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Full Scale Measurements of Impact Loads on a Large Flying Boat (Sunderland Mk. 5) Part V - Results of Rough Water Tests

By

R. Parker, B.Sc., and J. K. Friswell, B.Sc.

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MARINE AIRCRAFT EXPERIMENTAL ESTABLISHMENT, FELIXSTOWE, SUFFOLK

FULL SCALE MEASUREMENTS OF IMPACT LOADS ON A LARGE FLYING BOAT (SUNDERLAND MK.5)

PART V - RESULTS OF ROUGH WATER TESTS

by

R. Parker, B.Sc.
J.K. Friswell, B.Sc.

SUMMARY

The results of a number of take-off's and landings in various sea conditions are presented in the form of statistical data, both local pressures and overall accelerations being given.

During the tests the worst loading conditions were encountered in short to medium swells.

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/1. Introduction

1. INTRODUCTION

A series of landing impact tests has been carried out on a Sunderland Mk.V flying boat, the results of the tests in calm water having already been reported.[1, 2, 3, 4] The present report deals with the later tests in the series, which comprised landings in rough water, some measurements also being taken during the corresponding take-offs. Some tests preliminary to the main series, in which only a limited number of pressure pick-ups were used but in which the aircraft was severely damaged, have been reported on in Reference 5.

The rough water test results given in the present report include C.G. and pitching accelerations, as well as local pressures at a large number of points on the forebody and afterbody of the aircraft. The nature of the tests makes comparison of the results with theory very difficult, and accordingly the results have only been analysed to give maximum values of accelerations and local pressures, these results being roughly grouped and limited statistical analysis effected.

The main value of the results will lie in their application to flying boat design, and in their relation to present flying boat airworthiness requirements.

2. DESCRIPTION OF AIRCRAFT

The aircraft used was a standard Sunderland Mk.V flying boat with four Pratt and Whitney Twin Wasp engines. A general arrangement drawing and details of the load distribution used for the tests are given in Figure 1 and a lines plan of the aircraft in Figure 2. Aerodynamic data pertaining to the aircraft is given in Table I.

All tests were made at an all-up weight of 50,000 lbs. with the centre of gravity 3 ft. forward of the main step point, measured parallel to the hull datum.

3. INSTRUMENTATION

Much of the instrumentation used was also employed on the earlier tests and has already been described in some detail in Reference 1; brief details only of these items are therefore given, and reference is made to any variations from the original arrangements.

3.1. Measurement of Accelerations

Two accelerometers were used, one being fitted on the mainspar centre section and the other just above and slightly forward of the rear step point, both accelerometers measuring vertical acceleration (relative to the aircraft). From the readings of these two accelerometers the C.G. acceleration and pitching acceleration could be derived, the C.G. lying between the two accelerometer positions and close to the forward accelerometer.

For some of the tests the inductance type accelerometers[1] were replaced by N.A.E.L. recording accelerometers.

3.2. Measurement of Local Pressures.

The planing bottom pressures were measured by flush diaphragm type pressure pick-ups similar to those described in Reference 1, but of a more robust and watertight construction.[4]

/The

The pick-ups were distributed over the whole of the forebody and afterbody, being concentrated mainly in two lines, one near the keel and one near the chine, with only a small number at intermediate positions. The exact positions of the pick-ups are given in Table II and illustrated in Figure 3.

3.3. Measurement of Attitude and Roll

The attitude and roll of the aircraft were obtained by reference to a free vertical gyroscope, but only the attitude signal was applied to the recorder, the roll being observed visually by the observer. In no case did this deviate appreciably from zero, and accordingly this parameter was neglected.

3.4. Measurement of Vertical and Horizontal Velocities and Draught

With the exception of a few reference runs performed in calm water, all landings and take-offs were made in rough water. Accordingly draught readings would have had little significance, and also the absolute vertical velocity of the aircraft did not equal its vertical velocity relative to the water surface immediately below it. For these reasons the shore camera installation used to measure these quantities in the earlier, calm water, tests was discarded.

Horizontal velocity only was recorded, this being obtained by visual observation of a low reading airspeed indicator at the instant of touchdown in landings and at as near as possible to unstick during take-offs.

Wind speeds were obtained from a hand-held anemometer in a stand-by boat.

3.5. Recording of Readings

Apart from the readings of the recording accelerometers, when used, all readings were recorded on two 12-channel galvo camera recorders manufactured by Films and Equipment Ltd., used in conjunction with McMichael amplifiers where necessary.

3.6. Accuracy of Measurements

The accuracy achieved in the various measurements is estimated[1] to be as follows

Attitude	±	0.5°
Time	±	0.1%
Acceleration	±	0.1 g.
Pressures	±	5 %

(The minimum time of build-up which could be recorded was 0.01 seconds)

4. RANGE OF TESTS

Tests were made over as large a range of sea conditions as possible, and for convenience in analysis the seas encountered have been divided into five groups, namely,

I	Calm Sea
II	Choppy Sea
III	Short Swell
IV	Medium Swell
V	Long Swell

/Details

Details of the precise sea conditions included in each group are given in Tables III and IV.

Runs in Group I were included for comparison purposes, as it was felt desirable to have results from calm water landings and take-offs using the same piloting techniques and experimental methods as the rough water cases, rather than to attempt to use data obtained from previous tests.

Most of the rough water runs fell in Groups II, III and IV, the data from the one series of runs performed in Group V being unfortunately incomplete as the recordings were spoilt by adverse weather conditions.

5. PILOTING TECHNIQUES

5.1. Landings

The pilot was asked to make landings by techniques normal in squadron service for the sea conditions prevailing, except that when several landings had already been made in one sea condition at one touchdown airspeed he was asked to attempt either higher or lower speeds.

He was however asked wherever possible not to apply full engine power and take-off again after a skip, as would normally happen, but to continue his landing. This resulted in high engine power being used in all landings and in relatively low touchdown speeds. Two-thirds flap was used throughout, and all landings were made into wind.

5.2. Take-offs

Take-offs were made into wind with full power in all cases and with one-third flap, the pilot being given no special instructions. He was allowed to use any controls necessary to counter violent motion and it was usual for the take-off to end by the aircraft being thrown off the water. Take-off points were in general not very accurately observed, as it was difficult to know whether the aircraft would remain airborne or not in any particular case.

6. RESULTS

From the records obtained during the tests, typical examples of which are reproduced in Figures 4 - 7, the maximum values of pressures and accelerations were determined for each run and have been used as the basis for analysis. Owing to the confused nature of the seas encountered time histories, as such, of the results gave little useful data.

General details of the test conditions for the various runs are given in Tables III and IV.

6.1. Acceleration Results

The maximum positive and negative accelerations recorded on each accelerometer, together with the pitching accelerations when these occurred, are given in Tables V and VI for each run. Pitching accelerations have however been omitted in a number of cases as synchronisation of the various records could not be achieved owing to damage to the records after completion of the tests.

A detailed investigation of the quantities given in these tables failed to reveal any significant variation of the various

/accelerations

accelerations with wind speed and water speed, and accordingly the results were merely classified according to the sea groups in which the tests were made and mean values of the different maxima calculated for each group. These mean values are given in Tables VII and VIII, together with the absolute maxima over each group. The pitching accelerations given in the latter tables only represent the mean and absolute maxima of the values at instants of maximum readings on the individual accelerometers and are not necessarily indicative of the true maxima for the tests; they have been derived from Tables V and VI.

Since the centre of gravity of the aircraft is near to the forward accelerometer position, the forward acceleration can be regarded as giving an approximation to the c.g. acceleration. On this basis it will be seen that for landings c.g. accelerations are most severe in short swell conditions (Group III), this conclusion applying to both the mean and absolute maxima. At the rear of the aircraft, however, the accelerations increase in severity as the swell length increases, this increase being accompanied by an increase in pitching acceleration. These conclusions, which are drawn from the positive maxima, are in general substantiated by the negative maxima.

Similar remarks apply to the results of the take-offs, although here there is a shift of absolute maximum c.g. acceleration from short to medium swell conditions (Group IV). Again the severity of rear accelerations increases with swell length, and there is general agreement between conclusions drawn from positive and negative maxima. Pitching accelerations show no general trend here, however. In almost all cases take-off maximum accelerations are less than the corresponding landing accelerations.

6.2 Pressure Results

Tables IX and X show the maximum positive and negative pressures recorded by each pick-up for each run. As in the case of the acceleration results, there is no apparent correlation between these values and the wind and water speeds for the runs concerned. Here again, therefore, mean and absolute maxima have been calculated for results falling in each of the sea groups, these values being shown in the tables and plotted in diagrammatic form in Figures 8 and 9. In Figures 10 to 13 the keel values are replotted in an alternative form.

Examination of the different results for the forebody during landing shows that while there is little change in the general order of pressures near the main step point from one group to another, there is an increase in the chine pressures as one proceeds from Group I to Group III, and a movement forward of the point of maximum keel pressure together with an associated increase in pressures towards the bows. There is a slight reversal of these trends in proceeding from Group III to Group IV.

Similar trends are found in the take-off results, although the pressures are much smaller and conditions near the main step more confused.

There are very few significant differences between the various afterbody results, either during landings or take-offs, but it will be observed that both pressures and suctions are much higher on landing than on take-off.

The variations of the pressures and suctions over the planing surfaces within the various groups are much as would be expected, and do not call for any special comment.

/7

7. RESULTS OF PRELIMINARY TESTS

It is interesting to note that the results of the preliminary tests on this aircraft[5], which were made in a swell about 20 ft. long and 2 ft. high (sea group IV of the present report) give a different form of overall maximum pressure distribution along the keel during the landings than that found in the main series of tests.

The preliminary test results show two peaks in the pressure distribution, one at or near the main step as in the present tests and one towards the bows which is not present in the main series. The consistency of both sets of results within themselves indicates that both are true results, and it is known that high bow pressures were present in the preliminary tests as these in fact gave rise to local structural failures. It is quite possible that the differences are due to the presence in the preliminary tests of occasional crests and troughs of the order of 3 ft. high; these were thought at the time to be associated with the structural failures.

Both series of tests show a bow pressure peak during take-offs, but this is much more marked in the preliminary than in the main series.

The general overall orders of the pressures and accelerations encountered were the same in both series of tests, though only limited instrumentation was installed during the preliminary series.

8. THE USE OF LOCAL PRESSURE DATA IN DESIGN

When using the maximum pressure results of this report for design purposes, it must be borne in mind that the maxima at different points do not always occur simultaneously.

In calm water, as the aircraft touches down, a small region of high pressure near the edge of the wetted area moves across the planing bottom from the main step, as is shown for a typical case in Figure 4, and maximum pressures occur in succession at adjacent points. A similar, but rather more confused, state of affairs exists for landings in choppy seas (Figure 5).

When landings are made in swells, conditions are somewhat different. Here the first point on the aircraft to touch the water may well be not the main step, as in calm water landings, but some other part of the keel. Several of the individual impacts for which pressures are given in Figure 6 are of this type, this landing having been made in a short swell. It will be observed that in this case there is rather more of a tendency for the maximum pressures to occur simultaneously at several adjacent points than in the calm water case. A typical landing into a somewhat longer swell (Figure 7) shows some of the characteristics of each of the previous types, the first pressures not occurring at the main step, but there being less tendency for maximum pressures to occur simultaneously at several different points.

This difference in the timing of maximum pressures at different points will obviously have an important effect on design, as it will affect the ratio of the mean pressure over any particular area of the hull bottom to the maximum local pressures and so the local design loading. It would appear from the results of the present tests that swell conditions require a somewhat stronger structure than calm water conditions.

/9. Discussion

9. DISCUSSION

It is not proposed to add appreciably to the detailed remarks which have been made in earlier sections of the report. The main aim of the investigation has been to provide reliable information on the orders of pressures and accelerations likely to be met in various sea conditions, and in this it has been generally successful. The results are of course peculiar to the Sunderland aircraft, but it is probable that the general trends will be the same for other types, though of course the actual values will be different. It is worth mentioning that in none of the tests performed on the aircraft was the maximum design c.g. acceleration of 3.5 g. approached, the maximum of the present series being about 1.5 g. and of the preliminary series[5] 2.4 g. (the latter being the case in which structural failures occurred).

Higher accelerations, particularly pitching accelerations, can be expected if any pitching instability develops during take-off or landing, though this did not happen in the tests under consideration. It should also be borne in mind that the tests were done by experienced test pilots who were permitted free use of the controls to avoid serious damage to the aircraft.

10. CONCLUSIONS

While the data obtained in the tests does not allow detailed conclusions to be drawn, it can be said that the maximum accelerations normally recorded are appreciably less than those assumed in present day design. Short to medium length swells appear to produce the most severe loading conditions in general, but this does not preclude isolated severe loadings in other sea conditions.

/List of References

LIST OF REFERENCES

No.	Author(s)	Title
1	J.W. McIvor	Full Scale Measurements of Impact Loads on a Large Flying Boat. Part I - Description of Apparatus and Instrument Installation. C.P. 182. March, 1950.
2	J.A. Hamilton	Full Scale Measurements of Impact Loads on a Large Flying Boat (Sunderland Mk.5). Part II - Results for Impacts on Main Step. C.P. 205. February, 1951.
3	R. Parker	Full Scale Measurements of Impact Loads on a Large Flying Boat (Sunderland Mk.5). Part III - Data for Impacts on Main Step. C.P. 340. August, 1954.
4	R. Parker	Full Scale Measurements of Impact Loads on a Large Flying Boat (Sunderland Mk.5). Part IV - Data for Impacts on the Afterbody. C.P. 341. August, 1954.
5	R. Parker	Preliminary Pressure Measurements during the Landing of a Sunderland Mark 5 Flying Boat in Rough Water Conditions, including One on Which the Forebody was Severely Damaged. M.A.E.E. Report No. F/Res/227. September 1952. A.R.C. 15,201.
6	D.M. Ridland R. Parker	The M.A.E.E. Recording Accelerometer. C.P. 177. September, 1952.

TABLE I

DETAILS OF SUNDERLAND MK.5

Hull

Beam (max)	9.79 ft.
Length (F.P. to Rear Step)	62.12 ft.
Length : Beam Ratio	6.35
Forebody Length (F.P. to Main Step Keel)	32.94 ft.
Afterbody Length (Main Step Keel to Aft Step)	29.18 ft.
Keel-Chine Deadrise at Main Step	26°
Step Plan Included Angle	132°
Forebody Keel - Hull Datum Angle	3°
Heel - Heel Angle	9° 17'
Forebody Keel - Afterbody Keel Angle	7° 29'
Main Step Fairing Ratio	6:1

Wings

Area (gross)	1687 sq.ft.
Span	112.8 ft.
Incidence to Hull Datum	5° 9'
Section	Gottingen 436 modified

Flaps

Type	Gouge
Area	286 sq.ft.

