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MELBOURNE, VICTORIA

Structures Technical Memorandum 373

CALIBRATION OF CT-4A FATIGUE TEST ARTICLE - MARCH 1983

R.P. CAREY and D.G. FORD

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CALIBRATION OF CT-4A FATIGUE TEST ARTICLE - MARCH 1983

by

R.P. CAREY and D.G. FORD

SUMMARY

In preparation for fatigue testing, a strain gauged CT-4A fatigue test article has been calibrated by discrete static loadings. The strain/load data are analysed herein and strain sensitivities to various load parameters are reported.

The responses of some gauges have been compared with flight strains and ground calibrations.



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1. INTRODUCTION

Structures Division of ARL has been commissioned by the RAAF to fatigue test the CT-4A airframe A19-031A built for this purpose.

In preparation for fatigue testing, calibration loadings have been performed in a test rig to check that the strains in the airframe under the test loading system agree satisfactorily with strains measured during ground calibrations of the flight test aircraft A19-031.

This memo reports the gauge sensitivities under fatiguerig loading and also reports work done to isolate the influence of basic load parameters - torque and bending moments.

2. PROCEDURE

Various discrete calibration loads were applied to the fatigue test article by the rig to be used for the fatigue test.

Symmetric wing loadings (≤ 6.67 kN) were applied to each side by the hydraulic jack/whiffletree system. A symmetric tail plane loading (≤ 0.334 kN) was applied to each side, and an asymmetric loading was also performed using dead weights (≤ 0.545 kN) on the starboard side superimposed on the symmetric loading. A fin loading of 0.334 kN was applied in the starboard direction only. Further details are given in Table 1.

Strains were monitored with electric resistance strain gauges on the wing main spar (9C, 9T, 10C, 10T, 12C, 12T), front spar (21S, 22S), fin (33T), tail plane (37C, 37T, 38C), and fuselage longerons (51C, 52C, 53T, 54T). Precise descriptions of gauge stations are available from reference 1.

Linear regressions, strain against force, have been fitted and the results tabulated. Additional sensitivities have been derived by interpreting the slopes as responses to local moments. These results were compared with results from ground calibration of the flight test aircraft.

Further manipulation enabled the separation of sensitivities to fuselage bending moments and torque. Details of these analyses are given in Appendix A for the fatigue test article and Appendix B for the flight test aircraft ground calibration.

Some additional information on sensitivities of fuselage gauges to wing loading has been obtained from flight testing and has been included for comparison.

3. BASIC SENSITIVITY RESULTS

Two-parameter regressions were fitted to the available data so that an offset from the origin was permitted, but for brevity only the slopes have been included herein. The sensitivities of gauges to calibration forces have been tabulated as follows:-

Table 2. Wing loading Table 3. Symmetric tail loading Table 4. Asymmetric tail loading Table 6. Fin loading.

Additional sensitivities of empennage gauges to test rig bending moments are given as follows:-

Table 3. Symmetric tail loading Table 5. Asymmetric tail loading Table 6. Fin loading.

Factors to convert the base from root bending moments to local bending moments at gauge stations are also given with the latter tables. Fin and tail plane root positions are taken as stations 8.0 and 3.0 inches respectively.

4. FLIGHT TEST DATA

Additional data relating wing load and strains are available from flight test. These consist of strains recorded at eight wing load factors:- 1.0g, 3.7g, 0g, - 1.5g, 4.2g, 4.0g, - 1.5g, and 1.0g. Table 7 shows the results of linear regression analyses on these data. The data used were chosen to coincide with low empennage loads. The results in Table 7 can be compared with those in Table 2 for the fatigue test article.

5. SENSITIVITIES OF FUSELAGE GAUGES TO MOMENTS AND TORQUE

5.1 Response to Fuselage Vertical Bending

The response of the fuselage gauges to vertical bending moments has been calculated using data from various sources. For the fatigue test article calculations were based on two wing loadings and the tailplane loading and the slope of the pooled data obtained by the method shown in Appendix A. Table 9 shows the results.

Vertical bending sensitivity has also been determined for the flight test aircraft using data from ground calibration. No wind loading data were available so tail loading data were used as shown in Appendix B. The results are included in Table 12.

5.2 Response to Fuselage Torsion and Sideways Bending

By manipulation of responses by the fuselage gauges to various loadings, additional sensitivities have been extracted. Appendix A shows how sensitivities to fuselage torsion and sideways bending were obtained for the fatigue test article and Table 10 gives the values obtained. For the flight test aircraft it was necessary to assume sensitivities to torsion so that sideways bending sensitivity could be extracted. The assumed torsion sensitivities are contained in Table 11 and the sideways bending values are included in Table 12.

- 2 -

6. COMPARISON WITH GROUND CALIBRATION OF FLIGHT TEST AIRCRAFT A19-031

Table 13 shows the comparison between strain sensitivities measured on ground calibrations of the flight aircraft and the fatigue test airframe. Appropriate allowance has been made for the different positions of load applications to the empennage.

7. DISCUSSION AND CONCLUSIONS

- 1. Table 13 comparisons show that the sensitivities for the fatigue airframe calibration are reasonably consistent with those of the flight test aircraft A19-031, for the wing, fin and tailplane values.
- 2. On the fuselage of the test article there is good consistency in estimates of gauge sensitivity to sideways bending. This is despite the low responses of the gauges and the significant amount of computation required.
- 3. The derived sideways bending responses of gauges 53TE and 54TE on the flight test aircraft are of opposite sign to that expected
- (T (Table 13). It is likely that the unavailability of genuine torque sensitivity values and differences in fuselage support close to these gauges has affected the calculations and it is assumed that the sideways bending responses for the flight test aircraft are not reliable.
- 4. One gauge 53TE shows much lower torque response than the other fuselage gauges on the fatigue test airframe. This suggests that there is a considerable error in the estimated torque sensitivities and that this value is especially suspect.
- 5. In general the gauge sensitivities to bending moment and torque exhibit considerable scatter for both the fatigue test and the flight test airframes. Future torques responses should be measured by calibrating with torsion applied directly.

8. REFERENCE

 Carey, R.P. Group Calibration of a Strain-Gauged CT-4A Aircraft (1980).
 ARL Structures Technical Memorandum 349, October 1982.

- 3 -

APPENDIX A

A.1 RESPONSE OF FUSELAGE GAUGES ON FATIGUE TEST ARTICLE

By analysing the response of fuselage gauges to calibration loadings we establish in turn the sensitivities to vertical bending moment, torque, and side bending moment. These are required for the prediction of responses to general loadings.

The analysis is covered in detail hereafter, along with sample calculations for gauge 51CE.

