C-105 P/F.F. Models/8

SUMMARY OF FIRINGS OF

FREE FLIGHT MODELS 3, 5 AND 4

MAY AND JUNE 1955

W. Taylor ANALYZED July 11/55

Avro Aircraft Limited

INTER-DEPARTMENTAL MEMORANDUM

Date July 28, 1955 Reference No. 3423/31/J
To Mr. J.C. Floyd - Vice-President Engineering
From W. Taylor - Senior Test Engineer
Subject SUMMARY OF FIRINGS OF FREE FLIGHT MODELS 3, 5 AND 4

Attached herewith the following report:-

P/Free Flight Models/8 - Summary of Firings of Free Flight Models 3, 5 and 4, May and June 1955.

W. Taylor.

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SUMMARY OF FIRINGS OF FREE FLIGHT MODELS 3, 5 AND 4

MAY AND JUNE 1955

Free Flight Model 3 (Week of May 9th to 14th)

This was one of two Crude Models for developing a "yaw impulse" technique for future lateral stability models.

A combination of unsuitable camera weather and shipping delayed the firing of this model until Thursday the 12th May. Prior to this, assemhly of booster wrapper and yoke, telemetry checks, alignment and swinging for C. of G. were carried out satisfactorily.

The combination was moved to the pad at 0830 hours and fired at 1015 hours.

From telemetry records, it was confirmed that no yaw pulses occurred. A Radio heacon was not installed in this model, radar did not track.

Free Flight Model 5, i.e. 1st Drag Model (week of May 9th to 14th)

Technical difficulties were encountered when the Telemetry door was offered up to the model. The battery container fouled the micro switch wiring which in turn shorted out some of the power supply. This was modified and the vehicle (after a 3 hour delay because of shipping) was fired at 1540 hours.

Radar tracked the model from 13 seconds to impact in conjunction with the S-Band Beacon.

Complete Telemetry information was obtained.

Free Flight Model 4 (week of June 13th to 17th)

This model was fired at 1620 hours. Telemetry confirmed that yaw impulses occurred, the 10 puffs of smoke were observed visually.

The radio beacon apparently failed after two seconds of flight.

Kine Theodolite data was the best to date, two cameras tracking for 24 seconds.

General

For Telemetering, power supply data, and typical traces obtained, see Appendix I.

Note: For comments on Range Instrumentation at these trials, see 2805/31/J and 2310/31/J of June 28 and June 6 respectively.

TELEMETERING DATA

(1) Two Bendix type TXV-14 transmitters were used in each model, one operating at 218 mc and the other at 224 mc. All the transmitters were modulated by seven subcarrier oscillators except for the one operating at 224 mc. in FF-4 which was modulated by six. The transmitters were connected to a simple slot antenna through a Bendix Diplex Coupler. TNC-11 couplers were used in FF-3 and 4 (Ser. Nos. B-20 & 21) and a TNC-12 was used in F.F.-5.

(2) Power was applied to F.F.-3 at 0952 and model fired at 1015
Power was applied to F.F.-4 at 1557 and model fired at 1620
Power was applied to F.F.-5 at 1519 and model fired at 1540

(3) The α - β vanes for each model were locked in a zero degree position and the frequency taken for this position after a five minute warm-up. The zero degree frequencies were as follows:-

Angle of Attack	F.F.-3	-	21,246 c.p.s.
Angle of Yaw	F.F.-3	-	21,260 c.p.s.
Angle of Attack	F.F.-4	-	21,185 c.p.s.
Angle of Yaw	F.F.-4	-	21,243 c.p.s.
Angle of Attack	F.F.-5	-	20,970 c.p.s.
Angle of Yaw	F.F.-5	-	21,230 c.p.s.

(4) The frequency checks on the other channels were started approximately five minutes after power was applied and continued until about one minute before firing. The frequencies taken for the α - β vane during this period are of no value for launch frequencies as the locking device had been removed.

(5) f_H - correct frequency with the model in horizontal position
f_L - correct frequency with the model in launch position

(6) The Bendix type TOL-6 oscillator used on the 22 K.C. channels of F.F.-3 and 4 were modified to operate as Colpitts Oscillators.

(7) The commutated system used in F.F.-5 was similar to that written up in the Bendix Aviation report R DBT-574. The details of the commutator switch are as follows.

Type of Switch A.S.C.O.P. - Model B-00014 (Ser. Nos. 7294 & 7297)
No. of Banks per switch - 4(A, B, C and D)
No. of Contacts per Bank - 30 (shorting type)
Speed of Switch - 5 r.p.s.

TELEMETRY DATA

(7) Continued

The inputs of each bridge were connected to the oscillator by means of two paralleled adjacent contacts of the synchronized banks C and D, i.e. one side of the input to the bridge was connected to bank C and the other to bank D. One contact of bank A, which was rotationally displaced relative to banks C and D by an amount equal to half the distance between contacts, was used for connecting the output of each bridge to the TOR oscillator. Therefore, the output of each bridge was connected for one half the time the input was connected. Due to the displacement of bank "A" it was possible to connect the output to the contact mid-way between the two contacts used for the input thus insuring that the input was connected before and remained connected after the output. A reference point was obtained by having the oscillator disconnected from all bridges for a period of six contacts.

Two commutated systems were used, one on the 218 mc. channel and the other on the 224 mc. channel. Each system sampled twelve resistance bridge type pressure transducers. The sampling sequency of the two systems was as follows:-

TRANSDUCER POSITION AS PER DRWG. 7-0219-007	TRANSDUCER SERIAL NO.	SAMPLE NO.	
13	2358	1	)
25	2359	2	)
5	2360	3	)
6	2364	4	)
7	2365	5	)
16	2391	6	) On 218 mc. Channel
18	2384	7	)
19	2386	8	)
14	2390	9	)
15	2393	10	)
17	2394	11	)
24	2435	12	)
9	2380	1	)
10	2356	2	)
11	2357	3	)
12	2361	4	)
1	2372	5	)
2	2363	6	) On 224 mc. Channel
3	2354	7	)
8	2377	8	)
20	2381	9	)
21	2385	10	)
22	2387	11	)
23	2395	12	)

POWER SUPPLY DATA

Crude Model No. 3

Batteries were activated after 24 hours stand time. The following actual voltages were recorded:-

Nominal Volts	Actual Volts
180 Xmtr B+	170.5
108 osc B+	108.2
6 Filaments	5.7
5 VCO reference	5.12
28 Yaw mechanism & gyro motor	32
3v Firing voltage	3.6

Tests lasting approximately 20 minutes were made using the internal power pack and this pack was under load for 23 minutes on the launching pad before firing. Total use of this power pack was about 45 minutes.