Tailplane

Area (including elevators)	205 sq.ft.
Elevator area (including tabs)	84.5 sq.ft.
Elevator movement	16° 30' up and down

Engines

4 Pratt Whitney Twin Wasp R.1830-90B giving 1200 B.H.P. at 2,700 r.p.m. and + 9 lb/sq.in. boost for sea level take-off.

Loading

At A.U.Wt. 50,000 lb.

C.G. "Normal" is 3.02 ft. forward of main step at keel parallel to hull datum line.

TABLE II

DETAILS OF INDIVIDUAL PRESSURE PICK-UP AND ACCELEROMETER POSITIONS

Pick-up No.	l (in.)	l' (in.)	b (in.)	C (in.)	β_L
1	359.3		7.2	10.2	47.6°
2	324.3		9.6	12.8	42.5°
3	293.3		6.45	8.0	40.0°
3A	293.3		44.8	52.6	15.0°
4	253.3		7.7	9.15	34.6°
4A	253.3		49.1	55.5	15.5°
5	206.2		9.8	11.5	31.0°
6	144.7		10.85	12.6	30.5°
7	93.1		7.0	8.3	31.5°
8	70.3		7.3	8.7	31.0°
8A	70.3		52.1	56.3	18.0°
9	33.8		7.6	8.9	31.0°
9A	33.8		50.2	56.3	19.0°
9B	33.8		28.8	33.1	27.0°
10	13.7		7.6	9.0	31.0°
11		346.75	13.6	16.3	36.75°
12		319.25	10.4	12.4	35.7°
12B		319.25	29.8	35.3	30.75°
13		237.25	6.7	8.8	38.5°
13A		237.25	36.8	43.9	28.0°
14		175.75	6.4	8.1	37.0°
14A		175.75	23.3	28.1	28.5°
15		112.5	7.0	8.6	35.0°
15A		112.5	16.1	19.2	27.0°
16		69.0	6.8	8.1	31.5

Forward Accelerometer	13' 1" above main step 8' 6.3" forward of main step	measured parallel and normal to hull datum
Rear Accelerometer	26' 10.9" aft of main step	

l — Distance forward of main step at keel and parallel to keel datum.

l' — Distance forward of rear step and parallel to keel datum.

b — Horizontal distance from keel to pressure pick-up

C — Distance from keel to pick-up along keel-chine line.

β_L — Local deadrise

TABLE III

DETAILS OF LANDINGS

DATE	LAND -ING	TOUCHDOWN IAS KNOTS	WIND-SPEED KNOTS	SEA HT x LENGTH - FT.	GROUP	UNSERVICEABLE INSTRUMENTS
15.8.52	1	77	13	½ Chop	II	
	2	73	9	1½ Chop	II	Accelerometers. Some Pick-ups
	3	73	11	2 x 20	IV	Accelerometers. Some Pick-ups
	4	66	12	2 x 20	IV	
	5	73	9	2 x 20	IV	
	6	73	11	2 x 20	IV	
	7	77	13	½ Chop	II	
19.8.52	1	77	18	1½ x 12	III	
	2	68	18	1½ x 12	III	
	3	69	15	1½ x 12	III	
	4	71	20	1½ x 12	III	
	6	71	19	1½ x 12	III	
25.8.52	1	72	10	Calm	I	Accelerometers. Some Pick-ups
	2	69	10	Calm	I	
	3	66	6	Calm	I	
	4	76	10	Calm	I	
	5	72	9	Calm	I	
	6	71	9	Calm	I	
	7	67	11	Calm	I	Accelerometers. Some Pick-ups
	8	71	8	Calm	I	
27:8.52	1	77	17	1½ Chop	II	
	2	71	17	1¼ Chop	II	
3.9.52	1	71	19	1½ x 15	III	
	2	71	19	1½ x 15	III	
	3	68	20	2½ x 20	IV	Some Pick-ups
	4	71	19	2 x 20	IV	
	5	75	20	2 x 20	IV	
	6	72	20	2 x 15	III	Some Pick-ups
	7	72	20	2 x 15	III	Some Pick-ups
19.9.52	2	80	10	½ Chop	II	Accelerometers. Some Pick-ups
3.10.52	1	74	14	1 Chop	II	Accelerometers
	3	81	14	1 Chop	II	All Pick-ups. Accelerometers
6.10.52	1	78	18	1½ Chop	II	Accelerometer Synchronisation
	2	77	16	1¼ Chop	II	Accelerometer Synchronisation
	3	74	21	1½ Chop	II	Accelerometer Synchronisation
	4	74	16	1¾ Chop	II	Accelerometer Synchronisation
	5	76	12	1¾ Chop	II	Accelerometer Synchronisation
	6	83	16	1 Chop	II	All Pick-ups. Accelerometer Synchronisation.
19.10.52	1	79	21	1½ x 25	IV	Accelerometer Synchronisation
	2	79	18	1½ x 25	IV	Accelerometer Synchronisation
	3	76	19	1½ x 25	IV	Accelerometers
	4	83	16	2½ x 25	IV	Accelerometer Synchronisation
	5	73	20	2½ x 25	IV	Accelerometer Synchronisation
24.10.52	1	71	19	2½ x 12½	III	Accelerometers
	2	77	24	2 x 12½	III	Accelerometers
	3	77	13	2 x 12½	III	Accelerometers
	4	76	19	2 x 12	III	Accelerometers
	5	71	21	2 x 12	III	Accelerometers
31.10.52	1	70	15	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.
	2	69	15	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.
	3	68	11	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation
	4	73	11	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.
	5	70	11	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.
	6	74	8	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation

TABLE IV

DETAILS OF TAKE-OFFS

DATE	TAKE-OFFS	UNSTICK IAS-KNOTS APPROX.	WIND-SPEED KNOTS	SEA HT x LENGTH - FT.	GROUP	UNSERVICEABLE INSTRUMENTS
15.8.52	5	72	12	2 x 20	IV	
	7	44	14	2 x 20	IV	
19.8.52	2	70	18	1½ x 12	III	
	4	-	18	1½ x 12	III	
	6	44	21	1½ x 12	III	
25.8.52	4	71	10	Calm	I	
	5	71	8	Calm	I	
27.8.52	3	70	19	1½ Chop	II	
3.9.52	1	-	13	1½ x 15	III	Some Pick-ups
	2	74	25	1½ x 15	III	
	4	63	20	2½ x 20	IV	Some Pick-ups
	5	70	19	2 x 20	IV	
3.10.52	2	77	15	1 Chop	II	Accelerometer
6.10.52	1	-	18	1½ Chop	II	All Pick-ups. Accelerometer Synchronisation.
	3	68	17	1½ Chop	II	Accelerometer Synchronisation.
	6	74	15	1½ Chop	II	Accelerometer Synchronisation.
19.10.52	1	35-65	16	1½ x 25	IV	Accelerometer Synchronisation.
	2	67	18	1½ x 25	IV	Accelerometer Synchronisation.
	3	76	19	1½ x 25	IV	Accelerometer Synchronisation.
	4	77	19	1½ x 25	IV	Accelerometer Synchronisation
	5	67	21	2½ x 25	IV	Accelerometer Synchronisation.
24.10.52	2	63	14	2½ x 12½	III	Accelerometers
	3	-	14	2 x 12½	III	Accelerometers
	4	-	16	2 x 12½	III	Accelerometers
	5	-	19	2 x 12½	III	Accelerometers
31.10.52	2	65	18	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation
	3	77	11	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation
	4	76	10	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.
	5	65	11	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.
	7	69	8	2½x50-100	V	All Pick-ups. Accelerometer Synchronisation.

TABLE V (I)

MAXIMUM ACCELERATIONS FOR LANDINGS - GROUP I

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC^2

Run No.	25.8.52 L2	25.8.52 L3	25.8.52 L4	25.8.52 L5	25.8.52 L6	25.8.52 L8
Max. + VE reading on Front Accelerometer	1.10	1.0	0.34	1.15	1.09	1.20
Pitching Acceleration at time of Max. + VE reading on Front Accelerometer	0.80	0.65	0.26	0.92	0.81	0.54
Max. - VE reading on Front Accelerometer	- 0.38	- 0.37	- 0.33	- 0.63	- 0.54	- 0.30
Pitching Acceleration at time of Max - VE reading on Front Accelerometer	- 0.10	- 0.07	- 0.19	- 0.23	- 0.22	- 0.10
Max. + VE reading on Rear Accelerometer	0.38	0.53	0.13	0.63	0.37	0.72
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	0.01	- 0.02	0.10	0.02	0.13	0.37
Max - VE reading on Rear Accelerometer	- 0.73	- 0.62	- 0.18	- 0.65	- 0.63	- 0.74
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	0.51	0.85	0.06	0.77	0.48	0.99

TABLE V (II)

MAXIMUM ACCELERATIONS FOR LANDINGS - GROUP II

LINEAR ACCELERATIONS IN "G"

PITCHING ACCELERATIONS IN RADS./SEC^2

Run No.	1952 15.8 L1	15.8 L7	27.8 L1	27.8 L2	6.10 L1	6.10 L2	6.10 L3	6.10 L4	6.10 L5	6.10 L6
Max + VE reading on front Accelerometer	0.50	0.30	1.14	1.17	0.45	0.72	0.61	1.00	0.80	0.10
Pitching Acceleration at time of Max + VE reading on front accelerometer	0.12	0.11	0.67	0.81						
Max - VE reading on front Accelerometer	-0.32	-0.20	-0.70	-0.58	-0.39	-0.35	-0.30	-0.38	-0.30	-0.09
Pitching Acceleration at time of Max - VE reading on front Accelerometer	0.21	0.02	-0.38	-0.37						
Max. + VE reading on rear Accelerometer	0.38	0.26	0.56	0.46	0.73	0.79	0.58	0.9	0.60	0.16
Pitching Acceleration at time of Max + VE reading on rear Accelerometer	0.09	-0.03	-0.59	0.11						
Max - VE reading on rear Accelerometer	-0.25	-0.25	-0.75	-0.26	-0.41	-0.52	-0.38	-0.55	-0.30	-0.20
Pitching Acceleration at time of Max - VE reading on rear Accelerometer	0.17	0.22	0.28	-0.07						

TABLE V (III)

MAXIMUM ACCELERATIONS FOR LANDINGS - GROUP III

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC^2

Run No.	19.8 L1	19.8 L2	19.8 L3	19.8 L4	1952 19.8 L6	3.9 L1	3.9 L2	3.9 L6	3.9 L7
Max. + VE reading on Front Accelerometer	0.94	1.02	1.02	1.10	1.21	0.92	1.44	1.14	0.75
Pitching Acceleration at time of Max + VE reading on Front Accelerometer	0.92	0.71	0.71	0.82	0.87	0.48	1.29	0.82	0.42
Max - VE reading on Front Accelerometer	-0.66	-0.68	-0.47	-0.71	-0.70	-0.70	-0.52	-0.59	-0.37
Pitching Acceleration at time of Max - VE reading on Front Accelerometer	-0.48	-0.18	-0.14	-0.24	-0.33	-0.37	-0.29	-0.37	-0.23
Max + VE reading on Rear Accelerometer	0.63	0.61	0.59	0.75	0.68	0.60	0.46	0.55	0.42
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	-0.64	0.12	-0.18	-0.11	+0.05	-0.21	0.60	-0.37	0.10
Max - VE reading on Rear Accelerometer	-0.46	-0.63	-0.35	-0.48	-0.45	-0.33	-0.65	-0.52	-0.22
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	+0.03	0.40	-0.08	-0.12	0.20	-0.30	0.52	0.38	0.04

TABLE V (IV)

MAXIMUM ACCELERATIONS FOR LANDINGS -- GROUP IV

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC^2

Run No.	1952 15.8 I4	15.8 L5	15.8 L6	3.9 L3	3.9 I4	3.9 L5	19.10 I1	19.10 L2	19.10 I4	19.10 L5
Max + VE reading on Front Accelerometer	1.02	0.88	1.16	1.13	1.02	1.03	0.37	0.94	1.03	0.98
Pitching Acceleration at time of Max + VE reading on Front Accelerometer	0.71	0.65	0.79	0.72	0.24	0.62				
Max - VE reading on Front Accelerometer	-0.70	-0.83	-0.49	-0.69	-0.59	-0.77	-0.19	-0.59	-0.45	-0.56
Pitching Acceleration at time of Max - VE reading on Front Accelerometer.	-0.31	-0.21	-0.21	-0.42	-0.28	-0.45				
Max + VE reading on Rear Accelerometer	0.48	0.50	0.57	0.66	0.75	0.35	0.50	0.64	0.9	1.0
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	0.34	0.10	-0.18	-0.04	0.21	0.42				
Max - VE reading on Rear Accelerometer	-0.68	-0.70	-0.51	-0.29	-0.41	-0.45	-0.24	-0.39	-0.58	-0.42
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	0.14	0.40	0.42	-0.07	-0.10	0.09				

TABLE V (V)

MAXIMUM ACCELERATIONS FOR LANDINGS - GROUP V

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC.^{2}

Run No.	31.10.52 L1	31.10.52 L2	31.10.52 L3	31.10.52 L5
Max + VE reading on Front Accelerometer	0.79	0.96	0.73	0.91
Pitching Acceleration at time of Max + VE reading on Front Accelerometer				
Max - VE reading on Front Accelerometer	- 0.38	- 0.42	- 0.47	- 0.50
Pitching Acceleration at time of Max - VE reading on Front Accelerometer				
Max + VE reading on Rear Accelerometer	1.24	0.54	0.75	1.80
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer				
Max - VE reading on Rear Accelerometer	- 0.49	- 0.58	- 0.69	- 1.0
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer				

TABLE VI (I)

MAXIMUM ACCELERATIONS FOR TAKE-OFFS - GROUP I

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC.^{2}

Run No.	25.8.1952 T.0.4	25.8.1952 T.0.5
Max. + VE reading on Front Accelerometer	0.25	0.16
Pitching Acceleration at time of Max + VE reading on Front Accelerometer	0.15	0.10
Max - VE reading on Front Accelerometer	- 0.33	- 0.17
Pitching Acceleration at time of Max - VE reading on Front Accelerometer	- 0.25	- 0.07
Max + VE reading on Rear Accelerometer	0.18	0.09
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	- 0.07	- 0.01
Max - VE reading on Rear Accelerometer	- 0.13	- 0.17
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	0.02	0.02

TABLE VI (II)

