, 2.01 to 2.16

FLIGHT NO 10 RUN NO 2
 DATE OF FLIGHT 8/12/52
 ENGINE START CONDITIONS
 FUEL SPECIFIC WEIGHT 0.50 LB/LM
 FUEL TEMPERATURE 22.5 DEG C
 HYDROGEN PERMEATE SPECIFIC WEIGHT 1.170 LB/LM
 HYDROGEN PERMEATE TEMPERATURE 12.0 DEG C
 CROSS HEIGHT 2194.0 LBS
 T.L.T. - ACCELERATION

UN-MIXED DATA		AIRCRAFT DATA									
AIRCRAFT DATA		915	920	925	930	935	940	945	950	955	960
TIME	SEC	915	920	925	930	935	940	945	950	955	960
ALTITUDE (IC-13)	FEET	35307	35299	35291	35283	35275	35267	35259	35251	35243	35235
ALTITUDE (IC-13)	FEET	35307	35299	35291	35283	35275	35267	35259	35251	35243	35235
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0
AIRCRAFT DATA		965	970	975	980	985	990	995	1000	1005	1010
TIME	SEC	965	970	975	980	985	990	995	1000	1005	1010
ALTITUDE (IC-13)	FEET	35227	35219	35211	35203	35195	35187	35179	35171	35163	35155
ALTITUDE (IC-13)	FEET	35227	35219	35211	35203	35195	35187	35179	35171	35163	35155
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0
AIRCRAFT DATA		1015	1020	1025	1030	1035	1040	1045	1050	1055	1060
TIME	SEC	1015	1020	1025	1030	1035	1040	1045	1050	1055	1060
ALTITUDE (IC-13)	FEET	35087	35079	35071	35063	35055	35047	35039	35031	35023	35015
ALTITUDE (IC-13)	FEET	35087	35079	35071	35063	35055	35047	35039	35031	35023	35015
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0
AIRCRAFT DATA		1065	1070	1075	1080	1085	1090	1095	1100	1105	1110
TIME	SEC	1065	1070	1075	1080	1085	1090	1095	1100	1105	1110
ALTITUDE (IC-13)	FEET	34947	34939	34931	34923	34915	34907	34899	34891	34883	34875
ALTITUDE (IC-13)	FEET	34947	34939	34931	34923	34915	34907	34899	34891	34883	34875
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0

UN-MIXED DATA		AIRCRAFT DATA									
AIRCRAFT DATA		1115	1120	1125	1130	1135	1140	1145	1150	1155	1160
TIME	SEC	1115	1120	1125	1130	1135	1140	1145	1150	1155	1160
ALTITUDE (IC-13)	FEET	34737	34729	34721	34713	34705	34697	34689	34681	34673	34665
ALTITUDE (IC-13)	FEET	34737	34729	34721	34713	34705	34697	34689	34681	34673	34665
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0
AIRCRAFT DATA		1165	1170	1175	1180	1185	1190	1195	1200	1205	1210
TIME	SEC	1165	1170	1175	1180	1185	1190	1195	1200	1205	1210
ALTITUDE (IC-13)	FEET	34597	34589	34581	34573	34565	34557	34549	34541	34533	34525
ALTITUDE (IC-13)	FEET	34597	34589	34581	34573	34565	34557	34549	34541	34533	34525
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0
AIRCRAFT DATA		1215	1220	1225	1230	1235	1240	1245	1250	1255	1260
TIME	SEC	1215	1220	1225	1230	1235	1240	1245	1250	1255	1260
ALTITUDE (IC-13)	FEET	34387	34379	34371	34363	34355	34347	34339	34331	34323	34315
ALTITUDE (IC-13)	FEET	34387	34379	34371	34363	34355	34347	34339	34331	34323	34315
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0
AIRCRAFT DATA		1265	1270	1275	1280	1285	1290	1295	1300	1305	1310
TIME	SEC	1265	1270	1275	1280	1285	1290	1295	1300	1305	1310
ALTITUDE (IC-13)	FEET	34247	34239	34231	34223	34215	34207	34199	34191	34183	34175
ALTITUDE (IC-13)	FEET	34247	34239	34231	34223	34215	34207	34199	34191	34183	34175
FUEL TEMP ENG	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
FUEL TEMP A/B	DEG C	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
W/H2O2	LN/SEC	0	0	0	0	0	0	0	0	0	0
W/JPA	LN/SEC	0	0	0	0	0	0	0	0	0	0

ON-BARD DATA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT ROCKET DATA CHAMBER PRESSURE WF H2O2 WF JPA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT

WEATHER TABLE PRESSURE PSF ALTITUDE FEET TEMPERATURE DEG C WIND VELOCITY KNOTS TAPESIDE ALT. FEET WIND DIRECTION DEGREES TRUE A/C HEADING DEGREES TRUE

ON-BARD DATA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT ROCKET DATA CHAMBER PRESSURE WF H2O2 WF JPA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT

WEATHER TABLE PRESSURE PSF ALTITUDE FEET TEMPERATURE DEG C WIND VELOCITY KNOTS TAPESIDE ALT. FEET WIND DIRECTION DEGREES TRUE A/C HEADING DEGREES TRUE

FLIGHT NO 12 RUN NO 2 DATE OF FLIGHT 10/17/59 GRAV START CONDITIONS FUEL SPECIFIC WEIGHT 0.77 LB/GAL FUEL TEMPERATURE 17.0 DEG C HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.70 LB/GAL HYDROGEN PEROXIDE TEMPERATURE 15.0 DEG C GROSS WEIGHT 22395 LBS TEST - ACCELERATION

ON-BARD DATA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT ROCKET DATA CHAMBER PRESSURE WF H2O2 WF JPA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT

ON-BARD DATA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT ROCKET DATA CHAMBER PRESSURE WF H2O2 WF JPA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT

ON-BARD DATA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT ROCKET DATA CHAMBER PRESSURE WF H2O2 WF JPA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT

ON-BARD DATA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT ROCKET DATA CHAMBER PRESSURE WF H2O2 WF JPA AIRCRAFT DATA COUNTER NUMBER TIME AIRSPEED ALTITUDE (IC-19) ALTITUDE (EQUINOX) TIC FULL TEMP ENG FULL TEMP A/B RPM EGT

FLIGHT NO 24 RUN NO 2
 DATE OF FLIGHT 27 MAY
 ENGINE START CONDITIONS
 FUEL SPECIFIC WEIGHT 6.48 LB/GAL
 HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.50 LB/GAL
 HYDROGEN PEROXIDE TEMPERATURE 29.8 DEG C
 CRUISE HEIGHT 21800 - 185
 TEST - ACCELERATION

BEHIND DATA

COUNTER NUMBER	1170	1170	1180	1190	1200	1210	1220	1230	1240
TIME	1170	1171	1180	1190	1200	1210	1220	1230	1240
AIRSPEED	300.0	300.7	317.1	331.7	341.9	346.8	352.0	357.5	378.5
ALTITUDE (IC-19)	34207	34187	33935	33885	33729	33588	33426	33288	33231
ALTITUDE (INDENT)	34216	34196	33944	33894	33738	33597	33435	33297	33240
TIC	-18.8	-18.4	-15.8	-11.6	-8.8	-7.7	-6.5	-5.1	-3.4
FUEL TEMP ENG	42.2	42.2	42.8	43.0	43.1	43.3	43.3	43.3	43.3
FUEL TEMP A/B	32.7	32.7	31.2	30.7	30.3	30.3	30.1	29.9	29.7
RPM	7354	7351	7400	7429	7468	7493	7493	7493	7493
EGT	626	635	593	589	584	584	584	584	584
ROCKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MF H2O2	LB/SEC	0	0	0	0	0	0	0	0
MF JPA	LB/SEC	0	0	0	0	0	0	0	0

BEHIND DATA

COUNTER NUMBER	1250	1260	1270	1281	1292	1302	1312	1323	1333
TIME	1250	1260	1270	1281	1292	1302	1312	1323	1333
AIRSPEED	386.9	398.3	398.8	399.6	399.9	400.7	401.0	402.5	402.5
ALTITUDE (IC-19)	35037	35104	35037	35117	35117	35112	35097	35092	35075
ALTITUDE (INDENT)	35240	35141	35131	35171	35111	35104	35092	35082	35072
TIC	-1.9	2.9	1.7	2.1	2.4	2.4	2.4	2.4	2.4
FUEL TEMP ENG	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1
FUEL TEMP A/B	48.3	48.7	48.7	48.0	48.6	48.3	48.3	48.3	48.3
RPM	7493	7493	7493	7493	7493	7493	7493	7493	7493
EGT	584	584	584	584	584	584	584	584	584
ROCKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MF H2O2	LB/SEC	0	0	0	0	0	0	0	0
MF JPA	LB/SEC	0	0	0	0	0	0	0	0

BEHIND DATA

COUNTER NUMBER	1272	1273	1274	1275	1276	1277	1278	1279	1280
TIME	1272	1273	1274	1275	1276	1277	1278	1279	1280
AIRSPEED	406.2	411.5	406.3	402.1	406.9	472.2	477.3	482.4	487.4
ALTITUDE (IC-19)	34882	34807	34735	34735	34735	34822	34822	34822	34822
ALTITUDE (INDENT)	34882	34844	34844	34844	34844	34844	34844	34844	34844
TIC	12.9	14.4	15.9	17.4	18.7	20.2	21.7	23.4	24.9
FUEL TEMP ENG	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
FUEL TEMP A/B	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
RPM	7493	7493	7493	7493	7493	7493	7493	7493	7493
EGT	584	584	584	584	584	584	584	584	584
ROCKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MF H2O2	LB/SEC	0	0	0	0	0	0	0	0
MF JPA	LB/SEC	0	0	0	0	0	0	0	0

BEHIND DATA

COUNTER NUMBER	1281	1282	1283	1284	1285	1286	1287	1288	1289
TIME	1281	1282	1283	1284	1285	1286	1287	1288	1289
AIRSPEED	482.9	487.8	502.2	507.2	511.3	511.0	511.0	511.0	511.0
ALTITUDE (IC-19)	34617	34597	34597	34597	34597	34597	34597	34597	34597
ALTITUDE (INDENT)	34617	34617	34617	34617	34617	34617	34617	34617	34617
TIC	-0.9	-1.7	-1.3	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
FUEL TEMP ENG	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
FUEL TEMP A/B	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
RPM	7493	7493	7493	7493	7493	7493	7493	7493	7493
EGT	584	584	584	584	584	584	584	584	584
ROCKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MF H2O2	LB/SEC	0	0	0	0	0	0	0	0
MF JPA	LB/SEC	0	0	0	0	0	0	0	0

WEATHER TABLE

PRESSURE	TEMPERATURE	WIND VELOCITY	TAPELINE ALT.	IND DIRECTION	A/C HEADING
PSF	DEG C	KNOTS	FEET	DEGREES TRUE	DEGREES TRUE
676.38888	-40.70000	52.40000	31176.38888	230.20000	253.00000
522.00000	-44.70000	68.40000	31176.19871	248.20000	253.00000
417.40000	-57.70000	68.40000	30899.00000	248.90000	253.00000

BEHIND DATA

COUNTER NUMBER	1293	1010	1020	1030	1040	1050	1060	1070	1080
TIME	1293	1010	1020	1030	1040	1050	1060	1070	1080
AIRSPEED	1004	1010	1020	1030	1040	1050	1060	1070	1080
ALTITUDE (IC-19)	33544	33452	33452	33452	33452	33452	33452	33452	33452
ALTITUDE (INDENT)	33614	33520	33520	33520	33520	33520	33520	33520	33520
TIC	-22.3	-18.6	-14.8	-11.0	-7.2	-3.4	0.4	4.2	8.0
FUEL TEMP ENG	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
FUEL TEMP A/B	48.7	48.8	48.3	48.3	48.3	48.3	48.3	48.3	48.3
RPM	7493	7493	7493	7493	7493	7493	7493	7493	7493
EGT	584	584	584	584	584	584	584	584	584
ROCKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MF H2O2	LB/SEC	0	0	0	0	0	0	0	0
MF JPA	LB/SEC	0	0	0	0	0	0	0	0

WEATHER TABLE

PRESSURE	TEMPERATURE	WIND VELOCITY	TAPELINE ALT.	IND DIRECTION	A/C HEADING
PSF	DEG C	KNOTS	FEET	DEGREES TRUE	DEGREES TRUE
676.38888	-40.70000	52.40000	31176.38888	230.20000	253.00000
522.00000	-44.70000	68.40000	31176.19871	248.20000	253.00000
417.40000	-57.70000	68.40000	30899.00000	248.90000	253.00000

BEHIND DATA

COUNTER NUMBER	1089	1090	1091	1092	1093	1094	1095	1096	1097
TIME	1089	1090	1091	1092	1093	1094	1095	1096	1097
AIRSPEED	1085	1086	1086	1087	1087	1087	1088	1088	1089
ALTITUDE (IC-19)	34777	34777	34777	34777	34777	34777	34777	34777	34777
ALTITUDE (INDENT)	34884	34877	34877	34877	34877	34877	34877	34877	34877
TIC	-0.0	0.4	1.8	3.0	4.3	5.6	6.8	8.0	9.2
FUEL TEMP ENG	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
FUEL TEMP A/B	48.7	48.7	48.1	48.1	48.1	48.1	48.1	48.1	48.1
RPM	7493	7493	7493	7493	7493	7493	7493	7493	7493
EGT	584	584	584	584	584	584	584	584	584
ROCKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MF H2O2	LB/SEC	0	0	0	0	0	0	0	0
MF JPA	LB/SEC	0	0	0	0	0	0	0	0

WEATHER TABLE

PRESSURE	TEMPERATURE	WIND VELOCITY	TAPELINE ALT.	IND DIRECTION	A/C HEADING
PSF	DEG C	KNOTS	FEET	DEGREES TRUE	DEGREES TRUE
676.38888	-40.70000	52.40000	31176.38888	230.20000	253.00000
522.00000	-44.70000	68.40000	31176.19871	248.20000	253.00000
417.40000	-57.70000	68.40000	30899.00000	248.90000	253.00000

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

WEATHER TABLE table with columns: TEMPERATURE, WIND VELOCITY, TRACKLINE ALT., WIND DIRECTION, A/C HEADING.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

FLIGHT No. 26 RUN NO. 2
UNIC OF FLIGHT 273949
ENGINE START CONDITIONS
FUEL SPECIFIC WEIGHT 14.55 LB/ GAL
FUEL TEMPERATURE 17.00 DEG C
HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.60 LB/ GAL
HYDROGEN PEROXIDE TEMPERATURE 20.6 DEG C
FUEL SPECIFIC WEIGHT 13.95
FUEL TEMPERATURE 17.00
HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.60
HYDROGEN PEROXIDE TEMPERATURE 20.6

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

AIRCRAFT DATA table with columns: COUNTER NUMBER, TIME, AIRSPEED, ALTITUDE (IC-131), ALTITUDE (BENDSI), TIC, FUEL TEMP ENG, FUEL TEMP A/B, RPM, EGT, CHAMBER PRESSURE, MF H2O2, MF JPA.

OH-10ARD DATA
AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

WEATHER TABLE
PRESSURE HPG
TEMPERATURE DEG C
WIND VELOCITY KNOTS
TEMPERATURE ALT. FEET
WIND DIRECTION DEGREES TRUE
AFC HEADING DEGREES TRUE

AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

WEATHER TABLE
PRESSURE HPG
TEMPERATURE DEG C
WIND VELOCITY KNOTS
TEMPERATURE ALT. FEET
WIND DIRECTION DEGREES TRUE
AFC HEADING DEGREES TRUE

FLIGHT NO 28 RUN NO 2
DATE OF FLIGHT 19/ 6/64
ENGINE START CONDITIONS
FUEL SPECIFIC WEIGHT 7.94 LB/GAL
FUEL TEMPERATURE 32.5 DEG C
HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.55 LB/GAL
HYDROGEN PEROXIDE TEMPERATURE 27.0 DEG C
GROSS WEIGHT 21422. LBS
TEST - ACCELERATION

OH-10ARD DATA
AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

WEATHER TABLE
PRESSURE HPG
TEMPERATURE DEG C
WIND VELOCITY KNOTS
TEMPERATURE ALT. FEET
WIND DIRECTION DEGREES TRUE
AFC HEADING DEGREES TRUE

AIRCRAFT DATA
TIME SEC
AIRSPEED KNOTS
ALTITUDE (IC-191) FEET
ALTITUDE (INDICATED) FEET
FUEL TEMP ENG DEG C
FUEL TEMP A/B DEG C
RPM
EGT DEG C
ROCKET DATA
CHAMBER PRESSURE PSI
WF H2O2 LB/SEC
WF JP4 LB/SEC

FLIGHT NO. 61
 DATE OF FLIGHT: 11/22/54
 ENGINE SERIAL: 11072
 FULL SPECIFIC WEIGHT: 11.0
 FULL TEMPERATURE: 14.0
 WINDSPEED: 11.0
 WIND DIRECTION: 11.0
 WIND GUSTS: 11.0
 WIND ACCELERATION: 11.0

COUNTER NUMBER	SEC		1107		1108		1109		1110		1111		1112		1113		1114		1115	
	AIRSPED	KNOTS	1079	1089	1099	1109	1119	1129	1139	1149	1159	1169	1179	1189	1199	1209	1219	1229	1239	1249
ALTITUDE (C-13)	FET	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0
ALTITUDE (INDICATOR)	FET	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0
TIC	DEG C	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8
FUEL TEMP ENG	DEG C	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
FUEL TEMP A/F	DEG C	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
HMP	DEG C	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1
E/GT	DEG C	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1
SECRET DATA	DEG C	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1
CHAMBER PRESSURE	PSI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W/ W22	LB/SEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W/ JPA	LB/SEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA	
1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176

COUNTER NUMBER	SEC		1120		1121		1122		1123		1124		1125		1126		1127		1128	
	AIRSPED	KNOTS	1110	1120	1130	1140	1150	1160	1170	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280

WINDSPEED 11.0
 WIND DIRECTION 11.0
 WIND GUSTS 11.0
 WIND ACCELERATION 11.0

COUNTER NUMBER	SEC		1129		1130		1131		1132		1133		1134		1135		1136		1137		1138	
	AIRSPED	KNOTS	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350	1360	1370
ALTITUDE (C-13)	FET	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	
ALTITUDE (INDICATOR)	FET	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	3627.0	
TIC	DEG C	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	-24.8	
FUEL TEMP ENG	DEG C	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	
FUEL TEMP A/F	DEG C	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	
HMP	DEG C	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	
E/GT	DEG C	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	
SECRET DATA	DEG C	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	59.1	
CHAMBER PRESSURE	PSI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
W/ W22	LB/SEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
W/ JPA	LB/SEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA		SECRET DATA	
1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136

COUNTER NUMBER	SEC		1139		1140		1141		1142		1143		1144		1145		1146		1147		1148	
	AIRSPED	KNOTS	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350	1360	1370	1380

WINDSPEED 11.0
 WIND DIRECTION 11.0
 WIND GUSTS 11.0
 WIND ACCELERATION 11.0

COUNTER NUMBER	SEC		1149		1150		1151		1152		1153		1154		1155		1156		1157		1158	
	AIRSPED	KNOTS	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350	1360	1370	1380	1390

WINDSPEED 11.0
 WIND DIRECTION 11.0
 WIND GUSTS 11.0
 WIND ACCELERATION 11.0

COUNTER NUMBER	SEC		1159		1160		1161		1162		1163		1164		1165		1166		1167		1168	
	AIRSPED	KNOTS	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350	1360	1370	1380	1390	1400

WINDSPEED 11.0
 WIND DIRECTION 11.0
 WIND GUSTS 11.0
 WIND ACCELERATION 11.0

FLIGHT 25			FLIGHT 26			FLIGHT 27			FLIGHT 28			FLIGHT 29			FLIGHT 30			FLIGHT 31		
C/N	WPTOT	JRO	C/N	WPTOT	JRO	C/N	WPTOT	JRO	C/N	WPTOT	JRO	C/N	WPTOT	JRO	C/N	WPTOT	JRO	C/N	WPTOT	JRO
1074	13607.0	1215	1172	13607.0	1215	1074	13607.0	1215	1172	13607.0	1215	1074	13607.0	1215	1172	13607.0	1215	1074	13607.0	1215
1075	13607.0	1215	1173	13607.0	1215	1075	13607.0	1215	1173	13607.0	1215	1075	13607.0	1215	1173	13607.0	1215	1075	13607.0	1215
1076	13607.0	1215	1174	13607.0	1215	1076	13607.0	1215	1174	13607.0	1215	1076	13607.0	1215	1174	13607.0	1215	1076	13607.0	1215
1077	13607.0	1215	1175	13607.0	1215	1077	13607.0	1215	1175	13607.0	1215	1077	13607.0	1215	1175	13607.0	1215	1077	13607.0	1215
1078	13607.0	1215	1176	13607.0	1215	1078	13607.0	1215	1176	13607.0	1215	1078	13607.0	1215	1176	13607.0	1215	1078	13607.0	1215
1079	13607.0	1215	1177	13607.0	1215	1079	13607.0	1215	1177	13607.0	1215	1079	13607.0	1215	1177	13607.0	1215	1079	13607.0	1215
1080	13607.0	1215	1178	13607.0	1215	1080	13607.0	1215	1178	13607.0	1215	1080	13607.0	1215	1178	13607.0	1215	1080	13607.0	1215
1081	13607.0	1215	1179	13607.0	1215	1081	13607.0	1215	1179	13607.0	1215	1081	13607.0	1215	1179	13607.0	1215	1081	13607.0	1215
1082	13607.0	1215	1180	13607.0	1215	1082	13607.0	1215	1180	13607.0	1215	1082	13607.0	1215	1180	13607.0	1215	1082	13607.0	1215
1083	13607.0	1215	1181	13607.0	1215	1083	13607.0	1215	1181	13607.0	1215	1083	13607.0	1215	1181	13607.0	1215	1083	13607.0	1215
1084	13607.0	1215	1182	13607.0	1215	1084	13607.0	1215	1182	13607.0	1215	1084	13607.0	1215	1182	13607.0	1215	1084	13607.0	1215
1085	13607.0	1215	1183	13607.0	1215	1085	13607.0	1215	1183	13607.0	1215	1085	13607.0	1215	1183	13607.0	1215	1085	13607.0	1215
1086	13607.0	1215	1184	13607.0	1215	1086	13607.0	1215	1184	13607.0	1215	1086	13607.0	1215	1184	13607.0	1215	1086	13607.0	1215
1087	13607.0	1215	1185	13607.0	1215	1087	13607.0	1215	1185	13607.0	1215	1087	13607.0	1215	1185	13607.0	1215	1087	13607.0	1215
1088	13607.0	1215	1186	13607.0	1215	1088	13607.0	1215	1186	13607.0	1215	1088	13607.0	1215	1186	13607.0	1215	1088	13607.0	1215
1089	13607.0	1215	1187	13607.0	1215	1089	13607.0	1215	1187	13607.0	1215	1089	13607.0	1215	1187	13607.0	1215	1089	13607.0	1215
1090	13607.0	1215	1188	13607.0	1215	1090	13607.0	1215	1188	13607.0	1215	1090	13607.0	1215	1188	13607.0	1215	1090	13607.0	1215
1091	13607.0	1215	1189	13607.0	1215	1091	13607.0	1215	1189	13607.0	1215	1091	13607.0	1215	1189	13607.0	1215	1091	13607.0	1215
1092	13607.0	1215	1190	13607.0	1215	1092	13607.0	1215	1190	13607.0	1215	1092	13607.0	1215	1190	13607.0	1215	1092	13607.0	1215
1093	13607.0	1215	1191	13607.0	1215	1093	13607.0	1215	1191	13607.0	1215	1093	13607.0	1215	1191	13607.0	1215	1093	13607.0	1215
1094	13607.0	1215	1192	13607.0	1215	1094	13607.0	1215	1192	13607.0	1215	1094	13607.0	1215	1192	13607.0	1215	1094	13607.0	1215
1095	13607.0	1215	1193	13607.0	1215	1095	13607.0	1215	1193	13607.0	1215	1095	13607.0	1215	1193	13607.0	1215	1095	13607.0	1215
1096	13607.0	1215	1194	13607.0	1215	1096	13607.0	1215	1194	13607.0	1215	1096	13607.0	1215	1194	13607.0	1215	1096	13607.0	1215
1097	13607.0	1215	1195	13607.0	1215	1097	13607.0	1215	1195	13607.0	1215	1097	13607.0	1215	1195	13607.0	1215	1097	13607.0	1215
1098	13607.0	1215	1196	13607.0	1215	1098	13607.0	1215	1196	13607.0	1215	1098	13607.0	1215	1196	13607.0	1215	1098	13607.0	1215
1099	13607.0	1215	1197	13607.0	1215	1099	13607.0	1215	1197	13607.0	1215	1099	13607.0	1215	1197	13607.0	1215	1099	13607.0	1215
1100	13607.0	1215	1198	13607.0	1215	1100	13607.0	1215	1198	13607.0	1215	1100	13607.0	1215	1198	13607.0	1215	1100	13607.0	1215
1101	13607.0	1215	1199	13607.0	1215	1101	13607.0	1215	1199	13607.0	1215	1101	13607.0	1215	1199	13607.0	1215	1101	13607.0	1215
1102	13607.0	1215	1200	13607.0	1215	1102	13607.0	1215	1200	13607.0	1215	1102	13607.0	1215	1200	13607.0	1215	1102	13607.0	1215

ZOOM CLIMB MANEUVER DATA

Flight Number	Pullup Mach No.	Maximum Pitch Angle (deg)	Average Angle of Attack (deg)	Peak Tapeline Altitude (ft)
25	2.02	45	11	99 035
36	2.03	33	8	95 670
37	2.03	27	8	91 840
45	2.03	39	11	96 090
46	2.02	43	11	99 820
47	1.94	30.5	8	87 630
48	2.16	40	11	101 030
49	2.15	43	11	106 270
53	1.92	38	8	95 100
54	2.18	48	11	108 600
55	2.18	54	11	112 000
57	2.15	37	10.5	100 820
61	2.16	38	8	98 750
62	2.18	51	8	105 400
63	2.18	55	8	109 180

NINE RADAR DATA

Table with 10 columns: Altitude, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth. Contains radar data for various altitudes from 44.0 to 59.0.

NINE RADAR DATA

Table with 10 columns: Altitude, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth. Contains radar data for various altitudes from 44.0 to 59.0.

NINE RADAR DATA

Table with 10 columns: Altitude, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth. Contains radar data for various altitudes from 60.0 to 75.0.

NINE RADAR DATA

Table with 10 columns: Altitude, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth, Range, Azimuth. Contains radar data for various altitudes from 60.0 to 75.0.

NIKE RADAR DATA

T= 102.0 M= 03022.0 BR= 48172. RC= 208848. Q= 244.01
110255.01 V= 10351.0 VBR= 1381.2 VRC= -259.2 M= 1.6471
A/C/D= 259.4 VTA= 1021.0 MD= 122.3 PA= 123.5 TA= 387.3

NIKE RADAR DATA

T= 116.0 M= 55084.0 BR= 24054. RC= 202882. Q= 402.39
110254.01 V= 10168.0 VBR= -1478.9 VRC= -327.4 M= 1.4488
A/C/D= 257.5 VTA= 1061.5 MD= 198.1 PA= 199.3 TA= 388.3

NIKE RADAR DATA

T= 132.0 M= 08041.0 BR= 5061. RC= 198005. Q= 461.92
110225.01 V= 1493.0 VBR= -1365.1 VRC= -340.4 M= 1.5920
A/C/D= 248.4 VTA= 1527.2 MD= 197.4 PA= 275.4 TA= 397.4

NIKE RADAR DATA

T= 146.0 M= 43488.0 BR= 14322. RC= 145654. Q= 429.50
110241.01 V= 1299.1 VBR= -1007.8 VRC= -403.1 M= 1.3914
A/C/D= 231.4 VTA= 1365.1 MD= 215.0 PA= 316.9 TA= 400.2

ASASIA DATA

Table with columns: TIME, ALTITUDE, PRESSURE, RATE OF CLIMB, etc. for ASASIA DATA.

ASASIA DATA

Table with columns: TIME, ALTITUDE, PRESSURE, RATE OF CLIMB, etc. for ASASIA DATA.

FLIGHT NO 37 RUN NO 3
DATE OF FLIGHT 20 OCT 64
ENGINE START CONDITIONS
FUEL SPECIFIC WEIGHT 6.33 LB/GAL
WATER TEMPERATURE 20.0 DEG C
HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.76 LB/GAL
HYDROGEN PEROXIDE TEMPERATURE 16.7 DEG C
GROSS WEIGHT 22185 LBS
TEST - ZOOM CLIMB

OH-BWARD DATA table with columns: CHAMBER NUMBER, TIME, AIRSPEED, ALTITUDE, etc.

OH-BWARD DATA table with columns: CHAMBER NUMBER, TIME, AIRSPEED, ALTITUDE, etc.

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, DYNAMIC, ALTITUDE, VELOCITY, RSL, PRESSURE, MACH. Rows 0 to 194000.

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, DYNAMIC, ALTITUDE, VELOCITY, RSL, PRESSURE, MACH. Rows 60000 to 121000.

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, DYNAMIC, ALTITUDE, VELOCITY, RSL, PRESSURE, MACH. Rows 122000 to 194000.

NIKE RADAR DATA

Table with columns: Time, Rate #, Total, Dynamic, Altitude, Velocity, RSL, Pressure, Mach. Rows 0 to 121000.

NIKE RADAR DATA

To 16.0 No 91762.000 000 -17800.0 RC= 17664.0 O = 76.42
11762.000 VTE 1717.4 VSR= -1675.0 WCR= -767.6 H= 1.7736
A/CDO 259.7 VTH= 1766.7 WD= 247.0 PA= 36.0 TA= 403.2

NIKE RADAR DATA

To 29.0 No 97613.000 000 -14160.0 RC= 17088.0 O = 78.80
11762.000 VTE 1777.6 VSR= -1675.0 WCR= -970.0 H= 1.7764
A/CDO 259.7 VTH= 1766.6 WD= 247.1 PA= 36.0 TA= 402.9

NIKE RADAR DATA

To 47.0 No 85796.000 000 -9737.0 RC= 16432.0 O = 96.50
11762.000 VTE 1713.0 VSR= -1675.0 WCR= -970.0 H= 1.7720
A/CDO 259.7 VTH= 1766.6 WD= 247.0 PA= 36.0 TA= 396.1

NIKE RADAR DATA

To 56.0 No 79631.000 000 -20070.0 RC= 16296.0 O = 129.21
11762.000 VTE 1687.3 VSR= -1608.0 WCR= -378.2 H= 1.7677
A/CDO 259.7 VTH= 1696.7 WD= 246.0 PA= 60.0 TA= 390.0

NIKE RADAR DATA

Table with columns for Time, Altitude, Range, Azimuth, and other radar parameters. Includes sub-sections for On-board Data and Rocket Data.

NIKE RADAR DATA

Table with columns for Time, Altitude, Range, Azimuth, and other radar parameters. Includes sub-sections for On-board Data and Rocket Data.

FLIGHT NO 45 RUN NO 3
DATE OF FLIGHT 10/11/64
ENGINE START CONDITIONS

FUEL SPECIFIC WEIGHT 6.01 LB/GAL

FUEL TEMPERATURE 9.0 DEG C

HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.77 LB/GAL

HYDROGEN PEROXIDE TEMPERATURE 4.4 DEG C

TEST - 200H CLIVE

ON-BOARD DATA

Table containing engine and flight parameters such as Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

ROCKET DATA

Table containing rocket engine parameters such as Chamber Pressure, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure.

AIRCRAFT DATA

Large table with multiple columns for aircraft data including Counter Number, Time, Airspeed, Altitude, Fuel Temp, RPM, and engine pressure for various aircraft.

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, BSA, SYMMETRY, MAGN. Rows include time intervals from 120.000 to 163.000 with associated numerical data.

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, BSA, SYMMETRY, MAGN. Rows include time intervals from 120.000 to 216.000 with associated numerical data.

NIKE RADAR DATA

Table with columns: TIME, RATE #, TOTAL, BSA, SYMMETRY, MAGN. Rows include radar data for various time points from 123402.00 to 163.000.

NIKE RADAR DATA

Table with columns: TIME, RATE #, TOTAL, BSA, SYMMETRY, MAGN. Rows include radar data for various time points from 170.000 to 216.000.

NINE RADAR DATA

Table with columns: To, From, SR, VR, RC, WC, VC, PA, TA, TA. Contains radar data for various frequencies and altitudes.

NINE RADAR DATA

Table with columns: To, From, SR, VR, RC, WC, VC, PA, TA, TA. Contains radar data for various frequencies and altitudes.

NINE RADAR DATA

Table with columns: To, From, SR, VR, RC, WC, VC, PA, TA, TA. Contains radar data for various frequencies and altitudes.

NINE RADAR DATA

Table with columns: To, From, SR, VR, RC, WC, VC, PA, TA, TA. Contains radar data for various frequencies and altitudes.

NIKE RADAR DATA

Table of Nike Radar Data with columns for time (In), range (R), azimuth (A), elevation (E), and other parameters. Includes sub-headers like 'NIKE RADAR DATA' and 'FLIGHT NO 46'.

NIKE RADAR DATA

Table of Nike Radar Data with columns for time (In), range (R), azimuth (A), elevation (E), and other parameters. Includes sub-headers like 'NIKE RADAR DATA' and 'FLIGHT NO 46'.

NIKE RADAR DATA

Table of Nike Radar Data with columns for time (In), range (R), azimuth (A), elevation (E), and other parameters. Includes sub-headers like 'NIKE RADAR DATA' and 'FLIGHT NO 46'.

FLIGHT NO 46

ENGINE START CONDITION 18 TO 24
FUEL SPECIFIC WEIGHT 8.53 LB/GAL
FUEL TEMPERATURE 10.0 DEG F
HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.88 LB/GAL
HYDROGEN PEROXIDE TEMPERATURE 7.8 DEG C
GROSS WEIGHT 22250 LBS
TEST - 2200 CLIMB

RY-BROAD DATA

Table of Ry-Broad Data with columns for counter number, time, airspeed, altitude, fuel temp, rpm, rocket data, chamber pressure, and engine data. Includes sub-headers like 'RY-BROAD DATA' and 'ENGINE DATA'.

ASPHANIA DATA

Table with columns: TIME, CLIM, VELOCITY, ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include data for various altitudes and Mach numbers.

ASPHANIA DATA

Table with columns: TIME, CLIM, VELOCITY, ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include data for various altitudes and Mach numbers.

ASPHANIA DATA

Table with columns: TIME, CLIM, VELOCITY, ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include data for various altitudes and Mach numbers.

NIKE RADAR DATA

Table with columns: TIME, CLIM, VELOCITY, ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include data for various altitudes and Mach numbers.

NIKE RADAR DATA

15.0 M 91368. XR=133196. RC=148216. Q= 40.04
15091.07 VF= 1262.6 VR= -1101.7 VRC= 31.7 M= 1.3178
A/C/D= 271.6 VFM= 1291.1 WD= -56.0 PA= 32.9 TA= 392.9

NIKE RADAR DATA

30.0 M 48144. XR= 81044. RC= 188668. Q= 26.25
152006.03 VF= 1187.5 VR= -1128.0 VRC= 32.0 M= 1.2541
A/C/D= 271.6 VFM= 1231.7 WD= -81.4 PA= 23.8 TA= 402.3

NIKE RADAR DATA

48.0 M 69397. XR= 98202. RC= 149171. Q= 22.77
152022.03 VF= 1111.3 VR= -1105.4 VRC= 29.4 M= 1.2587
A/C/D= 271.6 VFM= 1197.7 WD= -92.4 PA= 22.3 TA= 402.8

NIKE RADAR DATA

64.0 M 94219. XR= 87624. RC= 149600. Q= 33.80
152038.03 VF= 1276.1 VR= -1192.4 VRC= 31.4 M= 1.2920
A/C/D= 271.6 VFM= 1297.1 WD= -85.9 PA= 26.7 TA= 391.7

NIKE RADAR DATA table with columns for time, range, bearing, elevation, and other radar parameters.

NIKE RADAR DATA table with columns for time, range, bearing, elevation, and other radar parameters.

NIKE RADAR DATA table with columns for time, range, bearing, elevation, and other radar parameters.

NIKE RADAR DATA table with columns for time, range, bearing, elevation, and other radar parameters.

NIKE RADAR DATA

Table with columns for time (T), altitude (A), velocity (V), and other radar parameters. Includes sub-sections for A/C/D and V/M.

NIKE RADAR DATA

Table with columns for time (T), altitude (A), velocity (V), and other radar parameters. Includes sub-sections for A/C/D and V/M.

NIKE RADAR DATA

Table with columns for time (T), altitude (A), velocity (V), and other radar parameters. Includes sub-sections for A/C/D and V/M.

NIKE RADAR DATA

Table with columns for time (T), altitude (A), velocity (V), and other radar parameters. Includes sub-sections for A/C/D and V/M.

RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA		RW-SOARD DATA	
PLANE	TYPE	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

ASKANIA DATA

TOTAL	W/C	W/C	DYNAMIC	MACH
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000

ASKANIA DATA

TOTAL	W/C	W/C	DYNAMIC	MACH
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000

ASKANIA DATA

TOTAL	W/C	W/C	DYNAMIC	MACH
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000
1000	1000	1000	1000	1000

ARMADIA DATA

Table with columns: TYPE, ALTITUDE, VELOCITY, PRESSURE, etc. for various aircraft configurations.

FLIGHT PLAN NO. 48 RUN NO. 3
DATE OF FLIGHT 8/10/68
ENGINE START CONDITIONS

Table with columns: AIRCRAFT DATA, COMPUTER NUMBER, TIME, AIRSPEED, etc. for various aircraft configurations.

Table with columns: AIRCRAFT DATA, COMPUTER NUMBER, TIME, AIRSPEED, etc. for various aircraft configurations.

Table with columns: AIRCRAFT DATA, COMPUTER NUMBER, TIME, AIRSPEED, etc. for various aircraft configurations.

W-PRM DATA

Table with multiple columns including AIRCRAFT DATA (COUNT NUMBER, TIME, AIRSPEED, ALTITUDE, etc.), SECRET DATA, and WEATHER TABLE headers.

WEATHER TABLE

Table with columns: PRESSURE (PSF, IN HG), TEMPERATURE (DEG C, DEG F), WIND VELOCITY (KNOTS, MPH), TAPING ALT. (FEET), WIND DIRECTION (DEGREES TRUE, DEGREES MAGNETIC), and A/C HINDING (DEGREES TRUE, DEGREES MAGNETIC).

ASKANIA DATA

Table with columns: TIME (SECONDS), RATE #, RATE #P, TOTAL, WSL, DYNAMIC, and MACH. Contains numerical data for various time intervals.

ASKANIA DATA

Table with columns: TIME (SECONDS), RATE #, RATE #P, TOTAL, WSL, DYNAMIC, and MACH. Continuation of Askania data for different time intervals.

IN-BRAND DATA		AIRCRAFT DATA									
COUNTER NUMBER	SEC	1724	1731	1738	1745	1752	1759	1766	1773	1780	1787
TIME	KNOTS	1724	1731	1738	1745	1752	1759	1766	1773	1780	1787
AIRSPED	KNOTS	1724	1731	1738	1745	1752	1759	1766	1773	1780	1787
ALTITUDE (IC-19)	FEET	75390	75390	75390	75390	75390	75390	75390	75390	75390	75390
ALTITUDE (BENDIX)	FEET	75390	75390	75390	75390	75390	75390	75390	75390	75390	75390
TIC	DEG C	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
FUEL TEMP ENG	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
FUEL TEMP A/B	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
RPM		5001	5124	5230	5336	5442	5548	5654	5760	5866	5972
EGT	DEG C	370	361	352	343	334	325	316	307	298	289
CKET DATA		CKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
WF W2P2	LB/SEC	0	0	0	0	0	0	0	0	0	0
WF JPA	LB/SEC	0	0	0	0	0	0	0	0	0	0

IN-BRAND DATA		AIRCRAFT DATA									
COUNTER NUMBER	SEC	1801	1808	1815	1822	1829	1836	1843	1850	1857	1864
TIME	KNOTS	1801	1808	1815	1822	1829	1836	1843	1850	1857	1864
AIRSPED	KNOTS	1801	1808	1815	1822	1829	1836	1843	1850	1857	1864
ALTITUDE (IC-19)	FEET	46114	46092	46070	46048	46026	46004	45982	45960	45938	45916
ALTITUDE (BENDIX)	FEET	46114	46092	46070	46048	46026	46004	45982	45960	45938	45916
TIC	DEG C	-25.3	-25.8	-26.3	-26.8	-27.3	-27.8	-28.3	-28.8	-29.3	-29.8
FUEL TEMP ENG	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
FUEL TEMP A/B	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
RPM		5001	5124	5230	5336	5442	5548	5654	5760	5866	5972
EGT	DEG C	120	120	119	118	117	116	115	114	113	112
CKET DATA		CKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
WF W2P2	LB/SEC	0	0	0	0	0	0	0	0	0	0
WF JPA	LB/SEC	0	0	0	0	0	0	0	0	0	0

IN-BRAND DATA		AIRCRAFT DATA									
COUNTER NUMBER	SEC	1793	1785	1777	1769	1761	1753	1745	1737	1729	1721
TIME	KNOTS	1793	1785	1777	1769	1761	1753	1745	1737	1729	1721
AIRSPED	KNOTS	1793	1785	1777	1769	1761	1753	1745	1737	1729	1721
ALTITUDE (IC-19)	FEET	325.2	318.2	311.2	304.2	297.2	290.2	283.2	276.2	269.2	262.2
ALTITUDE (BENDIX)	FEET	325.2	318.2	311.2	304.2	297.2	290.2	283.2	276.2	269.2	262.2
TIC	DEG C	-19.6	-19.3	-19.0	-18.7	-18.4	-18.1	-17.8	-17.5	-17.2	-16.9
FUEL TEMP ENG	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
FUEL TEMP A/B	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
RPM		5001	5124	5230	5336	5442	5548	5654	5760	5866	5972
EGT	DEG C	175	170	165	160	155	150	145	140	135	130
CKET DATA		CKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
WF W2P2	LB/SEC	0	0	0	0	0	0	0	0	0	0
WF JPA	LB/SEC	0	0	0	0	0	0	0	0	0	0

IN-BRAND DATA		AIRCRAFT DATA									
COUNTER NUMBER	SEC	1837	1829	1821	1813	1805	1797	1789	1781	1773	1765
TIME	KNOTS	1837	1829	1821	1813	1805	1797	1789	1781	1773	1765
AIRSPED	KNOTS	1837	1829	1821	1813	1805	1797	1789	1781	1773	1765
ALTITUDE (IC-19)	FEET	40467	40122	39777	39432	39087	38742	38397	38052	37707	37362
ALTITUDE (BENDIX)	FEET	40467	40122	39777	39432	39087	38742	38397	38052	37707	37362
TIC	DEG C	-18.6	-18.4	-18.2	-18.0	-17.8	-17.6	-17.4	-17.2	-17.0	-16.8
FUEL TEMP ENG	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
FUEL TEMP A/B	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
RPM		5001	5124	5230	5336	5442	5548	5654	5760	5866	5972
EGT	DEG C	295	295	295	295	295	295	295	295	295	295
CKET DATA		CKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
WF W2P2	LB/SEC	0	0	0	0	0	0	0	0	0	0
WF JPA	LB/SEC	0	0	0	0	0	0	0	0	0	0

IN-BRAND DATA		AIRCRAFT DATA									
COUNTER NUMBER	SEC	1783	1775	1767	1759	1751	1743	1735	1727	1719	1711
TIME	KNOTS	1783	1775	1767	1759	1751	1743	1735	1727	1719	1711
AIRSPED	KNOTS	1783	1775	1767	1759	1751	1743	1735	1727	1719	1711
ALTITUDE (IC-19)	FEET	290.4	283.4	276.4	269.4	262.4	255.4	248.4	241.4	234.4	227.4
ALTITUDE (BENDIX)	FEET	290.4	283.4	276.4	269.4	262.4	255.4	248.4	241.4	234.4	227.4
TIC	DEG C	-18.8	-18.6	-18.4	-18.2	-18.0	-17.8	-17.6	-17.4	-17.2	-17.0
FUEL TEMP ENG	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
FUEL TEMP A/B	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
RPM		5001	5124	5230	5336	5442	5548	5654	5760	5866	5972
EGT	DEG C	135	135	135	135	135	135	135	135	135	135
CKET DATA		CKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
WF W2P2	LB/SEC	0	0	0	0	0	0	0	0	0	0
WF JPA	LB/SEC	0	0	0	0	0	0	0	0	0	0

IN-BRAND DATA		AIRCRAFT DATA									
COUNTER NUMBER	SEC	1859	1851	1843	1835	1827	1819	1811	1803	1795	1787
TIME	KNOTS	1859	1851	1843	1835	1827	1819	1811	1803	1795	1787
AIRSPED	KNOTS	1859	1851	1843	1835	1827	1819	1811	1803	1795	1787
ALTITUDE (IC-19)	FEET	36589	36144	35699	35254	34809	34364	33919	33474	33029	32584
ALTITUDE (BENDIX)	FEET	36589	36144	35699	35254	34809	34364	33919	33474	33029	32584
TIC	DEG C	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1
FUEL TEMP ENG	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
FUEL TEMP A/B	DEG C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
RPM		5001	5124	5230	5336	5442	5548	5654	5760	5866	5972
EGT	DEG C	215	215	215	215	215	215	215	215	215	215
CKET DATA		CKET DATA									
CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0	0	0
WF W2P2	LB/SEC	0	0	0	0	0	0	0	0	0	0
WF JPA	LB/SEC	0	0	0	0	0	0	0	0	0	0

NIKE RADAR DATA

T= 17.0 M= 8705.0 NR= 1227.0 AC= 18472.0 Q = 72.01
131034.01 V= 1503.7 VAR= -1277.0 VRC= -62.4 WF= 1.6205
AFCD= 267.7 VFM= 1576.3 MD= -58.8 PA= 38.0 TA= 384.5

NIKE RADAR DATA

T= 34.0 M= 10203.0 NR= 12063.0 AC= 18469.1 Q = 33.08
131051.01 V= 1301.1 VAR= -1174.0 VRC= -65.3 WF= 1.4368
AFCD= 267.1 VFM= 1424.4 MD= 270.0 PA= 23.3 TA= 408.6

NIKE RADAR DATA

T= 51.0 M= 10590.5 NR= 8815.0 AC= 18263.5 Q = 19.32
131706.01 V= 1238.4 VAR= -1229.5 VRC= -58.6 WF= 1.2432
AFCD= 267.4 VFM= 1238.4 MD= 270.0 PA= 17.9 TA= 412.5

NIKE RADAR DATA

T= 48.0 M= 12405.0 NR= 6404.0 AC= 18188.0 Q = 22.06
131745.03 V= 1207.6 VAR= -1211.3 VRC= -56.9 WF= 1.2751
AFCD= 267.3 VFM= 1207.6 MD= 270.0 PA= 19.4 TA= 410.7

ON-BOARD DATA		AIRCRAFT DATA																								
COUNTER NUMBER	TIME	AIRSPED	ALTITUDE (IC-19)	ALTITUDE (BENDIX)	TIC	FUEL TEMP ENG	FUEL TEMP A/B	RPM	EGT	CHAMBER PRESSURE	WF H2O2	WF JP4	COUNTER NUMBER	TIME	AIRSPED	ALTITUDE (IC-19)	ALTITUDE (BENDIX)	TIC	FUEL TEMP ENG	FUEL TEMP A/B	RPM	EGT	CHAMBER PRESSURE	WF H2O2	WF JP4	
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568
	1470	1472	1474	1476	1478	1480	1482	1484	1486				1542	1544	1546	1548	1550	1552	1554	1556	1558	1560	1562	1564	1566	1568

WEATHER TABLE

PRESSURE	TEMPERATURE	WIND VELOCITY	TAXIWAY ALT.	WIND DIRECTION	A/C HEADING
29.920000	10.000000	0.000000	2415.000000	0.000000	0.000000
29.900000	10.200000	0.000000	2415.000000	0.000000	0.000000
29.880000	10.400000	0.000000	2415.000000	0.000000	0.000000
29.860000	10.600000	0.000000	2415.000000	0.000000	0.000000
29.840000	10.800000	0.000000	2415.000000	0.000000	0.000000

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, BSE, DYNAMIC, MAGN. Rows include data points for various times from 0 to 19.000.

