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# FORCE MANAGEMENT METHODS
## Task I Report — Current Methods

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A state-of-the-art survey was conducted as the initial phase of the preparation of a handbook of methods for accomplishing force management in accordance with the requirements of MIL-STD-1530A. This report presents the results of the survey and summarizes the information gathered from visits to 47 organizations and from a review of pertinent literature. In particular, the current methods for accomplishing individual aircraft tracking

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loads/environment spectra surveys, and force structural maintenance planning are described. Those methods which satisfy MIL-STD-1530A requirements are recommended for inclusion in the handbook. Data collection and data processing methods are reviewed and compared in terms of accuracy and cost. The coordination of the major elements of force management is reviewed with emphasis on the organizational and data analysis interfaces. Specific force management data was collected on all major operational Air Force airplanes and a summary for each is also presented.

PREFACE

The University of Dayton, teamed with Lockheed-Georgia Company and Vought Corporation, are conducting a study of Force Management Methods under Contract F33615-77-C-3122 sponsored by the Air Force Flight Dynamics Laboratory Structures Branch (AFFDL/FBE). Mr. Terry D. Gray is the Air Force Project Engineer. The contractor program managers are Larry E. Clay (University of Dayton), Doug S. Morcock (Lockheed), and Ned H. Sandlin (Vought).

The objective of the program is to describe applicable force management methods in an Air Force handbook for use by Air Force and industry engineers as a guideline in selecting methods of complying with the requirements of MIL-STD-1530A. The methods to be addressed include the development and execution of a force structural maintenance plan; the design, data collection, and analysis of a loads/environmental spectra survey of fleet operations; and the design, implementation, and analysis of an individual aircraft usage tracking program with applications to structural maintenance scheduling and planning. The University of Dayton will study data collection and processing methods. Lockheed-Georgia and Vought will study analysis and application methods and structural maintenance management for transport/bomber and attack/fighter/trainer aircraft types, respectively.

The program was started in September 1977. Task I, completed and reported herein, is a state-of-the-art survey of force management methods. Task II will be initiated after approval of this report and will develop improved methods of force management for utilizing fracture mechanics techniques and crack growth gages, mechanical strain recorders, and microprocessor-based digital recording systems. Task III will be the preparation and distribution of the handbook.

The University of Dayton prepared this report, incorporating edited portions of Reference 1 and 2 which were prepared, respectively, by Lockheed and Vought. The report has been reviewed by these companies and their comments have been incorporated. However, the report should be understood as a reflection of the programs under discussion, not as an indication of individual company positions.

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# INTRODUCTION

Within the Air Force Aircraft Structural Integrity Program (ASIP) as described in MIL-STD-1530A, a task called "Force Management" is defined. Force Management is defined as "those actions that must be conducted by the Air Force during force operations to ensure the damage tolerance and durability of each airplane". This military standard and its related specifications have provided a new approach to structural design. Instead of requiring the demonstration of a crack-free safe fatigue life of four times the design service life, the new approach requires the assumption of initial production flaws in the structure and the design for inspectability or for fail-safe or slow-crack growth so that failure is not reached before a period equal to twice the design service life.

Programs to evaluate the structural "durability" and "damage tolerance" have been completed or initiated on all new aircraft systems and on most existing aircraft systems. The methods for performing these analyses, for the collection of operational data, and for the interaction of the structural analyses with the structural inspection program are as varied as the aircraft systems to which they have been applied.

The elements of force management include an individual aircraft tracking program (IAT), a loads/environmental spectra survey (L/ESS), and a force structural maintenance plan (FSM). In addition, force management includes update of the design analyses, the development of inspection and repair criteria, and the formation of a structural strength summary.

The elements of force management are integrated as illustrated in Figure 1-1 to protect the structural integrity of the force. As shown, the initial tracking analysis and force structural maintenance plan are based on design usage spectra. When the L/ESS has defined a baseline operational spectra, the tracking analysis and force structural maintenance plan can be

TABLE 1.1

STATE-OF-THE-ART SURVEY
COVERAGE BY ORGANIZATION

| USAF AFSC | USAF AFLC | AIRFRAMES |
|---|---|---|
| A-10 SPO | HQ AFLC | BOEING-SEATTLE |
| C-5 SPO | OC-ALC | BOEING-WICHITA |
| E-3A SPO | OO-ALC | CESSNA |
| EF-111 SPO | SA-ALC | DOUGLAS |
| FIGHTER/ATTACK SPO | SM-ALC | FAIRCHILD-REPUBLIC |
| F-15 SPO | WR-ALC | GENERAL DYNAMICS |
| F-16 SPO | ASIMIS | LOCKHEED-CALIFORNIA |
| KC-10 SPO | AFALD | LOCKHEED-GEORGIA |
| T-43 SPO | | MCDONNELL |
| | OTHER | NORTHROP |
| | | ROCKWELL-LA |
| USAF USERS | ARMY-FT. EUSTIS | VOUGHT |
| | CONRAC | |
| HQ MAC | DELTA AIRLINES | |
| HQ SAC | GENERAL TIME | |
| HQ TAC | LEIGH INSTRUMENTS | |
| | NASA-LANGLEY | |
| | NAVY-NAVAIR | |
| | TECHNOLOGY INC. | |

