R &M No.3836

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PROCUREMENT EXECUTIVE, MINISTRY OF DEFENCE

Aeronautical Research Council
Reports and Memoranda

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London: Her Majesty's Stationery Office

£10 NET

UDC 519.233 : 629.13.012.6 : 539.431 : 533.6.048.5

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November 1977

SUMMARY

A study is made of the application to wings of fighter-type aircraft of a parametric method of deriving fatigue loads, similar to that developed previously for fins. In this method load is not measured directly but is deduced from a statistical correlation with an appropriate combination of aircraft motion variables and control surface angles. New problems arise in the application to wings associated with the variation in load levels upon which the manoeuvre loads are superimposed. The combined effect of symmetric and asymmetric loading is considered and the method can be regarded as extending current operational methods based on CG normal acceleration to include asymmetric and pitching effects.

The study is again centred on Lightning flight measurements; its scope is limited however by the lack of ground load calibrations for the wing strain gauges which has necessitated the development of parametric formulae for local rather than overall loads.

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* Replaces RAE Technical Report 77178 - ARC 37708

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1 INTRODUCTION

The commonly adopted practice of using normal acceleration at the CG of fixed-wing aircraft to obtain data on fatigue loads in wings can be regarded as a limiting case of the parametric method which occurs when the parametric combination reduces to a single parameter. With the development of multi-parametric methods for determining fatigue loads in parts of the structure other than the wing, it is logical to consider whether the accuracy with which wing loads are determined can be improved by the use of additional parameters. In particular, the inclusion of parameters representing the asymmetric effects, at present neglected, might be expected to produce improved estimates of wing fatigue loads for aircraft subjected to rapid rolling manoeuvres.

At the close of the fin loads flight trials on the Lightning, the opportunity was taken to fit in a short series of further trials to obtain measurements relating to the wing. Because of the short time available only a limited number of strain gauges could be fitted and there was no opportunity for their calibration under applied ground loads. This resulted in attention being focused on local bending moment loads in the spars rather than on overall bending moment, torque and shear loads at wing sections as envisaged in the present concept of the parametric method. Despite this limitation and the limited amount of flight data available, it was thought worthwhile to carry out a preliminary study of the application of the parametric method to wings, the results of which are presented in this Report.

The procedures adopted are mostly similar to those developed for the fin and are not described here in detail unless differing significantly from those for the fin. A summary of the latter is, however, reproduced for convenience in Appendix A. For a full discussion of the underlying concepts, reference should be made to the earlier report on the fin[1], and, for a more general discussion of the potentialities of the parametric method, to reports by Hovell[2] and by Hovell and Sturgeon[3].

2 PROBLEMS PECULIAR TO THE APPLICATION OF PARAMETRIC METHODS TO WINGS

The procedures developed previously for deriving statistically a combination of parameters from flight data to give loads in the fin, can, in general, be equally well applied to the wing. Only in a few respects, discussed below, do these procedures require modification.

2.1 Choice of datum levels

In the case of the fin the choice of datum levels from which to measure the strain-derived loads and parameters for use in the regression analysis presents little difficulty since all loads and parameters tend to approximate to zero in straight and level flight, as can be checked by comparison with the no-load ground condition, thus providing easily determinable datum levels from which to derive absolute loads. In the case of the wing the choice is not so obvious since not only do the straight and level flight loads vary with flight conditions but the ground no-load condition is not readily producible because of the ever-present effects of gravity.

Two choices present themselves; it may be possible to establish strain datum levels at zero load* by setting up a no-load condition on the ground - to achieve this the aircraft has to be supported at the fuselage and the wing weight counteracted by up-loads. Using these datum levels, loads can be derived in absolute terms. The corresponding choice of true zero datum levels for the parameters is in most cases straightforward but care has to be taken in defining zero aileron angle on account of float**. Care has also to be taken in the choice of normal acceleration datum level.

In general, the constraint of parameters to zero values at zero load may result in the linearisation inherent in the regression analysis being less accurate than if this constraint were not imposed. The constraint can be removed very simply by allowing the regression to choose its own constant for inclusion in the parametric formula. This allows more flexibility in linearising non-linear aerodynamic and elastic effects.

An alternative choice is to use an arbitrary steady flight condition to provide datum levels for all loads and parameters. This leads to the derivation of incremental loads which can only be converted to absolute values if these are known at the arbitrary condition. This method is likely, however, to provide a well matched set of datum levels for both strains and parameters. Moreover, if the arbitrary steady flight condition is in the range where the manoeuvres, causing fatigue damage, commonly occur, the need to introduce a constant into the regression because of non-linearities is not so great. In particular a realistic datum level can readily be obtained for aileron angle which takes proper account of aileron float.

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* The output of the strain gauge bridge is not necessarily zero at zero strain because of initial imbalance in the gauges.

** Float is defined as a tendency of an aileron to rotate under load owing to flexibility and backlash in the system.

In the Lightning study, because it had not been possible to establish the no-load ground condition, the choice fell inevitably on the use of non-zero datum levels. The arbitrary flight condition chosen consisted of straight and level flight at an altitude of 10000 ft, indicated air speed of 400 knots, and average flight all-up weight. (The datum levels were averages of the almost identical levels measured at 350 and 450 knots.) The datum level for the normal acceleration measurements is also taken in this condition.

2.2 Treatment of steady state loads

Wing loads can, broadly speaking, be regarded as of two sorts: those associated with steady flight and those associated with manoeuvres and gusts superimposed on the steady flight loads. Whereas, in the case of the fin, the former approximate to zero and so can be neglected, in the case of a wing the steady flight loads vary with flight conditions such as Mach number and fuel load and are by no means negligible. The appropriate steady flight loads can vary significantly during the course of a single manoeuvre due to speed, height and Mach number changes. One way of tackling this problem is not to attempt to derive the steady state loads from the parametric formula but to confine its use to providing incremental loads classified according to the flight regime in which they occur. Steady state loads, determined by calculation or separate measurement, can then be added at a later stage. This procedure would fit in well with the use of different coefficients in the parametric formula for different regimes of flight, *eg* for subsonic and supersonic flight.

Alternatively parameters can be introduced into the regression to provide estimates of the steady state loads. This introduces a new class of parameters into the analysis, namely those defining the flight conditions. The decision whether or not to include such parameters depends on the degree of complexity acceptable in the interest of accuracy. The regression analysis on the Lightning was carried out both with and without parameters defining flight conditions.

3 APPLICATION OF PARAMETRIC METHOD TO WING LOADS

The main procedures for applying the parametric method to the wing loads in the Lightning follow closely those proposed in the earlier report on the fin, an outline of which is given in Appendix A. Special flight tests were made in which wing loads were measured by means of strain gauges and at the same time measurements were made of parameters defining those motions of the aircraft and movements of the control surfaces thought relevant to the determination of the wing loads. Details of the strain gauge installation which was confined to the measurement of bending moment in individual spars are given in Appendix B. The recording instrumentation is described in the earlier report[1]. Measurements were made during general aerobatics and simulated combat manoeuvres; they included aileron, barrel, slow and hesitation (8-point) rolls, loops, wing-overs, rolling pull-outs and vertical step runs. Only a few supersonic manoeuvres were performed because supersonic flying proved so expensive in flight time. Some measurements were also made during low and medium level atmospheric turbulence of light intensity. Cases selected for inclusion in the regression analysis are listed in Table 1.

Maximum and minimum values of each strain gauge bridge output were extracted for the chosen flight cases, together with simultaneous values of the parameters. A number of maxima and minima were usually extracted for each manoeuvre in order to cover fatigue load cycles of various magnitudes. The maxima and minima for the different bridges did not necessarily occur simultaneously, major differences in timing occurring, as might be expected, between port and starboard wings. The data relating to each station are listed in Tables 2a to g.

3.1 Interpretation of the strain gauge bridge outputs

Because neither time nor funds were available for calibrating the strain gauges by the application of point loads as advocated in the Skopinski[4] method, the outputs from the strain gauge bridges could not be combined to give overall loads at the cross-sections gauged, as in the original concept of the parametric method. The only alternative appeared to be to treat the outputs of the strain gauge bridges separately and to determine parametric formulae for each output. The question then arose as to whether the bridge output should be kept in the form of strain or converted to local load. For convenience in discussing the parametric formulae it was considered preferable to express the bridge output in terms of local load. (Analytically the choice is trivial since it is only a matter of scaling each parametric formula by the appropriate conversion factor.) Generality is improved if the bridge output is expressed as a multiple of a local load which occurs in a simple flight condition related to a design case. The effects of stress concentrations on the bridge output due to, *eg* the proximity of rivets can then be partially eliminated, and the magnitude of the bridge output, particularly if expressed as a multiple of a 1 g load, rendered more meaningful.

The output from each strain gauge bridge was accordingly converted to load expressed as a multiple of the corresponding local spar bending moment per g experienced in a sustained 3 g turn at the same arbitrary flight conditions as were chosen for the datum levels, *ie* 400 knots at 10000 ft. Further details of this conversion are given in Appendix B. It should be emphasised that the magnitudes of the bridge outputs when expressed in this way depend on the arbitrary choice of flight conditions at which the calibration turn is made. The only guiding criterion used in this choice was that the set of conditions should be one at which fatigue damage commonly occurred.

It now remains to consider the implications of confining this Report to the study of parametric formulae for deriving local rather than overall loads. As it turns out, these are not as serious as might at first appear. For fatigue load measurements in general, it is probably preferable to develop separate parametric formulae for overall bending moment, torque and shear loads at a cross-section, since by combining their time histories in appropriate proportions the time histories of stress at all points in the cross-section are available for estimating fatigue damage*. The direct production of parametric formulae giving local loads simply cuts out the intermediate steps of combining the parametric formulae for overall loads. Since much of the qualitative study of this Report, *eg* that relating to the relative importance of symmetric and asymmetric effects, can only be made in terms of local stresses or loads, the restriction to directly derived formulae is not too serious, particularly since these formulae relate to key stations chosen for studying general effects rather than on account of their high stresses. The scope of the investigation is, however, somewhat hampered by the inability to consider separately the parametric formulae for overall bending moment, shear and torque.

3.2 Choice of parameters and filters for regression analysis

Two sets of parameters were used as initial data in the regression analysis which was conducted in two stages. The first and more simple set consisted of normal acceleration at a position 355 cm forward of the CG $(\ddot{z}_s)$, pitch rate $(\dot{\theta})$, pitch acceleration $(\ddot{\theta})$, roll rate $(\dot{\phi})$, roll acceleration $(\ddot{\phi})$ and aileron angle (ξ). Pitch and roll acceleration were determined by differentiating pitch and roll rates. Pitch and roll rates were conditioned by multiplying them by dynamic pressure and by the inverse of true airspeed, and aileron angle by multiplying it by dynamic pressure. The second set contained the additional parameters dynamic pressure, Mach number and Mach number squared. Normal acceleration $\ddot{z}_s$ was replaced by normal acceleration at the CG derived by combining $\ddot{z}_s$

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* Either by applying Palmgren-Miner's Law or by comparison with ground fatigue test results.

with an appropriate proportion of $\ddot{\theta}$. Two further independent variables were then introduced by multiplying the parameter $\ddot{z}_{CG}$ by M and by M^2.

The most notable omission in these lists of parameters is probably the angle of incidence. Sensors for measuring this parameter had not been fitted to the Lightning during the original installation and time did not allow installation at a later date. Other parameters such as angle of sideslip and yaw acceleration, which might otherwise have been included, could not be recorded owing to the shortage of channels on the main recorder. (Data for deriving additional slowly varying parameters such as dynamic pressure and Mach number, could be accommodated on a supplementary photographic paper recorder but this recorder was unsuitable for the faster-varying parameters.)

The loads and all parameters, other than dynamic pressure and Mach number, were subjected after digitising to a low-pass filter with a cut-off frequency of 5 Hz. This was designed to retain as much of the high frequency content of the loads as possible without running into structural oscillations (the fundamental wing frequency occurred at approximately 6 Hz). Even so it appeared that high speed aileron movement and the resulting wing loads in certain aileron manoeuvres were being reduced by the digitising rate of 20 samples a second and the application of the above filter. The two hesitation rolls, in which this reduction appeared particularly pronounced, were therefore re-digitised at 100 samples a second and subjected to a low-pass filter to remove information at frequencies greater than 20 Hz. A further 8-point hesitation roll included in a sequence of general aerobatics has not been subjected to this special treatment.

4 RESULTS OF FIRST STAGE OF REGRESSION ANALYSIS

The first stage of the regression analysis was an exploratory one in which an abbreviated list of parameters and somewhat crude conditioning factors, based on average values for each, or parts of each, manoeuvre were used to obtain parametric formulae for the local bending loads at the seven serviceable strain gauge stations. The eighth strain gauge bridge at station 1 remained unserviceable throughout the trials. The objective was to get an indication of the importance of the asymmetric effects and of the possibilities of improving the accuracy with which loads could be derived from normal acceleration, by the addition of one, or at most two, parametric measurements representing asymmetric effects. A secondary objective was to study the consistency of results obtained from the port and starboard wings with a view to confining further analysis in this Report to one wing only.

4.1 Importance of asymmetric effects

Information for achieving the above objectives stems from the last three parametric formulae for each station, containing 3, 2 and 1 parameters respectively (see Table 3). All parametric formulae when reduced to a single parameter retained the parameter normal acceleration $(\ddot{z}_s)$ confirming the present use of normal acceleration, albeit at the CG and the fact that wing fatigue loads tend to be primarily symmetric. When allowed a second parameter all formulae retained aileron angle (ξ) conditioned by multiplying it by dynamic pressure (q) as the additional parameter. The contribution from this parameter is indicated by its partial regression coefficient expressed as a percentage of the total of the partial coefficients; it is quite large, averaging 30% for the inboard section loads and as much as 45% for the outboard sections. Contributions of this magnitude suggest that worthwhile improvements can be made, particularly for outer wings, by the introduction of asymmetric parameters. With the simple approach adopted at this stage, the standard deviation of the error is reduced by the inclusion of the parameter ξ from 34% to 23% of the rms load at the inner sections and from 55% to 24% at the outer sections.

When a third parameter was included in the parametric formulae, the regression programme chose different additional parameters for the inboard and outboard wing sections. A further parameter representing symmetric effects, namely pitch rate $(\dot{\theta})$, was chosen for the inboard sections while a further parameter representing asymmetric effects, namely roll acceleration $(\ddot{\phi})$ was chosen for the outboard. The contribution from $\dot{\theta}$ is relatively small, averaging 7%; that for $\ddot{\phi}$ is larger, averaging 15%. The increase in accuracy is still significant but is starting to diminish, the reduction in the standard deviation of the error averaging only 2% for the inboard sections and 4% for the outboard. $\ddot{\theta}$ was also investigated and discarded.

4.2 Consistency of results from port and starboard wings

Results for the port and starboard wings were reasonably consistent provided comparison was confined to relative contributions and changes in accuracy, and was not made in terms of absolute magnitudes. Despite bridge outputs being expressed as multiples of the local loads per g at the corresponding stations in an attempt to reduce the effects of stress concentrations (and possible misalignment of gauges) on bridge sensitivity, the consistency considered in absolute terms between the two wings was not good. While it would have been of interest to pursue this matter further by a more detailed treatment of both wings, the need to cut down computational effort, and the fact that the two wings showed consistent trends, led to a decision to consider one wing only in the second stage of analysis. The starboard wing was chosen because all of its four strain gauge bridges were serviceable and because the starboard aileron deflections were measured more accurately than the port. Deflections of the starboard aileron were recorded on the main recorder whereas those of the port were recorded only on the subsidiary slow-running recorder. It was possible by means of a special ground calibration to convert starboard deflections to port but the conversion was complicated by aileron float.

4.3 Need for parametric representation of steady state loads

Comparison of the time histories of the strain-derived and parametrically-derived loads obtained in the first stage of the regression analysis indicated that considerable discrepancies were occurring due to the changes with flight conditions, both of the steady state loads and of the relation between wing load and normal acceleration. The discrepancies were so marked in the case of the high Mach number manoeuvre of Flight 159 that it was thought better to remove this case from the input data for stage 1 rather than to allow it to distort the parametric formulae.

In view of these discrepancies the new parameters listed in sub-section 3.2 were added in stage 2 for the starboard wing only. Their evaluation necessitated the matching of recordings from the supplementary and main recorders to the nearest 1/20 second. At the same time the conditioning data, which were also based on recordings from the supplementary recorder, were up-dated to take account of their variation during the manoeuvres and turbulence.

5 RESULTS OF SECOND STAGE OF REGRESSION ANALYSIS

The main concern of the second stage of the analysis was the development of parametric formulae to demonstrate the feasibility of estimating wing loads by the parametric method. In the light of stage 1 results attention was confined to one wing only and the accuracy of the conditioning data improved. Particular matters of concern in stage 2 were the choice of parameters for representing the wing loads and the improvement effected by using parameters additional to CG normal acceleration.

The regression programme produced a series of parametric formulae for each of the four starboard stations 5-8, the accuracy of which, as indicated by the total correlation coefficient and standard deviation of the error, remained constant or even increased slightly as the first two or three of the ten parameters were discarded in turn. The accuracy then decreased ever more rapidly as the remaining parameters were discarded. Thus for all practical purposes the choice for greatest accuracy fell on the 7-parameter formulae. In general, better accuracies were obtained for the rear than for the front spar stations and for the inboard than for the outboard stations (see Table 4). At best, *ie* station 5, the accuracy was comparable with that attained for the fin, the standard deviation of the error being 12.5%. The accuracy at the worst station, station 8, where the standard deviation of the error was never less than 21.9%, was somewhat disappointing but still compared well with that obtained from normal acceleration alone which was as low as 58%. Typical examples of the fit attained in the regression between the strain derived and parametrically derived loads are given in Fig 2. It has to be emphasised that the accuracy of fit achieved in the regression is not the final criterion of accuracy as regards the estimation of fatigue damage under operational conditions. Two further factors which have to be borne in mind are the degree to which the sample represents the operational population of loading cases, and the tendency of positive and negative errors to cancel each other out in the final assessment of fatigue damage. These matters are discussed in more detail in the earlier report. Because of misgivings with regard to the first, a parametric formula is sought which gives a good fit in time history for a wide range of loading cases. The second factor, on the other hand, is both a favourable and a powerful one, and one which can justify the use of an extremely abbreviated parametric formula if the sample can be relied upon to represent the operational population. It cannot, however, be relied upon to overcome systematic errors due to changes in pilot or automatic control practices or the introduction of new operational roles for the aircraft.

5.1 Feasibility of representing wing loads parametrically

In order to keep the number of parametric formulae under consideration to a reasonable size, two sets were selected from these series for further study. The first contained seven parameters and a constant and typified a choice for operational usage where accuracy was the prime consideration. (The 7-parameter formulae were less complex than appeared since two of the parameters were compounds of others.) Some adjustment was made to the formula for station 5 so that it contained the same parameters as the other stations. The justification for this is discussed in Appendix C. The second set of parametric formulae selected contained three parameters and a constant - a choice typical of the operational situation where some accuracy has to be sacrificed in the interests of simplicity. Consideration was also given to the single parametric formulae. The selected formulae are listed in Table 4.

Complete time histories of loads derived from the parametric formulae selected above are compared in Fig 3a to d with strain derived loads for four manoeuvres selected from the sample used in the regression. Fig 3e shows a similar comparison for two 3 g turns not included in the sample. Typical contributions from the individual parameters making up the formulae are shown in Fig 4a to e for the same manoeuvres.

The time history comparisons for the 7-parameter formulae show that the incremental loads associated with the manoeuvres can be well represented parametrically but that the accuracy with which the steady state loads are represented needs to be improved if a really close fit is to be attained. It is probable that a better parametric representation of the steady state loads could be found if a separate regression was performed on a sample composed of steady state loads only using parameters relating to steady state conditions. The list of parameters might need to be widened - a preliminary survey indicated dynamic pressure to be a relevant parameter despite its rejection in the early stages of stage 2. If this procedure were adopted the steady state component could then be removed from the maximum and minimum loads of the main sample prior to performing a separate regression on the incremental loads associated with manoeuvres and other loading cases.

5.2 Choice of parameters in formulae

The parameters for representing the incremental component of the loads associated with manoeuvres and gusts were in order of importance: $\ddot{z}_{CG}$, ξ conditioned by multiplying it by q , $M_{\ddot{z}_{CG}}$ ($M^2_{\ddot{z}_{CG}}$ for the inboard rear station), $\ddot{\phi}$ and $\ddot{\theta}$ ($\dot{\phi}$ and $\dot{\theta}$ for the inboard rear station conditioned by multiplying them by dynamic pressure and inverse true airspeed). The contribution of $\ddot{\phi}$ to the inboard root bending moment was extremely small.

For representing the steady state components of load the most important parameters were M and M^2 in that order, except for the inboard rear station where the order was reversed. The contribution from q tended to be extremely small. A constant was needed to help represent the steady loads but this was to be expected in view of the arbitrary datum levels from which the loads were measured. As discussed earlier the representation of the steady state loads was not altogether satisfactory.

5.3 Improvements on the current use of CG normal acceleration for deriving wing loads

The improvement to be made by the addition of aileron angle has already been discussed under stage 1 results (sub-section 4.1). The more accurate and comprehensive analysis of stage 2 confirms the results given there although small changes are apparent in the values of the percentage errors and contributions. The errors inherent in using $\ddot{z}_{CG}$ alone are further illustrated in stage 2 by the time history plots of Fig 3a to e and are particularly apparent in the hesitation rolls of Fig 3c and d. One further point needs to be made with regard to the use of $\ddot{z}_{CG}$ alone. The regression programme produces optimised coefficients for relating $\ddot{z}_{CG}$ to wing loads. Compared with coefficients based on the acceleration/strain relations of the flight calibration turns and pull-outs, the optimised coefficients are larger by as much as 30% for the outboard stations and 20% for the inboard front spar station. For the inboard rear spar the increase is only 2.5%. Since the coefficients based on the flight calibration turns and pull-outs are probably representative of those used in current fatigue life estimates, it appears that improvements could be made without even introducing additional parameters if a statistical approach was adopted for optimising the relation between $\ddot{z}_{CG}$ and wing loads. Furthermore, the improvement over current methods attainable by the addition of a second parameter ξ , conditioned by multiplying it by dynamic pressure, is likely to be greater than indicated earlier since the previous comparisons were based on the assumption of an optimised empirical coefficient for $\ddot{z}_{CG}$.

6 CONCLUSIONS

A study has been made of the application to the wing loads in a Lightning of a parametric method in which load is not measured directly but is deduced from a statistical correlation with an appropriate combination of motion variables and control surface angles. Because of the lack of opportunity to calibrate the strain gauges under applied ground loads, parametric formulae have had to be developed for local bending moments at a number of wing spar stations rather than for overall loads at a cross section. Since the former are, to a first approximation, combinations of the latter this restriction does not have too severe implications in the present context.

In order to attain a good match between strain-derived and parametrically-derived loads it is necessary to introduce into the parametric formulae certain parameters and possibly a constant to represent the steady state wing loads upon which the manoeuvre and other incremental loads are superimposed. The need to introduce a constant depends on the datum levels used in the flight test measurements on which the parametric formulae are based. The best results were obtained with a quadratic in Mach number but better accuracy might have been achieved had the selection been from a wider range of parameters, and a regression on steady state loads performed separately from that on manoeuvre loads.

A fair representation of local wing bending moment loads can be obtained with the parameters CG normal acceleration, $(\ddot{z}_{CG})$, aileron angle conditioned by multiplying it by dynamic pressure, (ξq), and Mach number squared although representation is rather poor at high Mach number. With the introduction of further parameters, $\ddot{\phi}$, $M\ddot{z}_{CG}$, $\ddot{\theta}$ and M, the matching of time histories of the parametrically and strain derived loads is improved, particularly in the case of rapid aileron usage, although the standard deviation of the error in matching the sample loads of the regression is only reduced from 21.9% to 18.2% (average errors for the starboard wing - which was studied in detail - expressed as a percentage of the rms loads). The parametric representation is some 5% less accurate at the outboard section of the starboard wing than at the inboard.

The parameter, angle of incidence, was not considered since no sensor was fitted for its measurement. No conclusions can therefore be drawn as to its suitability for representing wing loads. There were some indications that pitch rate $(\dot{\theta})$ could play a small part in representing loads at the inboard section, particularly if the steady state loads were not represented.

The study indicated that considerable improvement could be made to the current method of deriving operational wing fatigue loads from measurements of CG normal acceleration by the addition of measurements of aileron angle conditioned by multiplying it by dynamic pressure (standard deviation of error decreased from 34% to 23% and from 55% to 24% for the inboard and outboard wing sections respectively. Alternatively some improvement could be made in the use of normal acceleration alone by adopting a statistical approach to optimise the coefficients defining its relation to wing loads*.

The evidence of the Lightning study is that coefficients based on simple flight measurements in symmetric manoeuvres could lead to underestimation of loads especially in the outer wing.

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* The improvements quoted are relative to an optimised empirical $\ddot{z}_{CG}$ coefficient, not relative to the current method which was a coefficient derived from loads produced by steady symmetric manoeuvres.

Appendix A

METHOD OF DERIVING PARAMETRIC FORMULA AS DEVELOPED FOR FIN

A.1 Outline of method

The method previously developed[1] for determining a combination of parameters to give information on the overall loads, *ie* bending moment, shear and torque at a structural cross-section is now outlined briefly.

Starting from the point where flight measurements covering a comprehensive set of flight loading conditions are available in the form of time histories of the relevant parameters and strain gauges the procedure is as follows:

(i) Combine the strain gauge signals in the appropriate proportions according to Skopinski's method[4] to give the time histories of the required overall load; the variation of Skopinski's method developed by Hovell, Webber and Roberts[5] may be useful here. Apply a constant correction if necessary such that the combination produces zero load in straight and level flight. (Lateral trimming loads on the fin and rudder are assumed to be insignificant throughout the flight range.)

(ii) Filter out all structural frequencies from the parameters and from the overall load by application of a low pass filter.

(iii) Perform any differentiation required (signals from rate gyros may have to be differentiated as a substitute for rotational accelerations).

(iv) Select maxima and minima values of the overall load together with simultaneous values of the parameters.

(v) Adjust these values of the parameters as required according to dynamic pressure, true air speed, Mach number and aircraft mass.

(vi) Run special regression analysis programme on above data to select parameters and optimise their linear combination to give overall load[6].

(vii) Make final choice of parametric combination, re-running programme if necessary to include subjectively chosen parameters.

(viii) Check final choice to ensure close correlation between time histories of overall load and parametric combination outside matched points.

A.2 Choice of parameters

The choice under (vii) is guided by the following considerations:

(i) The advantages of trading off accuracy for simplicity by reducing the number of parameters.

(ii) The preference for parameters requiring little or no adjustment for flight conditions.

(iii) The preference for parameters which can be measured easily and with a high degree of reliability. Consistency of sensor performance, freedom from noise, and linearity of calibration are among the factors to be looked for here.

(iv) The preference for parameters which provide data useful for other purposes.

Appendix B

STRAIN GAUGE INSTALLATION AND FLIGHT CALIBRATION

B.1 Strain gauge installation

Micro-measurement EA350 gauges were attached with an epoxy adhesive to the exposed spar flanges of spars one and five at ribs six and fourteen (see Fig 1). One longitudinal gauge and one cross gauge were fitted between rivets on the top and bottom spar booms at each station. The gauges were connected to form a conventional bending moment bridge compensated for end load and temperature effects. The bridge outputs were conditioned using the fin load equipment and were recorded as FM analogue signals. One bridge, namely that at station 1, became unserviceable at the beginning of the flight tests and remained so throughout.

B.2 Calibration of strain gauges

The flying was carried out in two main sections, namely calibration and manoeuvres. The calibration flying consisted of steady turns and pull-ups at different heights and speeds to cover the range used in the manoeuvres.

The original intention was to evaluate the bridge response to applied normal acceleration at a variety of heights and speeds so that suitable calibration values in terms of μ-strain/g could be found, and zero strain datum levels established by extrapolation to zero g, dynamic pressure and Mach number. With a range of calibrations available, it was intended that the calibration values could be varied, if necessary, according to the flight conditions of a particular manoeuvre. In the event, however, the scatter between responses for repeated similar turns and pull-ups was larger than expected. In view of the small number of examples obtained it was difficult to establish any definite trends in response and so it was decided to use a mean of all the cases obtained for 350 knots and 450 knots at 10000 ft around which most of the flying was done. The scatter in results (see Table 5) is thought to be due to dynamic effects which could possibly be eliminated by a more careful analysis in which only the more sustained parts of the turns and pull-outs were used.

The overall sensitivity of recording for each bridge was determined by applying a known resistance across one arm and hence, using the gauge factor, a figure of microstrain per volt was obtained for each bridge as follows:

SG	2	3	4	5	6	7	8
μS/V	721.5	1025.4	595.2	596.9	965.4	765.4	490.5

The data for the turns and pull-ups were digitised and for each bridge a relation between microstrain and acceleration found by means of a least squares fit. Similar gauges on each wing should, of course, show a similar μ-strain/g relation, but this was not the case, the port values being 15%, 22% and 40% larger than the starboard. It is thought that the proximity of the spar rivets was the cause rather than poorly attached gauges, as the ground zero levels were repeatable. The results are listed in Table 5.