ASKANIA DATA

Table with columns: TIME, RATE #, TOTAL, BSE, DYNAMIC, MAGN. Rows include data points for various times from 0 to 19.000.

NIKE RADAR DATA

Table with columns: Time, Rate #, Total, Bse, Dynamic, Mag. Rows include radar data for times from 0 to 19.000.

NIKE RADAR DATA

Table with columns: Time, Rate #, Total, Bse, Dynamic, Mag. Rows include radar data for times from 0 to 32.000.

ASKANIA DATA

Table with columns: TIME, RATE OF CLIMB, TOTAL VELOCITY, MSU ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include time intervals from 0.2 to 5.0 seconds.

ASKANIA DATA

Table with columns: TIME, RATE OF CLIMB, TOTAL VELOCITY, MSU ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include time intervals from 6.0 to 11.0 seconds.

ASKANIA DATA

Table with columns: TIME, RATE OF CLIMB, TOTAL VELOCITY, MSU ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include time intervals from 12.0 to 17.0 seconds.

ASKANIA DATA

Table with columns: TIME, RATE OF CLIMB, TOTAL VELOCITY, MSU ALTITUDE, DYNAMIC PRESSURE, MACH. Rows include time intervals from 18.0 to 23.0 seconds.

FLIGHT NO 02 04 03 3
 GRID REF ALON 10 12 04
 ENROUTE STATION COORDINATES
 POINT SPECIFIC HEIGHT 4.55 NMAL
 PUEL TEMP ENG DEG C 11.5 19.5 C
 HYDRAULIC PRESSURE SPECIFIC WEIGHT 11.69 NMAL
 HYDRAULIC PRESSURE TEMPERATURE 19.0 DEG C
 CROSS WEIGHT 23950 LBS
 1011 - 2300 CLIMB

ENROUTE DATA
 AIRCRAFT DATA

COUNTER NUMBER	1375	1377	1379	1381	1383	1385	1387	1389	1391
TIME	1375	1377	1379	1381	1383	1385	1387	1389	1391
AIRSPED	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5
ALTITUDE (I-C-1)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
T/C	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
FUEL TEMP ENG	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
FUEL TEMP A/R	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
RAM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BAROMET DATA

CHAMBER PRESSURE	PSI	585	585	585	585	585	585	585	585
MP H282	L/R/SEC	0	0	0	0	0	0	0	0
MP JPM	L/R/SEC	0	0	0	0	0	0	0	0

RAVAR DATA

AIRSPED	KNOTS	1261.9	1262.4	1262.0	1261.0	1260.4	1259.5	1258.6	1257.8
ALTITUDE (I-C-1)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
A/C HEADING	DEGREE	257.4	257.7	257.9	258.0	258.0	258.0	258.0	258.0

WEATHER DATA

AMBIENT PRESSURE	IN-HG	7.07	7.06	7.05	7.04	7.03	7.02	7.01	7.00
AMBIENT TEMP	DEG C	-52.2	-52.1	-52.0	-51.9	-51.7	-51.6	-51.5	-51.4
TRUE WIND DIRECTION	DEG	245	245	245	245	245	245	245	245
WIND VELOCITY	KNOTS	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5

ENROUTE DATA
 AIRCRAFT DATA

COUNTER NUMBER	1465	1467	1469	1471	1473	1475	1477	1479	1481
TIME	1465	1467	1469	1471	1473	1475	1477	1479	1481
AIRSPED	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5
ALTITUDE (I-C-1)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
T/C	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
FUEL TEMP ENG	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
FUEL TEMP A/R	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
RAM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BAROMET DATA

CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MP H282	L/R/SEC	0	0	0	0	0	0	0	0
MP JPM	L/R/SEC	0	0	0	0	0	0	0	0

RAVAR DATA

AIRSPED	KNOTS	1317.7	1318.0	1318.0	1317.5	1317.0	1316.5	1316.0	1315.5
ALTITUDE (I-C-1)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
A/C HEADING	DEGREE	257.4	257.4	257.4	257.4	257.4	257.4	257.4	257.4

WEATHER DATA

AMBIENT PRESSURE	IN-HG	7.01	7.00	6.99	6.98	6.97	6.96	6.95	6.94
AMBIENT TEMP	DEG C	-52.2	-52.1	-52.0	-51.9	-51.8	-51.7	-51.6	-51.5
TRUE WIND DIRECTION	DEG	245	245	245	245	245	245	245	245
WIND VELOCITY	KNOTS	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5

ENROUTE DATA
 AIRCRAFT DATA

COUNTER NUMBER	1491	1493	1495	1497	1499	1501	1503	1505	1507
TIME	1491	1493	1495	1497	1499	1501	1503	1505	1507
AIRSPED	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5
ALTITUDE (I-C-1)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
T/C	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
FUEL TEMP ENG	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
FUEL TEMP A/R	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
RAM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BAROMET DATA

CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MP H282	L/R/SEC	0	0	0	0	0	0	0	0
MP JPM	L/R/SEC	0	0	0	0	0	0	0	0

RAVAR DATA

AIRSPED	KNOTS	1361.9	1362.0	1362.0	1361.5	1361.0	1360.5	1360.0	1359.5
ALTITUDE (I-C-1)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
A/C HEADING	DEGREE	257.4	257.4	257.4	257.4	257.4	257.4	257.4	257.4

WEATHER DATA

AMBIENT PRESSURE	IN-HG	7.00	6.99	6.98	6.97	6.96	6.95	6.94	6.93
AMBIENT TEMP	DEG C	-52.2	-52.1	-52.0	-51.9	-51.8	-51.7	-51.6	-51.5
TRUE WIND DIRECTION	DEG	245	245	245	245	245	245	245	245
WIND VELOCITY	KNOTS	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5

ENROUTE DATA
 AIRCRAFT DATA

COUNTER NUMBER	1519	1521	1523	1525	1527	1529	1531	1533	1535
TIME	1519	1521	1523	1525	1527	1529	1531	1533	1535
AIRSPED	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5	420.5
ALTITUDE (I-C-1)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
T/C	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
FUEL TEMP ENG	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
FUEL TEMP A/R	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
RAM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BAROMET DATA

CHAMBER PRESSURE	PSI	0	0	0	0	0	0	0	0
MP H282	L/R/SEC	0	0	0	0	0	0	0	0
MP JPM	L/R/SEC	0	0	0	0	0	0	0	0

RAVAR DATA

AIRSPED	KNOTS	1405.9	1406.0	1406.0	1405.5	1405.0	1404.5	1404.0	1403.5
ALTITUDE (I-C-1)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
ALTITUDE (RENDIA)	FEET	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0	10200.0
A/C HEADING	DEGREE	257.4	257.4	257.4	257.4	257.4	257.4	257.4	257.4

WEATHER DATA

AMBIENT PRESSURE	IN-HG	7.00	6.99	6.98	6.97	6.96	6.95	6.94	6.93
AMBIENT TEMP	DEG C	-52.2	-52.1	-52.0	-51.9	-51.8	-51.7	-51.6	-51.5
TRUE WIND DIRECTION	DEG	245	245	245	245	245	245	245	245
WIND VELOCITY	KNOTS	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5

AIRCRAFT DATA			WEATHER DATA		
COUNTER NUMBER	TIME	ALTITUDE (FT)	AMBIENT TEMP (DEG C)	TRUE WIND DIRECTION (DEG)	WIND VELOCITY (KNOTS)
1571	1572	1573	1574	1575	1576
1577	1578	1579	1580	1581	1582
1583	1584	1585	1586	1587	1588
1589	1590	1591	1592	1593	1594
1595	1596	1597	1598	1599	1600
1601	1602	1603	1604	1605	1606
1607	1608	1609	1610	1611	1612
1613	1614	1615	1616	1617	1618
1619	1620	1621	1622	1623	1624
1625	1626	1627	1628	1629	1630
1631	1632	1633	1634	1635	1636
1637	1638	1639	1640	1641	1642
1643	1644	1645	1646	1647	1648
1649	1650	1651	1652	1653	1654
1655	1656	1657	1658	1659	1660
1661	1662	1663	1664	1665	1666
1667	1668	1669	1670	1671	1672
1673	1674	1675	1676	1677	1678
1679	1680	1681	1682	1683	1684
1685	1686	1687	1688	1689	1690
1691	1692	1693	1694	1695	1696
1697	1698	1699	1700	1701	1702
1703	1704	1705	1706	1707	1708
1709	1710	1711	1712	1713	1714
1715	1716	1717	1718	1719	1720

AIRCRAFT DATA			WEATHER DATA		
COUNTER NUMBER	TIME	ALTITUDE (FT)	AMBIENT TEMP (DEG C)	TRUE WIND DIRECTION (DEG)	WIND VELOCITY (KNOTS)
1627	1628	1629	1630	1631	1632
1633	1634	1635	1636	1637	1638
1639	1640	1641	1642	1643	1644
1645	1646	1647	1648	1649	1650
1651	1652	1653	1654	1655	1656
1657	1658	1659	1660	1661	1662
1663	1664	1665	1666	1667	1668
1669	1670	1671	1672	1673	1674
1675	1676	1677	1678	1679	1680
1681	1682	1683	1684	1685	1686
1687	1688	1689	1690	1691	1692
1693	1694	1695	1696	1697	1698
1699	1700	1701	1702	1703	1704
1705	1706	1707	1708	1709	1710
1711	1712	1713	1714	1715	1716
1717	1718	1719	1720	1721	1722
1723	1724	1725	1726	1727	1728
1729	1730	1731	1732	1733	1734
1735	1736	1737	1738	1739	1740
1741	1742	1743	1744	1745	1746
1747	1748	1749	1750	1751	1752
1753	1754	1755	1756	1757	1758
1759	1760	1761	1762	1763	1764
1765	1766	1767	1768	1769	1770
1771	1772	1773	1774	1775	1776
1777	1778	1779	1780	1781	1782
1783	1784	1785	1786	1787	1788
1789	1790	1791	1792	1793	1794
1795	1796	1797	1798	1799	1800

ARKANIA DATA					
TIME	RATE OF CLIMB	TOTAL VELOCITY	MEL	PSI	BARIC PRESSURE
SEC	FT/SEC	FT/SEC	FT/SEC	IN. Hg	IN. Hg
1571	1572	1573	1574	1575	1576
1577	1578	1579	1580	1581	1582
1583	1584	1585	1586	1587	1588
1589	1590	1591	1592	1593	1594
1595	1596	1597	1598	1599	1600
1601	1602	1603	1604	1605	1606
1607	1608	1609	1610	1611	1612
1613	1614	1615	1616	1617	1618
1619	1620	1621	1622	1623	1624
1625	1626	1627	1628	1629	1630
1631	1632	1633	1634	1635	1636
1637	1638	1639	1640	1641	1642
1643	1644	1645	1646	1647	1648
1649	1650	1651	1652	1653	1654
1655	1656	1657	1658	1659	1660
1661	1662	1663	1664	1665	1666
1667	1668	1669	1670	1671	1672
1673	1674	1675	1676	1677	1678
1679	1680	1681	1682	1683	1684
1685	1686	1687	1688	1689	1690
1691	1692	1693	1694	1695	1696
1697	1698	1699	1700	1701	1702
1703	1704	1705	1706	1707	1708
1709	1710	1711	1712	1713	1714
1715	1716	1717	1718	1719	1720
1721	1722	1723	1724	1725	1726
1727	1728	1729	1730	1731	1732
1733	1734	1735	1736	1737	1738
1739	1740	1741	1742	1743	1744
1745	1746	1747	1748	1749	1750
1751	1752	1753	1754	1755	1756
1757	1758	1759	1760	1761	1762
1763	1764	1765	1766	1767	1768
1769	1770	1771	1772	1773	1774
1775	1776	1777	1778	1779	1780
1781	1782	1783	1784	1785	1786
1787	1788	1789	1790	1791	1792
1793	1794	1795	1796	1797	1798
1799	1800	1801	1802	1803	1804

ARKANIA DATA					
TIME	RATE OF CLIMB	TOTAL VELOCITY	MEL	PSI	BARIC PRESSURE
SEC	FT/SEC	FT/SEC	FT/SEC	IN. Hg	IN. Hg
1627	1628	1629	1630	1631	1632
1633	1634	1635	1636	1637	1638
1639	1640	1641	1642	1643	1644
1645	1646	1647	1648	1649	1650
1651	1652	1653	1654	1655	1656
1657	1658	1659	1660	1661	1662
1663	1664	1665	1666	1667	1668
1669	1670	1671	1672	1673	1674
1675	1676	1677	1678	1679	1680
1681	1682	1683	1684	1685	1686
1687	1688	1689	1690	1691	1692
1693	1694	1695	1696	1697	1698
1699	1700	1701	1702	1703	1704
1705	1706	1707	1708	1709	1710
1711	1712	1713	1714	1715	1716
1717	1718	1719	1720	1721	1722
1723	1724	1725	1726	1727	1728
1729	1730	1731	1732	1733	1734
1735	1736	1737	1738	1739	1740
1741	1742	1743	1744	1745	1746
1747	1748	1749	1750	1751	1752
1753	1754	1755	1756	1757	1758
1759	1760	1761	1762	1763	1764
1765	1766	1767	1768	1769	1770
1771	1772	1773	1774	1775	1776
1777	1778	1779	1780	1781	1782
1783	1784	1785	1786	1787	1788
1789	1790	1791	1792	1793	1794
1795	1796	1797	1798	1799	1800

TIME	RATE	CLIM	TOTAL	WIND	DYNAMIC	WIND
SEC/MIN	FT/SEC	FT/SEC	FT/SEC	FT/SEC	FT/SEC	FT/SEC
121.000	844.7	1399.1	6733.2	39.1136	1.3780	
122.000	845.2	1399.1	6733.2	39.1136	1.3780	
123.000	845.7	1399.1	6733.2	39.1136	1.3780	
124.000	846.2	1399.1	6733.2	39.1136	1.3780	
125.000	846.7	1399.1	6733.2	39.1136	1.3780	
126.000	847.2	1399.1	6733.2	39.1136	1.3780	
127.000	847.7	1399.1	6733.2	39.1136	1.3780	
128.000	848.2	1399.1	6733.2	39.1136	1.3780	
129.000	848.7	1399.1	6733.2	39.1136	1.3780	
130.000	849.2	1399.1	6733.2	39.1136	1.3780	
131.000	849.7	1399.1	6733.2	39.1136	1.3780	
132.000	850.2	1399.1	6733.2	39.1136	1.3780	
133.000	850.7	1399.1	6733.2	39.1136	1.3780	
134.000	851.2	1399.1	6733.2	39.1136	1.3780	
135.000	851.7	1399.1	6733.2	39.1136	1.3780	
136.000	852.2	1399.1	6733.2	39.1136	1.3780	
137.000	852.7	1399.1	6733.2	39.1136	1.3780	
138.000	853.2	1399.1	6733.2	39.1136	1.3780	
139.000	853.7	1399.1	6733.2	39.1136	1.3780	
140.000	854.2	1399.1	6733.2	39.1136	1.3780	
141.000	854.7	1399.1	6733.2	39.1136	1.3780	
142.000	855.2	1399.1	6733.2	39.1136	1.3780	
143.000	855.7	1399.1	6733.2	39.1136	1.3780	
144.000	856.2	1399.1	6733.2	39.1136	1.3780	
145.000	856.7	1399.1	6733.2	39.1136	1.3780	
146.000	857.2	1399.1	6733.2	39.1136	1.3780	
147.000	857.7	1399.1	6733.2	39.1136	1.3780	
148.000	858.2	1399.1	6733.2	39.1136	1.3780	
149.000	858.7	1399.1	6733.2	39.1136	1.3780	
150.000	859.2	1399.1	6733.2	39.1136	1.3780	
151.000	859.7	1399.1	6733.2	39.1136	1.3780	
152.000	860.2	1399.1	6733.2	39.1136	1.3780	
153.000	860.7	1399.1	6733.2	39.1136	1.3780	
154.000	861.2	1399.1	6733.2	39.1136	1.3780	
155.000	861.7	1399.1	6733.2	39.1136	1.3780	
156.000	862.2	1399.1	6733.2	39.1136	1.3780	
157.000	862.7	1399.1	6733.2	39.1136	1.3780	
158.000	863.2	1399.1	6733.2	39.1136	1.3780	
159.000	863.7	1399.1	6733.2	39.1136	1.3780	
160.000	864.2	1399.1	6733.2	39.1136	1.3780	

TIME	RATE	CLIM	TOTAL	WIND	DYNAMIC	WIND
SEC/MIN	FT/SEC	FT/SEC	FT/SEC	FT/SEC	FT/SEC	FT/SEC
161.000	864.7	1399.1	6733.2	39.1136	1.3780	
162.000	865.2	1399.1	6733.2	39.1136	1.3780	
163.000	865.7	1399.1	6733.2	39.1136	1.3780	
164.000	866.2	1399.1	6733.2	39.1136	1.3780	
165.000	866.7	1399.1	6733.2	39.1136	1.3780	
166.000	867.2	1399.1	6733.2	39.1136	1.3780	
167.000	867.7	1399.1	6733.2	39.1136	1.3780	
168.000	868.2	1399.1	6733.2	39.1136	1.3780	
169.000	868.7	1399.1	6733.2	39.1136	1.3780	
170.000	869.2	1399.1	6733.2	39.1136	1.3780	
171.000	869.7	1399.1	6733.2	39.1136	1.3780	
172.000	870.2	1399.1	6733.2	39.1136	1.3780	
173.000	870.7	1399.1	6733.2	39.1136	1.3780	
174.000	871.2	1399.1	6733.2	39.1136	1.3780	
175.000	871.7	1399.1	6733.2	39.1136	1.3780	
176.000	872.2	1399.1	6733.2	39.1136	1.3780	
177.000	872.7	1399.1	6733.2	39.1136	1.3780	
178.000	873.2	1399.1	6733.2	39.1136	1.3780	
179.000	873.7	1399.1	6733.2	39.1136	1.3780	
180.000	874.2	1399.1	6733.2	39.1136	1.3780	

FLIGHT NO 63 RUN NO 3
DATE OF FLIGHT 17/12/66
ENGINE START CONDITIONS
FUEL SPECIFIC WEIGHT 6.63 LB/GAL
FUEL TEMPERATURE 3.0 DEG C
HYDROGEN PEROXIDE SPECIFIC WEIGHT 11.87 LB/GAL
HYDROGEN PEROXIDE TEMPERATURE 5.0 DEG C
GROSS WEIGHT 22136 LBS
TEST - JRBW CLIM

ON-BOARD DATA	1200	1204	1208	1212	1216	1220	1224
COUNTER NUMBER	1202	1204	1208	1212	1216	1220	1224
TIME SEC	1202	1204	1208	1212	1216	1220	1224
AIRSPED KNOTS	768.1	769.7	771.3	772.9	774.5	776.1	777.7
ALTITUDE (C-19) FEET	39082	39082	39082	39082	39082	39082	39082
ALTITUDE (BENDIX) FEET	39079	39080	39081	39082	39083	39084	39085
TIC DEG C	140.4	139.2	138.0	136.8	135.6	134.4	133.2
FUEL TEMP ENG DEG C	27.5	27.5	27.5	27.5	27.5	27.5	27.5
FUEL TEMP A/B DEG C	27.5	27.5	27.5	27.5	27.5	27.5	27.5
RPM	2714.6	2714.6	2714.6	2714.6	2714.6	2714.6	2714.6
EGT DEG C	577.1	577.1	577.1	577.1	577.1	577.1	577.1
CHAMBER PRESSURE PSI	500.	500.	500.	500.	500.	500.	500.
WF HP2 LB/SEC	22.	22.	22.	22.	22.	22.	22.
WF JPA LB/SEC	4.	4.	4.	4.	4.	4.	4.

ON-BOARD DATA

COUNTER NUMBER	1230	1234	1238	1242	1246	1250	1254
TIME SEC	1230	1234	1238	1242	1246	1250	1254
AIRSPED KNOTS	1230	1230	1230	1230	1230	1230	1230
ALTITUDE (C-19) FEET	9999.9	9999.9	9999.9	9999.9	9999.9	9999.9	9999.9
ALTITUDE (BENDIX) FEET	9999.9	9999.9	9999.9	9999.9	9999.9	9999.9	9999.9
TIC DEG C	28.1	28.1	28.1	28.1	28.1	28.1	28.1
FUEL TEMP ENG DEG C	42.4	42.4	42.4	42.4	42.4	42.4	42.4
FUEL TEMP A/B DEG C	42.4	42.4	42.4	42.4	42.4	42.4	42.4
RPM	5923.	5923.	5923.	5923.	5923.	5923.	5923.
EGT DEG C	605.	605.	605.	605.	605.	605.	605.
CHAMBER PRESSURE PSI	500.	500.	500.	500.	500.	500.	500.
WF HP2 LB/SEC	22.	22.	22.	22.	22.	22.	22.
WF JPA LB/SEC	4.	4.	4.	4.	4.	4.	4.

ON-BOARD DATA AIRCRAFT DATA COUNTER NUMBER TIME SEC AIRSPEED KNOTS ALTITUDE (IC-101) FEET ALTITUDE (BENDIRI) FEET TIC DEG C FUEL TEMP ENG DEG C FUEL TEMP A/B DEG C RPM EST DEG C RACKET DATA CHAMBER PRESSURE PSI WF #202 LB/SEC WF #201 LB/SEC

WEATHER TABLE PRESSURE PSF TEMPERATURE DEG C WIND VELOCITY KNOTS TAILWIND ALT. FEET WIND DIRECTION DEGREES TRUE A/C HEADING DEGREES TRUE

NIKE RADAR DATA

Table with columns for target ID (e.g., 10.0, 11.0, 12.0), range (R), altitude (AL), and other radar parameters. Includes sub-headers like 'A/C' and 'A/B'.

NIKE RADAR DATA

Table with columns for target ID (e.g., 10.0, 11.0, 12.0), range (R), altitude (AL), and other radar parameters. Includes sub-headers like 'A/C' and 'A/B'.

NIKE RADAR DATA

Table of Nike Radar Data with columns for ID, Altitude, Range, Azimuth, and other parameters. Includes sub-headers like 'IN 5000' and 'AZ/CL 2010'.

NIKE RADAR DATA

Table of Nike Radar Data with columns for ID, Altitude, Range, Azimuth, and other parameters. Includes sub-headers like 'IN 5000' and 'AZ/CL 2010'.

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NIKE RADAR DATA

Table of Nike Radar Data with columns for ID, Altitude, Range, Azimuth, and other parameters. Includes sub-headers like 'IN 5000' and 'AZ/CL 2010'.

NIKE RADAR DATA

Table with columns: I#, A/C#, R#, M#, X#, Y#, Z#, R#, S#, Q#. Rows include radar data points such as I# 170.0, A/C# 054246.03, R# 46354, etc.

NIKE RADAR DATA

Table with columns: I#, A/C#, R#, M#, X#, Y#, Z#, R#, S#, Q#. Rows include radar data points such as I# 107.0, A/C# 054202.03, R# 43162, etc.

NIKE RADAR DATA

Table with columns: I#, A/C#, R#, M#, X#, Y#, Z#, R#, S#, Q#. Rows include radar data points such as I# 204.0, A/C# 054246.04, R# 43394, etc.

NIKE RADAR DATA

Table with columns: I#, A/C#, R#, M#, X#, Y#, Z#, R#, S#, Q#. Rows include radar data points such as I# 241.0, A/C# 054277.05, R# 42130, etc.

NIKE RADAR DATA

Table with columns: I, A/C/L, X, Y, Z, R, C, D, M, P, T. Contains radar data for various targets.

NIKE RADAR DATA

Table with columns: I, A/C/L, X, Y, Z, R, C, D, M, P, T. Contains radar data for various targets.

ASKANIA DATA

Table with columns: TIME, RATE OF CLIMB, VELOCITY, ALTITUDE, PRESSURE, MACH. Contains performance data for various altitudes.

ASKANIA DATA

Table with columns: TIME, RATE OF CLIMB, VELOCITY, ALTITUDE, PRESSURE, MACH. Contains performance data for various altitudes.

ASKANIA DATA

TIME SECONDS	RATE OF CLIMB FT/SEC	TOTAL VELOCITY FT/SEC	MSL ALTITUDE FEET	DYNAMIC PRESSURE LB./SQ.FT	MACH
124.000	-953.0	1459.6	91589.7	51.07475	1.4782
125.000	-975.3	1477.8	90627.2	54.95368	1.4995
126.000	-996.9	1495.9	89637.7	59.19915	1.5210
127.000	-1018.0	1514.0	88631.0	63.82203	1.5426
128.000	-1038.2	1532.0	87602.0	68.86508	1.5642
129.000	-1057.6	1549.6	86553.5	74.34698	1.5857
130.000	-1076.0	1567.1	85483.2	80.32814	1.6070
131.000	-1093.6	1584.3	84398.7	86.83417	1.6284
132.000	-1110.7	1601.6	83294.2	93.97755	1.6500
133.000	-1127.2	1619.2	82176.2	101.80026	1.6720
134.000	-1143.3	1636.8	81042.0	110.36206	1.6908
135.000	-1158.3	1654.2	79880.7	117.64148	1.7088
136.000	-1171.6	1670.9	78721.2	126.95160	1.7260
137.000	-1183.0	1686.6	77540.5	136.91160	1.7423
138.000	-1192.6	1701.7	76349.0	147.57868	1.7578
139.000	-1200.8	1716.4	75151.3	159.03897	1.7730
140.000	-1208.1	1731.2	73948.2	171.41978	1.7883
141.000	-1214.3	1745.8	72736.7	184.76941	1.8033
142.000	-1218.8	1759.6	71517.7	199.04328	1.8177
143.000	-1220.9	1772.2	70293.2	214.14665	1.8307
144.000	-1219.9	1783.3	69066.0	229.99257	1.8421
145.000	-1215.7	1792.7	67844.0	246.51804	1.8519
146.000	-1208.6	1801.2	66631.0	263.76775	1.8606
147.000	-1198.9	1808.6	65424.0	281.84669	1.8683
148.000	-1186.9	1815.3	64228.7	300.69877	1.8751
149.000	-1172.7	1820.3	63045.2	320.29771	1.8810
150.000	-1156.2	1825.7	61876.7	340.59638	1.8859
151.000	-1137.5	1829.4	60728.2	361.34333	1.8897
152.000	-1116.5	1832.0	59600.2	382.58332	1.8924
153.000	-1093.0	1833.5	58491.2	404.18664	1.8939
154.000	-1066.8	1833.5	57407.7	425.77139	1.8939
155.000	-1037.8	1832.0	56350.0	447.24670	1.8916
156.000	-1006.4	1829.3	55324.7	469.46454	1.8896
157.000	-973.3	1826.0	54334.2	489.52365	1.8862
158.000	-939.3	1822.6	53378.0	510.68935	1.8828
159.000	-905.4	1820.1	52456.2	532.35233	1.8802
160.000	-871.3	1818.4	51568.5	554.51620	1.8784

DASH CLIMBS TOTAL J79-GL-38 FUEL FLOW

FLIGHT 25		FLIGHT 36		FLIGHT 37		FLIGHT 45		FLIGHT 46		FLIGHT 47		FLIGHT 48		FLIGHT 49	
C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79
1214	35804.9	1344	91142.0	1448	25893.5	1674	28825.9	975	32203.8	1468	24796.8	1487	20280.3	1585	31962.8
1240	32118.6	1366	76508.7	1450	25862.7	1606	27576.7	977	30453.2	1468	23300.8	1459	24163.3	1587	30819.1
1245	28767.3	1368	49875.5	1452	27169.8	1608	26327.4	979	28702.4	1470	21806.5	1491	24163.3	1589	29675.4
1250	23416.1	1370	29242.3	1454	24764.5	1610	25078.2	983	26951.7	1472	20312.4	1493	24163.3	1591	28531.6
1255	21950.4	1372	32108.1	1456	25185.2	1612	23766.9	985	25184.2	1474	19932.3	1495	24099.7	1593	27325.7
1265	14392.3	1376	6757.9	1458	24063.9	1614	22380.4	985	23401.3	1476	17492.1	1497	22451.6	1595	25985.1
1270	11598.2	1378	6461.9	1460	22422.4	1616	20986.6	987	21595.6	1478	16556.2	1499	20721.1	1597	24394.5
1275	8315.8	1378	6152.0	1462	21761.2	1618	19358.4	989	19805.3	1480	15498.5	1501	18364.2	1599	22596.4
1280	5084.2	1380	5822.1	1464	20547.0	1620	17878.5	991	18060.6	1482	14310.4	1503	16910.4	1601	20638.8
1285	1981.7	1382	5468.6	1466	19266.3	1622	16470.0	993	16456.4	1484	13161.3	1505	15010.4	1603	18619.7
1290	130.4	1384	5107.3	1468	17556.2	1624	15211.6	995	14931.4	1486	12010.4	1507	13971.1	1605	16659.4
		1386	4707.3	1470	16175.0	1626	14038.3	997	13517.8	1488	10941.5	1509	12474.2	1607	14742.0
		1388	3924.0	1472	15409.2	1628	12889.9	1001	11013.6	1490	10035.2	1511	11714.2	1609	12874.6
		1390	3132.3	1474	14200.0	1628	11803.8	1003	9793.6	1492	9292.6	1513	10424.7	1611	10962.0
		1392	2568.1	1476	12946.5	1632	10446.4	1005	8566.0	1494	8626.9	1515	9125.2	1613	9014.6
		1394	3221.6	1478	11814.0	1634	8548.1	1007	7342.3	1496	7946.9	1517	8013.0	1615	7084.4
		1396	2387.0	1480	10618.0	1636	6875.8	1009	6073.2	1498	7293.0	1519	6825.2	1617	5220.4
		1398	2556.2	1482	9561.0	1638	5275.0	1011	4800.8	1500	6712.4	1521	5720.7	1619	3422.8
		1400	2230.1	1484	8670.0	1640	3736.7	1013	3488.5	1502	6229.7	1523	4706.2	1621	1559.1
		1402	1936.9	1486	7525.2	1642	2293.5	1015	2281.6	1504	5869.2	1525	3406.1	1623	1514.4
		1404	1703.6	1490	6768.9	1644	1089.5			1506	5640.8	1527	2050.5	1625	1503.0
		1406	1559.9	1492	6125.2	1648	640.5			1508	5502.7	1529	884.8	1627	1503.2
		1408	1488.5	1494	5524.8	1650	416.0			1510	5306.8			1629	1503.3
		1410	1468.9	1496	4874.1					1512	5114.9			1631	1503.5
		1412	1469.3	1498	4244.1					1514	5331.0				
		1414	1478.9	1498	3593.1										
		1416	1484.5	1500	2946.5										
		1418	1492.0	1502	1877.2										
		1420		1504	1557.4										
FLIGHT 53		FLIGHT 54		FLIGHT 55		FLIGHT 57		FLIGHT 61		FLIGHT 62		FLIGHT 63			
C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79	C/N	#FT@ J79		
1416	32475.1	1542	29179.7	1396	28093.7	1284	27528.8	1340	24788.5	1376	29686.0	1202	28874.6		
1418	30899.9	1544	27739.5	1398	26784.1	1286	26478.1	1342	23428.5	1377	28679.2	1204	28140.0		
1420	29324.8	1546	26299.3	1400	25474.6	1288	25427.4	1344	22178.5	1379	27272.4	1206	26400.5		
1422	27749.6	1548	24859.2	1402	24165.0	1290	24376.8	1346	20788.4	1381	26055.6	1208	24661.1		
1424	26239.0	1550	23358.9	1404	22766.0	1292	23224.9	1348	19410.6	1383	24735.9	1210	22923.6		
1426	24789.1	1552	21756.7	1406	21260.9	1294	21957.2	1350	17995.1	1385	23232.4	1212	21182.9		
1428	23327.2	1554	20048.0	1408	19841.8	1296	20551.2	1352	16575.8	1387	21521.6	1214	19414.5		
1430	21754.0	1556	18261.5	1410	17546.0	1298	19079.5	1354	15193.1	1389	19695.8	1216	17653.2		
1432	20005.8	1558	16478.0	1412	16246.5	1300	17577.9	1356	13857.8	1391	17832.6	1218	15928.9		
1434	18143.7	1560	14817.0	1414	14520.9	1302	16127.4	1358	12595.1	1393	16141.9	1220	14285.2		
1436	16315.2	1562	13340.5	1416	12908.3	1304	14745.6	1360	11314.7	1395	14618.1	1222	12762.7		
1438	14544.6	1564	12033.4	1418	11388.4	1306	13429.6	1362	10096.8	1397	13298.7	1224	11368.5		
1440	13078.4	1566	10811.3	1420	9943.5	1308	12194.6	1364	8931.9	1399	12138.8	1226	10072.7		
1442	11751.4	1568	9626.2	1422	8536.8	1310	10991.5	1366	7446.5	1401	11020.1	1228	8815.4		
1444	10508.4	1570	8442.8	1424	7122.8	1312	9832.6	1368	6288.1	1403	9911.1	1230	7533.1		
1446	9241.3	1572	7282.5	1426	5722.0	1314	8640.3	1370	5191.3	1405	8783.8	1232	6238.4		
1448	8008.6	1574	6134.3	1428	4290.9	1316	7445.2	1372	4471.4	1407	7630.7	1234	4929.4		
1450	6781.2	1576	5067.2	1430	2873.7	1318	6210.5	1374	3441.4	1409	6484.2	1236	3551.1		
1452	4438.7	1578	4022.3	1432	900.0	1320	4942.0	1376	2411.4	1411	5350.4	1238	380.9		
1454	1265.7	1580	3058.2	1434	726.4	1322	3688.3			1413	4201.7				
1456	1129.4	1582	2024.1	1436	552.7	1324	2409.3			1415	3051.1				
1458	1012.9	1584	990.0			1326	1177.0			1417	1897.2				
1460	897.1					1328	1056.2			1419	889.2				
1462	679.8					1330	976.8			1421	281.3				
1464	502.6					1332	914.4								
1466	325.3					1334	860.2								
						1336	814.6								
						1338	784.9								
						1340	760.4								
						1342	740.0								
						1344	723.5								

FLIGHT RESEARCH DIVISION

OFFICE MEMO

Capt C. D. Zaleski

December 1964

NF-104A LATERAL-DIRECTIONAL STABILITY ANALYSIS

Part of the NF-104A flight test program was to investigate the lateral-directional stability at high Mach numbers with the speed brakes extended. This flight condition was encountered during the entry following a zoom mission and no previous data were available. The data available for the speed brakes retracted configuration indicated that the directional stability parameter, $C_{n\dot{\beta}}$ decreased with increasing Mach number, and it was also known that the speed brakes detracted from the stability. The study received impetus when a lateral-directional oscillation was encountered on several NF-104 flights during the recovery from the high altitude portion of the zoom mission. In each case where these oscillations were encountered, the following conditions existed.

1. High Mach number
2. Angle of attack greater than 5 degrees
3. Jet engine shut down
4. Rocket engine off
5. Stability augmentation on
6. Speed brakes extended
7. Reaction control system (RCS) damper inactive

The pilot was able to damp these oscillations by lowering his angle of attack. (Figure 1). On flights 5 and 8 of the flight test program, the oscillations built up almost immediately after the RCS dampers were switched off. On flight 10, the oscillations occurred during a period of no RCS inputs, and they were damped out when the RCS damper inputs came on.

TEST METHOD

In order to study the lateral-directional characteristics of the NF-104 at these zoom recovery conditions, a low, flat zoom trajectory was devised using the NF-104 three degree of freedom simulation. (Reference 1). This mission enabled the duplication of the Mach number, angle of attack, and dynamic pressure of a zoom recovery, but did not require the high angle of attack for a safe recovery. Thus, lowering the angle of attack was a safe means of getting out of trouble at any time during the lateral-directional investigations.

The technique used to get the stability data was to light the rocket at Mach 2 and pull up to a pitch attitude of 25°. At an altitude of 65,000 ft, the pilot pushed over to zero "g" and came level about 80,000 ft and Mach 2. The rocket engine and jet engine were then shut down, the speed brakes extended, and the aircraft stabilized at the desired angle of attack. The pilot then turned off the roll and yaw stability augmentation and performed a rudder pulse at constant angle of attack while making a minimum of aileron inputs. Because of the rapid deceleration, in order to get the high Mach number data point, it was necessary to leave the engines on until after the angle of attack was stabilized, the speed brakes extended, and the dampers turned off. In Table I, the Mach number, angle of attack, dynamic pressure, weight, and center of gravity of the test points have been summarized. The Mach numbers ranged from 1.3 to 2.1 and angle of attack from 4 degrees to 13 degrees.

METHOD OF ANALYSIS

The object of the analysis was to determine the stability derivatives $C_{n\beta}$ and $C_{l\beta}$. The analog matching technique was the primary method of analysis. This method entailed the use of an analog computer simulation of NF-104 lateral-directional aerodynamics. The procedure was to duplicate on the simulator the flight conditions and aircraft weight and center of gravity at each data point and introduce into the computer the same control surface inputs which occurred in flight. The stability derivatives,

primarily $C_{n\beta}$ and $C_{l\beta}$, were then varied until the time history of the computer response in roll rate, roll angle, sideslip angle, and yaw rate matched as closely as possible the history of the aircraft response which had been recorded by an oscillograph. When the responses closely matched, the values of $C_{n\beta}$ and $C_{l\beta}$ which had been required by the simulation were recorded as the results of the analysis. This method of analysis is valid regardless of control inputs by the pilot, since they can be introduced into the simulation and taken into account. Thus it was possible to obtain results from the oscillations encountered on the earlier high zoom recoveries despite large control inputs by the pilot during the maneuver. In Reference 2, the analog matching technique has been described in more detail.

A secondary method of analysis was to use the natural frequency of the oscillations and the best known value of $C_{l\beta}$ to calculate $C_{n\beta}$ from the following body axis equations for the lateral-directional stability parameter ($C_{n\beta}^*$): (Appendix I)

$$C_{n\beta}^* = \frac{\omega_n^2 I_z}{qSb (57.3)} = C_{n\beta} \cos \alpha - \frac{I_{xz}}{I_x} C_{l\beta} \sin \alpha$$

$$+ \frac{I_{xz}}{I_x} [C_{l\beta} \cos \alpha - C_{n\beta} \sin \alpha]$$

The analog matching results were checked by substituting $C_{n\beta}$ and $C_{l\beta}$ into the equation for $C_{n\beta}^*$ and comparing with the value of $C_{n\beta}^*$ obtained using the natural frequency ω_n (rad/sec) obtained from the flight data. Figure 2 shows the comparison of results. The value of $C_{n\beta}^*$ had a range of values in some cases because the period of the oscillations varied slightly during the maneuver.

ASSUMPTIONS

The equations used in the analog matching were the lateral-directional equations of motion of a rigid airplane with linearized stability derivatives assumed (Appendix I). Consequently, angle of attack was assumed

to be constant and pitch rate to be zero. In addition, dynamic pressure was assumed to be constant for each maneuver. Angle of attack generally stayed within $\pm 1/2$ degree of the average value used in the calculations, and dynamic pressure was $\pm 10\%$ of its average value.

In the equation used to calculate $C_{n\beta}$ from the natural frequency and a known $C_{l\beta}$, all the side force terms, the damping derivatives, and the control derivatives were neglected in addition to the assumptions made for analog matching.

DISCUSSION OF RESULTS

The results of the analysis are presented in Figures 5 through 10 showing $C_{n\beta}$ corrected to center of gravity of 21% and 25% and $C_{n\beta}$ and $C_{l\beta}$ in both body axes and stability axes. This is done for convenience in making comparisons. The NF-104 stability axes wind tunnel data are also presented in Figure 11. (Reference 4).

The effect of the speed brakes was to lower the level of $C_{n\beta}$ (Figure 5) and $C_{l\beta}$ (Figures 8 and 10). Mach number had only a slight effect on $C_{l\beta}$ (Figure 6 and 8), but $C_{n\beta}$ decreased with Mach number in both speed brake configurations. It should be emphasized that $C_{n\beta}$ continued to decrease as Mach number increased above Mach 2.0 although not as rapidly as at the lower Mach numbers.

Insufficient data were obtained and scatter was too great to quantitatively define the effect of angle of attack on $C_{n\beta}$ and $C_{l\beta}$. It may be noted from any of the $C_{n\beta}$ plots that between Mach 1.6 and 1.8 there are several points above the faired curve. These points are high angle of attack points, and it can be stated that in this Mach region $C_{n\beta}$ increases with angle of attack at least until $\alpha = 13^\circ$. The effect of angle of attack explains the scatter of the brakes extended points on Figure 2. The two curves on this plot were calculated from the single curves of $C_{n\beta}$ and $C_{l\beta}$ on Figure 6 using two different angles of attack in order to show the effect of angle of attack on the lateral-directional stability parameter $C_{n\beta}^*$.

There were several data points for which the phase of yaw rate and roll rate could not be matched simultaneously. The cause of this was not determined and was attributed to either instrumentation errors or aircraft flexibility effects. Although the phase matching problem existed, it was felt that in each case the analog match obtained was valid, because as $C_{n\beta}$ and $C_{l\beta}$ were varied from the chosen values, the match became progressively worse. The closeness with which the calculated values agreed with the values obtained by analog matching also tended to verify the analog matching values. (Figure 2).

