

C. P. No. 728

PRINTED AND PUBLISHED BY
H. K. LEITCH, LTD., LONDON

C. P. No. 728



MINISTRY OF AVIATION

AERONAUTICAL RESEARCH COUNCIL

CURRENT PAPERS

Wind Tunnel Measurements of the
Unsteady Pressures in and behind
a Bomb Bay (Canberra)

By

J. E. Rossiter and A. G. Kurn

LONDON. HER MAJESTY'S STATIONERY OFFICE

1965

PRICE 4s 6d NET

October, 1962

WIND TUNNEL MEASUREMENTS OF THE UNSTEADY PRESSURES
IN AND BEHIND A BOMB BAY (CANBERRA)

by

J. E. Rossiter
and
A. G. Kurn

SUMMARY

The unsteady pressures acting in and behind the bomb bay of a 1/20 scale model of the Canberra aircraft have been measured in the 8 ft x 6 ft transonic tunnel. The unsteady pressures are described by their r.m.s. values and by amplitude and correlation frequency spectra. Time average values of the pressures were also measured.

The results show that the Canberra bomb bay is of the "shallow type" in which the airflow enters the bay and attaches to the roof before being deflected cut by the rear bulkhead. Pressure fluctuations are most intense in the vicinity of the rear bulkhead and on the roof of the bay where the flow attaches. Changing the Mach number from 0.3 to 0.6 has in general little effect on the unsteady pressures (when expressed non-dimensionally) but increasing incidence up to ten degrees produces some decrease in their magnitude.

LIST OF CONTENTS

	<u>Page</u>
1 INTRODUCTION	3
2 TEST DETAILS	3
2.1 The model	3
2.2 Instrumentation	3
2.3 Range of investigation	3
3 RESULTS	4
3.1 Presentation of results	4
3.2 Datum conditions	6
3.3 Mean pressure distributions	6
3.4 Distribution of the r.m.s. of the unsteady pressures	6
3.5 Amplitude spectra of unsteady pressures	6
3.6 Correlation spectra of unsteady pressures	7
4 CONCLUSIONS	8
LIST OF SYMBOLS	8
LIST OF REFERENCES	9
DETACHABLE ABSTRACT CARDS	-

LIST OF ILLUSTRATIONS

	<u>Fig.</u>
G.A. of model and support	1
Positions of pressure transducers	2
Photographs of model mounted in 8 ft x 6 ft tunnel	3
Conversion from non-dimensional frequency to full scale frequency	4
Amplitude spectra of pressures on fuselage with bay closed (Transducer H)	5
Mean pressure distribution in and behind bay	6
R.m.s. of unsteady pressures in and behind bay	7
Amplitude spectra of unsteady pressures $M = 0.3$	8
Comparison with tests of Ref.4	9
Effect of Mach number on amplitude spectra of unsteady pressures	10
Correlation spectra. $M = 0.3$, $\alpha = 5.6^\circ$	11

1 INTRODUCTION

As part of a programme of tests to investigate the effect of an open bomb bay on the vibration of an aircraft, the unsteady pressures measured in the bay of a Canberra are to be compared with measurements made on a wind tunnel model. This Note reports the results of the wind tunnel measurements. The tests were made on a 1/20 scale model of the Canberra B7 in the 8 ft x 6 ft transonic tunnel during April 1962.

2 TEST DETAILS

2.1 The model

Fig.1 is a general arrangement drawing of the model used for the wind tunnel tests. The model is complete with fuselage, wings and tailplane but the fin and pilot's cabin fairing have been omitted. A small block fitted in the front of the bay represents an instrument tray which will be carried during the flight tests.

The model was supported from above, by a short stream-lined strut attached to a sting which was held in the tunnel incidence mechanism (see Fig.3). This method of support was chosen as being the least likely to affect the air flowing over the bomb bay, and the lower side of the fuselage.

The bomb bay has an inverted V-shaped roof, and both the roof and the lower fuselage line are swept up slightly towards the rear (see Fig.1). The doors retract partially into the bay when it is open. No attempt has been made on the model to represent structural details such as rings and stringers. The bay has a mean length/depth ratio of approximately 8:1 and a mean length/width ratio of approximately 5:1.

2.2 Instrumentation

Small capacity type pressure transducers¹ (RAE type IT4-6-37) were used to measure the pressures acting at 7 positions along the roof of the bay, and 10 positions on the fuselage surface behind the bay (see Fig.2). The transducers were calibrated before each test period by applying a known steady pressure to each transducer and observing the outputs from the transducer amplifiers on a d.c. voltmeter. Variations in the calibration factors throughout the test were less than $\pm 5\%$. During the test, the outputs from the transducer amplifiers were observed on a d.c. voltmeter to give time average pressures, and on a Dawes true r.m.s. meter (Type 612A) to give the r.m.s. of the unsteady component of the pressures. In addition the outputs from selected transducers were recorded in pairs on an Ampex Type 306-2 two channel tape recorder for subsequent frequency analysis using a Muirhead-Pametrada D489 frequency analyser with a bandwidth ratio of 15.5%. The recording and analysing system is described fully in Ref.2.

2.3 Range of investigation

The model was tested over a Mach number range from 0.3 to 0.6 and, in order to facilitate comparison with the forthcoming flight tests, the model incidence was adjusted at each speed to simulate flight at altitudes of 5000 and 20,000 ft. Model vibration limited the kinetic pressure at which the tunnel could be operated to 150 p.s.f. The corresponding unit Reynolds number together with model incidences are given in the table below.

M	Re No. per ft x 10 ⁻⁶	Incidence to simulate flight at	
		5000 ft	20,000 ft
0.3	1.97	5.6°	10.4°
0.4	1.75	3.0°	5.6°
0.5	1.41	1.8°	3.4°
0.6	1.16	1.2°	2.2°

The time average and the r.m.s. of the pressures at each transducer position were measured for all the test conditions. For $M = 0.3$, $\alpha = 5.6^\circ$, amplitude spectra were measured at all the transducer positions. Correlation spectra were obtained for all transducers in the bay referred to transducer G (Fig.2), and for the transducers behind the bay on the starboard side of the fuselage referred to transducers J and N. In addition correlation spectra between transducers at the same longitudinal station but on opposite sides of the fuselage were measured.

For the other seven test conditions amplitude spectra were measured for transducer positions F,G,H and N.

In order to establish datum conditions, amplitude spectra were obtained for transducer H at $M = 0.3$ and 0.6 with the bomb bay filled in.

3 RESULTS

3.1 Presentation of results

Time average pressures have been expressed in terms of the usual pressure coefficient C_p , and the r.m.s. of the unsteady pressures have been made non-dimensional by dividing them by the tunnel kinetic pressure q .

A preliminary examination of the nature of the unsteady pressures showed that they were random in character. Such random functions can only be described by their average properties and it is convenient to use the nomenclature of spectral analysis.

A non-dimensional frequency parameter n , has been used in the frequency spectra where

$$n = \frac{fL}{U}$$

where f is measured frequency (c.p.s.)

U is tunnel speed (f.p.s.)

and L is the bomb bay length (ft)

Fig.4 gives conversion factors to enable n to be expressed in absolute frequency under full scale conditions.

The ordinate of the amplitude spectra has been expressed as $p_\epsilon/q\sqrt{\epsilon}$

where p_ϵ is the r.m.s. of the pressure fluctuations within the bandwidth of the analyser used to obtain the spectra

ϵ is the bandwidth ratio of the analyser (= 0.155)

and q is the tunnel kinetic pressure (p.s.f.).

Provided the ordinate of a spectrum varies slowly with n , then $p_\epsilon/q\sqrt{\epsilon}$ is independent of the value of ϵ and in the limit, as ϵ is made smaller $\epsilon \rightarrow dn/n$, so that the total mean square of the pressure fluctuations is related to the spectral density by

$$\frac{\overline{p^2}}{q^2} = \int_{n=0}^{n=\infty} \left(\frac{p_\epsilon}{q\sqrt{\epsilon}} \right)^2 d(\log n) .$$

An important corollary is that if the pressures are acting on a simple single degree of freedom system, with a natural frequency f_0 and an acceptance bandwidth Δf , then the r.m.s. of the relevant part of the excitation is given by

$$\sqrt{\frac{\overline{p^2}}{q^2}} = q \left[\frac{p_\epsilon}{q\sqrt{\epsilon}} \right]_{\text{at } f_0} \sqrt{\frac{\Delta f}{f_0}}$$

so that the ordinate of the spectrum may be used to make quantitative comparisons of buffet intensity.

The correlation between the pressures acting at two points x_i and x_j may be described by the correlation coefficient

$$R_{ij} = \frac{\overline{p(x_i, t) p(x_j, t)}}{\left[\overline{p^2(x_i, t)} \overline{p^2(x_j, t)} \right]^{1/2}} .$$

It will be appreciated that R_{ij} may be evaluated either for the pressure fluctuations within the whole frequency range or for the pressure fluctuations within narrow frequency bands, as say. In the latter case, R_{ij} is a function of the centre frequency, n , of the band and may be plotted as a "correlation spectrum".

$R_{ij}(n)$ was calculated by first measuring the amplitude spectra of the instantaneous sum and difference of $p(x_i, t)$ and $p(x_j, t)$ then

$$R_{ij}(n) = \frac{\left(\frac{p_\epsilon}{q\sqrt{\epsilon}} \right)_{\text{Sum}}^2 - \left(\frac{p_\epsilon}{q\sqrt{\epsilon}} \right)_{\text{Diff}}^2}{4 \left[\left(\frac{p_\epsilon}{q\sqrt{\epsilon}} \right)_{x_i} \left(\frac{p_\epsilon}{q\sqrt{\epsilon}} \right)_{x_j} \right]} .$$

In attempting to interpret the physical significance of the correlation coefficient it must be borne in mind that it is essentially a statistical quantity. The spatial distribution of the correlation coefficient gives an

indication of the size of the region over which disturbances retain their identity - on the average. In addition, the variation of the correlation coefficient along the direction in which the disturbances are travelling will contain a measure of their average speed. In this connection it is significant that for the special case of a pressure field which is entirely periodic in character, the correlation coefficient is equal to the cosine of the phase difference between the pressures at the two measuring points. Typically, the variation of $R_{ij}(n)$ along the direction of travel of disturbances superficially resembles a damped cosine wave. The distances between successive zero crossings may be interpreted loosely as half a mean wavelength of the disturbances and the rate of decrease in successive peak values as a measure of the rate of decay of the disturbances.

3.2 Datum conditions

The amplitude spectra of the unsteady pressures at transducer position H with the bay filled in are given in Fig.5 for $M = 0.3$ and 0.6 . At each speed the spectrum consists mainly of a peak which is at the fan blade frequency (i.e. fan speed in r.p.s. \times number of fan blades) together with one or more secondary peaks at harmonics of the fan blade frequency. This type of spectrum has been obtained previously in tests in the 8 ft \times 6 ft tunnel and the peaks are thought to be due to the setting up of standing wave patterns within the plenum chamber surrounding the working section. The spectral density for this datum case is small compared with the spectral density when the bay is open except at the frequency of the peaks and, for certain transducer position, at very high frequencies ($n > 5$) (compare Fig.5 with Fig.8, $x/L = 0.27$ and 1.26 , for example). The only correction which has been made to the frequency spectra obtained with the bay open is to remove any peaks which occurred at the fan blade frequency and its first and second overtones.

3.3 Mean pressure distributions

Fig.6 shows the distribution of the mean pressures along the roof of the bay and on the fuselage behind the bay for $M = 0.3$ and 0.6 . The pressure distributions at low incidence are typical of a shallow type bay in which the airflow enters the bay and attaches to the roof before being deflected out by the rear bulkhead (see for example Ref.3). The pressure rise associated with the flow attachment occurs at $x/L \approx 0.45$.