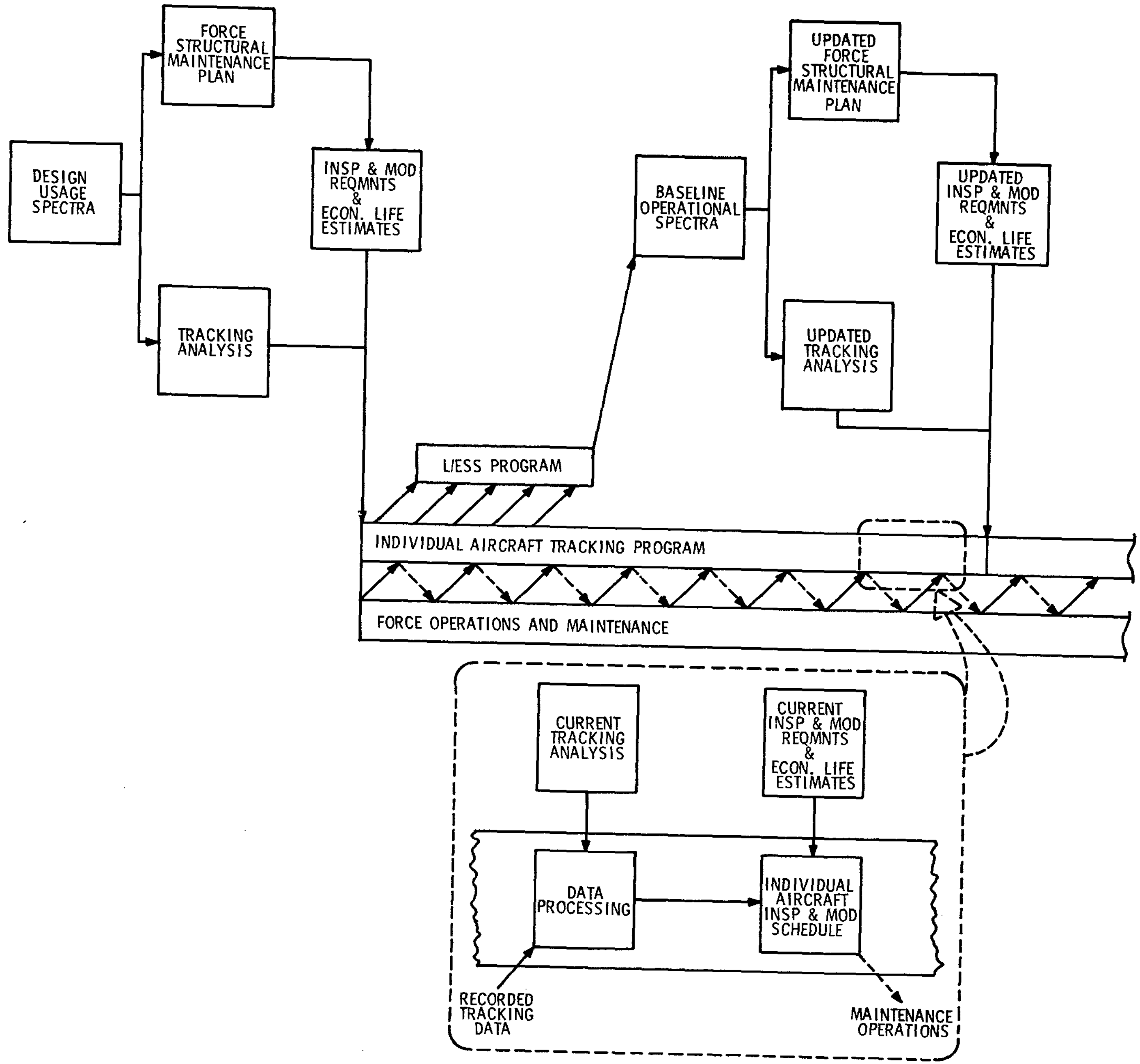



Figure 1.1 Block Diagram of Force Management Elements.

revised to reflect the observed operation. Some force management systems have been designed to continue the L/ESS program and to periodically revise the tracking analysis with current operational spectra data.

As defined in MIL-STD-1530A, the individual aircraft tracking program will predict potential flaw growth in initial areas of each airframe that is keyed to damage growth limits of MIL-A-83444, inspection times, and economic repair times. An individual aircraft tracking analysis method will be developed to establish and adjust inspection and repair intervals for each critical area of the airframe based on the individual airplane usage data. The analysis will provide the capability to predict crack growth rates, time to reach crack size limits, and the crack length as a function of the total flight time and usage data. Tracking data acquisition will start with delivery of the first operation airplane.

The L/ESS (loads/environmental spectra survey), in MIL-STD-1530A, will obtain time history records of those parameters necessary to define the actual stress spectra for the critical areas of the airframe. It is envisioned that 10-20 percent of the operational airplanes will be instrumented to record L/ESS data starting with delivery of the first operational airplane. The L/ESS duration is assumed to be 3 years or when the recorded flight hours of unrestricted operation reaches one design lifetime. Provisions must be made to detect a significant change in usage which would require further update of the baseline operational spectra. These provisions may be part of the individual aircraft tracking program.