A significant discrepancy between the analog response and some of the flight test data was found. When compared with the analog response to the same control surface inputs, the aircraft response seemed to be excited by an additional forcing function which caused the oscillations to diverge to a limit cycle amplitude. This divergence could not be duplicated with the analog simulation even though the phase and frequency could be matched, and any constant amplitude could be obtained by varying either rudder effectiveness or the initial conditions on the sideslip angle, roll rate and yaw rate. It was concluded during the program that both the lateral-directional oscillations encountered during zoom recoveries and the limit cycles encountered following rudder pulses during the test program were caused by an external forcing function which was not accounted for by the normal NF-104 aerodynamics as represented in the analog simulation. During flight 34, the last stability flight, the jet engine was allowed to run during the rudder pulse at Mach 2.12. After about two cycles of a damped oscillation, the jet engine was shut down. Immediately the oscillations diverged to approximately $\pm 5^\circ$ of sideslip. The oscillation damped out gradually as angle of attack was lowered and Mach number bled off. (Figure 3A and 3B). It was then concluded that the forcing function which caused the divergence was an oscillatory duct spillage condition that occurred at certain angles of attack and Mach numbers when the engine was off. An approximate boundary for these oscillations in terms of angle of attack and Mach number has been given in Figure 4. The F-104 aircraft had an earlier history of oscillations induced by unstable inlet duct conditions. The duct splitter was installed as a solution to a problem which arose as a result of divergent lateral-directional oscillations following compressor stalls. (Reference 3).

Aside from the duct spillage problem, the results of the lateral-directional stability analysis indicated that the levels of static stability, $C_{n_{\beta}}$ and $C_{l_{\beta}}$, were sufficient to provide satisfactory handling qualities up to at least Mach 2.12 (the highest Mach number tested) under the conditions which normally existed during a zoom recovery (listed on page 1). A "worst fairing" of brakes extended data showed that $C_{n_{\beta}}$ could go to zero at Mach 2.3 (Figure 6). However, total static lateral-directional stability, as indicated by the parameter $C_{n_{\beta}^*}$, appeared to be positive to at least Mach 2.3 (Figure 2). The dynamic instability, apparently due to duct spillage at high Mach numbers and angles of attack, indicated restriction of the practical use of the aircraft with the jet engine shut down to below approximately Mach 2.0. (Figure 4).

CONCLUSIONS

Values for the stability derivatives $C_{n_{\beta}}$ (yawing moment due to sideslip) and $C_{l_{\beta}}$ (rolling moment due to sideslip) were determined from flight test data for the NF-104 between Mach 1.3 and 2.1 with the speed brakes retracted and extended.

At Mach numbers above 1.6 and high angles of attack with the jet engine shut down, the lateral-directional mode of the aircraft was excited by engine air inlet duct spillage. This duct spillage condition was oscillatory and caused the oscillations of the aircraft to diverge to a limit cycle amplitude at some flight test conditions. (Figure 4).

Although the static lateral-directional stability appeared to be satisfactory even above Mach 2.12, the dynamic instability due to duct spillage indicated restriction of the practical use of the aircraft to below approximately Mach 2.0 with the jet engine shut down.

REFERENCES

1. Zaleski, Charles D, and Landry, Lloyd M., "NF-104A Analog Simulation Support," Flight Research Division Office Memo, December 1964.
2. Ranpy, Johnny M., and Berry, Donald T., "Determination of Stability Derivatives from Flight Test Data by Means of High Speed Repetitive Operation Analog Matching," AFFTC TDR 64-8, May 1964.
3. Hoey, Robert G., and Kincheloe, Ivan C., "F-104A Stability and Control," AFFTC TR 58-14, April 1958.
4. "Aerospace Trainer Stability Verification Test in LFL 4' x 4' Supersonic Wind Tunnel," Data Release, LFL 5-39, 6-6-62.

TABLE I

FLIGHT #	PULSE #	MACH #	ANGLE ATTACK DEG	DYNAMIC PRESSURE lbs/ft ²	WEIGHT lbs	c.g. % mac	DRAG BRAKES EXTENDED OR RETRACTED
5		1.87	7.7	325-425	15,500	16.5	ext
8		1.78	8	320	15,667	18.0	ext
10		1.93	5.25	522	15,037	18.6	ext
16	1	1.93	4.5	170	15,980	14.0	ret
	2	1.88	8.4	199			ret
	3	1.79	8.0	241.8			ret
	4	1.67	10.0	242.2			ret
	5	1.46	10.2	188.8			ext
17	1	1.89	9.8	184	15,980	14.0	ret
	2	1.75	9.6	188			ext
	3	1.56	5.8	190			ext
18	1	1.81	7.0	160.2	15,800	14.2	ext
23	1	1.78	10.9	144	16,262	15.0	ext
	2	1.69	6.1	142			ext
	3	1.64	10.0	174			ext
	4	1.48	11.1	180			ext
	5	1.33	5.4	160			ext
24	1	1.70	10.6	116.5	15,835	16.3	ext
	2	1.63	12.0	119			ext
31	1	1.77	10.5	213	15,538	16.8	ext
34	1	2.12	8.2	257	16,103	13.5	ext

Representative Moments of Inertia

$$I_x = 4240$$

$$I_{xz} = 4500$$

$$I_z = 75,000$$

APPENDIX I

Summary of Equations

1. Equations used in Lateral-Directional Analog Matching:

$$I_x \dot{P} = I_{xz} \dot{R} + qSb [C_{1\beta} \beta + C_{1\delta_r} \delta_r + C_{1\delta_a} \delta_a + C_{1R} \frac{Rb}{2V} + C_{1P} \frac{Pb}{2V}]$$

$$\dot{\beta} = P \sin \alpha - R \cos \alpha + \phi \frac{g}{V} \cos \alpha + qSb [C_{y\beta} \beta + C_{y\delta_r} \delta_r + C_{y\delta_a} \delta_a]$$

$$I_z \dot{R} = I_{xz} \dot{P} + qSb [C_{n\beta} \beta + C_{n\delta_r} \delta_r + C_{n\delta_a} \delta_a + C_{nP} \frac{Pb}{2V} + C_{nR} \frac{Rb}{2V}]$$

2. Assumptions used in matching:

$$\sin \phi \approx \phi ; \beta \approx \frac{v}{V} ; \dot{\beta} \approx \frac{\dot{v}}{V}$$

3. Equations used to derive analytical expression for $C_{n\beta}^*$:

$$C_{n\beta}^* = \frac{\omega_n^2 I_z}{(57.3) qSb} = C_{n\beta} \cos \alpha - \frac{I_z}{I_x} C_{1\beta} \sin \alpha + \frac{I_{xz}}{I_x} [C_{1\beta} \cos \alpha - C_{n\beta} \sin \alpha]$$

$$I_x \dot{P} = I_{xz} \dot{R} + qSb C_{1\beta}$$

$$\dot{\beta} = P \sin \alpha - R \cos \alpha$$

$$I_z \dot{R} = I_{xz} \dot{P} + qSb C_{n\beta}$$

4. Additional assumptions for $C_{n\beta}^*$ equation:

$$\delta_a = \delta_r = 0$$

$$C_{l_P} = C_{l_R} = C_{n_P} = C_{n_R} = 0$$

$$C_{y_\beta} = C_{y_{\delta_r}} = C_{y_{\delta_a}} = \phi = 0$$

5. Equation used for center of gravity correction:

$$C_{n_{\beta(.25c)}} = C_{n_{\beta(c.g.)}} + C_{y_\beta} \frac{c}{b} (.25c - c.g.)$$

Each point was corrected for c.g., and the curves were corrected by using average c.g. = .152 c.

6. Transformation between body axes and stability axes:

$$C_{n_{\beta_s}} = C_{n_{\beta_B}} \cos \alpha - C_{l_{\beta_B}} \sin \alpha$$

$$C_{l_{\beta_s}} = C_{l_{\beta_B}} \cos \alpha + C_{n_{\beta_B}} \sin \alpha$$

Each point was converted separately using the appropriate α . The curves were converted using average $\alpha = 8^\circ$.

LIST OF SYMBOLS

<u>Symbol</u>	<u>Definition</u>	<u>Units</u>
P	roll rate	rad/sec
Q	pitch rate	rad/sec
R	yaw rate	rad/sec
$I_{x,y,z}$	moment of inertia about body x, y, z axis	slug ft ²
I_{xz}	product of inertia	slug ft ²
α	angle of attack	degrees
β	sideslip angle	radians/degrees
ϕ	bank angle	radians
u	velocity along body x axis	ft/sec
v	velocity along body y axis	ft/sec
q	dynamic pressure	lbs/ft ²
S	wing area (F104A Ref)	196.1 ft ²
b	wing span (F104A Ref)	21.9 ft ²
c	mean aerodynamic chord	9.55 ft
δ_a	aileron position	degrees
δ_r	rudder position	degrees
$C_{n\beta}^*$	lateral-directional stability parameter	per degree
$C_{n\beta}$	yawing moment coefficient derivative	per degree
$C_{l\beta}$	rolling moment coefficient derivative	per degree
$C_{l_p}, C_{n_r}, C_{l_r}, C_{n_p}$	damping derivatives	per radian
$C_{n_{\delta_r}}, C_{l_{\delta_a}}, C_{n_{\delta_a}}, C_{l_{\delta_r}}, C_{y_{\delta_r}}, C_{y_{\delta_a}}$	control derivatives	per degree
$C_{y\beta}$	side force derivative	per degree
ω_n	natural frequency	rad/sec
g	acceleration of gravity	ft/sec ²

ANGLE OF ATTACK AND MACH NUMBER AT WHICH
OSCILLATIONS OCCURRED DURING NF104A ROOM RECOVERIES

13 NOV 64

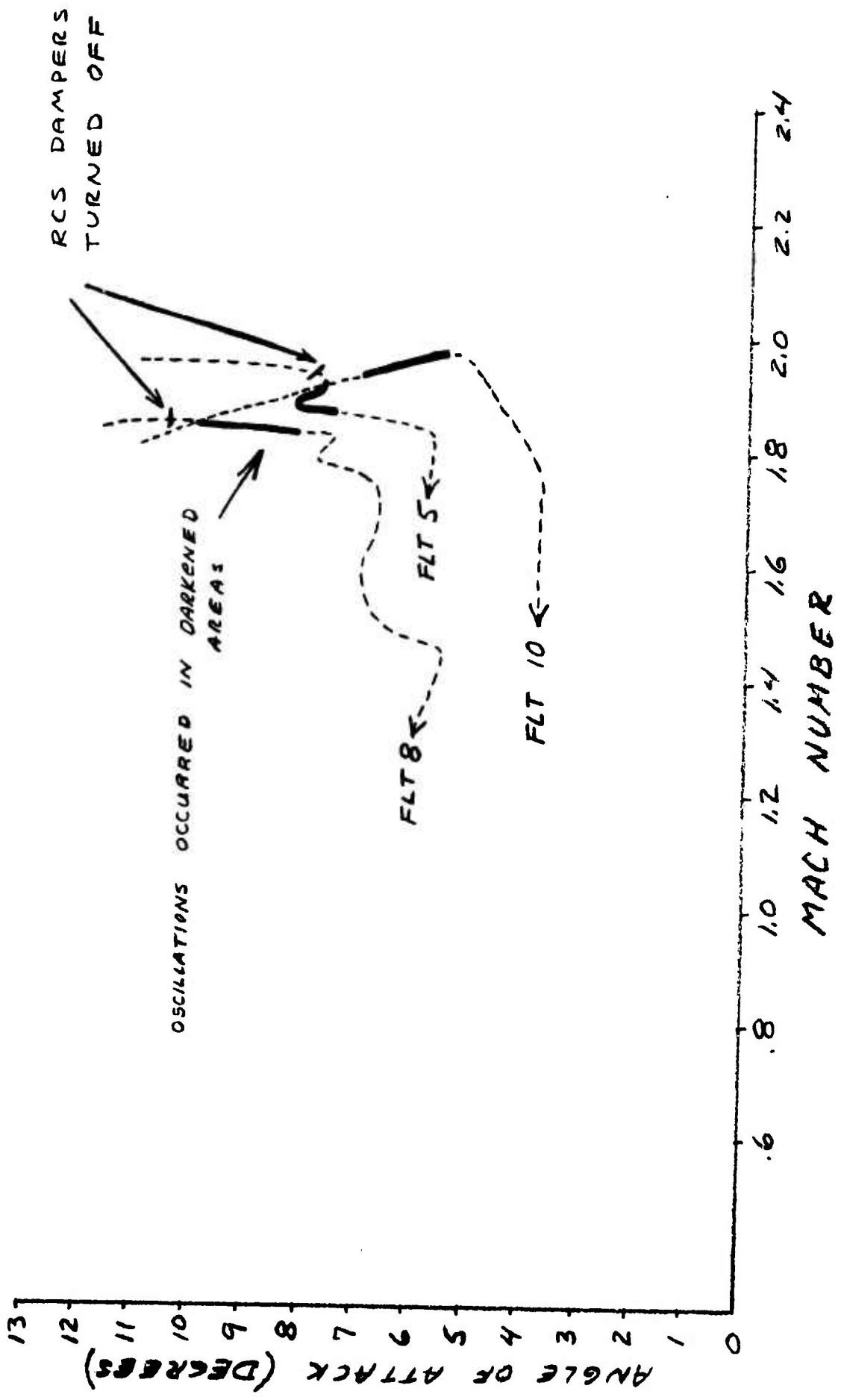
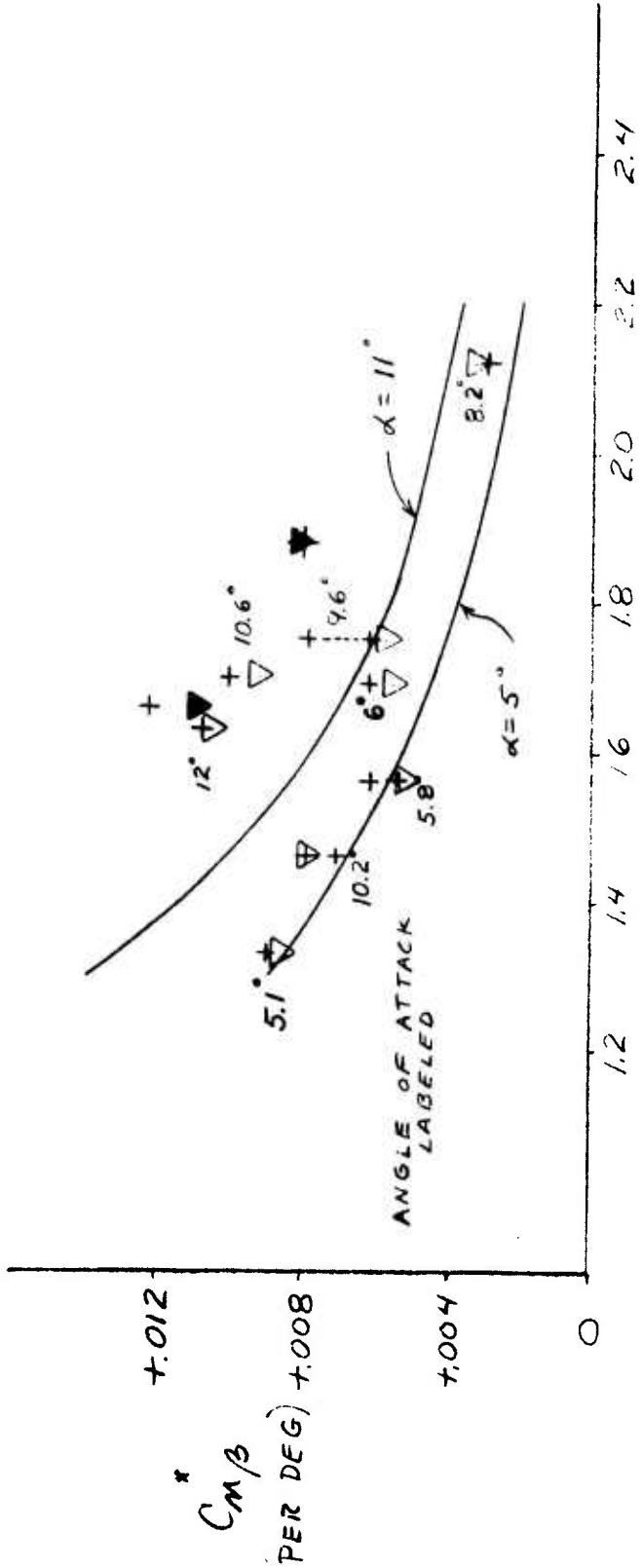


FIG 1

COMPARISON OF ANALOG MATCHING RESULTS
WITH
CALCULATIONS OF THE LATERAL-DIRECTIONAL STABILITY
PARAMETER, $C_{m\beta}$, MADE DIRECTLY FROM FLIGHT TEST RESULTS

13 NOV 64

- + — $C_{m\beta}^* = \frac{W_m^2 I_z}{(57.3) q S b}$ CALCULATED FROM FLIGHT TEST DATA + } RANGE
- ▽ — $C_{m\beta}^* = C_{m\beta} \cos \alpha - \frac{I_z}{I_x} C_{l\beta} \sin \alpha + \frac{I_x I_z}{I_x} [C_{l\beta} \cos \alpha - C_{m\beta} \sin \alpha]$ { CALCULATED FROM BODY AXES $C_{m\beta} + C_{l\beta}$
- ▼ — SPEED BRAKES RETRACTED { OBTAINED FROM ANALOG MATCHING



MACH NUMBER

FIG 2

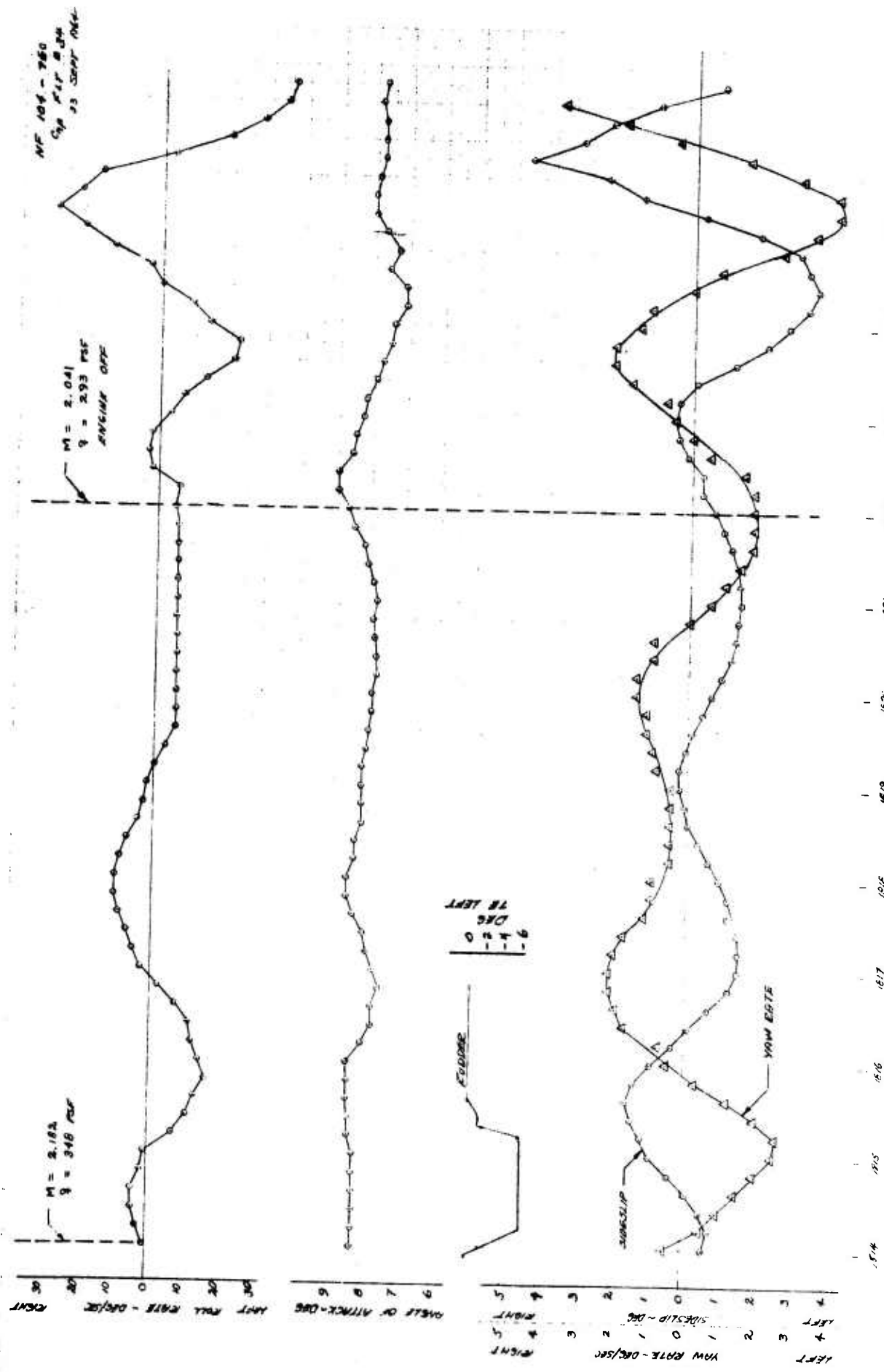
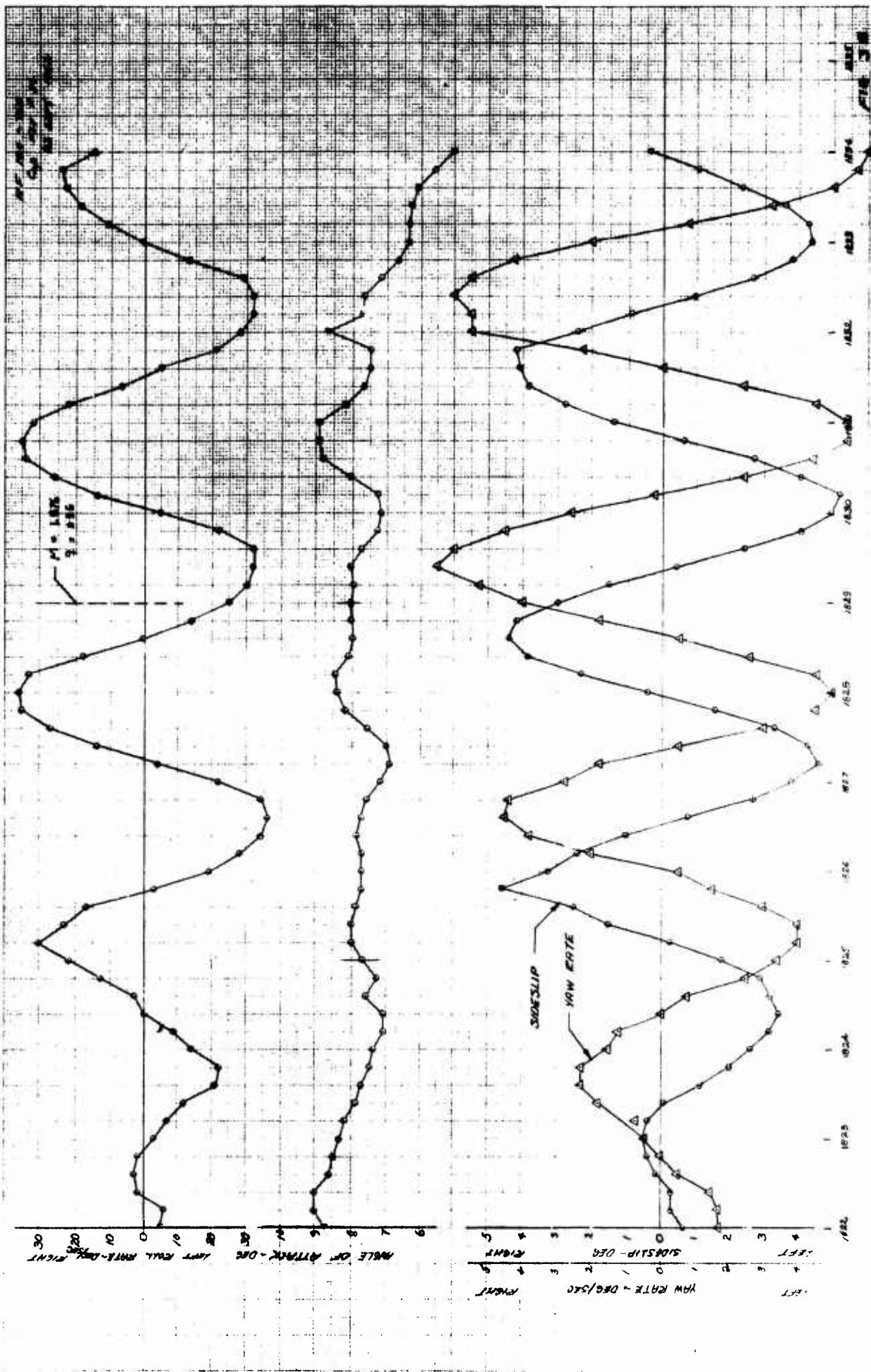


FIG 3A



ANGLE OF ATTACK AND MACH NUMBER FOR $C_{M\beta}$ TEST POINTS

DARKENED SYMBOLS INDICATE OSCILLATIONS DIVERGED TO LIMIT CYCLE AMPLITUDE

13 NOV 64

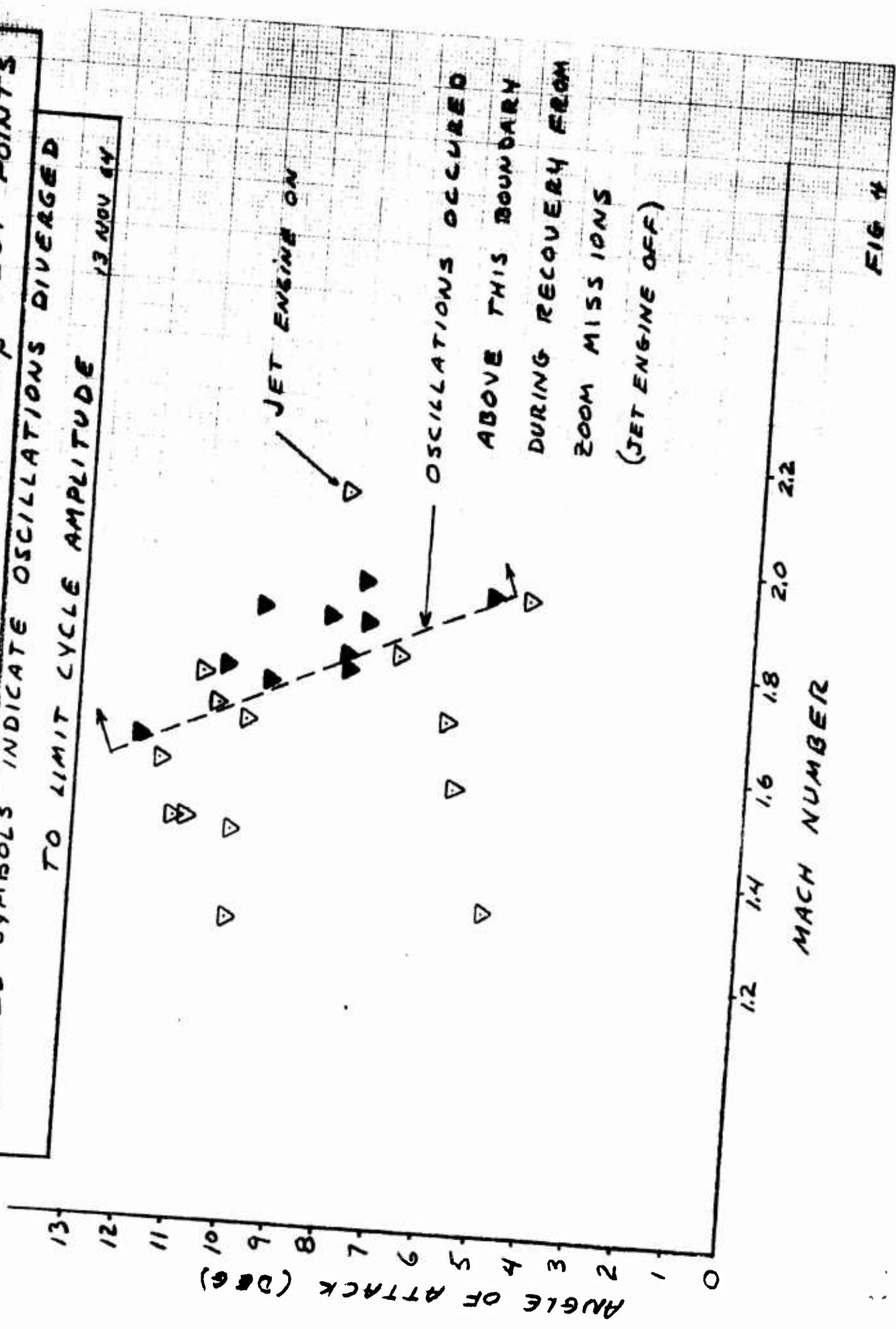
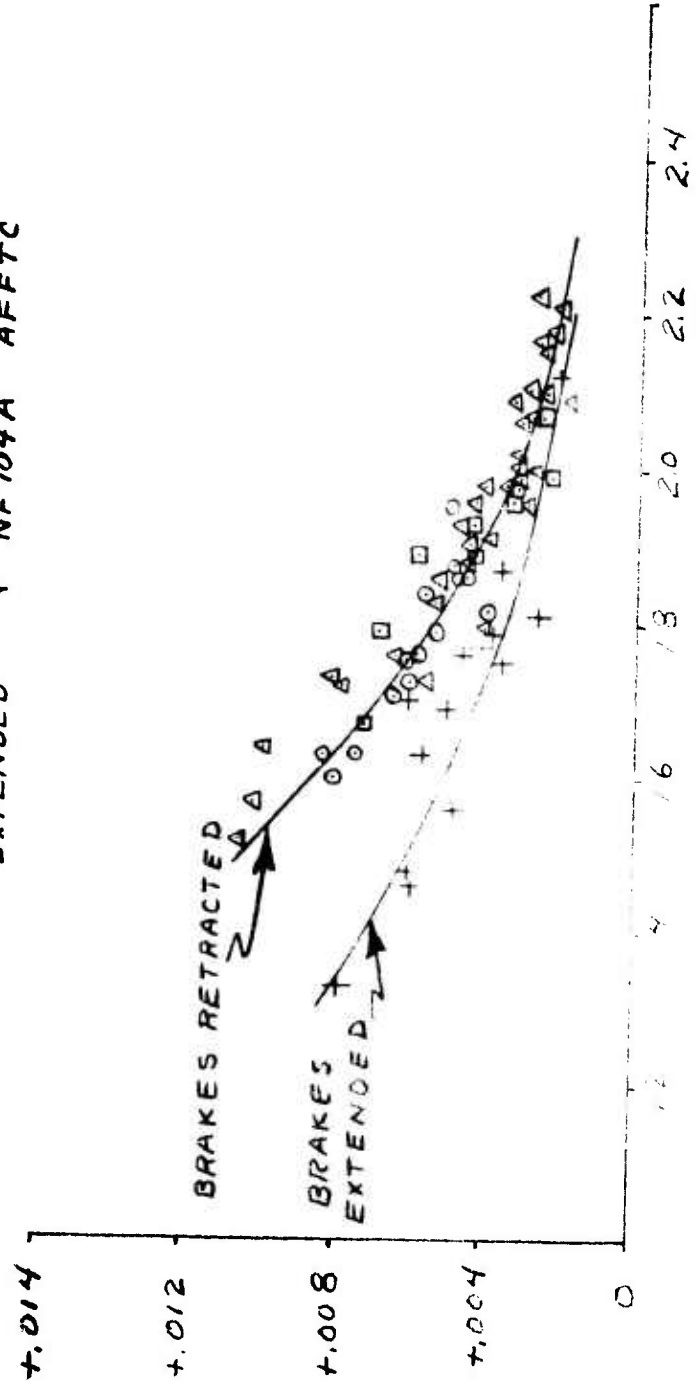


FIG 4

F104 FLIGHT TEST DATA
 $C_{m\beta}$ vs. MACH NUMBER
 STABILITY AXES FLIGHT TEST C.G.
 13 Nov 64

SPEED BRAKES RETRACTED { Δ F104 G LOCKHEED
 \circ NF104 A LOCKHEED
 \square NF104 A AFFTC

EXTENDED + NF104 A AFFTC



$C_{m\beta}$

MACH NUMBER

FIG 5

NF 104 FLIGHT TEST DATA
 $C_{m\beta}$ AND $C_{l\beta}$ VS MACH NUMBER
 BODY AXES — FLIGHT TEST C.G.
 BRAKES EXTENDED

16 NOV 64

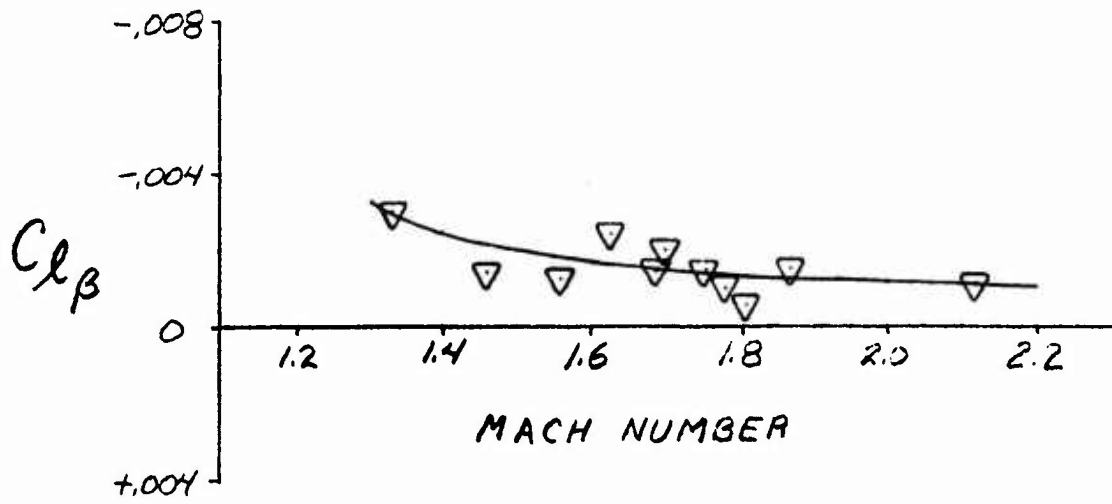
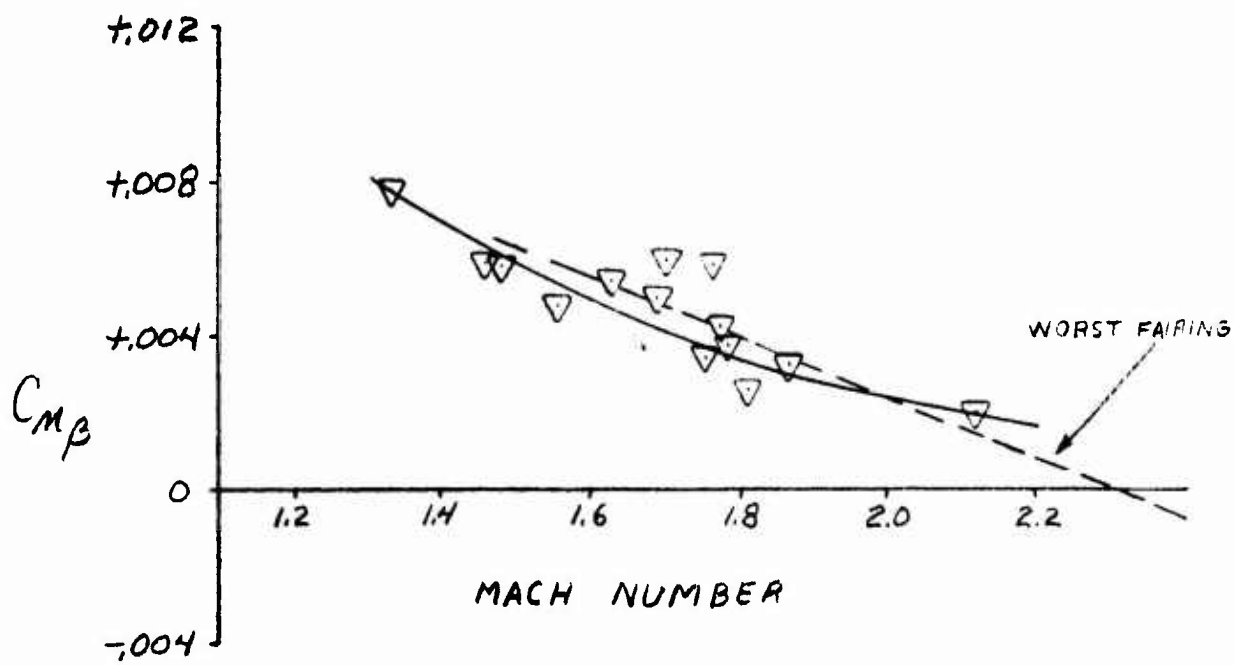


FIG 6

NF 104 FLIGHT TEST DATA
 $C_{m\beta}$ vs MACH NUMBER
 BODY AXES — CORRECTED C.G.
 BRAKES EXTENDED

17 NOV 64

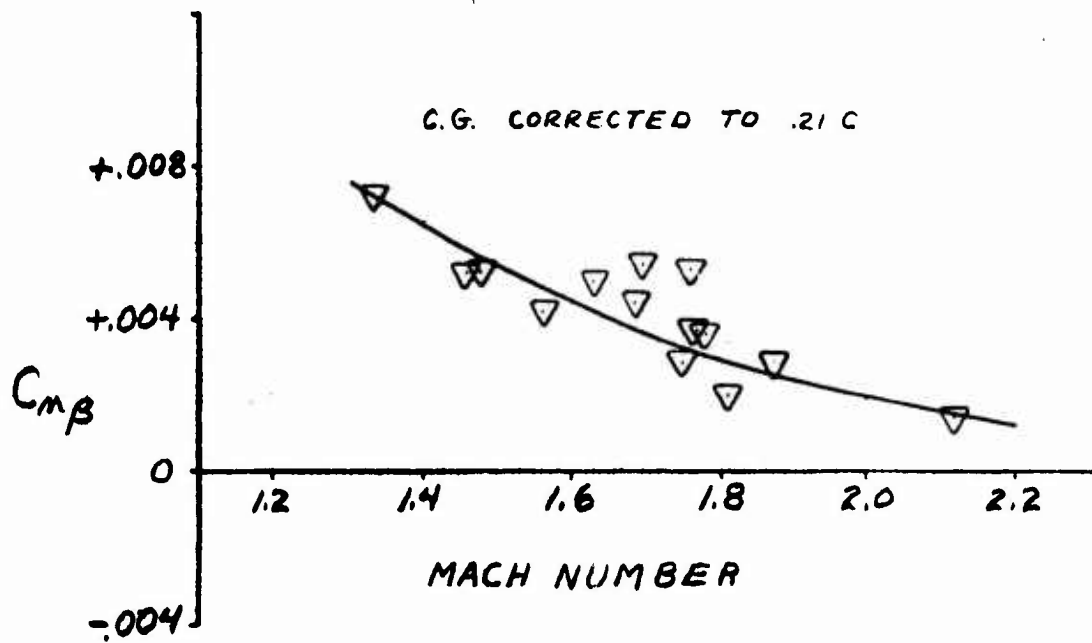
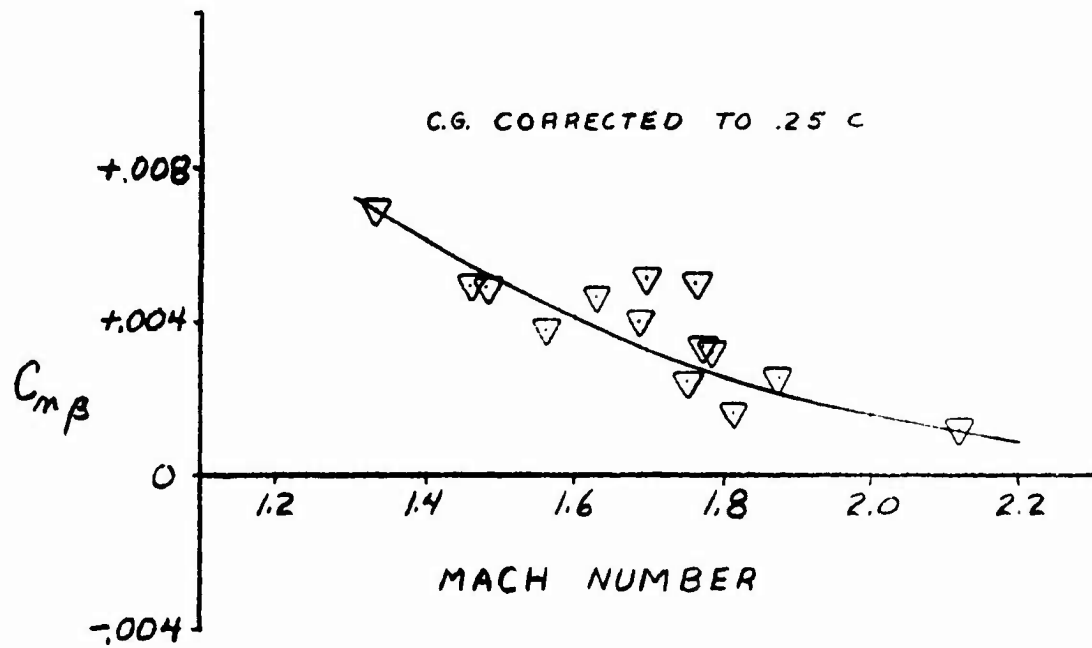


FIG 7

NF104A FLIGHT TEST DATA
 $C_{M\beta}$ AND $C_{L\beta}$ vs. MACH NUMBER
STABILITY AXES - FLIGHT TEST C.G.
BRAKES EXTENDED

16 NOV 64

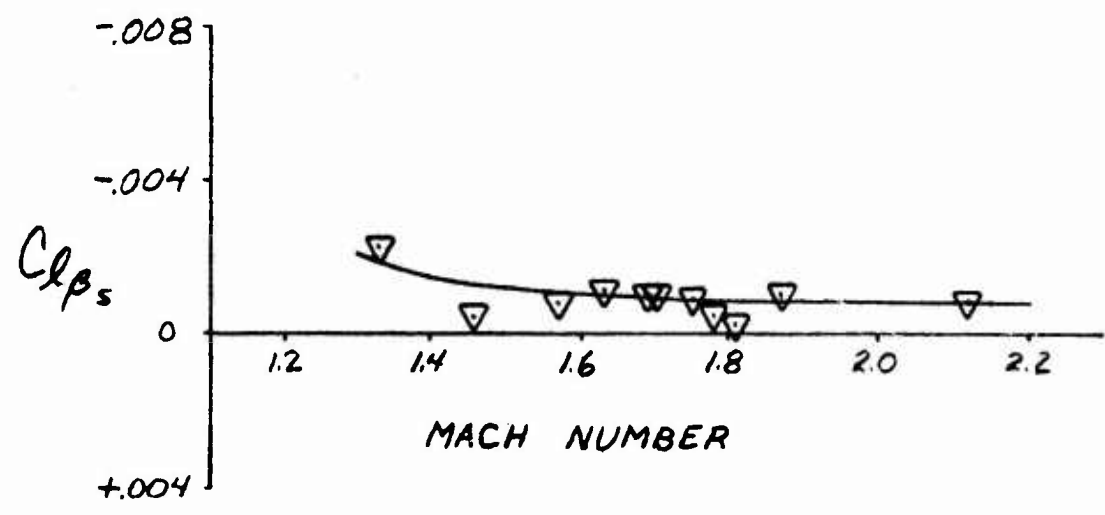
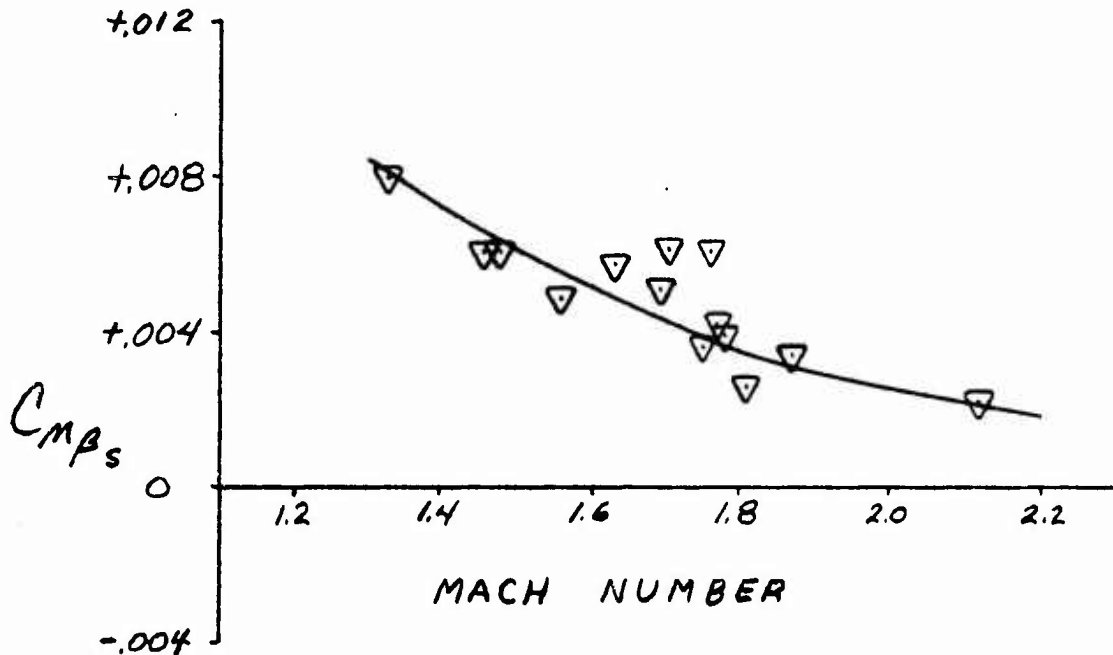


