# Chapter 3B

# FATIGUE INDEX DATA

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## FATIGUE INDEX DATA – INTRODUCTION

### General

1. Every aircraft suffers fatigue damage and because of this each type of aircraft is given a safe fatigue life at which it must either be retired from service or modified to permit further flying. The consumption of fatigue life must be monitored as each aircraft is flown to ensure that the declared safe fatigue life is not exceeded.

### Fatigue index

2. Fatigue life consumption is measured in terms of the consumption of 'Fatigue index' (FI) which is a non-dimensional number, calculated either from fatigue meter readings or by assessment of the sortie flown; the methods of calculation are described in the following paragraphs.

### Assessing fatigue life consumption

3. The fatigue life consumed is calculated by reading the fatigue meter counters at periodic intervals, subtracting the 'before' and 'after' readings to determine the counts recorded during the interval, and substituting these values in the fatigue formula. The aircraft may have several formulae to cover different all-up weights or operating patterns, or the fitment of different types of fatigue meters.

### Unmetered flying

4. If the aircraft does not have a fatigue meter fitted, or an installed meter is unserviceable, fatigue consumption is assessed from the details of the sortie flown and is dependent upon the types of aircraft manoeuvres and the theatre of operations. Fatigue consumption assessed in this way is always greater than the more accurate consumption figures calculated from fatigue meter readings.

### Recording of fatigue data

5. Instructions for the recording of fatigue data and references to the forms to be used are given in A.P.100B-01 order 0768. The following general instructions and precautions apply to all recording of fatigue data:

(1) The aircraft captain is responsible for completing the sortie details, while servicing personnel are responsible for reading fatigue meters (where fitted) and for recording the information. All personnel responsible for the collection and compilation of fatigue data must appreciate the need for accuracy and legibility of the entries. Careless or incomplete recording is dangerous if it causes a less damaging sortie to be assumed: it is wasteful if, in the interests of safety, the worst case has to be assumed. In extreme cases, continued careless or incomplete recording can result in the expensive premature retirement of an aircraft from service because of doubt regarding the true situation.

(2) All personnel responsible for reading fatigue meters are to be familiar with, and are to apply, the serviceability checks described in A.P.112G-0203-1, Chapter 2, 'Fatigue Meters', and the associated A.P.112G-0203-D1. In particular, the validity of fatigue meter readings is to be checked either before any fatigue life calculations are taken at the unit or before the appropriate forms are despatched from the unit for fatigue life calculations to be performed elsewhere. The replacement of unserviceable meters is to be regarded as a high priority task.

(3) The unit engineering record section is to retain or dispose of completed forms in accordance with the appropriate single-service instructions.

### Refining of fatigue index

6. When the fatigue records for an aircraft show that it has consumed 80 per cent of its fatigue life action is to be taken in accordance with A.P.100B-01 order 0768.

### Action on fitment of a new fatigue meter

7. When a fatigue meter is fitted or replaced, a new form is to be started and the readings from the counters of the meter to be fitted are to be recorded in the 'B/F' line of the fatigue calculation sheet. The checks specified in A.P.112G-0203-1 Chap.2 are to be applied after three flights have been completed with a new or replacement meter installed.

8. The following paragraphs give information on the fatigue life of the Vulcan B Mk.2 aircraft and details the methods of calculating the fatigue life consumed.

9. Fatigue life areas of the Vulcan airframe are determined from the results of a full scale Fatigue Test Specimen (FTS). Fatigue lifing of the pressure cabin has been determined from the results of a full scale test on a representative pressure cabin. Fatigue lives of Blue Steel fixed fittings have been determined by calculation.

**Aircraft critical point**

10. The critical point as determined by the Fatigue Test Specimen is on the rear spar bottom boom at y/s = 0.28 where there is a change in section.

## CALCULATION OF AIRFRAME FATIGUE LIFE – B MK.2

**Fatigue meter**

11. The fatigue meter fitted to Vulcan B.Mk.2 aircraft is a Type 18A with a remote fatigue load consumption indicator Type M2372.

12. The load levels of the meters and the notation for the number of counts recorded at different levels are as follows:-

| Meter Type | LOAD LEVEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18A | | 0.05 | 0.45 | 0.75 | 1.25 | 1.55 | 1.95 | 2.35 | 2.65 |
| Notation for Number of Counts Recorded | A | B | C | D | E | F | G | H | J |

13. For aircraft fitted with a Mark 11 meter, the notation J is to be ignored. For aircraft fitted with a Mark 18 meter, the notation A is to be ignored.