A.2 LIST OF SYMBOLS

P	×	fin load (positive to starboard)
^T s' ^T p	=	starboard, port tailplane loads (upwards positive)
W	z	wing lift force per side (upwards positive)
W ₄	2	reaction at aft tie-down, (upwards positive), shown in Figure 1
M V	2	fuselage bending moment in vertical plane (positive for upward load at tail)
M _H	2	fuselage sideways bending moment (positive for fin load to starboard)
M _T	ŧ	fuselage torque (positive for fin load to starboard)
h	Ξ	moment arm of fin load developing fuselage torque, shown in Figure 2. This is relative to the mid-depth of the fuselage at the same station as the fin load.
1 _H	z	moment arm for fin load inducing fuselage sideways bending moment (see Figure 1).
¹ v	2	moment arm for tail loads inducing fuselage bending moments, (shown in Figure 1)
¹ w	=	moment arm of furthest aft fuselage reaction point, (shown in Figure 1)
1 _T	Ħ	moment arm for difference of asymmetric tail loads producing fuselage torque (shown in Figure 2)
ε	E	strain at fuselage gauge
R	2	ratio of algebraic sum of tailplane loads to algebraic difference
ĸv	=	sensitivity of gauge to fuselage vertical bending moment

к _н	=	sensitivity to fuselage sideways bending moment
κ _T	=	sensitivity to fuselage torque
с _w	=	sensitivity to wing loading per side
с _т	=	sensitivity to total tail loading
с _А	=	sensitivity to algebraic excess of port side tail loading over starboard
с _ғ	=	sensitivity to fin loading.

A.3 RESPONSE TO FUSELAGE VERTICAL BENDING

Fuselage vertical bending is induced by wing loading and tail loading so that both types of loading can be used to estimate the sensitivity, as well as the flight test results.

Before combining the results from different tests they must be changed to compatible units so that the applied loads can be converted to fuselage bending moments. This is done in Sections A3.1 and A3.2 below. Section A3.3 discusses the separate slope estimates and their combination.

A.3.1 Fuselage Bending Moment Induced by Wing Loading

The vertical bending moments at the fuselage gauge stations are obtained in the following way. The aft reaction force is required and this can be determined from the geometry as -

$$W_{A} = -0.459596 W$$

Then referring to Figure 1, the bending moment induced by unit wing loading

$$M_{\rm v}/W = -0.4596 \, 1_{\rm w}$$
 ..(A1)

where

 $1_{...}$ = 27.50 inches for 51CE and 52CE

= 20.0 inches for 53TE and 54TE.

A.3.2 Fuselage Bending Moment Induced by Tail Loading

For the tailplane loading the aft reaction is obtained from the geometry as

$$W_{d} = -0.799908 (T_{n} + T_{e})$$
 ...(A2)

A.2

The bending moment induced by tail loading is (Figure 1) -

$$M_{v} = (T_{p} + T_{s}) 1_{v} + W_{4} 1_{W}$$

or for unit tail load

 $M_v / (T_p + T_s) = 1_v - 0.7999 1_W \text{ lb.in/lb}$..(A3)

Example

For gauge 51CE, referring to Figure 1

 $l_v = 122.50$ inches and $l_w = 27.50$ inches.

From (A3) the equivalent moment arm or sensitivity is therefore -

 $122.5 - 0.7999 \times 27.50 = 100.50$ inches ...(A4)

or twice this if the quoted tail load refers to just one side.

A.3.3 Pooling Sensitivity Estimates from Separate Tests

For estimating the strain sensitivity of a gauge to bending moment from several calibrations it is first necessary to discuss least squares fitting for one test.

Suppose we have a single set of strains denoted y. (i = 1 to n) corresponding to the fixed variable x. and the regression model -

 $y_{i} = m + bx_{i} + e_{i}$...(A5)

where

$$\mathbf{e}_i \sim N(\mathbf{0}, \sigma^2).$$

Then by least squares, which here is equivalent to maximum likelihood, the estimated slope

$$\hat{\mathbf{b}} = \sum_{i=1}^{n} (\mathbf{x}_{i} - \overline{\mathbf{x}}) (\mathbf{y}_{i} - \overline{\mathbf{y}}) / \sum_{i=1}^{n} (\mathbf{x}_{i} - \overline{\mathbf{x}})^{2} \dots (\mathbf{A6})$$

When this is rewritten in the notation used in the data analysis programs this may be abbreviated to:-

$$b = XPROD/SSX$$

For several tests or calibrations the terms on the right may be subscripted and in this notation the optimal slope estimate takes the form:-

 $\hat{\mathbf{b}} = \Sigma \quad \text{XPROD}_{j} / \Sigma \quad \text{SSX}_{j} \qquad \dots \text{(A7)}$

for the tests j = 1, 2 etc.

Example for Gauge 51CE

Combined XPROD from two compatible wing loadings (per side)

 $XPROD_1 + XPROD_2 = -147400 - 145700$ = -293100 microstrain lbf/side.

Converting the load parameter to fuselage bending moment:-

 $\frac{\text{XPROD}}{\text{V}} = -293100 \text{ (M}/\text{W})$ = -293100 (-12.63889) (see equation (A2)) = 3704500 microstrain lb in

Similarly XPROD from tail loading is:-

XPROD = 4740 microstrain lbf/side

and converting to bending moment :-

Then combining XPROD's from wing and tail loading

Combined XPROD = 3704500 + 953000= 4.658×10^6 microstrain lb in. ..(A8)

Similarly looking at SSX the combined value from wing tests is:-

Combined SSX from wing test = $2839000 + 2371000 \approx 5.260 \times 10^{6} \text{ lbf}^{2}$ Wing SSX in terms of bending moments

$$= 5.260 \times 10^{6} (M_{v}/W)^{2}$$
$$= 5.260 \times 10^{6} (-12.63889)^{2}$$
$$= 840.3 \times 10^{6} (lb.in)^{2}$$

The tail loading SSX in terms of bending moments

= 7235.6 $(2M_v/(T_p + T_s)^2)$ = 7235.6 $(201.0)^2$ = 292.3 x 10⁶ (lb.in)²

Combined SSX for wing and tail loadings

$$= 840.3 \times 10^{6} + 292.3 \times 10^{6}$$

= 1132.6 x 10⁶ (lb.in)² ...(A9)

Now the combined sensitivity to fuselage bending is available:-

Pool^Ad sensitivity to fuselage bending, $K_v = XPROD/SSX$ = 4.658 x 10⁶/1132.6 x 10⁶ reference (A8) and (A9) = .004113 microstrain/1b.in ...(A10)

A.4 SENSITIVITY TO FUSELAGE TORQUE

Asymmetric tail loading affects the fuselage gauges in two ways - through fuselage vertical bending and through torque. The sensitivity to bending, K, is known from paragraph A.3 so the torque sensitivity, K_{m} , is now determinable.

Sensitivity to asymmetric strain per unit load to stra

A.5

i.e.

$$C_{A} = d\varepsilon/d(T_{p} - T_{s})$$

$$= \frac{\partial\varepsilon}{\partial M_{v}} \cdot \frac{dM_{v}}{d(T_{p} + T_{s})} \cdot \frac{d(T_{p} + T_{s})}{d(T_{p} - T_{s})} + \frac{\partial\varepsilon}{\partial M_{T}} \cdot \frac{dM_{T}}{d(T_{p} - T_{s})}$$

$$= K_{v} \left(\frac{M_{v}}{T_{p} + T_{s}}\right) \cdot R + K_{T} \cdot 1_{T} \qquad \dots (A11)$$

 $\mathbf{K}_{_{\rm T}}$ is now the only unknown in (All)

Example

$$R = 0.25$$

$$I_{T} = 36.0 \text{ (see Figure 2)}$$

$$C_{A} = .0545 \text{ microstrain/lbf}$$

$$K_{V} = .004113 \text{ microstrain/lb.in (refer (A10))}$$

$$M_{V} / (T_{D} + T_{S}) = 100.5 \text{ inch (refer (A5))}$$

so that :-

 $.0545 = .004113 \times 100.5 \times 0.25 + K_T \times 36.0.$

Then torque sensitivity -

A.5 SENSITIVITY TO FUSELAGE SIDEWAYS BENDING

Fin loading affects the fuselage gauges through sideways bending of the fuselage and by torque. The torque influence can be evaluated as in the previous paragraph so that sensitivity to sideways bending can be determined.