A force structural maintenance plan, as defined in MIL-STD-1530A, will identify structural inspection and modification requirements and the estimated economic life of the airframe. The plan will include detailed information (when, where, how and cost data) and will be used for budgetary planning, force structure planning, and maintenance planning. The plan will be initially derived from design usage spectra and will be subsequently updated to reflect operational usage spectra provided by the L/ESS program.

The work reported herein covers a review of the current force management methods as described in the literature and during contacts with all principal organizations with Air Force force management activities. Table 1.1 lists the organizations contacted.

This Task I report describes the current methods, the coordination aspects of force management, criteria for selecting methods, current methods recommended for future applications, guidelines for application of methods, and recommendations for developing improved methods.

The appendices include an outline for a force management handbook, summaries of force management programs on current aircraft systems, and a copy of TO 1F-4C-6ASI-1 (an F-4 structural inspection document).

## SECTION II

## SUMMARY OF CURRENT METHODS

Methods of force management are a complex interaction of several organizations attempting to maintain, or improve, the structural integrity of their assigned aircraft system. Although the force management methods are treated herein as three separate tasks - IAT, L/ESS, and FSM - it is generally recognized that the method of approach to these tasks can not, and must not, be considered independently. Some organizations simplify the selection of methods by including the L/ESS as an integral part of the IAT or of the FSM and thus reducing force management to two tasks - IAT and FSM. The current force management requirements were finalized in MIL-STD-1530A during 1975. There has been a continuing evolution of different ASIP requirements through the years such as:

- ASD-TN-61-141 in 1961
- ASD-TR-66-57 in 1968
- MIL-STD-1530 in 1972

Because of the changing requirements, different techniques have evolved for force management, such as fatigue vs crack growth and testing to four lives vs one life. The aircraft now in the Air Force inventory have been designed, tested, and managed in various ways according to which of the above requirements was specified during procurement. Some aircraft types have been "upgraded" to varying degrees of more recent ASIP requirements.

During this study, working level technical personnel from forty-seven aircraft and instrument companies, using commands, and other government agencies were interviewed to determine methods currently used in aircraft structural force management. This section summarizes these methods. Additional details are included in the Appendices.

TABLE 2.1

AIRCRAFT SYSTEMS SURVEYED

TRANSPORT/BOMBER SYSTEMS

| Aircraft | Fleet Size | Primary Mission | Manufacturer | System Manager |
|---|---|---|---|---|
| B-1 | 3 | Strategic Bombing | Rockwell | AFSC/ASD |
| B-52 | 349 | Strategic Bombing | Boeing | OC-ALC |
| C-5A | 77 | Logistics | Lockheed | SA-ALC |
| C-9 | 23 | Med. Evacuation | Douglas | SA-ALC |
| C-130 | 711 | Logistics | Lockheed | WR-ALC |
| C/KC-135 | 751 | Transport/Tanker | Boeing | OC-ALC |
| C-140 | 15 | VIP Tranport | Lockheed | WR-ALC |
| C-141 | 271 | Logistics | Lockheed | WR-ALC |
| E-3A | 40* | Airborne Alert | Boeing | AFSC/ESD |
| FB-111A | 67 | Attack | General Dynamics | SM-ALC |
| KC-10A | 20* | Cargo/Tanker | Douglas | AFLC/ALD |
| T-39 | 142 | VIP Transport | Rockwell | SM-ALC |
| T-43 | 19 | Nav Training | Boeing | SA-ALC |

ATTACK/FIGHTER/TRAINER SYSTEMS

| Aircraft | Fleet Size | Primary Mission | Manufacturer | System Manager |
|---|---|---|---|---|
| A-7D | 400 | Air-Ground | Vought | OC-ALC |
| A-10 | 733* | Air-Ground | Fairchild-Republic | AFSC/ASD |
| A-37B | 200 | Air-Ground | Cessna | SA-ALC |
| F-4 | 1978 | Air-Ground | McDonnell | OO-ALC |
| F-5 E/F | 91** | Air-Ground | Northrop | AFSC/ASD |
| F-15 | 749* | Air-Air | McDonnell | AFSC/ASD |
| F-16 | * | Air-Air | General Dynamics | AFSC/ASD |
| F-100 | 2292 | Air-Ground | Rockwell | SM-ALC |
| F-105 | 200 | Air-Ground | Fairchild-Republic | SM-ALC |
| F-111 | 531 | Air-Ground | General Dynamics | SM-ALC |
| T-37 | 700 | Basic Training | Cessna | SA-ALC |
| T-38 | 920 | Advanced Training | Northrop | SA-ALC |

* Planned
** USAF Fleet Only

The force management methods used for the aircraft listed in Table 2.1 were considered during the state-of-the-art survey. A questionnaire form was completed for each aircraft type and these forms are included in Appendix B.

## 2.1 INDIVIDUAL AIRCRAFT TRACKING (IAT)

An individual aircraft tracking (IAT) method comprises the definition of structural control points at which life remaining will be predicted, the selection of usage parameters suited to life estimation, a data collection technique, and a data reduction and analysis scheme.

Structural control points are selected on the basis of cyclic test results, analytical safety margins, service structural failure experience, and engineering judgment. It is not likely that this technique for selecting control points will change in the foreseeable future.