**Calculations for Metered Flights**

14. All flying will normally be metered, in which case the fatigue index consumed is calculated from one of the following three formulae according to the type of flight:

*a. High - Low - High Flight*

$$\text{F1 Consumed} = \frac{K1 \times K2}{1\,000}(39.63B + 0.753C + 1.492D + 0.332E + 3.10F + 13.42G + 17.04H + 11.28J + 8.116N)$$

*b. Squadron High Level Flight*

$$\text{F1 Consumed} = \frac{K1 \times K2}{1\,000}(5.957B + 0.264C + 0.605D + 0.522E + 3.66F + 12.38G + 25.4H + 18.0J + 8.059N)$$

*c. OCU (non High - Low - High) Flight*

$$\text{F1 Consumed} = \frac{K1 \times K2}{1\,000}(13.75B + 1.142C + 0.253D + 0.653E + 3.182F + 18.3G + 49.64H + 25.85J + 7.66N)$$

where:

(1) B, C, D, E, F, G, H and J are the number of counts (incremental) recorded in the windows of the aircraft general fatigue meter at the following load levels:

| B | C | D | E | F | G | H | J | |
|---|---|---|---|---|---|---|---|---|
| 0.05 | 0.45 | 0.75 | 1.25 | 1.55 | 1.95 | 2.35 | 2.65 | 'g' load level |

(2) N is the number of full stop landings.

(3) K1 is a variable factor which depends on the all-up weight of the aircraft on take-off.

(4) K2 is a variable factor which depends on the weight of the bomb bay load.

15. If a high-low-high flight is undertaken at the OCU, then the flight is to be classified as a high-low-high flight. For transit, display, pre-delivery and test flights, the appropriate formula to be used is as follows:-

| Type of Flight | Formula to be Used |
|---|---|
| Display | High-Low-High |
| Long Range Transit | High Level |
| Pre-delivery | OCU |
| Air Tests below 2 000 ft | High-Low-High |
| Air Tests above 2 000 ft | High Level |

It is important that the formula used must be that which most closely matches the flight profile.

16. The number of counts (incremental), recorded by the fatigue meter at each load level, is obtained by subtracting the reading of each window before the flight, from the corresponding window reading after the flight.

**K1 Factor**

17. The K1 factor is dependent upon the type of flight and the all-up weight of the aircraft on take-off.

18. In the case of high-low-high flights, the factor is also dependent upon the weight of fuel used before the commencement of the low-level leg. The K1 factor is obtained from the appropriate tables 1 and 2.

**K2 Factor**

19. The K2 factor is dependent upon the weight of the load carried in the bomb bay. The bomb bay load should be considered in two categories:

(a) Loads which are carried throughout the flight, i.e. removable stores and equipment. It includes weapon carriers, weapons, panniers, dry weight of bomb bay fuel tanks and the weight of fuel remaining in the bomb bay tanks on landing.

(b) Weight of bomb bay fuel consumed during the flight.

The K2 factor is obtained from Table 3 in the case of high-low-high flights, or from Table 4 in the case of squadron high level and OCU flights.

20. If part of the bomb bay store (excluding fuel) is dropped during the flight, then the K2 factor for the flight is obtained as follows:-

$$K2\ (\text{store dropped}) = \tfrac{1}{2}\,(K2\ (\text{store carried}) - 1) + 1$$

**Calculations for Unmetered Flights**

21. If the flight is unmetered or the fatigue meter is unserviceable, then the fatigue index consumed must be calculated by means of the appropriate 'role life', in which case the fatigue index consumed is calculated as follows:-

$$F1\ \text{Consumed} = \frac{\text{Flight Duration (hours)}}{\text{Role Life (hours)}} \times 100K2$$

22. The K2 factor, which is dependent upon the weight of the load carried in the bomb bay, is obtained from Table 3 or 4, as appropriate, in the same way as that for metered flights. The role life appropriate to the flight is dependent upon the all-up weight of the aircraft on take-off and, in the case of high-low-high flights, the weight of fuel used before the start of the low-level run. The role lives are given at Tables 5, 6 and 7.

**Recording**

23. Comprehensive details and the amount of fatigue index consumed for every flight are to be recorded on STC Form Stats 2045.

**FATIGUE LIFE OF VULCAN B MK 2 AIRFRAME**

24. The fatigue life of the Vulcan B Mk 2 airframe is determined by the results of the FTS. Several areas of the aircraft have specific safe fatigue lives. In each lifed area, replacement or modification of the structure has to be carried out before a specified fatigue index is reached. In some areas inspections are required as the area approaches its safe fatigue life. Details of all lifed areas are listed at Table 8.

**FATIGUE LIFE OF PRESSURE CABIN**

25. The Vulcan pressure cabin has a safe working life of 2 685 pressurisations, a pressurisation being an inflation to a differential pressure of 6 $lb/in^2$ and above. This safe life is conditional on the cabin modification state and the renewal of specified lifed items.

(a) *Cabin Modification State.* The following Vulcan modifications have to be embodied:-

Modification 354

To be embodied not later that 300 pressurisations.