FIG 8

NF 104 FLIGHT TEST DATA
 $C_{m\beta}$ vs MACH NUMBER
 STABILITY AXES — CORRECTED C.G.
 BRAKES EXTENDED

17 NOV 64

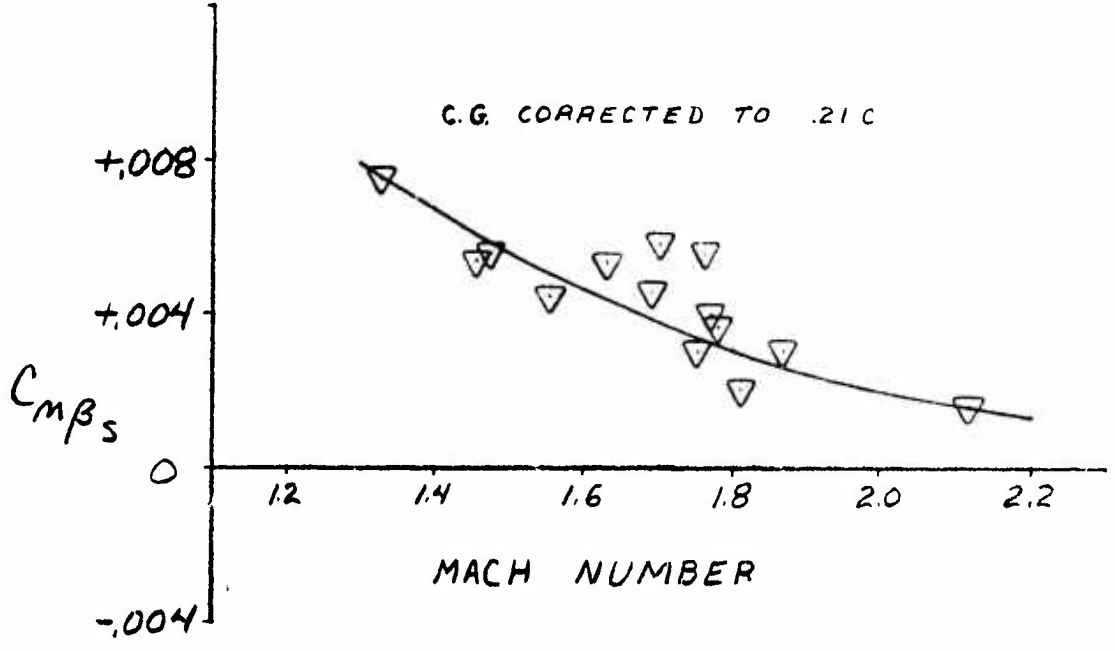
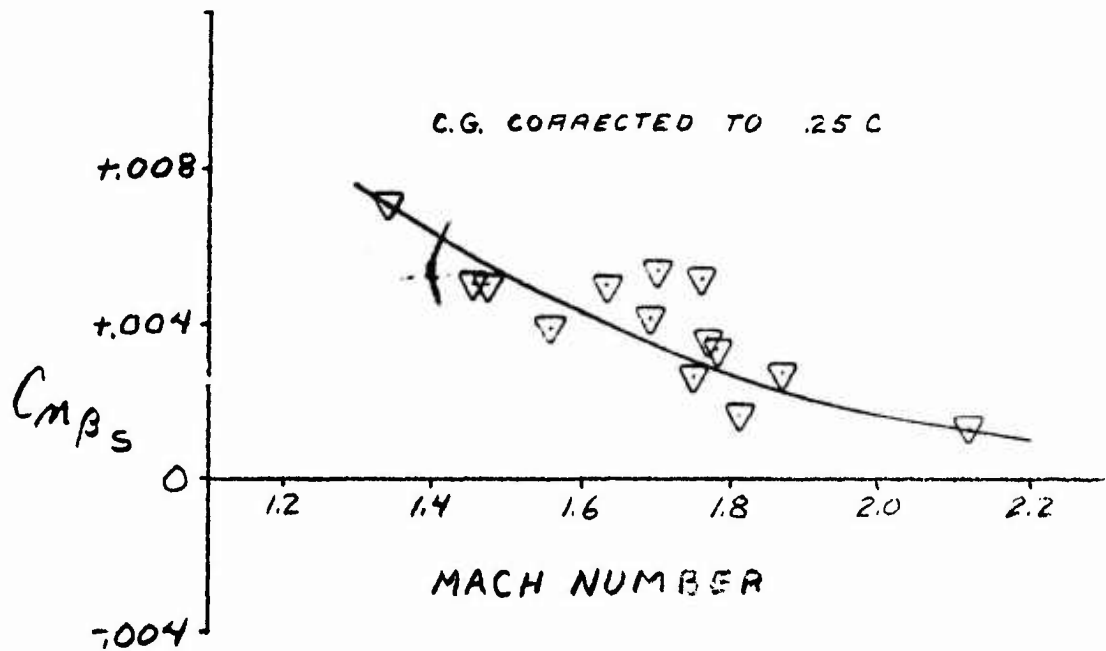


FIG 9

NF 104 A FLIGHT TEST DATA
 $C_{m\beta}$ AND $C_{l\beta}$ VS MACH NUMBER
STABILITY AXES — FLIGHT TEST C.G.
BRAKES RETRACTED

17 NOV 64

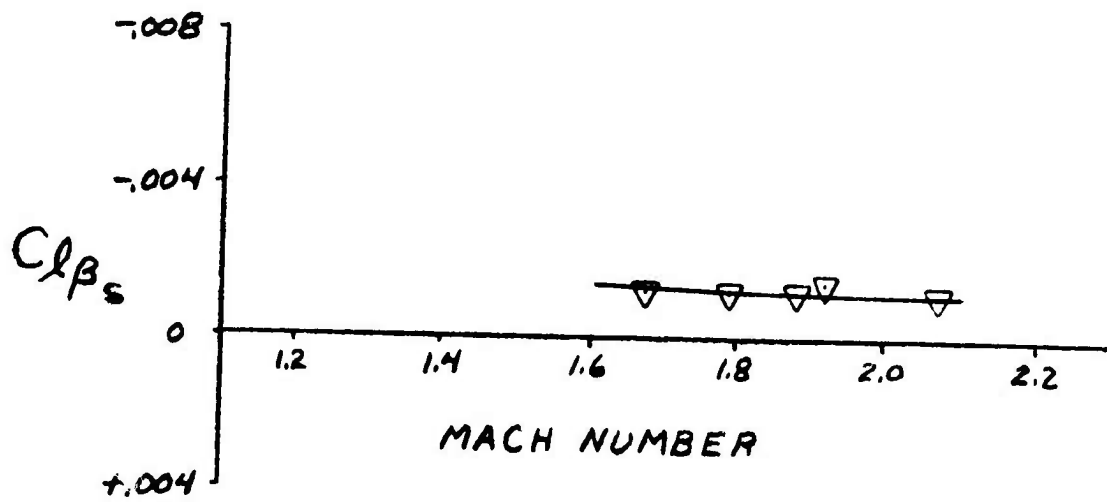
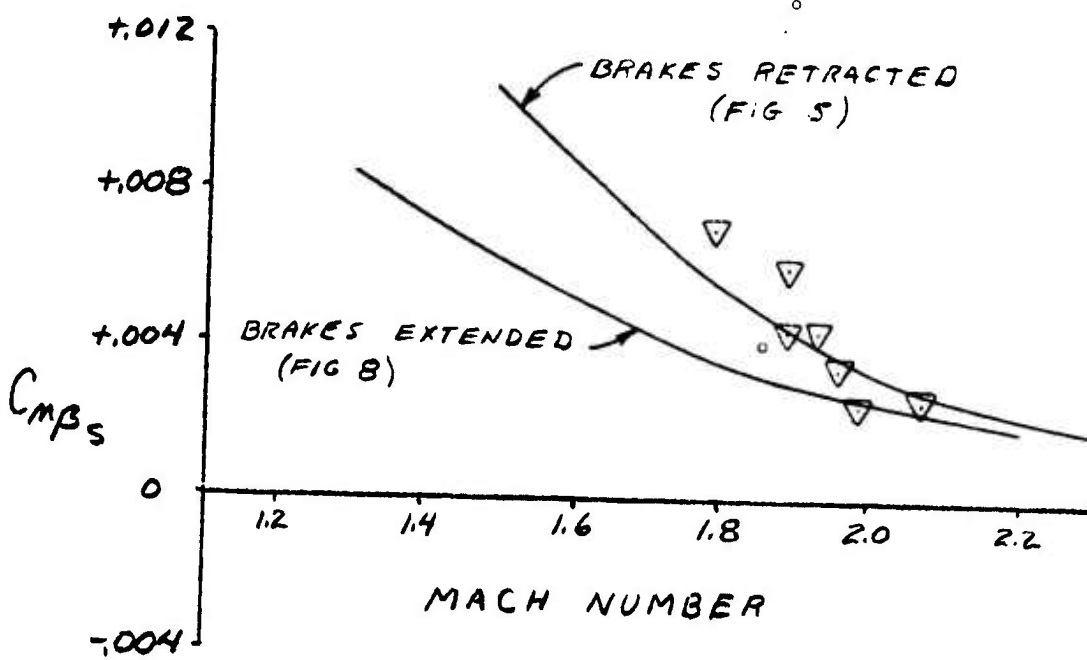


FIG 10

NF 104A LATERAL-DIRECTIONAL DATA
 LOCKHEED WIND TUNNEL
 STABILITY AXES SPEED BRAKES RETRACTED

13 NOV 61

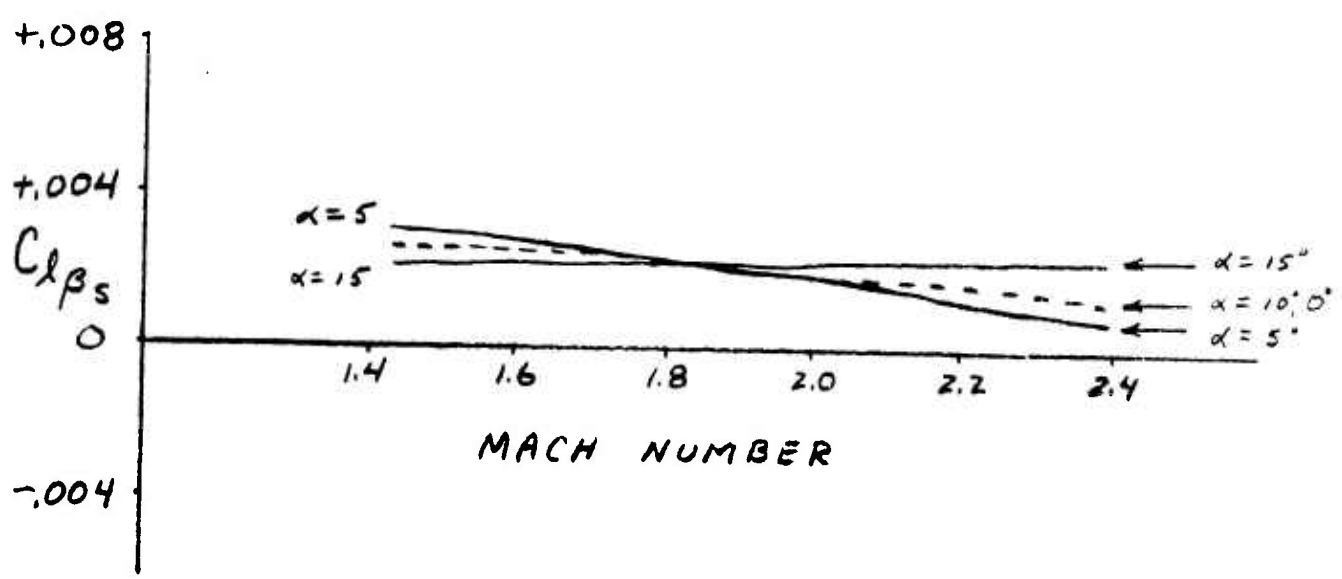
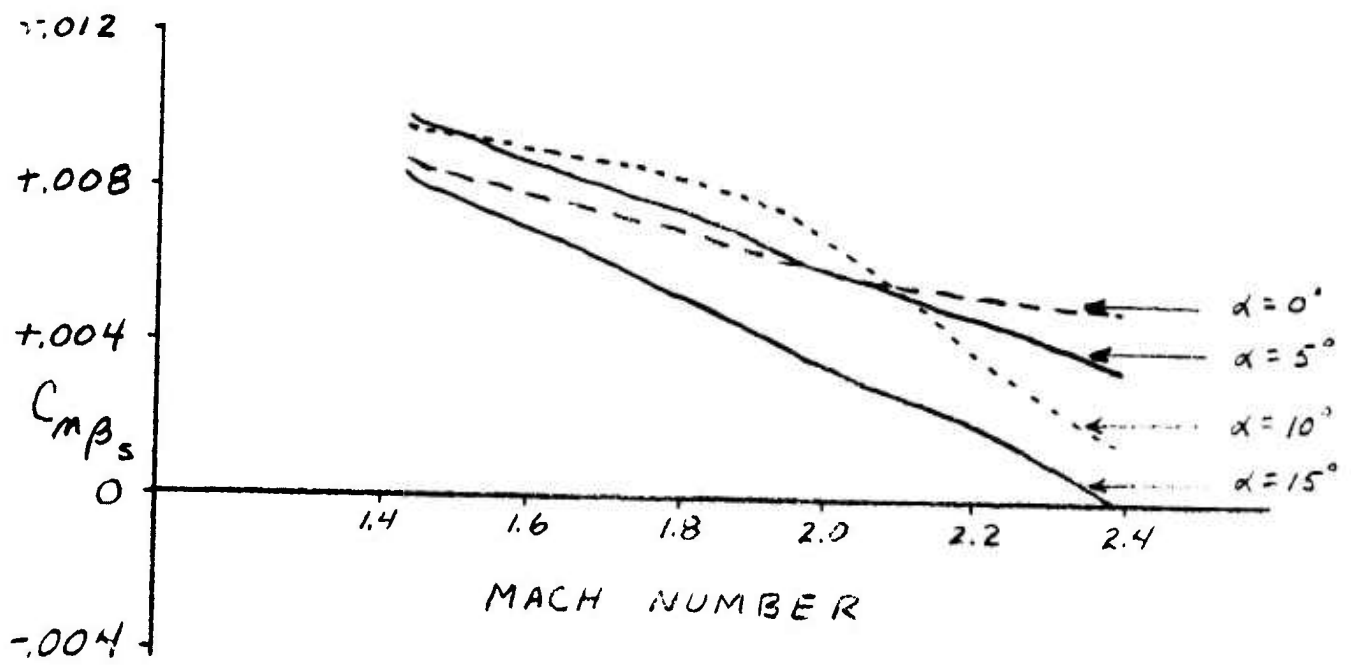


FIG 11

FLIGHT RESEARCH DIVISION
OFFICE MEMO

AV-65-1

NF-104A AND F-104A ANALOG SIMULATION SUPPORT

Capt Charles D. Zaleski
1st Lt Lloyd M. Landry

Feb 1965

7

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	THREE DEGREE OF FREEDOM STUDIES	2
	a. Spin Chute Study	
	b. Planning Stability Mission	
	c. Energy Management Planning	
	d. Optimizing Acceleration Time	
	e. Zoom Performance Study	
	f. F-104A Spin Accident Study	
III.	FIVE DEGREE OF FREEDOM STUDIES	6
	a. Lateral-Directional Handling Qualities Evaluation	
	b. Study of Parameters Affecting Pitch-up	
	c. Handling Qualities at Low Dynamic Pressure	
IV.	THREE DEGREE OF FREEDOM SIMULATION DESCRIPTION	13
	a. General Description	
	b. Equations of Motion	
	c. Weight, c.g., and Moments of Inertia	
	d. Flight Control System	
	e. Atmosphere	
	f. Drag Chute and Drag Brakes	
	g. Cockpit	
V.	FIVE DEGREE OF FREEDOM SIMULATION DESCRIPTION	17
	a. General Description	
	b. Equations of Motion	
	c. Flight Control System	
	d. Cockpit	

VI.	REFERENCES	23
VII.	APPENDICES	24
	Appendix 1 - Symbol Index	
	Appendix 2 - Aerodynamic Data	
	Appendix 3 - Figures	
	Appendix 4 - Derivation of Translational Equations of Motion	
	Appendix 5 - Engine Gyroscopic Effects	
	Appendix 6 - Wiring Diagrams	

NF-104A and F-104A ANALOG SIMULATION SUPPORT

I. INTRODUCTION

An analog simulation of the NF-104A was used in support of the NF-104A flight test program. This memo describes the mathematical model which was simulated and the manner in which the simulator was used during the test program. This memo should provide flight test engineers and computer programmers with a better understanding of the potential uses of analog computer equipment to support flight testing activities and the amount and type of data required to perform an adequate simulation.

F-104 analog simulation work was begun in January 1964, in support of the NF-104A flight test program. At this point in the flight test program, one aircraft had been lost after it became uncontrollable at an altitude of about 115,000 feet and entered a flat spin. Also, the lateral-directional stability with speed brakes extended at high Mach numbers had not been investigated and large lateral-directional oscillations had occurred during several zoom recoveries.

In order to have a working simulation as soon as possible, it was decided to program two simulations of limited and different scope rather than program one complete six degree of freedom simulator. The two simulations were:

(1) A three degree of freedom simulation used to study performance. This simulation was a wings-level, flight path simulation including the pitch plane rotational dynamics.

(2) A five degree of freedom simulation used to study handling qualities. This simulation included all the rotational dynamics for a chosen constant Mach number and altitude.

7

These two simulations were adequate for all the engineering studies performed. Later, a six degree of freedom simulation was programmed for the ARPS to be used as a procedural trainer, and it was used in subsequent engineering studies. When the complete six degree of freedom simulation was used to study handling qualities, the Mach number and altitude were usually held constant; and when this simulation was used to study performance, the bank angle was held to zero. A complete six degree of freedom simulator is usually needed only for procedural training or in support of detailed test flight planning. For engineering work, a five degree of freedom simulation satisfies most handling qualities study requirements, and a three degree of freedom simulation satisfies most performance study requirements.

II. THREE DEGREE OF FREEDOM STUDIES

The three degree of freedom simulator was programmed with lift, drag, thrust, weight, and the longitudinal dynamics. It was flown, only in pitch, from a stationary cockpit, and the altitude, Mach number, angle of attack, "g", flight path angle, pitch attitude, pitch rate, and elevator position were recorded on strip recorders in real time. Before using the results of this simulation, the lift and drag and engine thrust curves were adjusted slightly until critical performance parameters recorded during an actual NF-104 aircraft zoom mission were closely duplicated. The longitudinal dynamics were also checked against flight data before quantitative studies of aircraft performance and longitudinal handling qualities were begun.

See Part IV for a complete description of the simulation.

a. Spin Chute Study

A study of the use of the drag chute for spin recovery was made on the simulator. On the crash flight the drag chute had pitched the nose down and recovered the aircraft from the flat spin. The aircraft accelerated straight down to about 180 knots with the chute fully deployed. When the

drag chute was released, the aircraft immediately pitched up and entered another flat spin. An abrupt nose up trim change which resulted from the release of the chute caused the pitch up. A successful procedure for chute release was found using the simulator and wind tunnel chute characteristics. The procedure was to set in full forward trim while the chute was deployed and use stick force to fly straight down while accelerating to flying speed. Just prior to chute release, the stick was neutralized. This procedure counteracted the trim change due to drag chute jettison, and the aircraft could be recovered by a normal pullout. The minimum altitude for recovery was found to be about 25,000 feet. References 1 and 10 have described in detail the recommended spin recovery procedure developed on the simulation. Reference 2 has described the NF-104A maneuvers during the drag chute deployment, release, and the spin prior to crash.

b. Planning Stability Mission

In support of the NF-104A lateral-directional stability investigation, the three degree of freedom simulator was used to devise a zoom profile which would duplicate the Mach number, dynamic pressure, and angle of attack encountered during recovery from high altitude zoom missions, but at a shallower flight path angle. It was not desirable to duplicate the steep flight path angle which required that high angles of attack be used to recover since the stability problem was worse at high angles of attack. Therefore, a low, flat zoom mission was devised which resulted in high Mach number and level flight at an altitude of about 80,000 feet. The procedure developed was to light the rocket engine at Mach 2 and pull up at approximately constant Mach number to about 65,000 feet; then push over to zero "g" to reach level flight at about 80,000 feet. The engines were then shut down, the aircraft was stabilized at the proper flight conditions, and the stability pulses were performed. The simulator was used to modify this procedure in order to obtain data above Mach 1.9.

In order to keep the Mach number up, it was found necessary to leave the rocket on until after the aircraft was stabilized at the proper conditions and the speed brakes were extended. Approximately nine of these low zoom flights were flown during the test program, and the project pilot practiced the first few on the simulator before flying them in the aircraft. Reference 3 describes the NF-104A lateral-directional stability analysis in detail.

c. Energy Management Planning

In support of the NF-104A performance testing, the three degree of freedom simulator was used to determine ground rules for mission conduct or abort when confronted with non-standard acceleration runs. The pullup for a zoom mission was normally made upon accelerating to a predetermined Mach number. However, it was necessary to have the zoom mission terminate close enough to Edwards so that a flameout landing could be made in the event the engine did not relight. In a normal mission, the aircraft was flown to a turn-around point about 100 miles from Edwards, and the acceleration run was made toward Edwards at an altitude of about 35,000 feet. Consequently, Edwards could be overshoot if too much time were consumed in the acceleration run. It was found using the simulator, that pullups should not be initiated any closer to Edwards than 40 miles. A minimum fuel constraint was also computed allowing enough fuel to safely return to Edwards with required fuel safety margin following the mission. The final result was a flight plan which called for pullup when the first of the following conditions was met; the desired Mach number was reached, the radar track indicated that the aircraft was 40 miles from Edwards, or the fuel remaining reached 1200 pounds. A minimum pullup Mach number of 1.7 was required at the pullup point or the mission was to be aborted. The handbook (Reference 10) gives the energy management planning procedure in detail.

d. Optimizing Acceleration Time

The simulator was also used in a study to optimize the acceleration run with respect to fuel remaining at pullup by using the rocket engine during the acceleration. It was desirable to have as much fuel as possible

at pullup in order to keep the c.g. forward for improved stability at the top of the zoom and during recovery and to increase the fuel remaining safety margin during the landing pattern.

Since the excess thrust is lowest between Mach 1.1 and 1.4, the rocket engine was used during the acceleration through these Mach numbers. It was then started up again at Mach 1.9 for the zoom. The fuel weight savings at pullup derived from the faster acceleration resulted in a more forward c.g. of about 2% MAC.

e. Zoom Performance Study

The NF-104A zoom altitude performance data was generated using the three degree of freedom simulator and spot checking the results with actual zoom flights. The flight test maximum altitudes were within 1000 feet of the simulator predictions at the high climb attitudes — 50° to 60° but were up to 5000 feet low for the low climb angles — 30° to 40°. Mach numbers and dynamic pressures at peak altitude were predicted quite accurately by the simulator. The performance study obtained zoom altitude as a function of pullup Mach number, climb attitude, Mach number for rocket engine light, initial weight, pullup "g", pullup altitude, and nonstandard temperature. Each of these parameters could be varied while holding the others constant at some nominal values.

The initial weight, jet fuel remaining, and rocket fuel remaining at pullup calculated from the acceleration study were used as initial conditions on the zoom performance study. A zoom mission consisted of making a constant "g" rotation at a certain Mach number until a specified climb attitude was attained. This climb attitude was held until a certain angle of attack was reached after which this angle of attack (11° maximum) was flown all the way over the top.

The most significant factors in determining peak altitude were found to be pullup Mach number and climb attitude. The highest allowable pullup Mach number (about 2.2) and a climb attitude of about 65° resulted in the highest peak altitude. The lowest "g" pullup and highest possible pullup altitude at which the optimum climb angle could still be reached also increased peak altitude. The highest angle of attack which could be held after climb attitude began to fall off resulted in slightly higher peak altitudes. The effects of the other variables were less important. The effect of using the rocket engine during acceleration was a penalty of about 1000 feet at peak altitude. Reference 1 includes carpet plots of peak altitude as a function of Mach number for rocket engine light, pullup Mach number, and climb attitude.

f. F-104A Spin Accident Study

An F-104A spin accident on a zoom mission occurred during the NF-104A simulation program, and the simulator was used to provide information regarding the flight to the accident investigating board (Reference 13). With the altitude vs range plot and the velocity at peak altitude from the radar data available, it was possible to closely duplicate the flight profile of the aircraft up to peak altitude, which was the spin entry condition. These conditions (Mach number, dynamic pressure, and altitude) were then duplicated on the five degree of freedom simulator so that the handling qualities could be examined at the conditions of spin entry.

III. FIVE DEGREE OF FREEDOM STUDIES

See part V for a complete description of the simulation.

The five degree of freedom simulator was programmed with the pitching, yawing, and rolling dynamics as well as lift and side-force characteristics. The simulation was flown from the same cockpit as the three degree of freedom simulation. The control surface positions, body attitudes, body rates, angle of attack, sideslip angle and "g" were recorded on strip recorders in real-time. The primary lateral-directional stability parameters in the simulation were updated with flight test results as they become available.

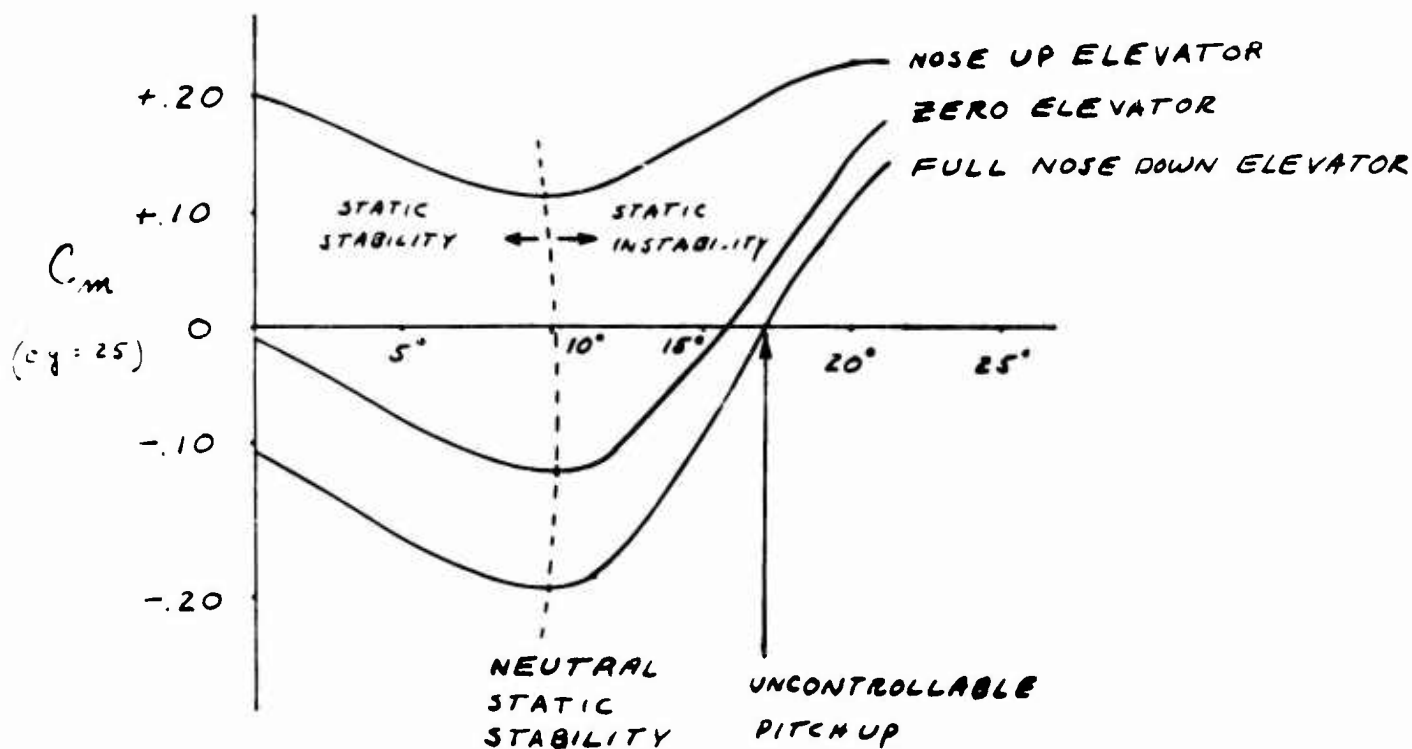
After the dynamic response of the simulation closely matched the aircraft response at several flight conditions, the simulator was used for handling qualities evaluations at various flight conditions of constant Mach number and altitude.

a. Lateral-Directional Handling Qualities Evaluation

The primary use planned for the five degree of freedom simulator was in conjunction with the NF-104A lateral-directional stability test program (Reference 1 and 3). Some large lateral-directional oscillations had occurred during several high Mach number zoom recoveries, and it was suspected that this was due to a deterioration in the directional stability with Mach number above 2.0 with speed brakes extended. Consequently, the handling qualities of the NF-104A were expected to get worse as Mach number increased. The plan for testing was to obtain initial test data at Mach numbers below 2.0. The lateral-directional stability parameters extracted from this data were then to be extrapolated to high Mach numbers and programmed into the five degree of freedom simulation for a predicted handling qualities analysis at higher Mach numbers. Additional test data were then to be obtained at higher Mach numbers updating the extrapolated data and handling qualities. By this method, a safe testing approach to an area of possible uncontrollability was planned. Two developments kept the plan from being implemented effectively. First, an early error in data reduction resulted in values of $C_{n\beta}$ which were much too low, resulting in a prediction of zero $C_{n\beta}$ and roll control reversal at a much lower Mach number than expected. Flight test revealed this discrepancy. It was discovered subsequently that the oscillations encountered at high Mach numbers were a primary result of engine air inlet duct spillage when the jet engine was off and not due solely to low directional stability (although directional stability is quite low; Reference 3). Using the final results of the stability analysis in the five degree of freedom simulation, the extrapolated handling qualities were found to be satisfactory at least to Mach 2.2 with speed brakes extended and the jet engine on.

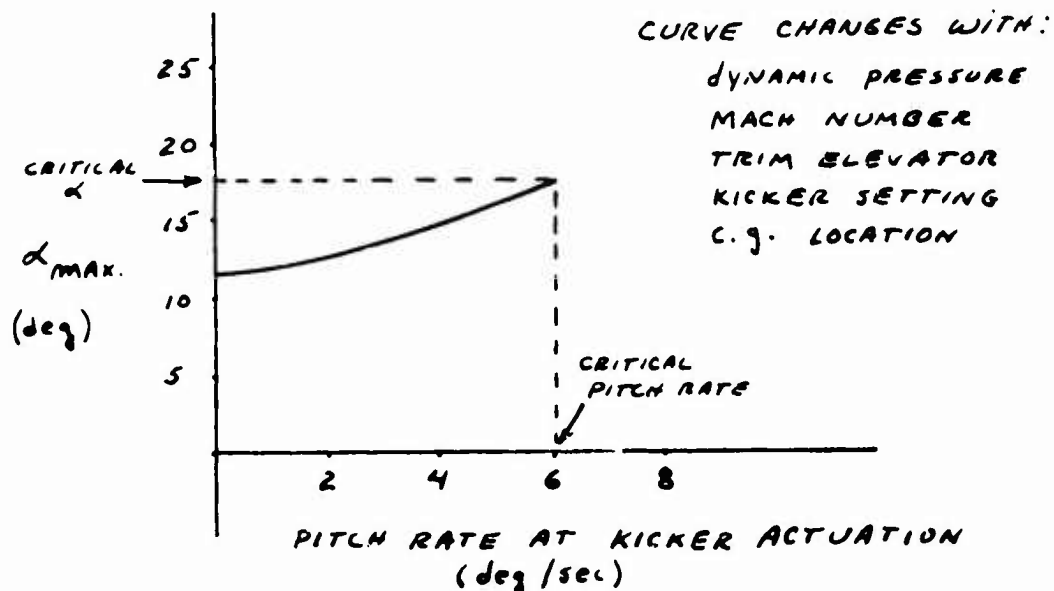
b. Study of Parameters Affecting Pitch-up

A study of methods to prevent the NF-104A from pitching up led to a five degree of freedom simulator study of the parameters which influence pitch-up. The simulator was also used for a similar study of the F-104A with strakes, and this study is documented in Reference 4.



Pitch-up occurs when an increase in angle of attack results in more positive (nose up) pitching moment. The stick kicker is the primary device used to keep the F-104A from pitching up. It is actuated by the sum of angle of attack and pitch rate. When the kicker is actuated, the elevator is driven

toward $+1^\circ$ (nose down) from the trim position producing a step increase in stick force. The normal stick kicker actuation point is slightly below the angle of attack for neutral stability. The actuation angle of attack is 13.8° for zero pitch rate, and $20^\circ/\text{sec}$ pitch rate for zero angle of attack. Changing the kicker setting to lower values was considered for the NF-104A to prevent inadvertent pitch-up at very high altitude and changing the setting to higher values in order to improve the subsonic maneuvering capability was studied for the F-104A. The results of these studies were analyzed by plotting maximum angle of attack reached as a result of pulling into the kicker at different pitch rates and noting the critical pitch rate at which the angle of attack overshoot resulted in pitch-up.



This critical pitch rate was affected by several parameters; dynamic pressure, elevator trim position, Mach number, and kicker setting. Understanding the effects of these parameters was important in the NF-104A flight test program and the F-104A strake tests.

It was found that as dynamic pressure decreased, the angle of attack overshoot increased following a stick kicker actuation, thus a lower dynamic pressure decreased the critical pitch rate for pitch-up and thereby caused the stick kicker to be less effective in preventing pitch-up.

Since the kicker moves the stabilizer one degree forward of trim, as the aircraft is trimmed to higher angles of attack, the kicker becomes less effective and critical pitch rate is reduced, in fact if the aircraft is trimmed above the kicker actuating angle of attack, the kicker becomes completely ineffective.

Mach number is important in that the maximum pitching moment required to pitch the aircraft up increases with Mach number. This increase is abrupt at Mach one, and thus it is significantly harder to pitch up when supersonic. Forward c.g. also results in larger stabilizing pitching moments and higher critical pitch rates.

As expected, reducing the kicker actuation angle of attack and pitch rate increases critical pitch rate for pitch-up. Increasing the kicker settings reduces the critical pitch rate, however, it was found that kicker settings as much as 2.5° above the angle of attack for neutral stability were adequate in preventing pitch-up for most normal flight conditions.

A reaction control system nose down kicker firing at 15° angle of attack was evaluated on the simulator. This RCS kicker increased critical pitch rate at low dynamic pressure, and it was incorporated in the NF-104A to reduce the possibility of inadvertent pitch-up at high altitudes.

c. Handling Qualities Study at Low Dynamic Pressure

An F-104A entered an inadvertent spin at the top of a zoom at a dynamic pressure (q) of about 8 psf, and the pilot was unable to recover. The pilot bailed out safely, and his comments indicated that he did not feel the pitch-up and spin were a result of a simple increase in angle of attack beyond the pitch-up angle of attack. Near the peak altitude he felt what he thought was a kicker, he pushed forward on the stick generating a large downward pitch rate to avoid a pitch-up. The airplane yawed left and became uncontrollable, and the subsequent maneuver eventually stabilized in the spin. The five degree of freedom simulation was then used in support of the accident investigation to study the low dynamic pressure (q) handling qualities. Two significant results were found. First, it was found that the damping became negative as q became very low because of one of the terms in the damping formula

$$-g \frac{\sin \phi}{v} \cos \theta,$$

which became dominant at low q. Thus at low q, a dynamic lateral-directional instability was found. Secondly, and more important, it was found that the engine gyroscopic effects which couple pitch rate into yawing moment and yaw rate into pitching moment became significant at low dynamic pressure where aerodynamic restoring forces became low. For example, in the F-104A accident a nose down pitch rate probably produced a left yawing moment due to gyroscopic coupling. Since q was low, the aerodynamic restoring moment in yaw was not great enough to overcome the gyroscopic yawing moment, and a left yaw rate developed. The development of a large sideslip angle caused an aerodynamic rolling moment, and the aircraft soon became uncontrollable. Both gyroscopic effects and aerodynamic effects were equally significant at the low q encountered, and the aircraft controls were not effective enough nor was the pilot trained to handle both effects. Duplicating on the simulator the F-104A pilot inputs which occurred prior to the spin entry resulted in the uncontrollable maneuvers described by the pilot. Reference 5 gives more detail on

gyroscopic effects. Reference 13 describes the F-104A accident and gives the analog simulator results.

It was then decided by the NF-104A test engineer to use the simulator to help define a minimum dynamic pressure to which the NF-104A should be zoomed. This minimum dynamic pressure would then be verified by flight test. Defining criteria for evaluating what dynamic pressure should be the minimum was somewhat a matter of pilot judgment since the aircraft had been flown to very low q and controlled by use of the reaction control system, (RCS). It was also noted that if the body rates were kept very low, a zoom below 10 psf could be safely accomplished without RCS. The criteria adopted were that the pilot should be capable of recovering from the coupled maneuver which results when the stick kicker is actuated by using only aerodynamic controls and no rudder (and without RCS). The selected trim conditions were 5° angle of attack at Mach 1.0. The minimum q arrived at on the simulator was around 20 psf. The trend toward dynamic instability caused by the

$$g \frac{\sin \phi \cos \theta}{v}$$

term became noticeable about $q = 15$ psf. The mechanical simulation of the stick kicker was considered inadequate for a realistic evaluation, and consequently the flight test verification of minimum q was made by an incremental approach starting at about 40 psf. This was done despite the fact that the pilot had successfully flown the aircraft at lower dynamic pressure with reaction controls after repeated kicker actuation. The flight tests verified that the minimum q for satisfactory handling qualities was about 20 psf. At this q , the reaction control training was fairly realistic if the aircraft was flown at the trim angle of attack. Thus corrections with the RCS were made about aerodynamic trim conditions at $q = 20$ psf.

IV. THREE DEGREE OF FREEDOM SIMULATION DESCRIPTION

a. General Description

The three degrees of freedom simulated were horizontal motion, vertical motion, and pitching motion. Therefore, this simulation was programmed with lift, thrust, drag, weight, moment of inertia, pitching moment, and center of gravity location. The simulation was suitable for studies of wings level performance and longitudinal control characteristics.

b. Equations of Motion

Equation of horizontal motion (stability axes):

$$m\dot{V} = T \cos \alpha - D - g \sin \gamma$$

Equation of vertical motion (stability axes):

$$\dot{\alpha} = Q - \frac{L}{mV} + \frac{g}{V} \cos \gamma - \frac{T \sin \gamma}{mV}$$

Equation of pitching motion (body and stability axes):

$$Q = \frac{M}{I_y}$$

Angular relationship for wings level attitude:

$$\dot{\gamma} = Q - \dot{\alpha}; \quad \gamma = \theta - \alpha$$

Calculation of lift:

$$L = (C_{L_0} + C_{L_\alpha} \alpha) qS$$

Calculation of drag:

$$D = \left(C_{d_0} + \frac{\partial C_d}{\partial C_L^2} C_L^2 + \Delta C_{d_{\text{speedbrakes}}} + \Delta C_{d_{\text{drag chute}}} \right) qS$$

Calculation of pitching moment:

$$M = \left(C_{m(\alpha)} + C_{m_{\delta_e}} \delta_e + C_L \Delta c.g. + \Delta C_{m_{\text{drag chute}}} \right) qSC$$

Calculation of maximum afterburner jet thrust (zero above 72,000 feet)

$$T_J = \frac{dT_J}{dh} (h - 72,000) + \Delta T_J$$

Rocket Thrust: 6250 lbs

Rocket Burn Time: 103 Seconds

Rocket Thrust Line: 9° below the positive body x axis

c. Weight, c.g., and Moment of Inertia

The weight and c.g. were programmed as variables using the data given below. This data were obtained from Figures 29 and 30. g was used as a constant.

Empty Weight	13,950 lbs
Max, Gross Weight	22,000 lbs
JP-4 Capacity	5,000 lbs
Rocket Fuel Capacity	
(H ₂ O ₂)	2,600 lbs
JP-4 Mass Flow Rate	.194 slugs/sec
H ₂ O ₂ Mass Flow Rate	.842 slugs/sec
c.g. Movement rate (jet only)	.000169 (per sec)
c.g. Movement rate (rocket only)	.00176 (per sec)
Moment of Inertia (I _y)	70,800 (slug ft ²)

d. Flight Control System

The stick signal, trim signal, and damper signal were summed and used directly as the elevator signal.

Elevator Limits	+5°, -17°
Stick Command Limits	+6°, -17°
Trim Command Limits	+2°, -11°
Damper Command Limits	+1°, -1°
Damper Gain	$\frac{\delta e}{Q} = .095 \text{ deg/deg/sec}$

The pitch reaction control system consisted of manual system, a damper system, and a kicker system. The manual system fired two reaction jets, and the damper system fired one. The kicker fired the two nose down jets when α exceeded 15 degrees.

Manual RCS Command	$\dot{Q} = 4.5 \text{ deg/sec}^2$
RCS Damper Command	$\dot{Q} = 2.25 \text{ deg/sec}^2$
RCS Damper Dead Band	$Q = \pm 2 \text{ deg/sec}$
RCS Kicker Actuation Angle	$\alpha = 15^\circ$

e. Atmosphere

Using the U.S. Standard Atmosphere, 1962, standard density and temperature were programmed into the simulation. Non-standard temperatures were accounted for by computing an equivalent altitude increment corresponding to the increment of non-standard temperature. This altitude increment was then added to the standard altitude before air density was computed.

$$h = h_s + \Delta h$$

$$\Delta h = 2.09 \times 10^4 \frac{\Delta T_a}{T_s}$$

$$T_s = 217^\circ$$

$$\Delta h = 96.3 \Delta T_a$$

ρ = stored function of altitude (h)

The non-standard temperature increment was added to the standard temperature, and the speed of sound was computed using the total value.

$$T_a = T_s + \Delta T_a$$

$$a = 65.6 \sqrt{T_a (^{\circ}\text{K})}$$

f. Drag Chute and Drag Brakes

ΔC_d for drag brakes was .052

ΔC_d for drag chute was .4

With drag chute deployed, the pitching moment curve was described by the following equation (c.g. = .25):

$$C_m = C_{m_0} + \frac{\partial C_m}{\partial C_L} C_L$$

$$C_{m_0} = - .12$$

$$\frac{\partial C_m}{\partial C_L} = - .373$$

g. Cockpit

The cockpit used during most of the simulator work was the X-20 centrifuge cockpit. A side-arm controller with a trim dial was used for pitch control. An NF-104A RCS stick was also used. A three axis attitude indicator displayed pitch angle. Angle of attack, altitude, Mach number, and rate of climb were presented in the cockpit. A drag chute switch and speed brakes switch were also provided. Since the three degree of freedom simulator was used primarily for performance studies, a true cockpit simulation was not of primary importance.

V. FIVE DEGREE OF FREEDOM SIMULATION DESCRIPTION

a. General Description

An analog computer simulation in five degrees of freedom of a rigid body F-104 was developed. The five degrees programmed were three rotational degrees (pitch, yaw, and roll) and two translational degrees (angle of attack and angle of sideslip). Angle of attack and sideslip were considered as translational degrees of freedom due to their derivation from force equations. (See Appendix 4).

The simulation was used with a static cockpit in which α , β , $\dot{\beta}$ and the aircraft attitudes were displayed. The simulation could be controlled in roll, pitch, yaw, and rate of climb with a two axis side stick and rudder pedals. The simulation was suitable for studying the handling qualities in all axes at a fixed Mach number and altitude.

Altitude and Mach number were held constant but could be set to any values. The aerodynamic coefficients, weight, moments of inertia, and c.g. position were set for each desired flight condition, and it was necessary to change these parameters when a new Mach number, weight, or c.g. was desired.

b. Equations of Motion

1. Translational Equations of Motion

(Derivation of these equations is in Appendix 4).

The translational equations of motion used in the simulation were:

$$\dot{\alpha} = -(C_L \cos \alpha + C_D \sin \alpha) \frac{qS}{\mu} + \frac{g \cos \phi \cos \theta}{\mu} - P\beta + Q$$

$$\dot{\beta} = (C_{y_{\delta_R}} \delta_R + C_{y_{\beta}} \beta) \frac{qS}{\mu} + \frac{g \cos \phi \cos \theta}{\mu} + P\alpha - R$$

2. Rotational Equations of Motion

(Derivation of these equations is in Reference 12).