Appendix C

STANDARDIZATION OF PARAMETERS APPEARING IN THE 7-PARAMETER FORMULAE FOR WING LOADS

The 7-parameter formula for the bending moment load at station 5, the inboard rear spar station, contained parameters that were different from those in the 7-parameter formulae for the other three starboard stations. The latter all contained the parameters $\ddot{z}_{CG}$, ξ, $\ddot{\theta}$, $\ddot{\phi}$, M, M^2 and $M\ddot{z}_{CG}$ whereas in the formula for station 5, $\dot{\theta}$, $\dot{\phi}$ and $M^2\ddot{z}_{CG}$ replaced $\ddot{\theta}$, $\ddot{\phi}$ and $M\ddot{z}_{CG}$. To see if the different choice for station 5 was significant, a revised 7-parameter formula was obtained for this station containing the same parameters as those selected for the other stations. Although this revised formula showed some loss of accuracy, the standard deviation of the error increasing from 12.5% to 14.0%, the time history of a typical rolling, pitching manoeuvre showed little detectable reduction in fit (see Fig 5). Since the adoption of a common set of parameters for local loads at any one cross-section was justified by the fact that, under standard procedures, parametric formulae for the local loads would all be derived from combinations of the same parametric formulae, namely formulae for overall bending, torque and shear loads at the relevant cross-section, and so could be expected to contain the same parameters, the decision was made to use the revised formula. The equally logical alternative of changing the parametric formula for station 7, the other inboard station to match station 5 was less attractive since it did not provide a common set of parameters for comparing contributions from different parameters at the inboard and outboard sections. However, the preference shown in the stage 1 analysis for $\dot{\theta}$ rather than $\ddot{\phi}$ at all three inboard stations (the fourth bridge was unserviceable) suggests that $\dot{\theta}$ should not be discarded too lightly.

Table 1

MANOEUVRES AND LOADING CASES USED IN PARAMETRIC COMBINATIONS

Flight No.	Altitude (ft)	IAS (kn)	Manoeuvre, etc
159	36000	570	Supersonic manoeuvres
163	25000	480	Supersonic manoeuvres
	300	525	Turbulence over sea
	24000	400	Turbulence
164	2000	500	Port and starboard aileron rolls
	2000	550	Port and starboard aileron rolls
	12500	350	Wing-overs, general aerobatics including hesitation roll, and combat type manoeuvres
165	9000	250	180° port and starboard aileron rolls
	9000	300	360° " " " " "
	9000	350	360° " " " " "
	9000	400	360° " " " " "
	9000	450	360° " " " " "
	6700	375	Vertical step runs
	7000	325	Barrel rolls with moderate buffet
166	5000	350	Hesitation (8-point) roll
	5000	420	Hesitation (8-point) roll
167	37000	300	Transonic pull-outs
	10000	400	Hesitation (8-point) roll - not completed by pilot
	10000	350	Slow roll

Table 2a

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 2 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 2 MULTIPLE OF 1G LOAD	VERT. ACCEL. G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2
163.1	5.6906	3.2857	3.1315	-4.7181	-2.0393	5.032	-5.675	340.47	42.649
	5.2264	3.4982	3.4821	-3.5296	9.5850	0.808	5.489	340.47	42.649
	3.7845	1.6252	7.4915	-3.4596	-1.9217	51.321	-5.466	340.47	42.649
	4.3335	3.2899	2.1216	-4.9250	5.6475	0.551	7.350	340.47	42.649
	5.4730	4.4071	2.3695	-7.5087	12.0167	4.603	15.991	340.47	42.649
163.2	0.7202	0.7416	-0.1052	0.1359	4.5781	-9.597	11.427	278.72	55.608
	0.9386	0.4673	0.9614	2.4617	-2.5489	-9.977	64.837	278.72	55.608
	-0.6596	0.0637	-1.1309	-0.6991	-32.3807	-4.242	-73.065	278.72	55.608
	0.9308	0.4879	0.0916	0.8412	-1.6960	-12.131	30.878	278.72	55.608
	-0.6648	0.0633	-1.3598	0.3434	-13.8719	-2.432	-16.194	278.72	55.608
	1.4074	0.3472	0.8737	2.0294	29.1059	-13.988	25.848	278.72	55.608
163.3	0.4168	0.4635	1.1343	0.8631	2.5297	1.408	19.260	406.02	42.649
	-0.4445	0.0026	0.6676	0.6818	-6.9653	6.123	-25.935	406.02	42.649
	-0.4409	-0.0702	0.6610	0.1214	-1.6472	1.058	-16.096	406.02	42.649
164.2	1.1459	0.0000	0.0011	-0.8661	1.5848	0.300	16.594	271.19	49.747
	-3.1572	0.4192	-7.6032	-0.1254	2.2148	-23.718	-400.194	271.19	49.747
	3.1797	1.7257	0.6779	-3.3678	38.9909	-61.237	473.486	271.19	49.747
	3.4645	0.0429	5.1335	0.3258	-2.1951	26.248	379.804	299.48	62.663
	-3.7924	0.2135	-7.3652	0.5848	-0.9647	-31.937	-447.330	299.48	62.663
	2.4058	0.4758	1.0552	-0.1981	3.7800	-62.838	420.360	299.48	62.663
	4.4060	0.6064	5.6396	-0.9207	-17.2355	31.508	418.864	299.48	62.663
	2.8155	1.7759	0.5533	-2.6185	-0.4531	2.630	50.817	299.48	62.663
	-1.4721	-0.2829	-3.8235	0.6173	0.6299	-55.402	-33.647	299.48	62.663
	1.3705	0.9801	-0.1012	-5.4900	-1.7423	-0.540	12.445	299.48	62.663
164.3	2.0516	1.5920	0.0059	-2.9317	0.7336	-9.432	38.793	219.66	22.599
	3.0848	2.4584	0.8020	-5.9836	-4.0626	4.376	-8.643	219.66	22.599
	2.1325	1.9543	0.5862	-3.4734	1.5235	2.724	21.112	219.66	22.599
	2.4867	2.5328	0.6050	-3.8166	7.7981	0.680	4.948	219.66	22.599
	3.6370	3.5992	1.4128	-6.4439	-6.3931	1.257	6.136	219.66	22.599
164.4	3.5217	3.9253	-1.4767	-7.3704	14.3887	-28.844	66.238	219.66	22.599
	4.5737	3.9302	1.7724	-6.9702	12.3574	3.662	69.867	219.66	22.599
	3.7799	3.8527	0.6876	-8.2804	8.7913	3.784	78.407	219.66	22.599
164.5	2.1270	2.6565	1.6243	-9.4732	-0.7223	-4.842	-156.589	219.66	22.599
	-0.7166	-0.3869	-0.4988	1.9078	2.2796	-6.302	13.359	219.66	22.599
	4.3302	4.1793	1.6253	-9.0190	-5.0106	6.112	39.386	219.66	22.599
	4.2503	4.4078	2.4548	-8.7843	8.7687	14.652	-55.154	219.66	22.599
164.6	3.0684	2.9580	0.8047	-6.0551	10.9891	13.556	14.210	219.66	22.599
	3.0877	0.5369	5.9103	-0.2908	9.6294	-43.481	481.523	267.10	39.107
	-5.5131	-2.4206	-7.3433	1.4226	14.0711	-17.752	-278.341	267.10	39.107
	2.7256	0.4089	5.0587	0.0201	-12.5929	-39.582	334.490	267.10	39.107
	4.2456	4.4558	1.8549	-10.8126	-4.1089	1.948	-67.512	219.66	22.599
164.7	3.1698	3.5904	1.5076	-11.4478	-16.0537	6.419	13.149	219.66	22.599
	2.7352	3.2188	2.9571	-11.9895	-14.1034	4.919	31.833	219.66	22.599
	3.0958	3.3316	1.5479	-7.7892	11.3977	6.668	71.365	219.66	22.599
	-1.0648	-0.2005	-4.4952	0.1200	-0.4730	-37.741	-14.619	219.66	22.599
	-0.7254	-0.3109	-0.5437	1.4355	-1.2418	2.347	-20.328	219.66	22.599
164.8	1.1684	1.0930	0.0000	-3.1758	1.1642	5.833	9.348	219.66	22.599
	1.3267	1.4475	0.0000	-3.7447	-1.1974	1.537	-3.947	219.66	22.599
	0.1538	0.3740	0.0000	-1.3926	2.5242	0.196	-1.476	219.66	22.599
165.1	2.0932	1.7581	1.7646	-3.5442	3.6600	29.185	79.430	149.83	11.051
	-0.5820	-0.2350	-2.2846	1.5068	2.7363	-18.702	35.465	149.83	11.051
	0.0043	0.0069	0.0072	0.0021	0.7185	-0.419	-11.379	209.62	22.701
	-1.3147	-0.4419	-7.0555	-5.3526	-3.7050	-82.887	45.144	180.13	16.340
	1.5194	0.9150	2.6352	-1.5813	0.8982	-0.156	2.586	180.13	16.340
	-1.4288	0.0553	-6.6697	-0.1248	-2.0658	-30.758	-162.618	209.62	22.701
	1.9265	1.3407	1.6455	-6.3686	19.8400	-40.179	208.870	209.62	22.701
165.2	1.9283	1.3449	1.6457	-6.4157	18.6838	-40.047	215.086	209.62	22.701
	1.7423	0.2388	7.0588	-0.6970	-0.0529	34.797	245.861	209.62	22.701
	-2.1241	0.0835	-7.5724	0.7401	7.0310	-29.123	-285.363	238.86	30.332
	2.6203	0.4127	6.1700	-3.7080	1.6651	131.476	197.865	238.86	30.332
	-2.1131	0.0000	-7.2630	-3.2247	2.0276	-121.632	-154.303	267.10	39.107
	2.4090	1.5614	1.2772	-2.3419	0.8726	-3.257	131.138	267.10	39.107
165.3	2.4070	1.5608	1.2812	-2.3321	0.8213	-3.021	134.199	267.10	39.107
	3.0566	0.5080	9.2628	-1.4974	0.5967	61.551	262.531	217.20	26.317
	1.9919	1.8387	1.0509	-9.1345	5.2098	7.836	29.025	217.20	26.317
	-2.3957	-0.7331	-7.5669	-2.3308	1.8093	-39.693	-229.974	217.20	26.317
	3.3656	3.0389	1.6044	-6.7094	29.1826	-10.757	-82.584	217.20	26.317
165.4	-2.2201	-1.1122	-7.6221	3.5984	-7.5564	-90.973	-20.175	217.20	26.317
	2.4514	1.9755	4.3268	-11.6436	-11.4068	28.793	-61.189	217.20	26.317
	3.7936	3.6993	1.7757	-8.1700	13.7332	-22.779	5.690	217.20	26.317
165.5	-2.1335	-1.3526	-7.1117	3.4612	-1.4600	-85.683	-15.755	217.20	26.317
165.6	3.2017	3.5274	2.9540	-14.3626	-69.4967	28.148	186.659	189.29	19.325
	-0.2596	-0.0356	0.0125	-0.6366	2.6697	-0.614	-27.188	189.29	19.325
	3.8267	3.9290	-0.1451	-14.0078	19.7781	2.419	-18.876	189.29	19.325
	-1.3991	-0.6387	-1.7165	1.2867	-4.2740	-29.748	-27.557	189.29	19.325
165.7	4.6806	4.3967	3.2497	-11.3981	2.5862	24.381	135.602	189.29	19.325
	-0.2229	-0.1393	-0.4862	-7.4043	-3.9788	-16.693	-24.240	189.29	19.325
	1.8149	1.9223	0.5221	-5.7266	2.2076	0.585	-62.670	189.29	19.325
	-0.6493	-0.1234	-2.2263	0.3413	-7.5469	-18.832	-42.775	189.29	19.325
166.1	-1.0968	-0.8322	-2.0882	-1.8121	5.8905	-11.711	67.254	198.00	22.609
	-2.3514	-0.5892	-8.9979	-3.0383	6.9634	-28.278	-171.833	198.00	22.609
	0.7711	-0.7269	3.9621	-6.0015	-9.4968	-62.996	342.201	198.00	22.609
	-3.7138	-2.2640	-8.5504	0.6222	-1.6248	-80.507	-187.573	198.00	22.609
	-1.2000	-2.3010	2.2634	0.8459	25.1069	-75.147	267.793	198.00	22.609
	-0.4635	-0.7575	0.5223	-3.7430	21.7042	-14.875	104.245	198.00	22.609
	-2.2085	-2.9054	1.8706	3.1592	-0.7316	-25.699	140.011	198.00	22.609
	-5.3492	-3.4510	-8.5282	-4.0097	-15.7105	-33.596	-151.582	198.00	22.609
	-0.2278	-1.8529	4.0045	-4.0537	19.1119	-81.254	473.509	198.00	22.609
	-4.0990	-2.1154	-8.2371	-2.0015	-32.4332	-13.297	-215.861	198.00	22.609
	0.5532	-1.2193	4.1001	-3.0022	-8.9860	-80.474	410.401	198.00	22.609
	-3.0598	-1.2739	-8.5171	-4.0356	3.0492	-43.168	-202.538	198.00	22.609
	1.1609	-0.6885	4.0982	-3.1903	-24.2738	-79.774	421.189	198.00	22.609
166.2	1.5055	-0.2905	3.2415	-4.0013	1.3811	-48.158	351.199	236.91	33.569
	-2.9409	-0.5110	-8.9650	-2.7308	-5.6529	-25.734	-331.871	236.91	33.569
	-2.9425	-2.0840	-3.9699	2.4553	-13.8342	-18.170	-17.811	236.91	33.569
	-4.8153	-2.3160	-9.0323	0.0597	-17.4024	-40.036	-231.105	236.91	33.569
	-1.1065	-2.2839	1.5689	2.4631	52.4119	-56.646	273.823	236.91	33.569
	-5.6130	-3.6755	-7.0710	-3.1762	-6.0920	-42.573	-69.102	236.91	33.569
	-0.3168	-2.5057	3.5987	-3.1880	-3.0831	-86.083	396.149	236.91	33.569
	-5.2472	-2.8256	-8.5464	-4.0022	-2.3618	-41.164	-139.461	236.91	33.569
	0.6784	-1.6701	3.6825	-4.3191	7.4706	-86.350	470.874	236.91	33.569
	-4.0137	-1.9239	-7.2566	-3.7991	-18.2908	-21.153	-139.980	236.91	33.569
	1.4265	-0.8460	3.9197	-5.8624	2.8290	-53.008	357.019	236.91	33.569
	-2.9506	-0.6456	-8.0141	-4.7741	-12.2404	-46.552	-291.020	236.91	33.569
	1.5390	-0.0887	2.3836	-5.1999	10.0865	-52.071	376.549	236.91	33.569
	-2.4806	-0.4552	-8.3155	-1.9048	3.9894	-93.979	-94.178	236.91	33.569
	1.8780	-0.3624	3.5937	-3.0273	-2.7444	-62.926	483.654	236.91	33.569
167.1	1.8564	1.8851	1.0004	-4.6715	1.7904	14.212	7.073	280.78	17.907
	-0.8142	-0.8100	1.2817	-0.7707	-2.9263	62.362	-3.229	212.28	8.503
	0.8248	0.4310	2.0830	0.1947	2.4739	39.548	29.083	265.59	14.594
	1.8903	2.0541	2.4542	-7.0100	-18.2195	46.662	20.746	278.24	16.701
	-0.9088	-0.8792	0.4059	-1.1115	4.4697	41.540	-6.274	258.92	14.077
167.2	1.1145	-0.5755	4.3715	-2.2749	3.7256	-2.707	298.243	241.97	30.294
	-3.3732	-1.1857	-8.1965	-1.8631	-20.0944	51.005	-425.607	241.97	30.294
	1.1267	-0.6884	4.9517	-3.1372	2.7580	1.205	340.698	241.97	30.294
	-3.4242	-1.1680	-8.2844	-4.8503	-35.7188	53.537	-351.749	241.97	30.294
	1.1602	-0.8962	4.9530	-4.4876	-3.4163	-24.293	344.395	241.97	30.294
	-3.2979	-1.0509	-8.3585	-5.9744	11.0637	41.883	-454.770	241.97	30.294
	1.1498	-0.6703	4.5612	-5.9631	5.1026	5.724	367.241	241.97	30.294
	-3.0323	-1.0612	-7.5777	-5.0807	-0.6416	60.226	-392.359	241.97	30.294
	1.4178	-0.4694	4.1682	-8.1952	11.2460	74.153	55.333	241.97	30.294
	-1.9897	-0.3057	-6.2178	-5.7611	5.0795	37.323	-429.242	241.97	30.294
	1.8065	0.2027	3.3691	-4.5989	-1.8840	24.542	239.289	241.97	30.294
	1.0158	0.7120	-1.0448	-4.7694	14.6162	-2.699	102.300	241.97	30.294
167.3	-0.1317	-0.3449	-0.8327	-3.4373	3.0834	-5.221	-61.547	212.43	22.671
	-3.3475	-3.0241	-1.2268	-1.4690	-3.1449	11.439	-23.575	212.43	22.671
	-0.8004	0.0136	-4.4110	-3.2426	-2.4056	3.013	89.040	212.43	22.671

Table 2b

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 3 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 3 MULTIPLE OF 1G LOAD	VERT. ACCEL. G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2
143.1	0.4274	0.1092	5.4512	0.5722	-1.6864	24.459	45.880	340.45	42.649
	3.0936	3.4961	2.5219	-4.9750	-3.1297	6.189	-6.932	340.45	42.649
	3.0525	3.4465	1.1868	-4.5257	-6.4083	-6.531	16.782	340.45	42.649
	3.9609	3.2751	2.3166	-4.4817	0.6902	1.970	0.721	340.45	42.649
	5.1141	4.6028	1.9660	-8.7012	1.8433	6.353	-12.270	340.45	42.649
143.2	0.4793	0.5451	-0.2552	0.4298	8.7467	-4.626	26.517	278.72	55.608
	-1.4984	0.0013	-0.4092	-0.0395	-5.5291	-7.974	13.490	278.72	55.608
	0.9078	0.7359	0.0214	0.9709	13.0189	-13.230	-57.510	278.72	55.608
	-0.6765	-0.2685	-0.6497	1.4106	-13.8127	-7.336	51.520	278.72	55.608
	1.0979	0.6139	0.7296	0.8831	23.2145	-15.006	-28.028	278.72	55.608
	-0.2116	0.3124	-1.8517	0.7535	-3.7743	-25.716	-24.016	278.72	55.608
143.3	-0.0634	-0.0370	0.9442	1.2023	-2.8119	8.062	-18.957	296.86	31.182
	0.6084	0.4967	0.7859	0.9535	4.3651	9.422	25.516	296.86	31.182
	0.2098	-0.0746	0.8895	0.5391	-4.8317	-0.141	-27.540	296.86	31.182
	-0.0772	-0.1285	0.9092	0.6107	-6.0396	3.009	-14.282	296.86	31.182
144.2	-1.2931	-0.4967	-7.1994	-1.9366	-5.7388	-120.550	-21.087	271.19	49.747
	2.7612	1.7257	0.6779	-3.3678	38.9909	-61.237	473.486	271.19	49.747
	0.1637	-0.7453	5.8097	-0.8479	4.9611	130.432	-1.959	271.19	49.747
	-1.6137	-0.4383	-7.2700	-1.3955	-4.9218	-112.812	-24.083	299.48	62.663
	2.2292	1.7750	0.5533	-2.6185	-0.4331	2.630	30.817	299.48	62.663
144.3	2.8991	2.3628	1.1709	-5.8183	6.7429	4.338	-36.022	219.66	22.599
	-0.5380	-0.1990	0.2858	1.2388	-5.3097	9.226	-12.601	219.66	22.599
	0.6865	0.7482	0.3022	-0.7964	3.1825	-0.195	-9.698	219.66	22.599
	-0.3630	-0.0490	0.1405	0.6202	-3.2163	1.684	-2.639	219.66	22.599
	2.6628	2.3495	0.5892	-3.7587	1.1568	1.071	7.917	219.66	22.599
	2.5079	2.3240	-0.3103	-4.8594	2.8721	-7.004	18.209	219.66	22.599
	3.2613	3.7488	0.3988	-10.4095	-42.8957	12.768	192.774	219.66	22.599
144.4	3.4607	3.4968	-0.5187	-9.0018	-2.9681	-15.992	-2.573	219.66	22.599
	4.2330	4.1970	0.3881	-8.6236	-13.3504	-0.073	25.598	219.66	22.599
	3.6600	3.8949	0.9849	-6.9966	-12.6169	0.818	252.317	219.66	22.599
144.5	1.9407	2.9908	0.7911	-10.7310	0.2708	5.560	12.667	219.66	22.599
	-0.7784	-0.3834	-0.3961	1.8753	3.2615	-5.762	-18.044	219.66	22.599
	4.5376	4.1307	1.5252	-8.8320	-5.4734	4.151	30.711	219.66	22.599
	3.8737	4.2337	3.1141	-8.4746	3.4307	9.282	48.128	219.66	22.599
144.6	2.8081	3.0502	0.9653	-8.1049	3.5178	-4.082	-54.035	219.66	22.599
	1.8408	1.7014	1.1844	-4.5337	-0.0296	1.368	32.827	219.66	22.599
	-4.7336	-2.4206	-7.3433	1.4226	14.0711	-17.752	-278.341	267.10	39.107
	1.2786	0.8227	3.4948	0.1217	-0.4804	-36.568	273.459	267.10	39.107
	4.4109	4.9310	1.2619	-12.4300	-11.3291	-3.984	4.104	219.66	22.599
144.7	3.1661	3.4066	1.5907	-10.8709	-13.2012	-1.400	22.491	219.66	22.599
	2.5047	3.2188	2.9571	-11.9895	-14.1034	4.919	31.833	219.66	22.599
	2.6966	2.9286	0.6636	-9.2176	-2.3061	-1.183	-28.546	219.66	22.599
	3.0548	3.3316	1.5479	-7.7892	11.3977	6.668	71.365	219.66	22.599
	-0.7764	-0.3525	-0.3139	1.5845	1.9513	1.099	-16.349	219.66	22.599
144.8	-0.3914	-0.0962	0.0000	0.9914	-0.8352	3.075	-7.477	219.66	22.599
	-0.4390	-0.1120	0.0000	0.7904	4.8599	0.169	-9.407	219.66	22.599
	1.5659	1.3578	0.0000	-4.1473	-0.4509	0.286	9.218	219.66	22.599
	1.5544	1.5044	0.0000	-4.2172	0.0036	1.413	1.562	219.66	22.599
	-0.1178	-0.0010	0.0000	0.1959	4.9079	2.877	9.218	219.66	22.599
145.1	2.0212	1.7581	1.7646	-3.5716	3.6600	29.411	79.430	150.99	11.051
	-0.4815	-0.3463	-2.2275	-0.3062	-14.2366	-20.631	-25.564	150.99	11.051
	1.4717	0.8360	7.3617	-6.6100	-14.8100	54.555	-45.587	150.99	11.051
	-0.2974	-0.1120	-2.0940	1.2202	-0.7539	-5.708	-40.267	180.13	16.340
	1.5572	0.9742	1.9717	-1.3014	-2.9063	-0.243	-1.700	209.62	22.701
	-0.6310	-0.2945	-7.2635	-6.0816	-5.5881	-90.105	-22.535	209.62	22.701
	1.9361	1.4488	0.7059	-2.0682	8.4237	-18.292	-33.766	209.62	22.701
145.2	-0.6322	-0.2988	-7.2643	-6.0377	-4.5734	-90.285	-29.375	209.62	22.701
	1.9394	1.4526	0.7067	-2.1197	7.2732	-18.158	-27.084	209.62	22.701
	-0.4216	-0.3158	-0.3252	1.1666	2.1239	0.440	57.789	209.62	22.701
	-0.7391	-0.2907	-7.0176	-1.8534	0.0754	-104.696	-138.338	238.70	30.332
	1.0578	1.1608	2.1869	-4.8106	24.6816	-43.638	361.003	238.70	30.332
	2.6267	2.1723	0.0389	-5.5259	1.9121	-3.045	-4.139	238.70	30.332
	-0.8819	0.1532	-7.1735	0.2721	-6.0540	-36.154	-293.012	267.10	39.107
	2.3315	1.8406	-1.0783	-4.6866	15.0967	-57.546	243.722	267.10	39.107
145.3	2.6229	2.1669	0.0284	-4.7623	2.7413	-2.559	4.674	267.10	39.107
	-0.8828	0.1554	-7.1818	0.2576	-5.9429	-36.349	-296.670	267.10	39.107
	2.3298	1.8391	-1.0826	-4.6926	15.2125	-57.771	239.917	267.10	39.107
	1.4423	0.4214	6.0489	-0.7579	9.6659	61.714	215.032	267.10	39.107
	-0.9606	-0.7289	-7.7464	-3.9181	-1.6200	-101.570	-32.091	217.20	26.317
	2.1587	1.8387	1.0509	-9.1345	5.2098	7.836	29.025	217.20	26.317
	-1.4100	-0.7331	-7.5669	-2.3308	1.8093	-39.693	-229.974	217.20	26.317
	3.7541	3.3209	2.5537	-8.1052	0.8886	-19.364	-79.848	217.20	26.317
	3.3191	3.0946	0.8644	-7.9731	1.6073	13.550	-5.321	217.20	26.317
145.4	2.1547	1.8366	1.0487	-9.1071	5.4996	7.758	25.495	217.20	26.317
	-1.3050	-0.6542	-7.3465	-2.3641	-2.9744	-49.993	-74.639	217.20	26.317
	3.7557	3.3181	2.5429	-8.1129	0.3144	-19.465	-80.406	217.20	26.317
	-1.5370	-1.1285	-7.5437	3.3628	-4.4344	-90.580	7.168	217.20	26.317
	3.8701	3.5948	1.8228	-10.4914	-11.4358	-10.393	-21.948	217.20	26.317
145.5	-1.7496	-1.3526	-7.1117	3.4612	-1.4600	-85.683	-15.755	217.20	26.317
145.6	3.0770	3.3957	2.5940	-14.6225	-5.1404	28.885	14.961	189.12	19.308
	3.8672	3.9220	-0.3357	-14.9961	-34.1534	3.357	52.990	189.12	19.308
	-1.1312	-0.7021	-1.1450	-0.0613	-1.9349	-10.801	34.520	189.12	19.308
145.7	4.6526	3.7866	1.9226	-8.5529	9.7608	27.804	8.218	189.29	19.325
	2.6716	3.3018	-0.2293	-10.4502	-39.4028	-1.751	0.487	189.29	19.325
	1.7854	1.9437	0.4061	-4.6430	-4.2419	-0.342	47.210	189.29	19.325
146.1	-0.6451	-0.6746	3.8380	-5.9956	3.6781	-54.418	437.371	197.27	22.609
	-2.5525	-2.3010	2.2634	0.8427	25.1069	-74.869	267.793	197.27	22.609
	-3.7782	-3.4590	-7.8666	1.1429	-24.2859	-27.638	-191.487	197.27	22.609
	-4.6998	-3.1187	-5.0878	-4.0083	-3.1390	-77.016	-32.186	197.27	22.609
	-3.8781	-3.4356	-7.2081	-2.7512	-24.2240	-19.527	-126.844	197.27	22.609
	-1.8881	-1.8529	4.0045	-4.0387	19.1119	-80.953	473.509	197.27	22.609
	-4.1600	-2.1117	-8.2391	-2.5001	-21.6060	-18.790	-291.431	197.27	22.609
	-1.1755	-1.2338	4.0594	-2.8994	-8.7345	-84.236	376.495	197.27	22.609
146.2	-0.4022	-0.3141	3.1073	-3.9733	0.3696	-40.718	395.947	236.91	33.569
	-0.5762	-0.6800	3.6493	-3.1985	32.0752	-67.410	356.407	236.91	33.569
	-4.6079	-2.3127	-8.9111	0.2317	-23.8027	-37.776	-237.886	236.91	33.569
	-2.7274	-2.2842	1.4975	1.9395	65.0912	-59.354	385.121	236.91	33.569
	-4.5085	-3.8884	-6.4195	-0.2737	-22.3059	-24.614	-123.310	236.91	33.569
	-2.6005	-2.5057	3.5987	-3.1880	-3.0831	-86.083	396.149	236.91	33.569
	-3.3790	-2.8562	-7.8534	-2.9649	-20.1833	-27.982	-195.889	236.91	33.569
	-1.4520	-1.6132	3.7414	-4.0419	13.5031	-72.037	392.127	236.91	33.569
	-4.0037	-1.9100	-7.1819	-3.6147	-12.7127	-19.769	-200.802	236.91	33.569
	-0.6858	-0.8460	3.9197	-5.8624	2.8290	-53.008	357.019	236.91	33.569
	-2.4279	-0.6824	-7.7168	-4.5282	0.9909	-29.254	-251.534	236.91	33.569
	-0.2140	-0.0887	2.3836	-5.1999	10.0865	-52.071	376.549	236.91	33.569
	-2.0199	-0.5027	-8.1839	-1.7690	-7.7196	-96.076	-41.683	236.91	33.569
	-0.2270	-0.3624	3.5937	-3.0273	-2.7444	-62.926	483.654	236.91	33.569
147.1	1.6416	2.2762	1.2876	-6.0887	-14.1438	19.882	-44.211	258.92	14.077
	-1.2118	-0.8034	0.8453	-0.4247	-2.2011	46.869	-11.086	258.92	14.077
	0.5696	0.5447	0.7905	-0.1847	2.4803	11.821	-11.478	258.92	14.077
	-0.2232	-0.0484	1.1263	0.7221	-0.7862	2.320	8.943	278.24	16.701
	1.7995	2.1808	2.0395	-4.2165	10.3096	117.356	21.315	265.59	14.594
	-1.3136	-0.9872	1.6174	-1.8187	-3.8953	44.532	-5.329	229.86	8.503
147.2	-1.1229	-0.6715	1.6847	-2.2703	9.4172	-9.507	149.838	241.97	30.294
	-2.9108	-1.1957	-8.0476	-2.0266	-16.3283	46.400	-461.652	241.97	30.294
	-0.3606	-0.6886	4.9517	-3.1372	2.7580	1.205	340.698	241.97	30.294
	-2.8925	-1.1960	-8.2559	-5.0018	2.5655	45.343	-437.759	241.97	30.294
	-0.7247	-0.9041	4.6743	-4.4529	-10.5696	-27.749	222.254	241.97	30.294
	-2.7811	-1.0509	-8.3585	-5.9744	11.0637	41.883	-454.770	241.97	30.294
	-0.5573	-0.6703	4.5612	-5.9631	5.1026	5.724	367.241	241.97	30.294
	-2.5009	-1.0072	-7.5501	-4.8081	19.8777	52.128	-399.233	241.97	30.294
	-0.1980	-0.4646	4.1553	-8.1113	8.8448	74.438	30.327	241.97	30.294
	-1.6483	-0.3193	-6.1355	-5.6622	9.3353	34.001	-329.491	241.97	30.294
	0.7066	1.0790	-1.5826	-5.5492	5.2528	0.708	14.203	241.97	30.294
147.3	-0.9371	-0.3402	-0.7723	-3.3880	5.0833	-5.896	-65.390	212.43	22.671
	-4.8070	-3.0919	-0.3782	-1.3965	-9.1166	21.997	38.844	212.43	22.671
	-1.1747	-0.0702	-4.4704	-3.1154	16.1453	3.457	-73.830	212.43	22.671