Modification 367

To be embodied not later than the first Major Servicing or 480

pressurisations whichever occurs first. To be embodied concurrently with Modifications 368, 405 and 449.

Modification 368 – As above.

Modification 405 – As above.

Modification 449 – As above.

All Vulcan B Mk2 aircraft have the above modifications embodied.

(b) *Lifed Items.* With all relevant modifications embodied, the following items must be changed before the number of pressurisations shown have occurred:

| | |
|---|---|
| Cockpit Rail Top Member Aft Portion Part No. 2D.10685 26DC/1433996 | 1 410 pressurisations |
| Rear canopy attachment hooks and pins Hooks, Pt.No.13a and 13b, D9524, Qty 2 each<br>Pins, Pt.No.12D.9524, Qty 2 | 2 530 pressurisations (May be increased to 2 685 pressurisations subject to frequent periodic inspection. Inspection details will be defined by B.Ae. (Manchester) on request. |
| Rear Canopy Release Unit Sealing Box Cover Port, Part No.205D.8754, 26DC/1432915 | 1 950 pressurisations |
| Rear Canopy Release Unit Sealing Box Cover Starboard, Part No. 206D.8754, 26DC/1432916 | 1 950 pressurisations |
| Former 302 Attachment to Cockpit Rail Angle Port Part No.69D.8754, 26DC/1432913 Angle Starboard, Part No. 70D.8754, 26DC/1432914 | 1 410 pressurisations |
| Rear Canopy Release Unit Housing, Housing Part No.2D.10021, 26DC/1433958, Qty 2, Housing Part No. 3D.10021, 26DC/1433959, Qty 2 | 2 010 pressurisations |
| Front Pressure Bulkhead Access Door Skin Door Part No.2D.8377, 26DC/1001 | 2 590 pressurisations |
| Stringer Termination Brackets (Front Pressure Bulkhead)<br>2D.12626, 26DC/1433728, Qty 2<br>3D.12626, 26DC/1433729, Qty 2<br>4D.12626, 26DC/1433830, Qty 2<br>19D.12624, 26DC/1433960, Qty 6<br>20D.12624, 26DC/1433961, Qty 4<br>21D.12624, 26DC/1433862, Qty 2<br>22D.12624, 26DC/1433963, Qty 6<br>23D.12624, 26DC/1433964, Qty 6 | 2 020 pressurisations |
| Canopy Pilot's (alternatives)<br>350D.8626/C, 26DC/120<br>367D.8626/W, 26DC/548<br>367D, 8626/C, 26DC/700<br>367D.8626/PC, 26DC/1433391 | 2 730 pressurisations |

*NOTE . . .*
*Lifed items renewed before life expiry may require further renewals during the remaining life of the cabin, i.e., a cockpit rail top member renewed at 1 000 pressurisations will require a further renewal not later than 2 410 pressurisations, if aircraft operations are to continue until the cabin life expires at 2 685 pressurisations.*

26. *Recording.* All pressurisations of 6 lb/in$^2$ and above are to be recorded.

## FATIGUE LIFE OF BLUE STEEL FIXED FITTINGS

27. Three of the Blue Steel fixed fittings have definite fatigue lives as detailed in paras. 30 to 33.

Tables
- 1 & 2 – K1 Factor Table
- 3 – K2 Factor Table for High-Low-High Flights
- 4 – K2 Factor Table for Squadron High-Level and OCU Flights
- 5, 6 & 7 – Role Lives for Unmetered Flying
- 8 – Fatigue Lives of Specified Areas

Paras.
- 28-33 – Fatigue Lives of Blue Steel Fixed Fittings.

TABLE 1

K1 FACTOR TABLE FOR HIGH–LOW–HIGH FLIGHTS FOR VULCAN 2 AIRCRAFT

| AUW on Take-off (lbs) | WEIGHT OF FUEL USED BEFORE START OF LOW LEVEL RUN | | |
|---|---|---|---|
| | < 16 000 | ⩾ 16 000 to 30 000 | ⩾ 30 000 |
| < 165 000 | 0.958 | 0.880 | 0.758 |
| ⩾ 165 000 to < 175 000 | 1.190 | 0.955 | 0.834 |
| ⩾ 175 000 to < 180 000 | 1.268 | 1.00 | 0.832 |
| ⩾ 180 000 | 1.285 | 1.117 | 0.906 |

TABLE 2

K1 FACTOR TABLE FOR HIGH LEVEL AND OCU FLIGHTS FOR VULCAN 2 AIRCRAFT

| AUW on Take-off (lbs) | TYPE OF SORTIE FLOWN | |
|---|---|---|
| | HIGH LEVEL | OCU |
| < 165 000 | 0.806 | 0.925 |
| ⩾ 165 000 to < 175 000 | 0.977 | 1.00 |
| ⩾ 175 000 to < 180 000 | 1.00 | 1.077 |
| ⩾ 180 000 | 1.07 | 1.073 |