Drag Model No. 5

Batteries were activated and a pack was built for this model, supplying the following voltages:-

POWER SUPPLY DATA

Drag Model No. 5 (Continued)

Nominal	Actual
130 Xmtr B+	172
150 Radar B+	140
108 osc B+	108
12 Commutator motors	14
6 Filaments	5.65
-6.5 Radar bias	-6.75

Tests lasting between 15 and 20 minutes were made using this second pack and it was on load at the pad for 21 minutes before launching giving a total life of about 40 minutes.

Crude Model No. 4

Batteries were activated in the morning of Tuesday June 14, and stood in free air for 24 hours before being assembled into the power pack case. The regular method of activation using a hypodermic syringe on each battery was used. The power pack was put under load at 12.53 p.m. on Wednesday June 15 and the following voltages were recorded.

Nominal	Accurate Reading
130 Xmtr B+	174
150 Radar B+	141
108 osc B+	108
28 Gyro and Yaw Mechanism	30
6 Filaments	5.59
-6.5 Radar bias	-6.75
5 osc Ref.	5.12
3 Cartridge firing voltage	3.4 under no load

The power pack was on for a period of 22 minutes for test purposes and then turned off preparatory to setting up the model on the launching pad. It was again on for a period of 22 minutes on the launching pad prior to take-off of the model. The total use of the power supply was thus 44 minutes in addition to the actual flight. This is within the design requirement of 1 hour's useful life.

TELEMETER DATA F.F. -3

CRUDE YAW MODEL

CHANNEL	OSCILLATOR TYPE	TRANSDUCER TYPE	FUNCTIONS ON 224 mc X'TMR (X'TMR SER. NO. B-646)	LOW FREQ. LIMIT	f_h
2.3 K.C.	TOL-5 Ser. No. B-6742	Bendix - TTP-20 Range 0 - 20,000' Ser. No. B-119	Free Stream Static Pressure	2127	2439 at 29.3" Hg.
3.0 K.C.	TOL-5 Ser. No.	Bendix - TTG-2 Range - 10g - 35g Ser. No. B-1899	Longitudinal Acceleration	2775	2940
3.9 K.C.	TOL-5 Ser. No. B6746	Bendix - TTG-2 Range - $\pm$ 15g Ser. No. - B-2024	Normal Acceleration	3607	3923
5.4 K.C.	TOE-27 Ser. No. B-1621	American Gyro Model B-405 VI-1-84 Range - $\pm$ 400°/Sec.	Roll Rate	4995	5761 at zero vo inputs
7.35 K.C.	TOL-5 Ser. No. B-6738	P.R.I. 1-2 Range 0 - 6g Ser. No. .003	Drag Acceleration	6799	6930
10.5 K.C.	TOE-27 Ser. No. B-1894	+ 5V applied at Separation	Separation	9712	
22 K.C.	TOL-6 Ser. No. B-511	Modified N.A.C.A. α - β Vane Range - $\pm$ 10° Ser. No. .002	Angle of Attack	20,350	21,126 at zero degre

APPENDIX I

	f_h	f_L	Δ_f TOLERATED	HIGH FREQ. LIMIT	MAXIMUM FREQUENCY RESPONSE	1ST FREQ. CHECK	2ND FREQ. CHECK	3RD FREQ. CHECK	4TH FREQ. CHECK	5TH FREQ. CHECK
	2439 at 29.3" Hg.	2444 at 29.8" Hg.	± 7 c.p.s.	2473	35 cps	2445	2446	2446	2445	
	2940	2947	± 9 c.p.s.	3225	45 cps	2953	2952	2952	2952	
	3923	3929	± 12 c.p.s.	4193	60 cps	3936	3936	3936	3935	
	5761 at zero volts inputs	5401	± 16 c.p.s.	5805	80 cps	5396	5395	5394	5394	
	6930	6839	± 22 c.p.s.	7901	110 cps	6856	6855	6855	6854	
			± 32 c.p.s.	11,288	160 cps	10,897	10,901	10,904	10,901	
0	21,126 at zero degrees		±132 c.p.s.	23,650	330 cps	24,551	24,670	24,678	24,672	

TELEMETER DATA F.F. - 3

CRUDE YAW MODEL

CHANNEL	OSCILLATOR TYPE	TRANSDUCER TYPE	FUNCTIONS ON 224 mc X'TMR (X'TMR SER. NO. B-652)	LOW FREQ. LIMIT	f_h
2.3 K.C.	TOL-5 B-6683	Bendix TTP-20 Range 0 - 20,000' Ser. No. - B-122	Free Stream Static Pressure	2127	2439 at 29.3" Hg.
3.0 K.C.	TOL-5 B-6772	Bendix TTP-18 Range 15 - 95 p.s.i. Ser. No. B-29	Free Stream Total Head	2775	2813
3.9 K.C.	TOL-5 B-6763	Bendix - TTG-2 Range - $\pm$ 10g Ser. No. - B-2049	Transverse Acceleration	3607	3915
5.4 K.C.	TOE-27 B-1622	Victory Engineering Corporation Thermistor Model - 32All	Instrument Bay Temperature	4995	5778 at zero volt input
7.35K.C.	TOR-6 B-207	Statham Model - AA14 Range - $\pm$ 50 rad/sec^2 Ser. No. 36	Yaw Angular Acceleration	6799	7350
10.5 K.C.	TOE-27 B-1893	Victory Engineering Corporation Thermistor Model - 32All	α - β Vane Temperature	9712	11,229 at zero volt input
22 K.C.	TOL-6 B-527	Modified N.A.C.A. α - β Vane Range - $\pm$ 10° Ser. No. .002	Angle of Yaw	20,350	21,376 at zero degrees

f_h	f_L	Δf TOLERATED	HIGH FREQ. LIMIT	MAXIMUM FREQUENCY RESPONSE	1ST FREQ. CHECK	2ND FREQ. CHECK	3RD FREQ. CHECK	4TH FREQ. CHECK	5TH FREQ. CHECK
2439 at 29.3" Hg.	2444 at 29.8" Hg.	± 7 cps	2473	35 cps	2440	2440	2441	2441	
2813	2813	± 9 cps	3225	45 cps	2816	2816	2815	2815	
3915	3915	±12 cps	4193	60 cps	3924	3924	3923	3922	
5778 at zero volts input		±16 cps	5805	80 cps	5237	5231	5229	5228	
7350	7350	±22 cps	7901	110 cps	7564	7561	7561	7559	
11,229 at zero volts input		±32 cps	11,288	160 cps	10,142	10,144	10,146	10,148	
21,376 at zero degrees		±132 cps	23,650	330 cps	21,240	21,302	21,322	21,314	