3.4 Distribution of the r.m.s. of the unsteady pressures

The distribution of the r.m.s. of the unsteady pressures is shown in Fig.7. The pressure fluctuations are most intense in the vicinity of the rear bulkhead and on the roof of the bay where the flow attaches. The intensity decreases rapidly with distance behind the bay.

The curves for $M = 0.3$, $\alpha = 5.6^\circ$ and 10.4° show that increasing incidence produces an appreciable reduction in the magnitude of the fluctuations within the bay, and suggests that the higher values of the r.m.s. of the pressures measured at $M = 0.6$ are probably mainly due to the lower incidences tested at this speed. The effect of the incidence change on the pressures behind the bay is negligible.

3.5 Amplitude spectra of unsteady pressures

Fig.8 shows the amplitude spectra of the unsteady pressures for $M = 0.3$, $\alpha = 5.6^\circ$. For all transducer positions the spectra are tolerably smooth and cover a broad band of frequencies, indicating that the pressure fluctuations are random in character. The spectra are similar to those

measured by Fail and others⁴ in a Canberra type bay formed in a cylindrical fuselage. In Fig.9, the spectra for two points near the rear bulkhead are compared with the earlier measurements. The agreement between the two sets of results is reasonable bearing in mind the differences in the external shapes of the models and the slightly different positions of the transducers.

Included in Fig.8 are spectra for $M = 0.3$, $\alpha = 10.4^\circ$ for two positions in the bay and for two positions behind the bay. It can be seen that, although as has already been noted, increased incidence produces an appreciable decrease in the magnitude of the unsteady pressures within the bay there is little change in the shape of the spectra.

The spectra obtained at different Mach numbers are compared in Fig.10 for two positions within the bay and for two positions on the fuselage behind the bay. In looking at these spectra it should be remembered that the incidence of the model was adjusted at each Mach number to simulate flight at 5000 and 20,000 ft. It is therefore difficult to separate the effects of incidence and Mach number. However since, as has already been noted, incidence has little effect on the unsteady pressures on the fuselage behind the bay (Fig.8) it follows from Fig.10 that Mach number also has little effect on these pressures. Within the bay, increasing incidence reduces the magnitude of the pressures (Fig.8) and hence the changes in the spectra shown in Fig.10 for $x/L = 0.95$ are probably mainly due to the change of incidence. For $x/L = 0.84$, however, although the changes in magnitude are similar to those for $x/L = 0.95$, there are also changes in the frequency at which the maximum spectral density occurs and these are probably due to the change in Mach number.

3.6 Correlation spectra of unsteady pressures

Selected correlation spectra for $M = 0.3$, $\alpha = 5.6^\circ$ are shown in Fig.11. Within the bay (Fig.11(a)) the main features of a spectrum is a trough followed at about twice the frequency by a peak. The high values of the correlation at the peaks suggests that disturbances retain their identity for quite large distances as they travel along the roof of the bay. It is therefore possible to calculate the time average speed of propagation \bar{u} , of these disturbances. For, if it is assumed that the frequency n' at which a peak occurs, may be associated with a disturbance whose wavelength λ' , is the same as the distance between the measuring points, then

$$\frac{\bar{u}}{U} = \frac{\lambda' n'}{L} .$$

Values so calculated are given in the table below:

x/L	$\frac{\bar{u}}{U}$ (mean value over given x/L range)
0.95 to 0.84	0.49
0.95 to 0.71	0.59
0.95 to 0.58	0.59
0.95 to 0.45	0.56

The mean value of \bar{u}/U is 0.57. It is not possible from the information available to calculate the speed of the airflow u_E , just outside the bomb bay but an idea of its magnitude can be estimated from the measured values of C_p given in Fig.6 by assuming

$$\left(\frac{u_E}{U}\right)^2 = (1 - C_p) .$$

This gives a value for u_E/U , meaned over the region of interest, of 0.73 so that $\bar{u}/u_E = 0.78$. That is, the mean propagation speed of disturbances along the roof of the bay is about three quarters of the mean stream velocity just outside the bay, which is of the same order as the mean speed of disturbances in a turbulent boundary layer measured by Tack and others⁵.

Behind the bay, the pressures on the side of the fuselage are well correlated in the region between the transducers at $x/L = 1.15$ and 1.37 (Fig.11(c)) but the pressures in this region are not well correlated with the pressures just behind the rear bulkhead ($x/L = 1.05$, Fig.11(b)), suggesting that there is a small region immediately behind the bay which is isolated in behaviour from the main stream. Fig.11(d) shows that whereas immediately behind the bay (J and K), in this small isolated region, the pressures are positively correlated in a cross plane, further downstream the correlation is large but negative, suggesting that the wake from the bay is unstable and moves from side to side of the fuselage.

4 CONCLUSIONS

- (1) The Canberra bomb bay is of the "shallow type" in which the airflow enters the bay and attaches to the roof before being deflected out by the rear bulkhead.
- (2) The pressure fluctuations are most intense in the vicinity of the rear bulkhead and on the roof of the bay where the flow attaches.
- (3) Changing Mach number from 0.3 to 0.6 has (in general) little effect on the pressure fluctuations (when expressed non-dimensionally) but increasing incidence up to ten degrees produces some decrease in their magnitude.
- (4) A study of the correlation spectra suggests that disturbances travel along the roof of the bay at about three-quarters of the local airspeed external to the bomb bay or at about one half of the free stream speed.

LIST OF SYMBOLS

C_p	pressure coefficient
f	frequency (c.p.s.)
L	length of bomb bay (= 1.11 ft)
M	tunnel Mach number
n	a non-dimensional frequency parameter (= fL/U)
p	pressure (p.s.f.)
p_E	r.m.s. of pressure in frequency band df (p.s.f.)
q	tunnel kinetic pressure (p.s.f.)
$R_{ij}(n)$	correlation spectrum between pressures at points i and j
t	time (seconds)

LIST OF SYMBOLS (Contd)

U	tunnel velocity (f.p.s.)
\bar{u} u_E	} see para 3.6
x	
α	wing incidence
ϵ	bandwidth ratio
λ	a wavelength (ft)

A bar - above a quantity has been used to indicate its time average value.

LIST OF REFERENCES

<u>No.</u>	<u>Author(s)</u>	<u>Title, etc</u>
1	Macdonald, W.R., Cole, P.W.	A sub-miniature differential pressure transducer for use in wind tunnel models. Unpublished M.O.A. Report.
2	Owen, T.B.	Techniques of pressure fluctuation measurements employed in the R.A.E. low speed wind tunnels. A.G.A.R.D. Report 172. March, 1958.
3	Roshko, A.	Some measurements of flow in a rectangular cut out. N.A.C.A. T.N.3488. August, 1955.
4	Fail, R., Owen, T.B., Eyre, R.C.W.	Low speed wind tunnel tests on the flow in bomb bays and its effect on drag and vibration. Unpublished M.O.A. Report.
5	Tack, D.H., Smith, M.W., Lambert, R.F.	Wall pressure correlations in turbulent air flow. J. Acous. Soc. <u>33</u> (4). April, 1961.

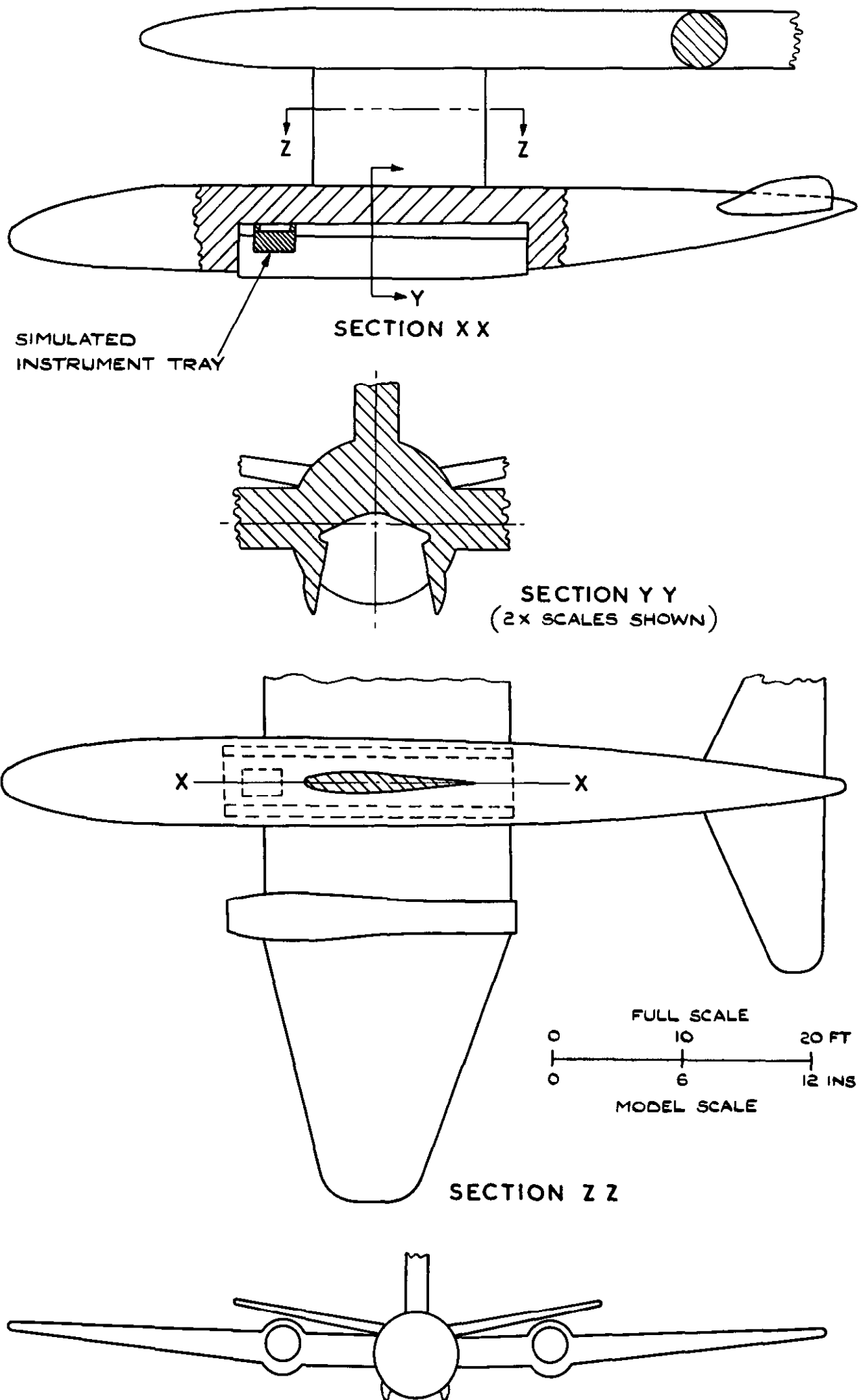


FIG. 1. G.A. OF MODEL AND SUPPORT.