# TABLE 3

## K2 FACTOR TABLE FOR HIGH-LOW-HIGH FLIGHTS BY VULCAN MK 2 AIRCRAFT

| WEIGHT OF BOMB BAY FUEL CONSUMED DURING FLIGHT (1000 LBS) | BOMB BAY STORE WEIGHT (1000 LBS) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 0 | 1 | 1·02 | 1·05 | 1·09 | 1·12 | 1·15 | 1·18 | 1·22 | 1·25 | 1·28 | 1·32 | 1·35 | 1·39 | 1·43 | 1·46 | 1·50 | 1·54 | 1·57 | 1·61 | 1·65 | 1·69 | 1·73 | 1·77 | 1·81 | 1·85 | 1·89 | 1·93 | 1·97 | 2·01 | 2·06 | 2·10 |
| 1 | | 1·03 | 1·06 | 1·10 | 1·13 | 1·16 | 1·19 | 1·23 | 1·26 | 1·29 | 1·33 | 1·36 | 1·40 | 1·44 | 1·47 | 1·51 | 1·55 | 1·58 | 1·62 | 1·66 | 1·70 | 1·74 | 1·78 | 1·82 | 1·86 | 1·90 | 1·94 | 1·98 | 2·02 | 2·07 | |
| 2 | | 1·04 | 1·07 | 1·11 | 1·14 | 1·17 | 1·20 | 1·24 | 1·27 | 1·31 | 1·34 | 1·37 | 1·41 | 1·45 | 1·48 | 1·52 | 1·56 | 1·59 | 1·63 | 1·67 | 1·71 | 1·75 | 1·79 | 1·83 | 1·87 | 1·91 | 1·95 | 1·99 | 2·03 | | |
| 3 | | 1·05 | 1·09 | 1·12 | 1·15 | 1·18 | 1·21 | 1·25 | 1·28 | 1·32 | 1·35 | 1·38 | 1·42 | 1·46 | 1·49 | 1·53 | 1·57 | 1·60 | 1·64 | 1·68 | 1·72 | 1·76 | 1·80 | 1·84 | 1·88 | 1·92 | 1·96 | 2·00 | | | |
| 4 | | 1·06 | 1·10 | 1·13 | 1·16 | 1·19 | 1·22 | 1·26 | 1·29 | 1·32 | 1·36 | 1·39 | 1·43 | 1·46 | 1·50 | 1·54 | 1·57 | 1·61 | 1·65 | 1·69 | 1·73 | 1·77 | 1·80 | 1·84 | 1·88 | 1·93 | 1·97 | | | | |
| 5 | | 1·07 | 1·10 | 1·14 | 1·17 | 1·20 | 1·23 | 1·27 | 1·30 | 1·33 | 1·37 | 1·40 | 1·44 | 1·47 | 1·51 | 1·55 | 1·58 | 1·62 | 1·66 | 1·70 | 1·73 | 1·77 | 1·81 | 1·85 | 1·89 | 1·93 | | | | | |
| 6 | | 1·08 | 1·11 | 1·15 | 1·18 | 1·21 | 1·24 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·45 | 1·48 | 1·52 | 1·56 | 1·59 | 1·63 | 1·67 | 1·70 | 1·74 | 1·78 | 1·82 | 1·86 | 1·90 | | | | | | |
| 7 | | 1·09 | 1·12 | 1·15 | 1·19 | 1·22 | 1·25 | 1·28 | 1·32 | 1·35 | 1·39 | 1·42 | 1·46 | 1·49 | 1·53 | 1·56 | 1·60 | 1·64 | 1·68 | 1·71 | 1·75 | 1·79 | 1·83 | 1·87 | | | | | | | |
| 8 | | 1·10 | 1·13 | 1·16 | 1·20 | 1·23 | 1·26 | 1·29 | 1·33 | 1·36 | 1·39 | 1·43 | 1·46 | 1·50 | 1·54 | 1·57 | 1·61 | 1·65 | 1·68 | 1·72 | 1·76 | 1·80 | 1·84 | | | | | | | | |
| 9 | | 1·11 | 1·14 | 1·17 | 1·20 | 1·24 | 1·27 | 1·30 | 1·33 | 1·37 | 1·40 | 1·44 | 1·47 | 1·51 | 1·54 | 1·58 | 1·62 | 1·65 | 1·69 | 1·73 | 1·77 | 1·81 | | | | | | | | | |
| 10 | | 1·12 | 1·15 | 1·18 | 1·21 | 1·24 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·44 | 1·48 | 1·52 | 1·55 | 1·59 | 1·62 | 1·66 | 1·70 | 1·74 | 1·77 | | | | | | | | | | |
| 11 | | 1·13 | 1·16 | 1·19 | 1·22 | 1·25 | 1·28 | 1·32 | 1·35 | 1·38 | 1·42 | 1·45 | 1·49 | 1·52 | 1·56 | 1·59 | 1·63 | 1·67 | 1·71 | 1·74 | | | | | | | | | | | |
| 12 | | 1·13 | 1·16 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·36 | 1·39 | 1·42 | 1·46 | 1·49 | 1·53 | 1·57 | 1·60 | 1·64 | 1·67 | 1·71 | | | | | | | | | | | | |
| 13 | | 1·14 | 1·17 | 1·20 | 1·23 | 1·27 | 1·30 | 1·33 | 1·36 | 1·40 | 1·43 | 1·47 | 1·50 | 1·54 | 1·57 | 1·61 | 1·64 | 1·68 | | | | | | | | | | | | | |
| 14 | | 1·15 | 1·18 | 1·21 | 1·24 | 1·27 | 1·31 | 1·34 | 1·37 | 1·40 | 1·44 | 1·47 | 1·51 | 1·54 | 1·58 | 1·61 | 1·65 | | | | | | | | | | | | | | |
| 15 | | 1·15 | 1·19 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·44 | 1·48 | 1·51 | 1·55 | 1·58 | 1·62 | | | | | | | | | | | | | | | |
| 16 | | 1·16 | 1·19 | 1·22 | 1·25 | 1·29 | 1·32 | 1·35 | 1·38 | 1·42 | 1·45 | 1·48 | 1·52 | 1·55 | 1·59 | | | | | | | | | | | | | | | | |
| 17 | | 1·17 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·36 | 1·39 | 1·42 | 1·46 | 1·49 | 1·53 | 1·56 | | | | | | | | | | | | | | | | | |
| 18 | | 1·17 | 1·20 | 1·23 | 1·27 | 1·30 | 1·33 | 1·36 | 1·39 | 1·43 | 1·46 | 1·50 | 1·53 | | | | | | | | | | | | | | | | | | |
| 19 | | 1·18 | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | 1·37 | 1·40 | 1·43 | 1·47 | 1·50 | | | | | | | | | | | | | | | | | | | |
| 20 | | 1·18 | 1·21 | 1·25 | 1·28 | 1·31 | 1·34 | 1·37 | 1·41 | 1·44 | 1·47 | | | | | | | | | | | | | | | | | | | | |
| 21 | | 1·19 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·44 | | | | | | | | | | | | | | | | | | | | | |
| 22 | | 1·19 | 1·22 | 1·25 | 1·29 | 1·32 | 1·35 | 1·38 | 1·41 | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·35 | 1·39 | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | 1·20 | 1·23 | 1·26 | 1·29 | 1·33 | 1·36 | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES 1. Bomb Bay Store Weight is defined as removable stores and equipment carried throughout the flight. This includes: Weapon Carriers;
Weapons;
Dry weight of Bomb Bay fuel tanks;
Weight of fuel remaining in bomb bay tanks on landing.