TABLE 2.2

TYPICAL FLIGHT CONDITION USAGE PARAMETERS

- Flight Segment Type
  (Taxi, Takeoff, Climb, Cruise, Refueling, Etc.)
- Landing Event
- Weight and Distribution
  (Cargo Weight, Fuel Weight)
- Aircraft Configuration (If Appropriate)
- Altitude
  (Gust Environment)
- Segment Duration
- Mission Type
- Airspeed

### 2.1.1 Current Transport/Bomber IAT Methods

The selection of usage parameters to be monitored depends on the particular aircraft system to be tracked and cannot be separated from the selection of the data collection technique. Usage parameters can generally be divided into two groups, those which monitor loads or stresses directly and those which monitor occurrences or durations of specific flight conditions from which the loading environment can be inferred based on the L/ESS data sample. The latter group of parameters are monitored by most, if not all, tracking programs for large flexible aircraft. These aircraft are more sensitive to the high frequency loads caused by turbulence and ground operation than to the low frequency maneuver loads. Thus, the dynamic response to these loads may make it impossible to compute stress histories over the entire airframe from a few monitored stresses. Therefore, the methods presented in this paragraph will be restricted to those which monitor flight condition usage parameters. (Other methods are presented in Paragraph 2.1.2).

Flight condition usage parameters are presented in Table 2.2 in their approximate order of importance. Variations of this list are used by each aircraft system with appropriate additional data for tracking peculiar structural problems or operational capabilities.

All transport/bomber aircraft with IAT programs currently use a form, commonly called a "pilot's log", filled out by a crew member as the means of data collection. The FB-111A is also equipped with counting accelerometers and the CT-39 is planning to use a mechanical strain recorder, but these devices are normally associated with the smaller aircraft classes and will be discussed in Paragraph 2.1.2.

The current transport/bomber IAT methods have been summarized into the six general methods listed in Table 2.3. These methods are described in the following paragraphs. Table 2.4 indicates which method is utilized by each of the surveyed aircraft systems. A more detailed description of the IAT for each system is presented in Appendix B.

#### 2.1.1.1 Method 1 - Flight Hours/Landings

One airplane (CT-39) is tracked by flight hours, i.e., the total number of flight hours is multiplied by fatigue damage coefficients for each control point. This is perhaps the simplest individual aircraft tracking system possible, and is probably sufficient for an airplane where all control points are flight critical and all missions are very similar. Many aircraft are tracked by flight hours to some extent with some structural inspections scheduled by hours. If the ground-air-ground cycle is determined to be significant, some accounting would have to be made for the number of flights also. Figure 2.1 shows the Method 1 procedure and analysis scheme.

Flight hours and landings are reported as part of the individual airframe operation and maintenance records. A relation between fatigue damage or crack growth and flight hours or landings is determined for a composite mission mix based on design or recorded L/ESS data. The basic premise of this method, then, is that this relation is not significantly affected by changes in operations between the individual aircraft in the force. Thus, all structural planning and scheduling can be accomplished with sufficient accuracy solely on the basis of total airframe hours and landings and on the past and current utilization rate.

#### 2.1.1.2 Method 2 - Parametric Fatigue Damage Tables

This is the most common current IAT method. Most aircraft systems will, however, abandon this method in the near future and will track crack growth instead.