Response to fin loading, $C_{_{\rm F}}$,

= strain per unit load caused by torque + strain per unit load caused by sideways bending. i.e.

1

$$C_{F} = \frac{\partial \varepsilon}{\partial M_{T}} \cdot \frac{dM_{T}}{dP} + \frac{d\varepsilon}{dM_{H}} \cdot \frac{dM_{H}}{dP}$$
$$= K_{T} \cdot h + K_{H} \cdot l_{H} \cdot ... (A13)$$

from which sensitivity to sideways bending moment, $K_{\underset{\mbox{H}}{H}}$ is found. Example

$$C_F = .225 \text{ microstrain/lbf} (\text{see Table 6})$$

 $K_T = -.001357 \text{ microstrain/lb.in} (\text{see Equation (A12)})$
 $h = 31.21 \text{ inch} (\text{see Figure 2})$
 $l_H = 100.1 \text{ inch} (\text{see Figure 1})$
 $C_F = (-.001357) \times 31.21 + K_H \times 100.1$

and sensitivity to sideways bending,

A.7

APPENDIX B

RESPONSE OF FUSELAGE GAUGES ON THE FLIGHT TEST AIRCRAFT

The data available from the flight test aircraft are not sufficient to isolate all of the effects separated for the fatigue test article. To overcome the deficiency values for fuselage torque sensitivity have been taken from the fatigue test article and modified by averaging the magnitudes of symmetrically placed pairs. The values as measured and modified are included in Table 11.

B.1 BENDING MOMENTS FROM UNIT FORCES

Referring to Figures 3 and 4 the following bending moments and torques are derivable:

To obtain fuselage sideways moment, reactions are assumed at the vertical reaction stations.

The aft sideways reaction per unit fin load

 $= - \frac{236.5 - 44.1}{135.4 - 44.1} = - \frac{192.4}{91.3} = - 2.1073.$

The fuselage sideways moment per unit fin load to starboard for gauges 51CE, 52CE

= 1.0(236.5 - 125.5) - 2.1073(135.4 - 125.5)

= 90.1 lb.in/lbf (ie. inch).

Fuselage sideways moment per unit fin load for gauges 53TE, 54TE

 $= 1 \times (236.5 - 133) - 2.1073 (135.4 - 133)$

= 98.4 inch.

Fuselage torque per unit fin load = 47.5 - (-4.8) = 52.3 inch.

Fuselage aft reaction per unit tailplane load

 $= - \frac{251.0 - 44.09}{135.4 - 44.09} = - 2.266 \, lbf/lbf.$

Fuselage vertical moment per unit tailplane total load (for gauges 51CE, 52CE)

- = 1.(251-125.5) 2.266(135.4-125.5)
- = 103.1 inch.

Fuselage vertical moment per unit tailplane total load (for gauges 53TE, 54TE)

- = 1.(251-133) 2.266(135.4-133)
- = 112.6 inch.

Fuselage aft reaction per unit wing load

- $= -\frac{85.5 44.1}{135.4 44.1}$
- = 0.483.

Fuselage vertical moment per unit wing load (for gauges 51CE, 52CE)

- = -.483(135.4 125.5)
- = -4.782 inch.

Fuselage vertical moment per unit wing load (for gauges 53TE, 54TE)

- = -.483(135.4-133)
- = 1.1592 lb.in/lbf.

B.2 SENSITIVITY TO FUSELAGE VERTICAL BENDING

Sensitivity to tailplane loading (Table 11) is readily modified to bending sensitivity using moments found in A.2.1 as in the following example for gauge 51CE. Sensitivity to tailplane vertical bending

- _ <u>Sensitivity to tailplane loading</u> Moment per unit load
- = .2046/103.1 = .001984 microstrain/lb.in.

The values obtained for all gauges are given in Table 12.

B.3 SENSITIVITY TO FUSELAGE SIDEWAYS BENDING

Fin loading influences the fuselage gauges in two ways firstly by inducing torque on the fuselage and secondly through sideways bending. The influence of torque on gauge 51CE is found thus for a unit fin load:- Torque = 52.3 lb.in (see paragraph B.1)

Strain due to torque = Torque x Sensitivity to Torque

 $= 52.3 (-.001163^*)$

= -.0608 microstrain/lbf.

* Obtained from Table 11.

Total strain = .1770 microstrain/lbf (see Table 11)

Net strain attributable to sideways bending

= .1779-(-.0608) microstrain/lbf

= .2387 microstrain/lbf.

Sideways Bending Moment = 90.1 lb.in.

Hence sensitivity to sideways bending moment is -

= $\frac{.2387}{90.1}$ microstrain/lb.in

= .002649 microstrain/lb.in.

The values for all gauges are included in TAble 12.

TABLE 1. FATIGUE TEST ARTICLE AIRFRAME CALIBRATION LOADINGS, MARCH 1983

TYPE OF CALIBRATION	TEST DATE	LOAD RANGE (NOMINAL	NO. OF SETS	STEPS	REMARKS
WING BENDING	17 MAR 18 Mar	0.0 to 6.67 kN (1500 lbf) 0.0 to 6.67 kN		1.11 KN 1.11 KN	FIRST ZERO LOAD POINT DISCARDED.
TAIL PLANE SYMMETRIC UP LOAD	18 MAR	(PER SIDE) 0.334 kn (75 lbf) PER SIDE	1	0.056 KN	
ASYMMETRIC TAILPLANE	21 MAR	0.0334 kN (75 lbf) UPWARDS ON PORT SIDE & .200 kN (45 lbf) DOWNWARDS ON STARBOARD SIDE	1	.056 kN PORT .034 kN STARBOARD	DEAD WEIGHT ON STARBOARD TAIL TO .534 KN MAX., MODIFVING SYMMETRIC JACK LOADS OF .334 KN.
NIA	21 MAR 22 MAR	0.334 kN (75 lbf) 0.334 kN (75 lbf) TO STARBOARD	п п	.056 kN .056 kN	DISCARDED. YAW RESTAINT BAR DISCONNECTED