2. Weight of Bomb Bay Fuel consumed during flight is Bomb Bay Fuel Weight on take-off minus Bomb Bay Fuel Weight on landing.

3. If all the bomb bay stores are carried throughout the flight, then K2 is obtained from the table above.

4. If part of the Bomb Bay Stores is dropped during the flight, obtain K2 from the table, then K2 (Store dropped) = ½ [K2 (Store carried) -1 ] + 1

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# TABLE 4

## K2 FACTOR TABLE FOR SQUADRON HIGH LEVEL AND OCU FLIGHTS BY VULCAN MK2 AIRCRAFT

| WEIGHT OF BOMB BAY FUEL CONSUMED DURING FLIGHT (1000 LBS) | BOMB BAY STORE WEIGHT (1000 LBS) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 0 | 1 | 1·03 | 1·06 | 1·08 | 1·11 | 1·14 | 1·17 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·35 | 1·39 | 1·42 | 1·45 | 1·48 | 1·51 | 1·54 | 1·58 | 1·62 | 1·65 | 1·69 | 1·74 | 1·78 | 1·82 | 1·87 | 1·92 | 1·97 | 2·02 | 2·05 |
| 1 | | 1·04 | 1·06 | 1·09 | 1·12 | 1·15 | 1·18 | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | 1·36 | 1·40 | 1·43 | 1·46 | 1·49 | 1·53 | 1·56 | 1·60 | 1·64 | 1·68 | 1·72 | 1·76 | 1·80 | 1·85 | 1·90 | 1·95 | 2·00 | 2·05 | |
| 2 | | 1·05 | 1·07 | 1·10 | 1·13 | 1·16 | 1·19 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·44 | 1·47 | 1·50 | 1·54 | 1·58 | 1·61 | 1·65 | 1·70 | 1·74 | 1·78 | 1·83 | 1·88 | 1·93 | 1·98 | 2·04 | | |
| 3 | | 1·05 | 1·08 | 1·11 | 1·14 | 1·17 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·35 | 1·39 | 1·42 | 1·45 | 1·48 | 1·52 | 1·55 | 1·59 | 1·63 | 1·67 | 1·72 | 1·76 | 1·81 | 1·86 | 1·91 | 1·96 | 2·02 | | | |
| 4 | | 1·06 | 1·09 | 1·12 | 1·15 | 1·18 | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | 1·36 | 1·40 | 1·43 | 1·47 | 1·50 | 1·53 | 1·57 | 1·61 | 1·65 | 1·69 | 1·74 | 1·79 | 1·83 | 1·89 | 1·94 | 1·99 | | | | |
| 5 | | 1·07 | 1·10 | 1·13 | 1·16 | 1·19 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·37 | 1·41 | 1·44 | 1·48 | 1·51 | 1·54 | 1·58 | 1·62 | 1·67 | 1·71 | 1·76 | 1·81 | 1·86 | 1·91 | 1·97 | | | | | |
| 6 | | 1·08 | 1·11 | 1·14 | 1·17 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·35 | 1·39 | 1·42 | 1·46 | 1·49 | 1·52 | 1·56 | 1·60 | 1·64 | 1·68 | 1·73 | 1·78 | 1·83 | 1·88 | 1·94 | | | | | | |
| 7 | | 1·09 | 1·12 | 1·15 | 1·18 | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | 1·36 | 1·40 | 1·43 | 1·47 | 1·51 | 1·53 | 1·57 | 1·61 | 1·66 | 1·70 | 1·75 | 1·80 | 1·85 | 1·91 | | | | | | | |
| 8 | | 1·10 | 1·13 | 1·16 | 1·19 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·45 | 1·48 | 1·52 | 1·55 | 1·59 | 1·63 | 1·67 | 1·72 | 1·77 | 1·82 | 1·88 | | | | | | | | |