MAXIMUM ACCELERATIONS FOR TAKE-OFFS - GROUP II

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC.^{2}

Run No.	27.8.52 T.O.3	6.10.52 T.O.1	6.10.52 T.O.3	6.10.52 T.O.6
Max + VE reading on Front Accelerometer	0.45	0.28	0.45	0.35
Pitching Acceleration at time of Max + VE reading on Front Accelerometer	0.33			
Max - VE reading on Front Accelerometer	- 0.62	- 0.53	- 0.33	- 0.30
Pitching Acceleration at time of Max - VE reading on Front Accelerometer	- 0.45			
Max + VE reading on Rear Accelerometer	0.27	0.43	0.39	0.38
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	- 0.02			
Max - VE reading on Rear Accelerometer	- 0.23	- 0.43	- 0.22	- 0.18
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	- 0.17			

TABLE VI (III)

MAXIMUM ACCELERATIONS FOR TAKE-OFFS - GROUP III

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC.^{2}

Run No.	19.8.52 T.O.2	19.8.52 T.O.4	19.8.52 T.O.6	3.9.52 T.O.1	3.9.52 T.O.2
Max + VE reading on Front Accelerometer	0.89	0.72	0.66	0.65	0.99
Pitching Acceleration at time of Max + VE reading on Front Accelerometer	0.74	0.55	0.50	0.15	0.63
Max - VE reading on Front Accelerometer	- 0.44	- 0.58	- 0.45	- 0.70	- 0.57
Pitching Acceleration at time of Max - VE reading on Front Accelerometer	- 0.19	- 0.21	- 0.26	- 0.65	- 0.57
Max + VE reading on Rear Accelerometer	0.45	0.32	0.40	0.60	0.40
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	0.29	0	- 0.45	- 0.29	0.47
Max - VE reading on Rear Accelerometer	- 0.25	- 0.40	- 0.47	- 0.10	- 0.33
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	- 0.05	- 0.05	0.03	0.48	0.63

TABLE VI (IV)

MAXIMUM ACCELERATIONS FOR TAKE-OFFS - GROUP IV

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC.^{2}

Run No.	1952 15.8 T.0.5	15.8 T.0.7	3.9 T.0.4	3.9 T.0.5	19.10 T.0.1	19.10 T.0.2	19.10 T.0.3	19.10 T.0.4	19.10 T.0.5
Max + VE reading on Front Accelerometer	0.66	0.60	1.02	1.04	0.38	0.45	0.40	0.41	0.91
Pitching Acceleration at time of Max + VE reading on Front Accelerometer	0.65	0.40	0.74	0.98					
Max - VE reading on Front Accelerometer	-0.71	-0.46	-0.62	-0.58	-0.34	-0.40	-0.42	-0.38	-0.37
Pitching Acceleration at time of Max - VE reading on Front Accelerometer	-0.56	-0.17	-0.46	-0.22					
Max + VE reading on Rear Accelerometer	0.41	0.37	0.43	0.37	0.48	0.40	0.49	0.45	0.66
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer	0.11	-0.13	-0.44	0.29					
Max - VE reading on Rear Accelerometer	-0.43	-0.41	-0.43	-0.60	-0.40	-0.38	-0.28	-0.30	-0.50
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer	0.26	0.16	0.25	0.86					

TABLE VI (V)

MAXIMUM ACCELERATIONS FOR TAKE-OFFS - GROUP V

LINEAR ACCELERATIONS IN "g"

PITCHING ACCELERATIONS IN RADS./SEC.^{2}

Run No.	31.10.52 T.0.2	31.10.52 T.0.3	31.10.52 T.0.4	31.10.52 T.0.5	31.10.52 T.0.7
Max + VE reading on Front Accelerometer	0.52	0.66	0.62	0.89	0.74
Pitching Acceleration at time of Max + VE reading on Front Accelerometer					
Max - VE reading on Front Accelerometer	- 0.44	- 0.38	- 0.47	- 0.42	- 0.25
Pitching Acceleration at time of Max - VE reading on Front Accelerometer					
Max + VE reading on Rear Accelerometer	0.49	0.73	0.42	0.61	0.39
Pitching Acceleration at time of Max + VE reading on Rear Accelerometer					
Max - VE reading on Rear Accelerometer	- 0.41	- 0.45	- 0.43	- 0.70	- 0.13
Pitching Acceleration at time of Max - VE reading on Rear Accelerometer					

TABLE VII

SUMMARY OF MEAN AND ABSOLUTE MAXIMUM VALUES OF ACCELERATIONS FOR LANDINGS

MEAN MAXIMUM ACCELERATIONS OF EACH GROUP

GROUP	FRONT ACCELEROMETER (g)		REAR ACCELEROMETER (g)		PITCHING ACCELERATION (+ VE or - VE)
	Max + VE	Max - VE	Max + VE	Max - VE	
I	0.98	- 0.43	0.46	- 0.59	0.16
II	0.68	- 0.36	0.54	- 0.38	0.45
III	1.07	- 0.60	0.59	- 0.45	0.51
IV	0.96	- 0.58	0.64	- 0.47	0.69
V	0.85	- 0.44	1.08	- 0.69	-

ABSOLUTE MAXIMUM ACCELERATIONS OF EACH GROUP

GROUP	FRONT ACCELEROMETER (g)		REAR ACCELEROMETER (g)		PITCHING ACCELERATION (+ VE or - VE)
	Max + VE	Max - VE	Max + VE	Max - VE	
I	1.20	- 0.63	0.72	- 0.74	0.25
II	1.17	- 0.70	0.90	- 0.75	0.45
III	1.44	- 0.71	0.75	- 0.65	0.74
IV	1.16	- 0.83	1.00	- 0.70	0.98
V	0.96	- 0.50	1.80	- 1.00	-

TAPLE VIII

SUMMARY OF MEAN AND ABSOLUTE MAXIMUM VALUES

OF ACCELERATIONS FOR TAKE-OFFS

MEAN MAXIMUM ACCELERATIONS OF EACH GROUP

GROUP	FRONT ACCELEROMETER (g)		REAR ACCELEROMETER (g)		PITCHING ACCELERATION (+ VE or - VE)
	Max + VE	Max - VE	Max + VE	Max - VE	
I	0.21	- 0.25	0.14	- 0.15	0.66
II	0.38	- 0.45	0.39	- 0.27	0.43
III	0.78	- 0.55	0.43	- 0.31	0.78
IV	0.65	- 0.48	0.45	- 0.41	0.62
V	0.69	- 0.39	0.53	- 0.42	-

ABSOLUTE MAXIMUM ACCELERATIONS OF EACH GROUP

GROUP	FRONT ACCELEROMETER (g)		REAR ACCELEROMETER (g)		PITCHING ACCELERATION (+ VE or - VE)
	Max + VE	Max - VE	Max + VE	Max - VE	
I	0.25	- 0.33	0.18	- 0.17	0.99
II	0.45	- 0.62	0.43	- 0.43	0.81
III	0.99	- 0.70	0.60	- 0.47	1.29
IV	1.04	- 0.71	0.66	- 0.60	0.79
V	0.89	- 0.47	0.73	- 0.70	-

TABLE IX (I)

MAXIMUM PRESSURES FOR LANDINGS - GROUP I (P.S.I)

Pick-up No. \ Run No.	1952 25.8 L1	25.8 L2	25.8 L3	25.8 L4	25.8 L5	25.8 L6	25.8 L7	25.8 L8	Mean Max. Pressures	Absolute Max. Pressures
1	-	-	-	-	-	-	-	-	-	-
2	-	0	0	0	0	0	-	-	0	0
3	-	3.4	0	0	0	0	-	0	0.6	3.4
3A	-	-	-	-	-	-	-	-	-	-
4	-	5.1	0	0	0	0	-	0	0.9	5.1
4A	-	2.1	0	0	0	0	-	0	0.4	2.1
5	-	4.9	0	0	0	0	-	0	0.8	4.9
6	-	10.3	16.4	0	9.1	8.5	-	14.2	9.8	16.4
7	11.5	16.6	17.5	10.0	20.4	18 3	18.5	22.8	17.0	22.8
8	13.3	14.8	15.1	14.4	21.4	19.1	20.1	19.6	17.6	24.4
8A	9.1	9.4	4 7	1.9	6.2	7.8	9.5	20.7	8.7	20.7
9	19.8	18.8	22.0	18.6	22.7	22.3	23.9	25.7	21.7	25.7
9A	11.7	25.6	24.0	0	23.2	24.5	23.5	27.8	19.8	27.8
9B	16.0	26.1	22.1	0	22.9	25.4	30.4	27.5	21.3	30.4
10	-	19.9	29.1	29.9	24.8	24.5	-	25.1	25.6	29.9
11	-	-	-	-	-	-	-	-	-	-
12	0 0	0 - 2.3	0 - 2.7	0 0	0 - 2.9	0 - 2.9	0 - 0.5	0 - 3.5	0 - 1.9	0 - 3.5
12B	0 0	0 - 2.6	0 - 3.0	0 - 0.7	0 - 2.5	0 - 2.7	0 - 5.4	2.6 - 3.5	0.3 - 2.6	2.6 - 5.4
13	0 0	0 - 2.7	3.0 - 3.0	0 0	0 - 3.2	0 - 2.9	5.8 - 5.1	0 - 3.5	1.1 - 2.5	5.8 - 5.1
13A	- -	4.5 - 1.4	3.1 0	3.8 0	3.1 - 5.3	4.5 0	- -	2.9 - 1.5	3.7 - 1.4	4.5 - 5.3
14	0 0	0 - 2.8	4.3 - 1.9	0 0	4.0 - 2.8	4.1 - 2.2	13.8 - 2.1	12.1 - 2.9	4.8 - 1.8	13.8 - 2.9
14A	- -	3.9 - 2.1	2.1 - 1.3	1.7 0	3.1 - 2.2	3.1 0	- -	3.6 - 3.0	2.9 - 1.4	3.9 - 3.0
15	0 0	8.5 0	7.2 0	0 0	9.1 0	7.3 0	6.7 - 2.4	13.8 - 0	6.6 - 0.3	13.8 - 2.4
15A	-	-	-	-	-	-	-	-	-	-
16	0 0	5.1 0	7.6 - 1.6	0 0	6.3 0	8.0 0	7.1 - 1.8	7.9 0	5.3 - 0.4	7.9 - 1.8

TABLE IX (II)

MEDIUM PRESSURES FOR LANDINGS - GROUP II (P.S.I.)

Run No / Pick-up No.	1952 15.8 L1	15.8 L2	15.8 L7	27.8 L1	27.8 L2	19.9 L2	3.10 L1	6.10 L1	6.10 L2	6.10 L3	6.10 L4	6.10 L5	Mean Max. Pressures	Absolute Max. Pressures
1	-	-	-	-	-	0	0	0	0	0	0	0	0	0
2	0	-	1.1	4.2	2.7	0	3.0	2.5	2.8	0	0	0	1.5	4.2
3	0	-	3.5	4.7	2.8	0	4.6	3.1	3.9	3.3	3.3	2.0	2.8	4.7
3A	-	-	-	6.3	4.6	-	5.5	0	3.2	0	0	0	2.5	6.3
4	0	-	3.9	6.4	5.2	0	5.2	2.9	2.7	3.0	4.9	5.0	3.6	6.4
4A	0	-	0	5.0	2.6	0	3.3	0	3.2	3.4	1.9	1.4	1.9	5.0
5	0	-	5.2	7.2	4.4	0	3.5	2.9	4.2	3.4	5.9	2.8	3.6	7.2
6	0	-	5.5	8.0	7.5	0	12.9	7.5	7.6	8.3	13.8	8.4	7.2	13.8
7	17.5	13.2	11.7	14.8	19.7	-	17.1	11.1	16.4	14.7	15.2	17.1	15.3	19.7
8	-	-	-	20.7	19.4	-	22.2	-	-	-	-	-	20.8	22.2
8A	0	9.2	4.0	15.2	9.6	-	26.3	10.5	8.4	10.3	23.2	6.3	11.2	26.3
9	24.9	17.7	29.3	24.6	25.6	-	24.4	11.2	18.5	18.3	19.9	22.1	21.5	29.3
9A	11.1	8.0	8.4	21.9	23.1	-	28.3	-	-	-	-	-	16.8	28.3
9B	-	-	-	-	-	-	26.8	17.3	20.3	19.0	24.9	17.8	21.0	26.8
10	23.9	-	26.0	21.4	18.5	19.8	17.9	14.9	17.9	14.5	20.0	14.1	19.0	26.0
11	0 - 0.1	0 0	0 0	-	-	-	-	0 - 3.0	0 - 2.9	0 - 3.5	0 - 4.3	0 - 2.3	0 - 2.0	0 - 4.3
12	0 - 0.8	0 0	0 0	0 - 1.2	0 - 1.7	-	0 - 2.1	0 - 2.3	0 - 2.4	0 - 2.8	0 - 2.8	0 - 1.6	0 - 1.6	0 - 2.8
12B	1.8 - 1.1	0 0	0.7 0	4.4 - 1.9	2.7 0	-	0 - 2.7	0 - 2.4	0 - 2.6	0 - 2.9	0 - 3.7	0 - 1.7	0.9 - 1.7	4.4 - 3.7
13	4.6 0	0 0	7.2 0	0 - 1.5	0 - 1.4	-	0 - 2.2	0 - 2.0	0 - 2.0	0 - 3.1	5.2 - 2.3	0 - 1.6	1.6 - 1.5	7.2 - 3.1
13A	3.7 0	-	4.6 0	1.8 - 1.6	2.5 0	-	5.4 0	2.0 - 0.7	2.0 - 1.8	3.5 - 1.5	3.3 0	3.5 0	3.2 - 0.6	5.4 - 1.8
14	3.9 0	0 0	4.8 0	1.7 - 1.6	4.7 - 0.9	-	5.6 - 2.5	0 - 1.1	12.3 - 1.4	5.4 - 2.1	5.8 - 2.2	2.7 - 1.7	4.3 - 1.2	12.3 - 2.5
14A	2.1 - 1.3	-	4.1 0	-	-	5.5 - 1.2	-	-	-	-	5.0 0	2.8 0	3.9 - 0.5	5.5 - 1.3
15	7.3 0	0 0	7.3 0	7.3 0	5.4 0	-	5.8 0	3.8 0	5.3 0	5.2 - 0.6	17.1 0	4.0 0	6.2 - 0.1	17.1 - 0.6
15A	6.2 0	0 0	7.1 0	6.7 0	9.5 0	-	5.5 0	3.8 0	4.4 0	4.0 - 1.0	6.6 0	4.2 0	5.3 - 0.1	9.5 - 1.0
16	- -	- -	- -	- -	4.9 0	- -	4.2 0	3.5 0	4.2 0	4.4 0	5.2 0	4.4 0	4.4 0	5.2 0

TABLE IX (III)

MAXIMUM PRESSURES FOR LANDINGS - GROUP III (P.S.I.)