The rotational equations of motion, including engine gyroscopic effects (Appendix 5), used in the simulation were:

$$\begin{aligned} I_{xx} \dot{P} &= (C_{l_{\beta}} \beta + C_{l_{\delta_a}} \delta_a + C_{l_{\delta_R}} \delta_R) qSb + (C_{l_R} R + C_{l_P} P) \frac{qSb^2}{2V} \\ &- QR (I_{zz} - I_{yy}) - (R - QP) (I_{xz}) \end{aligned}$$

$$\begin{aligned} I_{yy} \dot{Q} &= (C_m(\alpha) + C_{m_{\delta_e}} \delta_e + C_{L \Delta c.g.}) qSc + (C_{m_Q} Q) \frac{qSc^2}{2V} \\ &- PR (I_{xx} - I_{zz}) + (R^2 - P^2) I_{xz} - I\Omega R \end{aligned}$$

$$I_{zz} \dot{R} = (C_{n_\beta} \beta + C_{n_{\delta_a}} \delta_a + C_{n_{\delta_r}} \delta_r) qSb + (C_{n_R} R + C_{n_P} P) \frac{qSb^2}{2V} \\ + PQ (I_{yy} - I_{xx}) + \dot{P} (I_{xz}) + I_{\Omega} Q$$

$$\text{Where } C_{n_\beta} = (C_{n_\beta}_{c.g.} + C_{y_\beta} \frac{c}{b} \Delta c.g.) \\ C_{n_\beta}_{c.g.} = .25$$

These equations were solved in the body axis system. Solution of these equations yields angular rates in radians per second.

Principal axis moments of inertia were obtained from Figure 31. The moments of inertia were transformed to body axes by use of the following equations;

$$I_x = \frac{1}{2} (I_{x_p} + I_{z_p}) + \frac{1}{2} (I_{x_p} - I_{z_p}) \cos 2\epsilon$$

$$I_z = \frac{1}{2} (I_{z_p} + I_{x_p}) + \frac{1}{2} (I_{z_p} - I_{x_p}) \cos 2\epsilon$$

$$I_{xz} = \frac{1}{2} (I_{z_p} - I_{x_p}) \sin 2\epsilon$$

Where ϵ is the angle between the body x axis and the principal x axis, and ϵ is positive when the body x axis is above the principal x axis at the nose of the aircraft.

3. Euler Angles

The Euler angle equations used were:

$$\dot{\phi} = \dot{\psi} \sin \phi + P$$

$$\dot{\psi} = \frac{Q \sin \phi + R \cos \phi}{\cos \phi}$$

$$\dot{\theta} = Q \cos \phi - R \sin \phi$$

c. Flight Control System

1. Basic Controls

a. Deflection Limits.

$$\delta_e = 17^\circ \text{ to } + 5^\circ$$

$$\delta_a = 10^\circ \text{ to } + 10^\circ$$

$$\delta_r = 6^\circ \text{ to } + 6^\circ$$

b. Elevator Stick Authority:

It was possible to attain $+7^\circ$, -17.5° elevator travel, providing that trim was not such that the elevator reached a limit before stick travel limits were reached.

c. Trim Authority:

$$\delta_{e_T} = 2^\circ \text{ to } 11^\circ$$

Aileron trim was not simulated.

d. Rate Limits

$$\delta_e \text{ limited to } \pm 20^\circ/\text{sec}$$

δ_a , δ_r rate limits were not simulated

2. Damper System

a. General:

The flight control system dampers were approximated by the following transfer functions.

$$\frac{\delta_{e_d}}{n} = .095 \text{ deg/deg/sec}$$

$$\frac{\delta_{a_d}}{P} = \frac{.0294S}{(.119S + 1)} \text{ deg/deg/sec}$$

$$\frac{\delta_{r_d}}{R} = \frac{1.46S}{(.685S + 1)} \text{ deg/deg/sec}$$

b. Damper Limits:

$$\delta_{e_d} = \pm 1^\circ$$

δ_a, δ_r damper limits were not simulated

3. Reaction Control System and Dampers (NF-104A only)

a. The reaction control system was an "on - off" system which provided airplane control at low q areas through a reaction force which produced an angular acceleration about one of the body axes.

b. The values used in the simulation of the reaction control system were:

Controls

$$\dot{P} = 25.00 \text{ deg/sec}^2$$

$$\dot{Q} = 4.50 \text{ deg/sec}^2$$

$$\dot{R} = 4.50 \text{ deg/sec}^2$$

Dampers

$$\dot{P} = 12.50 \text{ deg/sec}^2$$

$$\dot{Q} = 2.25 \text{ deg/sec}^2$$

$$\dot{R} = 2.25 \text{ deg/sec}^2$$

Dead Band

$$P = \pm .5 \text{ deg/sec}$$

$$Q = \pm 2 \text{ deg/sec}$$

$$R = \pm .2 \text{ deg/sec}$$

c. A "shut-out" control was simulated, preventing the occurrence of damper inputs while the manual RCS controls were in use.

4. Stick Kicker

Although the movement of the stick following kicker actuation was not simulated, the effects of the stick kicker were simulated.

Angle of attack and pitch rate were sensed and the elevator was deflected $+1^\circ$ trim elevator position when the critical or pitch rate was reached. This deflection was maintained until the stick was returned to the neutral position by the pilot. A wash-out effect on the sensed pitch rate was also simulated. The wash-out time constant was .5 seconds. The critical combination of angle of attack and pitch rate which fired the kicker was $\frac{20}{13.8} \alpha + Q = 20$. For example, 13.8° α or $20^\circ/\text{sec}$ pitch rate caused kicker actuation.

d. Cockpit

1. Displays

An X-20 centrifuge cockpit was used with the simulation in which were provided the following displays:

a. Angle of attack on a strip indicator and on the attitude indicator as a horizontal bar. (ILS needle).

b. Angle of sideslip on a strip indicator and on the attitude indicator vertical bar. (ILS needle).

c. Pitch, yaw, and roll angles (Euler) appeared on a standard 3 axis attitude indicator.

d. Normal acceleration appeared on a dial indicator.

2. Pilot controls were provided through a two axis sidearm controller, providing elevator and aileron control and standard rudder pedals for yaw control.

VI. REFERENCES

1. C. L. Hendrickson, "NF-104A Aerospace Trainer Flight Test Report," to be published about June 1965 as an AFFTC TDR.
2. USAF Major Accident Report, NF-104A, SN 56-762, 10 Dec 1963.
3. Zaleski, C. D., "NF-104A Lateral-Directional Stability Analysis," Flight Research Division Office Memo, AV-64-8, December 1964.
4. Hoey, R. G., "A Simulation Study to Investigate the Effect of Increasing the F-104A Stick Kicker Boundary," Flight Research Division Office Memo, 2 Nov 1964.
5. Turley, W. R., "Some Considerations of Engine Gyroscopic Coupling Effects Upon the Motion of an Aircraft," Flight Research Division Office Memo, 29 June 1964, AC-64-5.
6. "Aerospace Trainer Stability Verification Test in the NASA-Ames Aeronautical Laboratory 14 Feet Transonic Wind Tunnel," Lockheed A.C. Report No. LFL N-12, 29 Dec 1962.
7. "Aerospace Trainer Stability Verification Test in LFL 4' by 4" Supersonic Wind Tunnel," Lockheed A.C. Report No. LFL S-39, 6 June 1962.
8. "Stability and Control and Handling Qualities F-104A," Lockheed A.C. Report No. 10794, 12 Dec 1955.
9. "Wind Tunnel Tests at High Subsonic Mach Numbers of a F-104A Equipped with Aft Body Strakes," Lockheed A.C. Report No. LFL N-35, 30 July 1964.
10. "Aerospace Trainer, Flight Manual NF-104A," AFFTC, January 1965.

11. "Low Speed High Angle Wind Tunnel Tests of an .0858 Scale Model F-104A With and Without Drag Parachute," Lockheed A.C. Report No. LAL 343, 11 Dec 1958.
12. Berry, Donald T., "Derivation of the Six Degree of Freedom Equations of Motion of an Airplane," Flight Research Branch Technical Memo 62-6, April 1962.
13. USAF Major Accident Report, F-104A, SN 56-674, 15 June 1964.

VII APPENDICES

1. Symbol Index
2. Aerodynamic Data
3. Figures
4. Derivation of Translational Equations
5. Jet Engine Gyroscopic Effect
6. Wiring Diagrams

APPENDIX I
SYMBOL INDEX

NOTE F-104A reference dimensions were used in the simulation

<u>SYMBOL</u>	<u>DEFINITION</u>	<u>UNITS</u>
α	Angle of attack	deg or rad
β	Sideslip angle	deg or rad
P	Roll rate	deg/sec or rad/sec
Q	Pitch rate	deg/sec or rad/sec
R	Yaw rate	deg/sec or rad/sec
ϕ	Roll angle	deg
θ	Pitch angle	deg
ψ	Yaw angle	deg
γ	Flight path angle	deg
M	Pitching moment	ft lb
C_m	Pitching moment coefficient	
$C_m(\alpha)$	Pitching moment coefficient as a function of (α)	
$C_{m\delta_e}$	Elevator effectiveness derivative = $\frac{\partial C_m}{\partial \delta_e}$	per degree
C_{mQ}	Longitudinal damping derivative $\frac{\partial C_m}{\partial Q} \frac{c}{2V}$	per degree
c	Wing cord length	9.55 feet
V	Total velocity	FPS
I_{yy}, I_{xx}, I_{zz}	Moments of inertia about Y, X, Z axes	slug ft ²

<u>SYMBOL</u>	<u>DEFINITION</u>	<u>UNITS</u>
i_{xz}	Cross product of inertia	slug ft ²
l	Rolling moment	ft lb
C_l	Rolling moment coefficient	
$C_{l\beta}$	Rolling moment derivative due to $\beta = \frac{\partial C_l}{\partial \beta}$	per degree
$C_{l\delta_a}$	Aileron effectiveness derivative = $\frac{\partial C_l}{\partial \delta_a}$	per degree
$C_{l\delta_r}$	Rudder cross control derivative = $\frac{\partial C_l}{\partial \delta_r}$	per degree
C_{lR}	Lateral cross damping derivative = $\frac{\partial C_l}{\partial \frac{Rb}{2V}}$	per degree
C_{lp}	Lateral damping derivative = $\frac{\partial C_l}{\partial \frac{pb}{2V}}$	per degree
b	Wing span	21.9 feet
N	Yawing moment	ft lb
C_n	Yawing moment coefficient	
$C_{n\beta}$	Yawing moment derivative due to $\beta = \frac{\partial C_n}{\partial \beta}$	per degree
$C_{n\delta_a}$	Aileron cross control derivative = $\frac{\partial C_n}{\partial \delta_a}$	per degree
$C_{n\delta_r}$	Rudder effectiveness derivative = $\frac{\partial C_n}{\partial \delta_r}$	per degree
C_{np}	Directional cross damping derivative = $\frac{\partial C_n}{\partial \frac{pb}{2V}}$	per degree

<u>SYMBOL</u>	<u>DEFINITION</u>	<u>UNITS</u>
C_{nR}	Directional damping derivative = $\frac{\partial C_n}{\partial \dot{\beta}} \frac{b}{2V}$	per degree
ρ	Air density	slugs/ft ³
q	Dynamic pressure	lbs/ft ²
S	Wing area	196.1 ft ²
m	Mass	slugs
δ_e	Elevator deflection	degree
δ_a	Aileron deflection	degree
δ_r	Rudder deflection	degree
h	Altitude	feet
h_s	Standard day altitude	feet
T	Total thrust	lb
T_j	Jet engine thrust	lb
T_r	Rocket engine thrust	lb
T_a	Ambient temperature	°K
T_s	Standard day temperature	°K
ΔT_a	Nonstandard temperature increment	°K
a	Speed of sound	ft/sec
D	Drag	lbs
C_d	Drag coefficient	
$\frac{\partial C_d}{\partial C_L^2}$	Drag coefficient slope	
C_{d_0}	Zero lift drag coefficient	

<u>SYMBOL</u>	<u>DEFINITION</u>	<u>UNIT</u>
L	Lift	lbs
C_L	Lift coefficient	
C_{L_0}	Zero lift coefficient	
C_{L_α}	Lift curve slope	per degree
c.g.	Center of gravity	fraction of c
$\Delta c.g.$	(c.g. - .25)	fraction of c
Ω	Engine RPM	rad/sec 100% = 781 rad/sec
I	J-79 engine moment of inertia	18.16 slug ft ²
ϵ	Angle between the body x axis and the principal x axis; positive when the body x axis is above the principal x axis at the nose of the aircraft.	
$I_{x_p}, I_{y_p}, I_{z_p}$	Principal moments of inertia	slug ft ²

APPENDIX 2

AERODYNAMIC DATA

SOURCES

The two primary sources of data were Lockheed Report No. 10794 (Reference 8) for the F-104A, and the two Lockheed NF-104A reports (References 6 and 7). LR 10794 is a complete aerodynamic description of the F-104A except for drag. The two NF-104A reports contain lift, drag, and pitching moment data through the entire Mach range, and $C_{n\beta}$ and $C_{l\beta}$ only at $M = 1.43$ and above. For the three degree of freedom simulation, the lift, drag, and pitching moment data came from the NF-104 reports, and the elevator effectiveness and the pitch damping coefficients came from LR 10794. For the five degree of freedom simulation, all data below $M = 1.43$ was F-104A data. Above Mach 1.43, lift, pitching moment, $C_{n\beta}$ and $C_{l\beta}$ were changed to NF-104A data, but all other data were F-104A data.

Two recent sources of F-104A data were used to update the five degree of freedom simulation. Lockheed provided lift and pitching moment data through the entire Mach range to update LR 10794. In connection with an F-104A strake evaluation, some lift, pitching moment, $C_{n\beta}$ and $C_{l\beta}$ data were obtained from NASA Langley for the F-104A both with and without strakes. This Langley data covered the Mach numbers .5, .8, .9, and 1.03 and is contained in a Lockheed report (Reference 9). Updated values of $C_{n\beta}$ and $C_{l\beta}$ were also obtained from flight tests at Mach numbers above 1.3.

It should be pointed out that both NF-104A and F-104A performance studies done on the three degree of freedom simulator used the same data. Also, both F-104A and NF-104A handling qualities studies made at Mach .5 up to 1.03 used the Langley strakes-off data for the F-104A.

DETAILED DESCRIPTION OF PROGRAMMED AERODYNAMICS

The data which were programmed were obtained from a combination of the referenced wind tunnel data and flight test data. In the areas where simulation effects were known to be minor, approximations were made to the wind tunnel data in order to program it on the analog computer. The data presented in the Figures in Appendix III represent the combined wind tunnel data (after approximations were made) and flight test data which were programmed on linear segment diode function generators on the analog computer.

FIVE DEGREE OF FREEDOM SIMULATION

The same control derivatives were used for F-104A and NF-104A (LR 10794). The elevator effectiveness was considered to be a linear function of α at Mach numbers 1.4 and below.

$$C_{m_{\delta_e}} = K_1 \alpha + K_2 + \{\Delta C_{m_{\delta_e}} \delta_e \text{ (positive } \delta_e \text{ only)}\}$$

K_1 and K_2 are functions of Mach number (Figure 2). $\Delta C_{m_{\delta_e}} \delta_e$ (Fig 2) was a factor added only for positive elevator deflection, and was obtained from NASA RN A57-K05. For five degree of freedom studies above $M = 1.4$, $C_{m_{\delta_e}}$ was considered to be independent of δ_e and α , and was given as a function of Mach only (Figure 3). $C_{m_{\delta_e}}$ was switched to zero at $\alpha = 22^\circ$. The other control derivatives were converted to body axes and used as functions of Mach number only (Figure 4). Above Mach 1.2 the difference between stability and body axes was neglected, and the control derivatives were used as functions of Mach number only and were taken directly from LR 10794.

The damping derivatives were taken from LR 10794. The pitch damping derivatives C_{mQ} and $C_{m\dot{\alpha}}$ were added to get $C_{m(Q + \dot{\alpha})}$ and multiplied by Q to get a ΔC_m . $C_{m(Q + \dot{\alpha})}$ was considered to be a function of Mach number only (Fig 5). The lateral-directional damping derivatives were taken from LR 10794 and converted to body axes. Below Mach 1.2 C_{n_p} and C_{l_p} were considered to vary linearly with α . C_{n_p} also varied with Mach number, but the variation in C_{l_p} with Mach number was neglected. C_{l_R} and C_{n_R} were considered to be functions of Mach number only.

$$C_{n_p} = C_{n_p(\alpha = 0)} - .03\alpha$$

$$C_{l_p} = - .4 + .026\alpha$$

C_{l_R} , C_{n_R} and $C_{n_p(\alpha = 0)}$ as functions of Mach number are given in Figure 6. Above Mach 1.2, the variation between stability axes and body axes was neglected, and values of damping derivatives were taken directly from LR 10794 at each Mach number.

For both the F-104A and the NF-104A, the lateral-directional static stability parameters C_{l_β} and C_{n_β} were obtained from the Langley data at Mach 1.03 and below. They were programmed as functions of angle of attack at each Mach number (Figs 7, 8, 9, 10). Above 1.03, the effect of angle of attack was neglected and the data from NF-104A flight test were used (Fig 11).

For both the F-104A and NF-104A, the pitching moment curves were taken from the Langley data at $M = 1.03$ and below (Figs 12, 13, 14, 15). The updated LR 10794 data at Mach 1.4 (Fig 16) were used at Mach 1.4 and above since the longitudinal characteristics are similar at high Mach numbers, and the handling qualities studies in this Mach range were lateral-directional and not longitudinal.

For both the F-104A and NF-104A, the lift curves at Mach 1.03 and below were from the Langley data (Figs 17, 18, 19 and 20). At Mach 1.4 and above, the Mach 1.4 lift curve from the updated LR 10794 were used (Fig 21). Since drag was of only secondary importance in the five degree of freedom simulation, only one drag curve was used for all Mach numbers (Fig 22).

Three Degree of Freedom Simulation

The elevator effectiveness was obtained from LR 10794 and programmed as a function of Mach number only (Fig 3), except that $C_{m\delta_e}$ varied linearly from -.0185 at $\alpha = 22^\circ$ to zero at $\alpha = 50^\circ$.

The pitch damping derivative was obtained from LR 10794 and programmed as a function of Mach number only (Fig 5).

The pitching moment curves for zero elevator deflection were obtained from the NF-104A reports and programmed as a function of α at several Mach numbers. The proper pitching moment was fed into the simulation by interpolating between the Mach numbers at which data were stored (Fig 23). Above angle of attack of 22° , only one set of data was used, and the curves for all Mach numbers were faired to this single curve between α of $+18^\circ$ and 22° .

The lift data were also obtained from the NF-104A reports, and $C_{l\alpha}$ was stored as a function of Mach number (Fig 24), and $C_{L\alpha=0}$ was -.03. For angles of attack greater than 18° , C_l was limited to its value at $\alpha = 18^\circ$.

The drag was obtained from the NF-104A reports and was programmed as:

$$C_d = C_{d_0} + \frac{\partial C_d}{\partial C_L^2} C_L^2$$

where C_{d_0} and $\frac{\partial C_d}{\partial C_L^2}$ were functions of Mach number (Figs 25, 26).

The thrust was obtained from the J-79 engine manual and was programmed as:

$$T = \frac{dT}{dh} (h - 72,000) + \Delta T (h)$$

where $\frac{dT}{dh}$ was a function of Mach number and $\Delta T(h)$ was a function of altitude (Figs 27, 28).

APPENDIX 3

FIGURES

<u>FIGURE</u>	<u>TITLE</u>
1	Axis System and Sign Convention
2	Stabilizer Effectiveness Functions, LR 10794, F-104A, c.g. = .25c
3	Stabilizer Effectiveness, F-104A, LR 10794, c.g. = .25c
4	Rudder and Aileron Control Derivatives, c.g. = .25c
5	Pitch Damping Coefficient, F-104A, LR 10794, c.g. = .25c
6	Yaw and Roll Damping Functions vs Mach Number, Body Axes, LR 10794, c.g. = .25c
7	Mach = 1.03, Strake Study, Langley Data, F-104A, $C_{n\beta} + C_{l\beta}$ vs α , Body Axis, c.g. = .25c
8	Mach = .9, Langley Data, F-104A, Strake Study, $C_{n\beta}$ and $C_{l\beta}$ vs α , Body Axis, c.g. = .25c
9	Mach = .8, Strake Study, F-104A, Langley Data, $C_{n\beta}$ and $C_{l\beta}$ vs α , Body Axis, c.g. = .25c
10	Mach = .5, Strake Airplane, F-104A, Langley Data, $C_{n\beta}$ and $C_{l\beta}$ vs α , Body Axis, c.g. = .25c
11	NF-104A Flight Test Data, $C_{n\beta}$ and $C_{l\beta}$ vs Mach Number, Body Axis, c.g. = .25c, Speed Brakes Extended
12	C_m vs α , Mach = 1.03, Strake Airplane, Langley Data, F-104A, c.g. = .25c
13	C_m vs α , Mach = .9, Strake Airplane, Langley Data, F-104A, c.g. = .25c
14	C_m vs α , Mach = .8, Strake Airplane, Langley Data, F-104A, c.g. = .25c

- 15 C_m vs α , Mach = .5, Strake Airplane, Langley Data,
F-104A, c.g. = .25c
- 16 C_m vs α , Mach 1.4, Updated LR 10794, F-104A, c.g. = .25c
- 17 C_L vs α , Mach 1.03, Strake Airplane, Langley Data, F-104A
- 18 C_L vs α , Mach .9, Strake Airplane, Langley Data, F-104A
- 19 C_L vs α , Mach .8, Strake Airplane, Langley Data, F-104A
- 20 C_L vs α , Mach .5, Strake Airplane, Langley Data, F-104A
- 21 C_L vs α , Mach 1.4, F-104A, Updated LR 10794
- 22 C_D vs α , F-104A, All Mach Numbers (5 Degree of Freedom
Simulation Only)
- 23 Pitching Moment Coefficient, NF-104A Data at $\alpha < 22^\circ$,
c.g. = .25c
- 24 Lift Curve Slope NF-104A Data vs Mach Number
- 25 Zero Lift Drag NF-104A vs Mach Number
- 26 NF-104A Data, Drag Slope, $\frac{\partial C_D}{\partial C_L^2}$ vs Mach
- 27 Analog Thrust Generation, Thrust Slope $\frac{\Delta T_J}{\Delta h}$ vs Mach

$$T_J = \left(\frac{\Delta T_J}{\Delta h}\right)(h - 72,000) + \Delta T_J, h < 72,000$$
Standard Day
- 28 Analog Thrust Generation, Δ Thrust vs Altitude

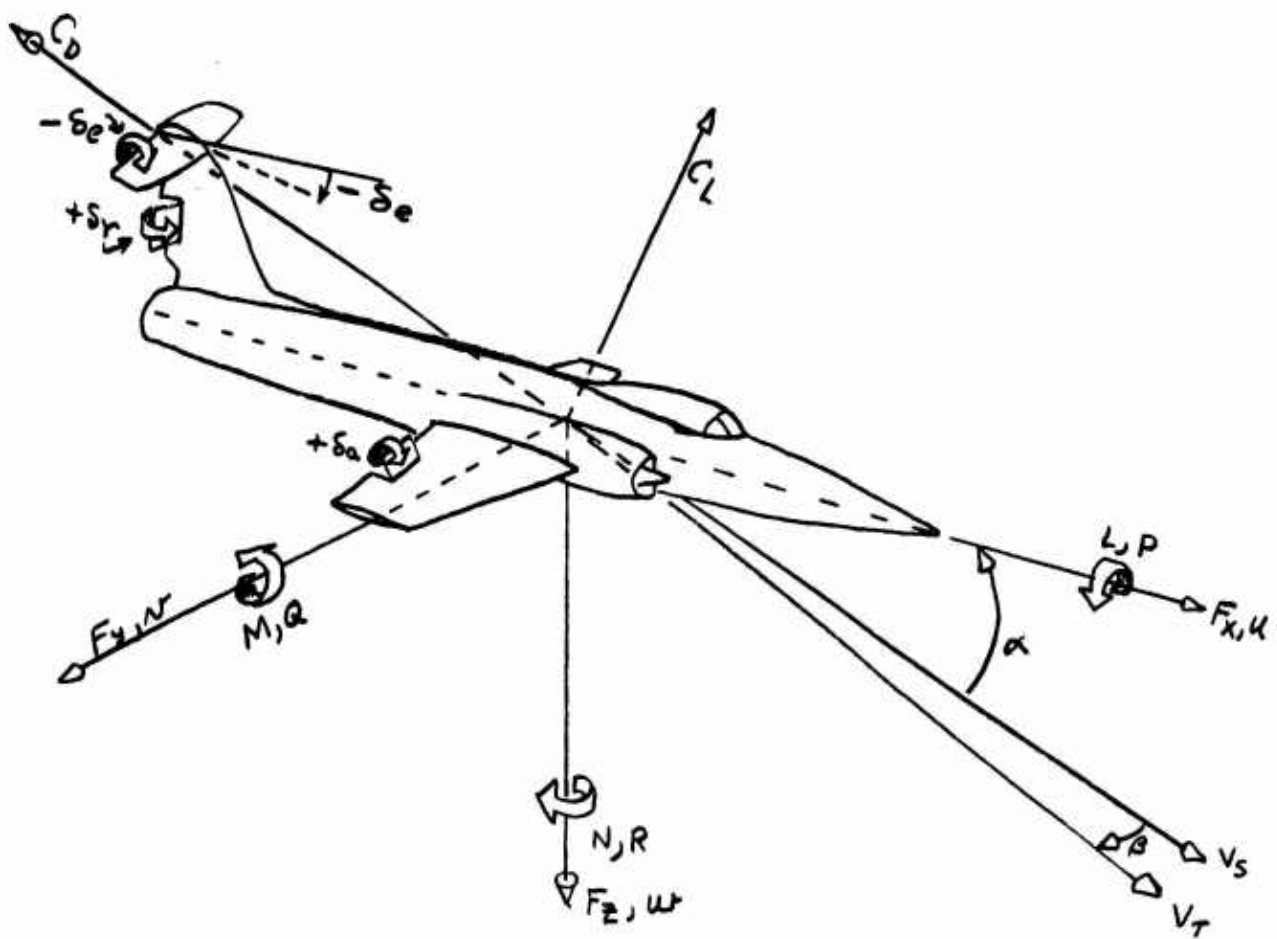
$$T_J = \left(\frac{\Delta T_J}{\Delta h}\right)(h - 72,000) + \Delta T_J, h < 72,000$$
Standard Day

29 Center of Gravity Travel With Reaction Fuel, NF-104A

30 Center of Gravity Travel Without Reaction Fuel, NF-104A

31 NF-104A PRINCIPLE MOMENTS OF INERTIA

**AXIS SYSTEM
 AND
 SIGN CONVENTION**



STABILIZER EFFECTIVENESS FUNCTIONS
 LR 10794, F104A C.G. = .25 C

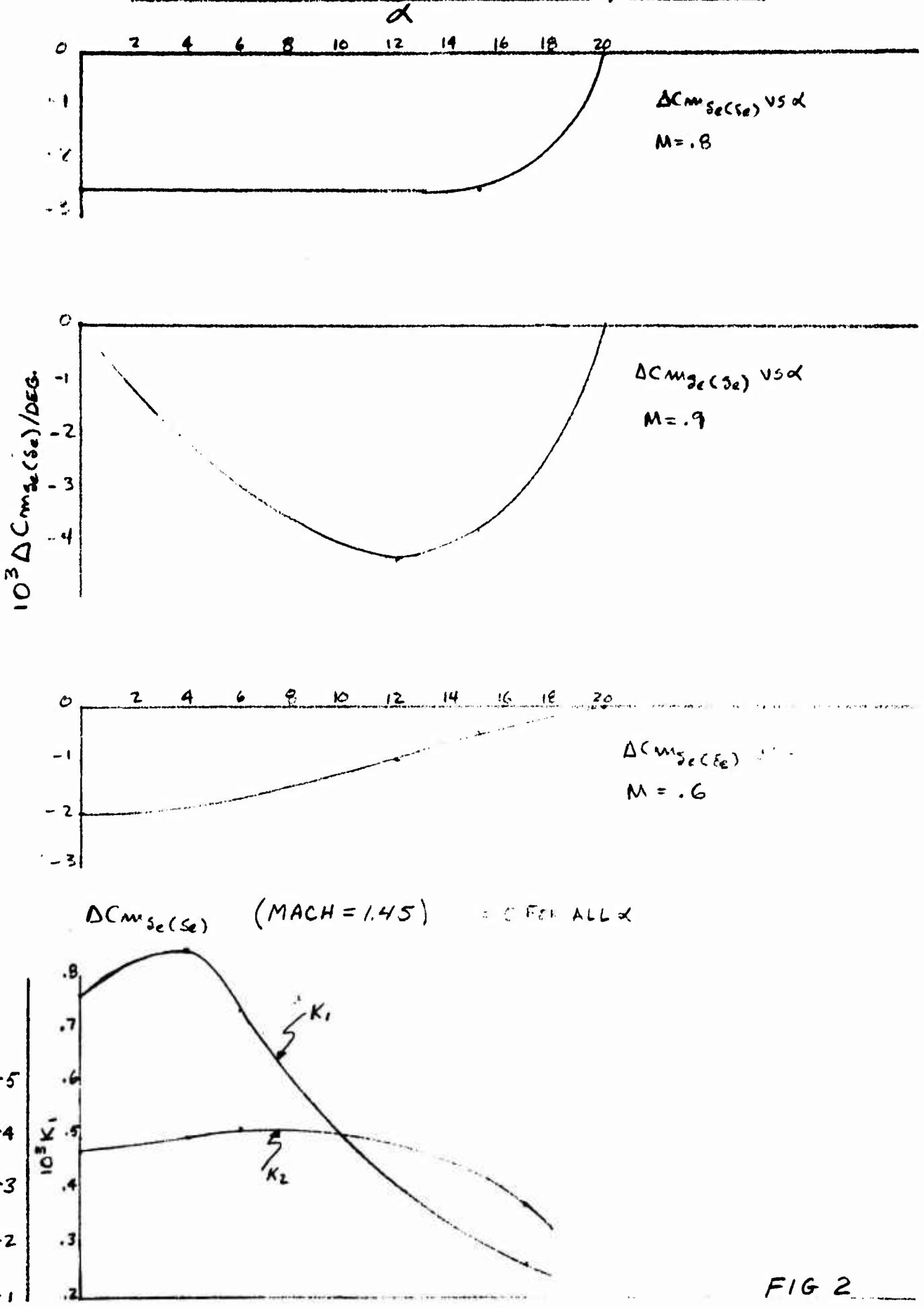


FIG 2

STABILIZER EFFECTIVENESS
F 104A LR 10794
C.G. = .25 C

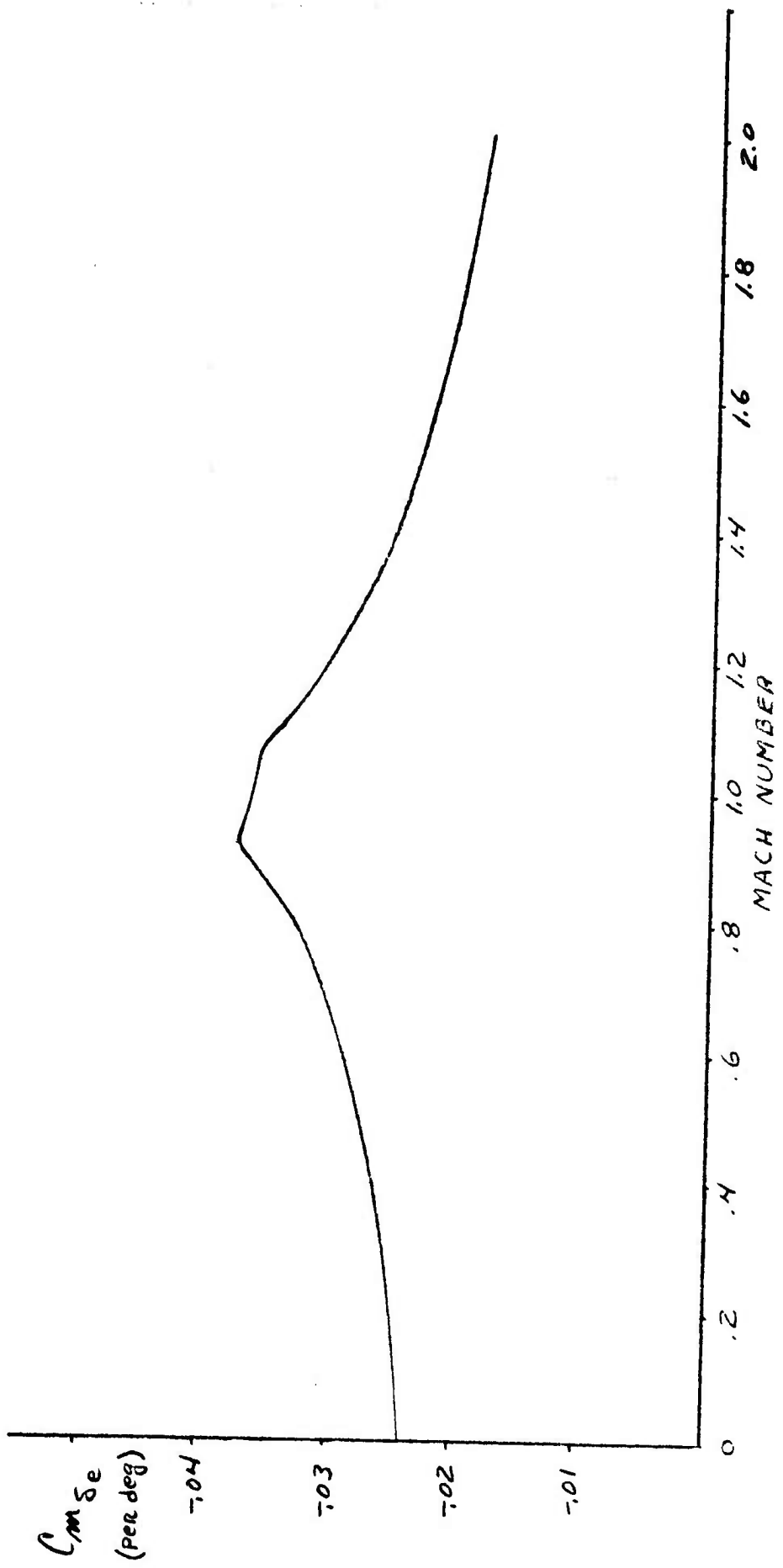


FIG 3

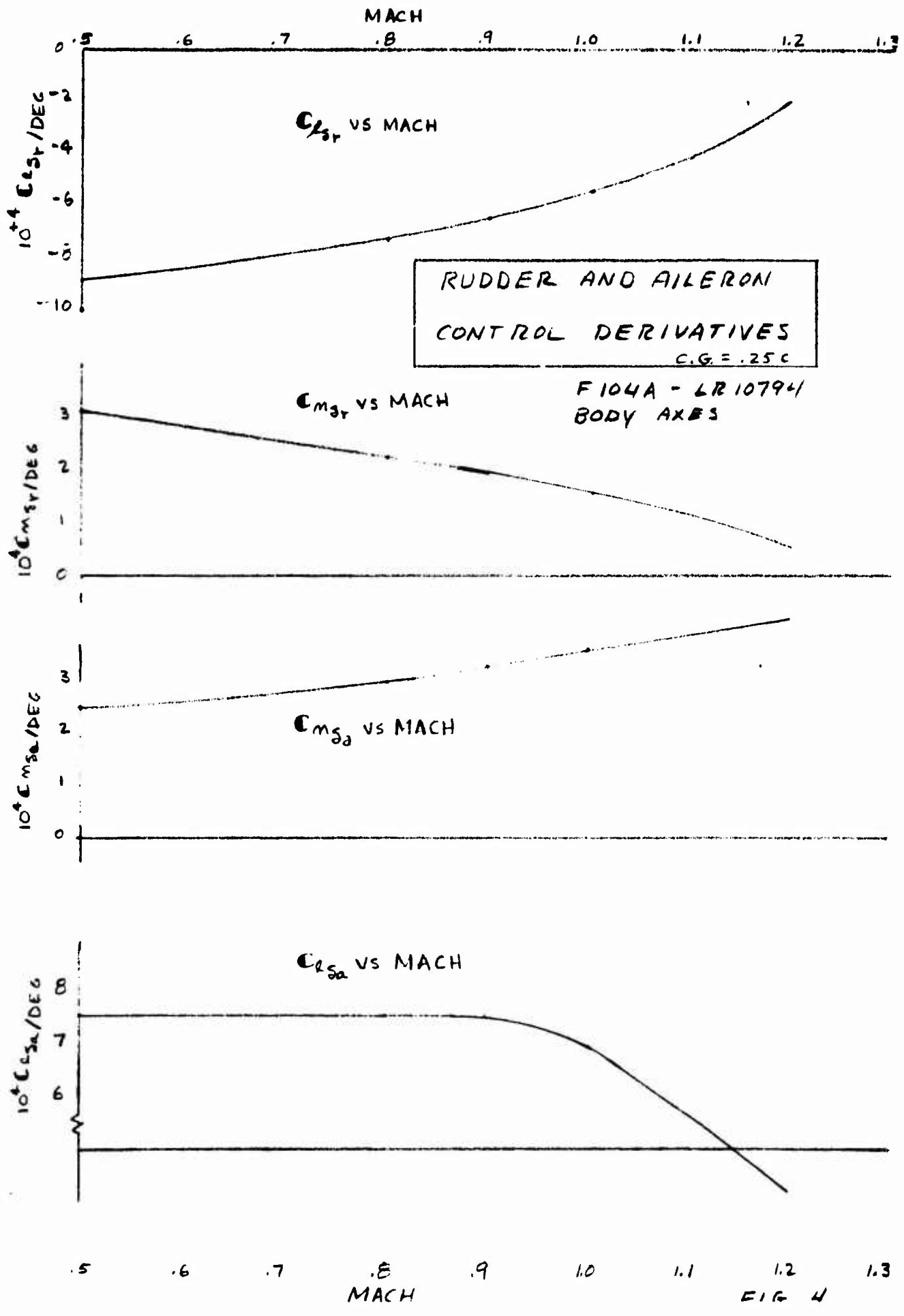
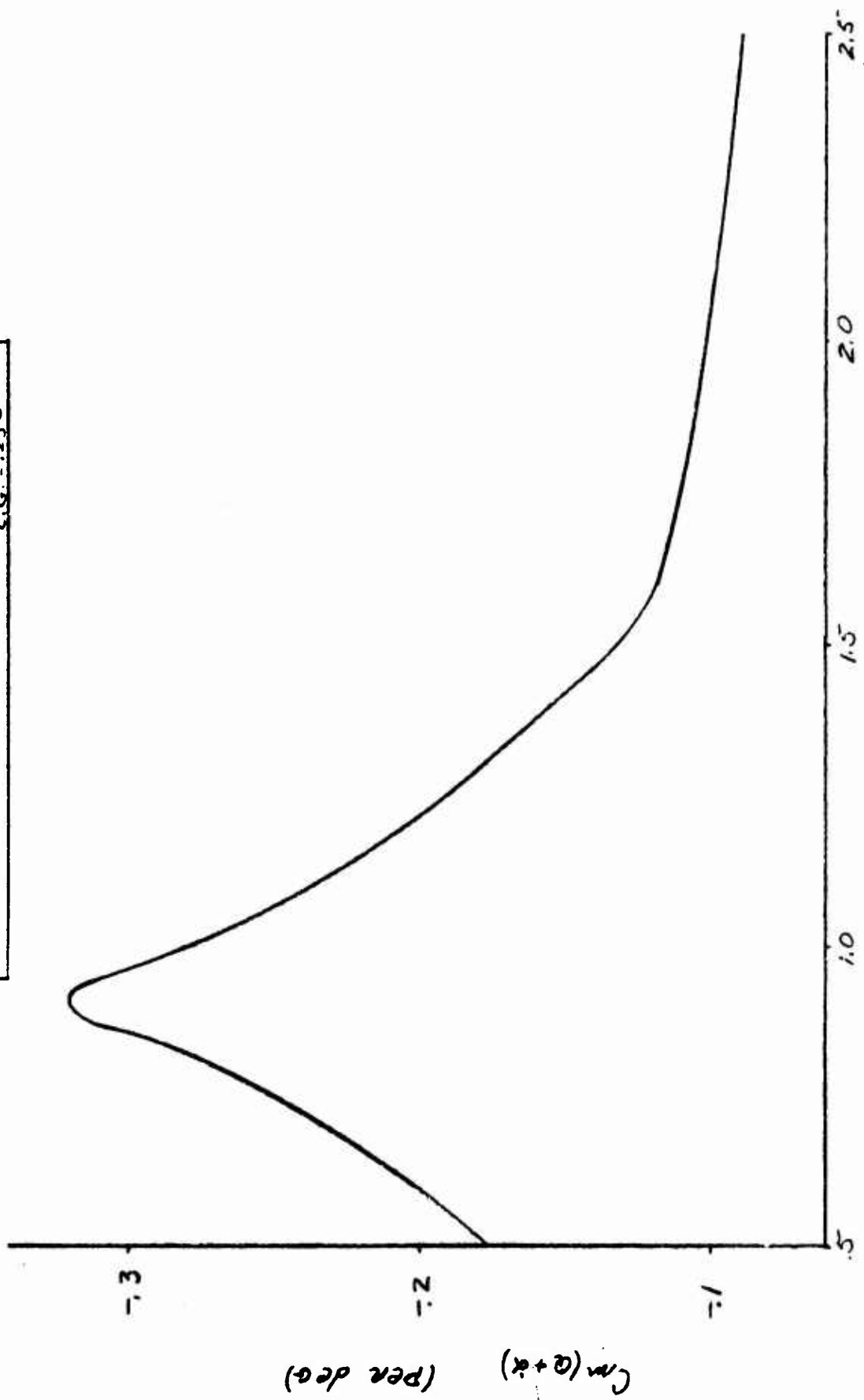


FIG 4

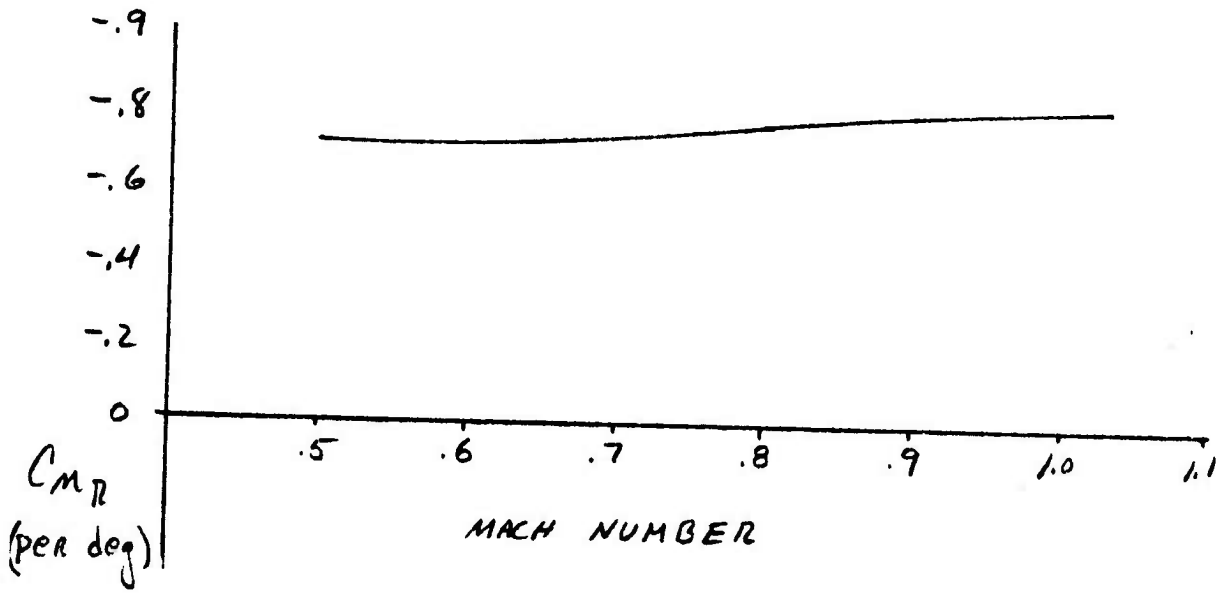
PITCH DAMPING COEFFICIENT
LR 10794
F104 A
C.S. = .25c



MACH NUMBER

FIG 5

YAW AND ROLL DAMPING FUNCTIONS
 VS
MACH NUMBER
 BODY AXES
 LR 10794 - F104A C.G. = .25C



C_{lr} WAS APPROXIMATELY CONSTANT = +.035 (per deg)