| 9 | | 1·12 | 1·14 | 1·17 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·35 | 1·39 | 1·42 | 1·46 | 1·50 | 1·53 | 1·56 | 1·60 | 1·64 | 1·69 | 1·74 | 1·79 | 1·84 | | | | | | | | | |
| 10 | | 1·13 | 1·15 | 1·18 | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | 1·36 | 1·40 | 1·43 | 1·47 | 1·51 | 1·55 | 1·58 | 1·62 | 1·66 | 1·71 | 1·76 | 1·81 | | | | | | | | | | |
| 11 | | 1·14 | 1·16 | 1·19 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·38 | 1·41 | 1·45 | 1·48 | 1·52 | 1·56 | 1·59 | 1·63 | 1·68 | 1·72 | 1·77 | | | | | | | | | | | |
| 12 | | 1·15 | 1·18 | 1·20 | 1·23 | 1·26 | 1·29 | 1·32 | 1·36 | 1·39 | 1·42 | 1·46 | 1·50 | 1·54 | 1·58 | 1·61 | 1·65 | 1·69 | 1·74 | | | | | | | | | | | | |
| 13 | | 1·16 | 1·19 | 1·21 | 1·24 | 1·27 | 1·30 | 1·34 | 1·37 | 1·40 | 1·44 | 1·48 | 1·51 | 1·55 | 1·59 | 1·62 | 1·66 | 1·71 | | | | | | | | | | | | | |
| 14 | | 1·17 | 1·20 | 1·23 | 1·26 | 1·28 | 1·32 | 1·35 | 1·38 | 1·42 | 1·45 | 1·49 | 1·53 | 1·57 | 1·61 | 1·64 | 1·68 | | | | | | | | | | | | | | |
| 15 | | 1·19 | 1·21 | 1·24 | 1·27 | 1·30 | 1·33 | 1·36 | 1·40 | 1·43 | 1·47 | 1·50 | 1·54 | 1·58 | 1·62 | 1·65 | | | | | | | | | | | | | | | |
| 16 | | 1·20 | 1·22 | 1·25 | 1·28 | 1·31 | 1·34 | 1·37 | 1·41 | 1·44 | 1·48 | 1·52 | 1·56 | 1·60 | 1·63 | | | | | | | | | | | | | | | | |
| 17 | | 1·21 | 1·24 | 1·26 | 1·29 | 1·32 | 1·36 | 1·39 | 1·42 | 1·46 | 1·49 | 1·53 | 1·57 | 1·61 | | | | | | | | | | | | | | | | | |
| 18 | | 1·23 | 1·25 | 1·28 | 1·31 | 1·34 | 1·37 | 1·40 | 1·44 | 1·47 | 1·51 | 1·55 | 1·58 | | | | | | | | | | | | | | | | | | |
| 19 | | 1·24 | 1·26 | 1·29 | 1·32 | 1·35 | 1·38 | 1·42 | 1·45 | 1·49 | 1·53 | 1·56 | | | | | | | | | | | | | | | | | | | |
| 20 | | 1·25 | 1·28 | 1·31 | 1·34 | 1·37 | 1·40 | 1·43 | 1·47 | 1·50 | 1·54 | | | | | | | | | | | | | | | | | | | | |
| 21 | | 1·27 | 1·29 | 1·32 | 1·35 | 1·38 | 1·41 | 1·45 | 1·48 | 1·51 | | | | | | | | | | | | | | | | | | | | | |
| 22 | | 1·28 | 1·31 | 1·34 | 1·36 | 1·40 | 1·43 | 1·46 | 1·49 | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | 1·30 | 1·32 | 1·35 | 1·38 | 1·41 | 1·44 | 1·47 | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | 1·31 | 1·34 | 1·37 | 1·39 | 1·43 | 1·46 | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | | 1·33 | 1·35 | 1·38 | 1·41 | 1·44 | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES 1. Bomb Bay Store Weight is defined as removable stores and equipment carried throughout the flight. This includes: Weapon Carriers;
Weapons;
Dry Weight of Bomb Bay Fuel Tanks;
Weight of fuel remaining in Bomb Bay Tanks on landing.