Run No / Pick up No	19.8 L1	19.8 L2	19.8 L3	19.8 L4	19.8 L6	3.9 L1	3.9 L2	3.9 L6	3.9 L7	24.10 L1	24.10 L2	24.10 L3	24.10 L4	24.10 L5	Mean Max. Pressures	Absolute Max. Pressures
1	-	-	-	-	-	0	0	0	0	0	0	1.0	1.6	0	0.29	1.6
2	2.0	0	0	0	0	3.1	2.9	2.6	0	4.1	1.8	4.3	3.7	2.5	1.9	4.3
3	2.9	0	3.2	0	0	3.3	3.4	3.2	2.9	3.4	3.9	4.7	3.9	3.8	2.8	4.7
3A	-	-	-	-	-	5.9	0	6.6	0	5.2	3.0	9.0	7.1	2.8	4.4	9.0
4	4.5	3.7	4.3	1.0	5.4	3.9	4.7	6.1	5.9	8.5	8.6	5.6	7.1	12.1	5.8	12.1
4A	4.3	0	0	0.9	0	3.5	3.1	2.3	2.6	3.7	4.7	5.4	6.1	4.3	2.9	6.1
5	6.1	9.8	3.7	1.2	7.9	7.2	9.9	7.0	5.0	6.5	8.7	11.9	10.6	7.4	7.4	11.9
6	9.2	6.0	9.7	7.6	13.0	7.7	11.3	9.7	6.2	9.6	10.6	11.4	16.3	14.0	10.2	16.3
7	21.8	17.2	19.5	20.2	20.7	15.5	14.4	-	-	18.1	16.0	19.6	17.6	13.1	17.8	21.8
8	18.9	17.3	16.3	13.1	13.4	12.4	20.9	-	-	14.2	19.7	19.2	16.4	16.0	16.5	20.9
8A	21.8	9.6	12.0	20.2	21.8	18.2	38.3	-	-	17.5	14.5	16.2	23.3	16.2	19.1	38.3
9	23.1	18.5	18.8	25.1	30.3	17.9	23.6	-	-	24.0	16.9	21.7	22.2	16.0	21.5	30.3
9A	28.0	18.2	17.5	29.8	26.0	18.1	34.0	-	-	29.6	15.5	26.5	17.8	14.3	22.9	34
9B	29.7	24.6	0	25.4	21.3	-	-	-	-	21.2	19.3	26.5	20.4	17.5	20.6	29.7
10	21.7	16.4	18.9	23.3	14.8	14.6	19.9	19.6	17.3	17.1	17.4	17.8	23.0	13.5	18.2	23.3
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	0 -2.6	0 -2.6	0 -2.3	0 -3.6	0 -1.2	0 -2.0	0 -3.4	0 -	0 -	0 -2.7	0 -2.9	0 -3.2	0 -2.7	0 -2.6	0 - 2.7	0 -3.6
12B	0 -3.7	0 -0.8	0 -3.1	0 -3.1	0 -1.7	0 -2.2	+1.7 -3.2	- -	- -	0 -1.5	+7.0 -1.0	+4.9 -1.6	3.9 -1.5	+5.7 0	+1.9 -2.0	+7.0 -3.7
13	0 -2.8	0 -3.0	+6.0 0	+7.6 -1.6	+4.7 -1.8	+9.0 -1.7	0 -2.4	- -	- -	0 -2.8	0 -2.9	0 -3.3	0 -2.9	0 -2.7	+2.3 -2.2	+9.4 -3.3
13A	+5.0 -1.0	+2.2 -1.5	-2.7 -0.7	+1.7 0	+2.2 -0.1	- -	- -	- -	- -	+6.7 -1.9	+6.4 -2.1	+2.2 -2.6	+3.2 -1.6	+3.0 -1.2	+3.5 -1.3	+6.7 -2.6
14	+6.1 0	+7.5 -0.8	+3.6 0	+5.0 -1.1	+2.1 0	+3.3 -1.3	+5.1 0	- -	- -	+3.0 -2.1	+4.8 -1.9	+8.1 -1.3	+4.7 -1.8	+8.3 -1.2	+5.2 -1.0	+8.3 -1.9
14A	+7.2 0	+5.9 0	+3.0 -0.7	+5.1 0	+2.1 0	- -	- -	- -	- -	- -	- -	- -	- -	- -	+4.7 -0.1	+7.2 -0.7
15	+6.5 0	+6.7 0	+4.9 0	+5.8 0	+6.4 0	+4.6 0	+6.8 0	- -	- -	- -	- -	- -	- -	- -	+6.0 0	+6.8 0
15A	+6.4 0	+5.1 0	+4.9 0	+6.4 0	+6.3 0	+6.6 0	+7.2 0	- -	- -	+7.9 -1.3	+6.1 0	+6.9 -2.5	+6.6 0	+6.7 0	+6.4 -0.3	+7.9 -2.5
16	- -	- -	- -	- -	- -	- -	- -	- -	- -	+4.4 0	+4.0 0	+3.6 0	+4.7 0	+4.6 0	+4.3 0	+4.7 0

TABLE IX (IV)

MAXIMUM PRESSURES FOR LANDINGS - GROUP IV (P.S.I)

Run No / Pick-up No.	1952 15.8 L3	15.8 L4	15.8 L5	15.8 L6	3.9 L3	3.9 L4	3.9 L5	19.10 L1	19.10 L2	19.10 L3	19.10 L4	19.10 L5	Mean Max Pressures	Absolute Max. Pressures
1	-	-	-	-	0	0	0	0	0.9	1.2	0	0	0.3	1.2
2	-	0	0	0	0	0	0	4.7	2.8	0	0	2.7	0.9	4.7
3	-	0	2.9	0	2.7	0	3.6	7.9	3.4	3.7	3.9	3.5	2.9	7.9
3A	-	-	-	-	0	0	4.4	9.2	1.6	0	2.6	2.3	2.5	9.2
4	-	0	5.1	2.7	3.6	4.6	5.1	10.9	4.2	6.2	5.1	4.4	4.7	10.9
4A	-	0	3.4	0	0	0	0	6.9	5.9	0	3.7	6.3	2.4	6.9
5	-	0	6.2	7.5	6.9	5.1	11.5	13.8	7.6	5.7	8.5	12.1	7.7	13.8
6	-	8.1	7.0	12.1	12.4	9.7	7.8	19.6	14.5	12.4	13.4	12.1	11.7	19.6
7	16.4	16.8	16.8	21.9	-	8.5	15.4	15.4	18.9	15.2	23.4	16.9	16.9	23.4
8	-	-	-	-	-	18.8	12.9	-	-	-	-	-	15.8	18.8
8A	-	9.9	21.5	13.3	-	15.1	14.5	7.3	24.3	19.9	13.2	17.5	15.7	24.3
9	20.8	18.0	21.3	24.4	-	17.7	15.6	26.0	17.2	22.0	17.8	23.4	20.4	26.0
9A	19.5	18.2	16.4	20.6	-	23.6	20.4	19.3	24.2	13.2	21.3	17.2	19.5	24.2
9B	-	-	-	-	-	-	-	21.4	22.7	22.4	22.0	23.1	22.3	23.1
10	-	22.0	27 0	23.8	19.6	19.5	19.0	33.1	17.3	17.2	18.2	21.8	21.7	33.1
11	0 - 3.6	0 - 5.6	0 - 3.3	0 - 4.2	- -	- -	- -	0 - 6.6	0 - 4.2	0 - 1.7	0 - 4.1	0 - 5.3	0 - 4.3	0 - 6.6
12	0 - 2.9	0 - 1.4	0 - 1.1	0 - 2.2	- -	0 - 3.9	0 - 2.3	0 - 2.8	0 - 1.5	0 - 1.6	0 - 2.7	0 - 4.0	0 - 2.4	0 - 4.0
12B	0 - 2.6	0 - 3.6	0 - 2.1	0 - 2.6	- -	0 - 3.8	0 - 2.4	0 - 1.8	1.4 - 1.8	0 - 1.7	0 - 2.5	3.8 - 3.3	0.5 - 2.6	3.8 - 3.8
13	0 - 2.7	0 - 3.0	0 - 2.1	0 - 2.0	- -	9.7 - 2.8	0 - 2.6	5.4 - 4.3	3.3 - 1.5	0 - 1.7	8.4 - 2.1	14.9 - 2.8	3.8 - 2.5	14.9 - 4.3
13A	- -	3.4 0	3.1 - 1.8	4.4 C	- --	- -	- -	3.8 - 2.1	3.4 - 1.2	7.8 0	4.3 0	6.1 - 1.9	4.5 - 0.9	7.8 - 2.1
14	18.0 - 2.4	4.9 - 1.0	4.9 - 2.8	1.7 - 1.8	- -	10.2 0	3.3 0	8.2 - 5.0	5.7 - 1.4	5.3 0	5.6 - 2.7	10.2 - 1.3	7.1 - 1.7	18.0 - 5.0
14A	- -	5.2 0	3.0 - 0.9	3.9 0	- -	- -	- -	- -	- -	- -	- -	- -	3.0 - 0.3	5.2 - 0.9
15	6.2 - 1.6	4.5 0	5.4 0	15.2 0	- -	9.5 0	5.9 0	0 0	- -	- -	- -	- -	6.7 - 0.3	15.2 - 1.6
15A	6.4 -	5.0 0	9.0 - 2.6	8.7 0	- -	7.3 0	6.6 0	5.6 0	4.6 - 1.1	7.1 0	4.0 0	5.4 - 1.5	6.3 - 0.5	9.0 - 2.6
16	- -	- -	- -	- -	- -	- -	- -	0 0	0 0	- -	- -	- -	0 0	0 0

TABLE X (I)

MAXIMUM PRESSURES FOR TAKE-OFFS - GROUP I (P.S.I.)

Run no. / Pick-up No.	25.8.52 T.O.4	25.8.52 T.O.5	Mean Max. Pressures	Absolute Max Pressures
1	-	-	-	-
2	0	0	0	0
3	0	0	0	0
3A	-	-	-	-
4	0	4.2	2.1	4.2
4A	0	0	0	0
5	5.0	3.7	4.4	5.0
6	5.5	4.2	4.9	5.5
7	9.3	7.3	8.3	9.3
8	8.2	10.2	9.2	10.2
8A	7.0	5.0	6.0	7.0
9	15.7	15.6	15.7	15.7
9A	13.6	9.6	11.6	13.6
9B	9.7	8.3	9.0	9.7
10	19.9	21.2	20.6	21.2
11	- -	- -	- -	- -
12	0 0	0 0	0 0	0 0
12B	0 0	0 0	0 0	0 0
13	0 0	0 0	0 0	0 0
13A	0 0	0 0	0 0	0 0
14	0 0	0 0	0 0	0 0
14A	0 0	0 0	0 0	0 0
15	0 0	0 0	0 0	0 0
15A	- -	- -	- -	- -
16	0 0	0 0	0 0	0 0

TABLE X (II)

MAXIMUM PRESSURES FOR TAKE-OFFS - GROUP II (P.S.I.)

Run No. / Pick-up No.	27.8.52 T.O.3	3.10.52 T.O.2	6.10.52 T.O.3	6.10.52 T.O.6	Mean Max. Pressures	Absolute Max. Pressures
1	-	0	0	0	0	0
2	0	4.2	0	0	1.1	4.2
3	0	4.2	2.3	3.3	2.45	4.2
3A	0	3.9	0	0	1.0	3.9
4	0	7.6	2.5	3.1	3.3	7.6
4A	0	4.5	1.8	2.6	2.2	4.5
5	0	5.4	4.9	3.7	3.5	5.4
6	5.6	10.4	8.0	5.4	7.4	10.4
7	12.1	11.5	10.9	9.9	11.1	12.1
8	10.9	11.8	-	-	11.4	11.8
8A	10.1	10.7	13.1	5.4	9.8	13.1
9	13.5	12.8	10.9	13.0	12.3	13.5
9A	11.5	25.7	0	0	9.3	25.7
9B	-	17.6	18.1	10.9	15.5	18.1
10	15.7	12.3	11.3	11.2	12.6	15.7
11	- -	- -	0 - 2.9	0 0	0 - 1.5	0 - 2.9
12	0 0	0 0	2.1 0	0 0	0.5 0	2.1 0
12B	0 - 0.8	0 - 0.9	0 - 2.4	0 0	0 - 1.0	0 - 2.4
13	0 0	0 0	1.1 0	0 0	0.3 0	1.1 0
13A	0 0	1.4 0	0 0	0 0	0.4 0	1.4 0
14	0 0	0 0	0 0	0 0	0 0	0 0
14A	- -	- -	- -	- -	- -	- -
15	0 0	0 0	3.0 0	3.1 0	1.5 0	3.1 0
15A	0 0	0 0	0 0	0 0	0 0	0 0
16	0 0	0 0	1.4 0	2.1 0	0.9 0	2.1 0

TABLE X (III)

DETAILS OF PRESSURES FOR TAKE-OFFS - GROUP III (P.S.I.)