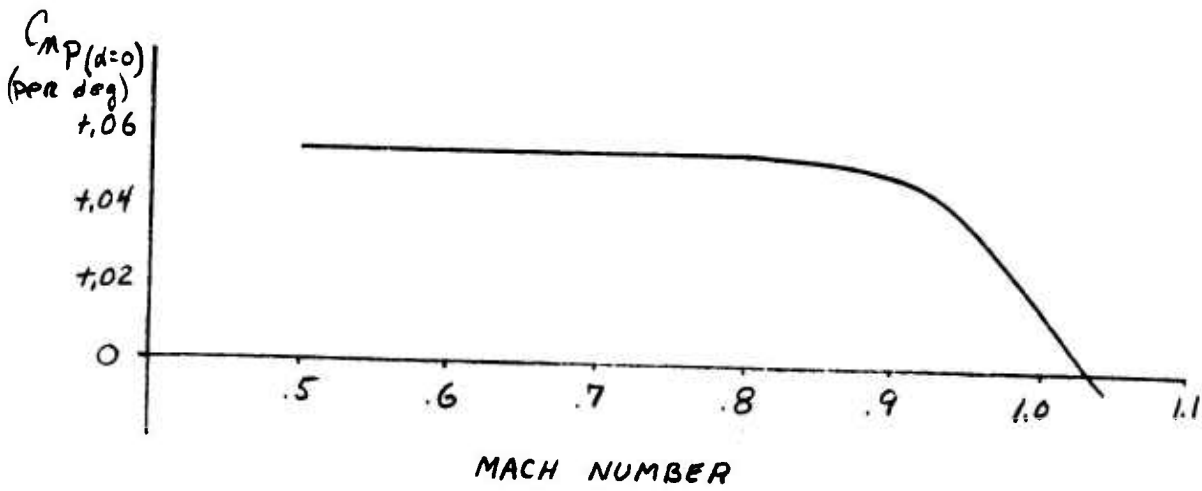
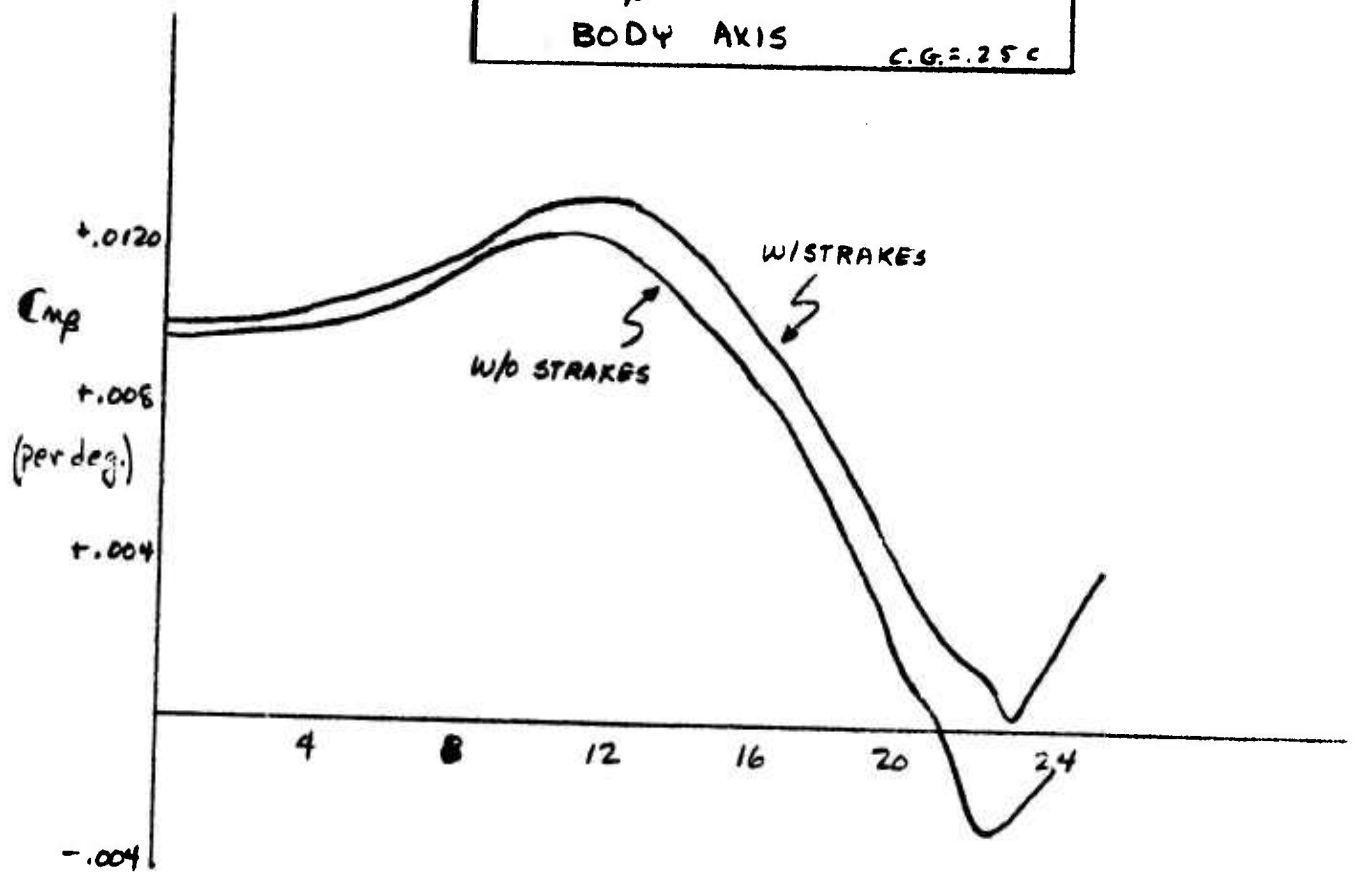


FIG 6

M=1.03 STRAKE STUDY
 LANGLEY DATA F104A
 $C_{m\beta}$ vs α
 BODY AXIS C.G.=.25c



$C_{l\beta}$ vs α
 BODY AXIS

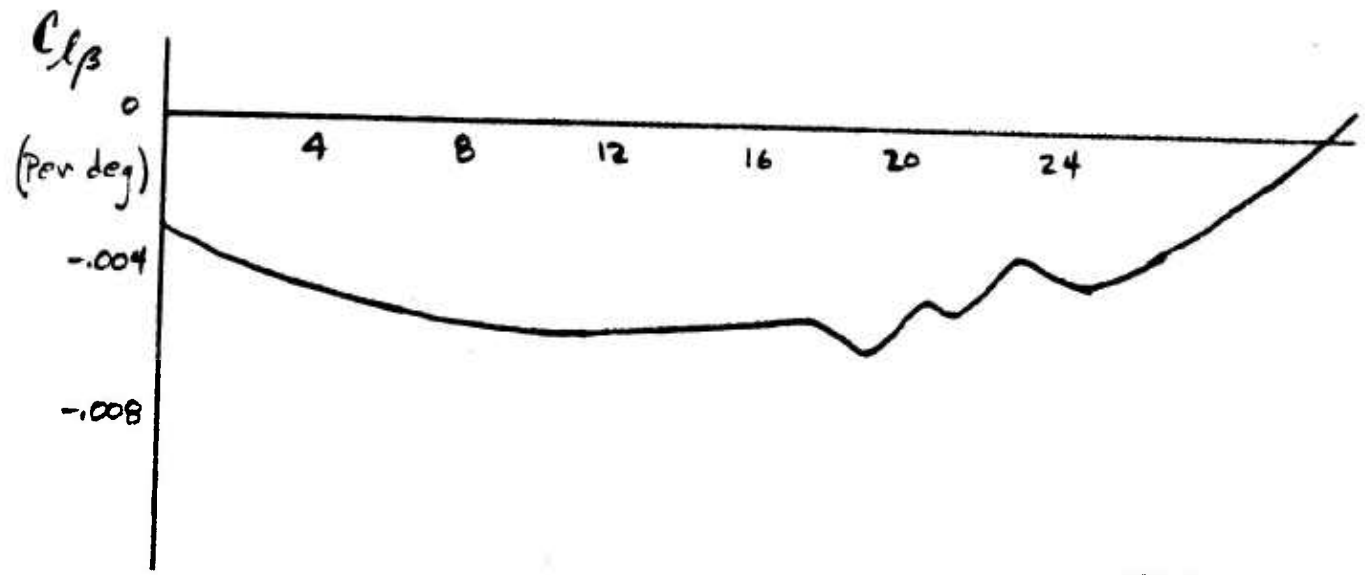
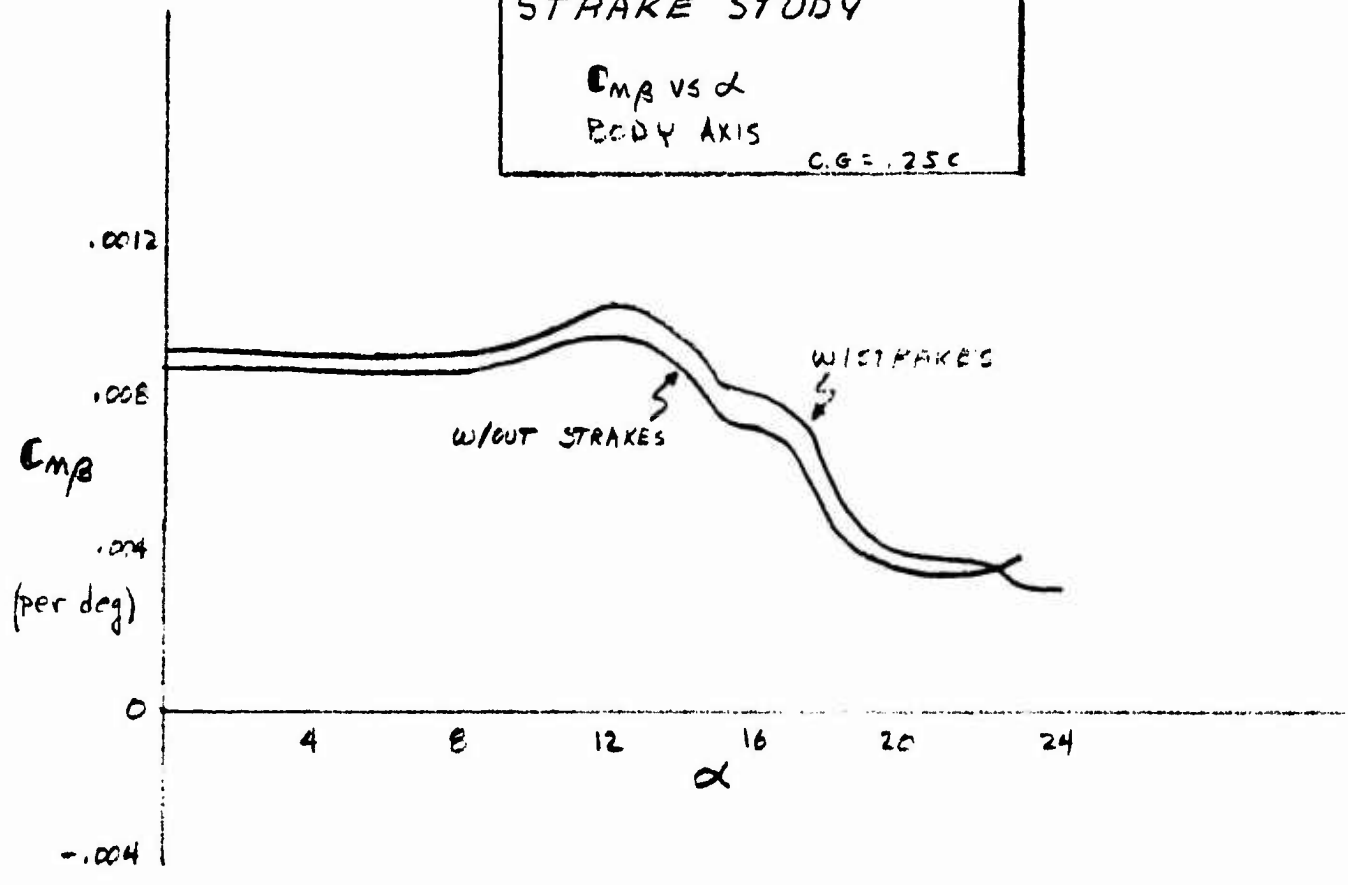


FIG 7

MACH = .9
 LANGLEY DATA - F104A
 STRAKE STUDY
 $C_{m\beta}$ vs α
 BODY AXIS
 C.G. = .25C



$C_{l\beta}$ vs α
 BODY AXIS

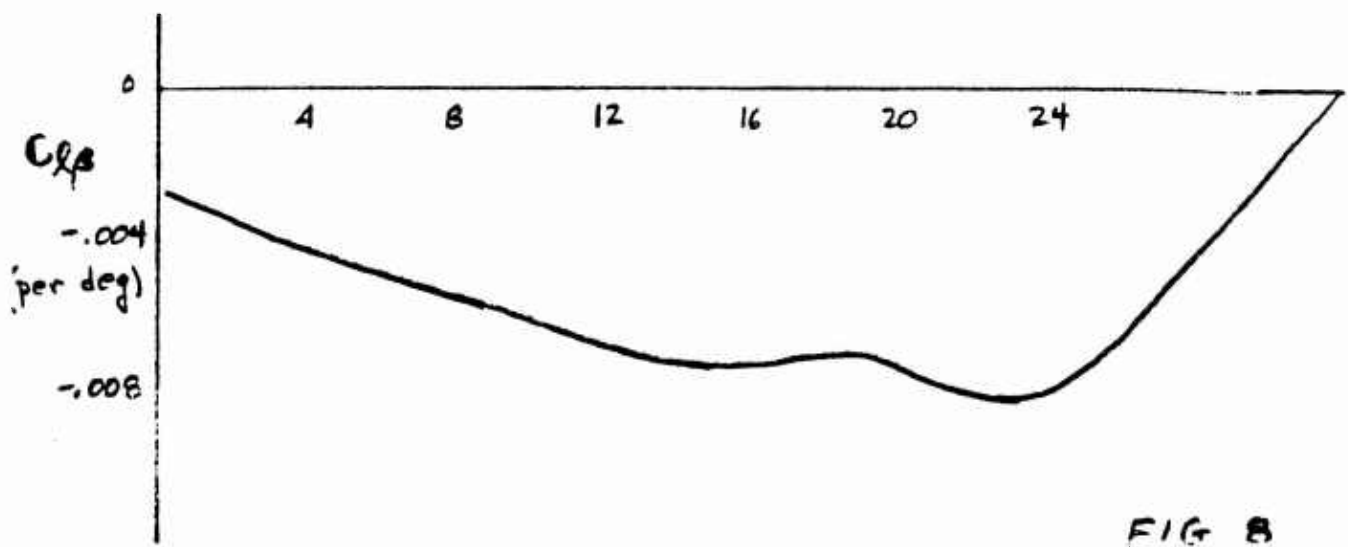
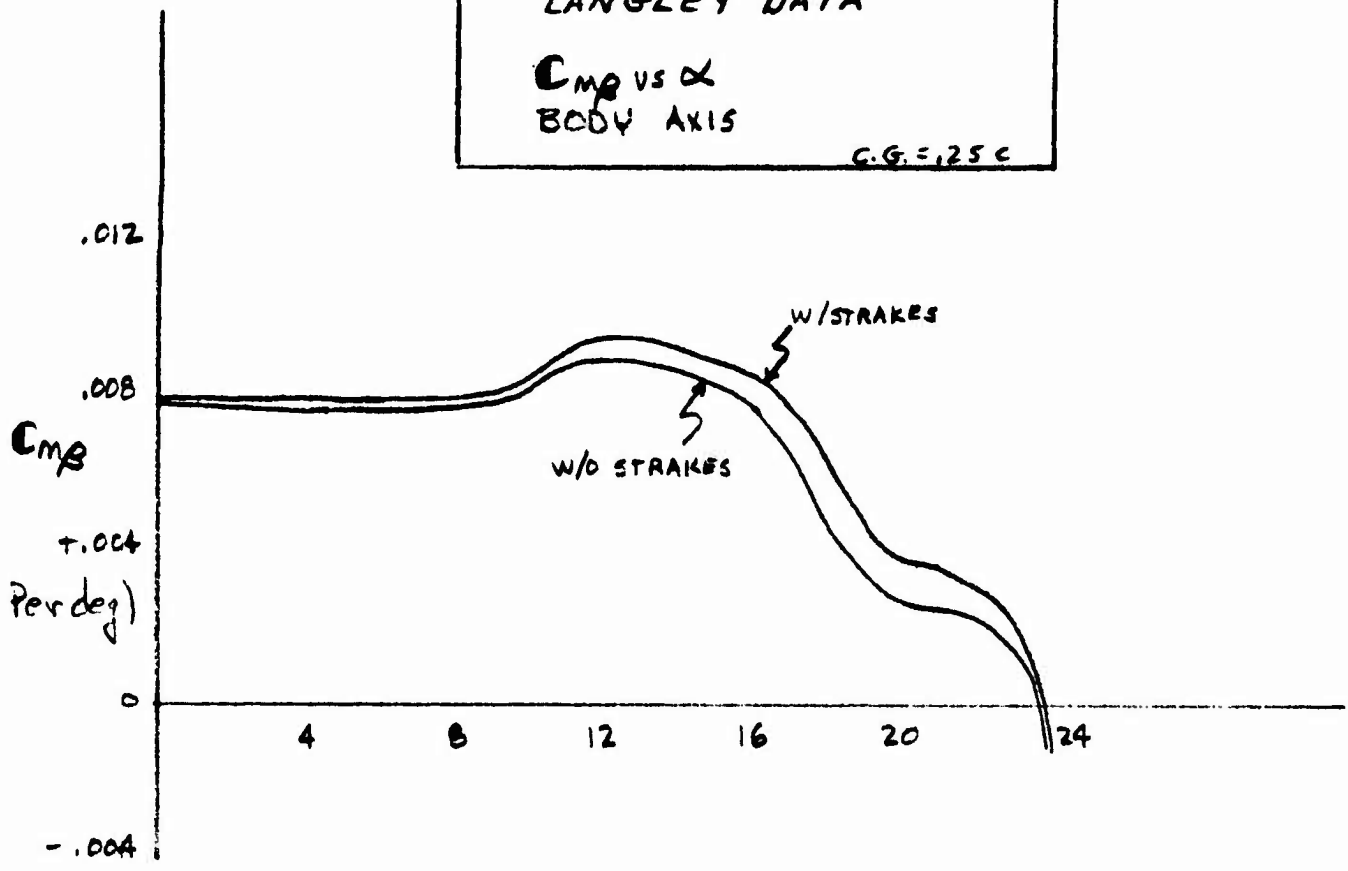


FIG 8

MACH = .8
 STRAKE STUDY F104A
 LANGLEY DATA
 $C_{m\beta}$ vs α
 BODY AXIS
 C.G. = .25 C



$C_{L\beta}$ vs α
 BODY AXIS

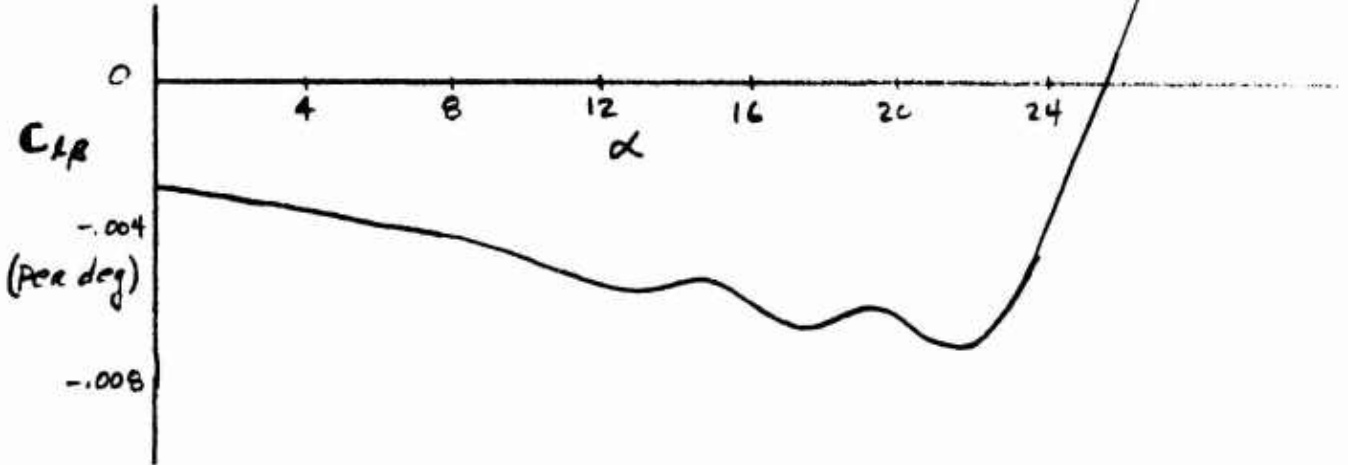
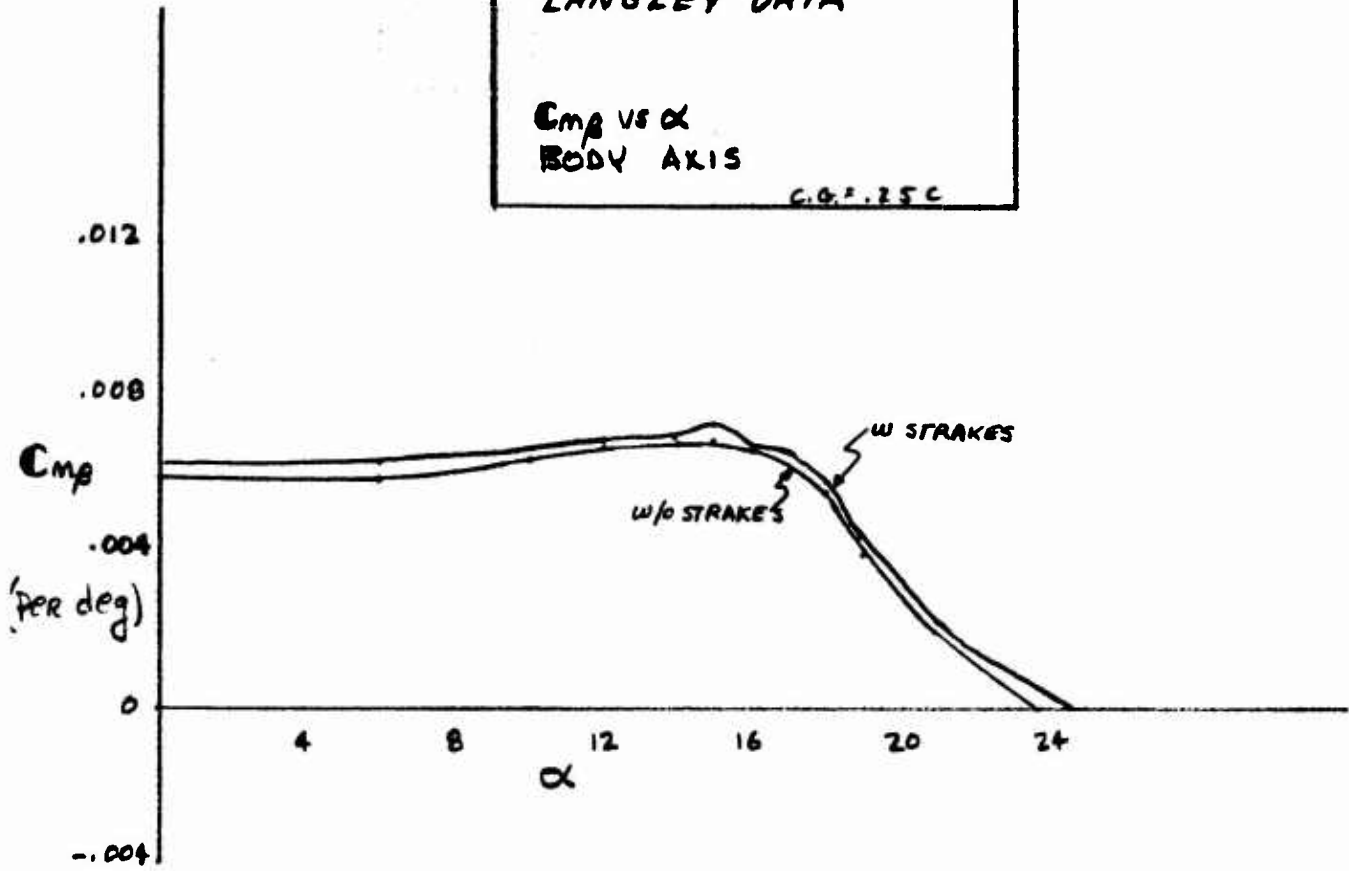