TELEMETER DATA - F.F. 5

DRAG MODEL

CHANNEL	OSCILLATOR TYPE	TRANSDUCER TYPE	FUNCTIONS ON 218 mc X'TMR (X'TMR SER. NO. B-674)	LOW FREQ. LIMIT	f_h
2.3 K.C.	TOE-27 Ser. No. B-2042	+ 5V applied at separation	Separation	2127	2480 at zero volts input
3.9 K.C.	TOL-5 Ser. No. B-6765	Bendix TTG-5 Range 0 - 30g Ser. No. - B-760	Longitudinal Acceleration	3607	3638
5.4 K.C.	TOL-5 Ser. No. B-6800	Bendix TTG-4 Range - ± 4g Ser. No. - B-325	Transverse Acceleration	4995	5458
7.35 K.C.	TOR-6 Ser. No. B-202	Statham - P81 Range - 0 - 95 psi Ser. No. 2388	Static Buzz Pressure	6799	6816 at 14.3 psia
10.5 K.C.	TOL-5 Ser. No. B-6839	Bendix TTP-18 Range - 15 - 95 psi Ser. No. B-22	Free Stream Total Head	9712	9793
14.5 K.C.	TOR-6 Ser. No. B-628	Statham - P81 Range - 0 - 95 psia (12 off)	Commutated See Note No. 7 - Page 2 and 3	13,412	13,500
22 K.C.	TOL-6 Ser. No. B-6784	Modified N.A.C.A. α - β Vane Range - ± 10° Ser. No. .003	Angle of Yaw	20,350	21,220 at zero degree

f_h	f_L	Δf TOLERATED	HIGH FREQ. LIMIT	MAXIMUM FREQUENCY RESPONSE	1ST FREQ. CHECK	2ND FREQ. CHECK	3RD FREQ. CHECK	4TH FREQ. CHECK	5TH FREQ. CHECK
2480 at zero volts input	2480	± 7 cps	2473	35 cps	2471	2472	2472	2472	2474
3638	3657	± 12 cps	4193	60 cps	3665	3664	3664	3663	3662
5458	5458	± 16 cps	5805	80 cps	5472	5471	5471	5470	5466
6816 at 14.3 psia	6820	± 22 cps	7901	110 cps	6886	6884	6883	6882	6874
9793	9793	± 32 cps	11,288	160 cps	9852	9849	9848	9846	9834
13,500		± 45 cps	15,588	220 cps					
21,220 at zero degrees		± 132 cps	23,650	330 cps	21,232	21,655	21,652	21,651	21,639

TELEMETER DATA F.F. - 5

DRAG MODEL

CHANNEL	OSCILLATOR TYPE	TRANSDUCER TYPE	FUNCTIONS ON 224 mc X'TMR (X'TMR SER. NO. B-663)	LOW FREQ. LIMIT	f_h
3.0 K.C.	TOR-6 Ser. No. B-731	Statham P-31 Range - 0 - 15 psia Ser. No. - 2228	Base Pressure	2775	3201 at 14.35 ps
3.9 K.C.	TOL-5 Ser. No. B-6766	Bendix - TTG-4 Range - 0 - 6g Ser. No. B-677	Drag Acceleration	3607	3647
5.4 K.C.	TOL-5 Ser. No. B-6748	PAL - 1-2 Ser. No. .002 Range - $\pm$ 3g	Normal Acceleration	4995	5270
7.35 K.C.	TOR-6 Ser. No. 585	Statham P-31 Range 0 - 95 psia Ser. No. - 2392	Full Rake Pressure	6799	6851 at 14.30 ps
10.5 K.C.	TOL-5 Ser. No. B-6507	Bendix TTP-20 Range - 10" - 30" Hg Ser. No. - B-114	Free Stream Static Pressure	9712	11,184 a 14.2 psi
14.5 K.C.	TOR-6 Ser. No. B-737	Statham P-31 Range - 0 - 95 psia (12 off)	Commutated (See Note No. 7 - Page 2 and 3)		13,500
22 K.C.	TOL-5 Ser. No. B-4753	Modified N.A.C.A. α - β Vane Range - $\pm$ 10° Ser. No. .003	Angle of Attack	20,350	21,195 a zero degree

. T	f_h	f_L	Δ_f TOLERATED	HIGH FREQ. LIMIT	MAXIMUM FREQUENCY RESPONSE	1ST FREQ. CHECK	2ND FREQ. CHECK	3RD FREQ. CHECK	4TH FREQ. CHECK	5TH FREQ. CHECK
	3201 at 14.35 psia	3212	± 9 cps	3225	45 cps	3216	3216	3215	3215	3215
	3647	3600	± 12 cps	4193	60 cps	3599	3599	3599	3598	3598
	5270	5306	± 16 cps	5805	80 cps	5313	5313	5319	5318	5319
	6851 at 14.30 psia	6855	± 22 cps	7901	110 cps	6846	6848	6848	6849	6851
	11,184 at 14.2 psia	11,216	± 32 cps	11,238	160 cps	11,251	11,249	11,247	11,245	11,239
	13,500		± 45 cps	15,588	220 cps					
)	21,195 at zero degrees		± 132 cps	23,650	330 cps	20,972	21,361	21,357	21,346	21,293