Table 2c

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 4 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 4 MULTIPLE OF 1G LOAD	VERT. ACCEL. G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2
163.1	-0.5124	0.1403	0.9236	0.8081	6.9888	1.489	23.958	340.45	42.649
	4.9500	3.2931	3.0452	-4.9578	-3.8356	5.359	5.245	340.45	42.649
	2.8379	1.5561	7.2435	-3.7049	-3.9218	51.649	5.280	340.45	42.649
	4.5307	4.4002	3.0056	-7.9962	0.0705	3.846	29.028	340.45	42.649
163.2	1.6135	0.7495	-0.0711	-0.0445	0.9706	-10.047	20.934	278.74	55.612
	1.6555	0.4673	0.9613	2.4617	-2.5489	-9.977	64.837	278.74	55.612
	-0.0503	0.0637	-1.1309	-0.6991	-32.3807	-4.242	-73.065	278.74	55.612
	1.7621	0.6532	0.0808	0.9078	-1.6078	-13.347	-2.995	278.74	55.612
	-0.2101	0.0633	-1.3597	0.3434	-13.8719	-2.432	-16.194	278.74	55.612
	1.8566	0.3472	0.8737	2.0294	29.1059	-13.988	25.848	278.74	55.612
163.3	0.2632	0.1504	0.9757	-0.2995	-0.5060	-1.332	3.931	296.86	31.182
	0.1903	-0.0702	0.9041	0.1214	-1.6472	1.058	-16.096	296.86	31.182
164.2	-1.9817	0.4192	-7.6032	-0.1254	2.2148	-23.718	-400.194	271.19	49.747
	4.3626	1.7257	0.6779	-3.3678	38.9909	-61.237	473.486	271.19	49.747
	-2.5735	0.2135	-7.3652	0.5848	-0.9647	-31.937	-447.330	299.48	62.663
	3.7190	0.6064	5.6396	-0.9207	-17.2355	31.508	418.864	299.48	62.663
	3.2382	1.7759	0.5533	-2.6185	-0.4331	2.630	50.817	299.48	62.663
	-1.5511	-0.2165	-3.7814	0.9397	0.7974	-43.428	-64.991	299.48	62.663
164.3	2.7375	2.4986	1.0207	-5.8508	-2.3248	5.758	24.674	219.66	22.599
	-0.7530	-0.2265	-0.0934	0.9028	0.1750	-1.684	-6.333	219.66	22.599
	0.6573	0.7482	0.3022	-0.7964	3.1825	-0.195	-9.698	219.66	22.599
	-0.3841	-0.0652	0.1073	0.6013	-0.4909	-0.217	-7.917	219.66	22.599
	2.4786	2.2951	0.6223	-4.2083	5.9869	0.417	-0.330	219.66	22.599
	2.9578	3.2232	1.9444	-7.4968	-5.3323	6.635	5.740	219.66	22.599
164.4	3.2560	4.0077	-1.4074	-7.1807	3.8144	-24.859	79.964	219.66	22.599
	-0.0990	0.2657	-2.1366	-2.3873	-1.4896	-31.441	-27.841	219.66	22.599
	4.8951	3.9302	1.7724	-6.9702	12.3574	3.662	69.867	219.66	22.599
	-0.0751	0.6021	0.1959	-8.0989	5.8345	-7.484	-11.710	219.66	22.599
	3.7813	3.6802	2.1152	-8.0276	28.5514	8.809	195.812	219.66	22.599
164.5	-0.7797	-0.3869	-0.4988	1.9078	2.2796	-6.302	13.359	219.66	22.599
	4.5303	4.1793	1.6253	-9.0190	-5.0106	6.112	39.386	219.66	22.599
	0.2146	0.7609	0.6704	-7.1456	-3.8482	1.064	23.157	219.66	22.599
	3.8280	4.2337	3.1141	-8.4746	3.4307	9.282	48.128	219.66	22.599
164.6	2.8468	3.0909	0.8661	-8.7426	-12.1864	-5.273	-24.189	219.66	22.599
	3.2986	0.5369	5.9103	-0.2908	9.6294	-43.481	481.523	267.10	39.107
	-5.2588	-2.4206	-7.3433	1.4226	14.0711	-17.752	-278.341	267.10	39.107
	2.6658	0.8227	3.4948	0.1217	-0.4804	-36.568	273.459	267.10	39.107
	4.2898	3.8949	1.3362	-9.3620	-7.8706	5.775	17.062	219.66	22.599
164.7	2.8986	3.7464	1.2564	-11.3674	22.2925	7.376	41.521	219.66	22.599
	0.1810	1.1007	-6.0556	-1.3985	-4.1540	-51.551	-31.573	219.66	22.599
	2.6271	2.9432	2.8552	-12.1457	-8.7071	11.602	-21.798	219.66	22.599
	0.4746	1.2532	-5.0405	-0.1706	-1.5818	-45.961	8.304	219.66	22.599
	3.3896	3.2453	1.4611	-8.6596	18.4200	1.215	37.715	219.66	22.599
	-1.0055	-0.2226	-4.5041	-0.2493	-4.8488	-38.860	-14.706	219.66	22.599
	-0.9662	-0.3109	-0.5437	1.4355	-1.2418	2.347	-20.328	219.66	22.599
164.8	-0.5542	-0.0752	0.0000	0.3553	-2.1842	0.884	-9.839	219.66	22.599
	1.3910	1.4877	0.0000	-4.3892	-2.2544	1.054	-4.698	219.66	22.599
	-0.3903	-0.1012	0.0000	0.3296	3.8767	-0.049	-8.731	219.66	22.599
165.1	1.7150	1.7327	1.7691	-4.7767	0.3945	12.236	-70.856	149.83	11.051
	-1.0852	-0.2588	-2.9223	0.1471	15.8693	-19.562	1.256	149.83	11.051
	-1.5688	-0.4419	-7.0555	-5.3526	-3.7050	-82.887	45.144	180.13	16.340
	1.5098	0.9150	2.6352	-1.5813	0.8982	-0.156	2.586	180.13	16.340
	-1.5186	0.0553	-6.6697	-0.1248	-2.0658	-30.758	-162.618	209.62	22.701
	2.0460	1.3407	1.6455	-6.3686	19.8400	-40.179	208.870	209.62	22.701
165.2	1.4574	0.2388	7.0588	-0.6970	-0.0529	34.797	245.861	209.62	22.701
	-0.9782	0.4207	-5.2300	-2.7689	1.1550	40.368	-330.592	209.62	22.701
	-2.1052	0.0835	-7.5724	0.7401	7.0310	-29.123	-285.363	238.86	30.332
	2.4640	1.1608	2.1869	-4.8138	24.6816	-43.668	361.003	238.86	30.332
	-2.4008	0.1532	-7.1735	0.2721	-6.0540	-36.154	-293.012	267.10	39.107
	2.7402	1.5630	1.1125	-2.3242	0.3578	-2.034	24.350	267.10	39.107
165.3	-1.9354	0.2370	-4.5946	-2.0803	-22.8753	65.131	-519.661	267.10	39.107
	-2.6249	-0.7331	-7.5669	-2.3308	1.8093	-39.693	-229.974	217.20	26.317
	3.3337	3.2815	1.9623	-8.8467	15.7711	-6.307	46.853	217.20	26.317
	3.0110	3.0211	0.7892	-7.0542	-0.1106	3.228	299.979	217.20	26.317
165.4	2.2709	2.3518	0.7291	-13.6624	15.5207	4.793	-133.540	217.20	26.317
	-0.9933	-0.1028	-2.1142	1.0978	-1.9412	-11.114	-41.236	217.20	26.317
	-2.5340	-1.2496	-7.5810	2.0392	0.9273	-102.303	86.017	217.20	26.317
	2.0180	2.1022	2.4644	-3.2424	50.8290	-23.865	65.475	217.20	26.317
	3.4389	3.7008	1.7261	-7.9032	5.1404	-16.950	111.220	217.20	26.317
165.5	-2.5742	-1.3526	-7.1117	3.4612	-1.4600	-85.683	-15.755	217.20	26.317
165.6	2.9464	2.9453	0.7842	-10.6295	13.5085	3.074	165.563	189.29	19.325
	3.1468	3.9212	0.3857	-9.4242	21.0393	-7.086	-94.697	189.29	19.325
	-1.7434	-0.7021	-1.1440	-0.0615	-1.9349	-10.801	34.520	189.29	19.325
165.7	4.5335	3.7866	1.9226	-8.5529	9.7608	27.804	8.218	189.29	19.325
	-0.7996	0.9316	-1.0780	-9.4329	15.1385	-11.744	16.673	189.29	19.325
	1.4320	1.9591	0.1948	-3.7962	-8.7341	1.256	-41.400	189.29	19.325
	-0.8538	-0.1106	-2.1953	0.7172	-8.0218	-16.704	-16.909	189.29	19.325
	1.5689	1.8540	0.6973	-6.3239	-10.3448	6.073	73.031	189.29	19.325
166.1	-1.4899	-0.5195	-7.6748	-2.1122	-1.6401	-77.140	-78.430	198.00	22.609
	1.1545	-0.5462	3.8578	-3.3921	-4.1349	-54.083	318.905	198.00	22.609
	-2.1054	-0.5877	-8.9721	-3.0231	1.4323	-30.043	-175.599	198.00	22.609
	0.9800	-0.7269	3.9621	-6.0015	-9.4968	-62.996	342.201	198.00	22.609
	-3.7272	-2.2640	-8.5504	0.6222	-1.6248	-80.507	-187.573	198.00	22.609
	-1.6144	-2.2778	2.2276	0.9849	13.8880	-72.511	264.104	198.00	22.609
	-5.3610	-3.4590	-7.8666	1.1471	-24.2859	-27.741	-191.487	198.00	22.609
	-2.4776	-2.9054	1.8706	3.1592	-0.7316	-25.699	140.011	198.00	22.609
	-5.5157	-3.4147	-8.0375	-3.2484	-2.2998	-26.570	-176.095	198.00	22.609
	-0.6135	-1.8529	4.0045	-4.0537	19.1119	-81.254	473.509	198.00	22.609
	-4.3807	-2.1127	-8.1571	-1.6793	-25.7826	-11.110	-185.636	198.00	22.609
	0.4362	-1.2193	4.1001	-3.0022	-8.9860	-80.474	410.401	198.00	22.609
	-3.1181	-1.2739	-8.5171	-4.0356	3.0492	-43.168	-202.538	198.00	22.609
	1.3662	-0.6885	4.0982	-3.1903	-24.2738	-79.774	421.189	198.00	22.609
166.2	1.6219	-0.2959	3.2278	-4.0199	1.2195	-51.691	393.878	236.91	33.569
	1.5115	-0.6994	3.7979	-2.8875	30.9809	-63.306	413.168	236.91	33.569
	-2.6139	-0.5110	-8.9650	-2.7308	-5.6529	-25.734	-331.871	236.91	33.569
	-1.6858	-2.2839	1.5689	2.4631	52.4119	-56.646	273.823	236.91	33.569
	-4.7734	-2.2939	-8.6510	0.4704	-23.3073	-35.350	-294.461	236.91	33.569
	-5.8699	-3.8983	-6.5585	-0.5609	-28.4316	-26.718	-206.514	236.91	33.569
	-1.1424	-2.5057	3.5987	-3.1880	-3.0831	-86.083	396.149	236.91	33.569
	-5.2619	-2.8234	-8.4476	-3.8528	-17.6730	-37.664	-226.315	236.91	33.569
	0.0336	-1.6701	3.6825	-4.3191	7.4706	-86.350	470.874	236.91	33.569
	-4.0989	-1.9100	-7.1819	-3.6147	-12.7127	-19.769	-200.802	236.91	33.569
	1.1153	-0.8460	3.9197	-5.8624	2.8290	-53.008	357.019	236.91	33.569
	-2.6920	-0.6536	-7.8409	-4.5273	0.2003	-32.086	-282.488	236.91	33.569
	1.6716	-0.0887	2.3836	-5.1999	10.0865	-52.071	376.549	236.91	33.569
	-1.9536	-0.1054	-7.9933	-2.9940	13.7400	-43.675	-198.865	236.91	33.569
	1.9614	-0.3624	3.5937	-3.0273	-2.7444	-62.926	483.654	236.91	33.569
167.2	0.8834	-0.5633	4.4935	-2.2884	-1.1499	1.090	378.432	241.97	30.294
	-3.5677	-1.1857	-8.1965	-1.8631	-20.0944	51.005	-425.607	241.97	30.294
	0.7512	-0.6884	4.9517	-3.1372	2.7580	1.205	340.698	241.97	30.294
	-3.5716	-1.1680	-8.2844	-4.8503	-35.7188	53.537	-351.749	241.97	30.294
	0.8084	-0.8962	4.9530	-4.4876	-3.4163	-24.293	344.395	241.97	30.294
	-3.3686	-1.0509	-8.3585	-5.9744	11.0637	41.883	-454.770	241.97	30.294
	0.7812	-0.6703	4.5612	-5.9631	5.1026	5.724	367.241	241.97	30.294
	-3.1187	-1.0612	-7.5777	-5.0807	-0.6416	60.226	-392.359	241.97	30.294
	0.9811	-0.5046	4.2212	-8.3668	-3.7897	72.955	74.154	241.97	30.294
	-1.9822	-0.3057	-6.2178	-5.7611	5.0795	37.323	-429.242	241.97	30.294
	1.7838	0.2027	3.3691	-4.5989	-1.8840	24.542	239.289	241.97	30.294
167.3	-0.1326	-0.3645	-0.8690	-3.0613	-0.4724	-3.383	86.599	212.43	22.671
	-4.1448	-2.9357	-1.3219	-1.4029	5.3785	11.784	-44.830	212.43	22.671
	-0.7246	0.0136	-4.4110	-3.2426	-2.4056	3.013	89.040	212.43	22.671

Table 2d

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 5 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 5 MULTIPLE OF 1G LOAD	VERT. ACCEL. CG G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2	MACH NUMBER
159.1	-0.6012	-0.2571	1.3612	0.2169	0.4466	-2.209	15.001	363.61	35.267	1.2286
	0.6555	0.2935	1.2755	-0.4298	-2.1458	-2.118	-10.629	383.13	40.468	1.2952
	3.1681	1.2447	1.7705	-1.2748	4.8305	-1.391	-4.670	473.27	73.965	1.6018
	0.8551	-0.3003	1.0852	0.7861	-13.2441	-4.185	-18.929	454.89	61.033	1.5406
	1.8592	0.4402	1.7445	-1.4055	-0.8932	1.306	11.584	446.08	53.257	1.5108
	0.6024	-0.2976	1.9181	-0.1925	-16.2422	-3.547	14.706	434.48	45.628	1.4715
	1.1794	0.2194	1.1467	-0.0413	6.1191	-6.417	17.951	419.42	34.814	1.4204
163.1	-0.7517	0.0985	5.4512	0.5722	-1.6864	24.460	45.880	379.73	54.751	1.2311
	4.9539	3.3087	-1.7182	-4.6652	1.8825	-14.452	-27.656	374.56	52.271	1.2158
	4.8684	3.6084	1.7161	-5.4420	-5.0984	-5.447	4.827	362.93	47.758	1.1790
	3.6322	3.3006	2.1500	-4.5165	-0.5568	0.467	-23.969	339.35	39.031	1.1067
	4.9906	4.6145	1.9661	-8.7018	1.8433	6.353	-12.270	332.54	41.477	1.0693
163.2	0.8784	0.8059	-0.4353	-0.6583	7.9016	-2.264	29.395	229.27	35.883	0.6737
	-0.6115	-0.0336	-0.4091	-0.0396	-5.5291	-7.975	13.490	260.15	48.100	0.7636
	-0.6194	-0.3558	-0.6497	1.4107	-13.8127	-7.337	51.520	285.88	60.262	0.8381
	0.5306	0.4323	-1.9519	-0.3521	-2.0489	-20.803	-48.962	278.90	56.867	0.8177
163.3	0.4741	0.5243	0.7858	0.9535	4.3651	9.422	25.516	263.04	23.431	0.8453
	-0.3465	-0.1651	0.8894	0.5391	-4.8317	-0.141	-27.540	262.50	23.300	0.8436
164.2	3.1367	1.3134	-6.2315	-5.0934	3.8094	-114.216	20.972	283.42	54.645	0.8389
	-1.8420	-1.0014	5.6372	0.1296	-1.8014	121.450	23.162	287.98	55.919	0.8538
	-1.3008	-0.2533	5.3879	-2.4422	-4.4001	103.700	35.721	300.87	62.646	0.8908
	2.1794	1.7240	-0.2902	-2.1708	0.8958	4.084	6.568	293.73	58.672	0.8706
164.3	2.8072	2.6467	0.2227	-5.6191	4.5818	0.807	26.851	243.47	29.929	0.7433
	-0.3664	-0.2326	0.2857	1.2390	-5.3097	9.227	-12.601	232.45	27.735	0.7072
	0.6754	0.7437	0.2154	-1.1017	4.0175	0.190	10.028	249.71	32.613	0.7597
	-0.2404	-0.0232	0.3010	0.5670	-0.5642	2.776	9.434	255.00	33.992	0.7770
	2.5470	2.3421	-0.3103	-4.8598	2.8721	-7.004	18.209	245.06	29.901	0.7493
	3.6096	3.4383	0.2915	-9.2498	-13.4408	-14.806	-43.609	234.13	27.232	0.7155
164.4	4.1557	4.0015	-1.6481	-8.1040	14.5462	-32.150	-35.197	239.54	31.215	0.7243
	4.4268	4.1126	0.3881	-8.6242	-13.3504	-0.073	25.598	281.34	45.795	0.8492
	3.8564	3.9602	0.6322	-10.7550	-9.5360	-8.212	-20.650	236.63	30.575	0.7150
164.5	2.7398	2.6118	0.5677	-9.0638	-30.8086	20.905	160.386	160.98	13.566	0.4851
	-0.4338	-0.3028	-0.3941	1.8754	3.2615	-5.762	-18.044	182.30	18.011	0.5480
	4.0614	4.0731	1.5658	-9.3572	-24.8620	7.384	41.630	255.19	37.187	0.7684
	4.1174	4.4627	0.4434	-10.0714	10.8677	-30.920	-208.839	236.88	29.957	0.7180
164.6	2.9291	3.0804	0.7551	-8.6556	7.1832	-3.984	-327.275	205.17	21.881	0.6213
	1.7131	0.7120	-11.8528	-0.0033	-0.6134	-40.119	-321.919	262.96	38.249	0.7959
	-3.5575	-2.4078	6.4245	6.5452	-16.6648	-14.954	233.678	268.25	39.512	0.8133
	1.1643	0.4770	-11.3520	-0.9088	6.8285	-48.817	-406.147	298.19	42.818	0.8421
	4.5430	4.8022	1.0120	-11.1532	5.9713	-1.927	-37.492	259.06	36.686	0.7854
164.7	3.4737	3.9331	1.4002	-10.4000	14.9608	1.010	10.813	193.37	19.884	0.5833
	3.3392	3.8142	1.5798	-11.7609	-2.6166	-1.601	-4.066	174.90	16.463	0.5259
	2.9483	2.9464	-3.2682	-5.3528	26.2403	-11.719	-50.345	190.63	21.283	0.5682
	3.1539	3.3188	1.6526	-8.3261	-7.0366	8.005	17.474	198.91	23.265	0.5930
	0.1504	0.1136	0.2586	-0.5752	-1.5226	2.848	-11.678	180.26	17.521	0.5419
164.8	-0.1310	-0.1015	0.0000	0.9914	-0.8352	3.076	-7.477	207.51	21.332	0.6322
	1.4135	1.4492	0.0000	-4.2180	1.4006	1.294	11.418	197.68	19.252	0.6020
	-0.0711	-0.0722	0.0000	-0.1787	-4.1282	2.173	-1.519	202.05	21.272	0.6115
165.1	1.8032	1.6172	0.2720	-6.3978	-16.9596	7.654	-15.738	173.20	16.052	0.5210
	-0.4456	-0.1891	0.6025	-1.5919	6.2231	0.538	-7.611	162.49	12.828	0.4940
	1.2068	0.3683	-6.7215	-5.5291	-2.7426	-84.136	113.189	187.80	17.832	0.5696
	-0.9257	-0.5678	4.9574	-2.4994	-6.8230	73.290	36.721	183.50	16.902	0.5568
	1.8938	0.8658	-6.1849	-7.5628	2.6593	-87.399	106.694	216.85	24.358	0.6578
165.2	-0.8379	-0.3766	6.7399	-1.7155	-6.5482	93.522	-29.117	215.96	23.781	0.6563
	2.0857	0.7859	-5.9284	-7.1837	-2.3453	-109.953	-110.368	246.75	32.475	0.7486
	-0.8208	-0.2716	6.7261	-3.2626	-12.9279	94.123	-125.814	247.66	32.816	0.7512
	2.9400	1.7652	-4.3943	-6.2599	4.3585	-90.658	-4.766	281.18	43.845	0.8530
	-0.7151	-0.4713	-0.5353	0.5261	-3.6944	-5.314	-15.334	288.60	46.132	0.8766
165.3	-0.9534	-0.4120	6.7630	-2.8854	-0.9079	116.269	-314.410	214.10	24.390	0.6466
	3.7213	2.1092	-5.6831	-11.5025	3.1359	-63.609	74.639	225.61	28.270	0.6793
	3.0878	3.1048	0.8644	-7.9732	1.6073	13.550	-5.321	216.75	27.231	0.6485
	-0.4665	-0.0518	7.7799	-4.2355	-5.3800	88.050	57.845	198.25	21.179	0.5971
165.4	2.4758	2.4481	0.5524	-14.4768	22.4795	11.758	29.930	191.91	18.952	0.5775
	-0.4854	-0.3129	0.6353	0.8428	-1.6397	6.099	24.239	199.29	20.700	0.6029
	0.9040	0.9265	1.2628	-2.1149	1.3219	6.972	12.859	196.79	20.049	0.5957
	-1.2230	-1.1026	1.2659	-1.6299	-18.8480	-88.351	103.757	195.77	19.654	0.5932
	2.2095	2.0049	2.2768	-12.5541	-31.6350	8.472	53.504	195.85	19.811	0.5930
	-0.9328	-0.3448	7.8215	-3.9903	-12.9631	30.157	194.579	207.15	23.191	0.6249
	3.7654	3.7133	1.7260	-7.9031	5.1404	-16.950	111.220	224.42	29.179	0.6725
165.5	-1.7215	-1.3187	-1.3271	0.4835	-13.2872	-75.771	20.262	160.00	12.931	0.4839
165.6	3.4636	3.1470	0.2694	-11.2480	-35.5613	10.873	6.298	190.73	19.920	0.5732
	4.2889	4.0168	-0.3652	-12.3261	4.7873	-0.991	195.688	216.90	27.257	0.6490
	-0.8173	-0.7467	-0.7933	-0.1358	-3.5359	-16.774	18.858	244.01	33.161	0.7360
165.7	4.6936	4.4127	2.7108	-16.1975	-97.1018	39.120	301.615	245.13	33.266	0.7399
	3.5310	3.9632	-1.8728	-11.9652	54.5991	-22.761	-155.388	175.81	16.378	0.5296
	-0.0375	-0.1953	-0.5630	-6.9652	-2.5797	-15.119	-15.209	112.27	6.183	0.3396
	2.1293	2.0536	0.2791	-4.4297	2.5157	-2.714	86.513	163.61	14.384	0.4915
	0.0599	-0.1551	-2.1569	1.1216	-4.9350	-15.863	4.848	178.28	17.429	0.5350
166.1	1.0703	-0.0706	-8.4011	-3.9758	9.7355	-31.058	-204.112	196.29	22.203	0.5866
	-0.7523	-0.6230	3.6937	-3.5028	-10.9496	-50.594	353.989	197.51	22.471	0.5903
	0.4575	-0.6719	-8.4134	-4.1295	-7.3074	-77.847	-126.395	197.64	22.470	0.5908
	-0.8505	-0.7780	3.9164	-6.0558	-5.2643	-59.036	397.924	198.23	22.604	0.5926
	-3.4020	-3.0889	0.4045	4.4674	-0.7110	-14.915	153.132	201.65	23.422	0.6029
	-2.5758	-3.0761	-8.0435	-3.3853	2.2817	-66.387	27.640	203.27	23.839	0.6078
	-3.6908	-3.1494	1.4174	2.9581	1.8455	-12.020	177.894	203.82	23.979	0.6094
	-1.7752	-2.5441	-8.5487	-5.6320	0.3798	-102.830	-179.940	203.45	23.933	0.6082
	-2.6986	-1.8435	3.9465	-4.2465	15.5598	-85.988	439.960	203.45	23.933	0.6082
	-0.6090	-1.4466	-7.7280	-3.0327	10.7108	-103.798	-41.276	208.07	25.178	0.6219
	-1.7513	-1.2760	4.1001	-3.0021	-8.9860	-80.474	410.401	208.07	25.178	0.6219
	0.0999	-0.9068	-8.3790	-1.9737	9.2093	-95.853	-69.490	211.39	26.163	0.6316
	-1.2177	-0.8553	4.1112	-3.4762	-28.1085	-75.382	437.666	211.39	26.163	0.6316
166.2	1.1759	-0.0196	-8.1736	-4.0687	16.4508	-34.570	-132.548	234.64	32.713	0.7016
	-0.6447	-0.3117	3.1073	-3.9736	0.3696	-40.719	395.947	235.29	32.881	0.7036
	0.7675	-0.5530	-9.0020	-2.8424	-4.4336	-32.944	-346.619	235.36	32.880	0.7039
	-1.1640	-0.3580	3.4338	-1.4308	55.8900	-47.653	500.898	235.98	33.049	0.7058
	-3.6453	-3.6450	-1.5339	5.3769	-22.1646	-14.414	59.328	237.78	33.560	0.7113
	-2.1419	-3.0857	-8.4409	-4.0787	4.5208	-101.962	-107.074	239.53	34.076	0.7166
	-3.6057	-2.5183	3.6722	-3.2600	-7.5040	-80.630	541.601	239.53	34.076	0.7166
	-1.1045	-2.1576	-8.5029	-5.0213	-2.3284	-107.804	-138.074	241.91	34.882	0.7237
	-2.4940	-1.6065	3.6941	-4.2605	5.7377	-80.984	537.369	242.98	35.236	0.7269
	-0.3918	-1.3211	-7.1906	-6.4622	10.1918	-75.366	-67.014	243.97	35.594	0.7297
	-1.5826	-0.8281	3.9197	-5.8625	2.8290	-53.008	357.019	245.51	36.135	0.7342
	0.8121	-0.4917	-7.3376	-5.4285	-7.3370	-85.134	-89.815	246.95	36.681	0.7384
	-0.4304	-0.1119	2.1838	-5.3202	-5.6401	-60.075	438.983	246.95	36.681	0.7384
	1.1085	-0.0970	-8.0116	-2.9689	2.8804	-46.992	-326.019	247.40	36.865	0.7397
	-0.8647	-0.3542	3.5936	-3.0974	-5.7248	-53.100	484.321	249.36	37.604	0.7453
167.1	2.0199	1.9299	1.1555	-5.2716	2.8974	-2.664	7.139	263.24	15.037	0.8915
	2.1759	2.2603	1.1371	-5.8623	4.5596	-5.739	-88.606	256.01	13.875	0.8671
	2.0263	2.2716	1.0968	-6.4237	-1.3861	9.735	3.474	247.18	12.569	0.8371
	-1.1882	-0.6804	2.4847	1.7196	0.4299	102.485	25.054	225.74	9.629	0.7645
	-0.8388	-0.4556	0.6810	-0.3436	8.0153	19.849	-7.657	214.90	7.868	0.7278
	-1.1602	-0.8173	0.8452	-0.4247	-2.2011	46.868	-11.086	213.48	7.566	0.7230
	1.9850	2.0177	1.4395	-5.6529	-3.9467	59.556	3.171	270.99	15.618	0.9178
	2.2299	2.2749	-0.0321	-5.1646	-7.6495	-47.491	23.620	259.19	13.653	0.8778
	1.6573	2.1393	1.0347	-8.1327	-28.6981	54.758	-39.658	235.44	10.498	0.7974
	-0.5376	-0.2822	2.3928	0.4114	-1.8097	280.658	-1.648	205.32	7.164	0.6954
	-1.2241	-1.0119	1.6169	-1.6799	-3.8953	41.129	-5.329	173.61	4.438	0.5880
	-1.0079	-0.7021	2.2405	-1.0480	1.0557	-3.058	7.125	173.75	4.385	0.5885
167.2	-1.3010	-1.2460	3.7997	-1.3354	-8.7922	72.318	74.856	234.60	28.166	0.7142
	0.1993	-1.2089	-8.0475	-2.0266	-16.3283	46.400	-461.652	234.60	28.166	0.7142
	-1.4324	-1.2451	4.2410	-3.2587	-13.5865	70.089	121.838	235.23	28.320	0.7162
	0.2741	-1.1798	-8.2560	-5.0018	2.5655	45.343	-437.759	235.23	28.320	0.7162
	-1.6084	-0.8632	5.1896	-4.4236	2.4820	-14.865	472.107	237.17	28.856	0.7221
	0.4581	-1.0709	-8.3177	-5.9204	5.9264	36.819	-507.826	238.74	29.331	0.7267
	-1.2693	-0.6524	4.5823	-5.9534	0.9933	9.284	355.702	240.63	29.974	0.7321
	0.3832	-0.8816	-7.5501	-4.8082	19.8777	52.128	-399.233	242.13	30.461	0.7365
	-1.3308	-0.7984	4.2487	-6.6012	-11.4423	18.195	309.729	245.43	31.619	0.7459
	1.0030	-0.2736	-6.2179	-5.7612	5.0795	37.323	-429.242	247.42	32.466	0.7512
	-0.0130	0.0632	3.2697	-4.5215	-15.5126	20.119	130.394	248.86	33.156	0.7549
	1.6500	1.0620	-1.7966	-5.4291	2.5859	-1.005	-31.675	250.51	34.033	0.7588
167.3	0.1039	-0.3080	-0.7724	-3.3879	5.0833	-5.897	-65.390	210.49	22.550	0.6394
	-3.1156	-3.0724	-0.2720	-1.4855	6.3515	20.011	10.317	216.03	23.781	0.6563
	0.8268	-0.0421	-4.4279	-3.2206	-8.4902	2.130	31.675	221.90	25.498	0.6736
	-0.2771	-0.6147	-1.1506	-2.4819	-5.7457	0.857	106.780	225.24	26.535	0.6831