FIG 9

MACH = .5
 STRAKE AIRPLANE F104A
 LANGLEY DATA

$C_{m\beta}$ vs α
 BODY AXIS

G.O.P. 25C



$C_{l\beta}$ vs α
 BODY AXIS

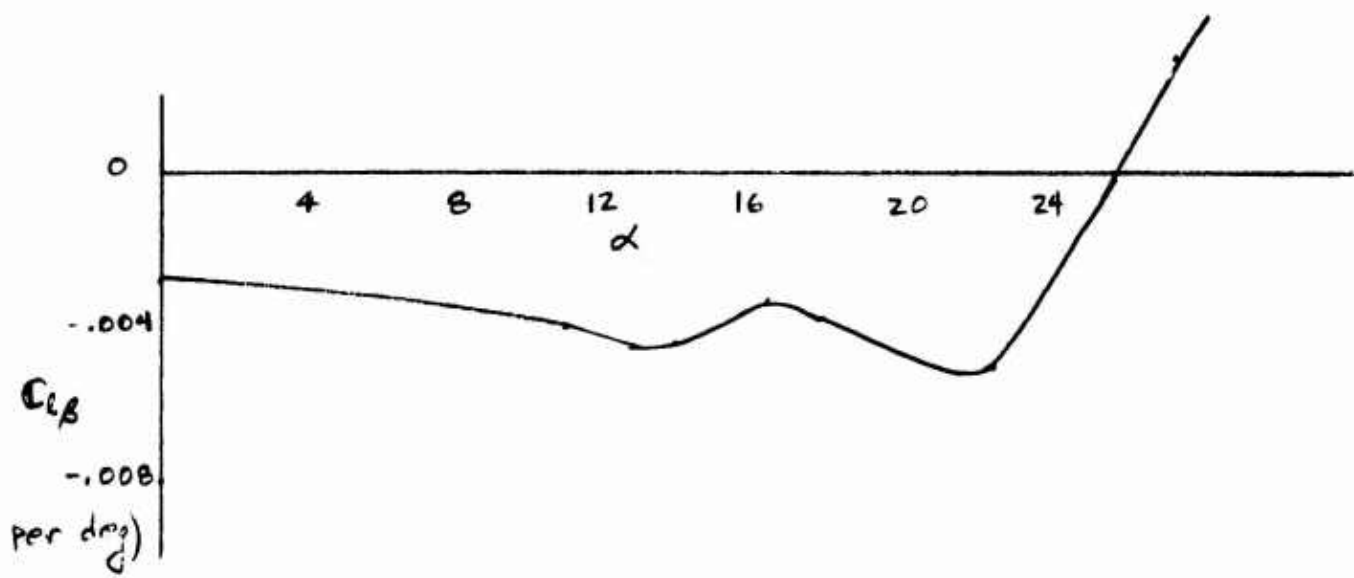


FIG 10

NF-104 FLIGHT TEST DATA
 $C_{M\beta}$ AND $C_{L\beta}$ VS MACH NUMBER
BODY AXES C.G. = .25 C
SPEED BRAKES EXTENDED

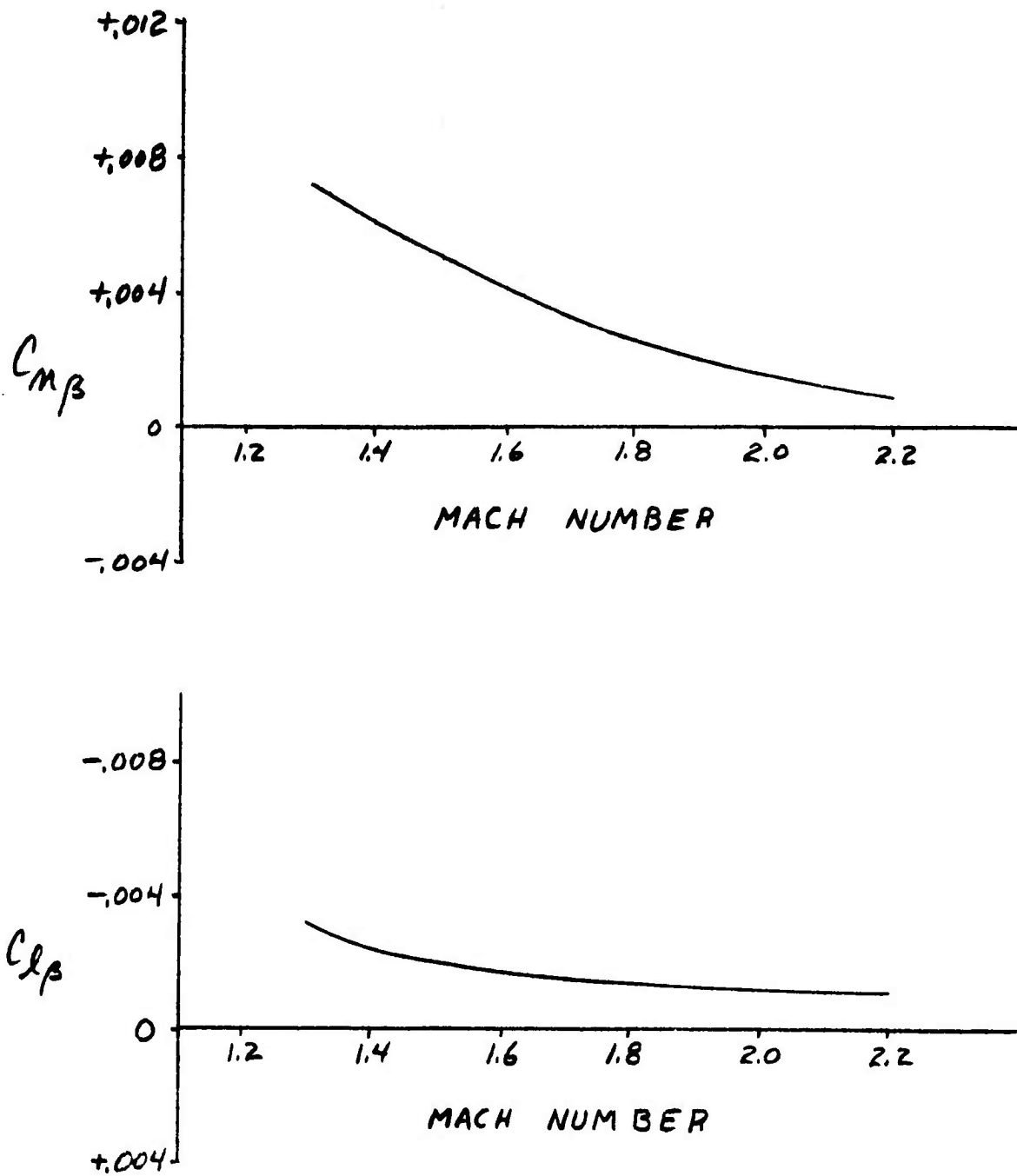


FIG 11

C_m vs α
 MACH = 1.03
 STRAKE AIRPLANE
 LANGLEY DATA F104A
 C.G. 12.5C

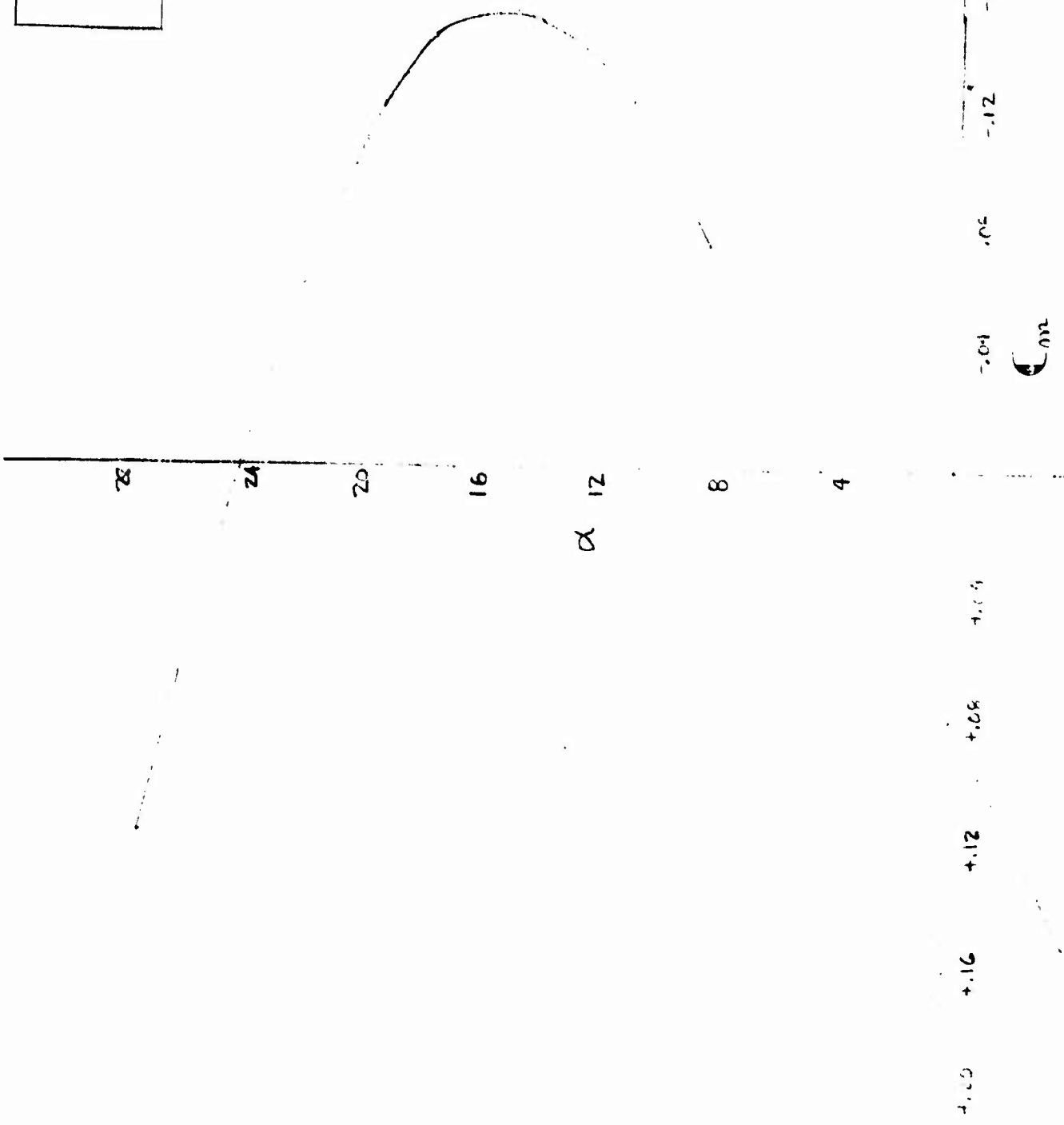


FIG 12

C_m vs α
 MACH = .7
 STRAKE AIRPLANE
 LANGLEY DATA F104A
 C.G. = .25 C

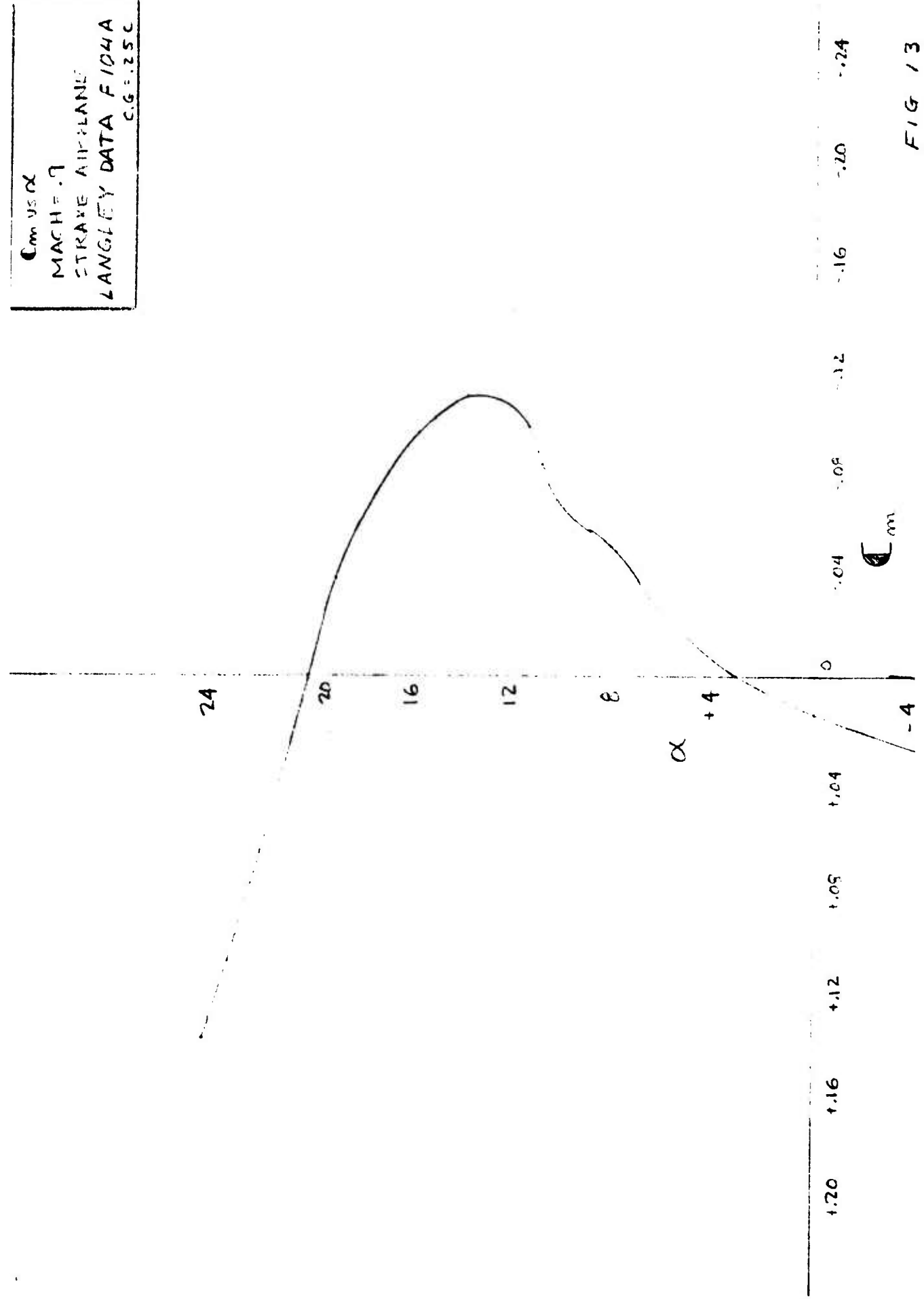


FIG 13

C_m vs α
 MACH = .8
 STRAKE AIRPLANE - F104A
 LANGLEY DATA
 C.G. F. 25 C

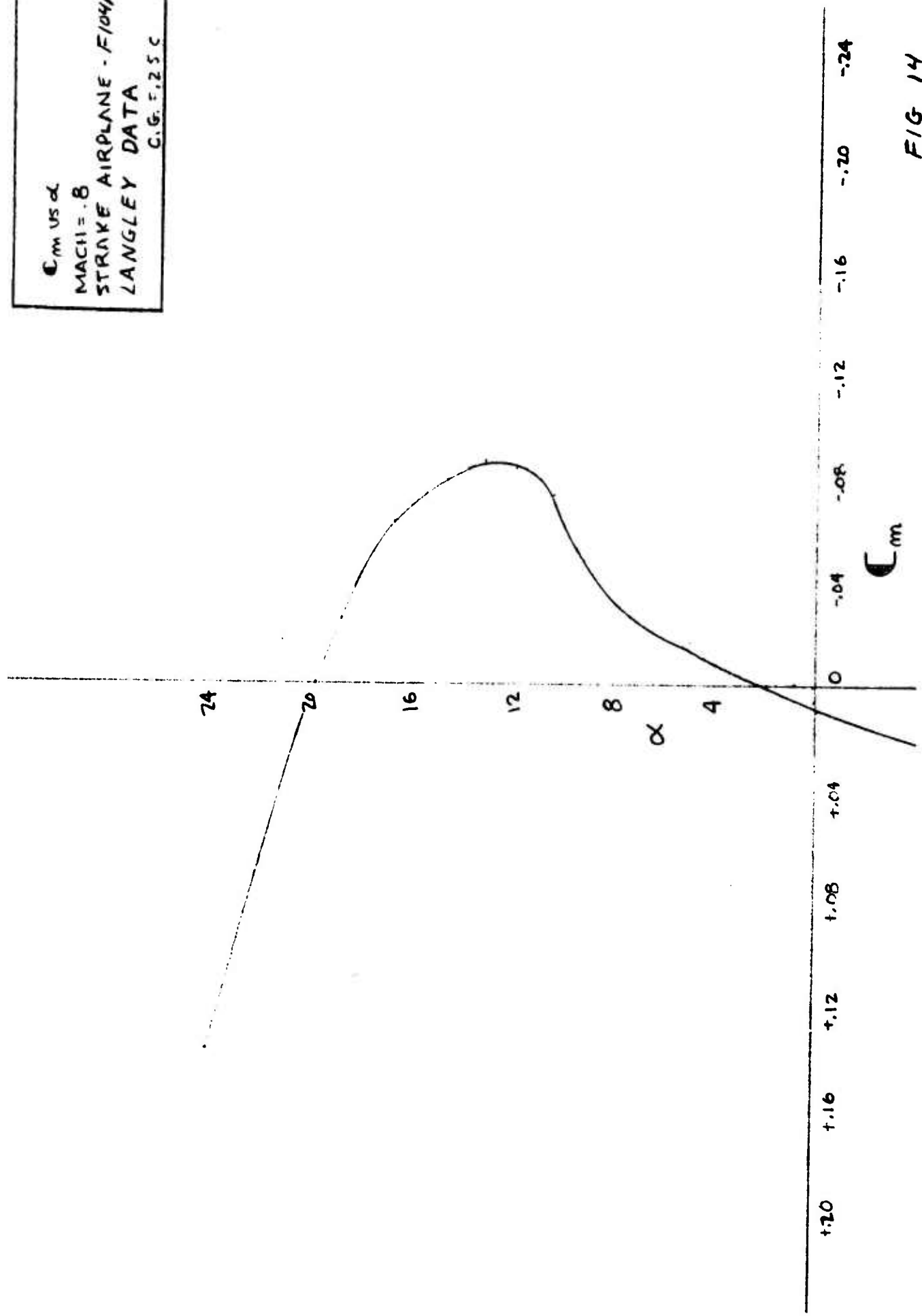


FIG 14

C_m vs α
 MACH = .5
 STRAKE AIRPLANE
 LANGLEY DATA F104A
 C.G. = .25c

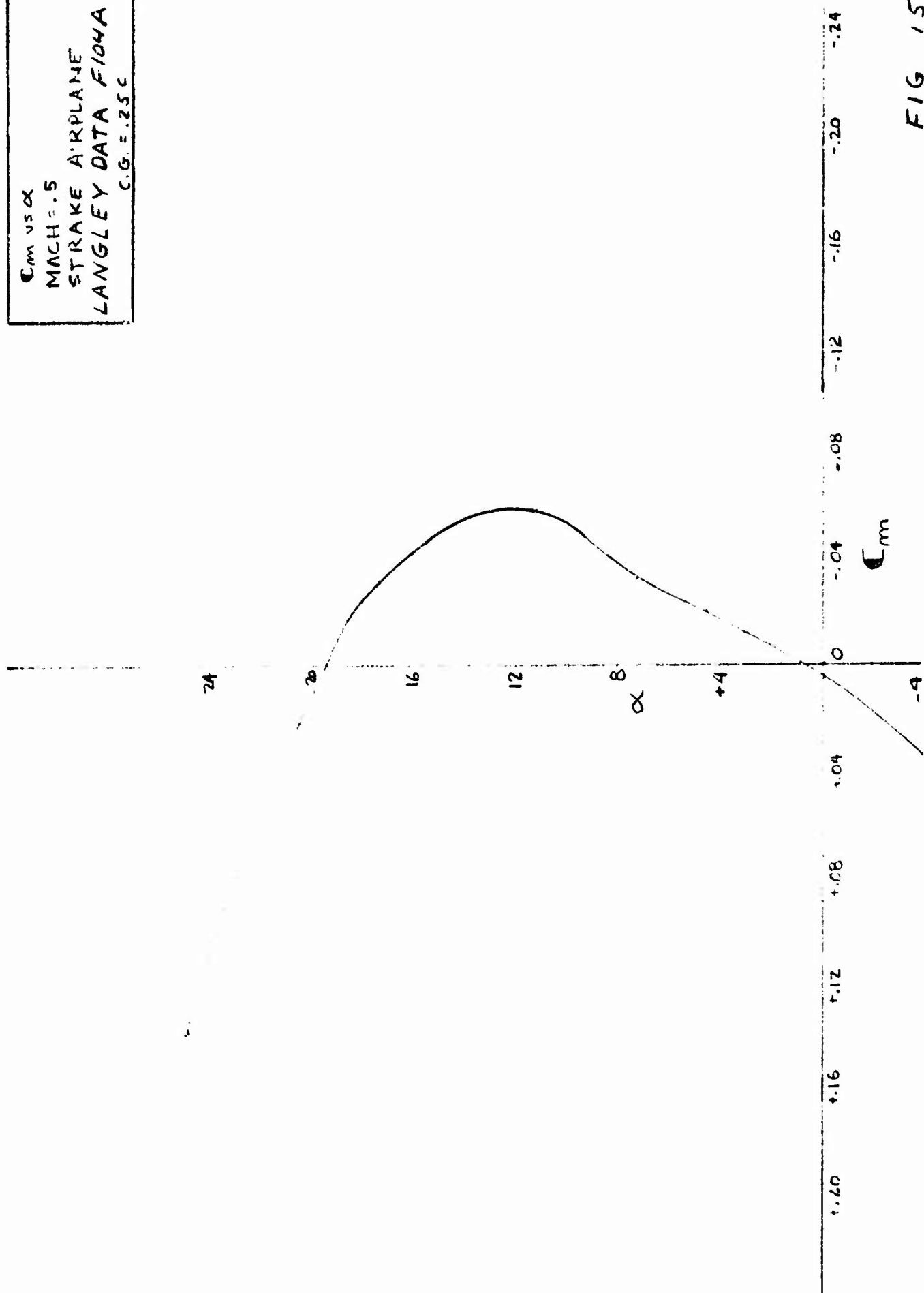


FIG 15

C_m vs α
MACH = 1.4
UPDATED LR10794
F104A
C.G.F. 25C

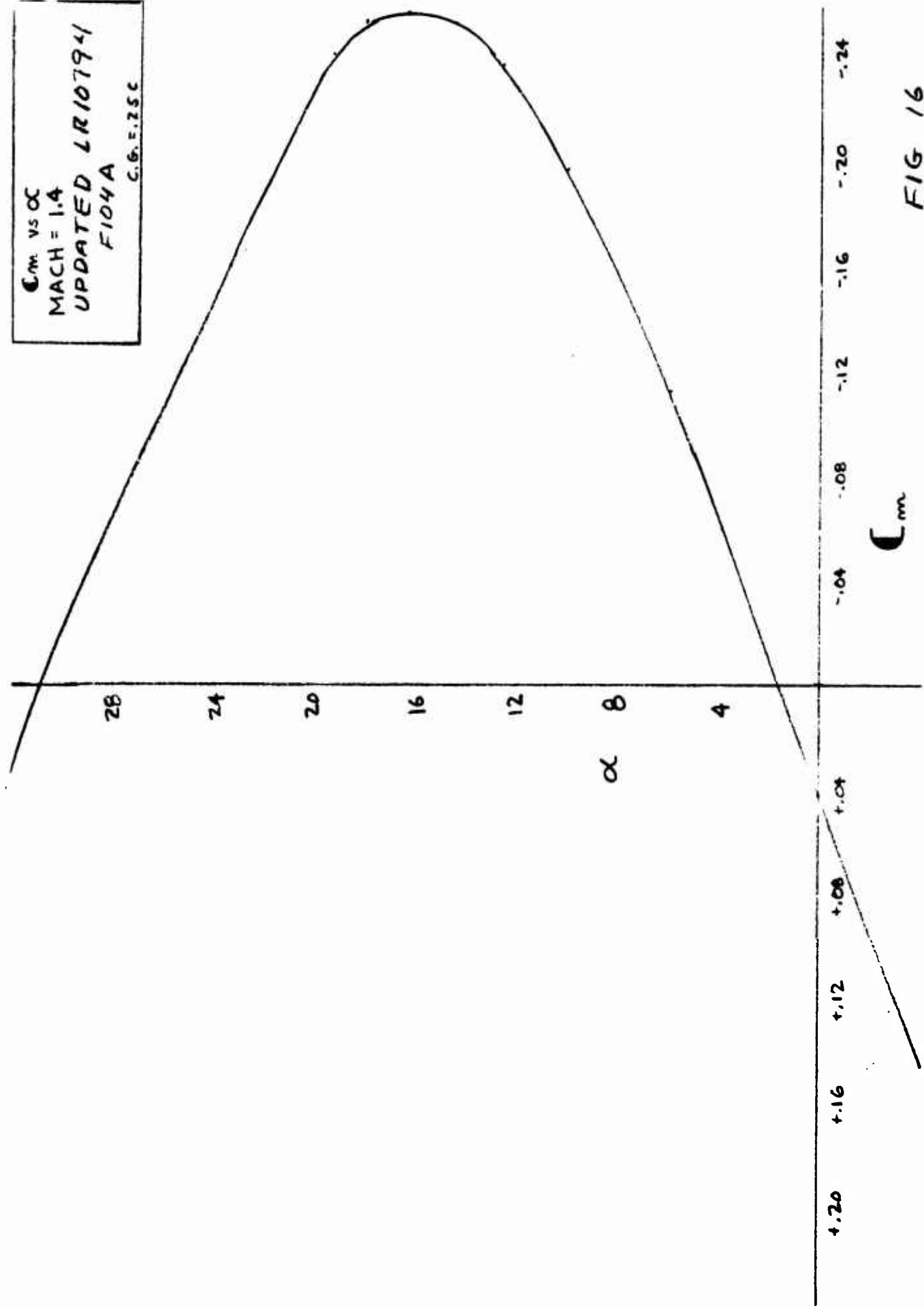


FIG 16

C_L vs α
MACH = 1.03
STRAKE AIRPLANE
LANGLEY DATA
F104A

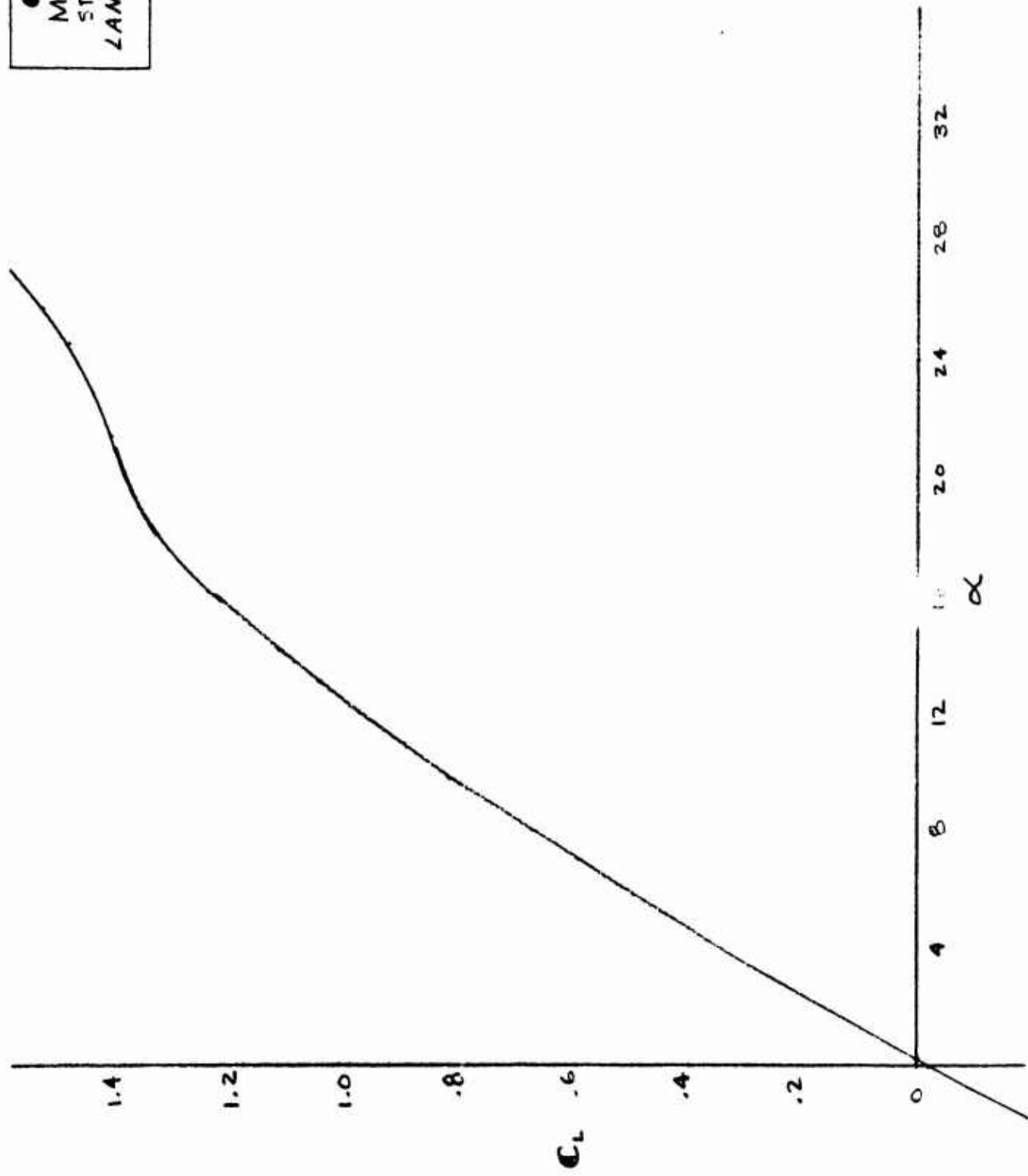


FIG 17

C_L vs α
MACH = .9
STRAKE AIRPLANE
LANGLEY DATA
F104A

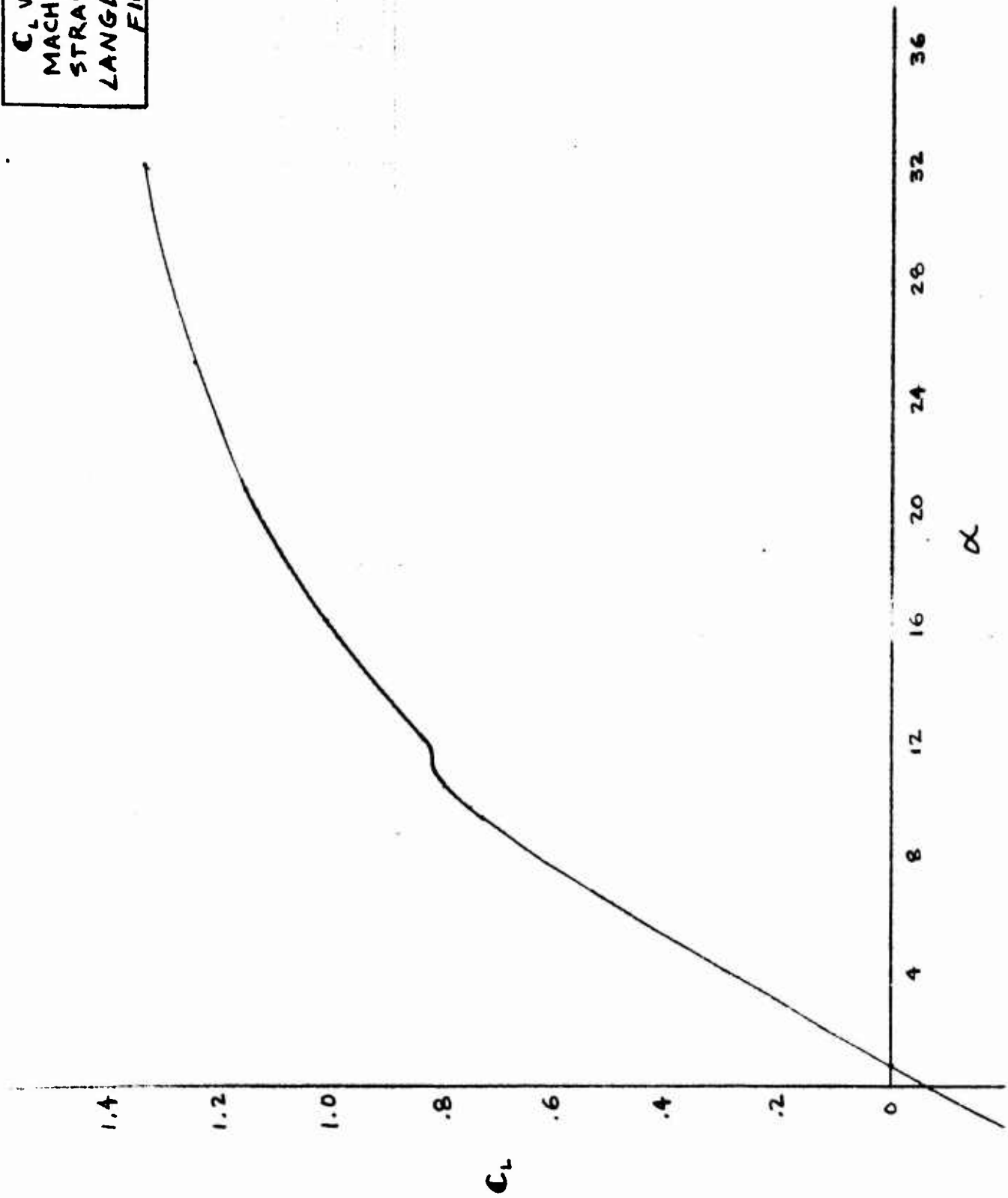


FIG 18

64

67

C_L vs α
MACH = .8
STRAKE AIRPLANE
LANGLEY DATA
F104A

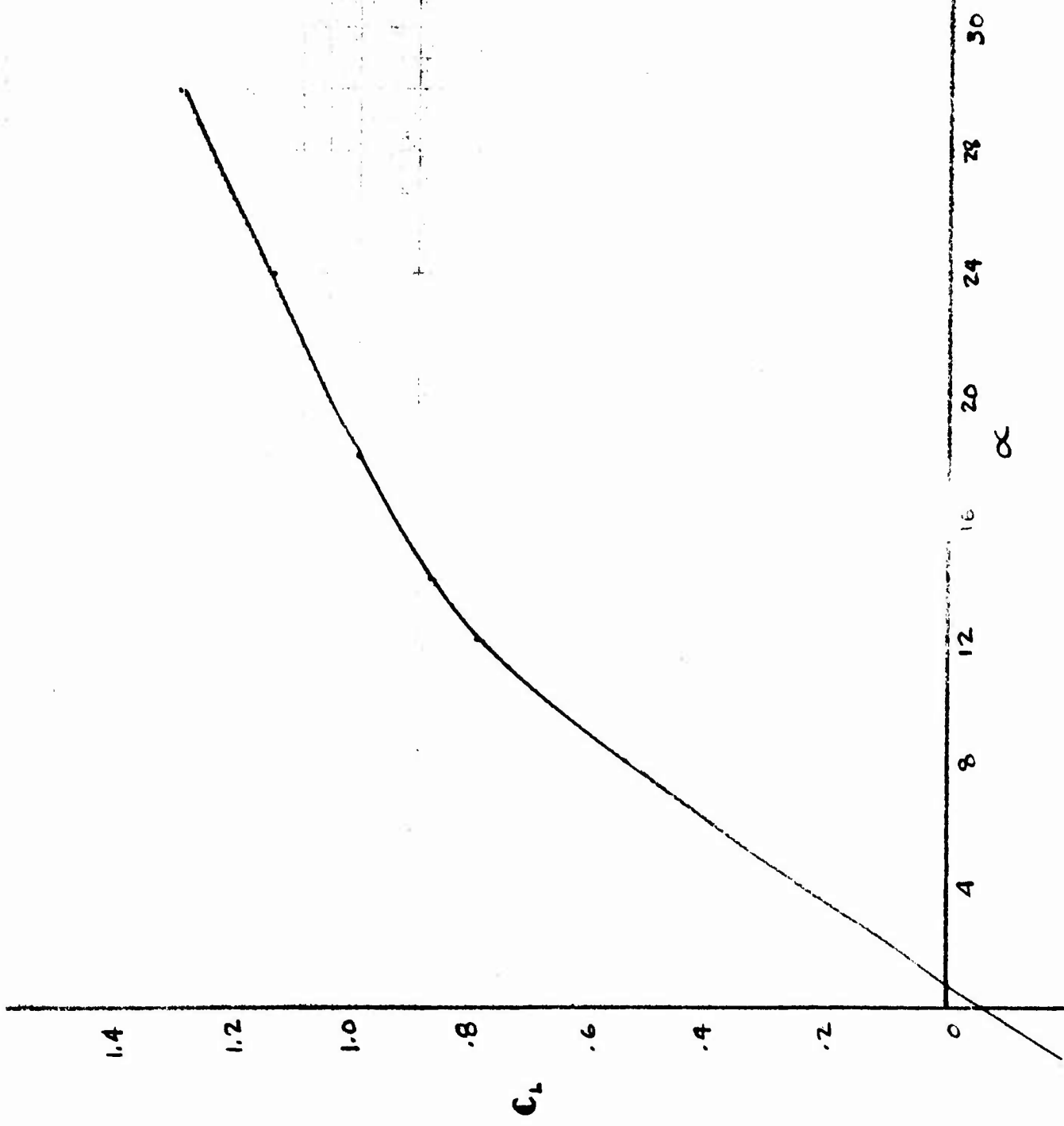
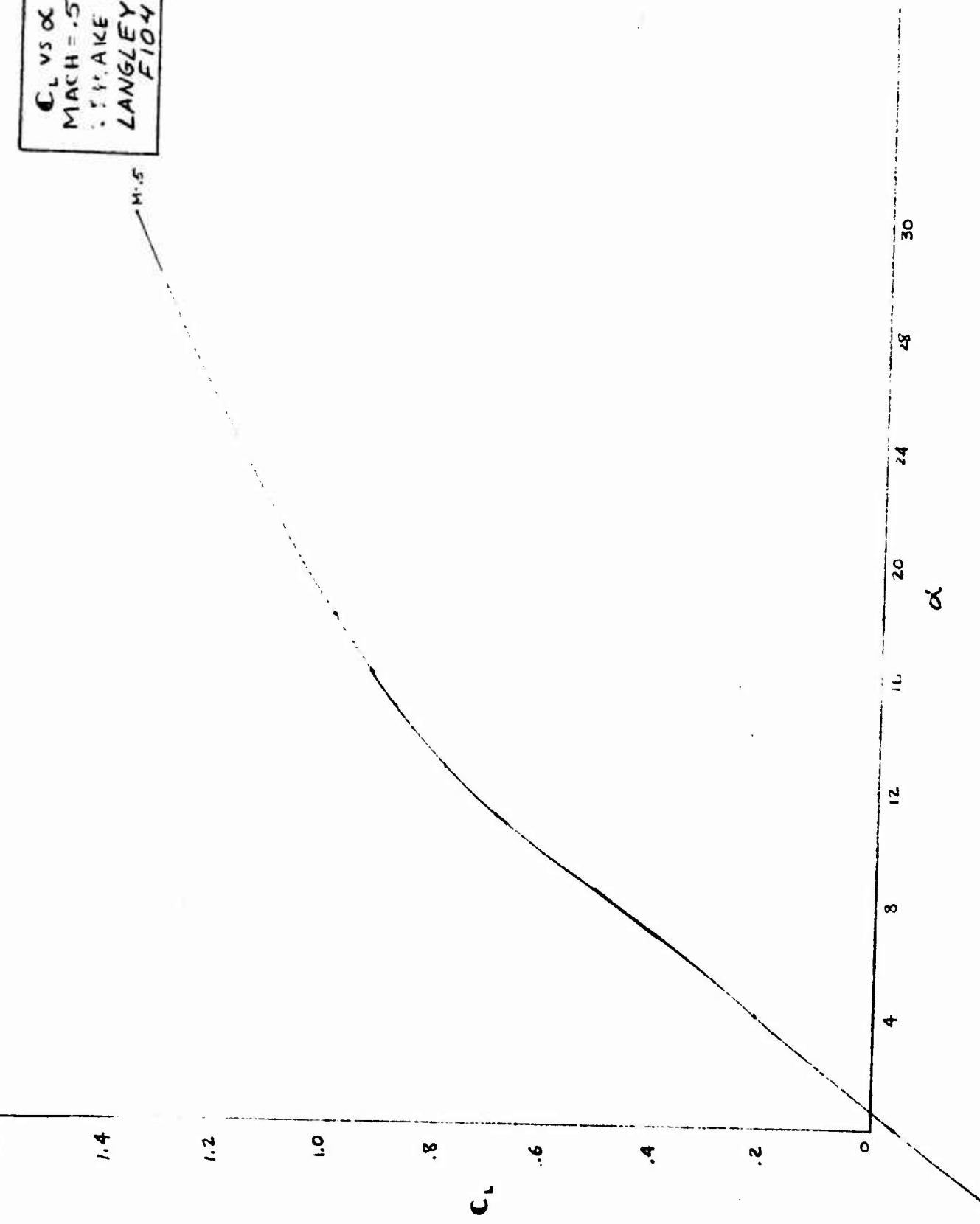


FIG 19



C_L vs α
 MACH = .5
 F104 AIRPLANE
 LANGLEY DATA
 F104 A

FIG 20

C_L VS α
MACH = 1.4
F104A
UPDATED CR10794

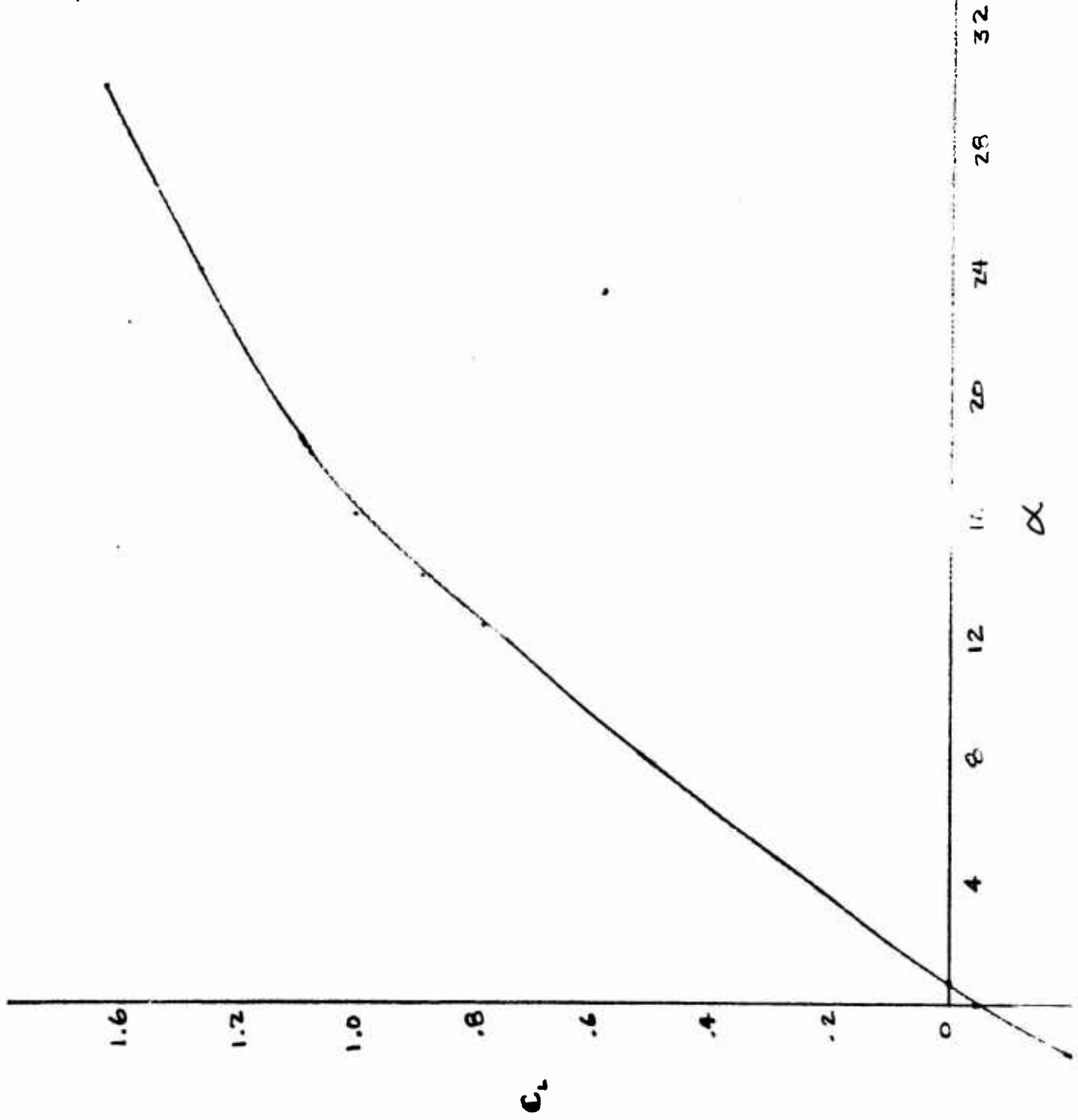


FIG 21

C_D VS α

F104A

ALL MACH NOS.

5 DEGREE SIMULATION ONLY

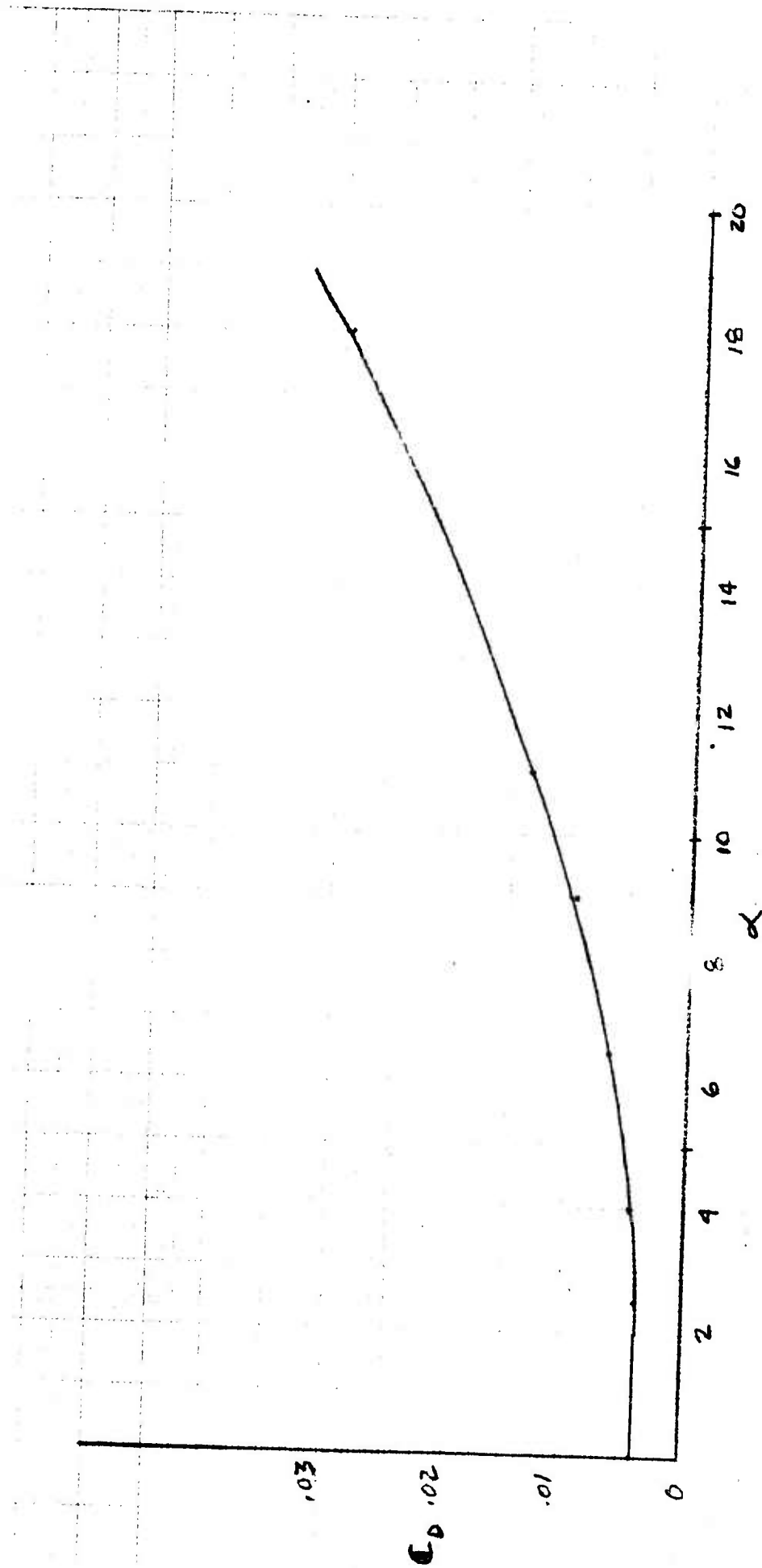


FIG 22

PITCHING MOMENT COEFFICIENT
 NF 104 DATA AT $\alpha < 22^\circ$
 C.G. = 25.6

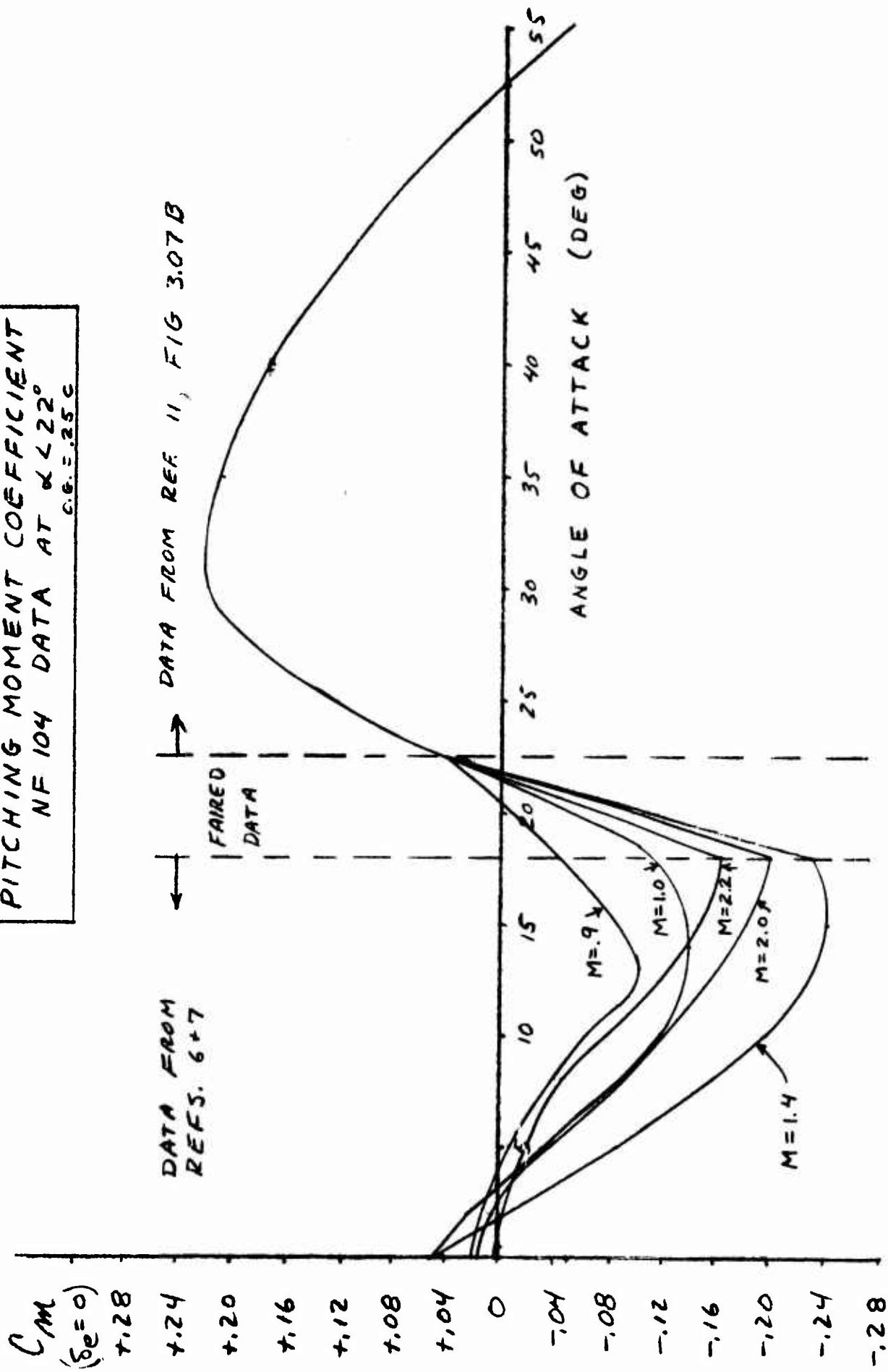


FIG 23

LIFT CURVE SLOPE, $C_{L\alpha}$ vs MACH NUMBER DATA

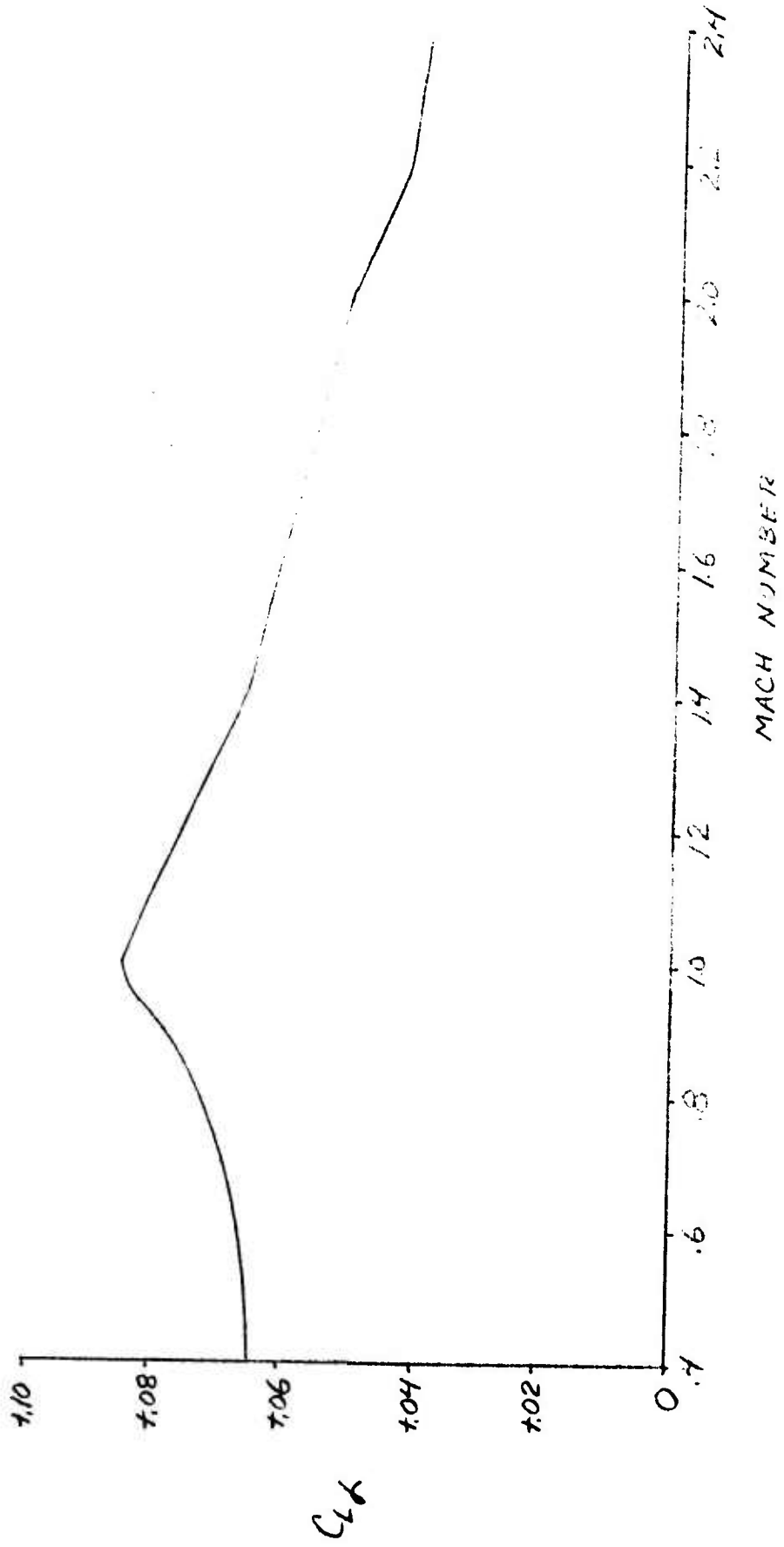


FIG 2-1

ZERO LIFT DRAG NF 1041
MACH^{VS} NUMBER

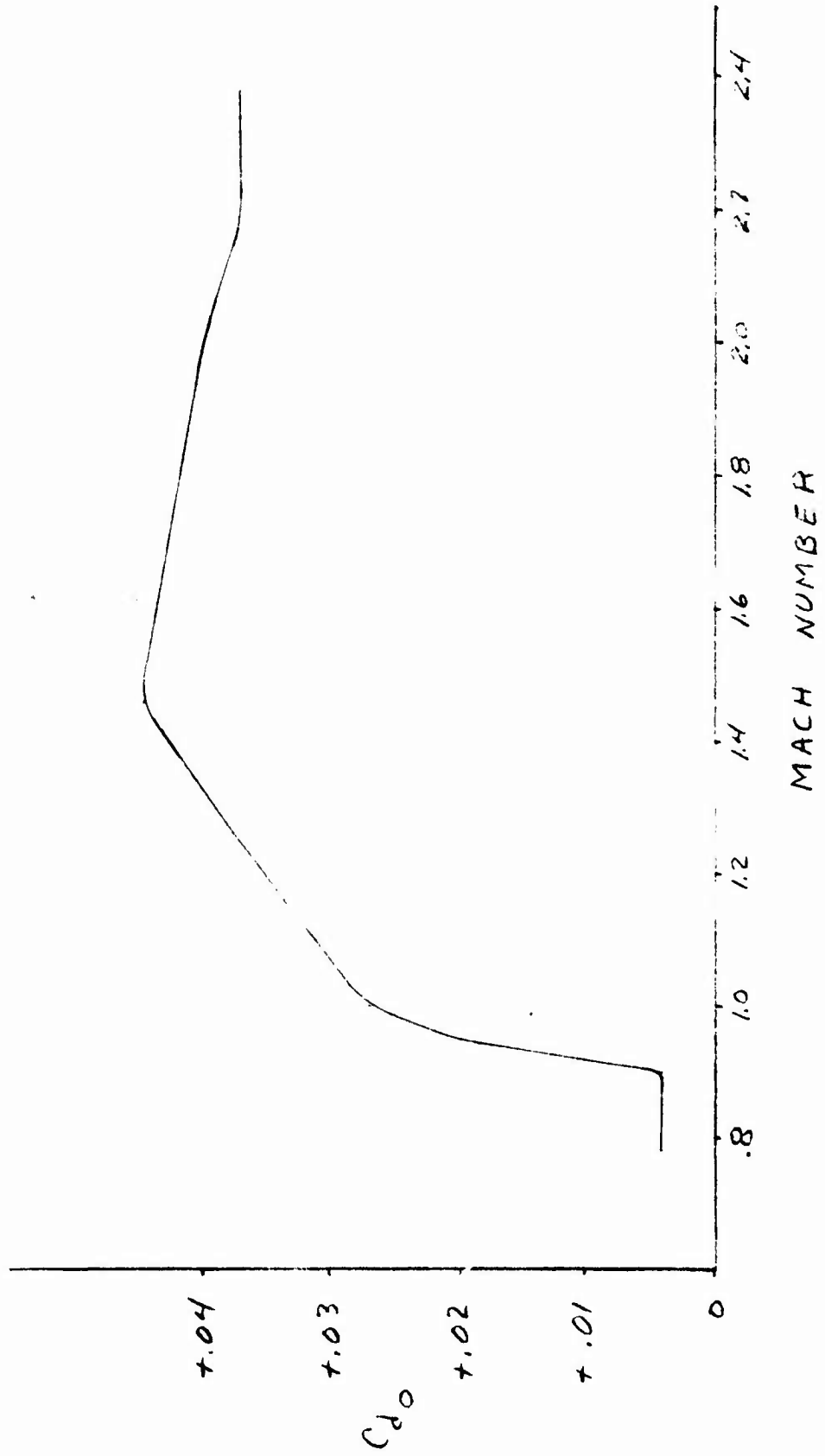


FIG 25

NF104 DATA
 DRAG SLOPE
 $\frac{\partial C_D}{\partial C_L}$ VS MACH

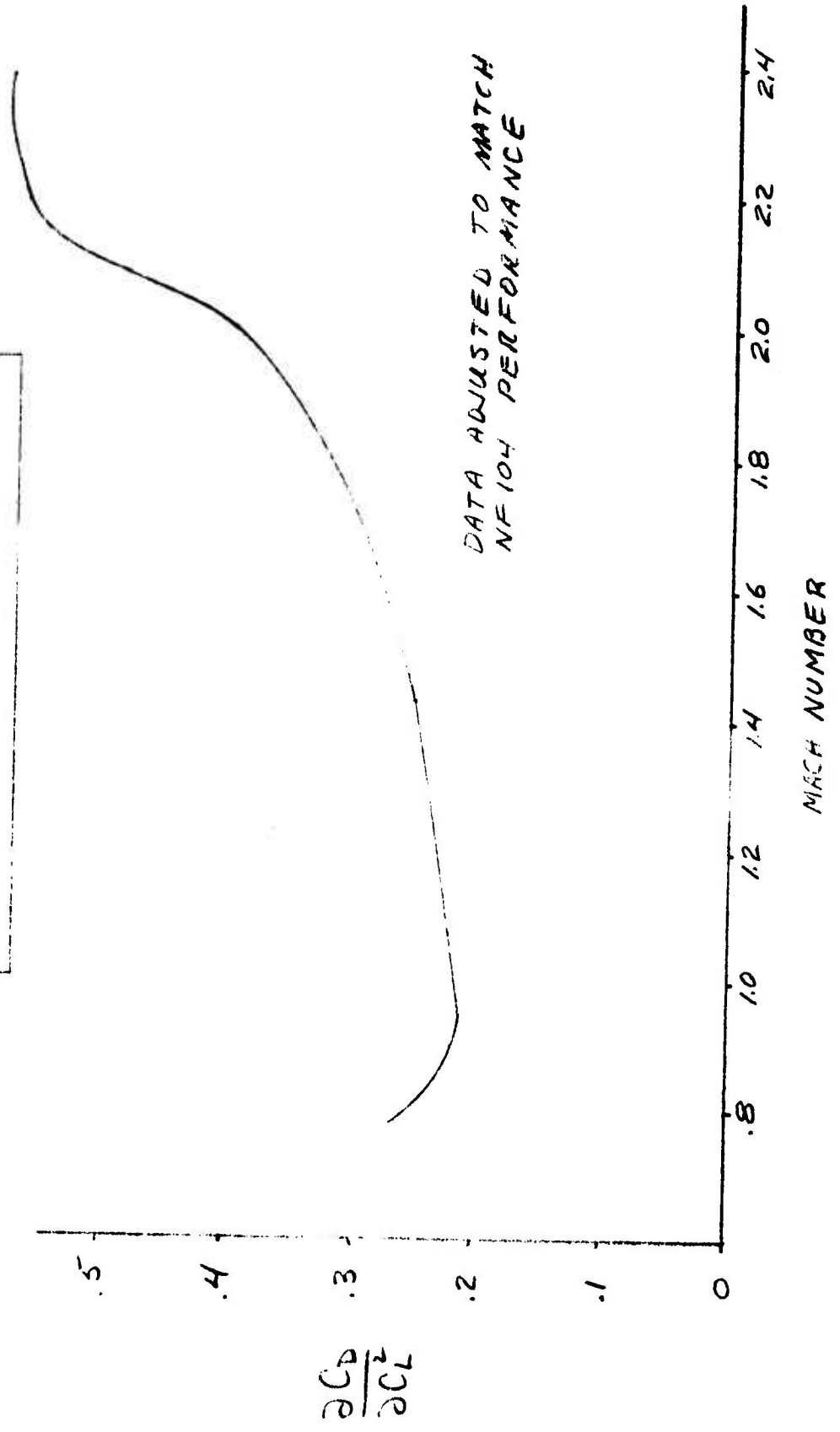


FIG 26

ANALOG THRUST GENERATION
 THRUST SLOPE $\left(\frac{\Delta T_J}{\Delta h}\right)$ VS MACH
 $T_J = \left(\frac{\Delta T_J}{\Delta h}\right)(h - 72,000) + \Delta T_J$
 $h < 72,000$ ft
 STANDARD DAY