TELEMETER DATA - F.F. 4

CRUDE YAW MODEL

CHANNEL	OSCILLATOR TYPE	TRANSDUCER TYPE	FUNCTIONS ON 224 mc X'TMR (X'TMR SER. NO. B631)	LOW FREQ. LIMIT	f_h
2.3 K.C.	TOL-5 Ser. No. B-6781	Bendix TTP-20 Range 0 - 20,000' Ser. No. B-123	Free Stream Static Pressure	2127	2441
3.0 K.C.	TOL-5 Ser. No. B-6745	Bendix TTG-2 Range - -10 + 35g Ser. No. B-1902	Longitudinal Acceleration	2775	2940
3.9 K.C.	TOL-5 Ser. No. B-6738	Bendix TTG-2 Range - ± 15g Ser. No. - B-2054	Normal Acceleration	3607	3921
5.4 K.C.	TOE-27 Ser. No. B-4330	American Gyro Model B-405 Range ±400°/sec. Ser. No. -2	Roll Rate	4995	5755 at zero volt input
7.35 K.C.	TOL-5 Ser. No. B-6843	PAL J-2 Range 0 - 6g Ser. No. .004	Drag Acceleration	6799	6810
10.5 K.C.	TOE-27 Ser. No. B-1397	+ 5V applied at Separation	Separation and Monitor of Rotation of Yaw Mechanism	9712	11,216 at zero volt input
22 K.C.	TOL-6 Ser. No. B-501	Modified N.A.C.A. α - β Vane Range - ± 10° Ser. No. - .001	Angle of Attack	20,350	21,450 at zero degree

T	f_h	f_L	Δ_f TOLERATED	HIGH FREQ. LIMIT	MAXIMUM FREQUENCY RESPONSE	1ST FREQ. CHECK	2ND FREQ. CHECK	3RD FREQ. CHECK	4TH FREQ. CHECK	5TH FREQ. CHECK
	2441	2441	± 7 cps	2473	.35 cps	2443	2443	2443	2443	
	2940	2947	± 9 cps	3225	45 cps	2950	2950	2950	2950	
	3921	3927	± 12 cps	4193	60 cps	3925	3924	3924	3923	
	5755 at zero volts input	5390	± 16 cps	5805	80cps	5399	5399	5398	5398	
	6810	6791	± 22 cps	7901	110 cps	6807	6807	6806	6805	
	11,216 at zero volts input	11,216	± 32 cps	11,288	160 cps	11,152	11,151	11,149	11,148	
	21,450 at zero degrees		±132 cps	23,650	330 cps	23,928			25,345	

TELEMETER DATA - F.F. 4

CRUDE YAW MODEL

CHANNEL	OSCILLATOR TYPE	TRANSDUCER TYPE	FUNCTIONS ON 218 mc X'TMR (X'TMR SER. NO. B-81)	LOW FREQ. LIMIT	f_h
2.3 K.C.	TOL-5 Ser. No. B-6694	Bendix TTP-20 Range - 0 - 20,000' Ser. No. - B-120	Free Stream Static Pressure	2127	2453
3.0 K.C.	TOL-5 Ser. No. B-6720	Bendix TTP-18 Range - 15 - 95 psi Ser. No. - 30	Free Stream Total Head	2775	2800
3.9 K.C.	TOL-5 Ser. No. B-6704	Bendix - TTG-2 Range - $\pm$ 10g Ser. No. B-2050	Transverse Acceleration	3607	3928
5.4 K.C.	TOE-27 Ser. No. B-1623	+ 3V applied during firing	Monitor of Cartridge Firing Voltage	4995	5793 at zero volt input
7.35 K.C.	TOR-6 Ser. No. B-208	Statham Model - AA14 Range - $\pm$50 rad/sec.^{2} Ser. No. 39	Yaw Angular Acceleration	6799	7350
22 K.C.	*TOL-6 Ser. No. B-510	Modified N.A.C.A. α - β Vane Range - $\pm$ 10° Ser. No. - .001	Angle of Yaw	21,380 at zero degrees	21,380 at zero degre

	f_h	f_L	Δf TOLERATED	HIGH FREQ. LIMIT	MAXIMUM FREQUENCY RESPONSE	1ST FREQ. CHECK	2ND FREQ. CHECK	3RD FREQ. CHECK	4TH FREQ. CHECK	5TH FREQ. CHECK
	2458	2458	± 7 cps	2473	35 cps	2458	2458	2457	2456	
	2800	2800	± 9 cps	3225	45 cps	2797	2796	2796	2796	
	3928	3928	± 12 cps	4193	60 cps	3929	3929	3928	3927	
	5793 at zero volts input	5793	± 16 cps	5805	80 cps	5757	5756	5755	5754	
	7350	7350	± 22 cps	7901	110 cps	7407	7399	7388	7374	7366
0 ro s	21,380 at zero degrees		±132 cps	23,650	330 cps	20,094			20,017	

WEATHER CONDITIONS (Extract from C.A.R.D.E. Range Officer's report TR-1015)

Crude Model No. 3

Ground	Barometer	1011.5 mbs
	Temperature	51.3°
	Wind	West
	Speed	10 m.p.h.

Upper Air

Height	Wind (m.p.h.)	Direction °
9,000	30	311
15,000	50	370
20,000	72	305
25,000	77	370

MB	HT. (ft.)	Temp. (°C)	D.P. (°C)
1000	652	+ 11.0	
850	5077	+ 0.8	

Drag Model No. 5

Ground	Barometer	1012.5 mbs
	Temperature	56°F
	Wind	South West
	Speed	8 miles

Upper Air

Height	Wind (m.p.h.)	Direction
3,000'	17	10
6,000'	24	10
9,000'	26	0
12,000'	48	357
15,000'	48	342
18,000'	55	335
21,000'	60	331

Drag Model No. 5 (Continued)