Table 2e

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 6 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 6 MULTIPLE OF 1G LOAD	VERT ACCEL. CG G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2	MACH NUMBER
159.1	-0.3868	-0.3242	1.2695	-0.1193	-1.4015	-6.023	-10.067	365.11	35.657	1.2336
	1.1110	0.4636	1.3770	-0.5285	4.5277	0.353	5.451	383.13	40.468	1.2950
	2.8396	1.2447	1.7705	-1.2748	4.8305	-1.391	-4.670	473.27	73.965	1.6018
	0.4273	-0.2763	1.1451	0.1814	-12.0995	-4.027	1.289	454.89	61.033	1.5406
	1.6917	0.4566	1.9302	-1.3932	6.0368	4.112	-16.627	445.04	52.251	1.5072
	0.3284	-0.2309	1.9711	-0.8027	-2.8798	-0.058	14.673	434.48	45.628	1.4715
	0.9942	0.1553	1.3836	0.0187	-0.4723	7.151	10.384	422.69	37.734	1.4316
163.1	-1.5871	0.1600	5.7469	-0.2109	-1.7256	42.297	39.134	380.46	55.014	1.2335
	6.3655	3.3108	-2.1175	-4.0364	3.5611	-16.398	-12.107	374.56	52.271	1.2158
	5.6623	3.2686	-0.0265	-4.5756	0.8863	-15.385	-8.664	370.28	50.566	1.2032
	4.5359	2.3713	-2.3380	-1.8433	7.4672	-28.679	-26.039	345.04	43.003	1.1175
	5.5740	4.3996	0.7357	-7.9628	6.4946	-10.942	-46.136	327.56	40.653	1.0510
163.2	1.0062	0.8164	-0.5728	-0.8128	4.1371	-5.656	-48.119	228.21	35.526	0.6706
	-0.5711	0.0042	0.3769	2.1565	-4.7743	-0.472	60.185	258.28	47.251	0.7582
	-0.2072	0.0523	0.0760	2.3851	-6.6565	-5.582	119.265	279.45	57.106	0.8195
	1.5166	0.4120	-1.9461	0.9017	16.7442	-24.771	-41.228	278.90	56.867	0.8177
163.3	0.7489	0.4728	0.6955	1.8516	4.3454	6.033	-29.214	264.63	23.855	0.8500
	-0.3418	-0.1533	0.8403	0.2441	-4.9024	2.260	-10.025	264.98	23.852	0.8515
164.2	5.2951	1.3134	-6.2315	-5.0934	3.8094	-114.216	20.972	283.42	54.645	0.8389
	-4.3434	0.0290	6.4662	0.3717	-2.1951	29.941	379.804	287.00	55.675	0.8505
	5.3766	0.3577	-7.2166	0.6209	12.7966	-15.145	-388.329	301.35	62.661	0.8926
	-3.6680	0.4975	5.6394	-0.9207	-17.2355	31.508	418.864	302.38	63.436	0.8952
	2.8148	1.7272	-0.3231	-2.2122	-1.1123	3.420	-17.746	293.73	58.672	0.8706
164.3	3.5141	2.5740	0.1981	-5.9592	-6.9179	3.310	49.547	243.47	29.929	0.7433
	3.2203	2.1459	-0.9267	-4.5659	-0.0226	-12.467	-26.390	250.12	31.560	0.7641
	4.3436	3.8307	0.3227	-7.1276	43.6064	-5.194	-124.953	234.13	27.232	0.7155
164.4	5.1113	4.0318	-1.4074	-7.1808	3.8144	-24.860	79.964	239.54	31.215	0.7243
	4.9763	4.2054	0.4735	-8.0304	12.3574	-2.628	-50.734	291.98	47.526	0.8490
	4.6550	3.8152	0.9850	-6.9967	-12.6169	0.818	252.317	236.63	30.575	0.7150
164.5	4.0373	2.5639	-0.8406	-6.0486	-0.6772	-2.338	-21.013	158.12	13.216	0.4758
	6.2907	4.3811	0.6999	-10.6553	-13.0683	2.879	55.682	252.44	36.091	0.7606
	6.5495	4.2684	-0.2656	-10.0458	-7.3918	-4.792	188.984	235.40	28.861	0.7157
164.6	3.5577	3.0490	0.2875	-6.6762	37.0540	-15.406	-148.459	207.98	22.384	0.6304
	4.0413	0.7120	-11.8530	-0.0033	-0.6134	-40.117	-321.919	262.96	38.249	0.7959
	-5.7524	-1.8655	9.4624	2.2601	-0.5247	-88.971	315.223	270.02	40.074	0.8187
	3.6540	0.4770	-11.3522	-0.9088	6.8285	-48.815	-406.147	277.74	42.818	0.8421
	4.9369	3.8309	-2.2623	-3.4938	20.5157	-19.538	-20.172	249.49	33.801	0.7556
164.7	2.3936	0.9046	-6.0589	-1.6821	-2.0252	-66.595	-28.805	174.41	16.153	0.5253
	2.9278	3.5514	1.3950	-11.0390	1.8183	-3.325	-13.581	175.94	16.663	0.5291
	3.0881	1.6011	-5.2301	-0.3602	-2.2026	-40.895	12.024	190.96	21.388	0.5691
	3.5050	3.3617	1.4611	-8.6596	18.4200	1.216	37.715	198.91	23.265	0.5930
164.8	1.6501	1.3465	0.0000	-3.8652	-0.9239	-1.831	7.050	200.61	19.866	0.6110
	1.0606	0.6750	0.0000	-2.2096	-0.0184	-4.565	-6.050	192.00	18.365	0.8536
	0.7149	0.3905	0.0000	-1.5760	-7.2473	0.022	1.228	216.05	27.400	0.6456
165.1	2.0449	0.9279	-6.8693	-4.5371	-0.8854	-45.580	-61.177	158.92	12.947	0.4799
	-0.4367	0.3348	5.0208	-4.5226	-10.3676	10.536	38.051	162.87	13.751	0.4913
	2.0434	1.7467	-0.9023	-1.9342	5.8029	1.995	2.586	173.11	16.053	0.5206
	-1.0655	0.1016	7.1652	-5.2795	-2.5855	23.519	132.254	163.49	13.025	0.4969
	1.3365	0.5057	-5.6213	-5.2538	-3.6377	15.569	-206.065	165.20	13.427	0.5016
	-0.3322	-0.1285	-1.2542	0.4093	-1.5173	-16.653	-28.298	178.01	16.010	0.5394
	1.4939	0.4346	-4.7573	-5.7841	-5.1581	-77.426	134.176	187.80	17.832	0.5696
	-1.7156	-0.4569	7.0853	-3.2592	-2.8293	88.525	11.304	183.50	16.902	0.5568
	1.2643	0.5853	-2.5694	-2.6413	8.0099	5.109	-66.349	186.30	17.479	0.5652
	2.6509	0.9544	-5.1220	-7.4954	1.4724	-89.509	-42.262	216.85	24.358	0.6578
165.2	-1.8002	0.2385	7.0587	-0.6970	-0.0529	34.798	245.861	215.85	23.782	0.6559
	2.3609	0.4280	-5.2300	-2.7690	1.1550	40.368	-330.592	217.54	24.203	0.6610
	3.2714	0.7859	-5.9284	-7.1837	-2.3453	-109.953	-110.368	246.75	32.475	0.7486
	-2.0118	0.4592	6.6145	0.1352	4.3954	46.721	184.419	247.76	32.815	0.7516
	4.3071	1.7652	-4.3943	-6.2599	4.3585	-90.658	-4.766	281.18	43.845	0.8530
165.3	-1.6821	-0.3543	5.2603	-4.3030	7.6672	-62.959	237.018	196.34	19.520	0.5959
	1.5480	0.1574	-7.5637	-0.0062	3.6347	-25.250	-224.657	195.35	19.272	0.5930
	2.2996	1.9552	0.3395	-9.6938	8.0683	4.335	21.154	200.37	20.532	0.6076
	4.3823	2.1992	-5.6631	-11.5025	3.1359	-63.609	74.639	225.61	28.270	0.6793
	3.3699	3.1702	0.6049	-6.9116	14.5651	-13.714	-257.300	216.75	27.231	0.6485
	0.4518	0.3744	-0.1822	-0.8426	-0.9127	-0.100	-3.954	201.54	22.509	0.6052
165.4	2.8207	2.4881	0.5523	-14.4767	22.4795	11.758	29.930	190.92	18.855	0.5775
	-0.9761	0.0233	7.9179	-3.1003	-2.5862	84.529	73.456	192.13	19.120	0.5813
	2.0217	1.8783	0.7654	-7.1447	7.4345	14.671	-225.246	195.55	19.904	0.5915
	1.2164	-0.0029	-7.1977	3.5153	18.0485	-25.958	-87.722	194.09	19.308	0.5880
	-1.9295	-0.8899	3.8753	-6.8291	-42.2175	-56.858	188.743	194.07	19.295	0.5880
	2.3470	2.4675	2.2358	-5.9061	53.1993	-27.308	-29.264	195.85	19.811	0.5930
	-2.0881	-0.3730	7.6237	-4.8587	-16.7146	41.022	207.065	207.15	23.191	0.6249
	3.9265	3.6967	1.6205	-9.6293	16.4643	-8.329	39.315	224.42	29.179	0.6725
165.5	0.6290	-0.1502	-7.0353	4.3370	15.9851	-24.960	-25.544	163.44	13.760	0.4933
	-1.5356	-1.1574	-0.7702	-0.7711	-10.7684	-71.156	57.589	158.77	12.686	0.4804
165.6	3.2352	2.4931	-0.8057	-11.4827	-40.2750	-10.369	-237.708	202.10	22.619	0.6071
	-0.3351	0.1571	4.8570	-1.3482	5.7050	40.624	21.868	153.21	12.449	0.4606
	-0.1946	-0.0797	0.2361	-0.7116	1.0107	-0.145	-71.589	185.82	19.022	0.5570
	4.2722	3.8583	-0.5391	-10.1666	-27.1354	-15.609	-105.904	216.90	27.257	0.6490
	2.4878	1.6263	-1.2080	-3.4778	0.6803	-17.991	-0.979	235.35	31.524	0.7074
	-0.8683	-0.6895	-0.7833	-0.0031	2.6375	-15.399	27.132	244.01	33.161	0.7360
165.7	4.3356	5.0304	1.8923	-9.6760	93.8418	25.429	-10.110	245.14	35.267	0.7399
	3.3763	3.6100	-1.1257	-11.2148	33.0174	-15.624	25.497	179.54	17.136	0.5408
	2.2300	1.8174	-0.0762	-3.9399	-19.0984	0.665	28.911	165.50	14.807	0.4969
166.1	1.6746	-0.0206	-8.4011	-3.9758	9.7355	-31.058	-204.112	196.29	22.203	0.5866
	-2.6381	-0.5723	3.8578	-3.3920	-4.1349	-54.083	318.905	197.51	22.471	0.5903
	1.0319	-0.5593	-6.9850	-3.1073	6.3013	-26.553	-220.774	197.01	22.336	0.5889
	-2.8334	-0.7869	3.9621	-6.0015	-9.4968	-62.995	342.201	198.23	22.604	0.5926
	-0.2824	-1.5465	-9.3210	2.2258	10.6749	-27.667	-244.187	198.80	22.739	0.5943
	-5.0580	-3.1078	1.0537	4.8538	-8.6190	-21.617	128.929	201.65	23.422	0.6029
	-2.5921	-3.0761	-8.0435	-3.3853	2.2817	-66.387	27.640	203.27	23.839	0.6078
	-5.3595	-3.2032	1.6135	3.0005	-15.8774	-15.225	86.436	203.82	23.979	0.6094
	-1.6625	-2.4299	-8.8390	-5.6823	13.6013	-97.390	-62.062	203.45	23.933	0.6082
	-0.3467	-1.4180	-8.3542	-3.3046	16.4212	-103.343	-2.254	208.07	25.178	0.6219
	-3.8477	-1.2890	4.0595	-2.9102	-8.7345	-84.549	376.495	208.07	25.178	0.6219
	0.5237	-0.7935	-8.4087	-2.0670	25.5417	-95.186	-52.529	211.39	26.163	0.6316
	-3.2677	-0.8419	4.0983	-3.1902	-24.2738	-79.774	421.189	211.39	26.163	0.6316
166.2	2.2475	-0.0396	-8.1736	-4.0687	16.4508	-34.570	-132.548	234.64	32.713	0.7016
	-2.7665	-0.2817	3.2415	-4.0013	1.3811	-48.159	351.199	235.29	32.881	0.7036
	2.0094	-0.5579	-9.0153	-2.7987	-6.4565	-29.471	-376.177	299.88	41.517	0.7039
	-3.3447	-0.4601	3.7975	-2.4964	39.1215	-58.194	507.067	235.98	33.049	0.7058
	-0.5525	-2.4259	-9.0323	0.0596	-17.4024	-40.036	-231.105	236.60	33.218	0.7077
	-4.5334	-2.1399	1.5062	3.2245	36.5829	-53.816	132.866	237.78	33.560	0.7113
	-1.6606	-3.1022	-8.7137	-4.2563	9.6553	-98.319	-172.050	239.53	34.076	0.7166
	-6.2708	-2.5251	3.5986	-3.1880	-3.0831	-86.083	396.149	239.53	34.076	0.7166
	-0.5246	-2.1505	-8.5257	-5.0027	-0.1053	-106.395	-136.950	241.91	34.882	0.7257
	-5.0814	-1.6229	3.6825	-4.3191	7.4706	-86.350	470.874	242.98	35.236	0.7269
	-1.8168	-1.0568	-1.3853	-5.9608	3.8046	-79.411	116.165	243.97	35.594	0.7297
	-3.9683	-0.8782	3.8685	-5.8915	0.1053	-56.581	340.574	245.51	36.135	0.7342
	1.5744	-0.6386	-8.0357	-4.6517	-1.3658	-43.655	-256.750	245.96	36.317	0.7355
	-2.3734	-0.1004	2.3072	-5.3000	1.7534	-55.853	419.492	246.95	36.681	0.7384
	2.3494	-0.0185	-7.9932	-2.9940	13.7400	-43.675	-198.865	241.91	34.882	0.7237
	-3.3178	-0.3537	3.6360	-3.0417	-1.5121	-57.964	497.387	249.36	37.604	0.7453
167.1	2.3620	1.9062	1.2272	-5.5033	-4.6494	7.071	33.657	263.24	15.037	0.8915
	-0.6678	-0.7561	2.5796	1.4613	-1.4793	115.739	9.763	225.74	9.629	0.7645
	-0.1937	-0.5250	0.6235	-0.3101	0.6321	23.061	10.835	214.90	7.868	0.7278
	-0.6609	-0.8795	1.2725	0.5336	-4.4626	44.889	7.235	213.12	7.567	0.7218
	2.2117	1.7162	1.1071	-4.3686	3.6579	-3.094	35.971	271.85	15.818	0.9207
	2.1266	2.1195	0.6058	-5.6477	-39.7272	-27.987	77.159	253.69	12.856	0.8592
	-0.1399	-0.1485	3.8815	1.6682	-2.8364	236.976	-8.130	208.88	7.506	0.7074
	0.5554	0.1478	1.2461	-0.9937	-3.3627	15.116	20.014	190.50	5.707	0.6452
	-0.8644	-1.0119	16.1745	-1.6799	-3.8953	41.129	-5.329	173.61	4.438	0.5880
167.2	-3.1923	-0.6509	4.4337	-2.3734	-8.6113	4.855	379.820	234.57	28.167	0.7141
	1.0936	-1.3127	-8.1966	-1.8632	-20.0944	51.006	-425.607	234.60	28.166	0.7142
	-3.4483	-0.6710	4.9516	-3.1371	2.7580	1.205	340.698	234.66	28.166	0.7144
	1.1257	-1.4090	-8.1510	-4.4916	-36.4416	57.068	-374.922	235.23	28.320	0.7162
	-3.8788	-0.9178	4.9530	-4.4876	-3.4163	-24.294	344.395	237.17	28.856	0.7221
	1.5213	-0.9810	-8.3585	-5.9744	11.0637	41.883	-454.770	238.74	29.331	0.7267
	-3.3880	-0.6381	4.5612	-5.9630	5.1026	5.724	367.241	240.63	29.974	0.7321
	1.3477	-1.0384	-7.3274	-5.0709	3.6486	64.137	-336.934	242.13	30.461	0.7365
	-3.4339	-0.7788	4.2741	-6.4866	-4.9075	15.076	241.668	245.43	31.619	0.7459
	1.8583	-0.2756	-6.2179	-5.7612	5.0795	37.323	-429.242	247.42	32.466	0.7512
	-1.8378	0.0356	3.2229	-4.3617	-21.5723	18.843	92.899	248.86	33.156	0.7549
	1.2848	1.0796	-1.7432	-5.4007	2.9247	-0.979	2.493	250.51	34.033	0.7588
167.3	-0.4351	-0.3704	-1.9030	-4.2796	0.3825	-11.000	85.878	211.58	22.822	0.6427
	-4.2612	-3.0224	-0.2720	-1.4855	6.3515	20.011	10.317	216.03	23.781	0.6563
	0.8114	-0.0421	-4.4279	-3.2206	-8.4902	2.130	31.675	221.90	25.498	0.6736