2. Weight of Bomb Bay Fuel consumed during flight is Bomb Bay Fuel Weight on take-off minus Bomb Bay Fuel Weight on landing.

3. If all the Bomb Bay Stores are carried throughout the flight, then K2 is obtained from the table above.

4. If part of the Bomb Bay Stores is dropped during the flight, obtain K2 from the table, then K2 (Store dropped) = ½ [K2 (Store carried) -1 ] + 1

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TABLE 5

ROLE LIFE FOR VULCAN 2 AIRCRAFT FOR HIGH-LOW-HIGH FLIGHTS

| AUW on Take-off (lbs) | WEIGHT OF FUEL USED BEFORE START OF LOW LEVEL RUN (lbs) | | |
|---|---|---|---|
| | < 16,000 | ≥16,000 to < 30,000 | ≥ 30,000 |
| < 165,000 | 590 Hrs | 1,080 Hrs | 1,670 Hrs |
| ≥ 165,000 to < 175,000 | 740 Hrs | 1,610 Hrs | 2,000 Hrs |
| ≥ 175,000 to < 180,000 | 1,180 Hrs | 1,490 Hrs | 2,670 Hrs |
| ≥ 185,000 | 1,100 Hrs | 1,636 Hrs | 3,010 Hrs |

TABLE 6

ROLE LIFE FOR VULCAN 2 AIRCRAFT FOR HIGH LEVEL AND OCU FLIGHTS

| AUW on Take-off (lbs) | High Level Flights (Hrs) | OCU Flights (Hrs) |
|---|---|---|
| < 165,000 | 2,661 | 1,980 |
| ≥ 165,000 to < 175,000 | 3,685 | 2,410 |
| ≥ 175,000 to < 180,000 | 3,907 | 4,470 |
| ≥ 180,000 | 4,426 | 3,940 |

TABLE 7

ROLE LIFE FOR VULCAN 2 AIRCRAFT FLOWN IN MINOR ROLES

| ROLE | ROLE LIFE (Hrs) |
|---|---|
| Display | 750 |
| Long Range Transit | 11,100 |
| Pre-Delivery | 840 |
| Test Flights (Below 2,000 Ft) | Refer to High-Low-High Table above |
| Test Flights (Above 2,000 Ft) | Refer to High Level Table above |

## FATIGUE LIVES OF SPECIFIED AREAS

28. The full scale Fatigue Test Specimen (FTS) has at July 1969 completed testing to FI 239. Failures have occurred at several areas and safe fatigue lives have been calculated for these areas. Remedial modifications or replacement of lifed items have to be carried outbefore the safe life is reached. The actual time of embodiment of the larger modifications will be governed by Return to Works programmes, details of which will be advised by Command Headquarters.