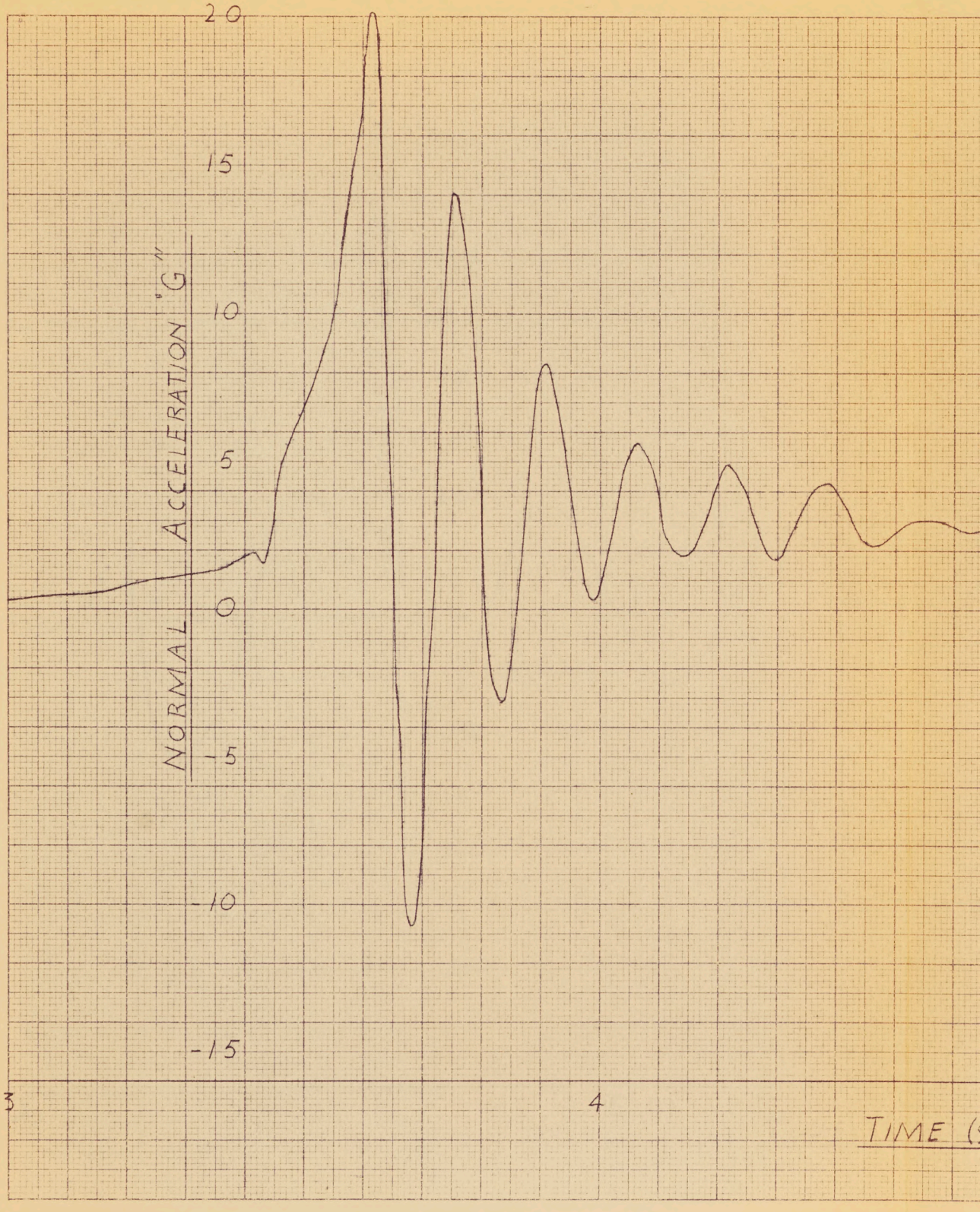
MB	HT. (ft.)	Temp.(°C)	D.P. (°C)
1000	568	+ 12.6	+ 0.4
850	4995	+ 5.0	- 12.0
700	10072	- 3.1	- 25.4
500	18644	- 13.1	- 34.3
400	23962	- 30.4	- 45.3

Crude Model No. 4: Wind

Height ft.	Speed m.p.h.	Direction °	Pressure mbs	Temp. °C	R.H.	D.P.
1,000	22	280	969	-20.1	65	-13.4
2,000	19	293	934	-19.4	65	-12.6
3,000	19	311	906	-17.3	69	-11.5
4,000	19	324	867	-14.6	71	- 9.2
5,000	15	324	838	-13.2	71	- 8.0
6,000	7	325	812	-12.0	73	- 7.2
7,000	12	333	776	-11.0	71	+ 5.8
8,000	-	-	756	- 6.6	73	- 2.1
9,000	33	350	737	- 4.4	71	- 0.4
10,000	33	350	714	- 3.8	66	- 2.0
11,000	29	350	698	- 2.2	64	- 4.0
12,000	24	357	661	- 0.2	55	- 7.8
13,000	29	13	644	- 1.0	37	-14.0
14,000	26	355	624	- 2.0	44	-12.6
15,000	22	349	584	- 5.8	42	-15.3
16,000	26	342	-	-	-	-
17,000	24	342	-	-	-	-
18,000	24	345	-	-	-	-
19,000	31	5	-	-	-	-
20,000	36	5	-	-	-	-

Crude Model No. 4 (Continued)

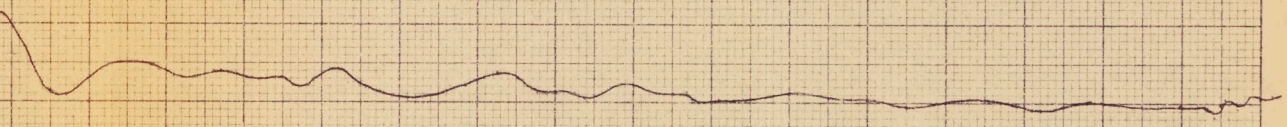
Ground	Barometer	1.003.1 mbs
	Temperature	64°F
	Wind	North West
	Speed	10 m.p.h.
	R.H.	67
	D.P.	11.6°C