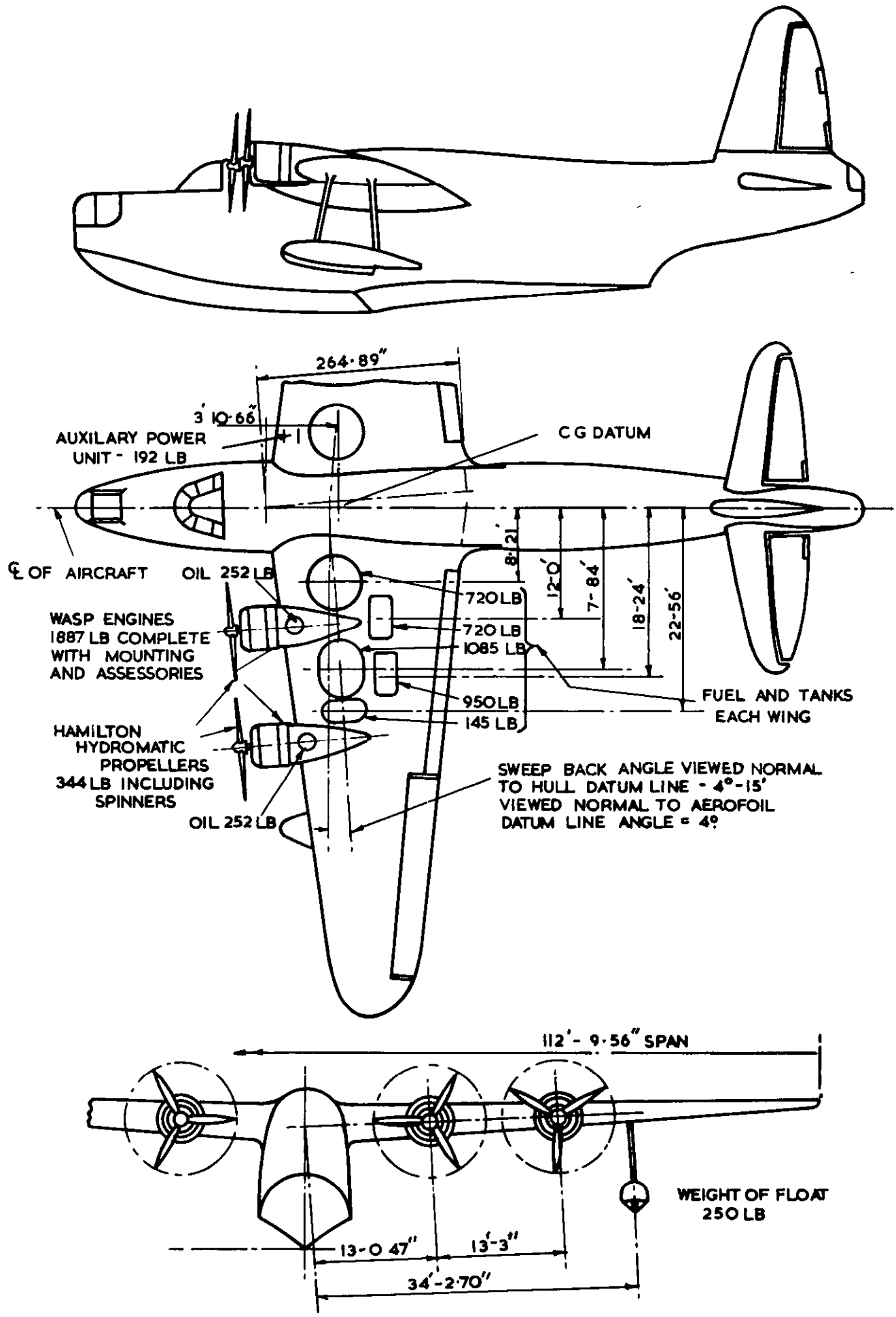
Run no / Pick-up No.	19.8 T.0.2	19.8 T.0.4	19.8 T.0.6	3.9 T.0.1	3.9 T.0.2	24.10 T.0.2	24.10 T.0.3	24.10 T.0.4	24.10 T.0.5	Mean Max. Pressures	Absolute Max. Pressures
					1952						
1	-	-	-	0	0	0	0	0	0	0	0
2	0	0	0	0	4.3	0	6.0	0	2.6	1.4	6.0
3	0	4.3	0	0	5.0	3.2	3.5	4.9	9.0	3.3	9.0
3A	-	-	-	0	7.1	0	3.4	0	6.8	2.9	7.1
4	0	7.0	9.8	7.7	5.7	10.6	17.1	10.4	17.5	9.5	17.5
4A	0	2.3	0	0	5.3	2.8	4.6	3.1	4.9	2.6	5.3
5	8.4	5.5	5.9	5.2	5.9	5.4	12.9	13.6	11.2	8.2	13.6
6	7.4	7.0	9.9	6.2	7.5	8.5	15.4	11.3	10.7	9.3	15.4
7	14.4	14.6	9.7	-	10.7	15.0	11.8	14.8	10.8	12.7	15.0
8	12.3	11.3	8.2	-	10.7	13.0	12.6	16.5	17.2	12.7	17.2
8A	13.2	13.1	13.4	-	11.1	15.1	10.1	10.7	9.4	12.0	15.1
9	12.0	16.8	15.4	-	14.4	17.7	18.6	17.5	15.6	16.0	18.6
9A	15.1	13.9	16.9	-	16.5	16.0	13.9	14.5	12.2	14.9	16.9
9B	-	-	-	-	-	17.6	12.7	16.7	14.9	15.4	17.6
10	13.2	19.0	16.5	15.5	11.3	17.8	18.1	13.3	16.0	15.6	19.0
11	- -	- -	- -	- -	- -	- -	0 0	0 0	0 0	0 0	0 0
12	0 0	0 0	0 0	- 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
12B	0 - 0.9	0 0	0 0	- -	0 - 1.1	3.7 0	0 0	0 0	0 0	0.5 - 0.3	3.7 - 1.1
13	0 0	0 0	0 0	- -	0 0	0 -1.1	0 0	0 0	0 0	0 - 0.1	0 - 1.1
13A	1.0 0	0.9 0	0 0	- -	- -	0 0	1.7 0	0 - 3.1	0 - 1.9	0.5 - 0.7	1.7 - 3.1
14	0 0	0 0	0 0	- -	0 0	0 -0.9	0 0	0 0	0 0	0 - 0.1	0 - 0.9
14A	0 0	2.7 0	0 0	- -	- -	- -	- -	- -	- -	0.9 0	2.7 0
15	2.9 0	0 0	0 0	- -	1.7 0	- -	- -	- -	- -	1.2 0	2.9 0
15A	0 0	0 0	0 0	- -	1.7 0	2.4 0	0 0	0 - 2.6	0 - 2.5	0.5 - 0.6	2.4 - 2.6
16	- -	- -	- -	- -	- -	3.5 0	0 0	0 0	0 0	0.9 0	3.5 0

TABLE X (IV)

DETAILS OF PRESSURES FOR TAKE-OFFS - GROUP IV (P.S.I.)

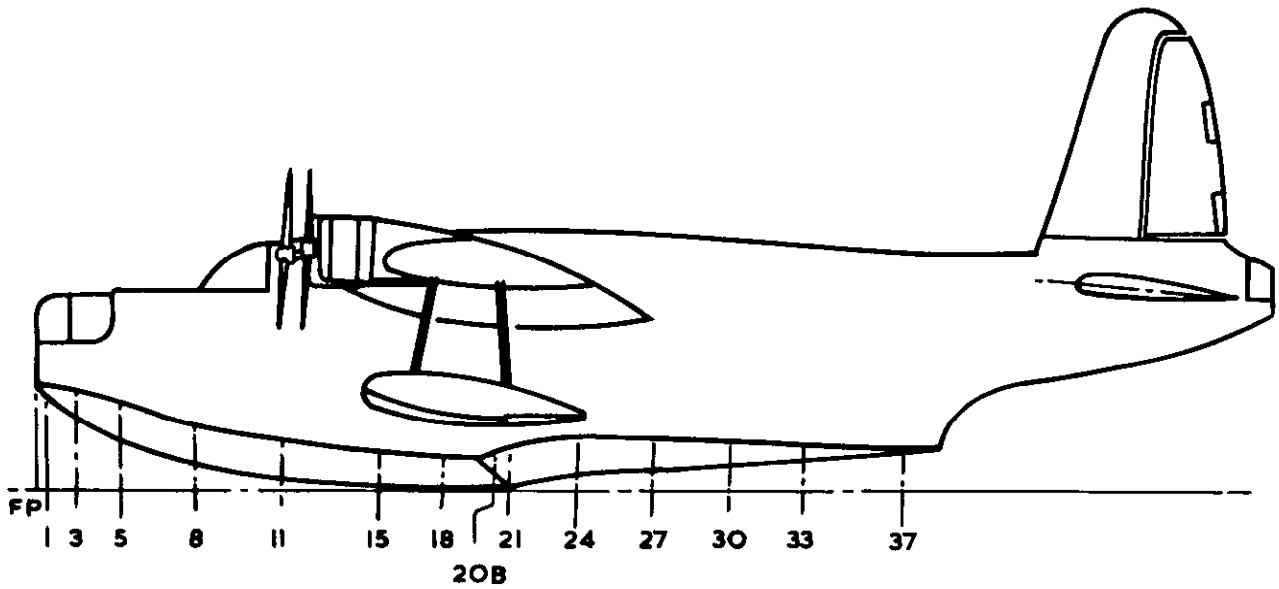
Run No. / Pick-up No.	15.8 T.0.5	15.8 T.0.7	3.9 T.0.4	3.9 T.0.5	19.10 T.0.1	19.10 T.0.2	19.10 T.0.3	19.10 T.0.4	19.10 T.0.5	Mean Max. Pressures	Absolute Max. Pressures.
				1952							
1	-	-	0	0	0	0	1.2	0	3.7	0.7	3.7
2	0	0	4.1	2.8	2.9	3.5	2.0	2.6	3.5	2.4	4.1
3	0	0	4.6	3.0	2.9	4.4	5.6	3.9	4.0	3.2	5.6
3A	-	-	0	0	0	2.4	2.6	3.3	5.7	2.0	5.7
4	0	0	5.8	3.9	2.6	2.8	4.3	3.6	6.3	3.3	6.3
4A	0	0	2.0	2.7	4.5	3.2	5.8	3.4	7.6	3.2	7.6
5	5.7	3.8	6.9	6.9	4.1	9.1	6.9	4.7	8.9	6.3	9.1
6	7.7	7.5	7.2	7.5	7.5	12.0	7.8	11.5	8.7	8.6	12.0
7	10.9	11.2	-	10.8	10.3	10.5	10.9	11.7	11.6	11.0	11.7
8	-	-	-	9.4	-	-	-	-	-	9.4	9.4
8A	9.8	9.6	-	15.4	10.9	8.7	7.5	11.5	8.1	10.2	15.4
9	15.7	15.4	-	9.8	11.3	11.7	11.1	11.4	17.9	13.0	17.9
9A	15.3	17.4	-	16.9	12.4	13.1	12.0	10.5	10.0	13.5	17.4
9B	-	-	-	-	13.2	11.8	11.5	11.5	15.2	12.6	15.2
10	16.2	19.0	12.7	21.5	9.5	10.2	11.5	12.0	16.3	14.3	21.5
11	0 - 1.6	0 0	- -	- -	0 0	0 0	0 - 1.7	0 0	0 - 5.5	0 - 1.3	0 - 5.5
12	0 - 1.3	0 0	- -	0 - 1.8	0 0	0 - 0.6	0 - 1.2	0 0	0 - 4.1	0 - 1.1	0 - 4.1
12B	0 - 1.3	0 0	- -	0 - 1.7	0 - 0.8	0 - 0.6	0 - 1.7	0 - 0.5	2.0 - 3.3	0.3 - 1.2	2.0 - 3.3
13	0 - 1.4	0 0	- -	0 - 1.7	0 0	0 - 0.6	0 - 1.6	2.9 0	7.3 0	1.3 - 0.7	7.3 - 1.7
13A	1.6 0	0.6 - 0.7	- -	- -	2.2 0	0 0	0 0	0 0	2.3 0	1.0 - 0.1	2.3 - 0.7
14	0 - 1.1	0 0	- -	1.9 0	3.6 0	0 - 0.6	3.6 0	2.2 0	4.1 0	1.9 - 0.2	4.1 - 1.1
14A	0 0	0 0	- -	- -	- -	- -	- -	- -	- -	0 0	0 0
15	0 0	0 0	- -	2.3 0	- -	- -	- -	- -	- -	0.8 0	2.3 0
15A	0 0	0 0	- -	1.8 0	0 0	0 0	1.6 0	2.4 0	4.1 0	1.2 0	4.1 0
16	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

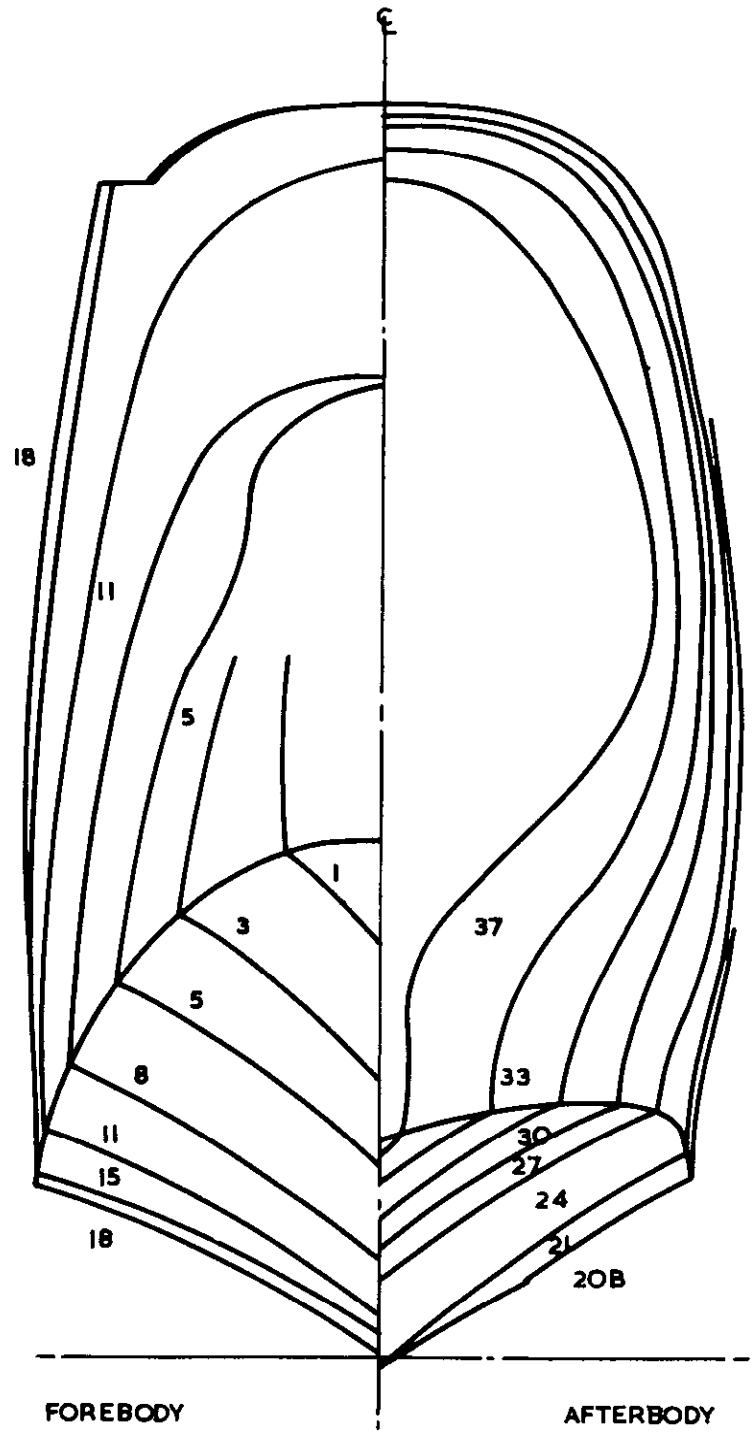
FIG. 1.



SUNDERLAND MK V FLYING BOAT
GENERAL ARRANGEMENT AND POSITIONS OF MASSES IN WINGS.

FIG. 2.