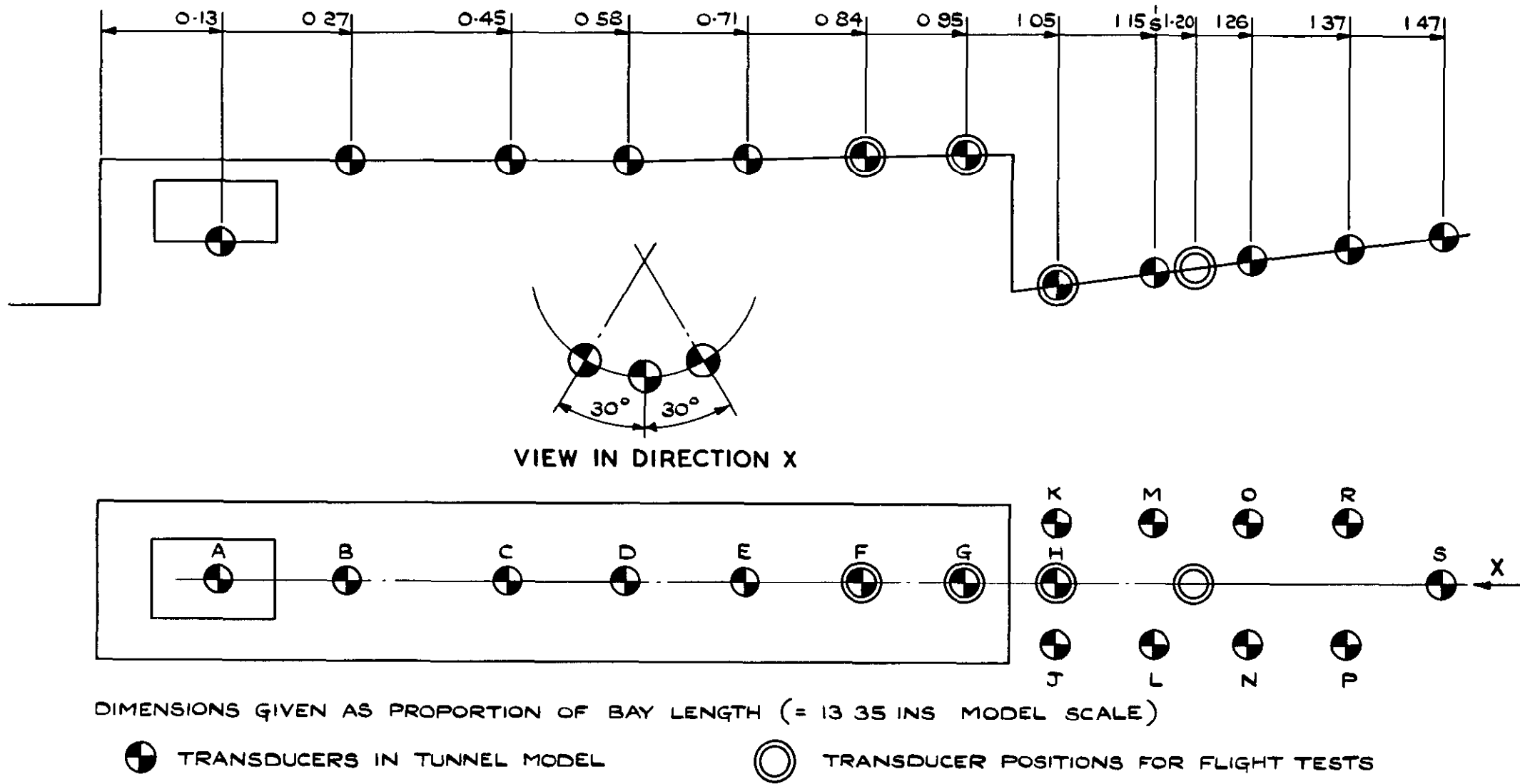


FIG. 2. POSITIONS OF PRESSURE TRANSDUCERS.

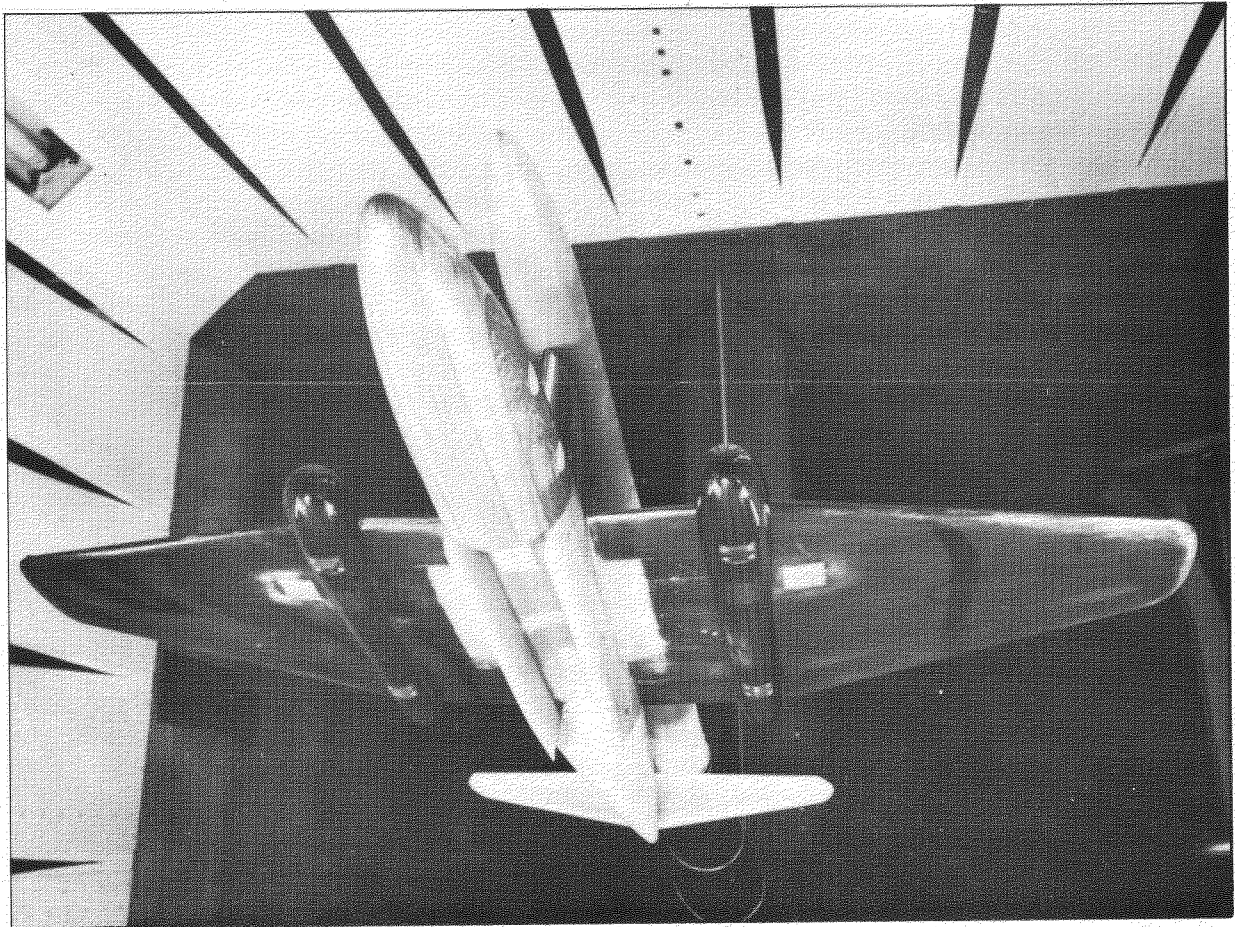
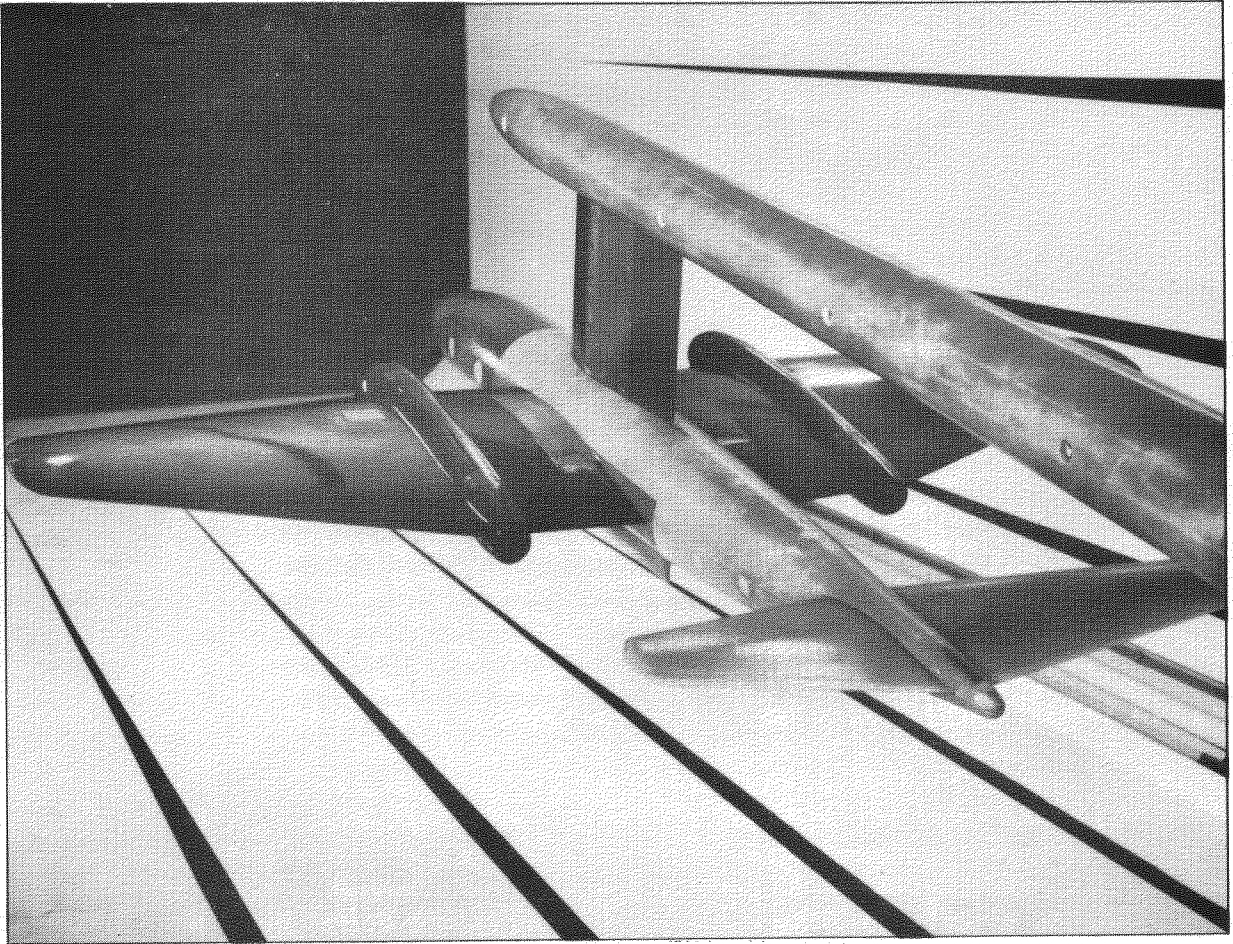