P/FFM/8

FF#4

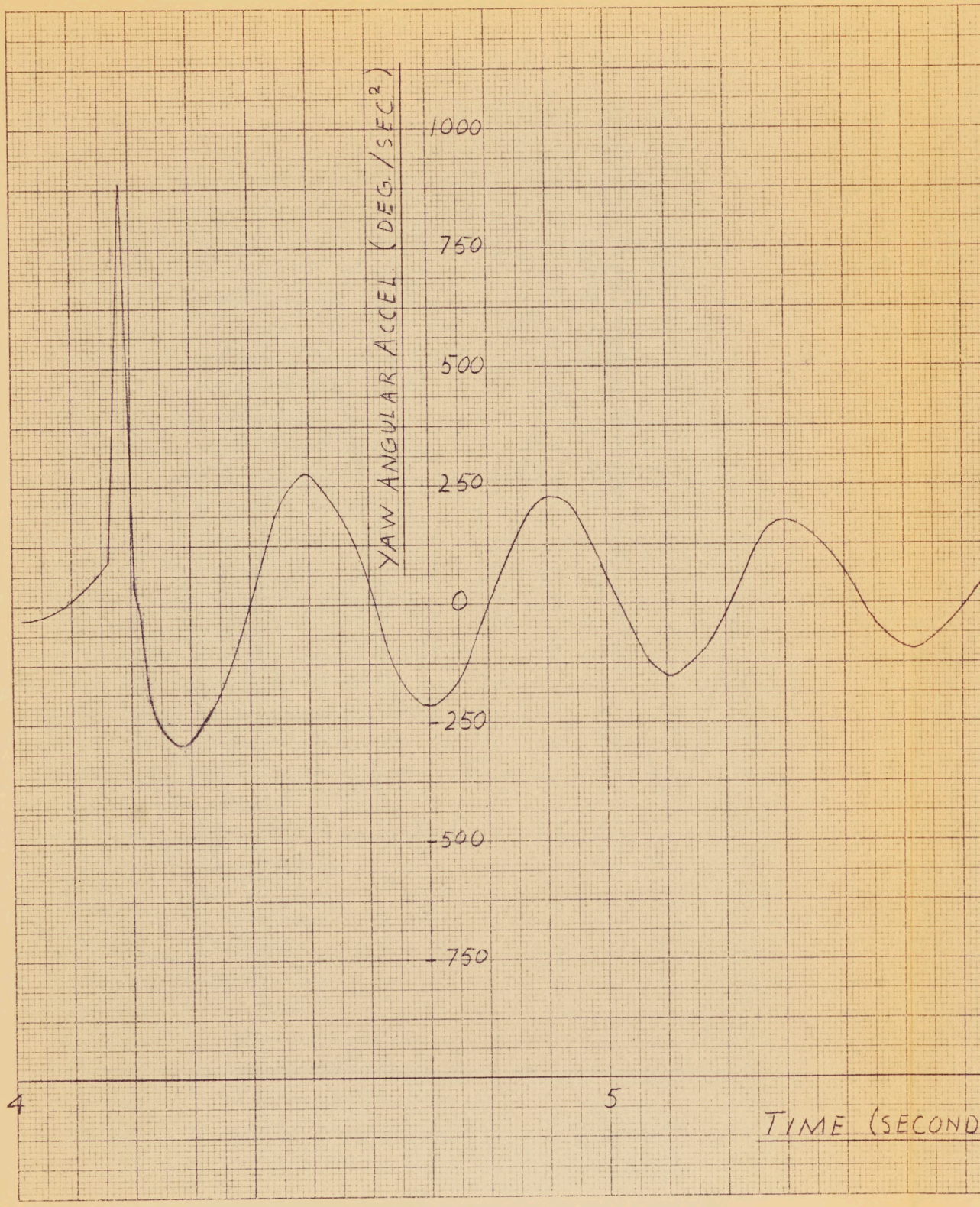
NORMAL ACCELERATION



5

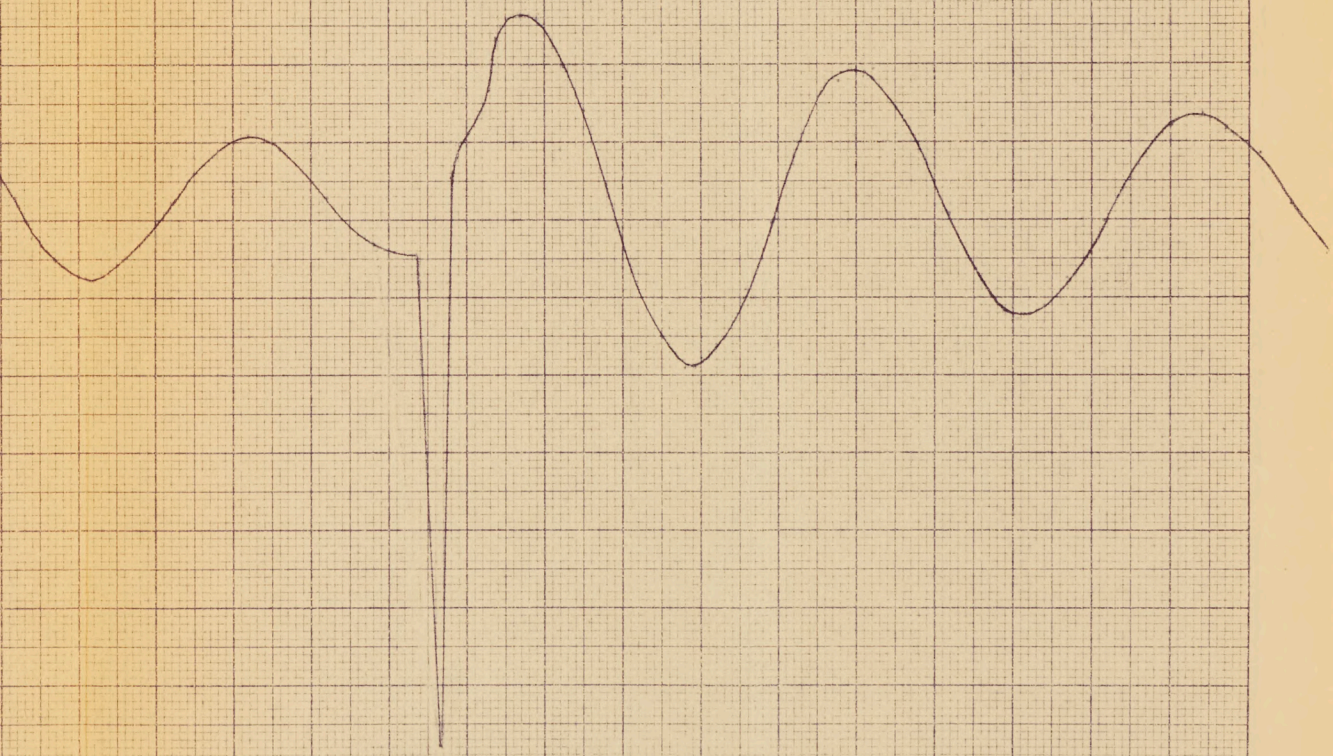
6

TIME (SECONDS)