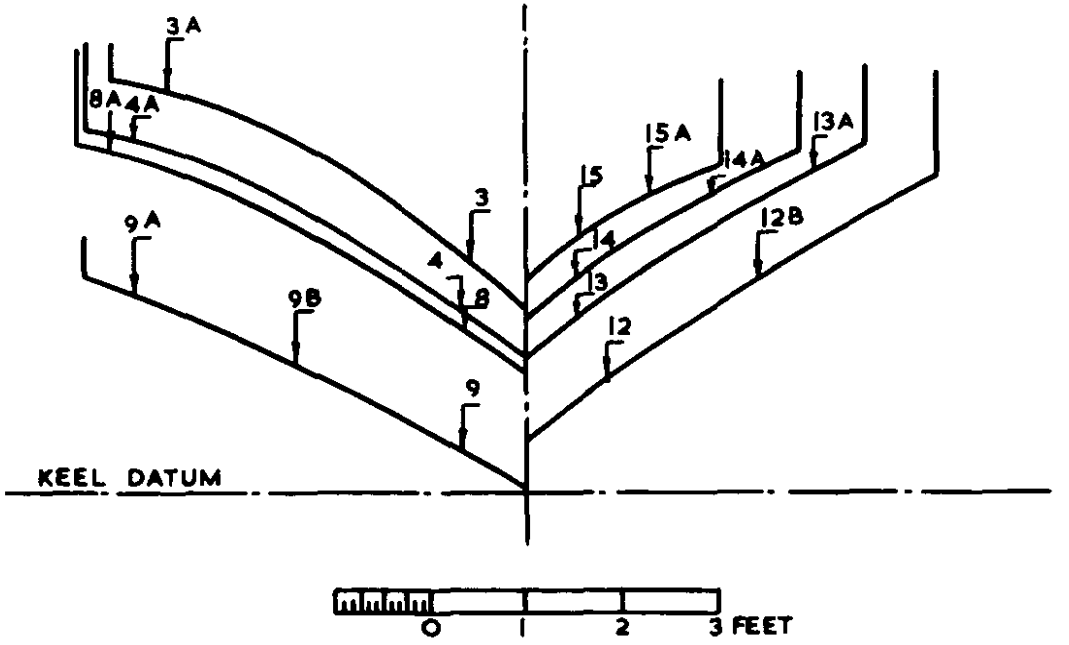


SUNDERLAND MK. V HULL LINES

POSITIONS OF PRESSURE PICK-UPS

VIEW IN DIRECTION OF ARROW "X" SHOWING PRESSURE PICK-UP POSITIONS FORWARD OF MAIN STEP

VIEW IN DIRECTION OF ARROW "Y" SHOWING PRESSURE PICK-UP POSITIONS FORWARD OF REAR STEP



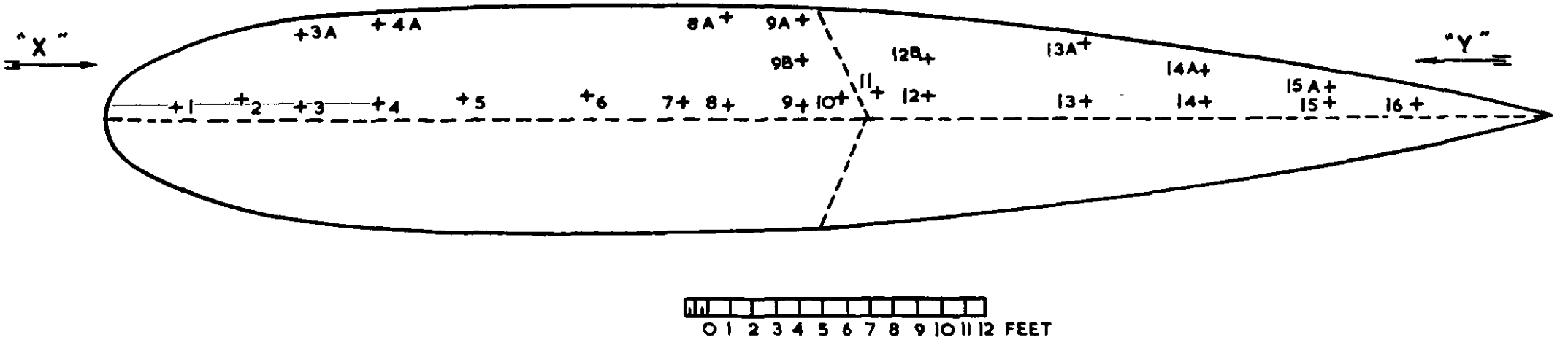
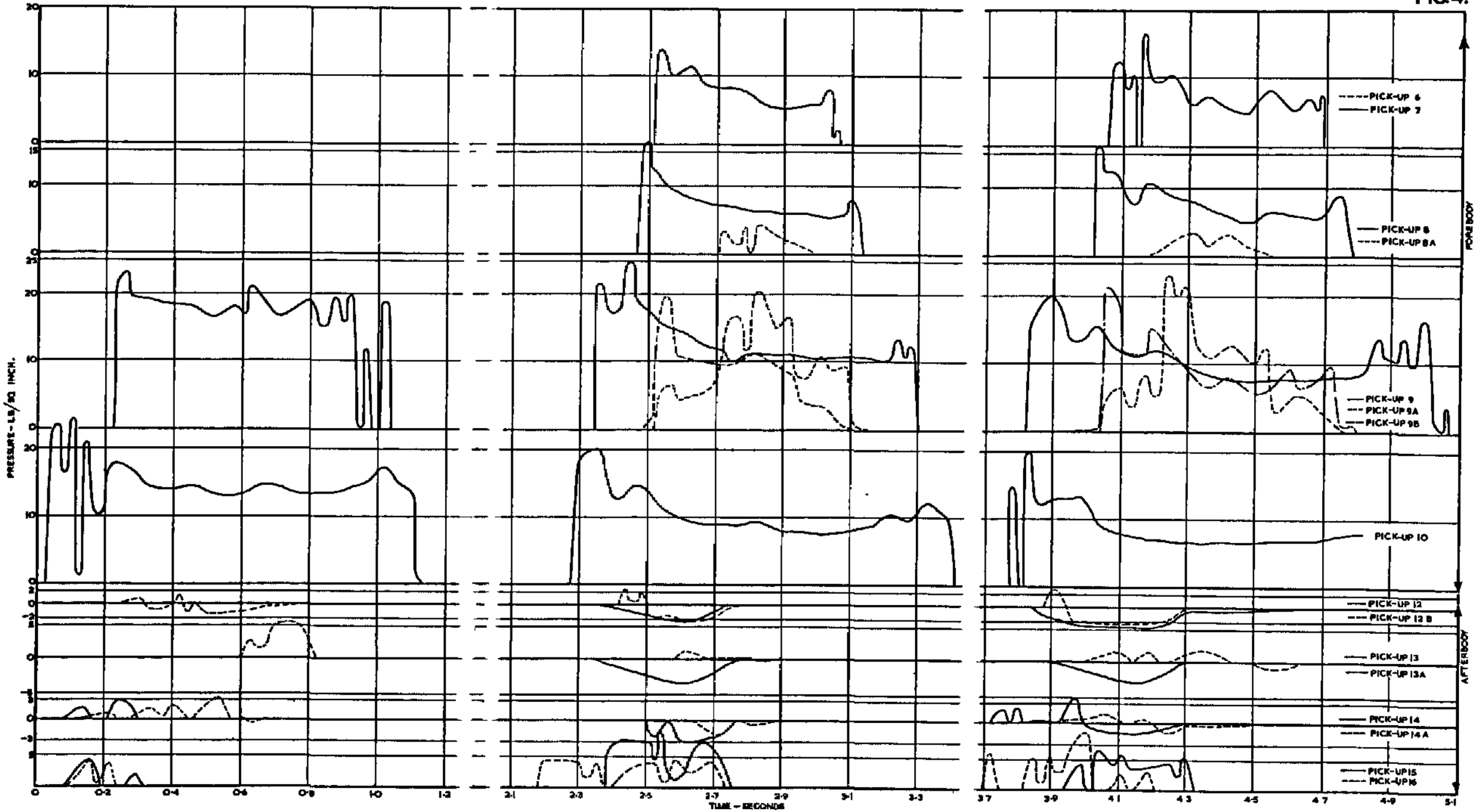


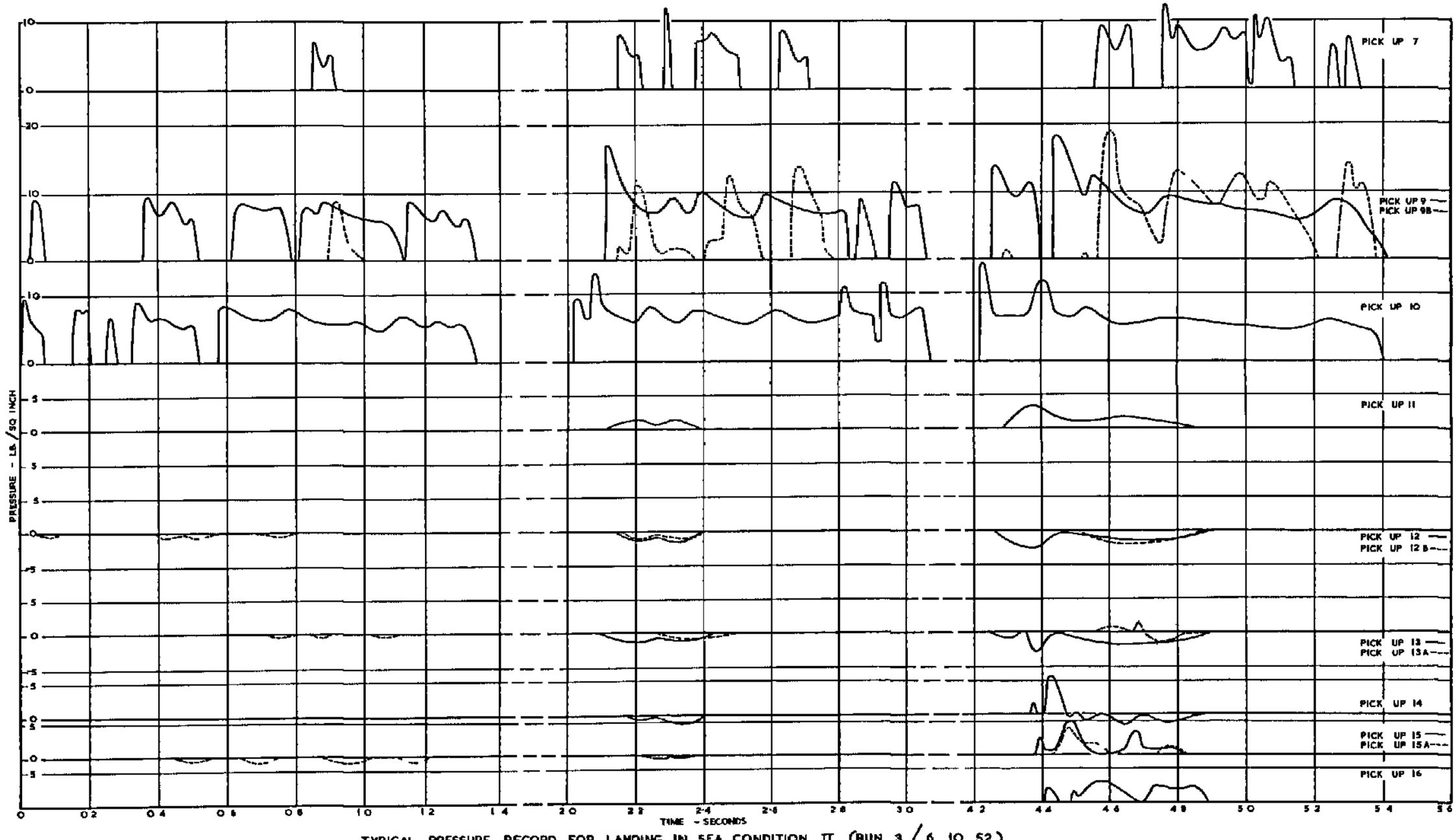
FIG.3.

FIG. 4.



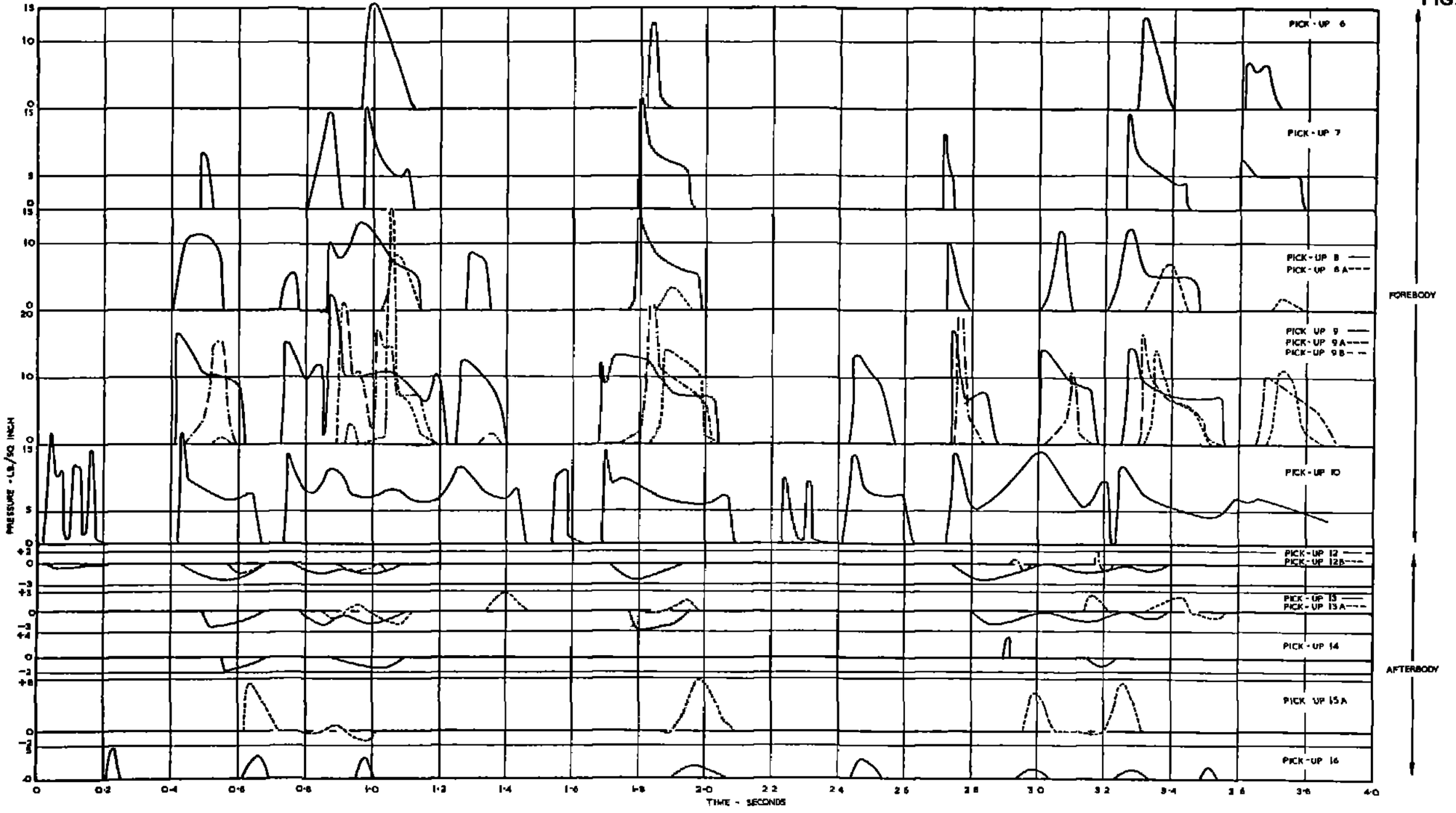
TYPICAL PRESSURE RECORD FOR LANDING IN SEA CONDITION I (RUN 5/25-8-52)