TABLE 2.3

TRANSPORT/BOMBER IAT TRACKING METHODS

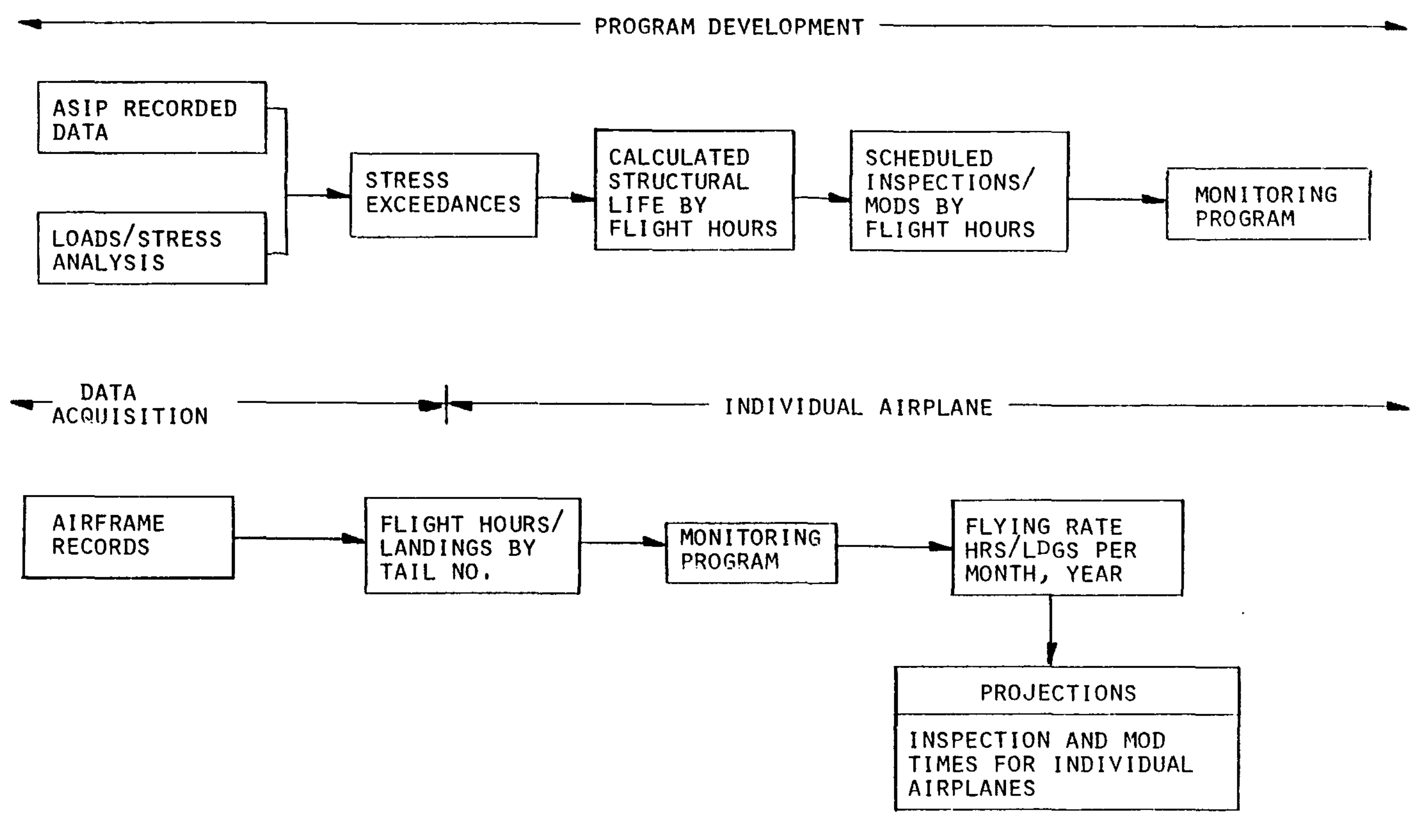
| | |
|---|---|
| METHOD 1 | FLIGHT HOURS/LANDINGS |
| METHOD 2 | PILOTS LOG + TIME BY DATA BLOCK + PARAMETRIC FATIGUE DAMAGE TABLES |
| METHOD 3 | PILOTS LOG + EQUIVALENT MISSION TYPE + MISSION FATIGUE DAMAGE TABLES |
| METHOD 4* | PILOTS LOG + TIME BY DATA BLOCK + PARAMETRIC CRACK GROWTH TABLES |
| METHOD 5* | PILOTS LOG + EQUIVALENT MISSION TYPE + MISSION CRACK GROWTH TABLES |
| METHOD 6* | PILOTS LOG + CALCULATED STRESS OCCURRENCES + CYCLE-BY-CYCLE CRACK GROWTH |

* These methods were presented in Reference 8. Although not being used operationally, they are being considered during current IAT program revisions.