-

TABLE 2. WING LOADING CALIBRATION ON FATIGUE TEST AIRFRAME

Fitted Strain/Load Sensitivities

GAUGE	STRAIN (X	10 ⁻⁶)/LOAD FACTO	R (G's)	STRAIN/FORCE (1bf)/SIDE	STRAIN/FORCE (N)/SIDE
1	17 MAR	18 MAR	17, 18 Mar, Average	17, 18 Mar, Average	17, 18 Mar, Average
9CE	-261	- 258	-259.5	389	0875
9TE	179	182	180.5	.270	.0607
10CE	-253	-253	-253	379	0852
lote	192	194	193	. 289	.0650
12CE	-346	-345	-345.5	518	1165
12TE	264.5	264.5	264.5	.396	.0890
21SE	- 25.85	- 25.78	- 25.82	0387	00870
22SE	- 37.21	- 36.74	- 36.98	0554	0125
33TE	.35	.36	.355	.5x10 ⁻³	1.1×1.
37CE	83	.10	36	6x10 ⁻³	-1.3×10
37TE	.94	.08	.51	.6×10 ³	1.3×10
38CE ,	.12	1.01	.56	.8x10 ⁻³	1.8×10
51CE	- 41.08	- 34.07	- 37.58	0563	0127
52CE	- 25.58	- 25.99	- 25.79	0386	0087
53TE	22.38	22.24	22.31	.0334	.0075
54TE	26.19	33.87	30.03	.0450	.010

TABLE 3. SYMMETRIC TAIL LOADING CALIBRATION ON FATIGUE TEST AIRFRAME

Fitted Strain/Load Sensitivities

Test Date: 18 March 1983

33TE 601 X 10 ⁻³ 135 X 10 ⁻³ 1 37CE -1.60 360 37TE 1.56 .351 37TE 1.62 .364 38CE -1.62 364 51CE .655 .147 N/ 51CE .427 .096 53TE 737 166 166	135 X 10 ⁻³ -1.4	.82 X 10 ⁻⁵ 0485 ⁺ 0473 ⁺	-1.61 X 10 ⁻⁴
37CE -1.60 360 37TE 1.56 .351 - 37TE 1.56 .351 - 38CE -1.62 364 - 38CE -1.62 364 - 38CE -1.62 .364 - 51CE .655 .147 N/ 51CE .427 .096 - 53TE 737 166 -	0.	0485 ⁺ 0473 ⁺	
37TE 1.56 .351 38CE -1.62 364 38CE -1.62 .364 51CE .655 .147 51CE .655 .147 52CE .427 .096 53TE 737 166		0473 ⁺	430
38CE -1.62 364 51CE .655 .147 N/ 52CE .427 .096 53TE 737 166	.351 .0		.419
51CE .655 .147 N/ 52CE .427 .096 53TE .737 166	3640	0491 ⁺	.435
52CE .427 .096 53TE 737 166	.147 N/AI	APPLICABLE	N/APPLICABLE
53TE737166	.096	=	Ŧ
	166	=	:
54TE -1.11250	250		

+ FOR CONVERSION TO STRAIN PER LOCAL BENDING MOMENT MULTIPLY BY 1.179 (ARM = 28.0")

AIRFRAME	
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Fitted Strain/Load Sensitivities

Test Date 21 March 1983

GAUGES				strain (x10 ⁻⁶) per	FORCE INDICATE	ID BELOW		
	UP LOAD ON	PORT SIDE	DOWN LOAD ON	STARBOARD SIDE	NET LOAD	ON TAIL	LOAD DIFFEREN	ICE ON TAIL
	(Ibf)	(N)	(1bf)	(N)	(1bf)	(N)	(1hf)	(N)
33TE	454X10 ⁻³	102X10 ⁻³	.757X10 ⁻³	.170X10 ⁻³	1.135X10 ⁻³	.255X10 ⁻³	.2838X10 ⁻³	.064X10 ⁻³
37CE PORT	-1.71	384	*	*	*	*	*	¢
37TE PORT	1.71	.384	*	*	*	*	*	*
38CE STAR- BOARD.	*	*	-1.64	369	*	*	*	*
SICE	*	*	*	*	.218	.0490	.0545	.0123
52CE	*	*	*	*	.4225	.0950	.10563	.0237
53TE	*	*	*	*	3375	0759	08438	0190
54TE	*	*	*	*	7825	1759	19563	0439

* THESE VALUES ARE NOT RELEVANT - E.G. INFLUENCE OF PORT TAIL LOAD ON STARBOARD GAUGES WHEN STARBOARD LOADING IS ALSO APPLIED.

TABLE 5. ASYMMETRIC TAIL LOADING CALIBRATION ON FATIGUE TEST AIRFRAME

Fitted Strain/Root Bending Moment Sensitivities

Test Date 21 March 1983

GAUGE	STRAIN PER ROOT BENDING MOMENT (Ib.in) (arm=33.0")	STRAIN PER ROOT BENDING MOMENT (N.m) (arm=0.838m)
37CE PORT	-0.0518 ⁺	-0.458+
37TE PORT	-0.0518 ⁺	-0.458
38CE STARBOARD	-0.0497 ⁺	-0. 4 40 ⁺

+ FOR SENSITIVITY TO LOCAL BENDING MOMENT AT GAUGES 37BE, 38BE MULTIPLY

BY 1.179 (arm = 28")

TABLE 6. FIN LOADING CALIBRATION ON FATIGUE TEST AIRFRAME

Fitted Strain/Load Sensitivities

Test Date: 22 March 1983

GAUGE	STRAIN (X10 ⁻⁶) PER Load (1df)	STRAIN (X10 ⁻⁶) PER LOAD (N)	STRAIN (X10 ⁻⁶) PER FIN ROOT BENDING MOMENT (lb.in) (ARM = 18.41")	STRAIN (X10 ⁻⁶) PER FIN ROOT BENDING MOMENT (N.m) (ARM = .467 m)
33TE	1.27	.286	+0690.	.611
37CE	020	0045	00109	-, 00966
37TE	.042	. 0094	.00228	.0202
38CE	.037	.0083	.00201	.0178
SICE	.225	.0506	N/APPLICABLE	N/APPLICABLE
52CE	211	0474	Ŧ	=
53TE	.167	.0375	=	=
54TE	221	0497	÷	E

STRAIN PER LOCAL BENDING MOMENT AT 33TE = 0.0843 X 10^{-6}/1b.in (**ARM - 15.07 INCH**) = 0.747 X $10^{-6}/N.m$ +

TABLE 7. FLIGHT TEST - FUSELAGE GAUGE SENSITIVITIES TO WING LOAD FACTOR

GAUGE	STRAIN (X10 ⁻⁶) PER LOAD FACTOR	STRAIN (X10 ⁻⁶) PER WING LOAD PER SIDE (16f)	STRAIN (X10 ⁻⁶) PER WING LOAD PER SIDE (N)
51CE	-31.291	046842	01053
52CE	-27.733	041516	00933
53TE	32.863	.049196	.01106
54TE	35.057	.05248	.001180

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NOTE: THE DATA WERE OBTAINED FROM CT-4A FLIGHT TRIALS:

FLIGHT 013, FILE 6, 30 APRIL 1980.