Table 2f

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 7 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 7 MULTIPLE OF 1G LOAD	VERT. ACCEL. CG G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2	MACH NUMBER
159.1	-0.3110	-0.4139	1,7178	-0,0147	-0,8007	-7.103	-6,039	362,87	35,074	1.2261
	1.1476	0.4431	1,1484	0,2293	8,1364	1.675	13,987	382,51	40,253	1.2933
	3.0518	1.2311	1,7699	-0,8380	8,7319	-2.625	-12,137	473,26	73,964	1.6018
	0.5900	-0.3003	1,0852	0,7861	-13,2441	-4.185	-18,929	454,89	61,033	1.5406
	1.6980	0.4422	1,7124	-0,2593	3,8193	-1.240	-7,070	447,15	54,550	1.5144
	0.2727	-0.2664	1,8290	0,6197	-14,1680	-5.334	3,438	434,48	45,628	1.4715
	1.2551	0.2232	1,4412	-0,0292	2,7309	2.926	14,865	422,02	37,907	1.4293
163.1	-0.6637	0.1148	5,6442	0,6068	0,5490	28.667	67,035	379,73	54,751	1.2311
	3.5468	3.3108	-2,1175	-4,0364	3,5611	-16.398	-12,107	374,56	52,271	1.2158
	5.0278	4.3624	0,3972	-8,1148	-10,5734	-5.317	-28,470	343,59	41,352	1.1170
	3.9001	3.0063	0,3496	-3,9074	11,3892	-9.897	-8,897	327,56	40,653	1.0510
163.2	1.0532	0.8387	-0,3087	-0,4953	2,1960	-10.869	-60,766	228,21	35,526	0.6706
	-0.6346	0.0821	0,4822	0,6287	-3,4900	-13.535	36,838	276,70	55,637	0.8117
	-0.4314	-0.2671	-0,8376	0,6115	-20,3031	-3.945	86,149	285,88	60,262	0.8381
	0.0737	0.4312	-0,8678	-0,9351	3,6958	-20.026	-23,929	278,90	56,867	0.8177
	-0.7578	0.0342	-0,1646	1,0265	-6,5585	-3.707	15,701	279,41	57,111	0.8192
	-0.5218	0.0349	-0,4286	-0,0148	-12,7739	-9.575	0,814	283,15	58,983	0.8301
163.3	0.0005	0.0685	1,3831	-0,0603	-2,1217	-4.674	8,537	262,54	23,299	0.8438
	0.7915	0.4643	0,9557	1,1839	2,9767	5.582	13,583	262,54	23,295	0.8439
	0.8545	0.5031	1,1010	0,1607	2,2159	8.568	22,795	265,09	23,851	0.8519
	-0.0158	-0.1533	0,8403	0,2441	-4,9024	2.260	-10,025	264,98	23,852	0.8515
164.2	3.3317	1.3134	-6,2315	-5,0934	3,8094	-114.216	20,972	283,42	54,645	0.8389
	-2.4568	-1.0014	5,6322	0,1296	-1,8014	121.450	23,162	287,98	55,919	0.8538
	1.6353	0.1938	-7,0277	-0,0048	10,7492	-122.888	27,655	300,96	62,364	0.8917
	-2.0500	-0.2533	5,3879	-2,4422	-4,4001	103.700	35,721	300,87	62,646	0.8908
	1.1910	1.2012	-0,5862	-0,7847	13,3475	16.211	-109,934	302,23	63,642	0.8944
	1.9924	1.7340	-0,2902	-2,1708	0,8958	4.084	6,568	293,73	58,672	0.8706
164.3	2.9332	2.5740	0,1981	-5,9592	-6,9179	3.310	49,547	243,47	29,929	0.7433
	-0.5755	-0.2198	0,2360	0,1093	-6,0714	6.814	-20,452	232,51	27,735	0.7074
	0.5463	0.6398	0,0926	-1,2686	-1,8677	-0.300	-1,187	249,71	32,613	0.7597
	-0.3771	-0.1257	0,0956	0,4504	-2,6577	2.265	-5,146	255,62	34,161	0.7783
	2.6749	2.3421	-0,3103	-4,3594	2,8721	-7.004	18,209	245,06	29,901	0.7493
	3.3022	3.7855	0,2370	-7,9331	-1,4106	-7.242	-54,561	233,95	27,258	0.7146
164.4	0.3531	0.5543	4,7449	-4,0785	-10,8112	54.438	-12,898	192,42	17,140	0.5902
	4.1091	4.0163	-1,4766	-7,3704	14,3887	-28.845	66,238	239,54	31,215	0.7243
	4.7707	4.2130	1,1079	-8,1489	4,5592	-3.478	-1,286	284,80	47,526	0.8587
	3.7195	3.1532	-1,6453	-7,5879	-15,4602	-23.298	12,106	238,75	30,585	0.7233
164.5	2.1643	3.1287	0,7732	-7,4815	42,6022	-3.117	-33,943	160,75	13,463	0.4847
	-0.7193	-3.3028	-0,3941	1,8754	3,2615	-5.762	-18,044	182,30	18,011	0.5480
	-0.1719	0.1401	0,0313	0,8416	0,9931	0.328	0,890	221,21	27,509	0.6648
	4.2813	4.1476	1,6253	-9,0191	-5,0106	6.112	39,386	256,37	37,831	0.7714
	3.0924	4.4627	0,4434	-10,0710	10,8677	-30.919	-208,839	236,88	29,957	0.7180
164.6	2.6525	3.1661	0,4162	-6,5583	16,9609	8.844	-182,621	201,53	21,050	0.6103
	1.6353	1.4198	-0,2133	-4,9142	1,4558	0.365	-30,538	261,82	38,019	0.7921
	1.8839	0.7120	-11,8530	-0,0033	-0,6134	-40.117	-321,919	262,96	38,249	0.7959
	-4.9058	-1.8655	9,4624	2,2601	-0,5247	-88.971	315,223	270,02	40,074	0.8187
	4.3142	0.4770	-11,3522	-0,9088	6,8285	-48.815	-406,147	277,74	42,818	0.8421
	4.3755	4.7538	1,2691	-11,6560	-9,8733	0.492	-9,460	261,95	37,585	0.7938
164.7	3.9170	3.8873	1,2564	-11,3677	22,2925	7.376	41,521	199,55	21,210	0.6061
	2.6311	3.4142	1,5801	-11,7604	-2,6166	-1.601	-4,066	174,90	16,463	0.5259
	2.9324	2.4465	-4,3904	-3,0229	-4,7453	-36.758	-24,654	190,63	21,283	0.5682
	2.8571	3.4008	1,2868	-6,9189	18,1683	11.339	-34,947	197,30	22,771	0.5885
	-0.4308	-1.1624	-0,1324	0,0559	0,6652	1.670	-13,667	174,19	15,667	0.5261
	-0.7126	-1.5430	0,1081	1,4419	1,5078	1.089	-2,162	205,11	20,826	0.6248
164.8	-0.4741	-0.1305	0,0000	0,7111	-1,3784	1.166	-5,937	208,09	21,463	0.6340
	1.4168	1.5044	0,0000	-4,2172	0,0036	1.413	1,562	206,92	20,153	0.6020
	-0.4191	-0.0625	0,0000	1,6736	-0,5174	1.818	1,838	206,96	22,677	0.6255
165.1	1.7025	0.8638	-6,4331	-8,8745	-12,2378	-32.693	29,037	152,50	11,699	0.4613
	2.2928	1.8073	-0,6804	-2,0411	25,8674	7.038	36,130	173,57	16,165	0.5220
	-0.3984	-0.1894	0,6025	-1,5919	6,2231	0.538	-7,611	162,49	12,828	0.4940
	1.4273	0.4348	-4,7573	-5,7841	-5,1581	-77.426	134,176	187,80	17,832	0.5696
	-0.3727	-0.5139	6,9616	-4,0845	-1,6521	91.440	29,259	183,50	16,902	0.5565
	2.0192	0.9590	-2,9892	-7,6597	-3,4355	-89.781	-5,468	216,85	24,358	0.6578
165.2	2.6923	0.7859	-5,9784	-7,1837	-2,3453	-109.953	-110,368	246,75	32,475	0.7486
	-1.8673	-1.1831	6,7448	-3,5523	-5,7734	82.768	-229,199	247,76	32,815	0.7516
	2.7775	2.2914	-0,1706	-5,5094	3,3880	1.792	49,254	244,70	31,628	0.7431
	3.2677	1.8264	-3,1926	-5,9990	5,2343	-88.422	44,746	281,18	43,845	0.8530
	-0.6339	-1.4197	-0,6619	0,1154	2,2410	-0.276	-31,186	287,33	45,709	0.8726
165.3	2.0921	1.8496	0,2654	-9,3335	6,8637	2.121	-42,603	200,37	20,532	0.6076
	-0.5124	-0.5829	-0,7738	-2,5815	-9,5745	-0.622	-50,437	213,95	24,390	0.6464
	3.8637	2.1992	-5,6831	-11,5025	3,1359	-63.609	74,639	225,61	28,270	0.6793
	0.1688	1.1355	-0,3542	1,2798	-2,3275	3.550	54,058	222,07	28,958	0.6639
	3.4940	3.1104	0,2649	-6,4143	9,3948	-25.007	-216,008	216,75	27,231	0.6485
165.4	2.5173	2.2711	-0,3963	-13,2159	13,1427	6.414	-74,195	190,92	18,855	0.5775
	-0.3134	-1.0962	7,8679	-5,2506	-10,4571	97.358	36,506	192,13	19,120	0.5813
	0.0164	0.0390	0,4368	1,5127	-1,2963	7.671	31,260	197,34	20,307	0.5969
	-1.3356	-1.3413	2,7872	-2,9144	-24,4797	-78.608	185,411	195,77	19,654	0.5915
	2.2236	2.1467	2,2738	-12,3986	5,0643	-1.436	-189,038	195,85	19,811	0.5930
	-1.0416	-1.3448	7,8215	-3,9903	-12,9631	30.157	194,579	207,15	23,191	0.6249
	3.6375	3.3669	3,1705	-7,5366	-17,9180	-7.386	-15,888	223,53	29,052	0.6694
165.5	-1.5591	-1.1574	-0,7702	-0,7711	-10,7684	-71.156	57,589	158,77	12,686	0.4804
165.6	3.1525	3.1381	2,9540	-14,3626	-69,4947	28.148	186,659	194,78	20,798	0.5854
	4.2792	3.4773	-0,4209	-10,4154	-28,5258	-23.745	46,618	225,33	30,015	0.6733
	-0.8171	-1.6576	-0,6256	0,3239	1,5433	-14.780	0,739	244,01	33,161	0.7360
165.7	4.1577	4.6361	2,4830	-15,1690	20,7405	42.955	76,446	245,14	33,267	0.7399
	3.2177	3.5183	-1,6953	-10,7392	11,0122	-1.267	12,770	179,54	17,136	0.5408
	-0.0597	-0.1502	-0,3135	-6,7015	-3,9595	-11.598	59,270	111,35	6,075	0.3369
	2.0146	2.1887	0,0028	-3,7757	26,2793	-0.608	-54,837	165,50	14,807	0.4969
166.1	0.3404	0.0266	-8,3162	-4,0746	14,0913	-29.018	-214,086	196,29	22,203	0.5866
	-2.0133	-1.5723	5,8578	-3,3920	-4,1349	-54.083	318,905	197,51	22,471	0.5903
	-0.3173	-0.6227	-8,2699	-4,0538	0,8906	-77.651	3,344	197,64	22,470	0.5908
	-2.2129	-0.7869	3,9621	-6,0015	-9,4968	-62.995	342,201	198,23	22,604	0.5926
	-4.1992	-3.0922	0,7596	4,5589	-14,7481	-18.234	182,420	201,65	23,422	0.6029
	-3.9331	-3.1997	-7,9665	-3,4773	-9,3838	-66.794	-44,769	203,27	23,839	0.6078
	-4.5771	-3.1894	1,4174	2,9581	1,8455	-17.020	177,894	203,82	23,979	0.6094
	-2.9133	-2.3046	-7,3334	-5,0838	20,2156	-104.815	-56,057	203,45	23,933	0.6082
	-4.3018	-1.8435	3,9465	-4,2465	15,5598	-85.988	439,960	203,45	23,933	0.6082
	-1.4771	-1.4066	-7,7330	-3,0327	10,7108	-103.798	-41,276	208,07	25,178	0.6219
	-3.1058	-1.2760	4,1001	-3,0021	-8,9860	-80.474	410,401	208,07	25,178	0.6219
	-1.5335	-1.9068	-8,3790	-1,9737	9,2093	-95.853	-69,490	211,39	26,163	0.6316
	-2.4716	-1.8046	4,0096	-2,9365	-14,6485	-83.970	359,034	211,39	26,163	0.6316
166.2	0.6555	0.0112	-8,2018	-3,8511	21,9061	-36.570	-199,935	234,64	32,713	0.7016
	-1.9368	-0.3117	3,1073	-3,9736	0,3696	-40.719	395,947	235,29	32,881	0.7036
	0.2126	-0.5579	-9,0153	-2,7986	-6,4565	-29.471	-376,177	235,36	32,880	0.7036
	-2.3968	-0.4601	3,7975	-2,4964	39,1215	-58.194	507,067	235,98	33,049	0.7058
	-5.4033	-3.5876	-1,3512	5,7384	-11,5216	-15.922	111,763	237,78	33,560	0.7113
	-3.3149	-3.0817	-8,3263	-4,0419	3,7225	-103.242	-126,992	239,53	34,076	0.7166
	-5.4513	-2.9083	3,6722	-3,2600	-7,5040	-80.630	541,601	239,53	34,076	0.7166
	-1.9379	-2.1588	-8,1041	-4,8743	10,3638	-109.565	-69,878	241,91	34,882	0.7237
	-4.1393	-1.6065	3,6941	-4,2605	5,7377	-80.984	537,369	242,98	35,236	0.7269
	-1.2760	-1.2869	-6,9269	-6,3019	7,3883	-77.235	-94,504	243,97	35,594	0.7297
	-2.9349	-0.8782	3,8685	-5,8915	0,1053	-56.581	340,574	245,51	36,135	0.7342
	1.0152	-0.5494	-7,8022	-5,2167	-1,0320	-81.004	-150,544	245,96	36,317	0.7355
	-1.7139	-0.1710	2,1838	-5,3202	-5,6401	-60.075	438,983	246,95	36,681	0.7384
	0.5142	-0.0185	-7,9933	-2,9940	15,7400	-43.675	-198,865	247,40	36,865	0.7397
	-2.2395	-0.3542	3,5936	-3,0974	-5,7248	-53.100	484,321	249,36	37,604	0.7453
167.1	2.0806	1.9290	1,1555	-5,2716	2,8974	-2.664	7,139	263,24	15,037	0.8915
	2.1742	2.2603	1,1371	-5,8623	4,5596	-5.739	-88,606	256,01	13,875	0.8671
	2.1307	2.2232	1,3139	-6,8663	-20,9168	32.351	-32,726	252,11	13,262	0.8538
	-1.0288	-0.7085	2,3642	1,5657	0,0802	142.934	-10,702	224,76	9,461	0.7612
	-0.4293	-0.4934	1,4515	-0,7137	7,6239	71.331	-4,715	219,89	8,645	0.7447
	-1.0210	-0.8795	1,2725	0,5336	-4,4826	44.889	7,235	213,12	7,567	0.7218
	2.1969	1.7162	1,2670	-4,7719	3,6579	-3.380	35,971	270,99	15,617	0.9178
	2.2780	2.0177	1,4393	-5,6530	-3,9467	59.557	3,171	268,39	15,186	0.9090
	2.2167	2.3983	0,3145	-6,4229	-10,3031	-30.996	-28,565	259,19	13,653	0.8778
	-0.3560	-0.2653	2,1282	-0,9653	-4,0430	279.911	-2,195	205,32	7,164	0.6954
	-0.9764	-1.0119	16,1745	-1,6799	-3,8953	41.129	-5,329	173,61	4,438	0.5880
	-0.7529	-0.6835	9,7660	-3,3543	-0,4653	-44.463	2,483	173,75	4,385	0.5885
167.2	-2.2542	-1.2460	3,7997	-1,3354	-8,7922	72.318	74,856	234,60	28,166	0.7142
	-0.2508	-1.3127	-8,1966	-1,8632	-20,0944	51.006	-425,607	234,60	28,166	0.7142
	-2.4352	-1.2592	4,2474	-3,5099	-9,5892	72.169	31,379	235,23	28,320	0.7162
	-0.1399	-1.1798	-8,2560	-5,0018	2,5655	45.343	-437,759	235,23	28,320	0.7162
	-2.6523	-1.9178	4,9530	-4,4876	-3,4163	-24.294	344,395	237,17	28,856	0.7221
	0.0566	-1.0209	-8,3177	-5,9204	5,9264	36.819	-507,826	238,74	29,331	0.7267
	-2.3355	-0.6084	4,5197	-6,0146	2,2574	2.043	309,930	240,63	29,974	0.7321
	-0.0754	-0.8816	-7,5501	-4,8082	19,8777	52.128	-399,233	242,13	30,461	0.7365
	-2.3331	-0.7788	4,2741	-6,4866	-4,9075	15.076	241,668	245,43	31,619	0.7459
	0.5668	-0.2590	-6,1356	-5,6621	9,5353	34.001	-329,491	247,42	32,466	0.7512
	-0.9346	0.0356	3,2229	-4,3617	-21,5723	18.843	92,899	248,86	33,156	0.7549
	1.1146	1.0796	-1,7432	-5,4007	2,9247	-0.979	2,493	250,51	34,033	0.7588
167.3	-0.6935	-0.2476	-0,9810	-3,8541	10,3155	-9.694	60,173	210,49	22,550	0.6394
	-4.5180	-3.1913	-0,3052	-1,5465	-15,2603	19.916	-31,587	215,96	23,781	0.6563
	0.1288	-0.1222	-4,4236	-2,7325	-2,1749	3.610	-40,869	221,90	25,498	0.6736
	-1.2747	-0.6147	-1,1506	-2,4819	-5,7457	0.857	106,780	225,24	26,535	0.6831

Table 2g

MAXIMUM AND MINIMUM BENDING MOMENT LOADS AT STATION 8 AND SIMULTANEOUS VALUES OF PARAMETERS

FLIGHT AND RUN NO.	B M 8 MULTIPLE OF 10 LOAD	VERT. ACCEL. CG G	AILERON ANGLE DEG	PITCH RATE DEG/S	PITCH ACCEL. DEG/S2	ROLL RATE DEG/S	ROLL ACCEL. DEG/S2	TRUE AIRSPEED M/S	DYNAMIC PRESSURE KN/M2	MACH NUMBER
159.1	-0.1177	-0.2460	1.3937	-0.0687	-2.7668	-3.806	-23.872	364.36	35.461	1.2311
	1.1466	0.2935	1.2755	-0.4298	-2.1458	-2.118	-10.629	383.12	40.467	1.2952
	2.8850	1.1016	1.7637	-0.8783	5.0717	-7.033	-11.203	473.27	73.963	1.6018
	0.6729	-0.3003	1.0852	0.7861	-13.2441	-4.185	-18.929	454.89	61.033	1.5406
	1.6848	0.4694	1.7368	1.2626	13.7938	-2.356	19.133	446.08	53.257	1.5108
	0.4152	-0.1996	1.7399	1.3278	-4.4917	-5.750	-17.945	434.48	45.628	1.4715
	1.3954	0.1879	1.2856	-0.2589	-0.4568	-1.937	-19.449	422.70	37.734	1.4316
163.1	-1.4717	0.1181	5.8333	-1.1066	-1.8512	44.635	29.621	380.46	53.014	1.2335
	6.9457	3.3883	-1.8238	-4.2599	6.4632	-15.637	-18.910	374.96	52.271	1.2158
	3.2558	2.4361	0.9532	-3.7169	11.1382	12.342	-5.292	323.83	29.966	1.0753
	3.4283	3.8300	2.5919	-8.2312	-8.0242	3.622	30.726	344.20	43.638	1.1117
163.2	1.1717	0.8387	-0.3087	-0.4953	2.1960	-10.869	-60.766	228.21	35.526	0.6706
	-0.3267	0.2024	0.4266	0.6831	1.3725	-9.784	95.279	276.70	55.637	0.8117
	1.4170	0.2885	-1.8516	0.7536	-3.7743	-25.718	-24.016	278.90	56.867	0.8177
163.3	0.5751	0.4918	0.7696	1.1338	4.7807	9.501	-20.376	264.63	23.853	0.8500
	-0.5439	0.0685	1.3831	-0.0603	-2.1217	-4.674	8.537	262.54	23.299	0.8438
164.2	5.5392	1.2304	-6.7075	-5.2367	6.0636	-115.119	48.973	284.60	55.124	0.8424
	-4.0028	0.0290	6.4662	0.3717	-2.1951	29.941	379.804	287.00	55.675	0.8505
	3.8254	0.0605	-7.0952	0.5358	5.2367	-123.011	-5.992	301.32	62.598	0.8927
	-3.6783	-0.2533	3.3879	-2.4422	-4.4001	103.700	35.721	300.87	62.646	0.8908
	2.6366	1.7257	-0.3475	-2.6906	-2.0574	-0.900	25.005	289.69	56.455	0.8592
164.3	3.1269	2.6053	0.5017	-6.9586	-2.6577	-0.286	5.937	244.68	30.256	0.7470
	-0.6198	-0.1780	0.0822	0.8921	-0.3104	-0.639	-0.725	239.19	29.492	0.7280
	0.7321	0.7437	0.2154	-1.1015	4.0175	0.190	10.028	249.71	32.613	0.7597
	-0.3895	-0.0683	0.1074	0.6013	-0.4909	-0.217	-7.917	254.33	33.822	0.7742
	3.0446	2.1459	-0.9267	-4.5659	-0.0226	-12.467	-26.390	250.12	31.560	0.7641
	3.6533	3.5937	-0.0913	-7.8678	13.7844	-3.637	-93.814	230.00	26.410	0.7020
164.4	4.5243	4.0746	-2.5681	-6.2445	46.1234	-35.722	-43.016	239.54	31.215	0.7243
	4.6637	4.1126	0.3881	-8.6238	-13.3504	-0.074	25.598	284.80	47.526	0.8587
	4.0640	3.1724	-1.8523	-5.6793	-15.0200	-26.813	26.159	238.75	30.585	0.7233
164.5	2.0298	2.9043	0.8377	-8.9079	3.0582	14.657	-138.872	160.75	13.463	0.4847
	-0.7886	-0.3628	-0.3941	1.8734	3.2615	-5.762	-18.044	182.30	18.011	0.5480
	3.9445	4.0528	1.2767	-7.9591	6.5906	7.300	-35.824	240.72	33.264	0.7233
	4.1431	4.2684	-0.2656	-10.0458	-7.3918	-4.792	188.984	235.40	28.861	0.7157
164.6	2.8949	3.0288	1.3406	-9.4647	6.9394	17.334	-20.345	207.10	22.272	0.6274
	3.3330	0.7120	-11.8530	-0.0033	-0.6134	-40.117	-321.919	262.96	38.249	0.7959
	-6.3759	-1.8655	9.4624	2.2601	-0.5247	-88.971	315.223	270.02	40.074	0.8187
	2.8210	0.4770	-11.3522	-0.9088	6.8285	-48.815	-406.147	277.74	42.818	0.8421
	4.5618	3.5075	-2.5587	-3.5999	-3.9759	-24.919	-75.762	249.49	33.801	0.7556
164.7	2.6919	2.3770	-5.3204	-0.9579	29.9498	-22.086	7.266	172.83	15.744	0.5209
	2.3725	3.6724	1.9226	-12.1766	30.0387	17.532	25.259	181.86	17.831	0.5471
	3.2767	2.9464	-3.2684	-5.3524	26.2403	-11.719	-50.345	190.63	21.283	0.5682
	3.0495	3.3543	1.1231	-5.0029	25.0867	6.816	-59.254	197.30	22.771	0.5885
	-0.9751	-0.2294	1.2831	1.6098	-3.9470	22.904	-1.211	174.19	15.667	0.5261
164.8	-0.7277	-0.1080	0.0000	0.5422	0.0110	2.363	1.968	207.51	21.332	0.6322
	1.0266	1.3603	0.0000	-3.6954	3.3225	2.258	12.057	193.53	18.402	0.5893
	-0.7845	-0.0818	0.0000	-0.0131	-0.5284	-0.408	-8.591	207.23	22.790	0.6262
169.1	2.3376	0.8786	-6.8069	-5.5905	-11.8561	-43.262	25.269	158.92	12.947	0.4799
	2.3411	1.7324	-0.0916	-4.3178	-2.9673	13.001	-68.491	173.11	16.053	0.5206
	-0.5607	0.1016	7.1652	-5.2795	-2.5855	23.519	132.254	163.49	13.025	0.4969
	1.7841	0.5057	-5.6213	-5.2538	-3.6377	15.369	-206.065	165.20	13.427	0.5016
	2.3726	0.4174	-6.6877	-5.5358	3.6408	-86.917	26.599	187.80	17.832	0.5696
	-1.2263	-0.5306	6.9635	-3.1231	-2.6818	87.962	9.309	183.97	16.945	0.5568
	3.0634	0.9544	-5.1220	-7.4954	1.4724	-89.509	-42.262	216.85	24.358	0.6578
165.2	0.4378	0.1530	0.0665	-0.0555	1.4581	5.194	-20.840	215.85	23.782	0.6559
	0.6216	0.2283	-0.2080	-0.6993	-1.5432	4.756	-48.811	246.75	32.475	0.7486
	3.7285	0.7859	-5.9284	-7.1837	-2.3453	-109.953	-110.368	247.76	32.815	0.7516
	-1.7005	-0.1831	6.7448	-3.5524	-5.7734	82.768	-229.199	248.55	32.982	0.7541
	4.6226	0.9316	-6.5298	-6.8524	1.0876	-117.774	39.167	280.12	43.433	0.8499
165.3	2.1378	1.8496	0.2854	-9.3333	6.8637	2.121	-42.603	200.37	20.532	0.6076
	4.4748	2.1992	-5.6831	-11.5025	3.1359	-63.609	74.639	225.61	28.270	0.6793
	-0.9789	-0.0271	8.0139	-5.0355	-6.4418	88.186	-19.177	198.25	21.179	0.5971
165.4	2.9004	2.2405	-0.2805	-13.9062	-3.0546	10.278	-78.701	190.92	18.855	0.5773
	-0.8793	0.0233	7.9179	-3.1003	-2.5862	84.529	73.456	192.13	19.120	0.5813
	2.3579	1.8969	0.7709	-5.8653	5.4804	8.215	24.461	195.55	19.904	0.5915
	1.7030	0.0600	-7.6129	2.5712	18.3635	-21.358	-174.329	194.09	19.308	0.5880
	-1.6472	-0.9692	3.6467	-4.6199	-32.5611	-66.751	226.137	195.77	19.654	0.5932
	2.2213	2.4675	2.2358	-5.9061	53.1993	-27.308	-29.264	195.85	19.811	0.5930
	-1.8037	-0.3448	7.8215	-3.9903	-12.9631	30.157	194.579	207.15	23.191	0.6249
	3.8424	3.6967	1.6205	-9.6293	16.4643	-8.329	39.315	224.42	29.179	0.6725
165.5	0.7252	0.4598	0.2369	-0.2416	0.4941	3.530	11.525	158.77	12.686	0.4804
165.6	2.7711	3.3839	1.4900	-12.4867	-7.0271	13.835	86.180	194.78	20.798	0.5854
	-0.3496	0.1858	5.8936	-0.5386	-1.5338	46.276	6.612	152.09	12.251	0.4572
	4.1635	3.8383	-0.5391	-10.1666	-27.1354	-15.609	-105.904	216.90	27.257	0.6490
	2.5698	1.5653	-1.4090	-3.6611	1.7904	-19.725	-19.504	235.35	31.524	0.7074
165.7	3.9982	4.8867	2.1637	-7.4470	44.6589	19.105	-126.480	245.14	33.267	0.7399
	3.0124	3.0657	-1.9710	-14.5593	-55.2022	-5.669	-16.111	175.84	16.380	0.5296
	2.0601	1.9665	0.0554	-2.9859	1.7327	-0.783	28.911	112.27	6.183	0.3396
	-0.0186	-0.1164	-0.2625	-6.7930	-1.9252	-12.290	-13.849	165.50	14.807	0.4969
	0.1160	0.1622	0.0802	0.7110	3.4332	4.624	104.059	175.94	16.969	0.5279
166.1	1.5804	-0.0206	-8.4011	-3.9758	9.7355	-31.058	-204.112	196.29	22.203	0.5866
	-2.6967	-0.5723	3.8578	-3.3920	-4.1349	-54.083	318.905	197.51	22.471	0.5903
	0.8507	-0.5787	-8.9721	-3.0230	1.4323	-30.043	-175.599	197.01	22.336	0.5889
	-2.8697	-0.7869	3.9621	-6.0015	-9.4968	-62.995	342.201	198.23	22.604	0.5926
	-5.2218	-2.7927	0.1851	-1.9217	29.4680	-60.516	148.676	203.27	23.839	0.6078
	-2.2041	-2.4500	-8.8816	-5.8162	11.4398	-96.804	-14.947	203.45	23.933	0.6082
	-3.1269	-1.9799	3.9016	-4.4034	7.1071	-90.404	328.398	203.45	23.933	0.6082
	-0.8712	-1.4842	-8.5393	-3.4718	8.7602	-103.343	-40.999	208.07	25.178	0.6219
	-4.1053	-1.2890	4.0595	-2.9102	-8.7345	-84.549	376.495	208.07	25.178	0.6219
	0.1402	-0.9068	-8.3790	-1.9737	9.2093	-95.853	-69.490	211.39	26.163	0.6316
166.2	1.4571	-0.4196	-8.3945	-2.9586	-7.6477	-84.203	-110.360	234.64	32.713	0.7016
	-2.8362	-0.3117	3.1073	-3.9736	0.3696	-40.719	395.947	235.29	32.881	0.7036
	-4.8125	-1.9526	1.3690	2.4630	52.4119	-56.646	273.823	236.60	33.218	0.7077
	-4.4810	-2.1714	0.4962	-1.4545	20.5682	-47.306	137.671	239.53	34.076	0.7166
	-5.3071	-1.6281	3.6103	-4.3930	12.2455	-91.050	372.705	241.91	34.882	0.7237
	-2.4972	-1.1057	-0.4726	-6.0249	-6.5464	-78.205	125.581	242.98	35.236	0.7269
	-4.2357	-1.7409	1.8205	-0.3314	-13.4654	-14.224	274.373	243.97	35.594	0.7297
	1.1636	-0.6538	-7.9659	-4.5792	-5.3835	-34.800	-272.955	245.51	36.135	0.7342
	-2.5902	-0.1004	2.3072	-5.2999	1.7534	-55.853	419.492	245.96	36.317	0.7355
	2.0795	0.0196	-7.9621	-3.1343	20.8684	-41.734	-115.925	246.95	36.681	0.7384
	-3.4161	-0.3537	3.6360	-3.0417	-1.5121	-57.964	497.387	249.36	37.604	0.7453
167.1	1.8410	2.2949	0.9506	-6.3676	30.5878	-26.511	-38.483	260.02	14.502	0.8806
	-0.9307	-0.7594	2.4956	1.5370	-2.6279	112.937	-2.017	224.76	9.461	0.7612
	-0.2457	-0.5287	1.5905	0.6405	3.1573	45.569	-0.909	218.05	8.329	0.7385
	-0.8656	-0.8286	0.7745	-0.5679	-2.9263	45.948	-3.229	213.48	7.566	0.7230
	1.9047	1.9426	1.6385	-5.4548	-2.8654	58.643	47.803	277.70	16.944	0.9405
	-0.2321	-0.2653	2.1281	-0.9653	-4.0430	279.913	-2.195	268.39	15.186	0.9090
	0.3232	0.3456	5.2504	4.9888	-2.5124	173.132	-20.406	205.32	7.164	0.6954
	0.1172	0.1341	0.1635	-4.1966	9.2122	29.209	-4.435	216.31	8.184	0.7326
	0.3689	-0.0198	1.2641	-0.9296	0.4909	2.086	-13.451	191.26	5.803	0.6477
	-0.1179	-0.2629	0.0924	-3.7840	-5.3136	-47.293	15.927	422.70	37.734	1.4246
167.2	-2.7370	-0.7972	4.1847	-1.1912	2.0521	38.193	206.948	234.57	28.167	0.7141
	1.1583	-1.3127	-8.1966	-1.8632	-20.0944	51.006	-425.607	234.60	28.166	0.7142
	-3.2766	-0.7409	4.9674	-3.2048	-6.6593	4.141	292.663	234.66	28.166	0.7144
	1.1701	-1.3938	-8.2844	-4.8504	-35.7188	53.537	-351.749	235.23	28.320	0.7162
	-3.7293	-0.9178	4.9530	-4.4876	-3.4163	-24.294	344.395	237.17	28.856	0.7221
	1.5544	-0.9810	-8.3585	-5.9744	11.0637	41.883	-454.770	238.74	29.331	0.7267
	-3.3210	-0.6684	4.5197	-6.0146	2.2574	2.043	309.930	240.63	29.974	0.7321
	1.2923	-1.0652	-7.5777	-5.0806	-0.6416	60.227	-392.359	242.13	30.461	0.7365
	-3.2717	-0.7788	4.2741	-6.4866	-4.9075	15.076	241.668	245.43	31.619	0.7439
	1.7777	-0.2590	-6.1356	-5.6621	9.5353	34.001	-329.491	247.42	32.466	0.7512
	-1.9019	0.0356	3.2229	-4.3617	-21.5723	18.843	92.899	248.86	33.156	0.7549
	1.4111	1.1131	-1.5827	-5.5492	5.2528	0.708	14.203	250.51	34.033	0.7588
167.3	-0.4248	-0.3689	-1.9257	-4.2769	0.0257	-10.502	48.436	211.58	22.822	0.6427
	-4.3899	-3.1913	-0.3052	-1.5466	-13.2603	19.915	-31.587	216.03	23.781	0.6563
	-0.1405	-0.4348	-3.7277	-1.9986	3.3375	-5.989	-12.992	223.77	26.088	0.6789
	-1.2216	-0.5726	-1.2891	-2.4555	3.3684	-6.072	57.497	224.79	26.385	0.6819

Table 3

PARAMETRIC FORMULAE FOR STAGE 1 ANALYSIS

Station No.	Parametric formula	Total correlation coefficient	Standard deviation of error % of rms BM
2	$BM_2 = 0.9699\ddot{z}_s + 6.955 \times 10^{-3}\xi q + 2.385 \times 10^{-3}\ddot{\phi}$	0.9902	14
	$BM_2 = 0.9180\ddot{z}_s + 9.817 \times 10^{-3}\xi q$	0.9828	19
	$BM_2 = 1.1663\ddot{z}_s$	0.8426	55
3	$BM_3 = 0.7182\ddot{z}_s + 3.945 \times 10^{-3}\xi q + 0.6377\dot{\theta}q/V_t$	0.9823	19
	$BM_3 = 1.0963\ddot{z}_s + 4.465 \times 10^{-3}\xi q$	0.9757	22
	$BM_3 = 1.1833\ddot{z}_s$	0.9512	31
4	$BM_4 = 0.9826\ddot{z}_s + 5.889 \times 10^{-3}\xi q + 2.412 \times 10^{-3}\ddot{\phi}$	0.9800	20
	$BM_4 = 0.9423\ddot{z}_s + 9.028 \times 10^{-3}\xi q$	0.9709	24
	$BM_4 = 1.1545\ddot{z}_s$	0.8434	54
5	$BM_5 = 0.6059\ddot{z}_s - 4.265 \times 10^{-3}\xi q - 0.15270\dot{\theta}q/V_t$	0.9820	20
	$BM_5 = 0.6224\ddot{z}_s - 4.380 \times 10^{-3}\xi q$	0.9814	20
	$BM_5 = 0.6106\ddot{z}_s$	0.9473	33
6	$BM_6 = 1.3263\ddot{z}_s - 8.458 \times 10^{-3}\xi q - 2.597 \times 10^{-3}\ddot{\phi}$	0.9834	19
	$BM_6 = 1.3812\ddot{z}_s - 11.286 \times 10^{-3}\xi q$	0.9759	22
	$BM_6 = 1.3176\ddot{z}_s$	0.8119	60
7	$BM_7 = 1.8736\ddot{z}_s - 5.453 \times 10^{-3}\xi q + 0.7153\dot{\theta}q/V_t$	0.9693	25
	$BM_7 = 1.6849\ddot{z}_s - 4.956 \times 10^{-3}\xi q$	0.9578	29
	$BM_7 = 1.6657\ddot{z}_s$	0.9218	39
8	$BM_8 = 1.2048\ddot{z}_s - 8.108 \times 10^{-3}\xi q - 3.124 \times 10^{-3}\ddot{\phi}$	0.9667	26
	$BM_8 = 1.2433\ddot{z}_s - 10.522 \times 10^{-3}\xi q$	0.9546	30
	$BM_8 = 1.2727\ddot{z}_s$	0.8119	59