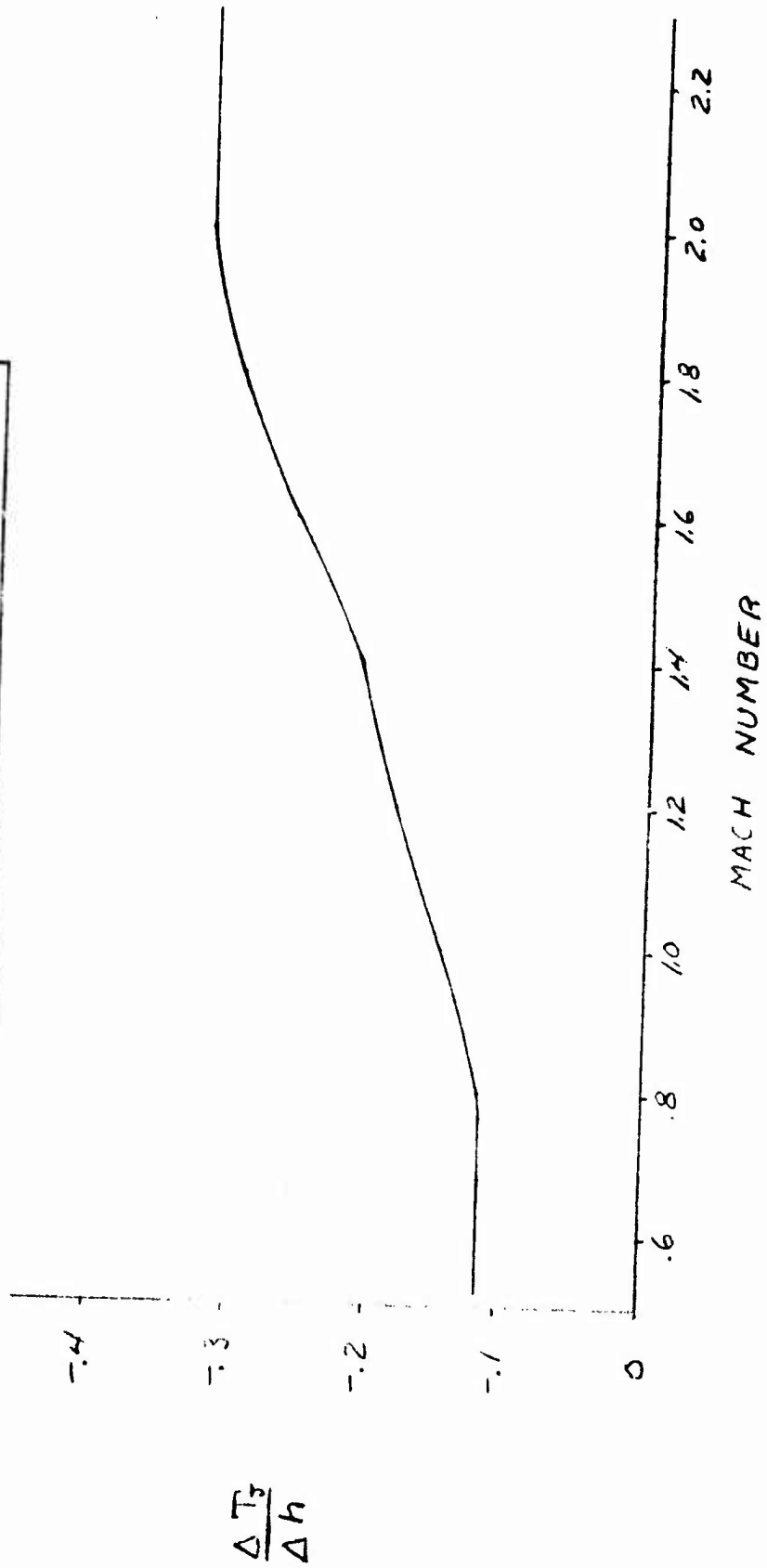


FIG 27

ANALOG THRUST GENERATION

Δ THRUST VS. ALTITUDE

$$T_c = \left(\frac{\Delta T_j}{\Delta h} \right) (h - 72,000) + \Delta T_j$$

$h < 72,000$

STANDARD DA /

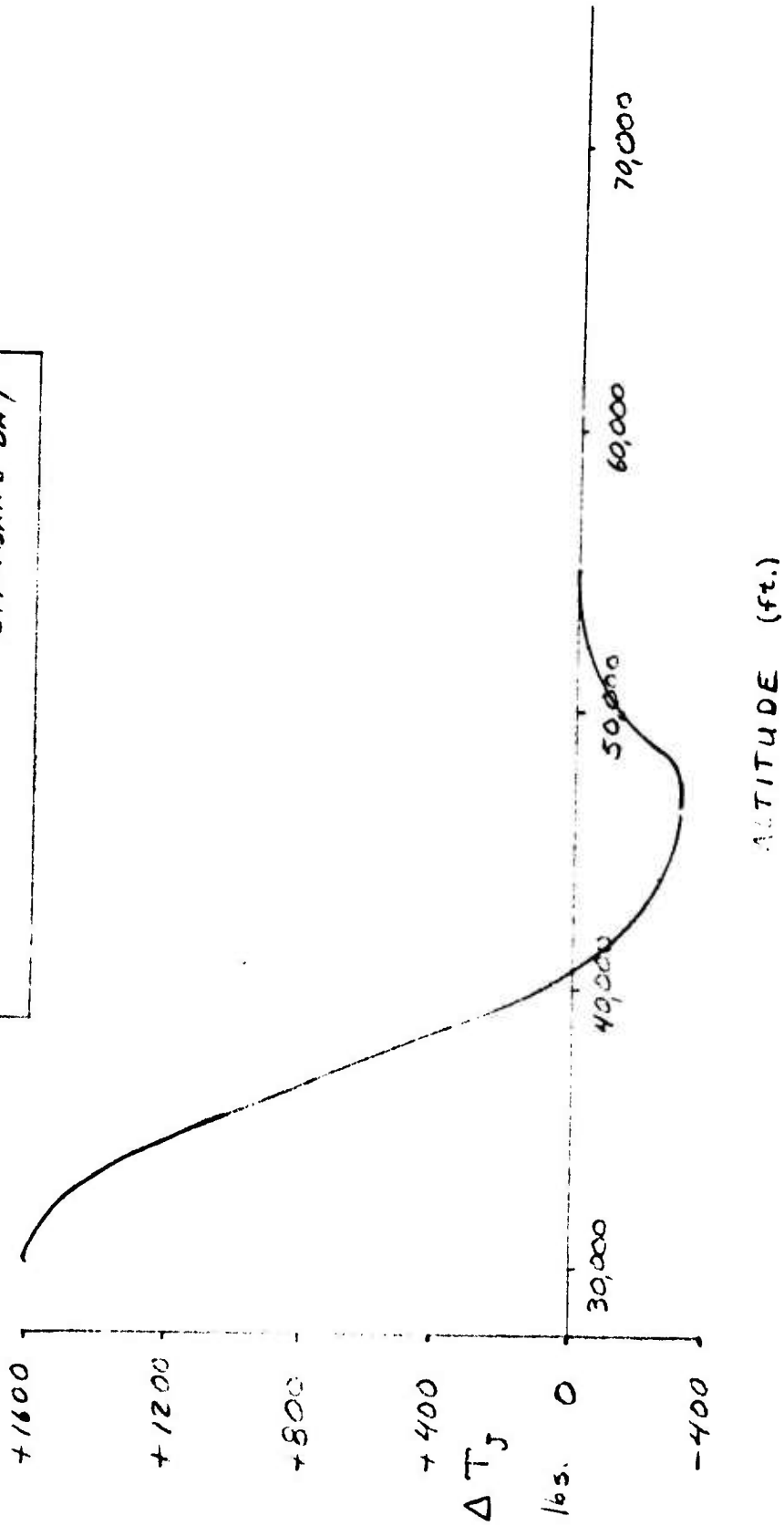
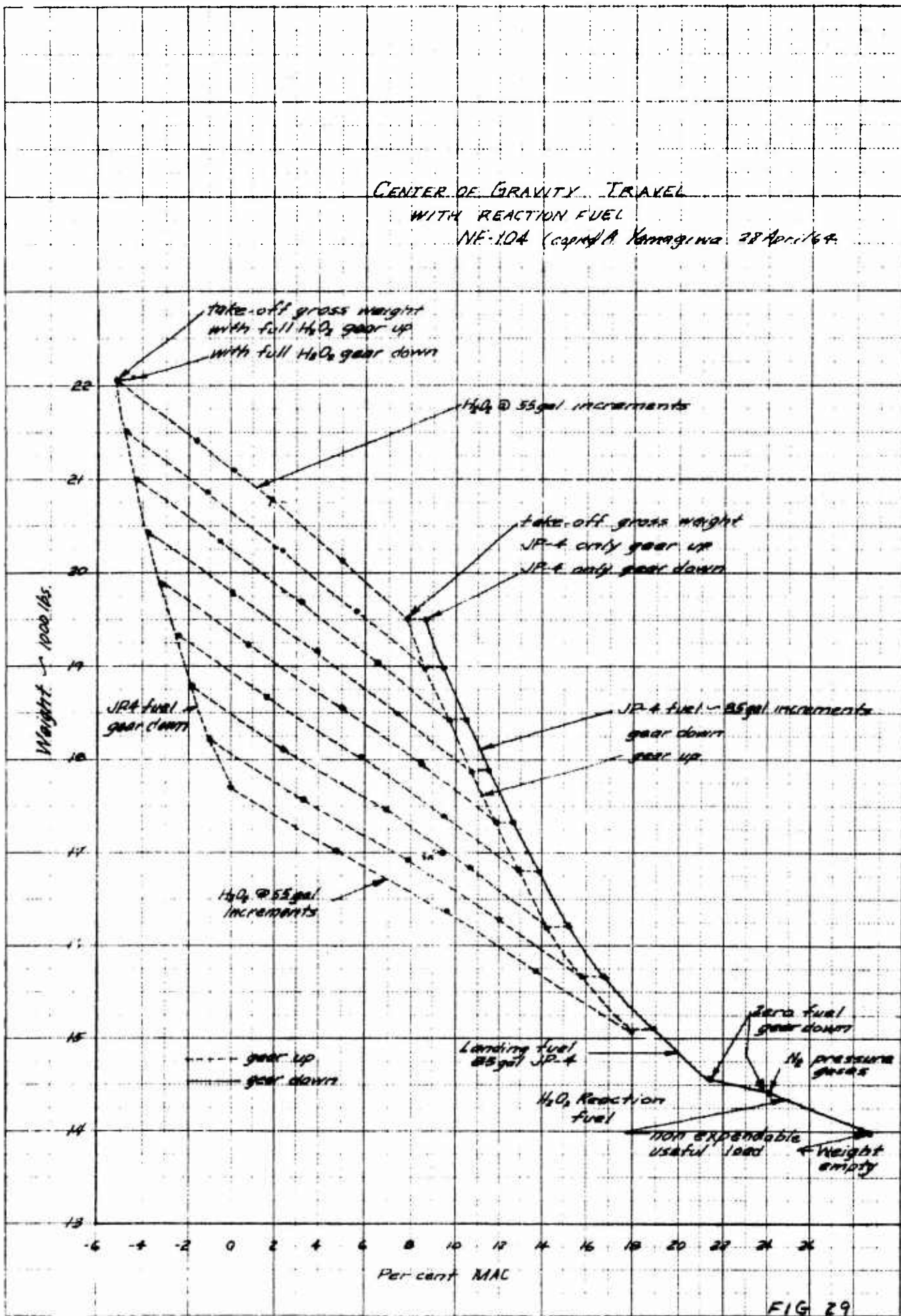


FIG 28

CENTER OF GRAVITY TRAVEL
 WITH REACTION FUEL
 NE-104 (copy) A Yamaguchi 28 April 64



CENTER OF GRAVITY TRAVEL
 WITHOUT REACTION FUEL
 NF-104 *copied by A. Kampman*

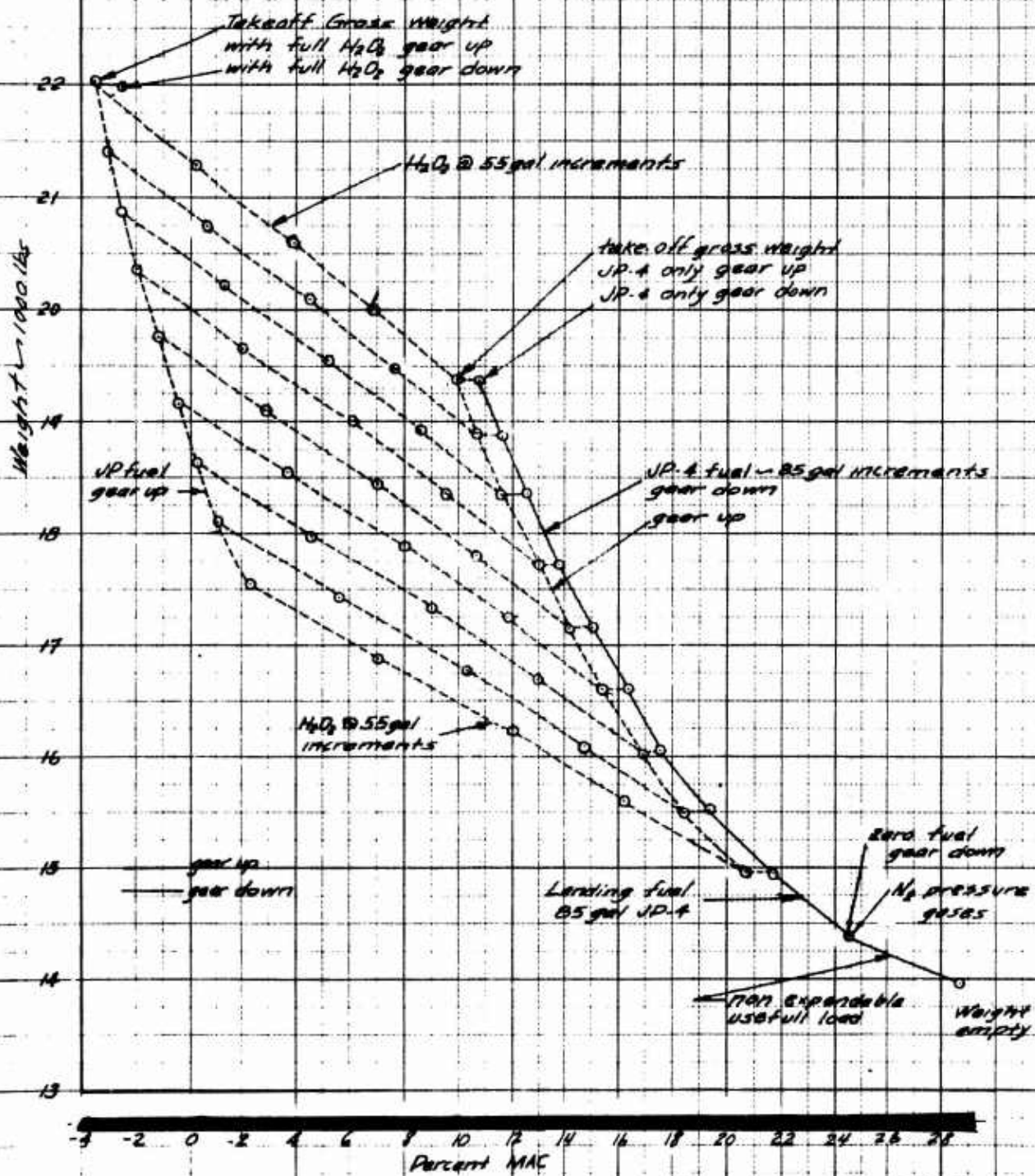
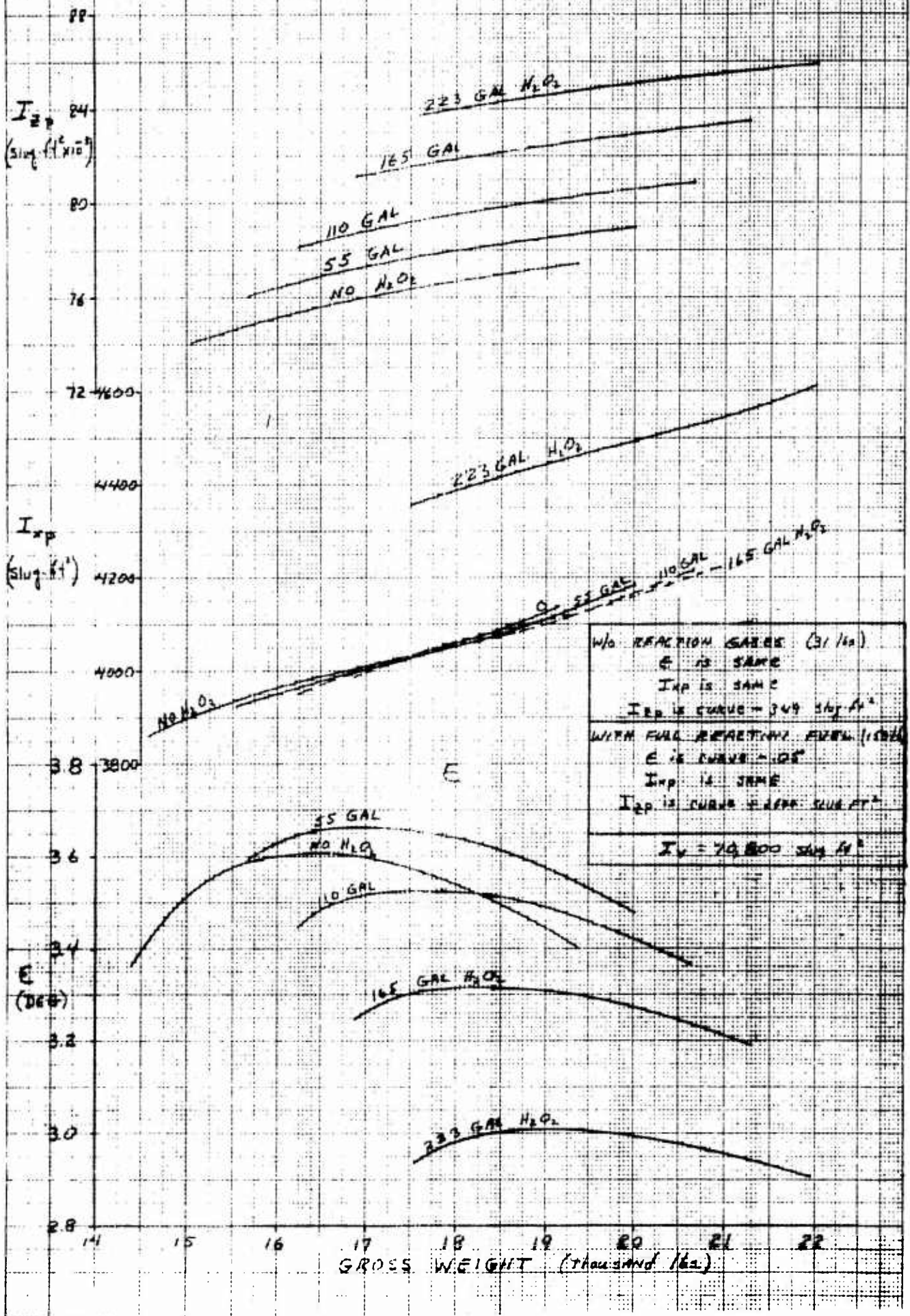


FIG 30

NF-104A PRINCIPAL MOMENTS OF INERTIA

GEAR UP, REACTION CASES FULL (GN_2), REACTION FUEL EMPTY (H_2O_2)



APPENDIX 4

DERIVATION OF THE TRANSLATIONAL EQUATIONS OF MOTION

The basic equation was:

$$\vec{F} = m \frac{d\vec{V}}{dt}$$

or $\vec{F} = m (\dot{V} \hat{i}_V + \vec{\omega} \times \vec{V})$

Now $\vec{\omega} \times \vec{V} = \hat{i} (Qw - Rv) + \hat{j} (-Pw + Ru) + \hat{k} (Pv - Qu)$

and $\dot{V} \hat{i}_V = \hat{i} \dot{u} + \hat{j} \dot{v} + \hat{k} \dot{w}$

$\therefore \vec{F}_x = (\dot{u} + Qw - Rv)m$ (1)

and $\vec{F}_y = (\dot{v} - Pw + Ru)m$ (2)

and $\vec{F}_z = (\dot{w} + Pv - Qu)m$ (3)

From equation (2)

$$\vec{F}_y = (\dot{v} - Pw + Ru)m$$

$$\frac{\vec{F}_y}{mu} = \frac{\dot{v}}{u} - P \frac{w}{u} + R$$

The small angle assumption was made:

$$\frac{v}{u} = \beta; \quad \frac{\dot{v}}{u} = \dot{\beta}$$

and $\frac{w}{u} = \alpha$; $\frac{\dot{w}}{u} = \dot{\alpha}$

$\therefore \frac{\dot{F}_y}{mu} = \dot{\beta} - P\alpha + R$

$\dot{\beta} = \frac{F_y}{mu} + P\alpha - R$

But $F_y = C_y qS + g \sin \phi \cos \theta$
 $= (C_{y_{\delta_r}} \delta_r + C_{y_{\beta}} \beta) qS + g \sin \phi \cos \theta$

$\therefore \dot{\beta} = (C_{y_{\delta_r}} \delta_r + C_{y_{\beta}} \beta) \frac{qS}{mu} + \frac{g \sin \phi \cos \theta}{mu} + P\alpha - R$

From equation (3)

$\dot{F}_z = (\dot{w} + Pv - Qu) m$

$\frac{F_z}{mu} = \frac{\dot{w}}{u} + \frac{Pv}{u} - Q$

As in equation (2)

$\frac{F_z}{mu} = \dot{\alpha} + P\beta - Q$

or $\dot{\alpha} = \frac{F_z}{mu} - P\beta + Q$

But $F_z = \frac{C_z qS}{mu} + \frac{g \cos \phi \cos \theta}{mu}$

and $C_z = -C_L \cos \alpha - C_D \sin \alpha$

$\therefore \dot{\alpha} = (-C_L \cos \alpha - C_D \sin \alpha) \frac{qS}{mu} + \frac{g \cos \phi \cos \theta}{mu} - P\beta + Q$

APPENDIX 5

JET ENGINE GYROSCOPIC EFFECT

The engine gyroscopic terms $I\Omega R$ and $I\Omega Q$ were added to the normal aircraft rotational equations by taking the angular momentum of the jet engine into account in the derivation of the moment equations. Total aircraft moment (M_T) expressed as the rate of change of total aircraft angular momentum (H_T) has been expressed in vector form as:

$$\vec{M}_T = \frac{d\vec{H}_T}{dt} = \frac{dH_T}{dt} \vec{i}_{H_T} + \vec{\omega} \times \vec{H}_T$$

where: $H_T = H_A + H_e$

\vec{i}_{H_T} = unit vector in H_T direction

$\vec{\omega}$ = aircraft angular velocity

$$\vec{\omega} = P \vec{i}_x + Q \vec{i}_y + R \vec{i}_z$$

\vec{H}_A = airframe angular momentum

\vec{H}_e = angular momentum of jet engine

$$\vec{H}_e = I \Omega \vec{i}_x \text{ (in body axis } x \text{ direction)}$$

The engine gyroscopic terms are included in the $\vec{\omega} \times \vec{H}_T$ term. The terms due to engine gyroscopic moment are:

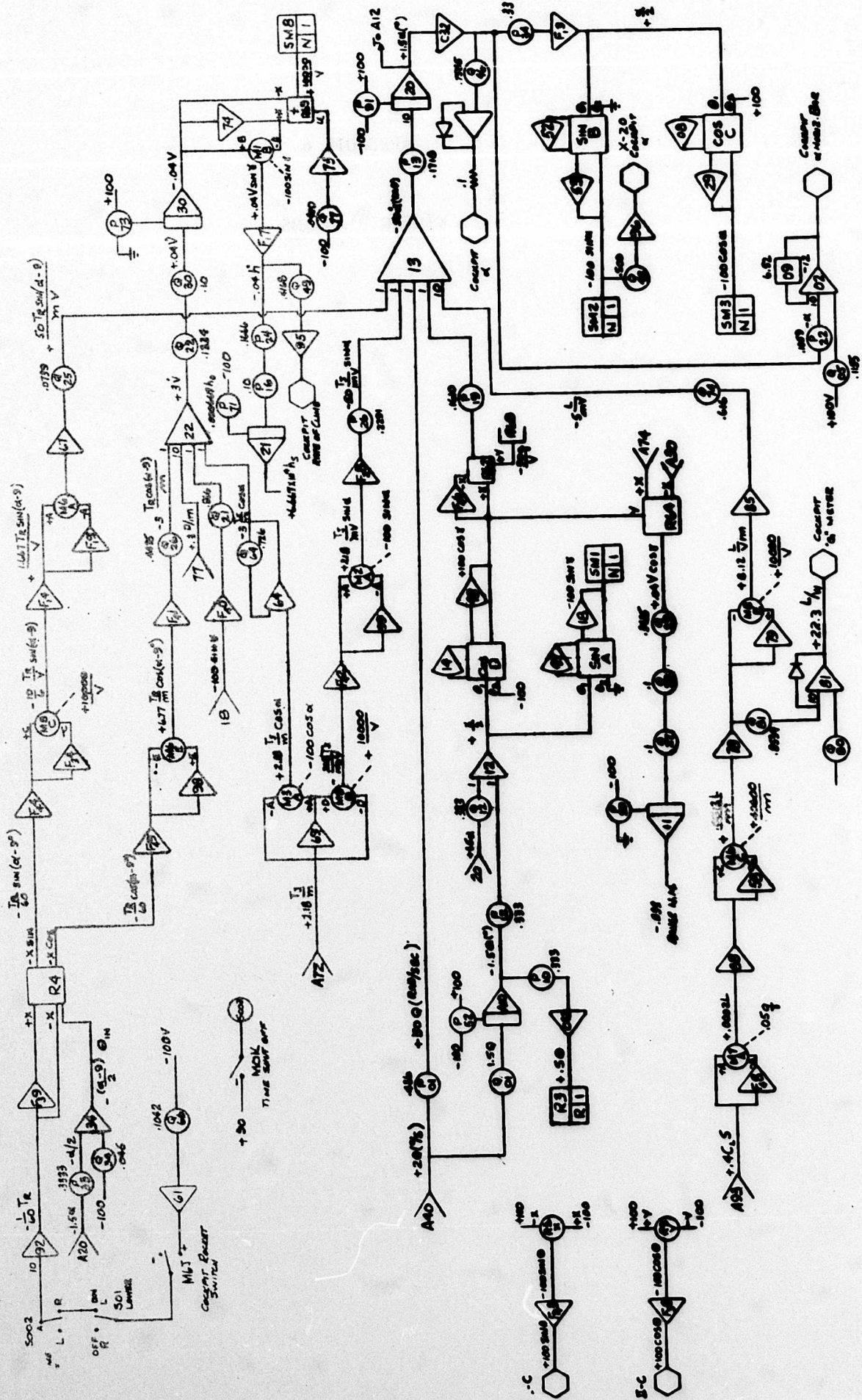
$$\vec{\omega} \times \vec{H}_e = I\Omega R \vec{i}_y - I\Omega Q \vec{i}_z$$

These two terms are added to the moment equations written about the y and z axes.

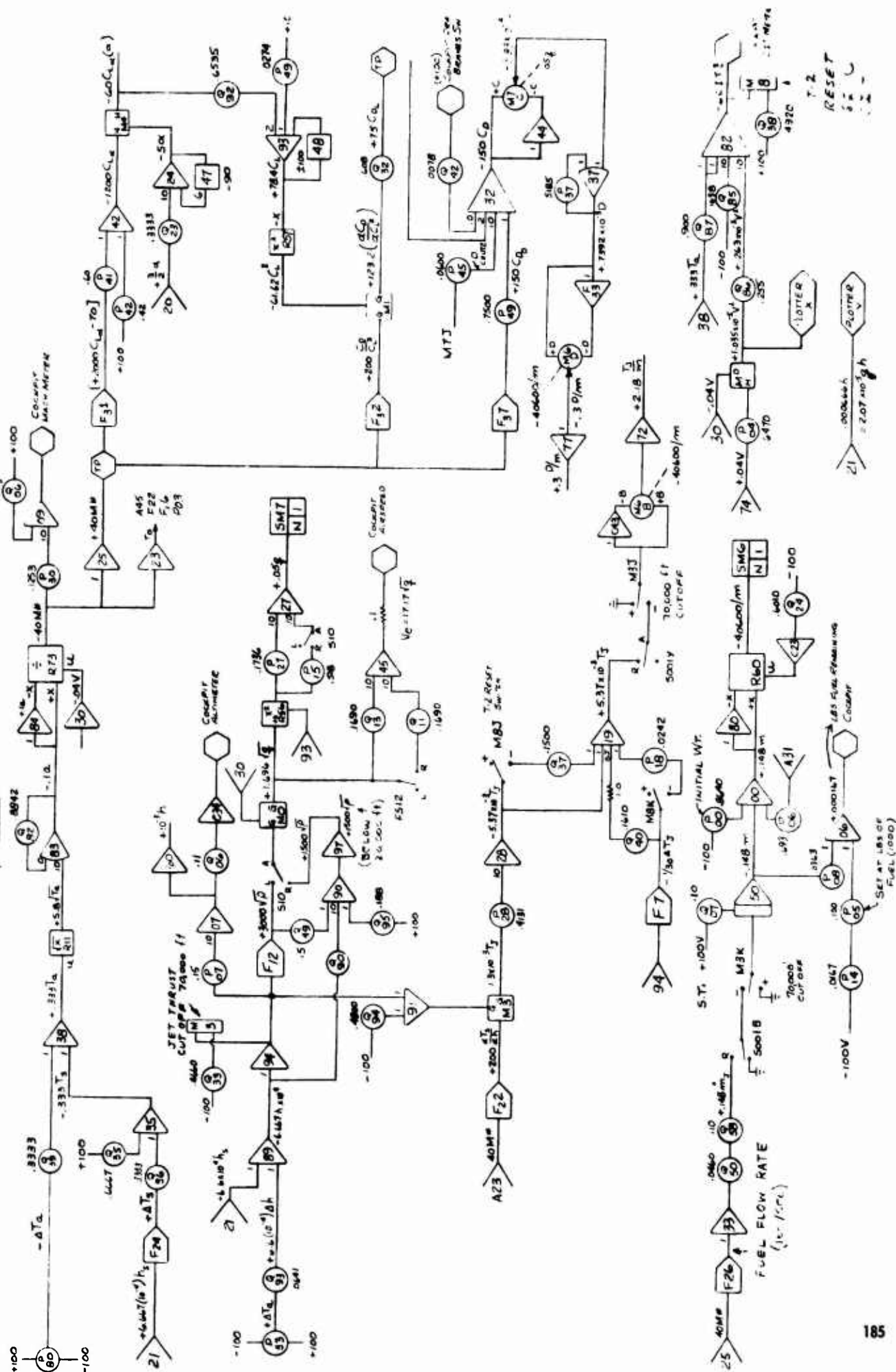
APPENDIX 6

WIRING DIAGRAMS

N-F104 3° OF FREEDOM
 ANGLE OF ATTACK, FLIGHT PATH ANGLE, VELOCITY & RANGE



N-F104 3° OF FREEDOM
LIFT, DRAG, DYNAMIC PRESSURE, JET THRUST & MACH



N-1104 3rd OF FREEDOM
GENERATION OF Cm, Q_z
REACTION CONTROL

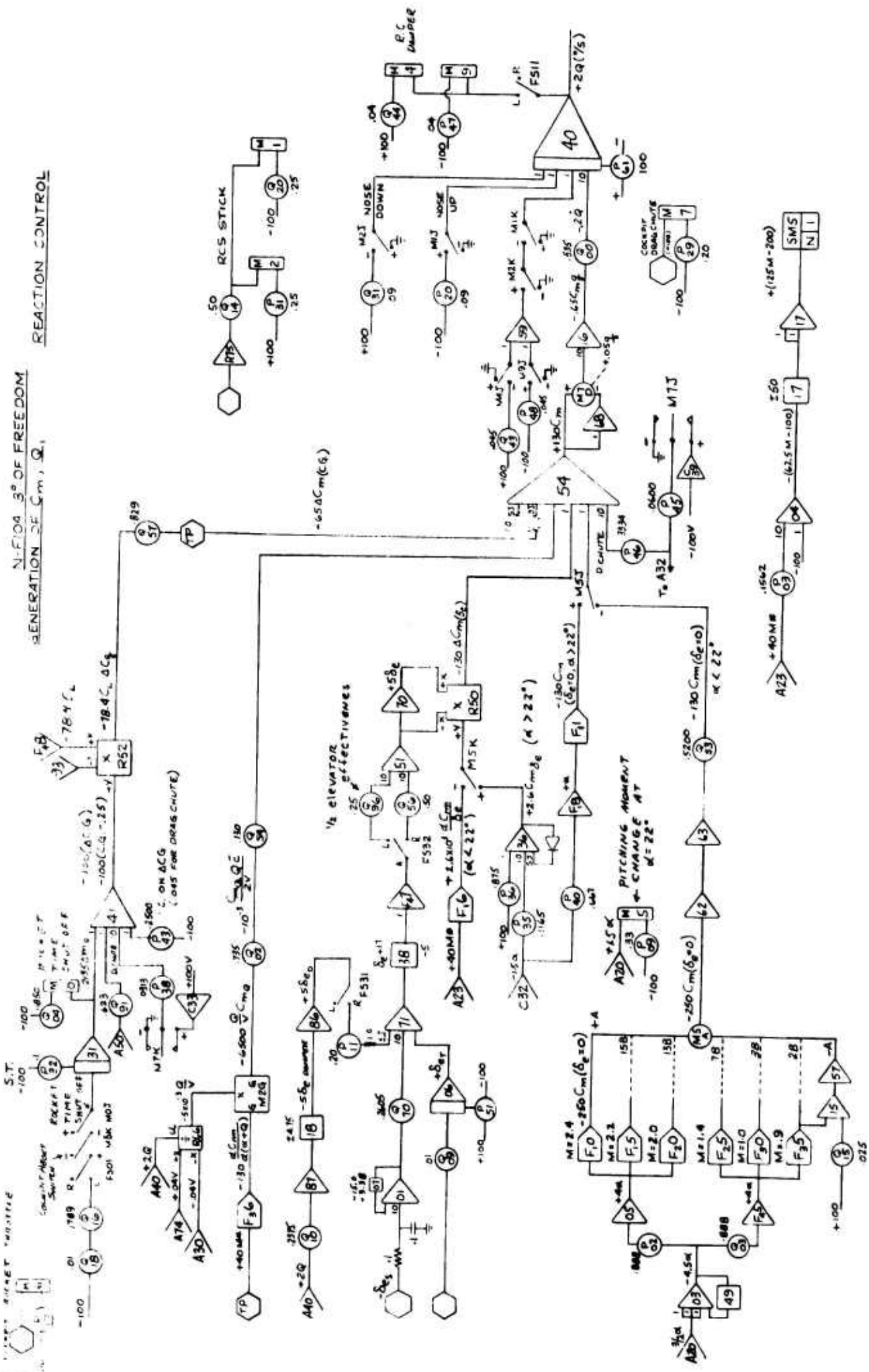
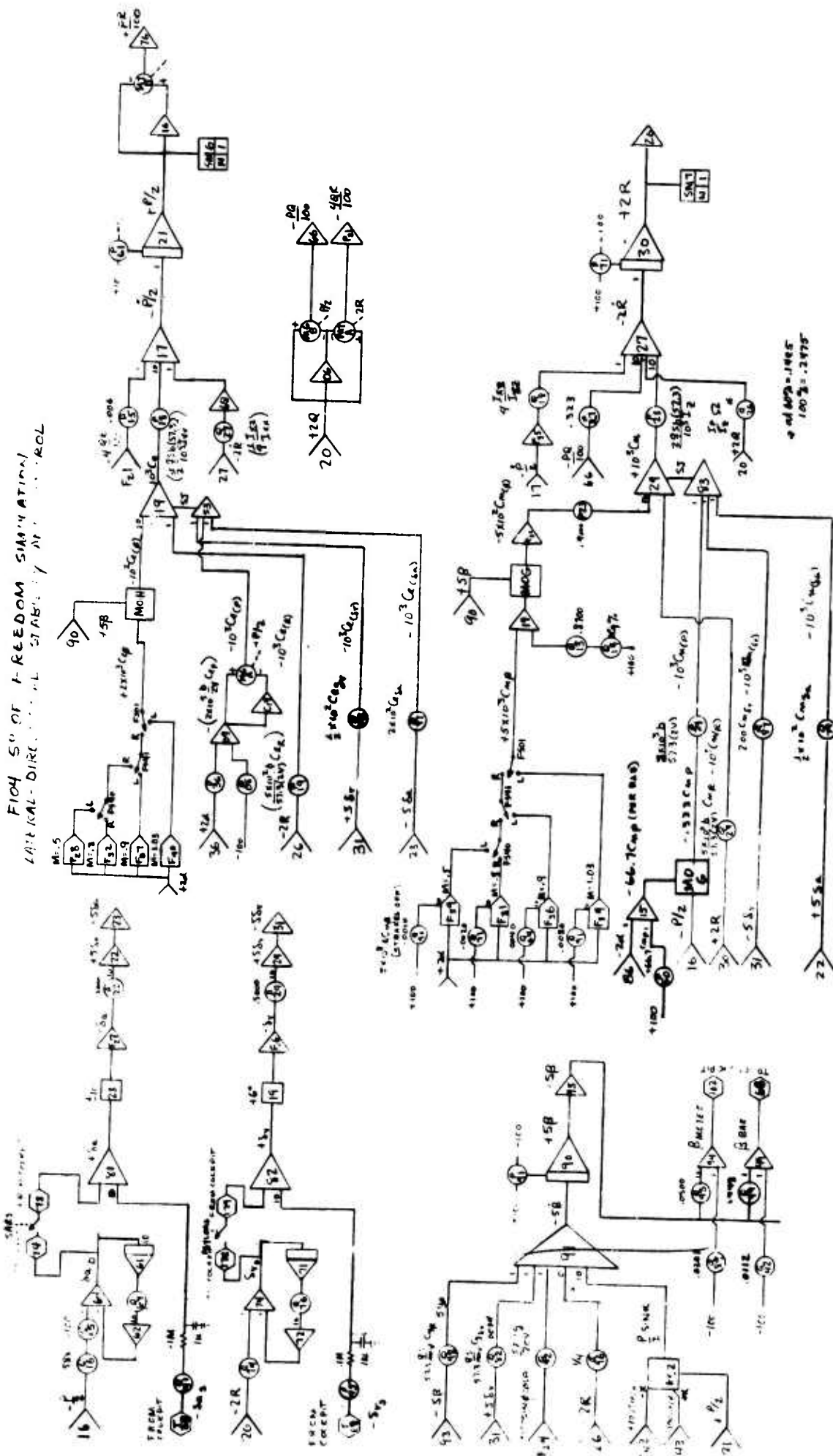


FIG 5 OF FREEDOM SIMULATION
 LAR KAL-DIRE... STABIL... CONTROL



4 of 400 = 1.00E
 100% = 1.00E

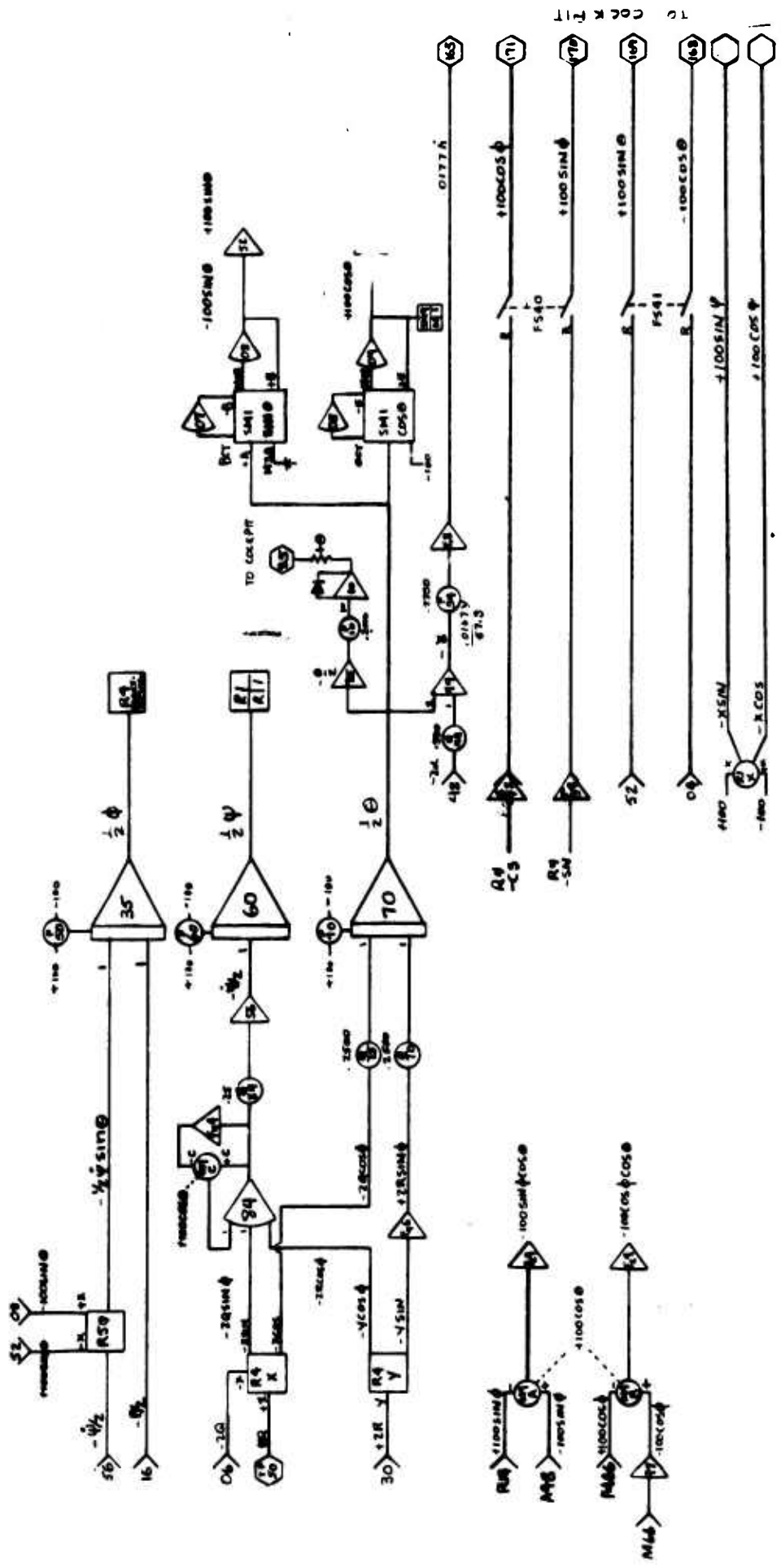
10³ C(s)
 10⁴ C(s)
 10⁵ C(s)

FROM PLANT

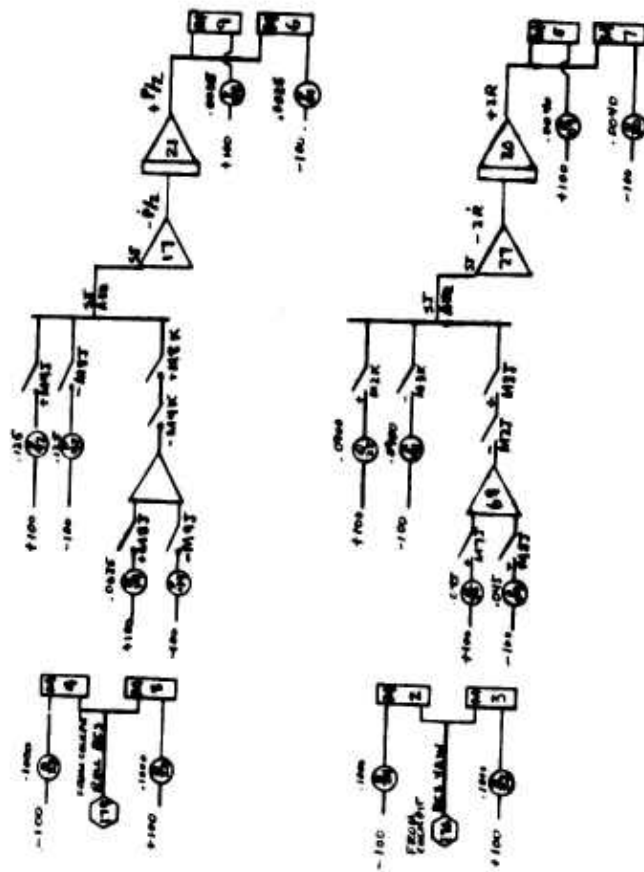
FROM CONTROL

LAR KAL-DIRE

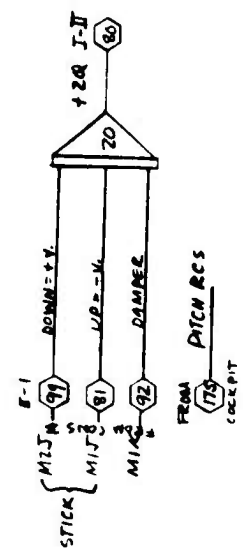
NF-104 5° PROBLEM-1
EULER ANGLE GENERATION



NF-104 REACTION CONTROL SYSTEM
WITH DAMPERS



PITCH RCS



ACTUAL GENERATION
ON CONS I
M2 = NOSE DOWN
M1+ = NOSE UP