TABLE 8. MOMENT ARMS FOR BENDING MOMENTS AND TORQUES

SYMBOL	FORCE	MOMENT PRODUCED	STRAIN GAUGES	MOMENT ARM - METRE FATIGUE TEST	(INCH VALUES IN BRACKETS) FLIGHT TEST AIRCRAFT
				ARTICLE	GROUND CALIBRATION
1v	TAILPLANE LIFT	VERTICAL BENDING	51CE, 52CE	3.109 (122.5)	3.189 (125.5)
		ON LOSENAGE	53TE, 54TE	2.919 (115.0)	2.998 (118.0)
1 W	AFT FUSELAGE	VERTICAL BENDING	51CE, 52CE	.698 (27.5)	.252 (9.9)
	REACTION	ON FUSELAGE	53TE, 54TE	.508 (20.0)	.061 (2.4)
1 _T	DIFFERENCE IN	FUSELAGE TORQUE	51CE, 52CE	.914 (36.0)	1.576 (62.03)
	TALLPLANE LIFT BETWEEN SIDES		53TE, 54TE		
1 _H	FIN FORCE	FUSELAGE SIDEWAYS	51CE, 52CE	2.541 (100.1)	2.820 (111.0)
			53TE, 54TE	2.350 (92.6)	2.630 (103.5)
£	FIN FORCE	FUSELAGE TORQUE	51CE, 52CE	.792 (31.21)	1.329 (52.3)
			53TE, 54TE		

CONT....

TABLE 8. (CONT.)

M FITICUE FATICUE SADEL SAD	SYMBOL	FORCE	MOMENT PRODUCED	STRAIN GAUGES	MOMENT ARM - METRE	(INCH VALUES IN BRACKETS)
M_V EFFECTIVE LENGTH TP ^{+T} VERTICAL BENDING 51CE, 52CE 2.551 (100.5) 2.619 (103.1) $(T_P^+T_S)$ APPLICABLE TO TOTAL TALL ON FUSELAGE 53TE, 54TE 2.513 (99.0) 2.861 (112.6) $M_V^/W$ EFFECTIVE LENGTH VERTICAL BENDING 51CE, 52CE 321 (-12.639) 121 (-4.782) $M_V^/W$ EFFECTIVE LENGTH VERTICAL BENDING 51CE, 52CE 321 (-12.639) 121 (-4.782) $M_V^/W$ EFFECTIVE LENGTH VERTICAL BENDING 51CE, 52CE 321 (-12.639) 121 (-4.782) $M_V^/W$ EFFECTIVE LENGTH VERTICAL BENDING 51CE, 52CE 321 (-12.639) 121 (-4.782) $M_V^/W$ EFFECTIVE LENGTH VERTICAL BENDING 51CE, 52CE 321 (-12.639) 121 (-4.782) $M_V^/W$ EFFECTIVE LENGTH VERECALE 53TE, 54TE 233 (-9.192) 029 (-1.159) $M_H^/P$ EFFECTIVE LENGTH SIDEWAYS BENDING 51CE, 52CE 2.541 (100.1) 2.289 (90.1) $M_H^/P$ EFFECTIVE LENGTH SIDEWAYS BENDING 51CE, 52CE 2.541 (100.1) 2.280 (90.1) </th <th></th> <th></th> <th></th> <th></th> <th>FATIGUE TEST ARTICLE</th> <th>FLIGHT TEST AIRCRAFT GROUND CALIBRATION</th>					FATIGUE TEST ARTICLE	FLIGHT TEST AIRCRAFT GROUND CALIBRATION
M/W EFFECTIVE LENGTH VERTICAL BENDING 51CE, 52CE 321 (-12.639) 121 (-4.782) APPLICABLE TO ON FUSELAGE 53TE, 54TE 333 (-9.192) 121 (-1.769) M/H * EFFECTIVE LENGTH SIDEWAYS BENDING 51CE, 52CE 233 (-9.192) 029 (-1.159) M/H * EFFECTIVE LENGTH SIDEWAYS BENDING 51CE, 52CE 2.541 (100.1) 2.289 (90.1) M/H * PPLICABLE TO FIN ON FUSELAGE 51CE, 52CE 2.541 (100.1) 2.280 (90.1)	$\mathbf{M}_{\mathbf{V}}^{\mathbf{M}}$	EFFECTIVE LENGTH APPLICABLE TO TOTAL TAIL LIFT	VERTICAL BENDING ON FUSELAGE	51CE, 52CE 53TE, 54TE	2.551 (100.5) 2.513 (99.0)	2.619 (103.1) 2.861 (112.6)
M _H /P * EFFECTIVE LENGTH SIDEWAYS BENDING 51CE, 52CE 2.541 (100.1) 2.289 (90.1) APPLICABLE TO FIN ON FUSELAGE 53TE, 54TE 2.350 (92.6) 2.500 (98.4)	* M/V	EFFECTIVE LENGTH APPLICABLE TO WING LIFT/SIDE	VERTICAL BENDING ON FUSELAGE	51CE, 52CE 53TE, 54TE	321 (-12.639) 233 (-9.192)	121 (-4.782) 029 (-1.159)
	₩ [,] /₽ *	EFFECTIVE LENGTH APPLICABLE TO FIN LOAD	SIDEWAYS BENDING ON FUSELAGE	51CE, 52CE 53TE, 54TE	2.541 (100.1) 2.350 (92.6)	2.289 (90.1) 2.500 (98. 4)

* DERIVATIONS ARE GIVEN IN APPENDICES A AND B.

TABLE 9. RESPONSE OF FUSELAGE GAUGES TO FUSELAGE BENDING

MOMENT IN THE VERTICAL PLANE

(FATIGUE TEST ARTICLE LOADINGS MARCH 1983)

	STRAIN (X10 ⁻⁶) PER FUSELAGE BENDING M	OMENT (N.m)
	(STRAIN (X10 ⁻¹	°) PER IN.LB SHOWN IN BR	ACKETS)
GAUGES	SYMMETRIC TAILPLANE LOADING	WING LOADING	COMBINATION OF DATA FROM TAILPLANE AND WING LOADINGS
51CE	.02883	.03902	.03640
	(.003258)	(.004409)	(.004113)
52CE	.01880	.02702	.02490
	(.002124)	(.003053)	(.002813)
53TE	03294	03215	03244
	(003722)	(003633)	(003666)
54TE	04961	04380	04608
	(.005606)	(~.004949)	(005207)

TABLE 10. RESPONSE OF FUSELAGE GAUGES TO FUSELAGE TORQUE AND FUSELAGE SIDE BENDING

(FATIGUE AIRFRAME - MARCH 1983)

CALLER .	STRAIN SENSITIV TORS	ITY TO FUSELAGE LON	STRAIN SENSITIVITY SIDEWAYS BENDING MC	l to fuselage Ment at gauge
	STRAIN (X10 ⁻⁶) PER LB.IN	STRAIN (X10 ⁻⁶) PER N.M	STRAIN (X10 ⁻⁶) PER LB.IN	STRAIN (X10 ⁻⁶) PER N.m
SICE	001357	01201	.002674	.02366
52CE	60700.	.008592	002411	02134
53TE	•0001764	.001561	.001744	.01543
54TE	-,001854	01641	001762	01559