FF #4 (CRUDE MODEL)

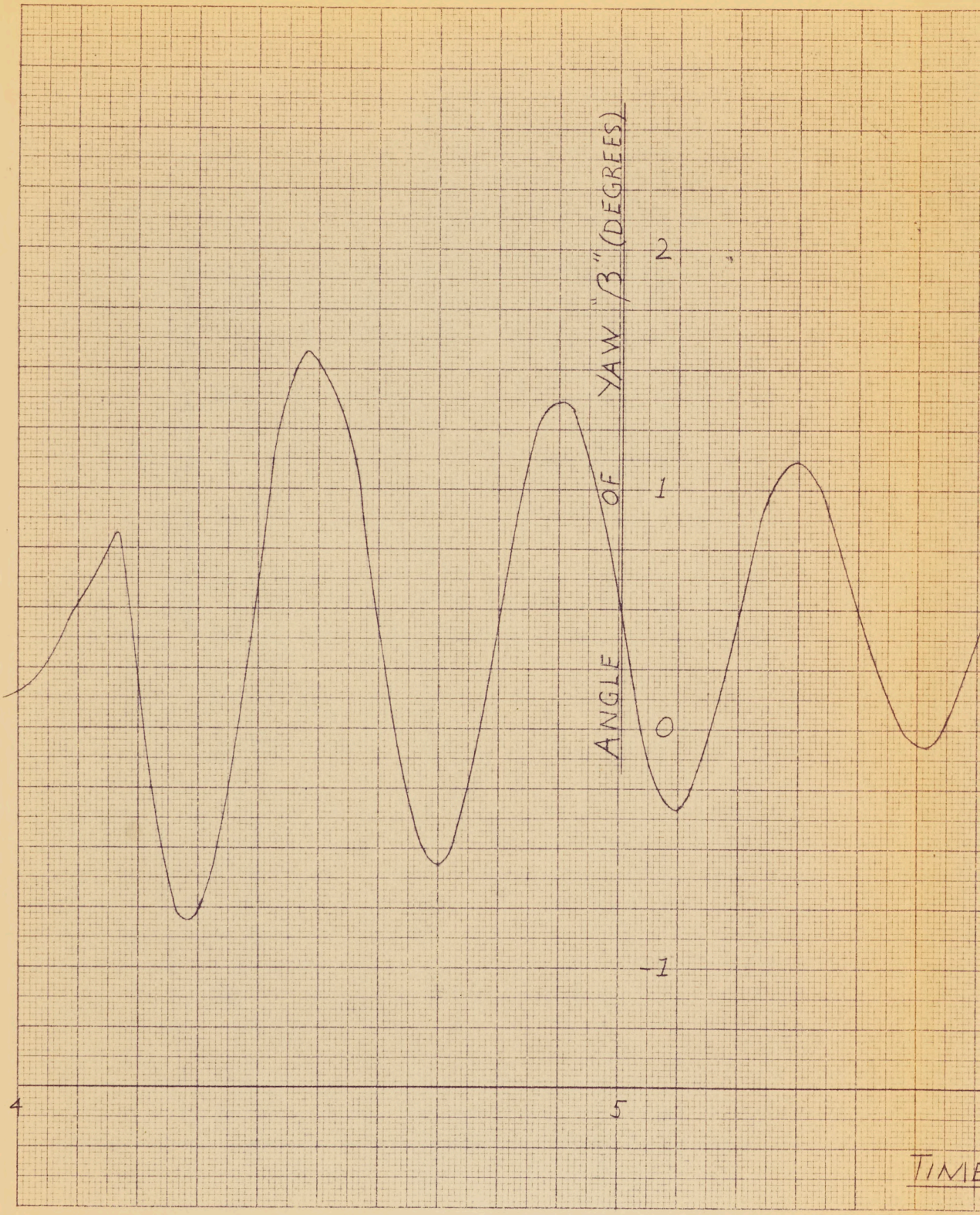
YAW ANGULAR ACCELERATION



6

7

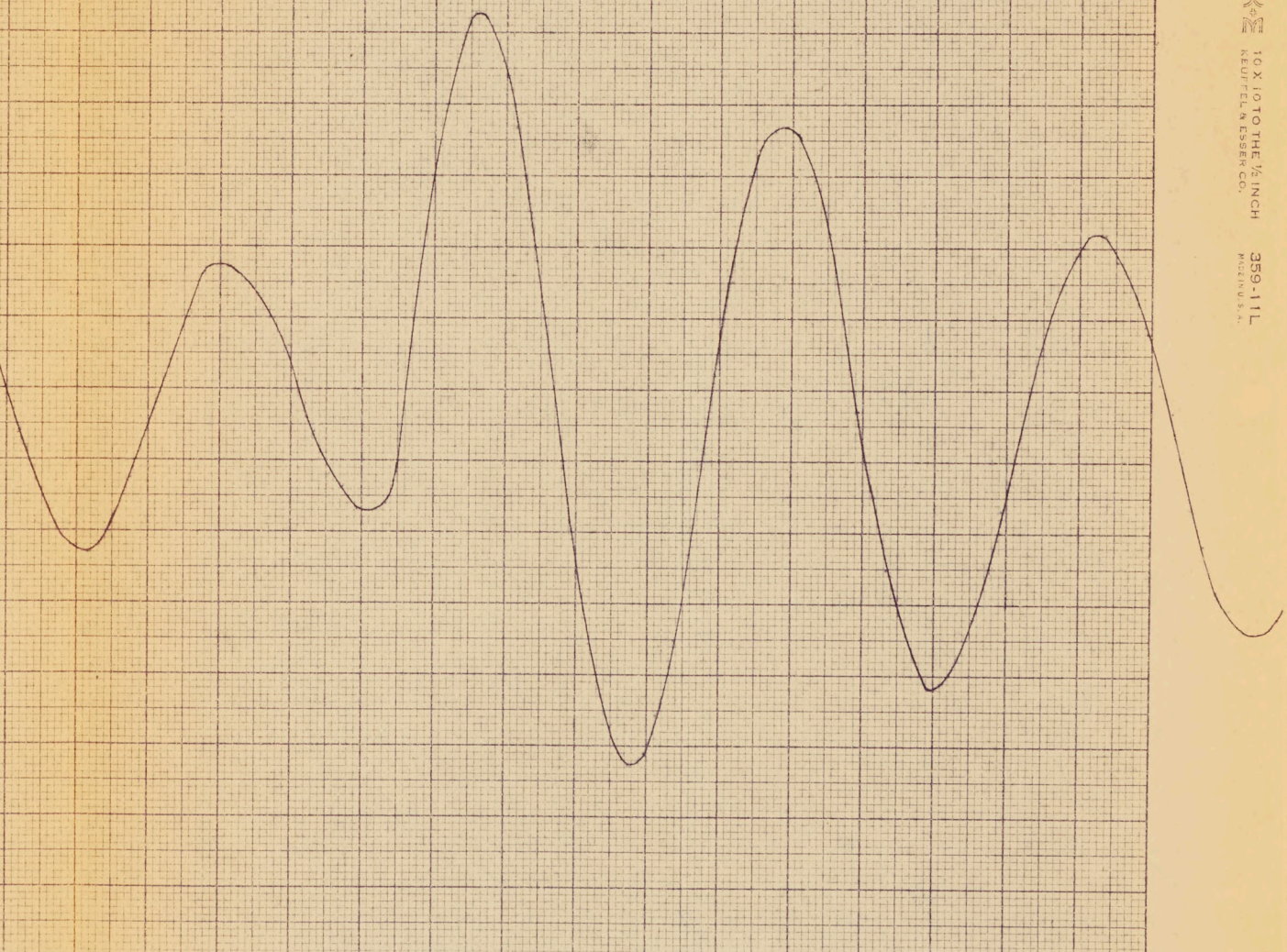
(SECONDS)