FIG.3. MODEL MOUNTED IN 8ft. x 6ft. TUNNEL

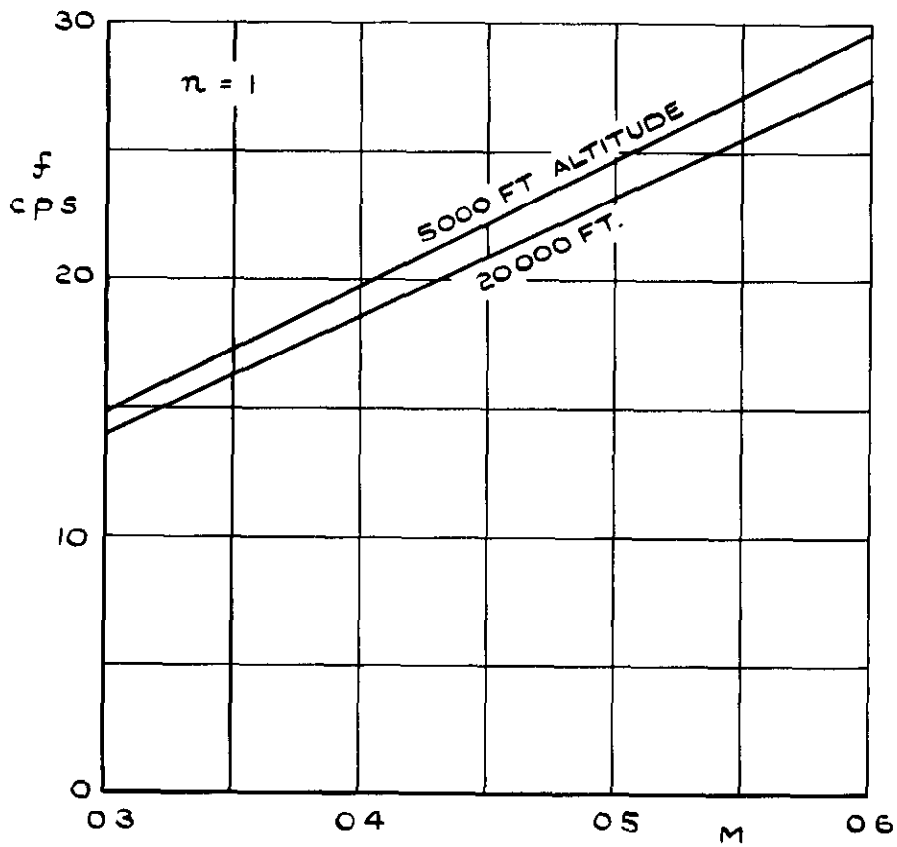


FIG. 4. CONVERSION FROM NON DIMENSIONAL FREQUENCY TO FULL SCALE FREQUENCY

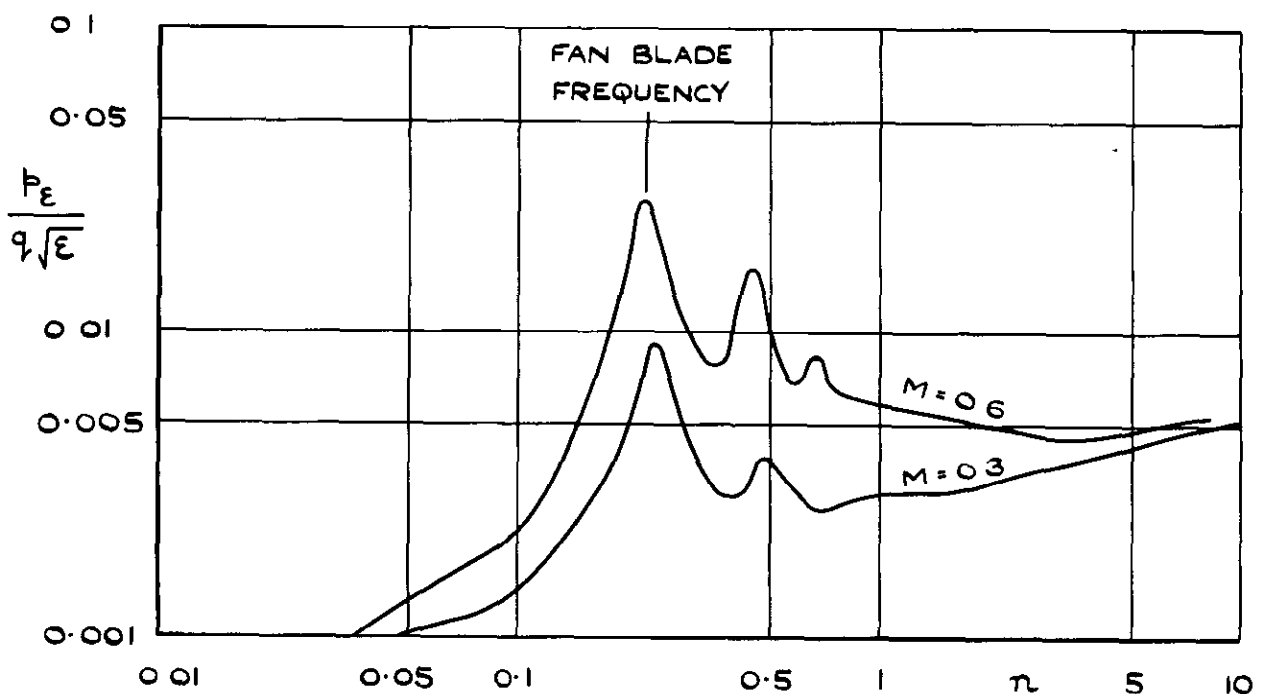


FIG. 5. AMPLITUDE SPECTRA OF PRESSURES ON FUSELAGE WITH BAY CLOSED (TRANSDUCER H)

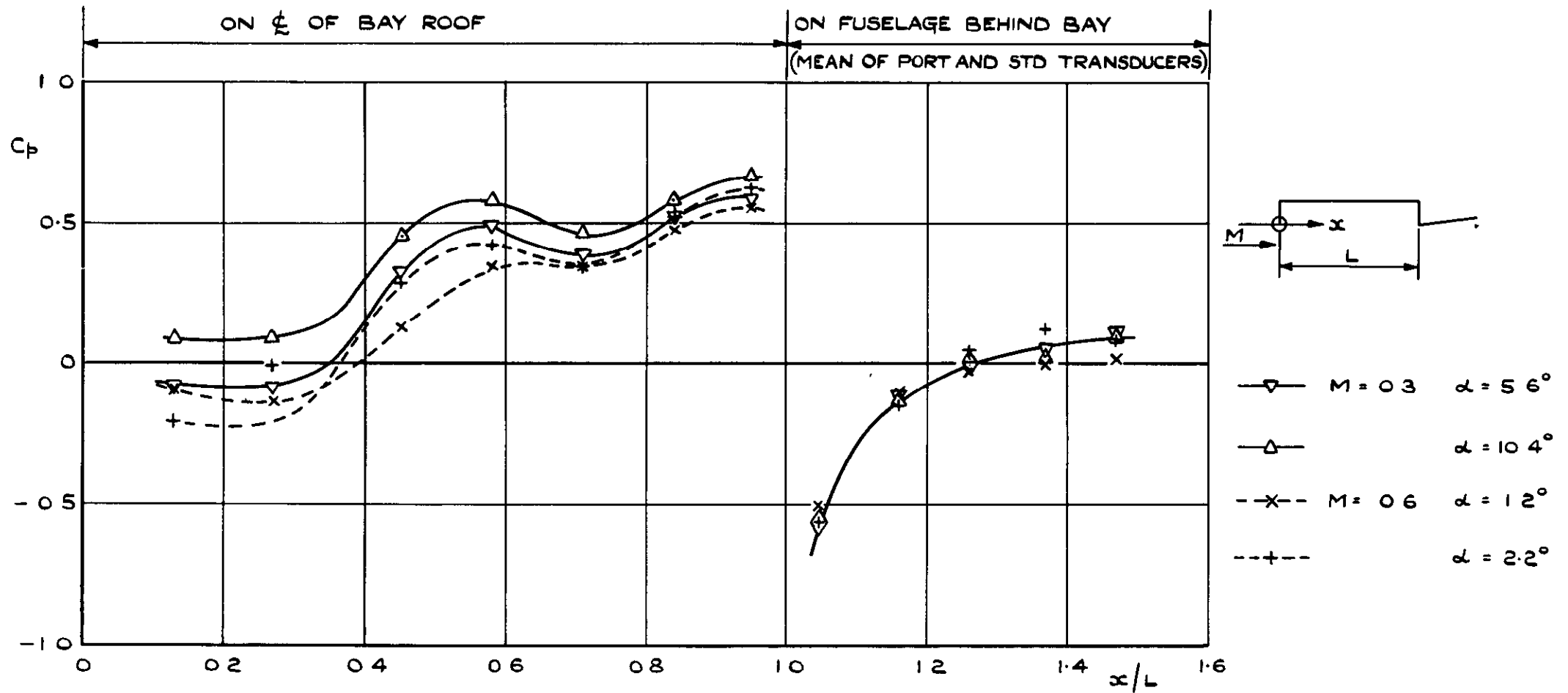


FIG.6. MEAN PRESSURE DISTRIBUTIONS IN AND BEHIND BAY

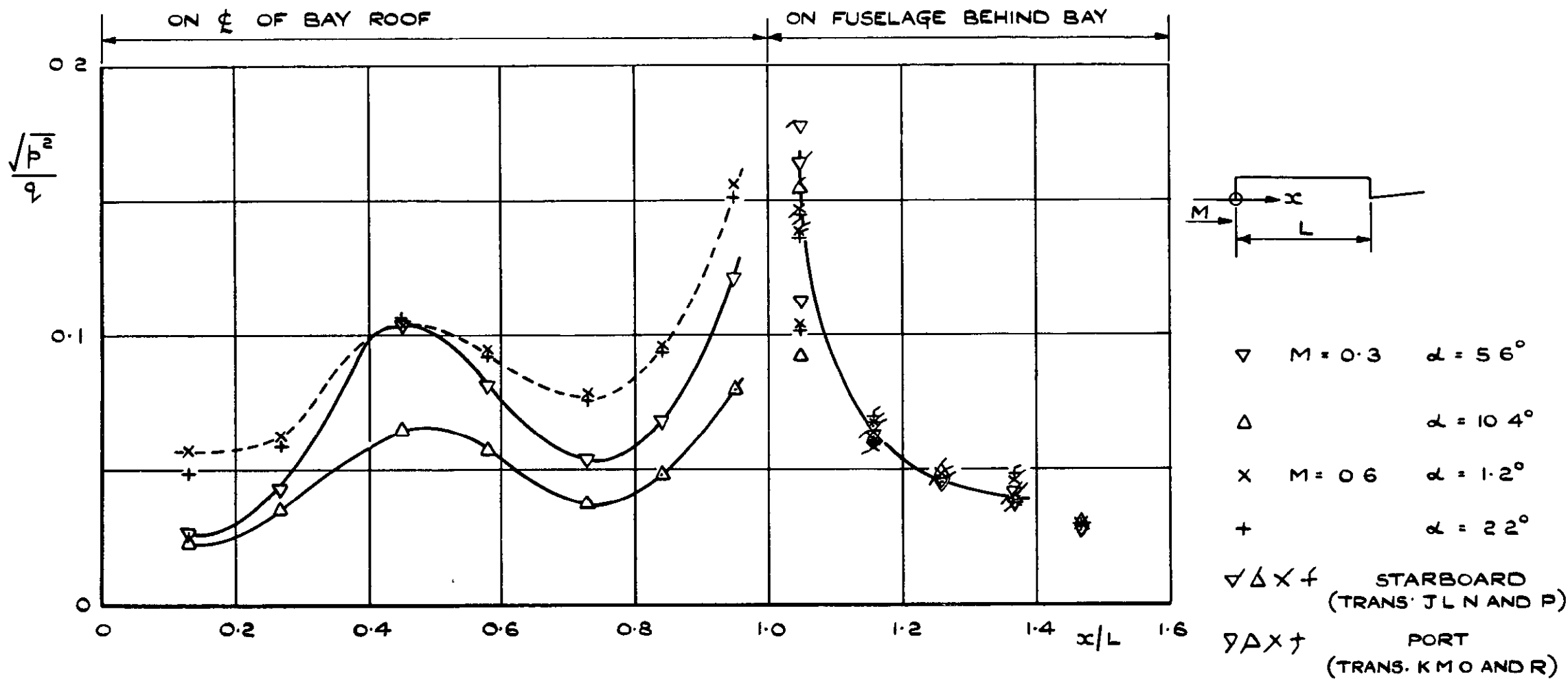


FIG.7. r.m.s. OF UNSTEADY PRESSURES IN AND BEHIND BAY.