TABLE 11. FUSELAGE GAUGE RESPONSES USED IN ANALYSIS FOR GROUND CALIBRATION OF FLIGHT TEST AIRCRAFT

OL ALIAILISNES	TINU	1.4	JSELAGE GAUGE N	0		REFERENCE
		51CE	52CE	53TE	54TE	
TAILPLANE LOAD/SIDE	MICROSTRAIN PER N	. 092	.124	157	145	TABLE 11 Reference 1
	MICROSTRAIN PER 1bf	.2046	.2758	3492	3225	
FIN LOAD	MICROSTRAIN PER N	.040	051	016	.019	TABLE 14 Reference 1
	MICROSTRAIN PER 1bf	.1779	2268	0712	.0845	
FUSELAGE TORQUE (VALUES FROM FATIGUE RIG)	MICROSTRAIN PER N.M	(01201)	(.00859)	(.00156)	(01641)	TABLE 10
MODIFIED VALUES ASSUMED FOR	Ŧ	01030	.01030	.00899	00899	
FLIGHT TEST AIRCRAFT	MICROSTRAIN PER lb.in	001163	.001163	.001015	001015	

TABLE 12. FUSELAGE GAUGE RESPONSE TO VERTICAL AND SIDEWAYS BENDING

(GROUND CALIBRATION OF FLIGHT TEST AIRCRAFT - AUGUST 1980)

		STRAIN SENSI	ITIVITY TO:-	
GAUGES	FUSELAGE VERT	ICAL BENDING ILPLANE LOAD	FUSELAGE SI	DEWAYS BENDING
	STRAIN (X10 ⁻⁶) PER LB.IN	STRAIN (X10 ⁻⁶) PER N.m	STRAIN (X10 ⁻⁶) PER LB.IN	STRAIN (XIO ⁻⁶) PER N.m
51CE	.00198	.0176	.00265	. 0235
52CB	.00268	.0237	00319	0283
53TE	00310	0275	00126	0112
54TE	00286	0254	.00140	.0124

. . . .

FATIGUE	S AIRFRAME C	ALIBRATION - N	MARCH 1983 FLIGHT TEST AIRC	RAFT GROUND CALIBRATION - AUGUST 1980 ¹	REFERENCE
GAUGE	STRA IN/L	OAD (UNITS SHC	JMN) GAUGE	STRAIN/LOAD	
NING	LOADING		(UNITS: STRAIN (X10 ⁻⁶)/LOAD F.	ACTOR)	
8 2	-260 181	220 Average	9 B E	227	TABLE 20 REF. 1
100	-253 193	223 Average	108E	220	(SEE NOTE 2
12C 12T	-346 265		12 TOP 12 BOTTOM	365 (1 ARM ONLY) -247	TABLE 25 REF. 1 (SEE NOTE 2
215 225	-25.8 -37.0		21S 22S	-28.9 -61.1	TABLE 20 Ref. 1 (See Note 2
TAIL	LOADING		(UNITS: STRAIN (X10 ⁻⁶)/LOCAL B	SUDING MOMENT (N.m.))	
37CE TTE	.521 ³	VILOAD ONLY	37BE	$.528\frac{4}{2000}$ DOWN LOAD	TARLE 22
38CE	516 ³		38BE	.5264 DOWN LOAD .5424 UP	REF. 1