ANGLE OF YAW "β" (DEGREES)
2
1
0
-1
4
TIME

P/FFM/8

FF #4

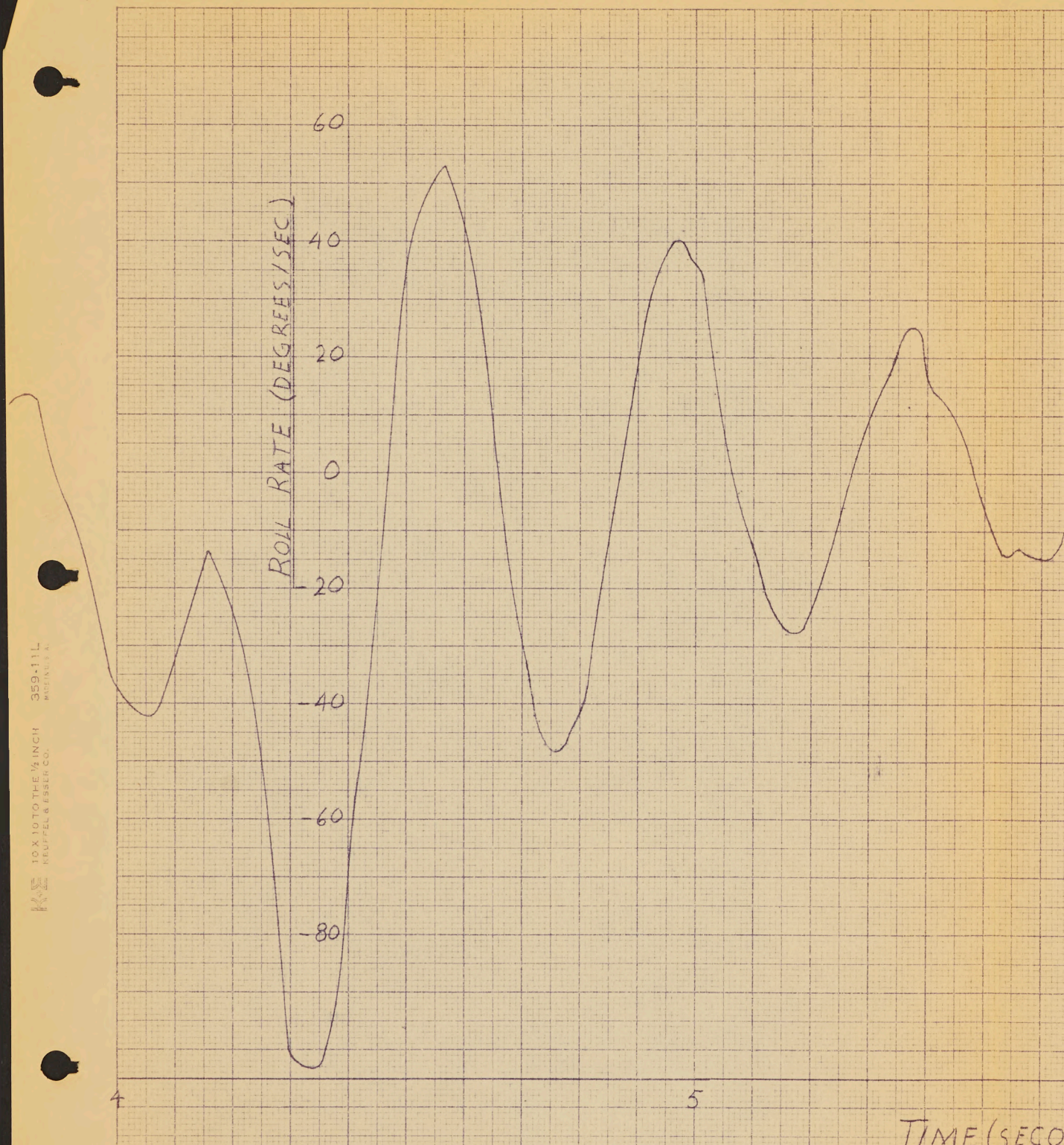
ANGLE OF YAW "β"



6

7

TIME (SECONDS)



P/FFM/8

FF # 4

ROLL RATE