— $\alpha = 5.6^\circ$ (CORRESPONDING TO FLIGHT AT 5,000 FT)
 - - - $\alpha = 10.4^\circ$ (CORRESPONDING TO FLIGHT AT 20,000 FT.)

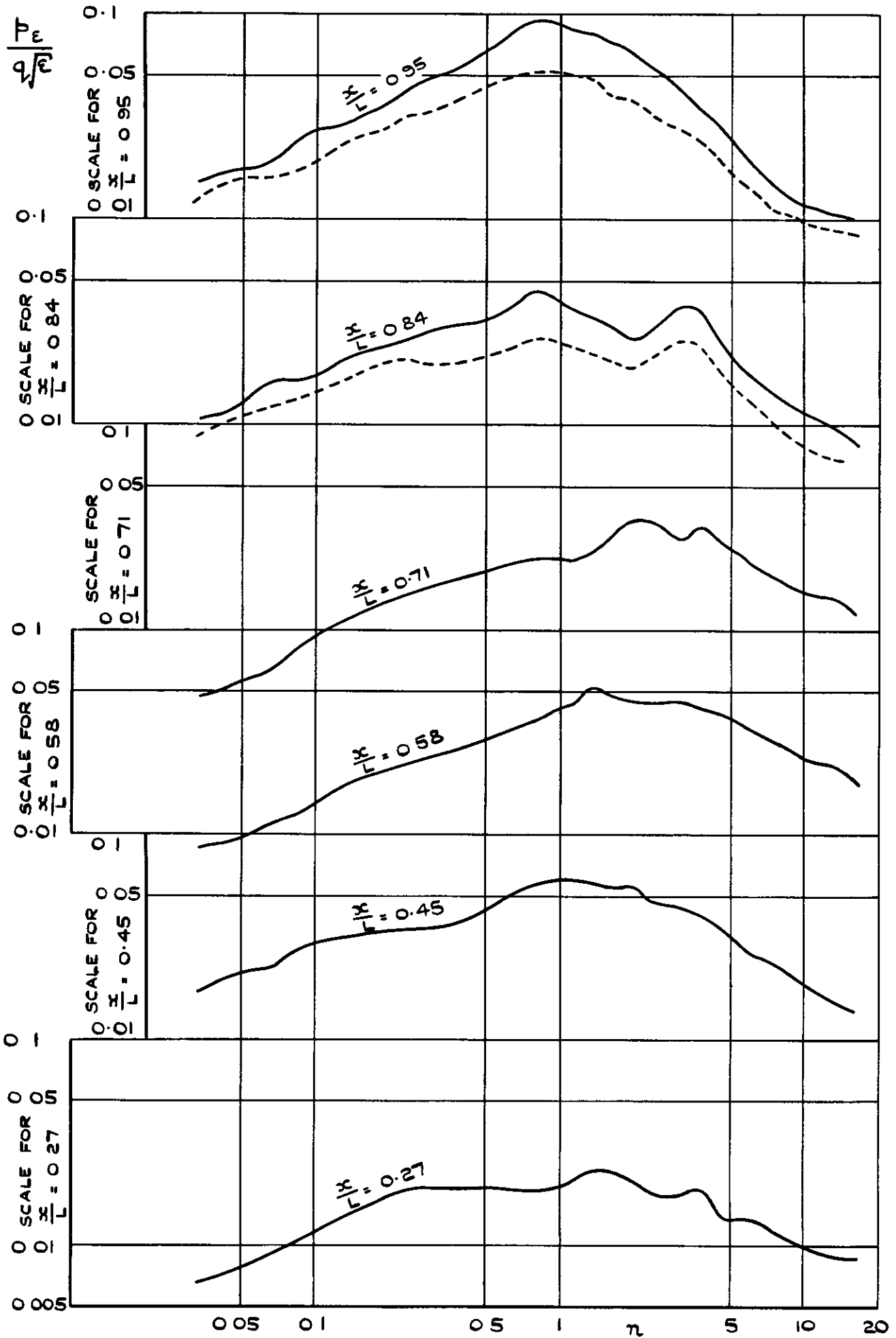


FIG.8. AMPLITUDE SPECTRA OF UNSTEADY PRESSURES $M = 0.3$ (a) IN BAY

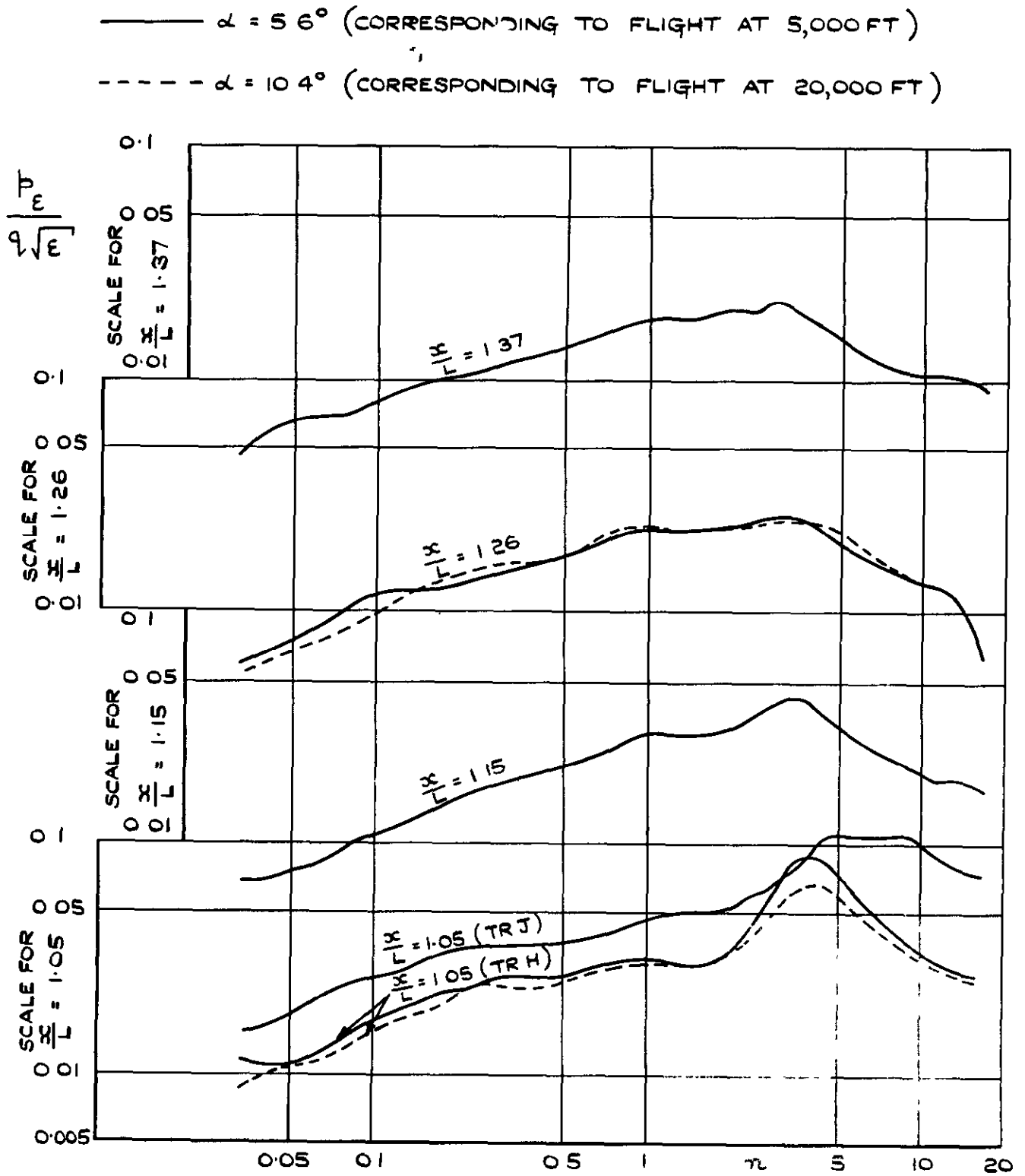
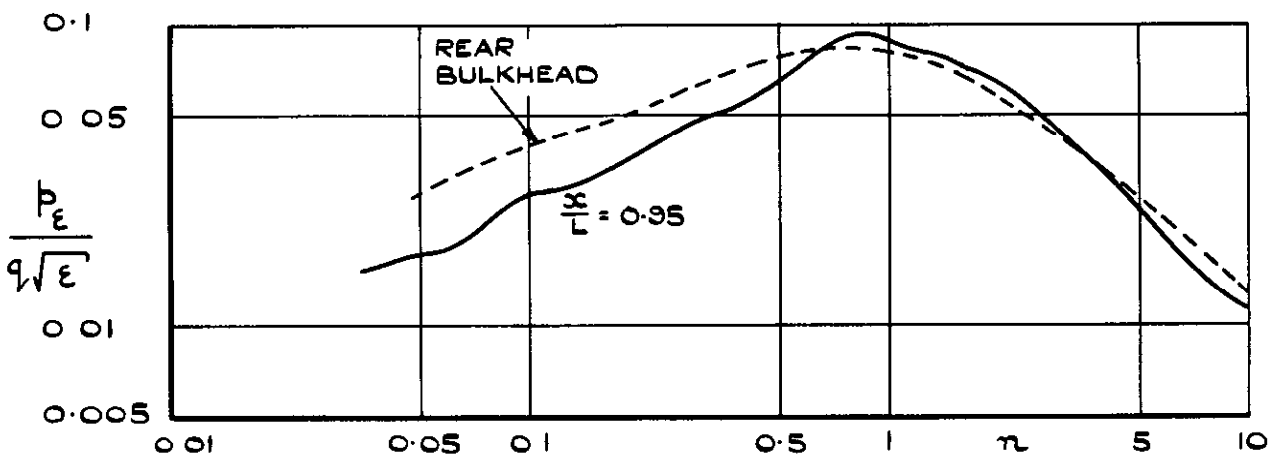


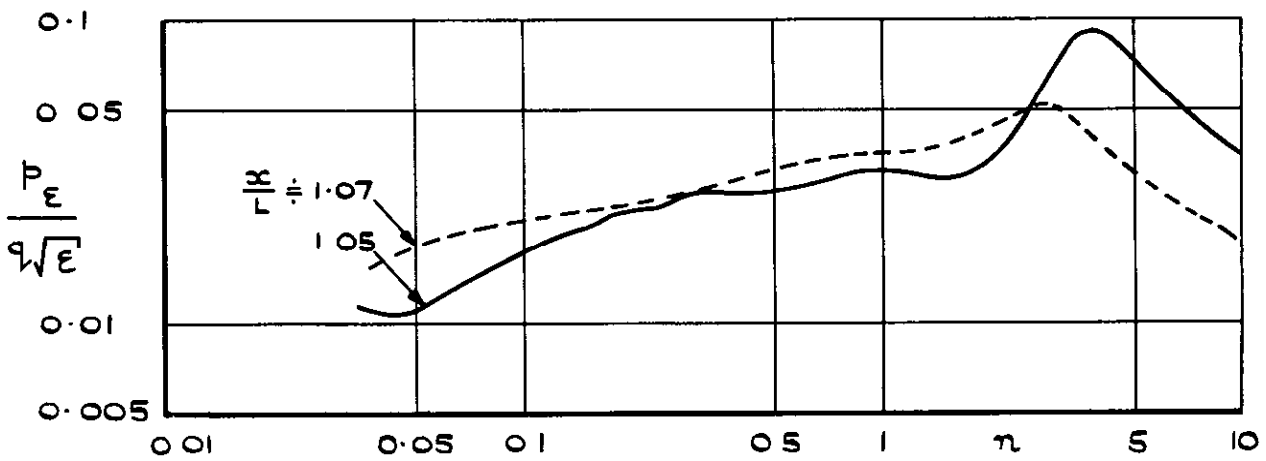
FIG.8. (CONCL'D) AMPLITUDE SPECTRA OF UNSTEADY PRESSURES $M=0.3$ (b) BEHIND BAY

———— 1/20 SCALE MODEL $M = 0.3$, $\alpha = 5.6^\circ$

----- 1/85 (APPROX) SCALE CANBERRA TYPE BAY
IN CIRCULAR SECTION FUSELAGE (REF 4)



(a) IN BAY



(b) BEHIND BAY

FIG. 9. COMPARISON WITH TESTS OF REF. 4.