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MATCHE ALTERNATION - MACH 1903 FLIGHT TEST ALRCHAFT GROND CALLERATION - AUGUST 190 ¹ REFERENCE GUGS STRAIN/LOAD (INITS SHOM) GAUGE STRAIN/LOAD REFERENCE Image: Caller and the short of the sho	Matter Alterbase Cultebatron - MacH 1963 FLGHT TEST ALRCHAFT GROUP CULTEBATION - AUGUST 1960 ¹ REFRENCE CAUGE STRAIN/LOAD (MITTS SHOM) GAUGE STRAIN/LOAD MCUST 1960 ¹ REFRENCE Image: Strain - Mount (MUTTS SHOM) GAUGE STRAIN/LOAD MCUST 1900 ¹ REFRENCE Image: Strain - Mount (MUTTS SHOM) JATE STRAIN/LOAD MCUST MCU				
GMCG STRAIN/LOAD (UNITS SHORN) GAUCE STRAIN/LOAD MATERIADE FN LOADING (UNITS: STRAIN GAUCE STRAIN/LOAD MATERIADE 337E .743 ² (STARBGARD DIRECTION) 337E .783 ⁵ (STARBGARD DIRECTION) REF. I 337E .743 ² (STARBGARD DIRECTION) 337E .783 ⁵ (STARBGARD DIRECTION) REF. I 337E .743 ² (STARBGARD DIRECTION) 337E .783 ⁵ (STARBGARD DIRECTION) REF. I 337E .7031 .783 .783 .783 .783 .783 51CE .00211 STE .0036 .0019 .784 .774 .784 .774 .774 .774 .774 .774 .774 .774 .774<	GUGG STRAIN/LOAD UNITES SHOWN GAUGE STRAIN/LOAD MATERGAGE FIN LOADING (UNITES, STRAIN (x10 ⁻⁶)/LOCAL BENDIKG MONENT (N.m.)) STRAIN/LOAD MATERGAGE 33TE .141 ² (STRABOARD DIRECTION) 33TE .783 ⁵ (STRABOARD DIRECTION) MALE IA 31TE .141 ² (STRABOARD DIRECTION) 33TE .783 ⁵ (STRABOARD DIRECTION) REF. I 51CE 0.0411 .141 ² (UNITE: STRAIN (x10 ⁻⁶ /J)).10.1 .865 ⁵ .865 ⁵ .866 ⁵ <td< td=""><th>FATIG</th><td>UE AIRFRAME CALIBRATION - MARCH 1983</td><td>FLIGHT TEST AIRCRAFT GROUND CALIBRATION - AUGUST 1980¹</td><td></td></td<>	FATIG	UE AIRFRAME CALIBRATION - MARCH 1983	FLIGHT TEST AIRCRAFT GROUND CALIBRATION - AUGUST 1980 ¹	
FIN LONDING STRAIN/LOND FIN LONDING (INITTS: STRAIN (X10 ⁻⁶)/LOCAL BENDING MORENT (N.m.)) TABLE 14 3375 .747 ² (STARBOARD DIRECTION) 3375 .783 ⁵ (STARBOARD DIRECTION) RES. 1 3375 .747 ² (STARBOARD DIRECTION) 3375 .783 ⁵ (STARBOARD DIRECTION) RES. 1 5105 .0041 .783 ⁵ (FORT DIRECTION) RES. 1 . 5105 .0041 .0012 .783 ⁵ (FORT DIRECTION) RES. 1 5105 .00361 .00260 (FORT DIRECTION) RES. 1 . 5105 .00361 .001260 .001260 .001260 .001260 .001260 5475 .003261 .001260 .002261 .002126 .002126 .001260 .00126	FIN LODING STRAIN/LOD FIN LODING (INUTS: STRAIN (X10 ⁻⁶)/LOCAL BENDIKG MONENT (N.m.)) STRAIN/LOD 3375 .747 ² (STABBOARD DIRECTION) 3375 .809 ⁵ (STRBBOARD DIRECTION) TABLE 3375 .747 ² (STABBOARD DIRECTION) 3375 .809 ⁵ (STRBBOARD DIRECTION) REF. I 51CF .00411 .783 ⁵ .783 ⁵ .783 ⁵ .784 ⁵ .784 ⁵ 1 51CF .00261 .51CE .00268 .	GAUGE	STRAIN/LOAD (UNITS SHOWN)	Calify	REFERENCE
FIN CONDITION CONTENS: STRATIN (NUTES: PABLED (NUTES: PABLED PABL	FIN LONDING(INITTS: STRAIN (X10 ⁻⁶)/POCAL BENDING MORETT (A))33TE.147 ² (STARBOARD DIRECTION)33TE.783 ⁵ (STARBOARD DIRECTION)TABLE 14SENSITIVITY TO FUERLACE VERTICAL BENDING MORETT (N).783 ⁵ (FORT DIRECTION)REF. 1.783551CE.00411.7805.7805.7905.781551CE.00411.51CE.00199.7816.781551CE.00261.00199.00199.7816.781151CE.00261.51CE.00199.7816.781551CE.00261.51CE.00199.7816.781651CE.00261.00268.00199.7816.781651CE.00261.572.00199.7816.781651CE.00261.00268.00196.7816.781651CE.00261.00196.00196.7816.781651CE.00261.00268.00196.70216.781151CE.00261.00268.00268.00268.7021651CE.00114.51CE.00196.00126.781651CE.00114.00126.00126.00126.781651CE.00114.00116.00126.00126.781651CE.00136.00136.00126.0013651CE.00136.00136.00136.781651CE.00136.00136.00136.781651CE.00136.00136.0013651CE.00136.00136 <th></th> <th></th> <th>GAUGE STRAIN/LOAD</th> <th></th>			GAUGE STRAIN/LOAD	
33RE .747 ⁶ (STARBOARD DIRECTION) 33TE .783 ⁵ (STARBOARD DIRECTION) TABLE I SENTITUTY TO FUSETAGE VERTICAL BENDING MONENT 33TE .783 ⁵ (STARBOARD DIRECTION) REF. 1 SENSITIVITY TO FUSETAGE VERTICAL BENDING MONENT 31TE .783 ⁵ (STARBOARD DIRECTION) REF. 1 STARTIVITY TO FUSETAGE VERTICAL BENDING MONENT (INITS: STRAIN (IN1 ⁻⁶ /1) ¹ , in) .00098 .00198 .00198 REF. 1 STRE .000381 \$2CE .000380 .00198 RABLES 9 STRE .00261 \$3TE .00198 .00130 AND 12 STRE .00261 \$3TE .00210 .00265 AND 12 STRENTY TO FUSETAGE SIDEMAYS BENDING MONENT (INITS: STRAIN (XI0 ⁻⁶ /1b.in) .00266 AND 12 STARE .00267 .00295 .00140 STARE .00210 .00140 STARE .00216 .00140 STARE .00140 .00140 .00140 .00140 .0014	JATE (ATA (STARBOARD DIRECTION) JATE .73 ⁵ .00 ³ (FORT DIRECTION) TABLE I .80 ³ (FORT DIRECTION) TABLE I .80 ³ (FORT DIRECTION) SENSITIVITY TO FUSEIAGE VERTICAL BENDING MONENT (INITY: STRAIN (A10 ⁻⁶)/1)in) .00 ³ (FORT DIRECTION) TABLE 3 51CE .00411 51CE .00190 TABLE 3 53TE .00367 .00190 TABLE 3 54TE .00310 .00260 .00260 54TE .00310 .00260 .00260 54TE .00310 .00260 .00260 54TE .00210 .00260 .00260 54TE .00130 .00260 .00130 54TE .00136 .00130 .00120 54TE .00136 .00130 .00120 54TE .00136 .00130 .00130	LIN	LOADING (UNITS: STRAIN	(X10 ⁻⁶)/LOCAL BENDING MOMENT (N. m.))	
STRETTY TO FUSETAGE VERTICAL BENDING NOMENT (UNITYS, STRAIN (X10 -6)/1b.in) REF. 1 51CE .000411 51CE .00198 TABLES 9 53CE .002613 51CE .00198 .00268 AND 12 53CE .00261 51CE .00198 .00268 AND 12 53CE .00261 53TE .00268 AND 12 53CE .00261 53TE .00268 AND 12 53CE .00241 53TE .00266 AND 12 53CE .00241 51CE .00266 AND 12 53CE .00174 52CE .00219 AND 12 53CE .00176 53CE .00126 AND 12 54TE .00176 53CE .00126 AND 12 54TE .00176 54TE .00126 .00126 AND 12 54TE .00176 54TE .00126 .00126 AND 12 54TE .00136 .00126 .00126 .00126 .00126 .00126 54TE .00136 .00126 .00126	SINGLIFTURY TO FURFLACE VERTICAL BENDING MOMENT (INITY: STRAIN (X10 ⁻⁶)/1b.in) NOT LINECTION REF. 1 51CE :00411 51CE :00199 TABLES ************************************	33778	.747 ^c (STARBOARD DIRECTION)	33TE . 783 ⁵ (STARBOARD DIRECTION)	TABLE 14