Table 4

PARAMETRIC FORMULAE FOR STAGE 2 ANALYSIS

Station No.	Parametric formula	Total correlation coefficient	Standard deviation of error % of rms BM
5	$BM_5 = 0.777\ddot{z}_{CG} - 3.861 \times 10^{-3}\xi q - 6.784 \times 10^{-3}\ddot{\theta} + 0.26792 \times 10^{-3}\ddot{\phi} + 1.9579M\ddot{z} - 3.9275M + 2.5649M^2 + 1.4573$	0.9900	13.9
	$BM_5 = 1.0202\ddot{z}_{CG} - 3.9083 \times 10^{-3}\xi q + 0.7283M^2 + 0.3396$	0.9859	16.3
	$BM_5 = 1.0242\ddot{z}_{CG} + 0.14209$	0.9458	31.4
6	$BM_6 = 1.060\ddot{z}_{CG} - 8.3477 \times 10^{-3}\xi q - 10.02 \times 10^{-3}\ddot{\theta} - 2.1796 \times 10^{-3}\ddot{\phi} + 2.1248M\ddot{z} - 4.2985M + 0.29745M^2 + 1.2768$	0.9862	16.6
	$BM_6 = 1.3434\ddot{z}_{CG} - 10.045 \times 10^{-3}\xi q + 1.0749M^2 - 8.628$	0.9777	20.8
	$BM_6 = 1.30611\ddot{z}_{CG} + 0.026132$	0.8099	57.6
7	$BM_7 = 0.94947\ddot{z}_{CG} - 3.592 \times 10^{-3}\xi q - 9.6056 \times 10^{-3}\ddot{\theta} - 1.6748 \times 10^{-3}\ddot{\phi} + 0.3435M\ddot{z} - 3.962M + 2.7473M^2 + 1.0073$	0.9801	20.3
	$BM_7 = 1.2148\ddot{z}_{CG} - 4.7098 \times 10^{-3}\xi q + 0.9548M^2 - 0.9116$	0.9724	23.5
	$BM_7 = 1.2126\ddot{z}_{CG} - 0.2746$	0.9258	37.8
8	$BM_8 = 0.5964\ddot{z}_{CG} - 7.7496 \times 10^{-3}\xi q - 13.664 \times 10^{-3}\ddot{\theta} + 2.69537 \times 10^{-3}\ddot{\phi} + 0.90148M\ddot{z} - 0.71427M + 3.3289M^2 + 1.5873$	0.9763	21.9
	$BM_8 = 1.2687\ddot{z}_{CG} - 9.6272 \times 10^{-3}\xi q + 1.17137M^2 - 0.9790$	0.9605	27.7
	$BM_8 = 1.2937\ddot{z}_{CG} - 0.17554$	0.8052	58.6
	7-PARAMETER FORMULA FOR STATION 5 CHOSEN BY REGRESSION (SEE APPENDIX C)		
5	$BM_5 = 0.8256\ddot{z}_{CG} - 4.2164 \times 10^{-3}\xi q - 0.9111 \times 10^{-3}\dot{\theta}\frac{q}{V_t} - 0.07646 \times 10^{-3}\dot{\phi}\frac{q}{V_t} - 4.0503M + 2.724M^2 + 0.2361M^2\ddot{z} + 1.30862$	0.9919	12.5

Table 5

CALIBRATION FLIGHT GAUGE RESPONSE

Flight No.	Height (ft)	IAS (kn)	Port stations			Starboard stations				Case
			SG2	SG3	SG4	SG5	SG6	SG7	SG8	
160	10000	350	146.0	111.5	93.9	184.3	122.5	97.0	70.7	3g turn - port
			157.0	124.4	107.8	189.3	118.5	102.9	72.4	3g pull out
			138.3	104.8	87.8	181.2	117.9	90.9	68.4	
			134.9	102.5	84.2	174.3	117.4	90.0	67.4	
			135.2	105.8	87.6	174.6	175.3	91.3	66.5	
			134.0	105.3	85.6	179.2	120.6	94.2	69.3	Turn
161	10000	350	136.5	101.7	-	147.3	100.4	68.1	49.4	Turn
			123.6	93.5	-	167.9	108.2	76.2	54.0	Turn
163	10000	350	131.7	113.0	-	179.4	129.9	91.9	68.1	Turn
			148.7	113.9	-	168.0	114.5	80.26	57.8	Turn port
164	10000	350	128.3	111.1	-	162.2	113.2	83.8	60.4	Turn
			118.5	90.8	-	158.5	99.7	69.9	51.5	
165	9000	350	133.8	105.7	-	182.8	127.2	89.8	66.2	Turn port
			125.8	100.2	-	180.9	127.5	85.3	65.7	Turn starboard
166	10000	350	136.9	107.1	-	173.0	125.8	87.3	64.8	Turn port
			134.8	103.5	-	164.8	117.3	80.6	60.5	Turn starboard
167	10000	350	136.4	105.1	-	162.9	114.3	81.2	56.8	Turn
			124.4	95.0	-	164.3	114.8	77.1	56.5	Turn
168	10000	350	143.7	100.5	87.4	154.3	107.0	77.4	48.5	
			-	97.1	71.9	176.3	139.8	96.0	79.1	
			123.9	97.0	82.4	154.8	108.5	76.7	52.3	
Mean of flights	10000	350	134.62	104.3	87.6	170.5	117.2	85.1	62.2	
160	10000	450	129.9	111.6	87.3	178.4	119.0	97.6	68.0	
			142.1	118.7	95.9	182.6	115.5	101.1	69.5	5 g
			126.9	109.8	88.6	181.2	119.5	98.0	69.5	Pull up 5 g
			127.7	103.1	81.7	173.9	106.8	90.0	69.3	Turn port 5 g
			131.9	110.3	82.5	180.5	101.5	98.6	67.2	Turn starboard 5 g
168	10000	450	130.5	95.8	82.3	124.4	-	-	-	
			117.4	114.3	95.2	171.0	115.9	92.9	-	
Mean of flights	10000	450	129.5	109.1	87.6	170.3	113.3	96.3	68.3	
Mean of all Table 5 flight			128.5	105.5	87.6	170.45	116.3	87.5	63.4	

LIST OF SYMBOLS

BM_2-BM_8	bending moments at stations 2-8 in multiples of 1 g load
M	Mach number
p_s	static pressure (N/m^2)
p_{tot}	total pressure (N/m^2). Equal to $p_s\left[1 + \frac{\gamma - 1}{2} M^2\right]^{\gamma/(\gamma-1)}$
q	dynamic pressure (kN/m^2). Difference between total and static pressures $(p_{tot} - p_s)$. (Not kinetic pressure, $\frac{1}{2}\rho V_t^2$)
V_t	true airspeed (m/s)
$\ddot{z}$	kinematic normal acceleration (g)
γ	specific heat ratio for air
$\dot{\theta}$	pitch rate (degree/s). Positive, aircraft nose pitching down (nonstandard sign)
$\ddot{\theta}$	pitch acceleration $(degree/s^2)$. (Same sense as for $\dot{\theta}$)
ξ	aileron angle (degree). Positive, starboard aileron up (nonstandard sense)
$\dot{\phi}$	roll rate (degree/s). Positive, rolling to starboard
$\ddot{\phi}$	roll acceleration $(degree/s^2)$
subscripts CG	at the centre of gravity
s	at a position 355 cm forward of the centre of gravity

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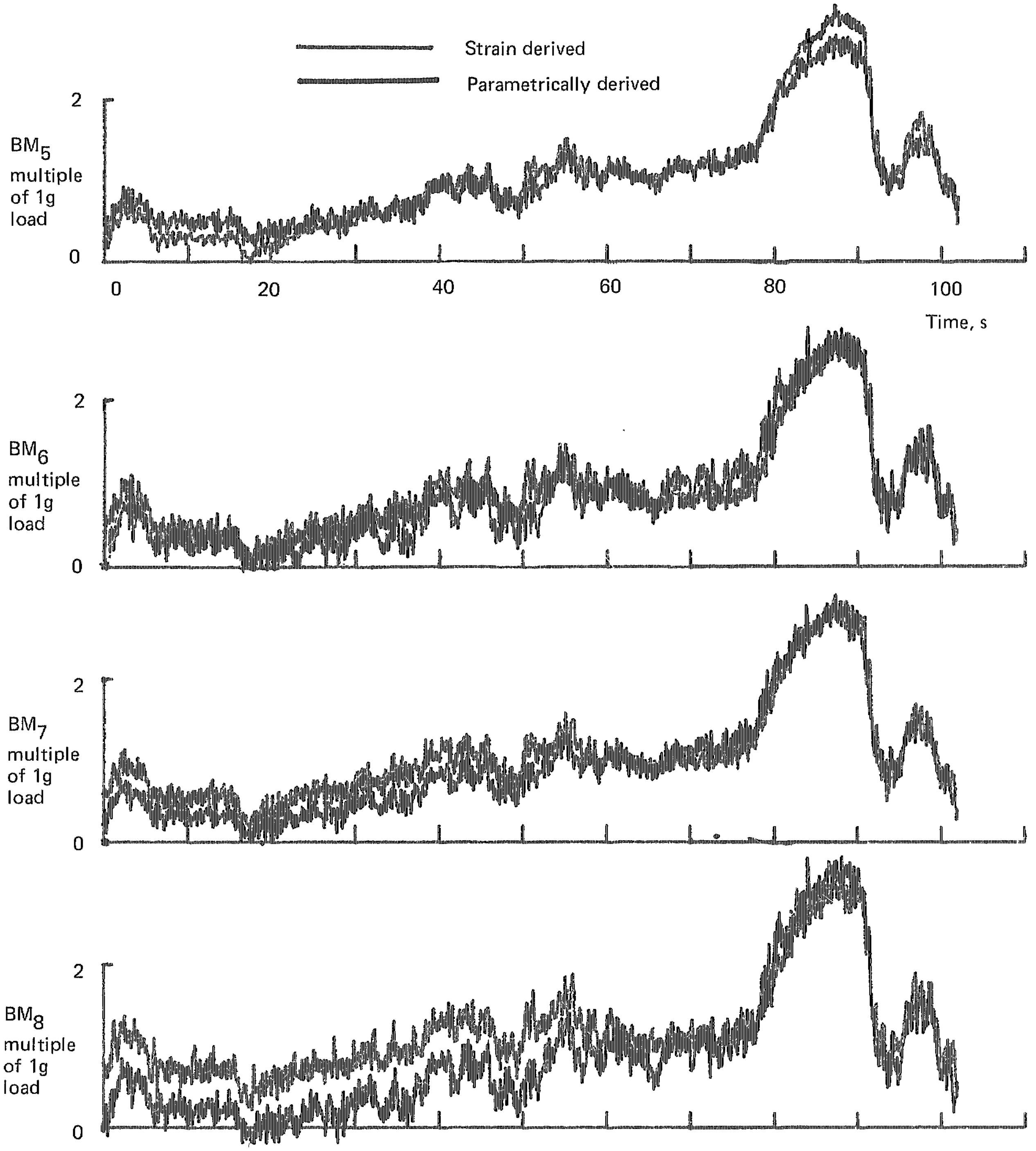
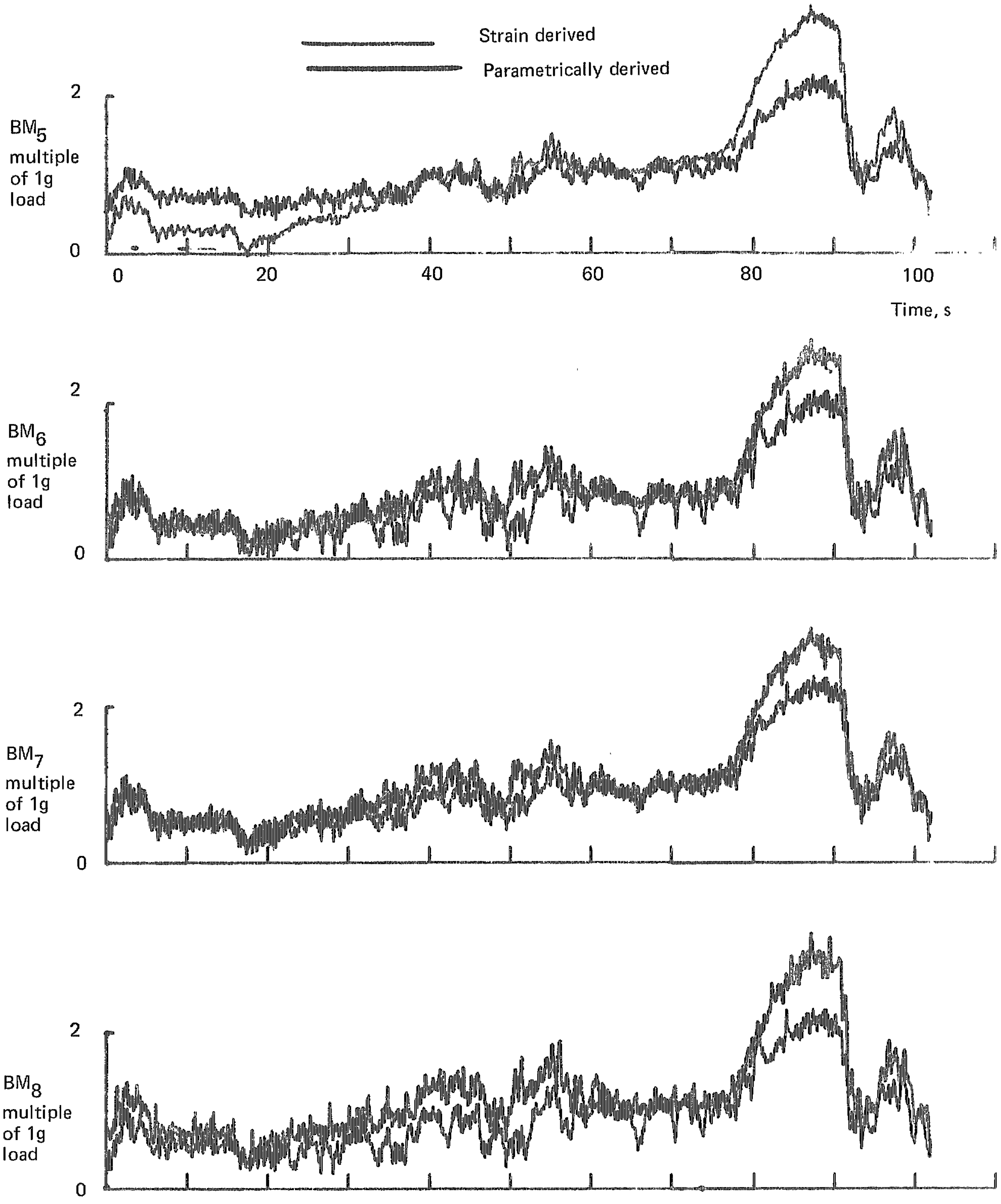


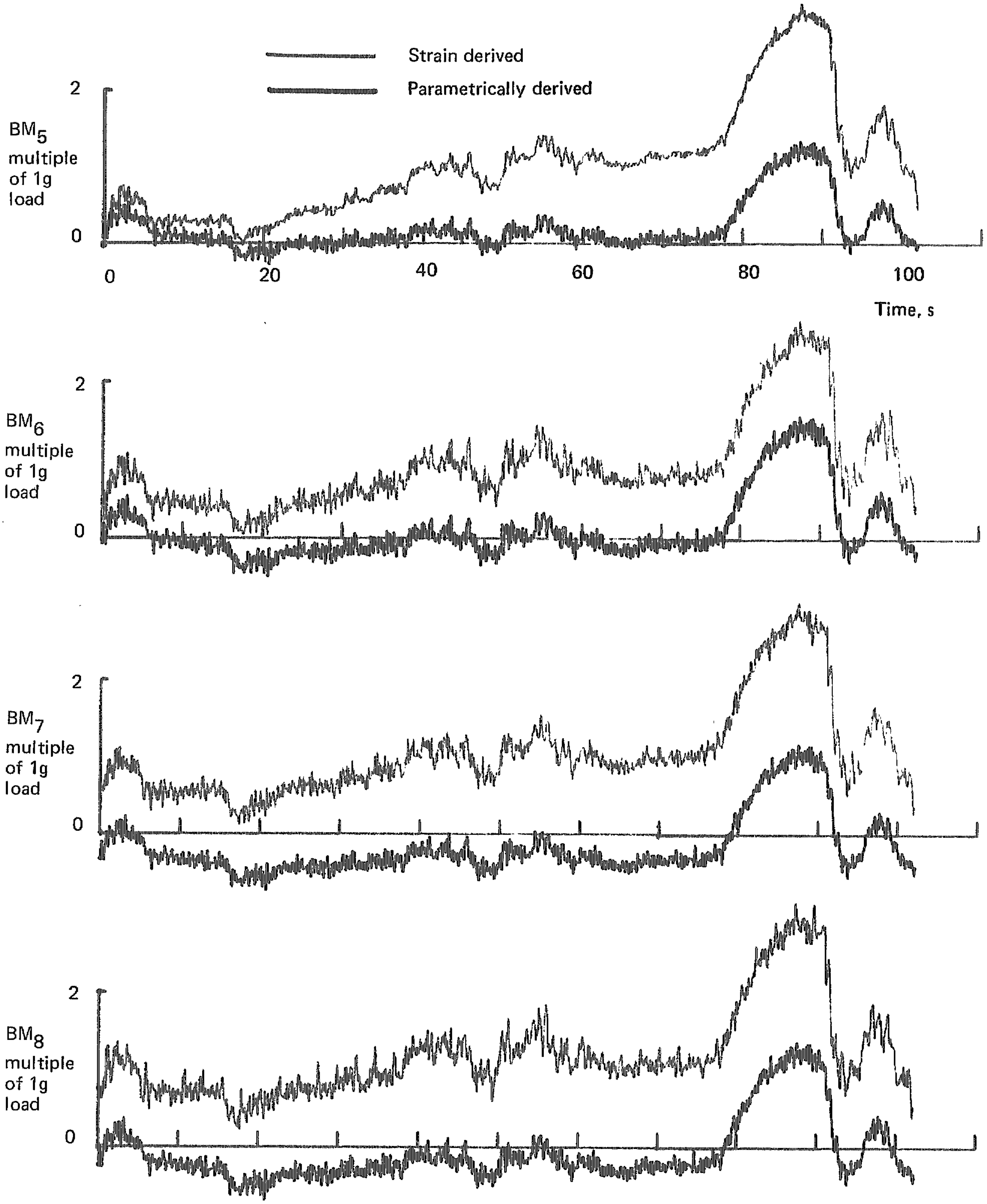
a. Flight 159 run 1. High Mach number longitudinal manoeuvring, 36000 ft, M = 1.2 to 1.6. 7-parameter formulae

Fig 3 Time histories of parametrically derived and strain derived bending moment loads for formulae containing 7, 3 and 1 parameters



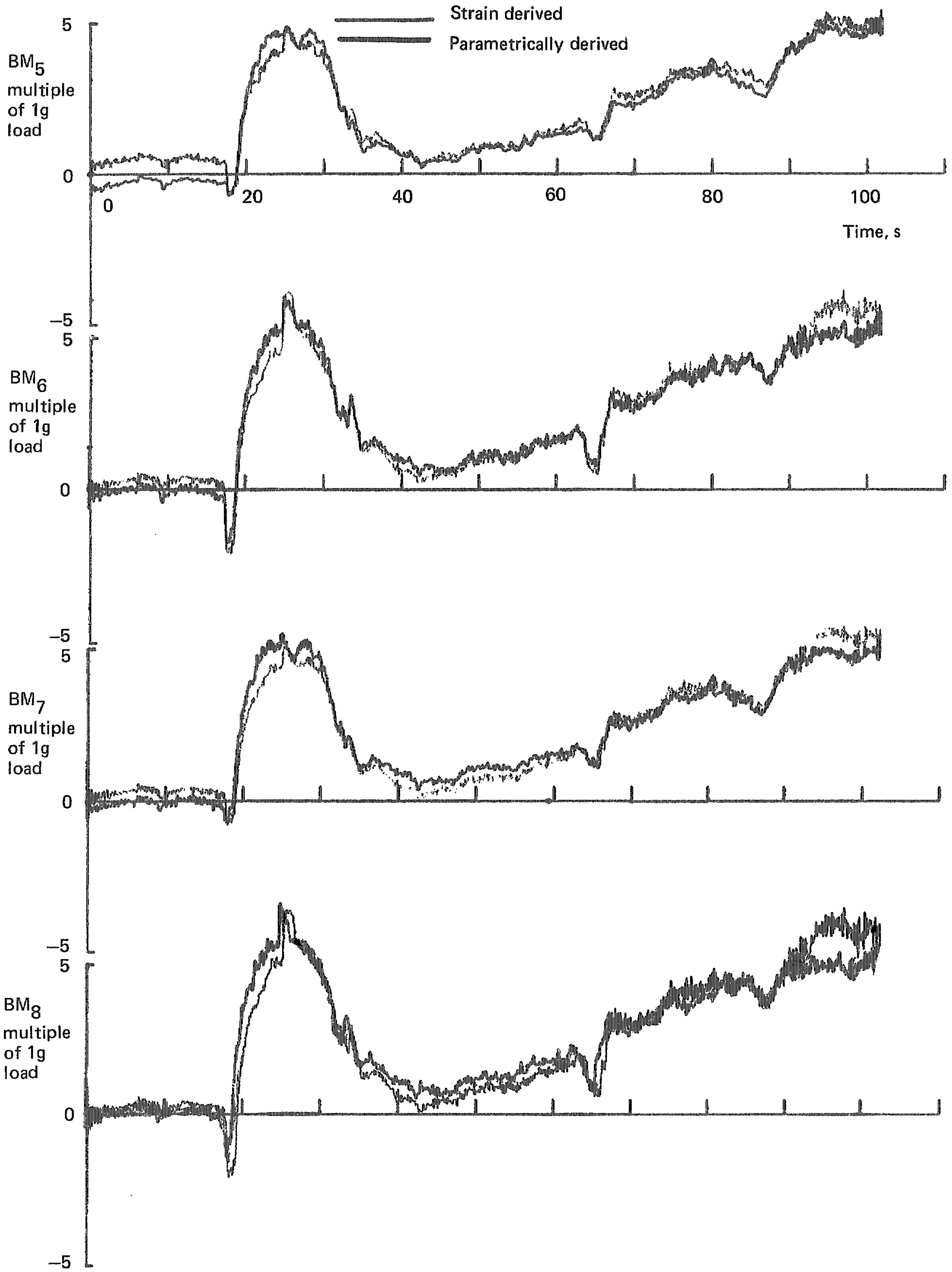
a. Flight 159 run 1. 3-parameter formulae

Fig 3 contd



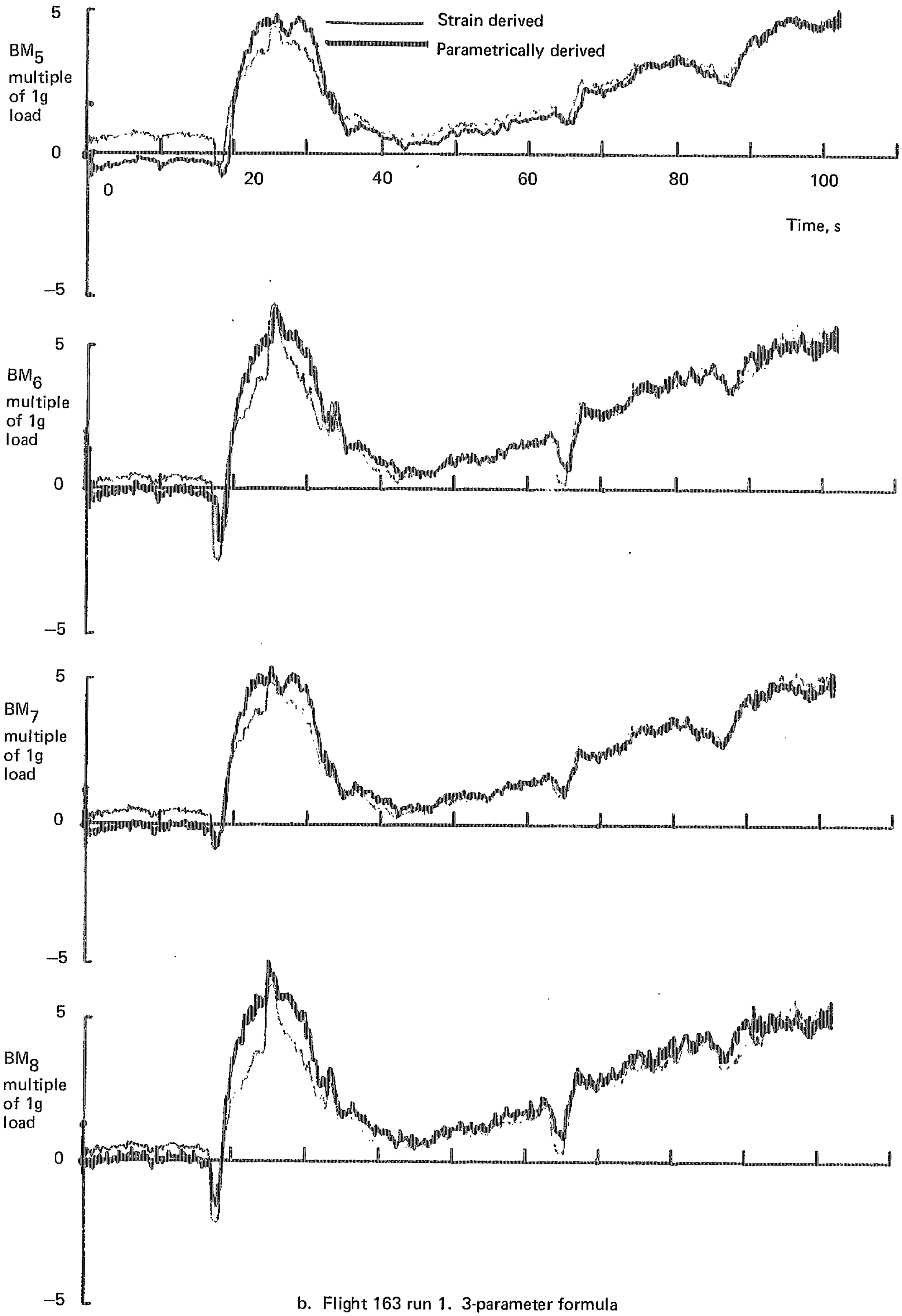
a. Flight 159 run 1. 1-parameter formulae

Fig 3 contd



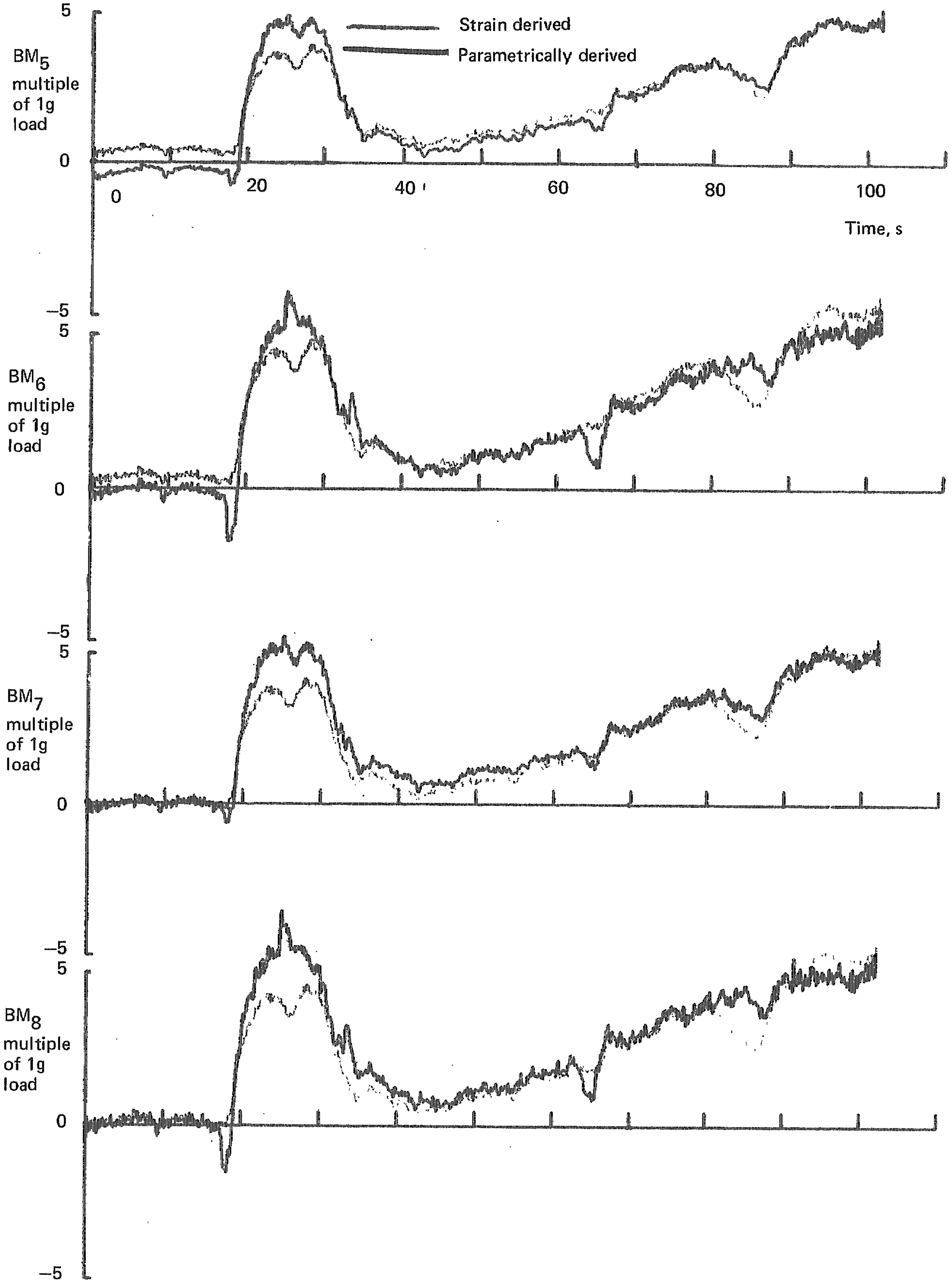
b. Flight 163 run 1. Supersonic manoeuvres, 25000 ft, M = 1.0 to 1.2. 7-parameter formula