FIG 5



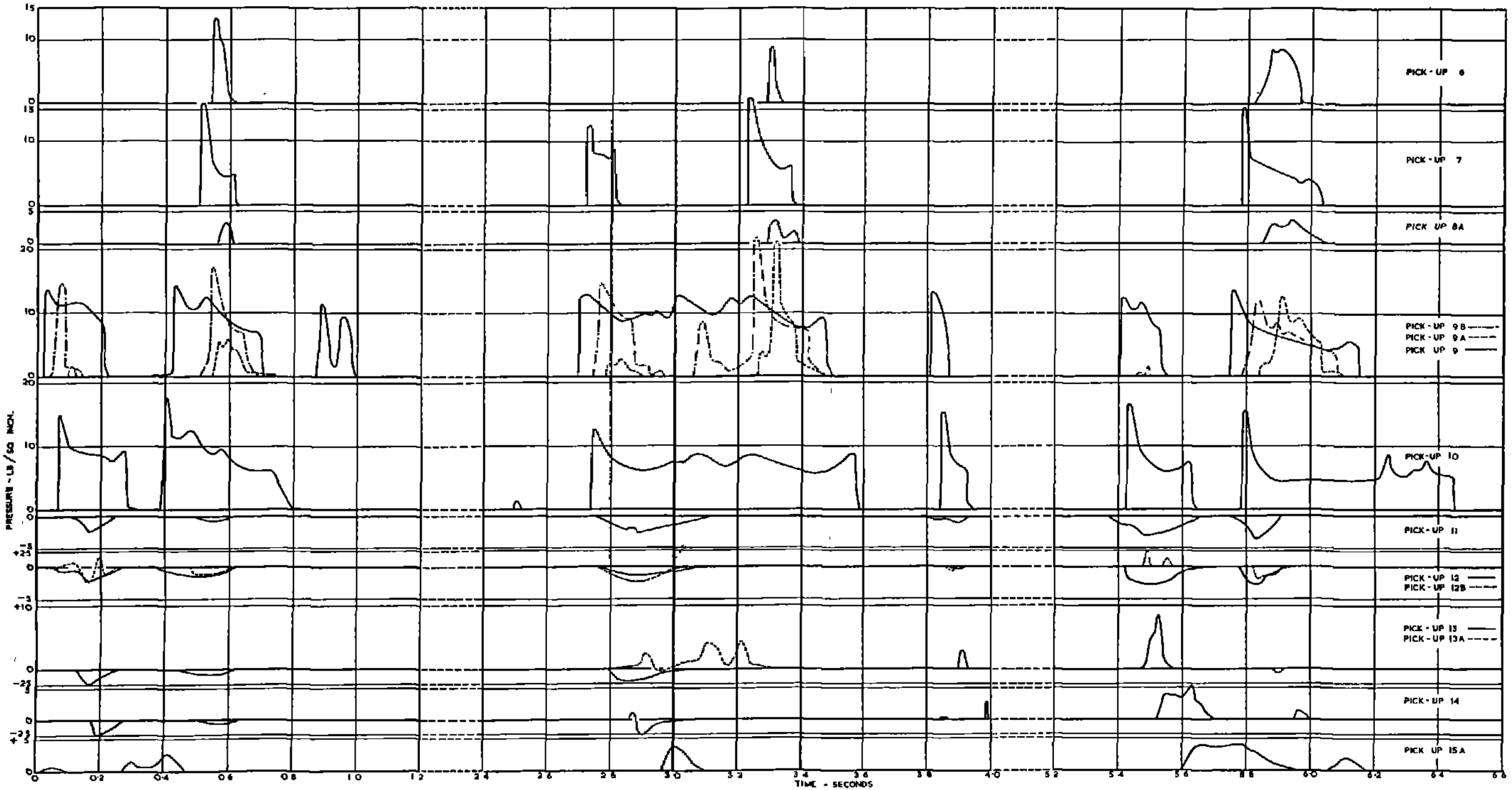
TYPICAL PRESSURE RECORD FOR LANDING IN SEA CONDITION II (RUN 3/6 10 52)

FIG. 6.



TYPICAL PRESSURE RECORD FOR LANDING IN SEA CONDITION III (RUN 1/24 10-52)

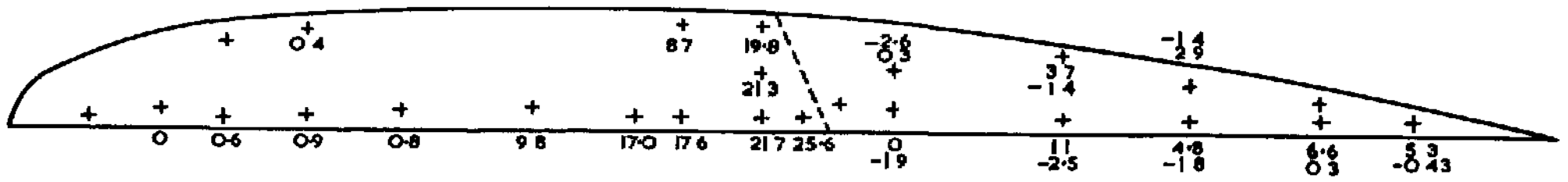
FIG. 7.



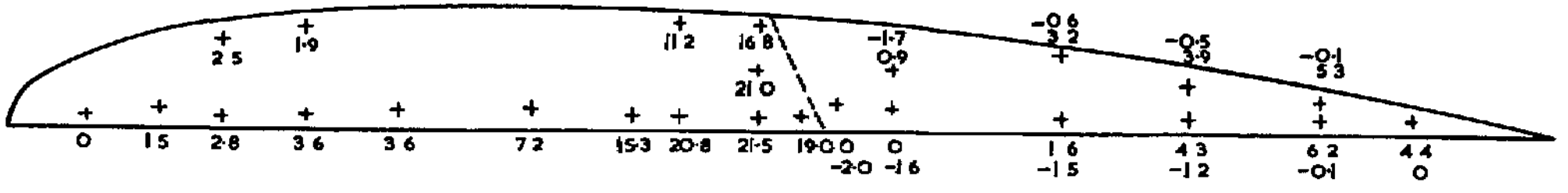
TYPICAL PRESSURE RECORD FOR LANDING IN SEA CONDITION IV (RUN 4/19-10-52)

FIG. 8.

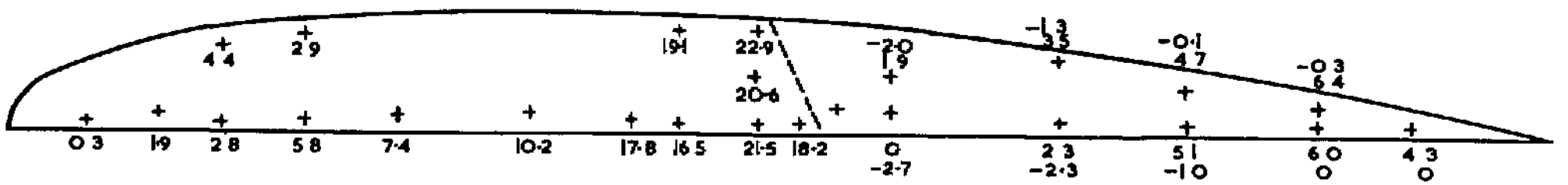
GROUP I



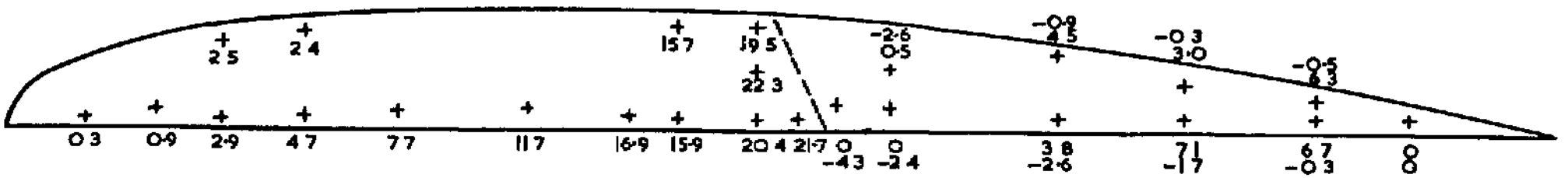
GROUP II



GROUP III



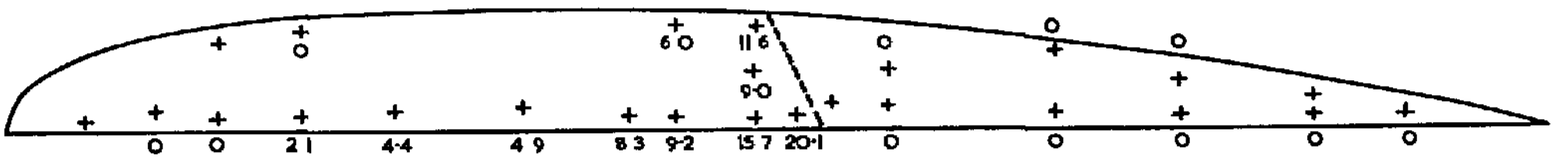
GROUP IV



MEAN MAXIMUM PRESSURES AND SUCTIONS FOR LANDINGS – LBS / SQ INCH

FIG 9

GROUP I



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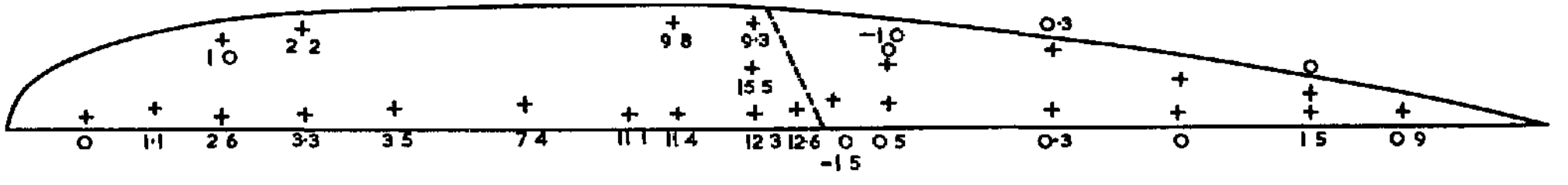
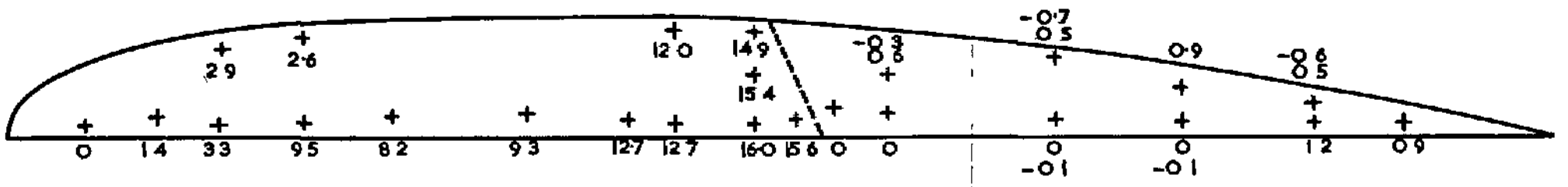
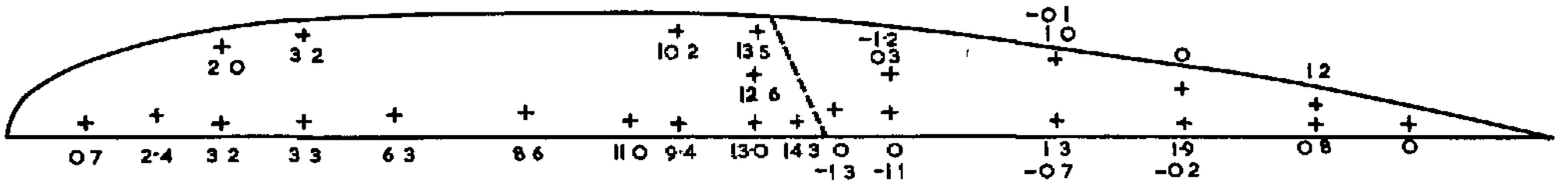