TABLE 2.4

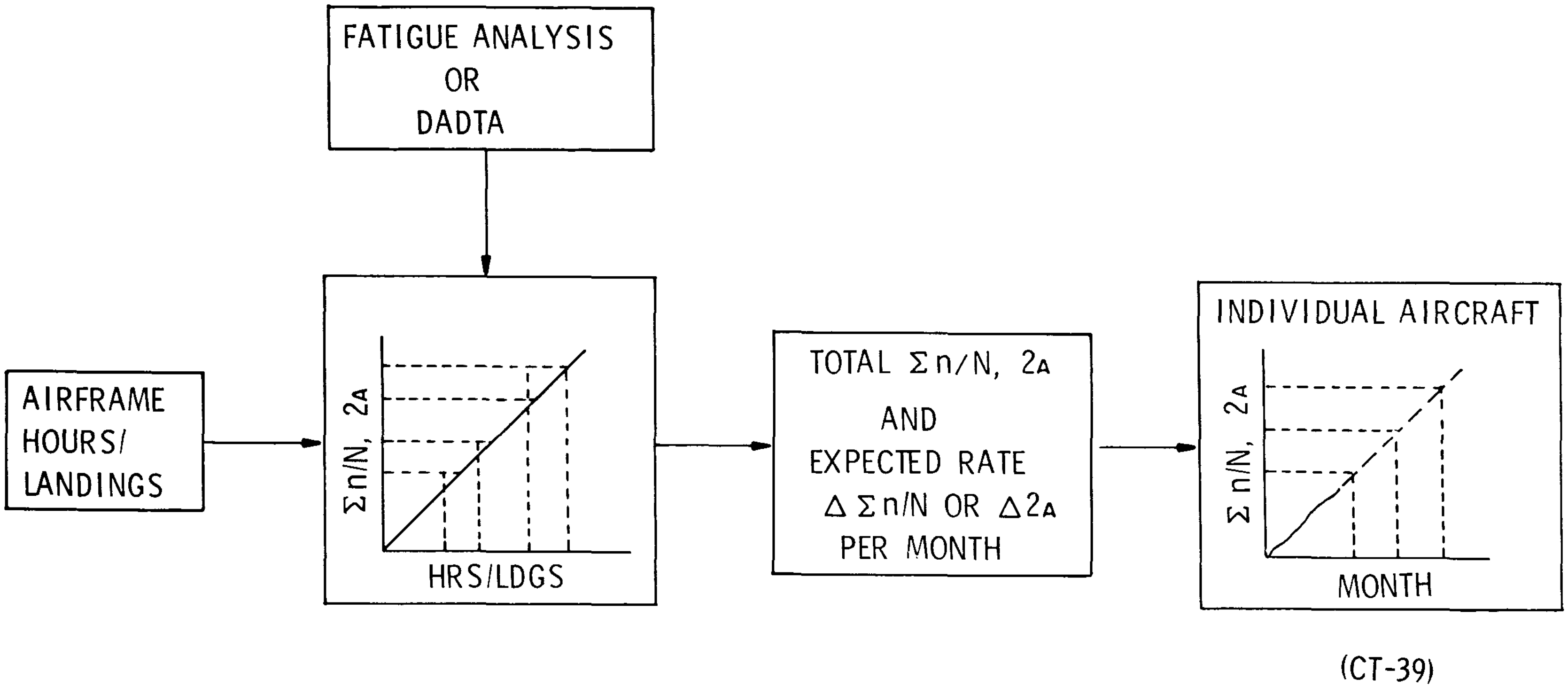
TRANSPORT/BOMBER IAT PROGRAM SUMMARY

| Aircraft | Current Method | DADTA Status | Pending IAT Revision |
|---|---|---|---|
| B-1 | None | Minimum | None |
| B-52 | 2 | In Work | 4, 5, or 6 |
| C-5A | 2 | Completed | 4 or 5 |
| C-9 | None | None | None |
| C-130 | 2 | Pending | None |
| C/KC-135 | 2 | In Work | 4, 5, or 6 |
| C-140 | None | None | None |
| C-141 | 2 | Completed | 4 or 5 |
| E-3A | - | In Work | 4 or 5 |
| FB-111A | 3 | None | None |
| KC-10A | - | Pending | Unknown |
| T-39 | 2 | In Work | MSR? |
| T-43 | 2 | None | None |




a) Tracking Procedure - METHOD 1

Figure 2.1 IAT METHOD 1 - Flight Hour/Landings.




b) Analysis Scheme - METHOD 1

Figure 2.1 (Concluded)

As shown in Figure 2.2., IAT METHOD 2 utilizes pilots logs to determine the time spent in selected data blocks. During program development, the rate of damage accumulation in each data block was calculated from a recorded sample of operational data. It is assumed that the loads within each data block (whether maneuvers, turbulence, ground, etc.) for prolonged operation of an individual aircraft will eventually approximate that recorded for the same data block during the operational data sample. Periodic review and update of the parametric fatigue damage tables is necessary to make sure that the operational data sample is current.

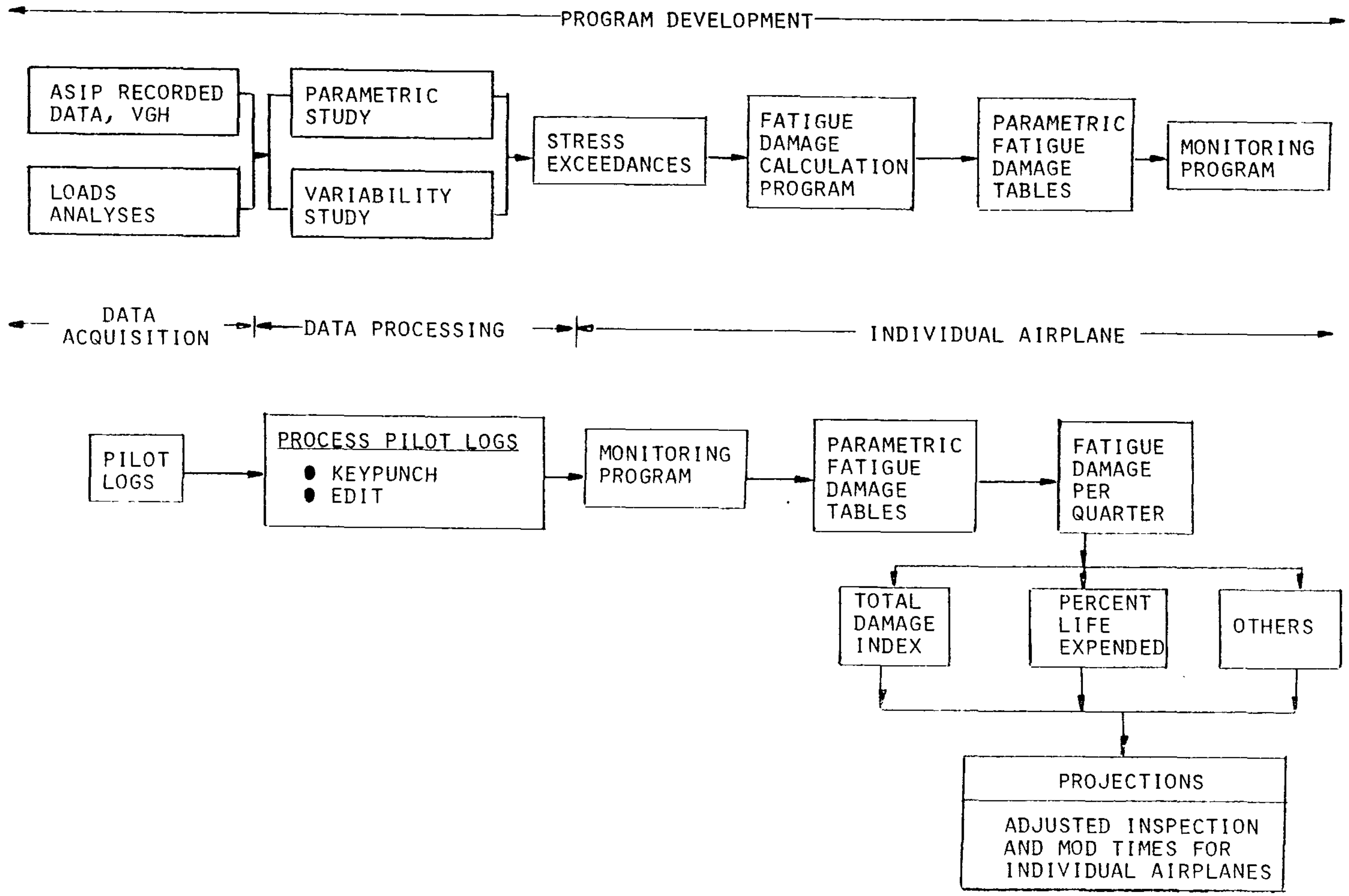
Of course the fatigue damage approach assumes that the accumulation of damage can be considered linear, i.e., independent of the sequence of applied loads. During normal operational usage, the actual loading sequence becomes less important as the total hours on an airframe increases, and the resulting cumulative damage index is considered adequate as an "indicator" for planning force structural inspections and modifications or for adjusting aircraft utilization.