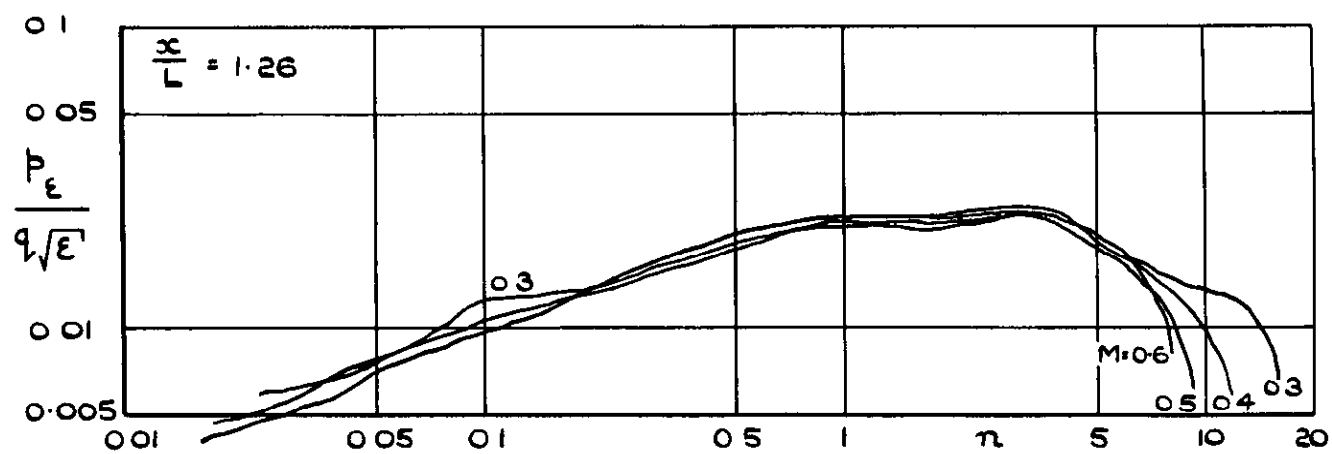
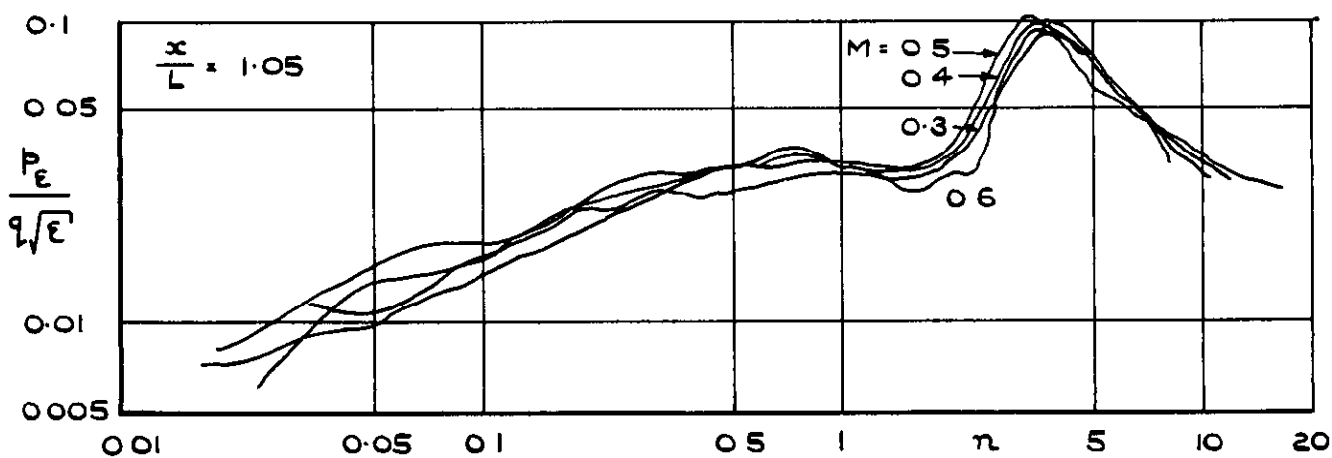
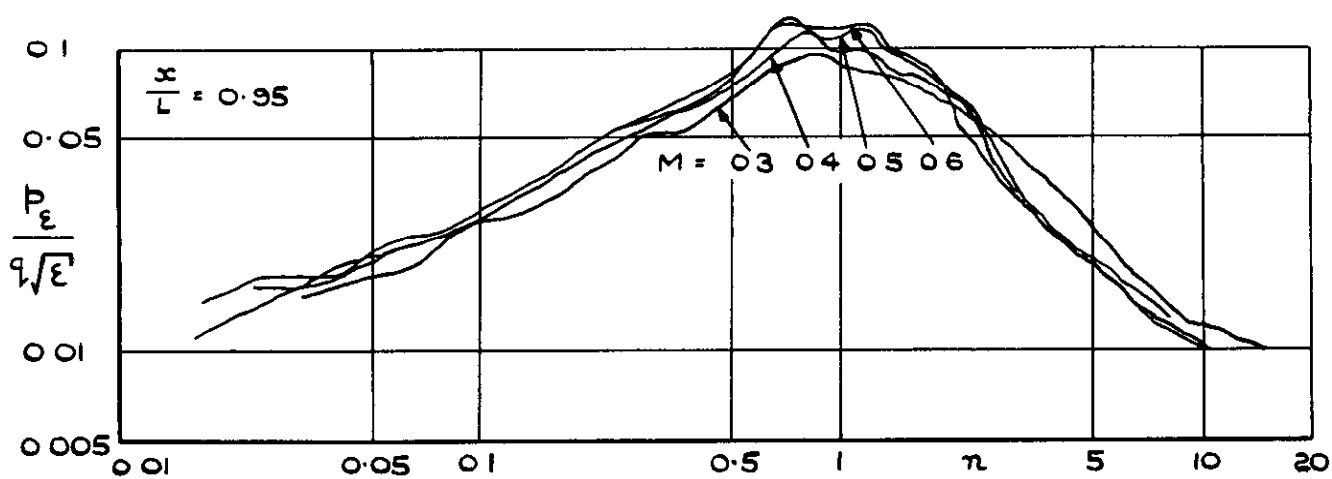
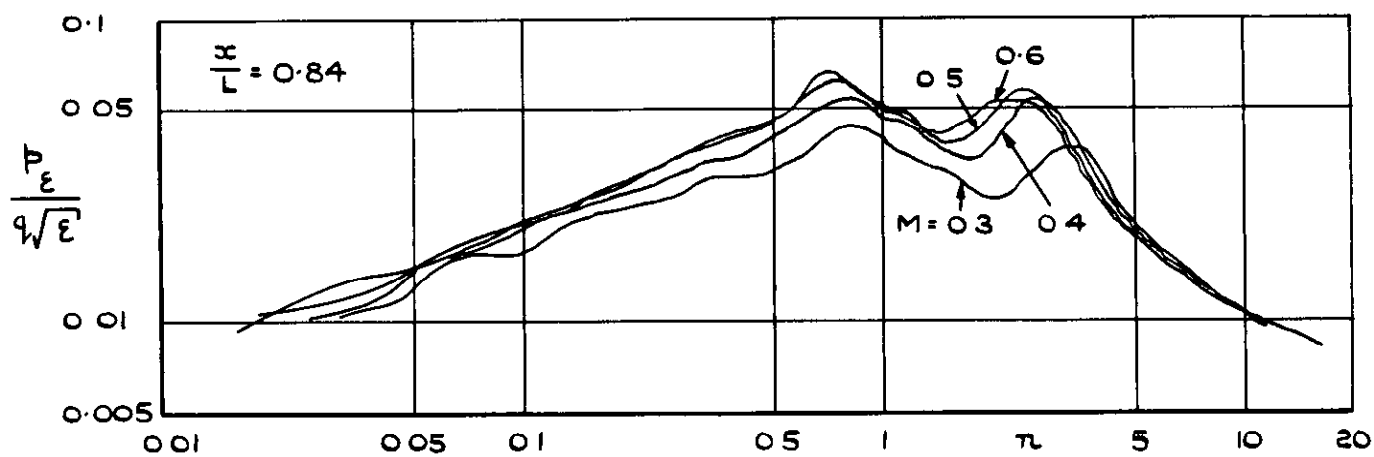


FIG.10. EFFECT OF MACH NUMBER ON AMPLITUDE SPECTRA OF UNSTEADY PRESSURES (a) MODEL INCIDENCES CORRESPONDING TO FLIGHT AT 5,000 FT.