29. The failures on the FTS up to July 1969 are:

TABLE 8

| Ser No. | Item | Safe Life of Item | Repair Modification No. | Remarks |
|---|---|---|---|---|
| (a) | (b) | (c) | (d) | (e) |
| 1 | Top hat flexible joint | FI 33 | – | Joint replaced every 33 FI |
| 2 | U/c side load beam bracket | FI 34 | 2044 | Replacement bracket |
| 3a | Rear spar bottom boom | FI 81 | 2222 | Repair to boom |
| 3b | Rear spar bottom boom | App FI 230 | Not yet submitted | Replacement of boom |
| 4 | Leading edge joint 4 at Station 428 | FI 84 | 2199 | Mod will have to be repeated no later than 84 FI after replacement of skins at Item 9 |
| 5 | Front spar bottom boom and skin at u/c rib station | FI 114 | 2081 | Repair to boom |
| 6 | Leading edge joints 2 and 3 at Station 352 | FI 119 | 2221 | Mod will have to be repeated no later than 119 FI after replacement of skins at Item 9 |
| 7 | Front spar web (port only) at inboard air intake | FI 129 | 2248 | Repair to web |
| 8 | Front spar web at bomb bay rib | FI 152 | 2205 | Repair to web |
| 9 | Leading edge skins between joints 3 and 5 | FI 160 | Not yet submitted | Fitment of new skins |
| 10 | Leading edge joint 5 at Station 492 | FI 220 | Not yet submitted | Fitment of new skins and butt straps |
| 11 | Front spar bottom boom | App FI 250 | Extended version of Mod 2081 not yet submitted | Embodiment point depends on when Mod 2081 for Station 5 is embodied |

### FATIGUE LIFE OF BLUE STEEL INSTALLATIONS FIXED FITTINGS

30. The following are the three most critical items in fatigue of the Blue Steel fixed fittings:

(a) Carrier beam lower forward boom - (lifed on crutchings only).

(b) Hoist jack ram - (lifed on crutchings only).

(c) Carrier beam lower aft boom.

31. For those items lifed on crutchings only, the lives are:

(a) Carrier beam lower forward boom: 3 000 crutchings.

(b) Hoist jack ram: 5 700 crutchings.

32. The life of the carrier beam lower aft boom depends upon the pattern of utilisation, and the rate of consumption is expected to be slow. Calculation of the life consumed is by use of the formula:

FI Consumed =

$$1/1\,000\,(37.5N_1 + 35.7N_3 + 14.4H_1 + 22.0H_2 + 0.4H_3 + 2.5H_4 + 14.8H_5 + 0.5H_6)$$

where:

$N_1$ = W100A crutchings

$N_3$ = W103A crutchings

$H_1$ = W100A hours of squadron flying

$H_2$ = W100A hours of low level flying

$H_3$ = W103A hours of squadron flying

$H_4$ = W103A hours of OCU flying

$H_5$ = W103A hours of display flying

$H_6$ = W103A hours of low level flying.

33. For those flights on which a missile is carried, the number of the missile in addition to all flight details is to be recorded on STC Form Stats 2045. When a missile is crutched to an aircraft, the number of the missile and the serial number of the aircraft, together with other relevant details, is to be reported on STC Form Stats 2048.

### CALCULATION OF AIRFRAME FATIGUE LIFE – SR MK.2

34. The following paragraphs give information on the provisional fatigue meter formula provided for Vulcan SR Mk.2 aircraft and the method of calculating the fatigue life consumed. The formula is based on the flight profile for the SR role and the theoretical loading spectrum. Account is taken of the results obtained from the Fatigue Test Specimen (FTS) and test flights of the fatigue life support programme and is based on the FTS failure at the rear spar bottom boom adjacent to the outboard undercarriage rib (rib 338). The formula will be reviewed when more operational data on the SR role becomes available.

**Fatigue meter**

35. The fatigue meter fitted to Vulcan SR Mk.2 aircraft is a Type 18A with a remote fatigue load consumption indicator Type M2372.

36. The load levels of the meters and the notation for the number of counts recorded at different load levels are as follows:-

| Meter Type | LOAD LEVEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 18A | | 0.05g | 0.45g | 0.75g | 1.25g | 1.55g | 1.95g | 2.35g | 2.65g |
| Notation for number of counts recorded | A | B | C | D | E | F | G | H | J |

▶ 37. On a Type 18A meter the notation A is to be ignored. ◀

**Calculations for metered flight**

38. The index consumed is given by:-

$$\text{FI consumed} = \frac{1}{1000} \times \left\{ \begin{array}{l} 3.34A + 10.562B \\ + \ 2.597C \ + \\ 1.275D + 0.198E \\ + \ 3.945F \ + \\ 13.23G \ + \\ 23.463H \ + \\ 30.51J + 8.506n \end{array} \right\}$$

Where A to J are the counts recorded in flight at the load levels shown in para.36 and n is the number of full-stop landings.

**Calculations for unmetered flight**

39. If the flight is unmetered or the fatigue meter is unservicable the fatigue index is calculated as follows:-

$$\text{FI consumed} = 0.01535 \times \left\{ \begin{array}{l} \text{Unmetered hours} \\ \text{flown by the} \\ \text{aircraft for the} \\ \text{period} \\ \text{considered.} \end{array} \right\}$$