GROUP III

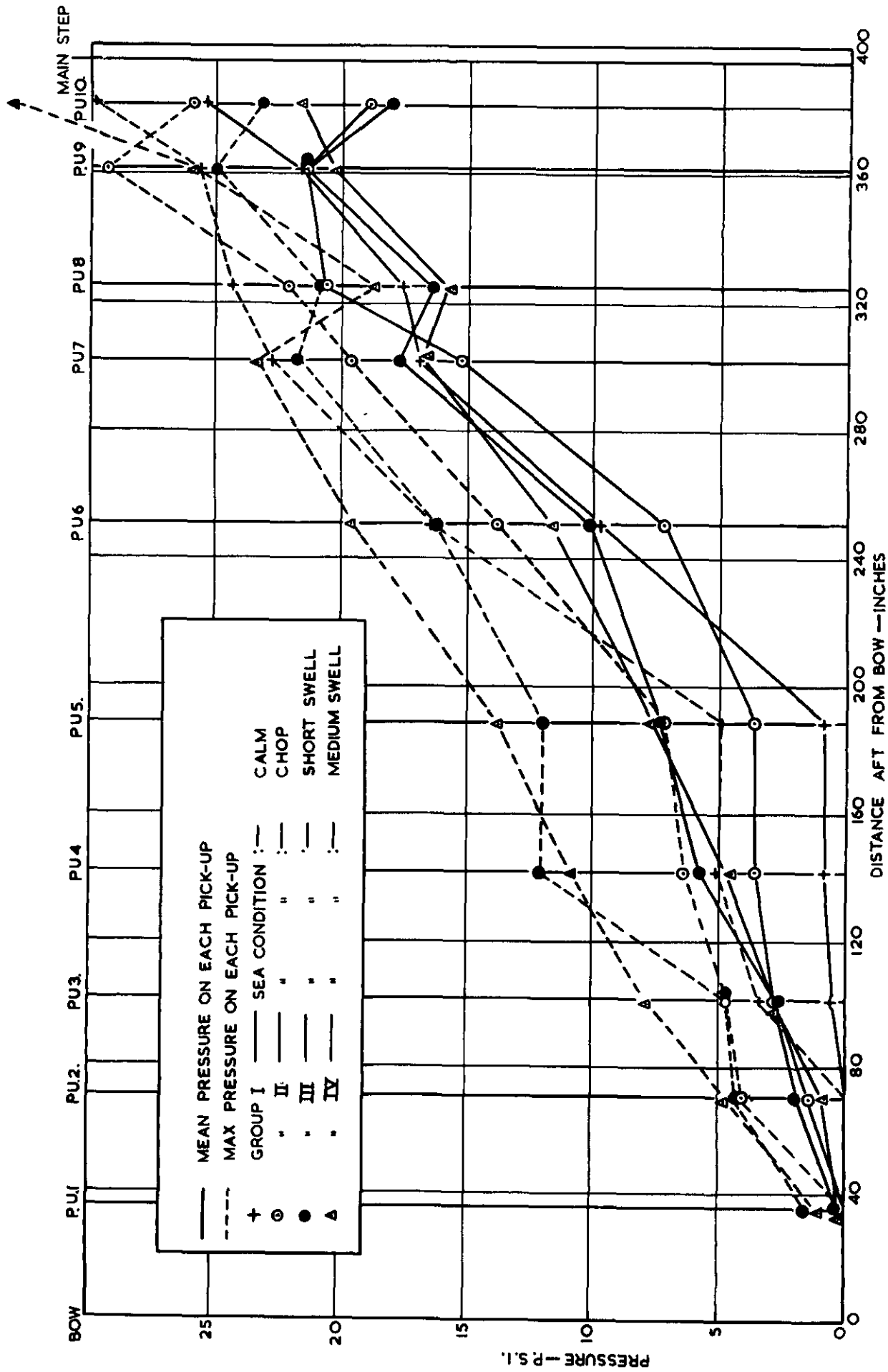


GROUP IV



MEAN MAXIMUM PRESSURES AND SUCTIONS FOR TAKE-OFFS – LBS / SQ INCH

FIG.10.



DISTRIBUTION OF MAXIMUM AND MEAN VALUES OF P.MAX ALONG THE FOREBODY KEEL FOR LANDINGS

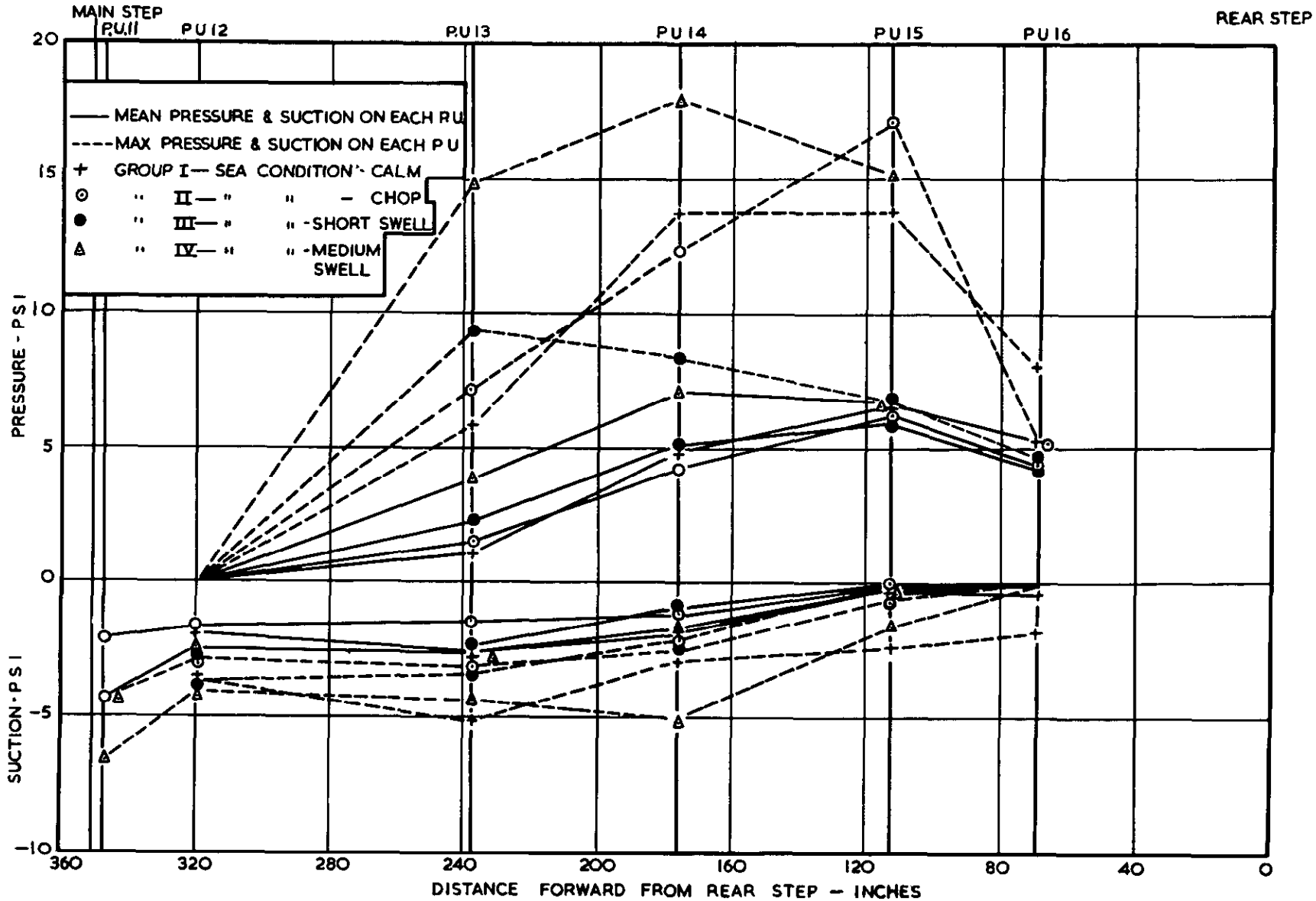
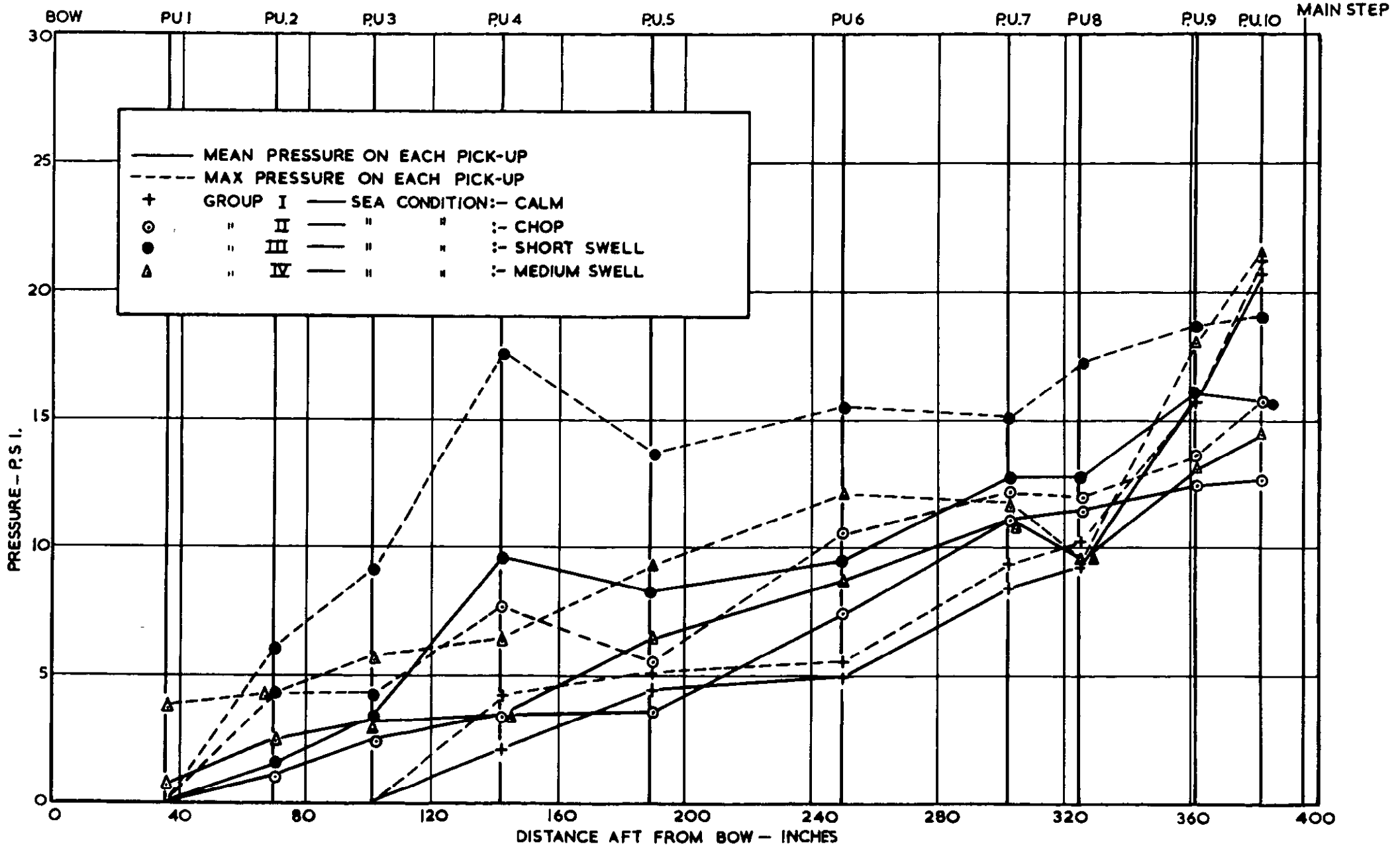


FIG. 11.

DISTRIBUTION OF MAXIMUM AND MEAN VALUES OF P. MAX. (POSITIVE AND NEGATIVE) ALONG THE AFTERBODY KEEL FOR LANDINGS



DISTRIBUTION OF MAXIMUM AND MEAN VALUES OF P.MAX ALONG THE FOREBODY KEEL FOR TAKE-OFFS

FIG.12.

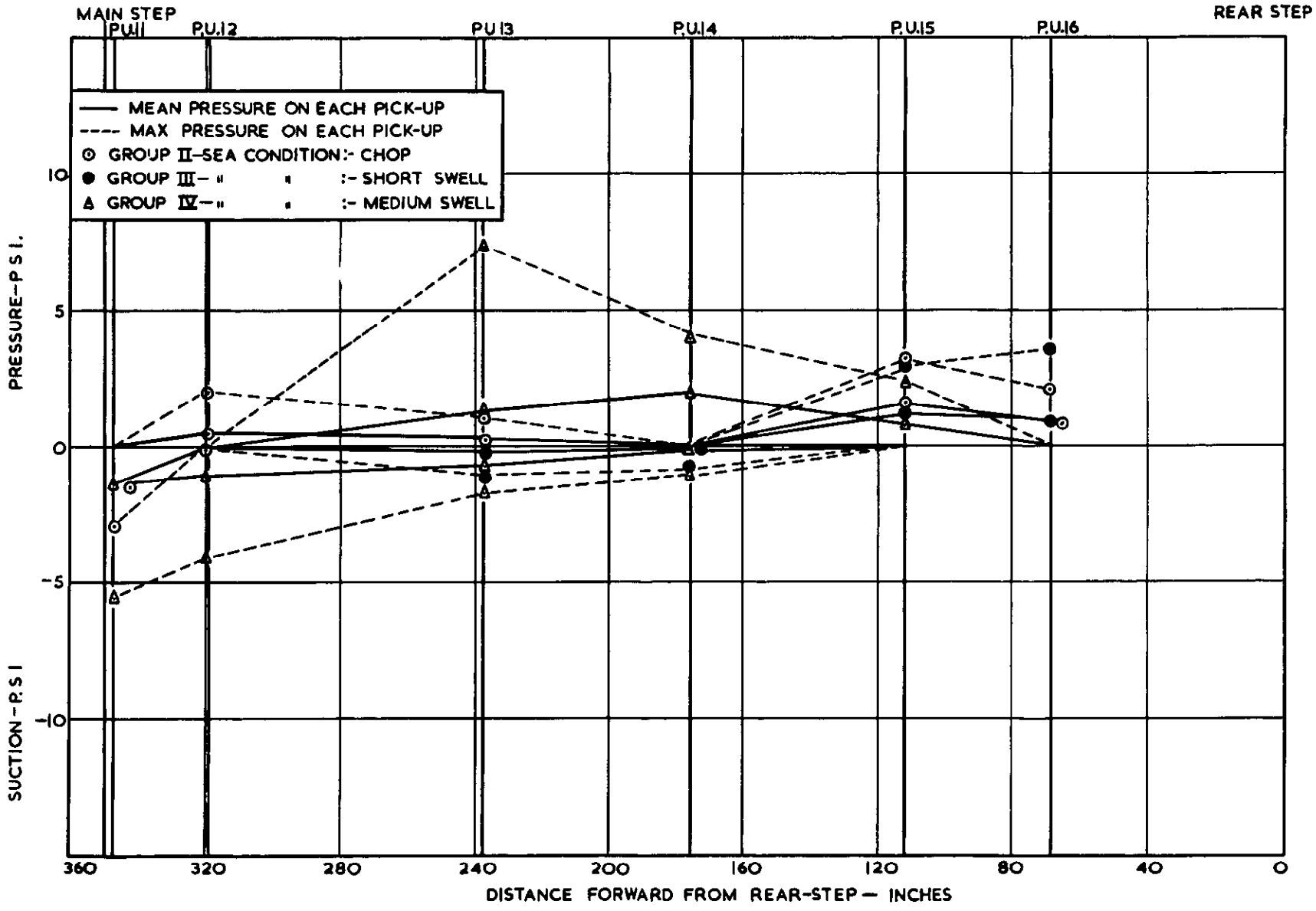


FIG.13.

DISTRIBUTION OF MAXIMUM AND MEAN VALUES OF P.MAX.(POSITIVE AND NEGATIVE) ALONG THE AFTERBODY KEEL FOR TAKE-OFFS

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