The parametric fatigue damage tables are generated for each structural control point. A loads spectrum (and a stress cycle spectrum) is developed for each data block and for each control point from a sample of recorded data. With this data and a set of SN data for each control point, a damage rate ( $\Sigma$ n/N per hour or per occurrence) is computed for each data block.

The output of this method may be a fatigue damage index as shown in Figure 2.2 or "equivalent hours" of a representative spectrum as used for the C-5A IAT.

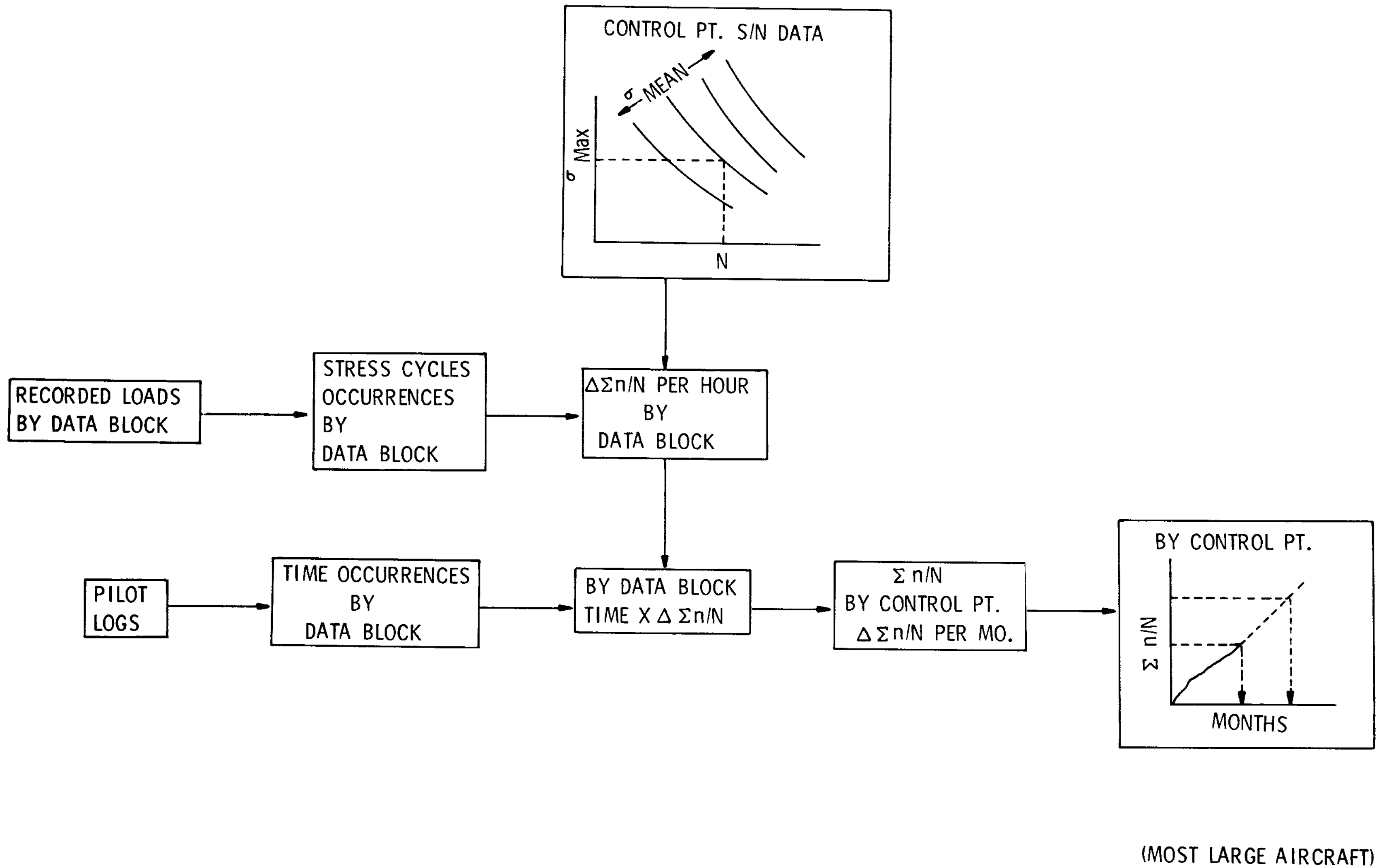
2.1.1.3 Method 3 - Mission Fatigue Damage Tables