Fig 3 contd



b. Flight 163 run 1. 3-parameter formula

Fig 3 contd



b. Flight 163 run 1. 1-parameter formulae ($\ddot{z}_{cg}$)

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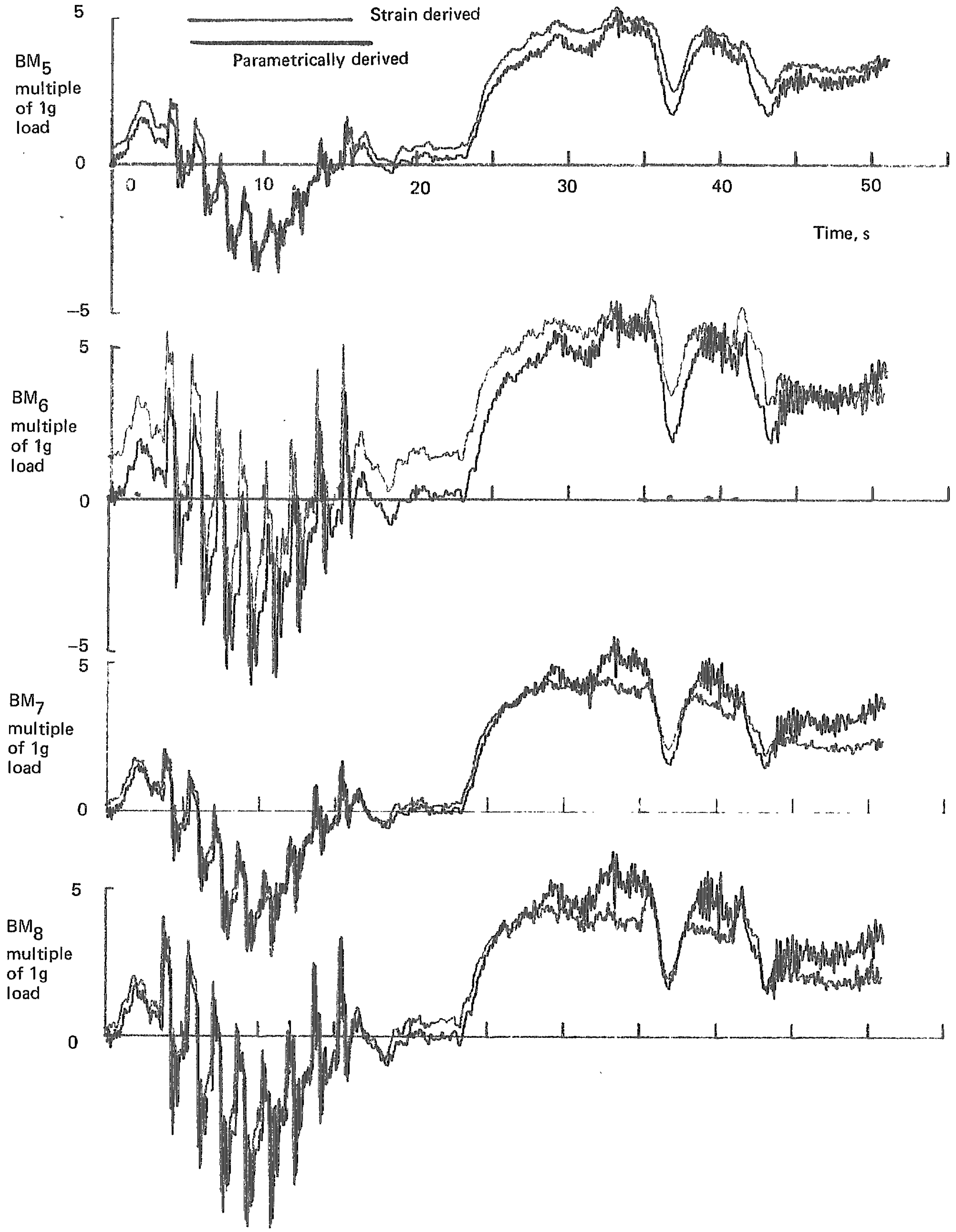
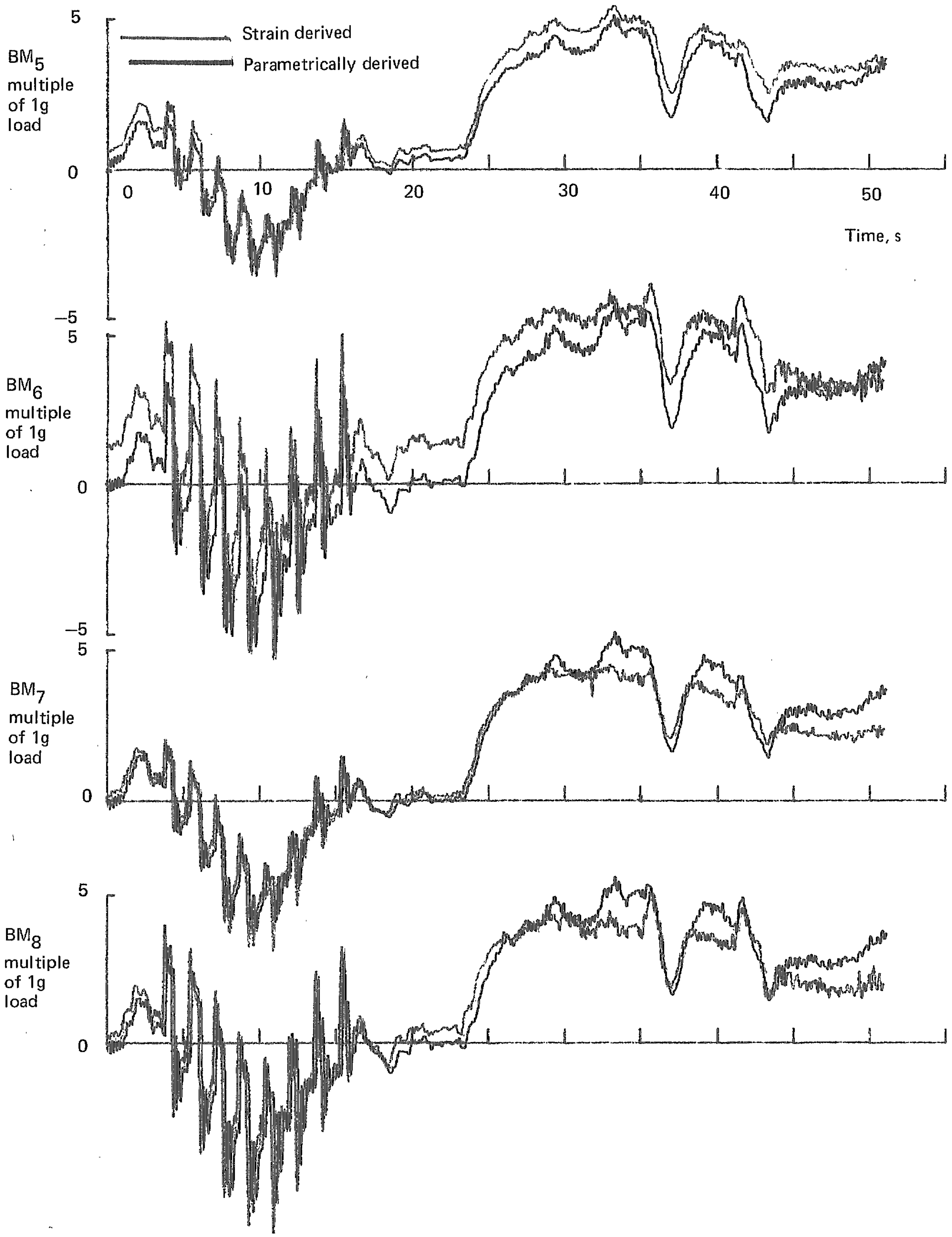


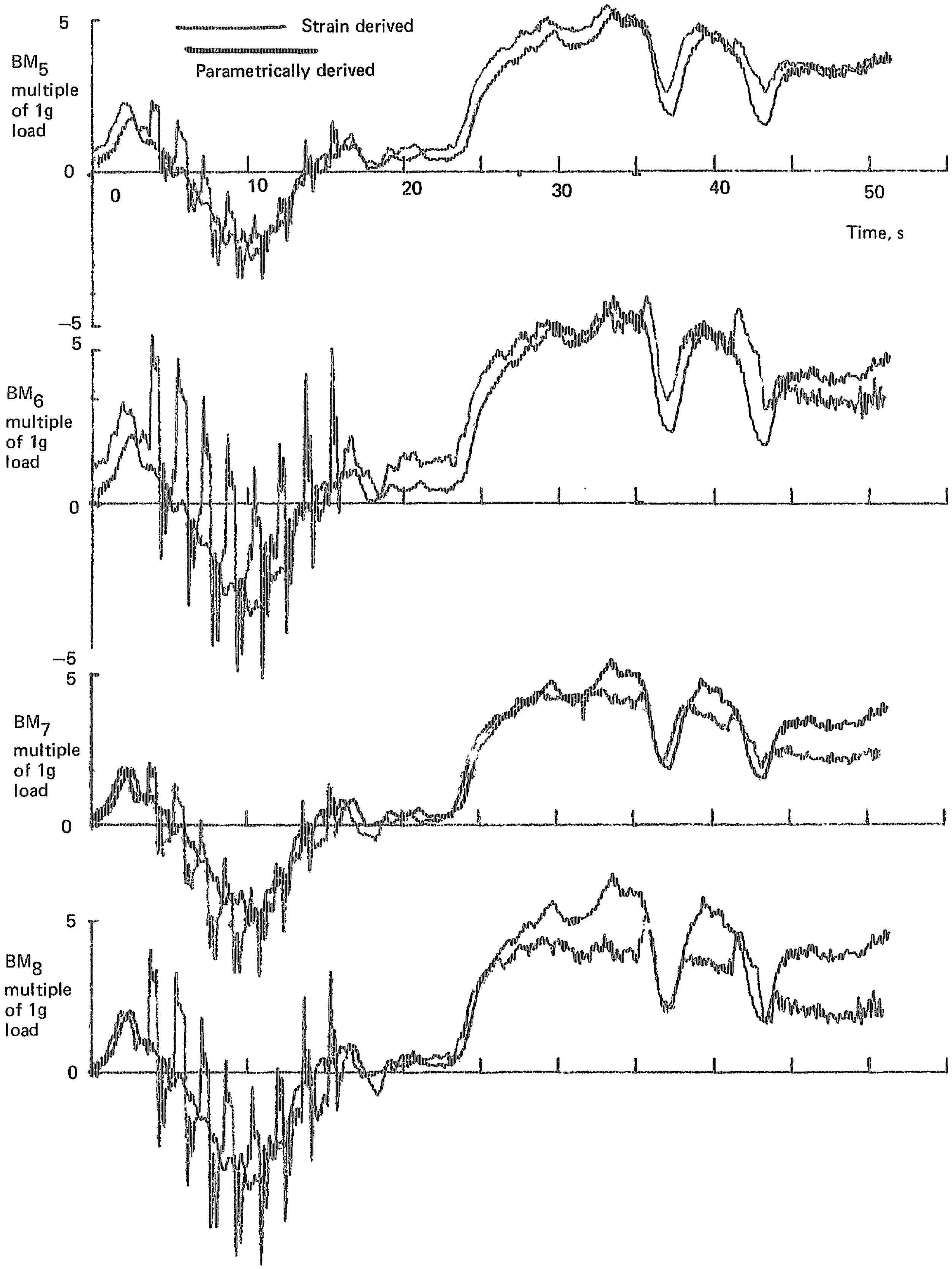
c. Flight 164 run 6. Hesitation roll and g manoeuvre with aileron, 9000 ft (approx), 450 kn IAS (approx) 7-parameter formulae

Fig 3 contd



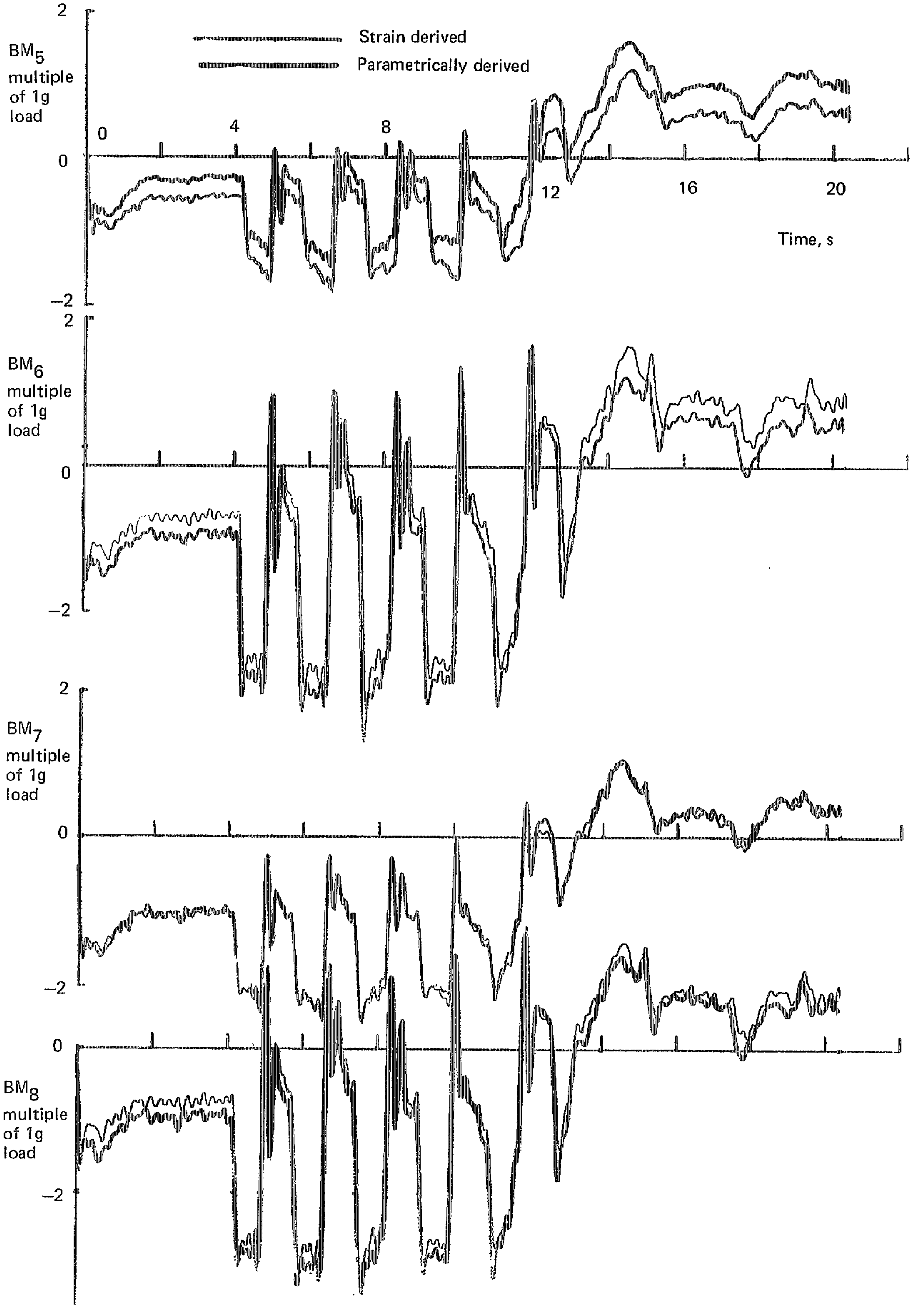
c. Flight 164 run 6. 3-parameter formulae

Fig 3 contd



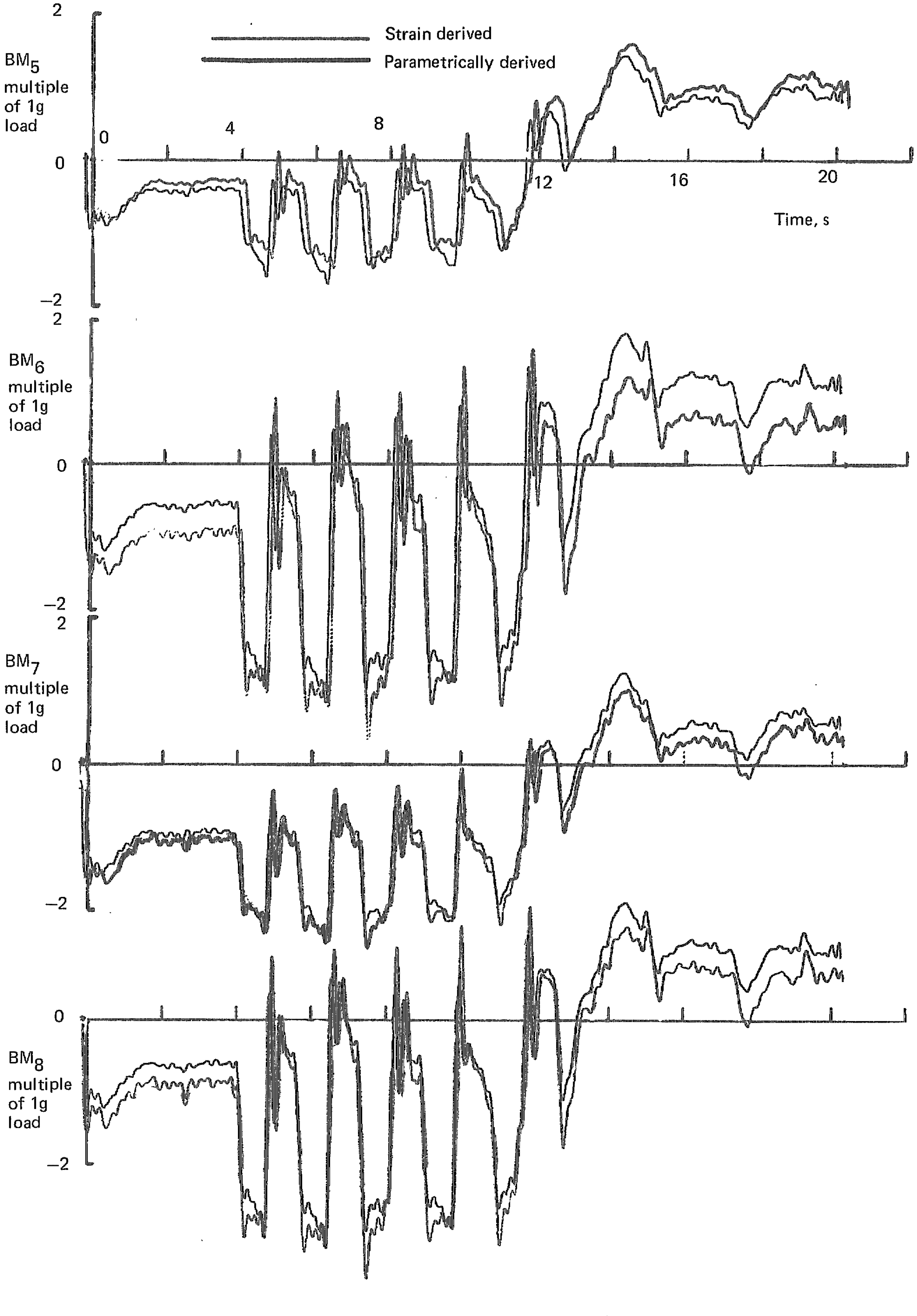
c. Flight 164 run 6. 1-parameter formulae ($\ddot{z}_{cg}$)

Fig 3 contd



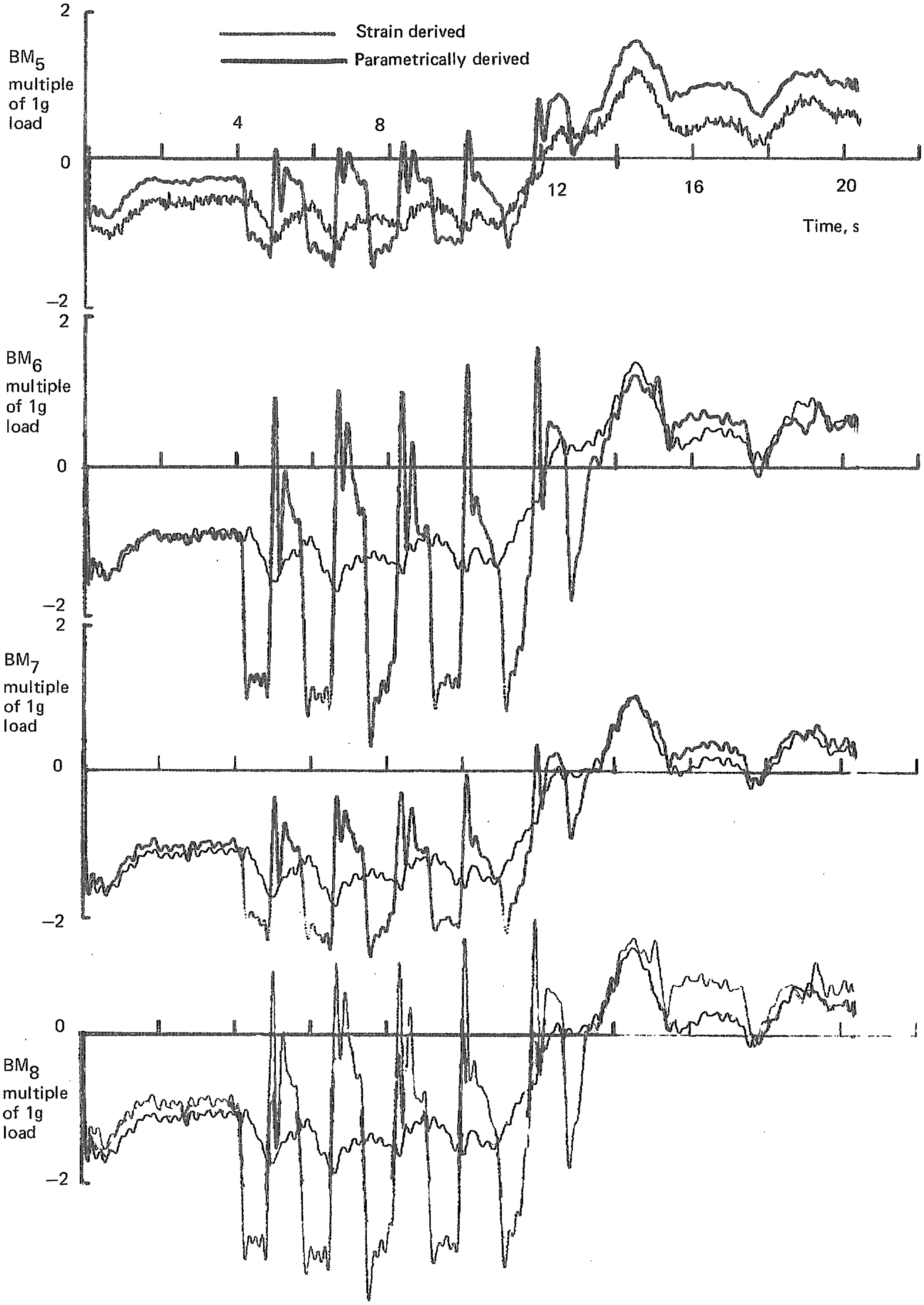
d. Flight 167 run 2. Hesitation roll, 10000 ft, 400 kn IAS. 7-parameter formulae

Fig 3 contd



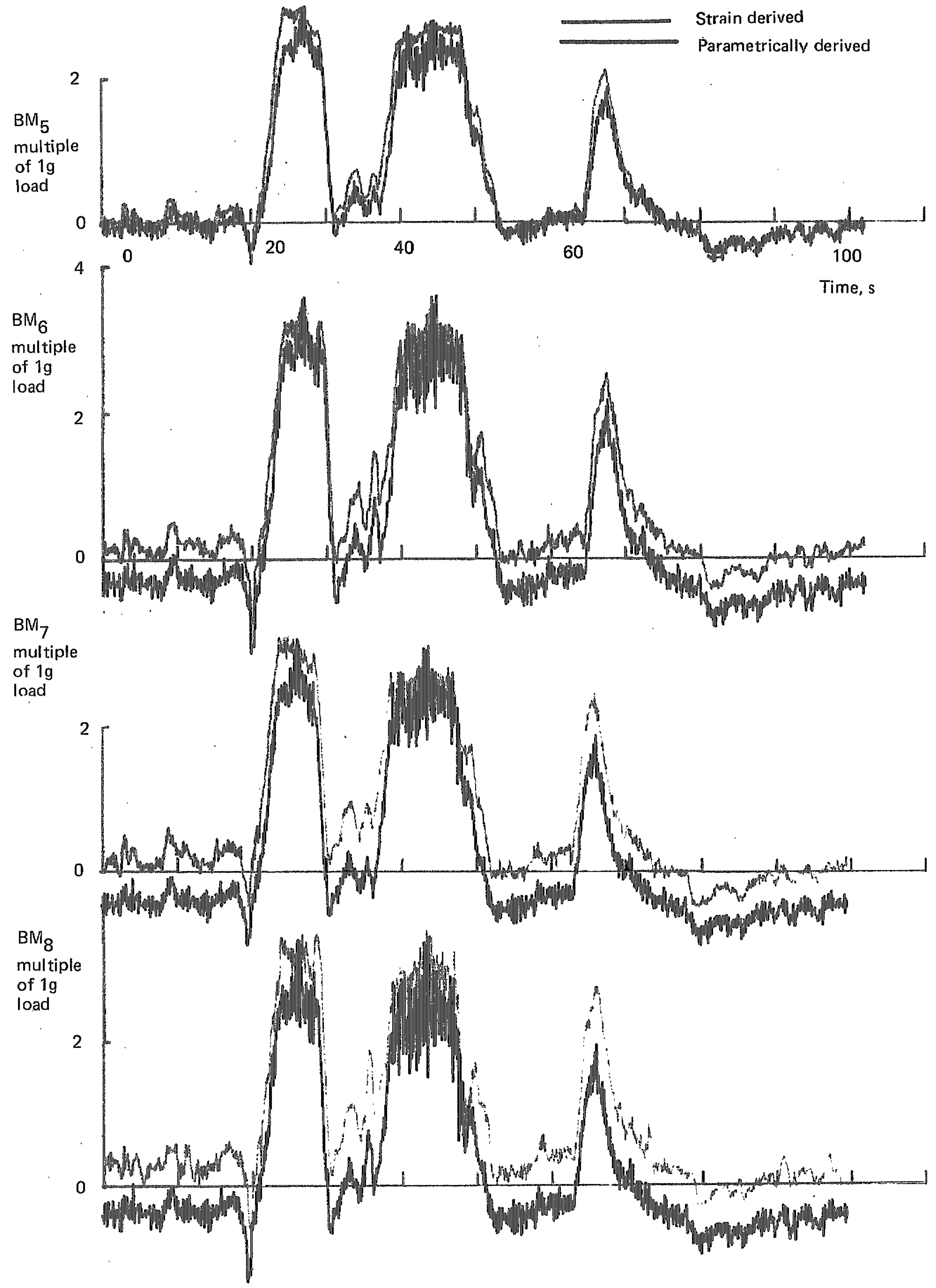
d. Flight 167 run 2. 3-parameter formulae

Fig 3 contd



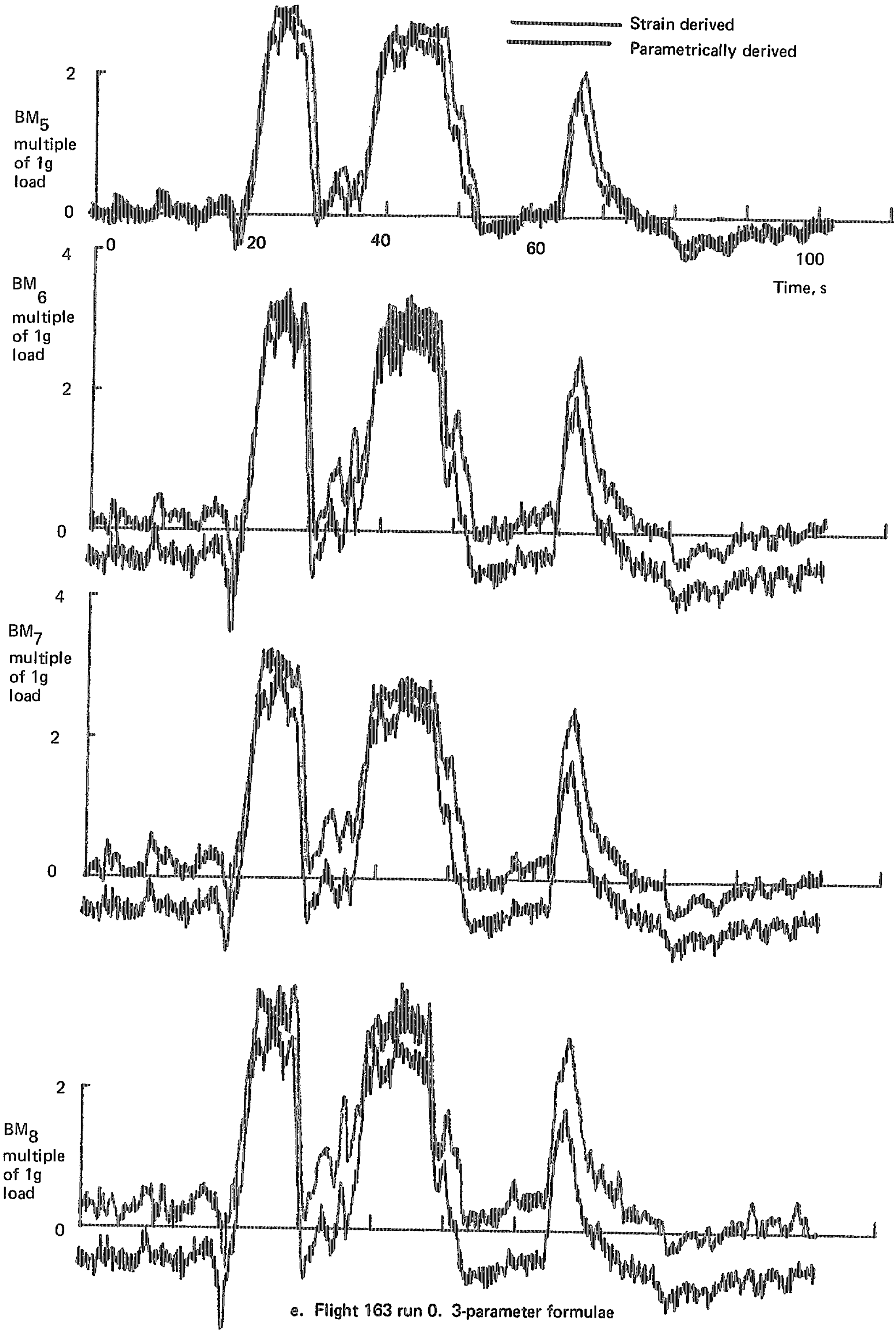
d. Flight 167 run 2. 1-parameter formulae ($\ddot{z}_{cg}$)