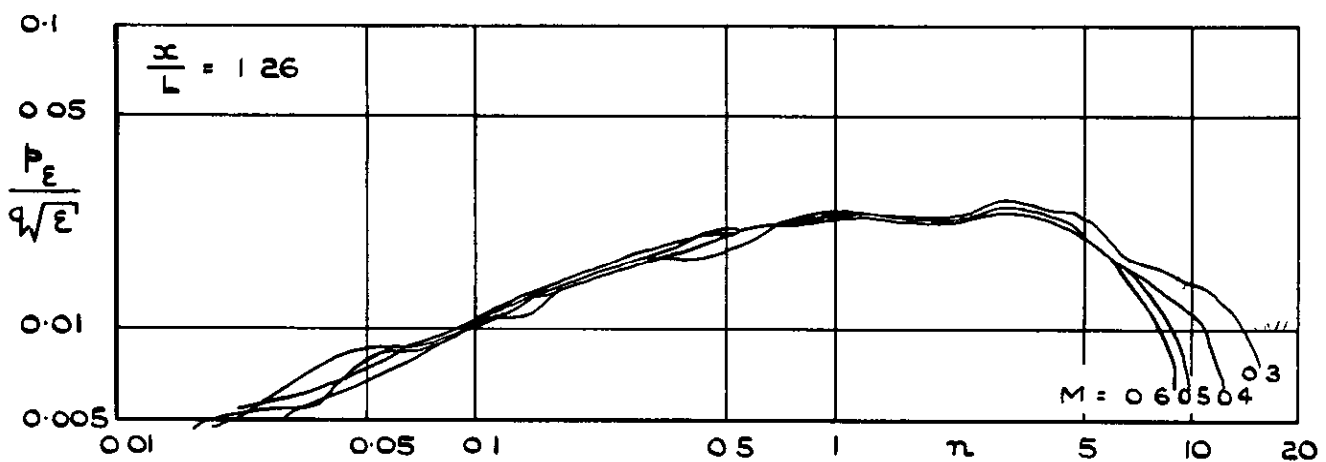
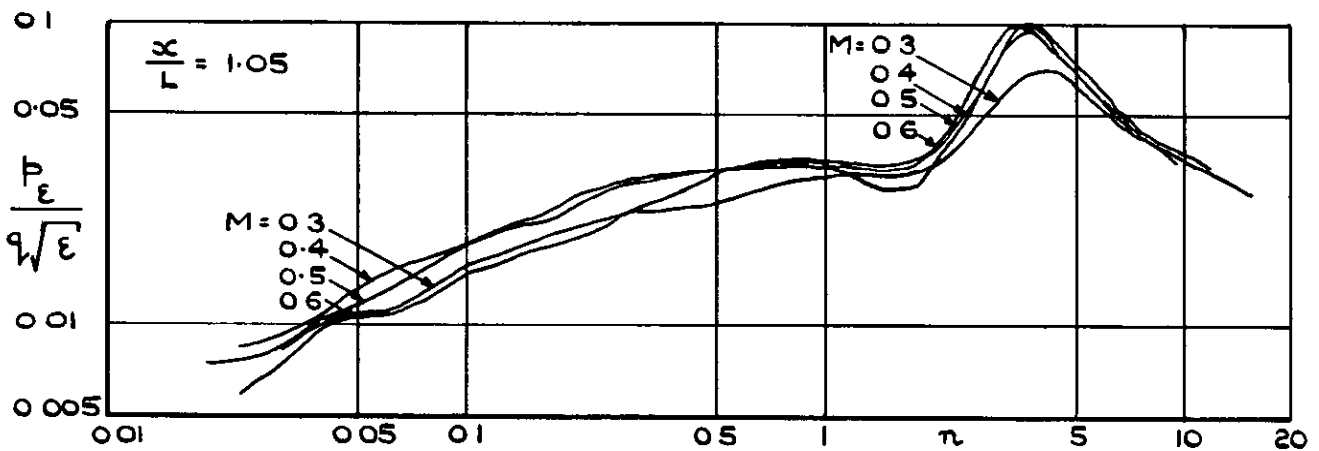
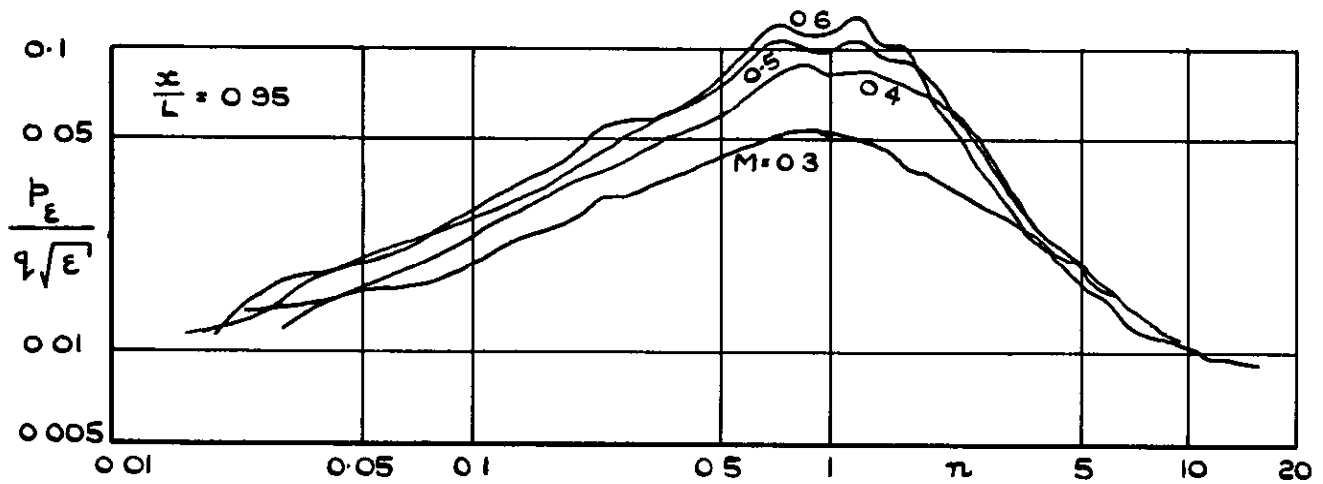
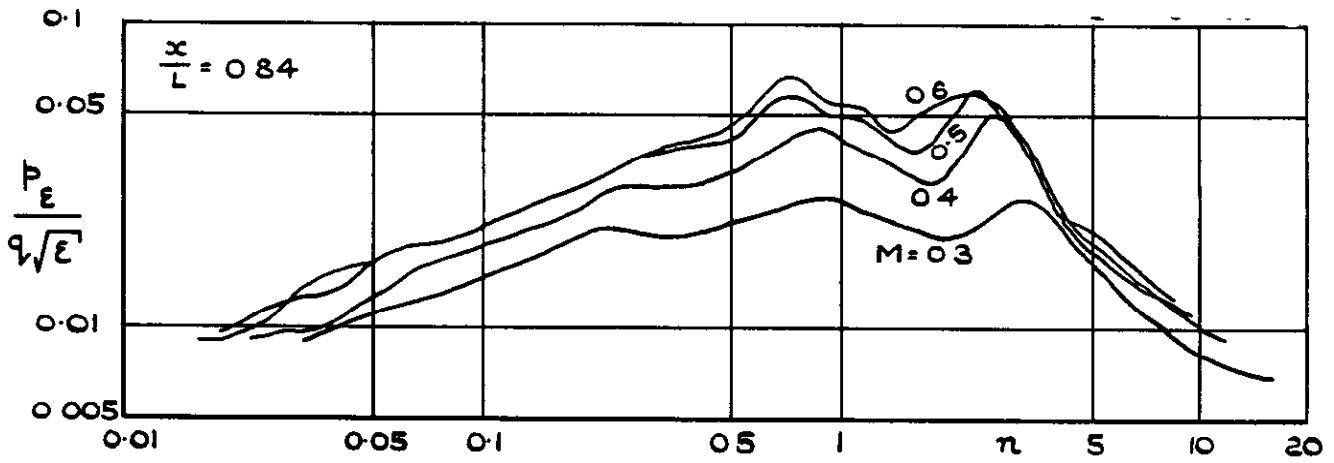
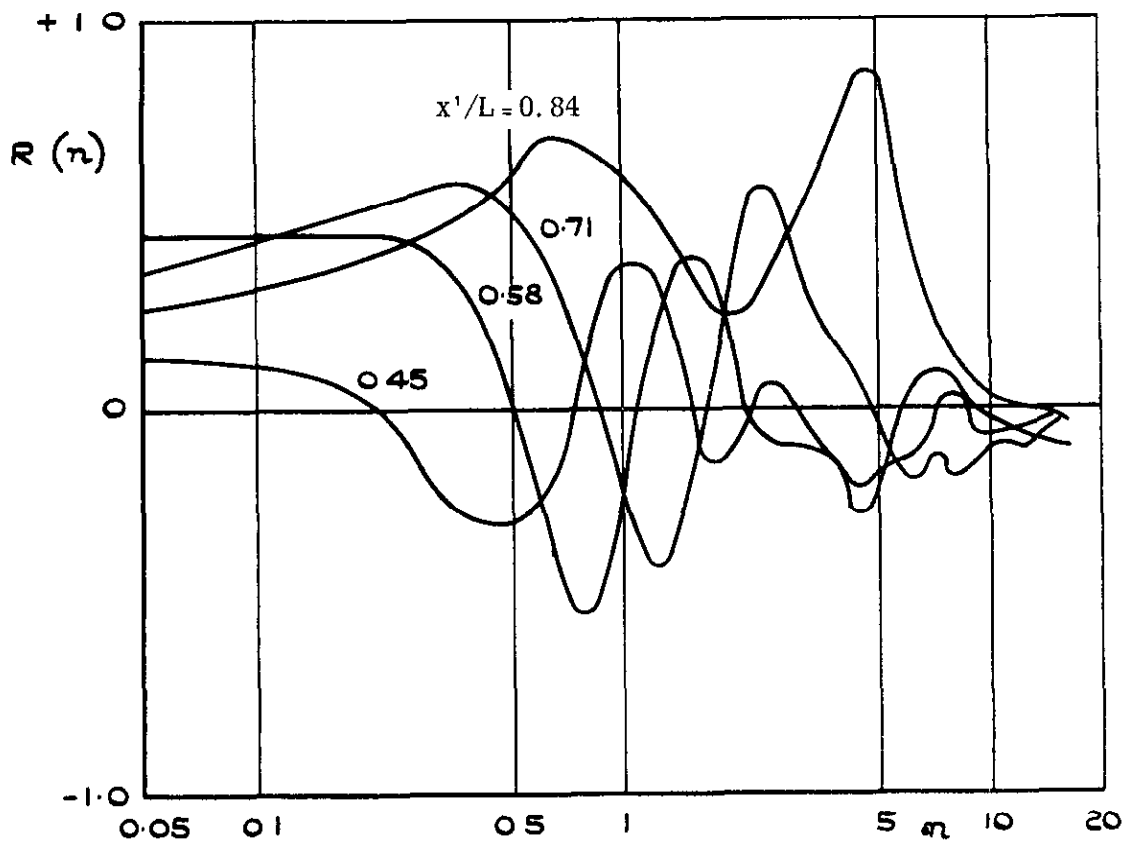
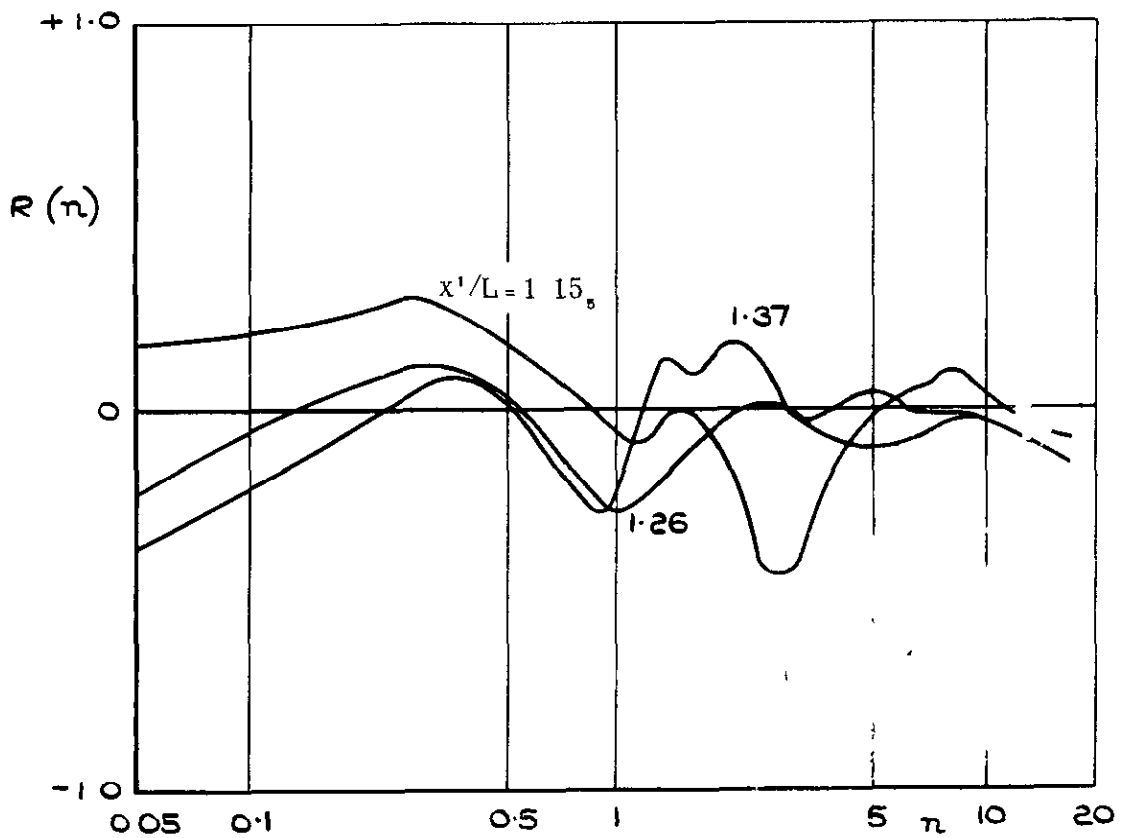


FIG.10 (CONCL'D) EFFECT OF MACH NUMBER ON AMPLITUDE SPECTRA OF UNSTEADY PRESSURES (b) MODEL INCIDENCES CORRESPONDING TO FLIGHT AT 20,000 FT.