5LE .00411 STEMIN (X10 ⁻⁰)/1b.in) 52CE .00261 52CE .00196 TABLES 9 54TE 00367 53TE .00196 AND 12 54TE 00310 53TE .00196 AND 12 54TE 53TE .00266 .00266 AND 12 54TE 53TE .00310 AND 12 54TE .00310 54TE .00310 51CE .00241 53TE .00319 51CE .00241 51CE .00319 51CE .00241 51CE .00319 51CE .00136 54TE .00319 51CE .00136 54TE .00319 51CE .00136 54TE .00136 51CE .00136 .00136 AND 12 51CE .00136 .00136 AND 12 51CE .00136 .00136 .00136 51CE .00136 .00136 .00136 51CE .00136	5/CE .00411 5/CE .00411 5/CE .00419 TABLES 9 5/3TE 00367 5/CE .00198 5/CE .00198 TABLES 9 5/4TE 00367 5/ATE .00310 5/ATE .00316 AND 12 5/4TE 00367 5/ATE .00316 5/ATE .00268 AND 12 5/ATE 00286 5/ATE .00286 .00268 AND 12 5/ATE .00286 5/ATE .00286 AND 12 5/ATE .00286 .00286 AND 12 5/ATE .00241 5/ATE .00286 5/ATE .00214 5/ATE .00319 AND 12 5/ATE .00140 5/ATE .00140 .00265 5/ATE .00140 5/ATE .00140 .00140 5/ATE .00140 .00140 .00140 .00140 5/ATE .00140 .00140 .00140 .00140 5/ATE .00140	SENS	ITIVITY TO FUSELAGE VERTICAL RENDING NO	NOIT DIRECTION	REF. 1
Construct 00411 51CE 00198 TABLES 5 54TE -00251 53TE -00268 -00268 AND 12 54TE -0051 53TE -00268 -00268 AND 12 54TE -0051 54TE -00266 -00266 AND 12 51CE -00241 51CE -00265 -00265 AND 12 51CE -00241 51CE -00265 AND 12 52CE -00241 51CE -00265 AND 12 53TE -00174 52CE -00319 AND 12 53TE -00176 53TE -00140 AND 12 54TE -00176 54TE -00140 AND 12 54TE -00140 -00140 -00140 AND 12 54TE -00136 NOT ANTIABLE -00140 -00140 54TE -00136 NOT ANAILABLE -00140 -00140 54TE -000136 NOT ANAILABLE -00140 -00140 5	57E .00411 51CE .00198 TABLES 9 57F 00281 52CE .00268 .00268 .00198 7ABLES 9 57F 00521 54TE 00310 54TE 00310 AND 12 58TE 0051 54TE 00310 54TE 00310 AND 12 58TETIVITY TO FUSELAGE SIDEWAYS BENDING MOMENT (INITTS: STRAIN (XI0 ⁻⁶ /1b.in) 00286 00210 .00110 .00110 51CE 00241 51CE 00215 .00265 .00126 .00126 53CE 00174 52CE 00126 .00126 .00126 .00126 54TE 00176 53TE .00126 .00126 .00126 .00126 54TE 00126 53TE .00126 .00126 .00126 .00140 51CE 00136 53TE 00126 00126 00126 00140 51CE 00136 00136	30 F 3		$(1)^{(1)}$ (NITS: STRAIN (X10 ⁻⁰)/1b.in)	
53TE 00367 53TE 00198 TABLES 9 54TE 00521 53TE 00269 AND 12 SENSTITUTY TO FUSELAGE SIDEMAYS BENDING MOMENT (UNITS: STRAIN (X10 ⁻⁶ /1b.in) 00286 00286 AND 12 51CE .00241 53TE 00286 00286 00286 52CE 00241 51CE .00266 00241 S1CE .00266 52CE 00241 51CE .00266 00241 S1CE .00266 7ABLES 10 53CE 00174 51CE .00266 00240 XND 12 54TE .00140 53CE 00140 XND 12 54TE .00140 53CE 00140 XND 12 54TE .00140 .00140 .00140 .00140 54TE .00136 .00140 .00140 .00140 54TE .00140 .00140 .00140 .00140 54TE .00136 .00140 .00140 .00140 54TE </td <td>53TE 00198 53TE .00198 TABLES 9 54TE 0051 53TE .00268 .00268 .00198 AND 12 54TE 0051 53TE .00266 .00268 .00268 .00110 51CE .00241 51CE .00265 .00176 51CE .00265 TABLES 10 51CE .00241 51CE .00265 .00265 TABLES 10 52CE .00174 51CE .00265 .00126 301 12 301 12 53TE .00174 52CE .00126 .00126 .00140 AND 12 54TE .00176 54TE .00140 .00140 .00140 AND 12 51CE .00136 .00136 .00140 .00140 .00140 .00140 51CE .00136 .00136 .00140 .00140 .00140 51CE .00136 .00136 .00140 .00140 .00140 .00140 .00140</td> <th>52CE</th> <td>.00411</td> <td>SICE</td> <td></td>	53TE 00198 53TE .00198 TABLES 9 54TE 0051 53TE .00268 .00268 .00198 AND 12 54TE 0051 53TE .00266 .00268 .00268 .00110 51CE .00241 51CE .00265 .00176 51CE .00265 TABLES 10 51CE .00241 51CE .00265 .00265 TABLES 10 52CE .00174 51CE .00265 .00126 301 12 301 12 53TE .00174 52CE .00126 .00126 .00140 AND 12 54TE .00176 54TE .00140 .00140 .00140 AND 12 51CE .00136 .00136 .00140 .00140 .00140 .00140 51CE .00136 .00136 .00140 .00140 .00140 51CE .00136 .00136 .00140 .00140 .00140 .00140 .00140	52CE	.00411	SICE	
54TE 00521 53TE 00210 AND 12 SENSTTUUTY TO FUSELACE SIDEMAYE BENDING MMENT (UNITS: STRAIN (X10 ⁻⁶ /1b.in) 00266 00210 AND 12 51CE 00241 54TE 00210 00265 00210 51CE 00241 51CE 00265 00176 J.L.in) 52CE 00174 53TE 002265 00126 JND 12 54TE 00176 53TE 002126 00126 JND 12 54TE 00176 53TE 00126 00126 JND 12 54TE 00136 TABLES 10 00140 00140 00140 54TE 00136 00126 00140 00140 00140 54TE 00136 00140 00140 00140 00140 54TE 00136 00140 00140 00140 00140 51CE 00136 00140 00140 00140 00140 51CE 00136 001	54TE 00521 53TE 00286 00286 AND 12 SENSTITUTY TO FUSELAGE SIDEWAYE BENDING MOMENT (UNITS: STRAIN (X10 ⁻⁶ /1b.in) 00286 00286 00286 00286 51CE .00241 51CE .00265 00286 00286 00286 52CE 00241 51CE .00265 00219 MD 12 53TE .00174 51CE .00219 MD 12 54TE .00140 53TE 00140 AND 12 54TE .00140 .00140 .00140 .00140 51CE .00136 .00140 .00140 .00140 54TE .00140 .00140 .00140 .00140 51CE .00136 .00140 <td< td=""><th>53TE</th><td>00367</td><td>S2CE</td><td>TABLFC O</td></td<>	53 T E	00367	S2CE	TABLFC O
SINSTITUTY TO FUSELAGE SIDEMAYS BENDING MOMENT (UNITS: STRAIN (X10 ⁻⁶ /1b.in) 51CE .00267 51CE .00265 52CE 00241 51CE .00265 53TE .00174 51CE .00265 54TE .00176 53TE .00140 54TE .00176 53TE .00140 54TE .00140 .00140 .00140 54TE .00140 .00140 .00140 51C 00136 .00140 .00140 51C .00136 .00140 .00140 51C .00018 .00140 .00140 51C .00018 .00140 .00140 51C .	SENSITIVITY TO FUSELAGE SIDEWAYS BENDING MOMENT (UNITS: STRAIN (X10 ⁻⁶ /1b.in) 51CE .00267 51CE .00265 52CE 00241 51CE .00265 53TE .00174 51CE .00265 53TE .00174 51CE .00265 53TE .00174 51CE .00265 53TE .00176 53TE .002126 54TE .00176 53TE .00126 54TE .00126 54TE .00126 54TE .00136 .00140 .00140 51CE	54TE	00521	53TE	AND 12
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TABLE 13 (CONT.)

- 1. THE TAILPLANE VALUES ALSO INCLUDED TESTS ON ANOTHER TAILPLANE PERFORMED IN AUGUST 1980. NOTES:
 - 2. A LOAD OF 2.923 KN PER UNIT LOAD FACTOR IS ASSUMED.
- 3. AVERAGING SYMMETRIC AND ASYMMETRIC LOADINGS.
- 4. MOMENT ARM OF CALIBRATION LOAD = 1.373 m.
- 5. MOMENT ARM OF LOAD = 0.918 m.

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FIG. 1. LOADS INDUCING FUSELAGE VERTICAL BENDING IN FATIGUE RIG.



FIG. 2 - EMPENNAGE FATIGUE RIG LOADING.







FIG. 4 - POSITIONS OF FORCES - GROUND CALIBRATION

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The strain/load data are analysed herein and strain sensitivities to various load parameters are reported.				
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