Fig 3 contd



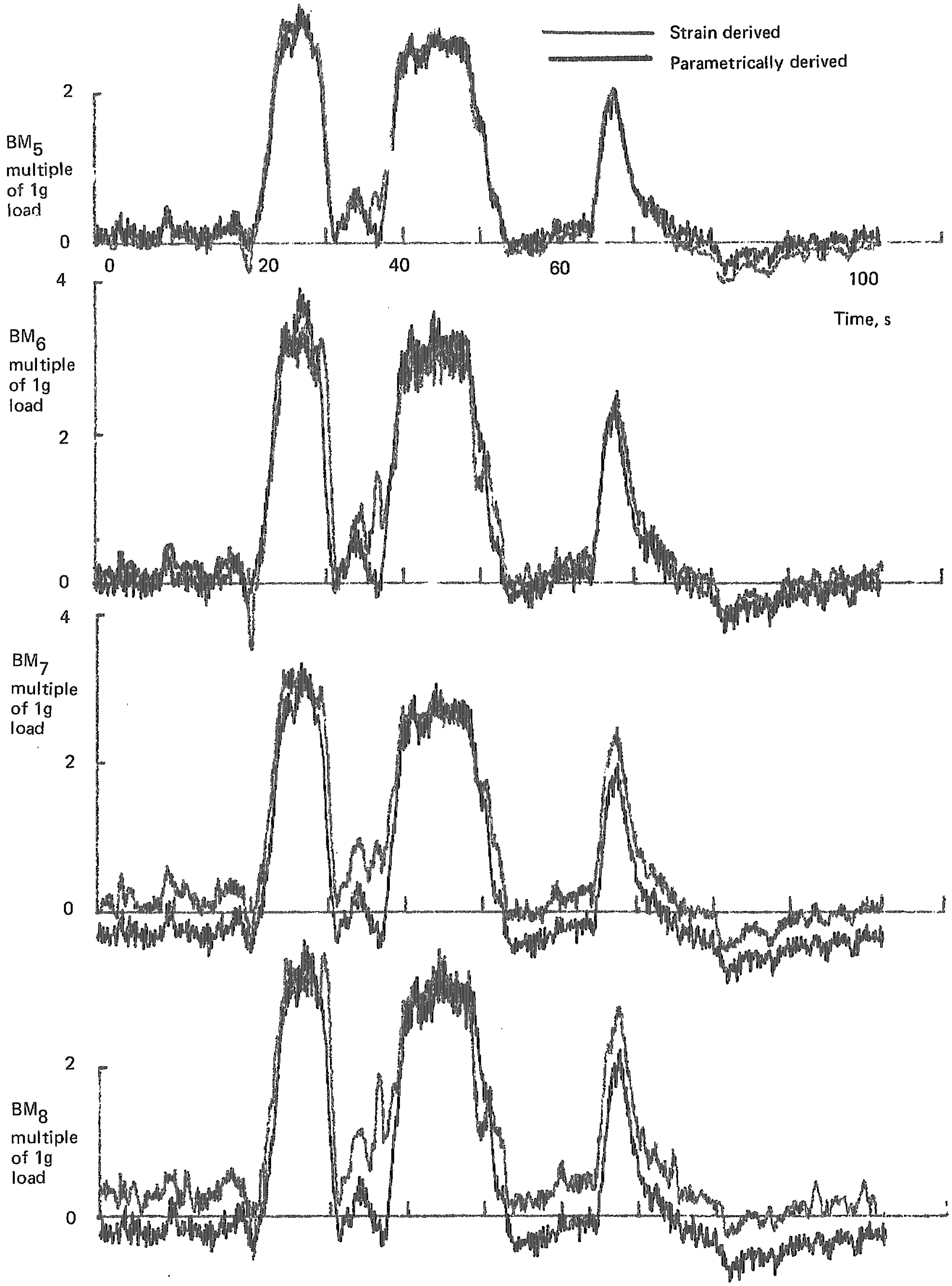
e. Flight 163 run 0. 3.5g turns port and starboard, 10000 ft, 350 kn IAS. 7-parameter formulae

Fig 3 contd



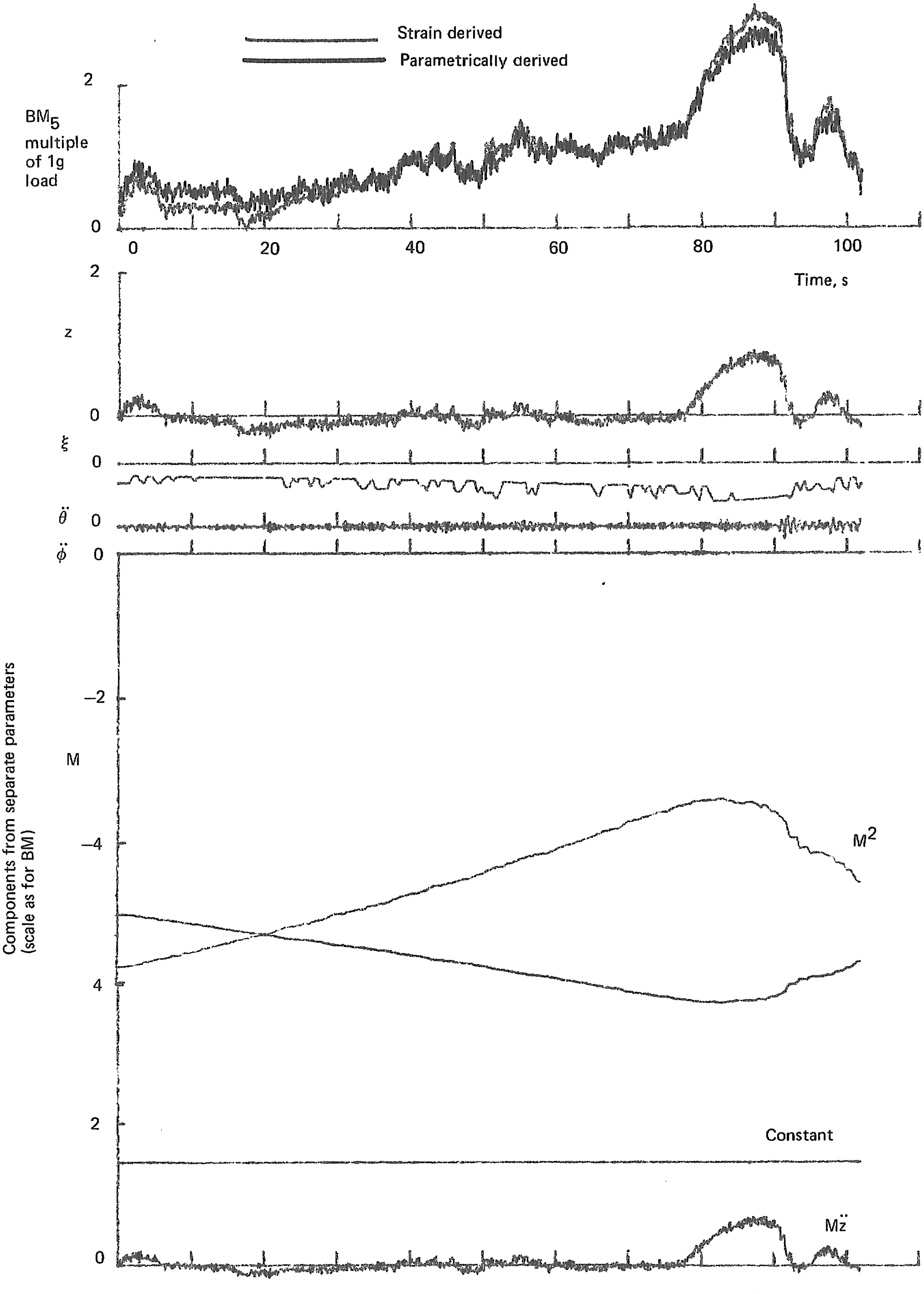
e. Flight 163 run 0. 3-parameter formulae

Fig 3 contd



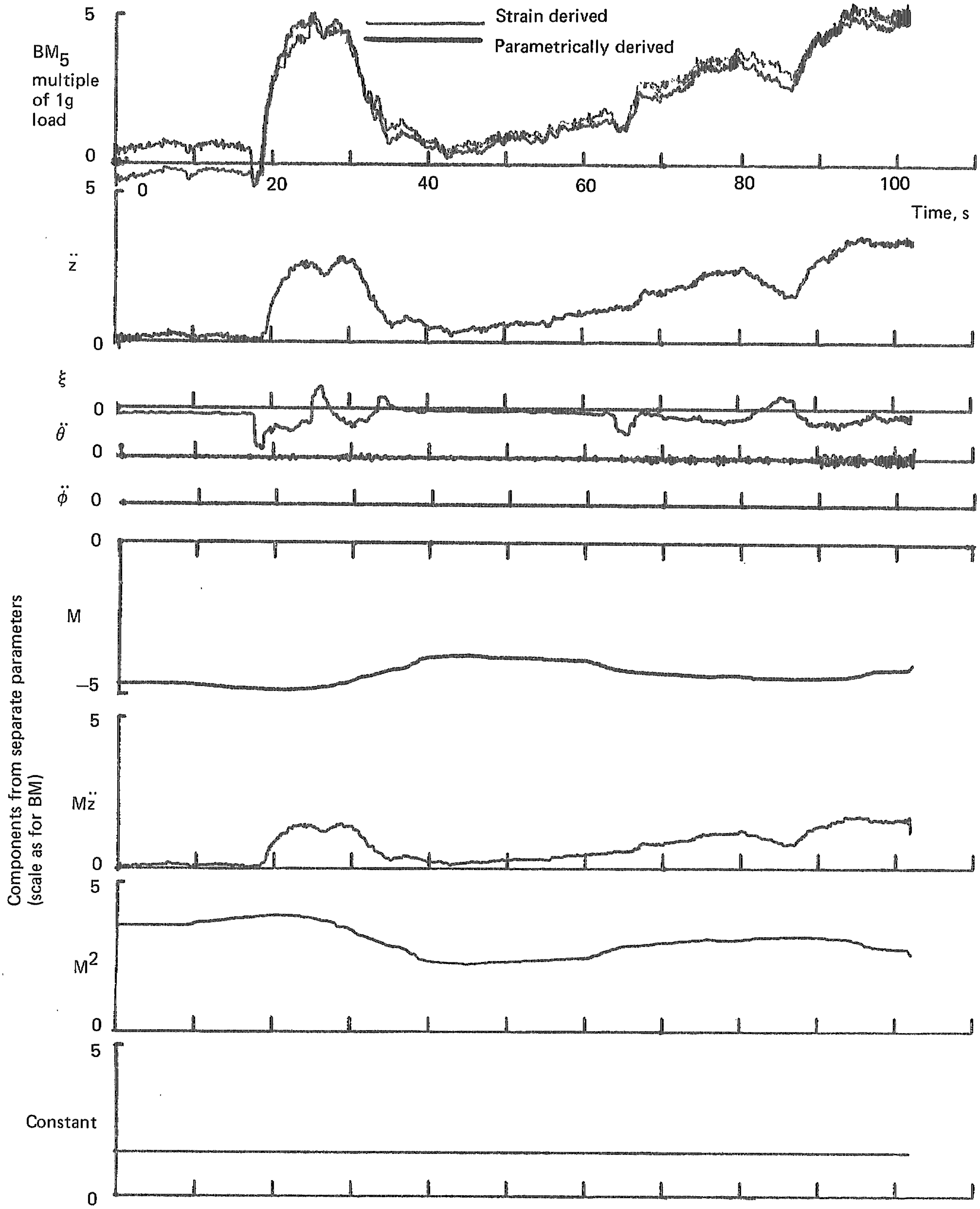
e. Flight 163 run 0. 1-parameter formulae ($\ddot{z}_{cg}$)

Fig 3 concld



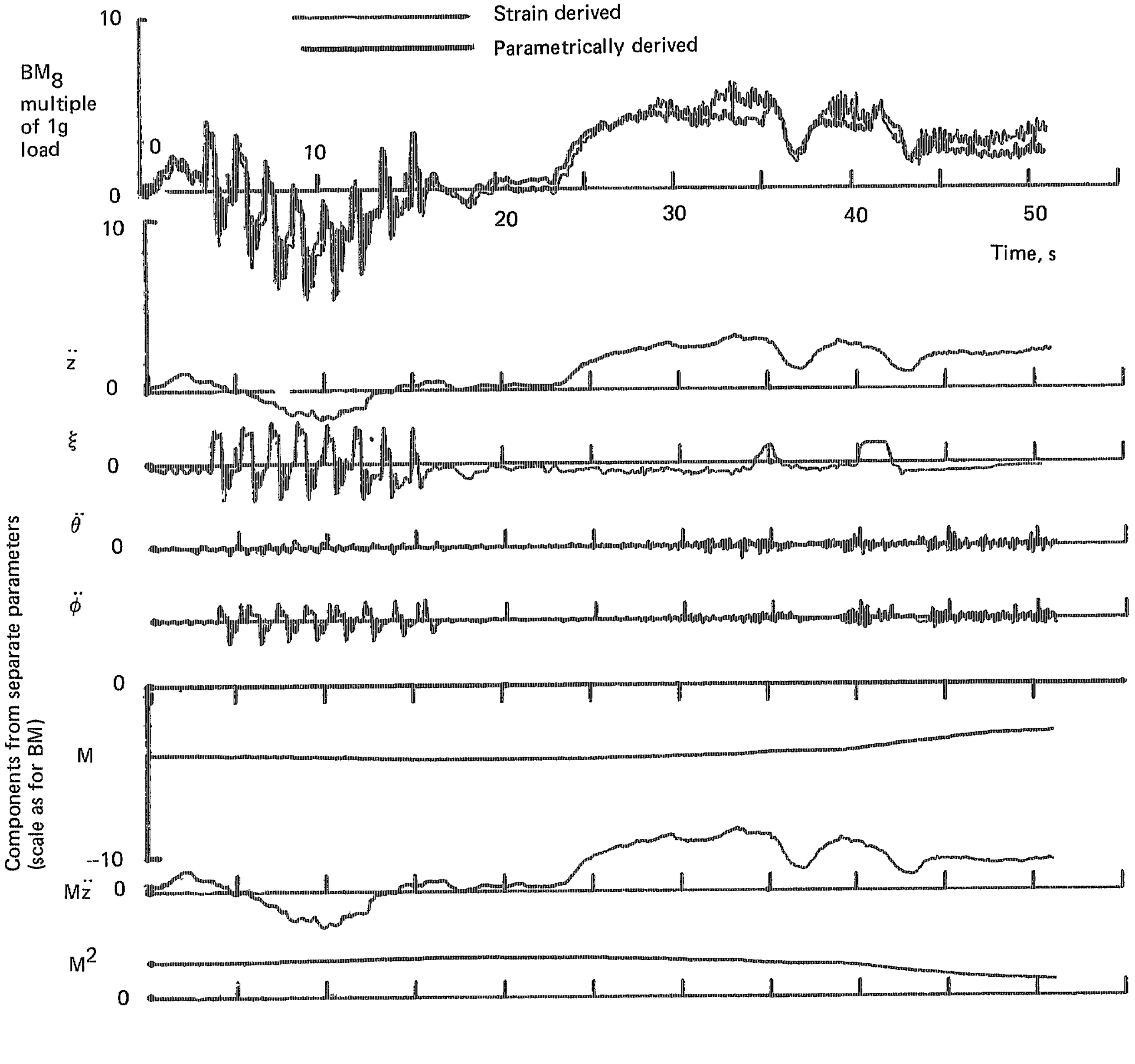
a. Flight 159 run 1. High Mach number longitudinal manoeuvring, 36000 ft, M = 1.2 to 1.6

Fig 4 Separate parametric components in 7-parameter formulae

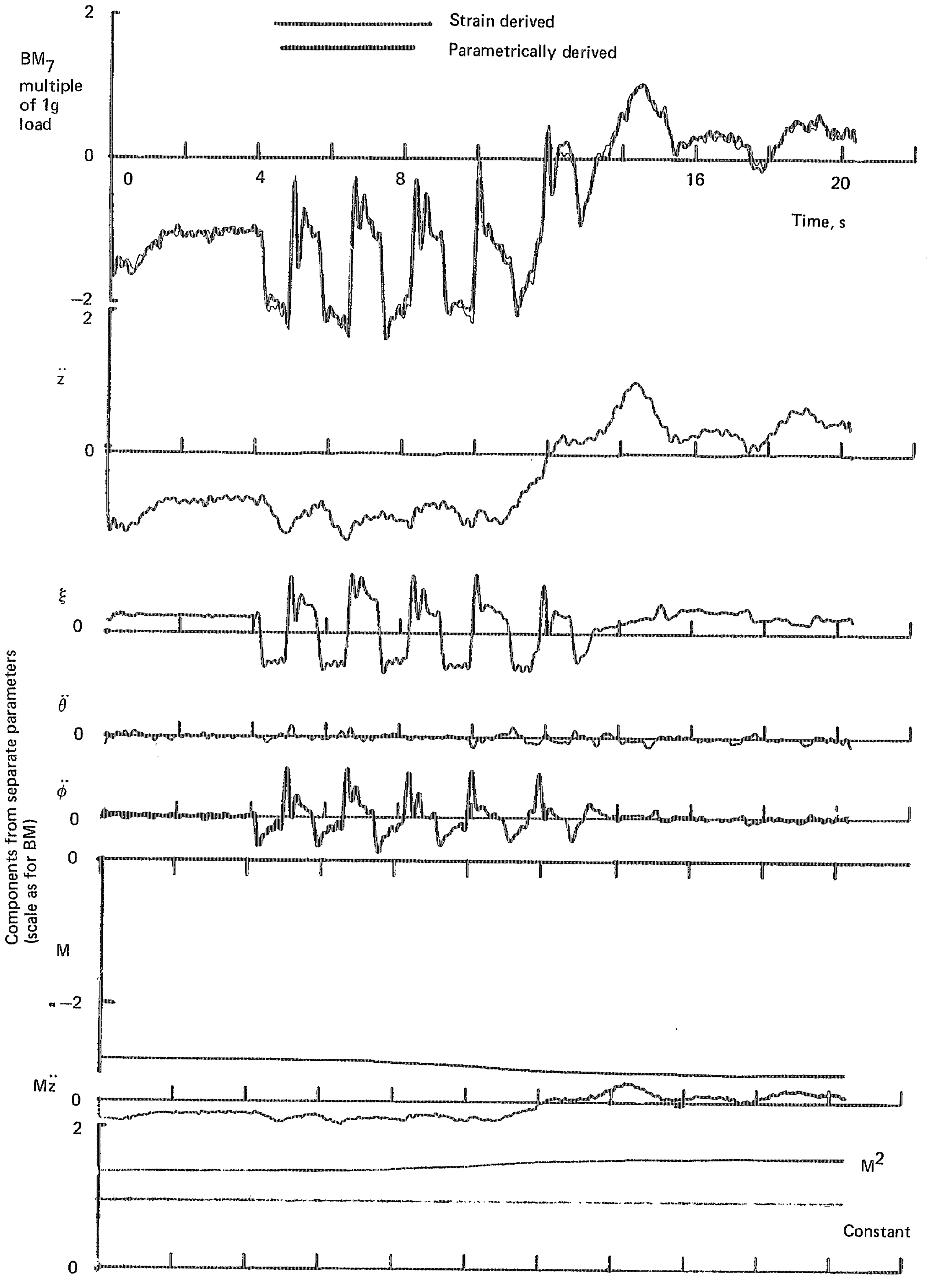


b. Flight 163 run 1. Supersonic manoeuvres, 25000 ft, M = 1.0 to 1.2

Fig 4 contd

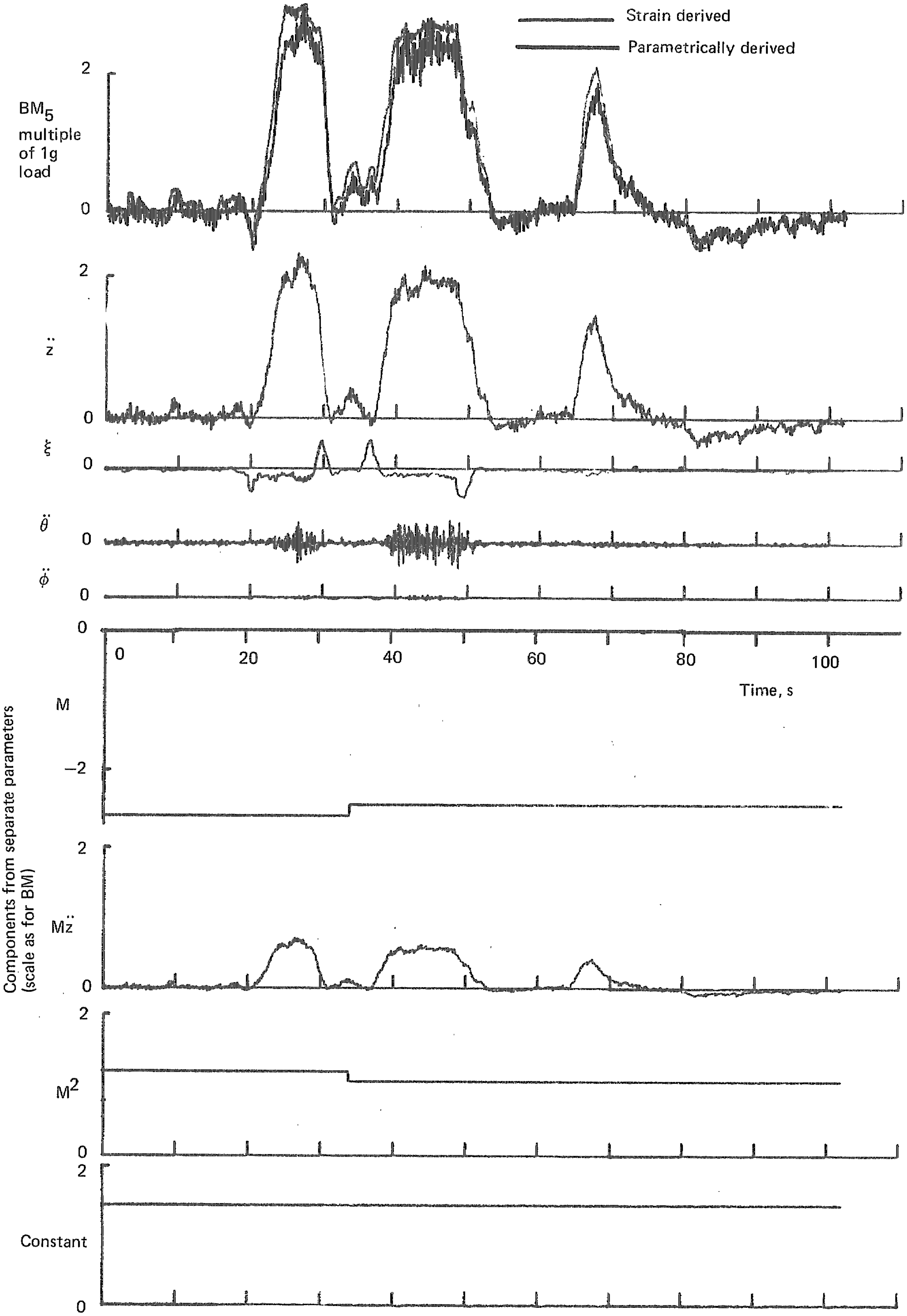


c. Flight 164 run 6. Hesitation roll and g manoeuvre with aileron, 9000 ft (approx), 450 kn IAS (approx)



d. Flight 167 run 2. Hesitation roll, 10000 ft, 400 kn

Fig 4 contd



e. Flight 163 run 0. 3.5g turns port and starboard, 10000 ft, 350 kn IAS

Fig 4 concld

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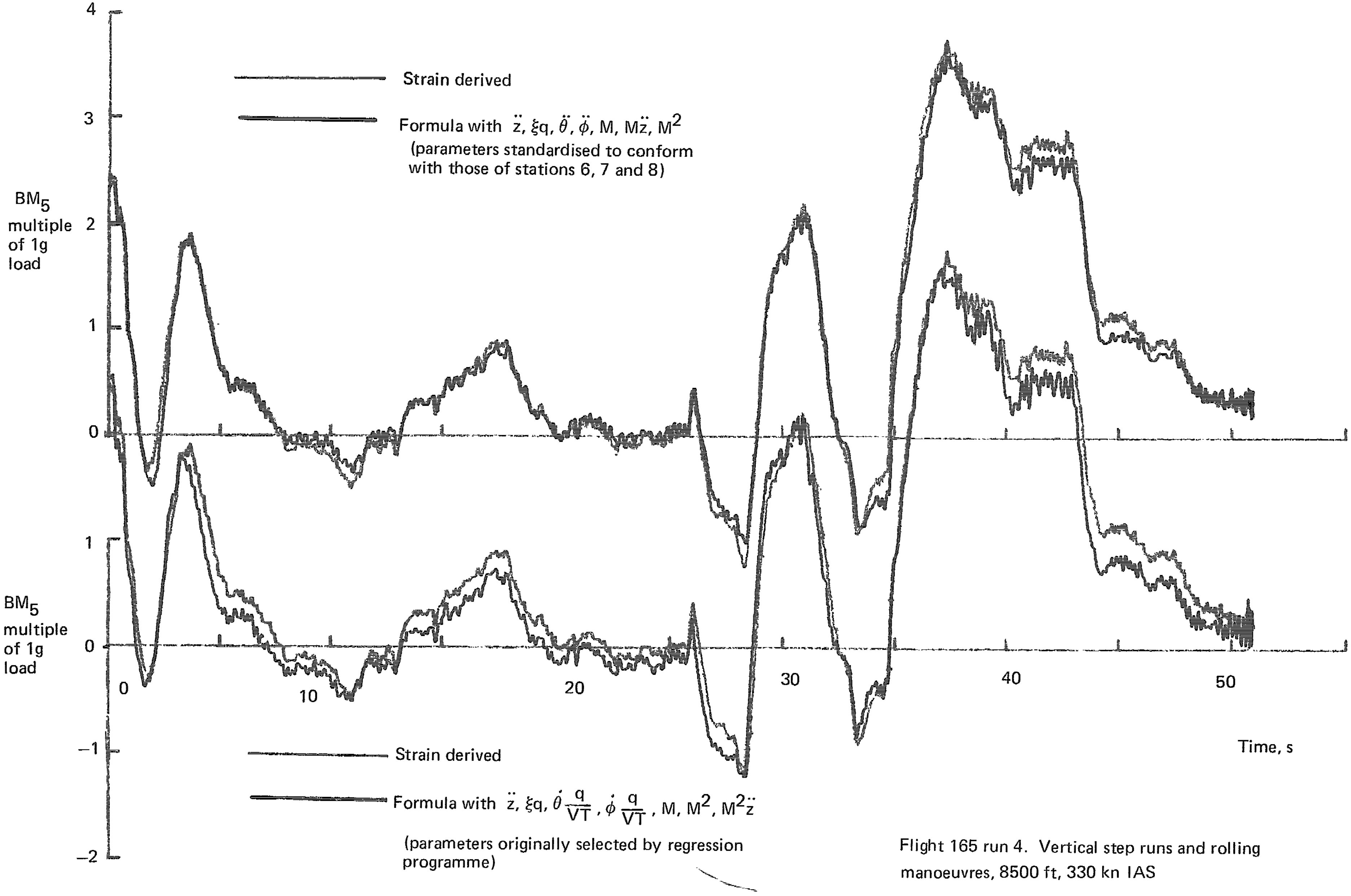

Fig 5 Time histories for alternative 7-parameter formulae for BM$_5$ compared with strain-derived bending moment

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