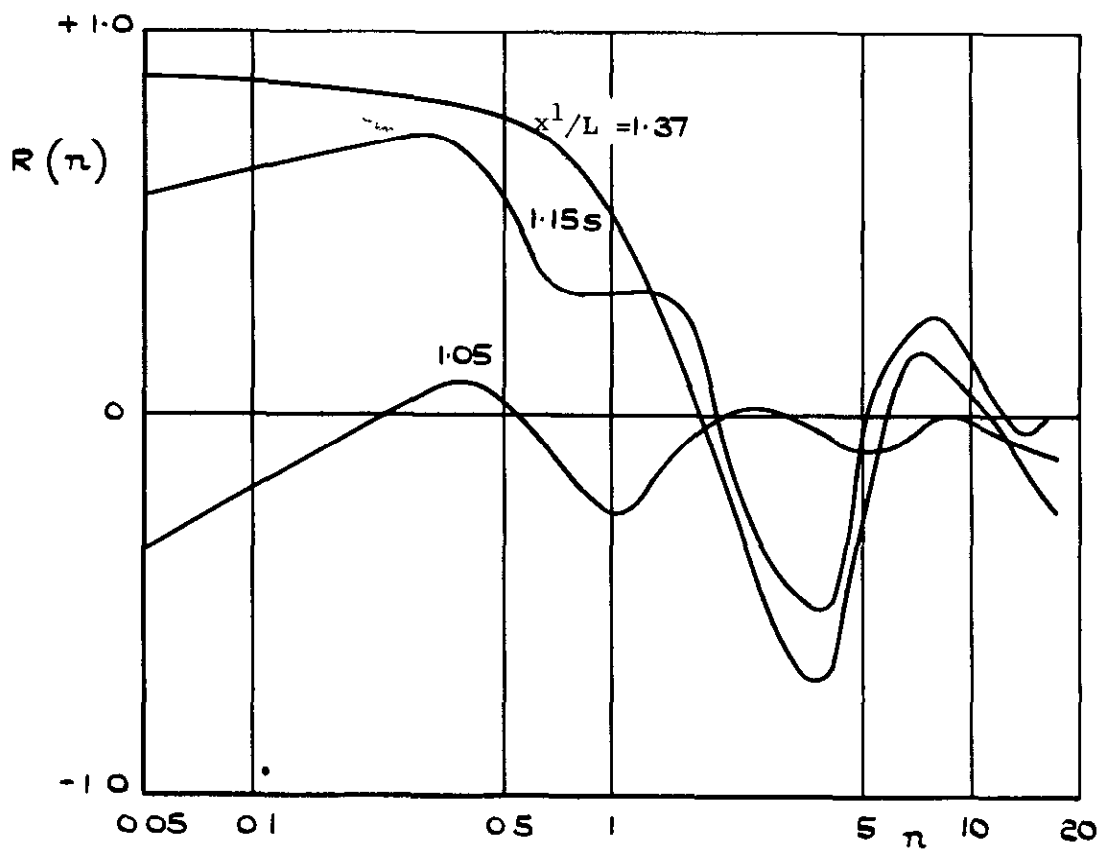


(a) IN BAY (RELATIVE TO $x/L = 0.95$)

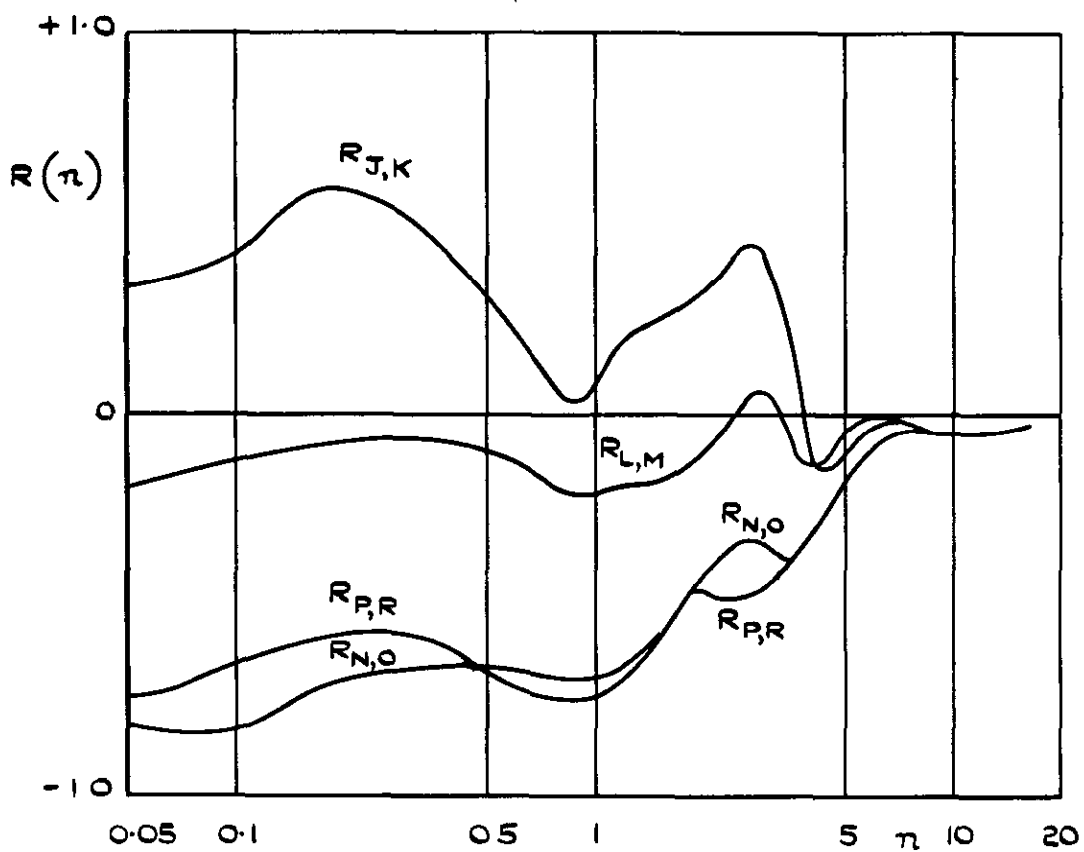


(b) BEHIND BAY (RELATIVE TO $x/L = 1.05$)

FIG. II. CORRELATION SPECTRA $M = 0.3$ $\alpha = 5.6^\circ$



(c) BEHIND BAY (RELATIVE TO $x/L = 1.26$)



(d) BEHIND BAY

FIG. II (CONCL'D) CORRELATION SPECTRA $M = 0.3$ $\alpha = 5.6^\circ$

A.P.C. C.F. No. 723

A.I.(42) E.E.Canberra :
533.695.9 :
533.6.013.2 :
533.6.011.35

WIND TUNNEL MEASUREMENTS OF THE UNSTEADY
PRESSURES IN AND BEHIND A BOMB BAY (CANBERRA).
Rossiter, J.E. and Kurn, A.G. October, 1962.

The unsteady pressures acting in and behind the bomb bay of a 1/20 scale model of the Canberra aircraft have been measured in the 8 ft x 6 ft transonic tunnel. The unsteady pressures are described by their r.m.s. values and by amplitude and correlation frequency spectra. The average values of the pressures were also measured.

The results show that the Canberra bomb bay is of the "shallow type" in which the airflow enters the bay and attaches to the roof before being deflected out by the rear bulkhead. Pressure fluctuations are most intense

(Over)

A.P.C. C.F. No. 728

A.I.(42) E.E.Canberra :
533.695.9 :
533.6.013.2 :
533.6.011.35

WIND TUNNEL MEASUREMENTS OF THE UNSTEADY
PRESSURES IN AND BEHIND A BOMB BAY (CANBERRA).
Rossiter, J.E. and Kurn, A.G. October, 1962.

The unsteady pressures acting in and behind the bomb bay of a 1/20 scale model of the Canberra aircraft have been measured in the 8 ft x 6 ft transonic tunnel. The unsteady pressures are described by their r.m.s. values and by amplitude and correlation frequency spectra. The average values of the pressures were also measured.

The results show that the Canberra bomb bay is of the "shallow type" in which the airflow enters the bay and attaches to the roof before being deflected out by the rear bulkhead. Pressure fluctuations are most intense

(Over)

A.P.C. C.F. No. 726

A.I.(42) E.E.Canberra :
533.695.9 :
533.6.013.2 :
533.6.011.35

WIND TUNNEL MEASUREMENTS OF THE UNSTEADY
PRESSURES IN AND BEHIND A BOMB BAY (CANBERRA).
Rossiter, J.E. and Kurn, A.G. October, 1962.

The unsteady pressures acting in and behind the bomb bay of a 1/20 scale model of the Canberra aircraft have been measured in the 8 ft x 6 ft transonic tunnel. The unsteady pressures are described by their r.m.s. values and by amplitude and correlation frequency spectra. The average values of the pressures were also measured.

The results show that the Canberra bomb bay is of the "shallow type" in which the airflow enters the bay and attaches to the roof before being deflected out by the rear bulkhead. Pressure fluctuations are most intense

(Over)

in the vicinity of the rear bulkhead and on the roof of the bay where the flow attaches. Changing the Mach number from 0.3 to 0.6 has in general little effect on the unsteady pressures (when expressed non-dimensionally) but increasing incidence up to ten degrees produces some decrease in their magnitude.

in the vicinity of the rear bulkhead and on the roof of the bay where the flow attaches. Changing the Mach number from 0.3 to 0.6 has in general little effect on the unsteady pressures (when expressed non-dimensionally) but increasing incidence up to ten degrees produces some decrease in their magnitude.

in the vicinity of the rear bulkhead and on the roof of the bay where the flow attaches. Changing the Mach number from 0.3 to 0.6 has in general little effect on the unsteady pressures (when expressed non-dimensionally) but increasing incidence up to ten degrees produces some decrease in their magnitude.

C.P. No. 728

© *Crown copyright* 1965

Published by

HER MAJESTY'S STATIONERY OFFICE

To be purchased from

York House, Kingsway, London, W.C. 2

423 Oxford Street, London, W. 1

13A Castle Street, Edinburgh 2

109 St Mary Street, Cardiff

39 King Street, Manchester 2

50 Fairfax Street, Bristol 1

35 Smallbrook, Ringway, Birmingham 5

80 Chichester Street, Belfast 1

or through any bookseller

Printed in England for Her Majesty's Stationery Office by Keyswift Ltd, Edgware

C.P. No. 728

S O Code No 23-9015-28