This method is similar to METHOD 2 except that the pilot log data is processed into the time spent in standard missions (instead of data blocks). This method is illustrated in Figure 2.3.



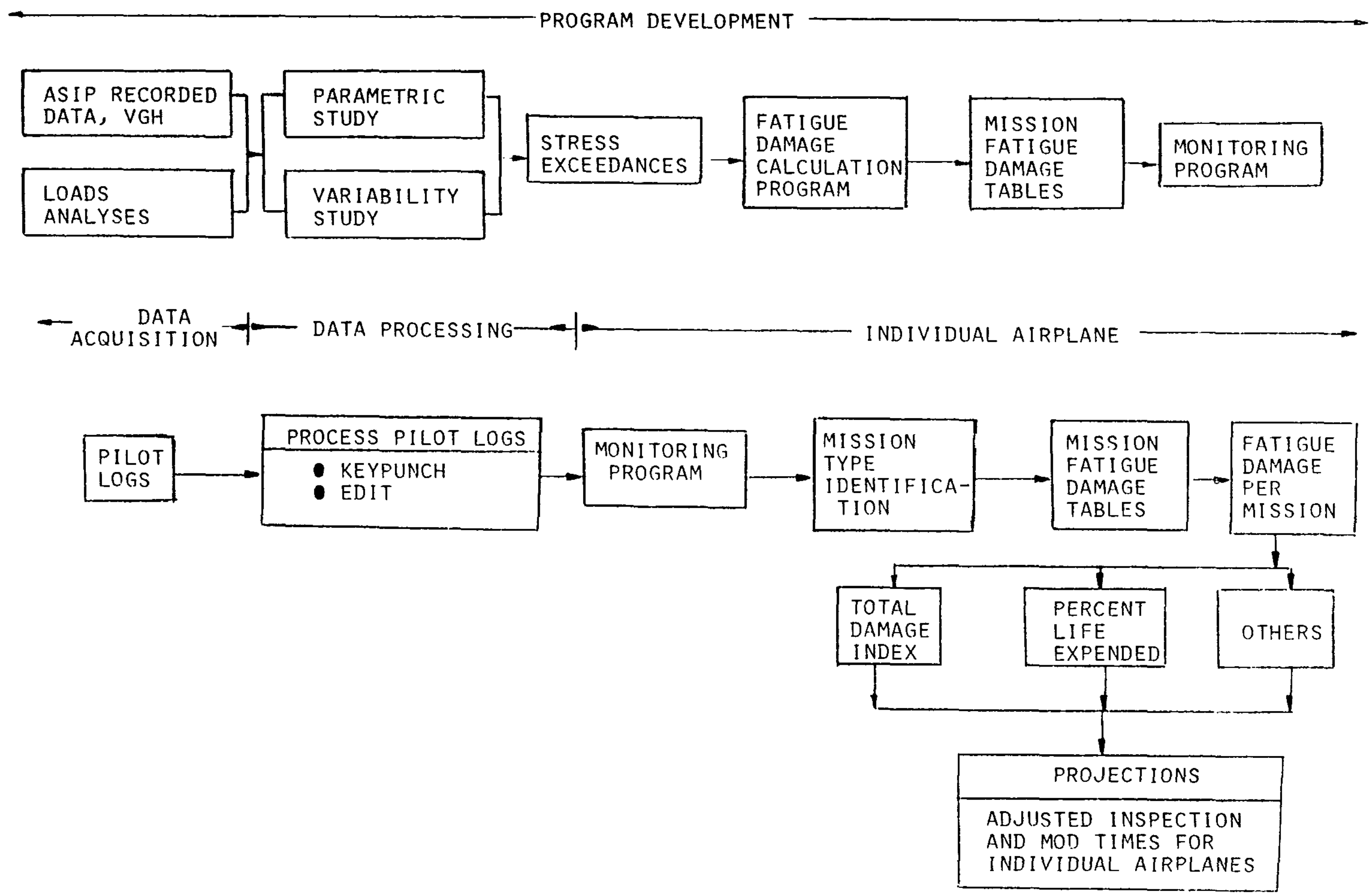

a) Tracking Procedure - METHOD 2

Figure 2.2 METHOD 2 - Parametric Fatigue Damage Tables.



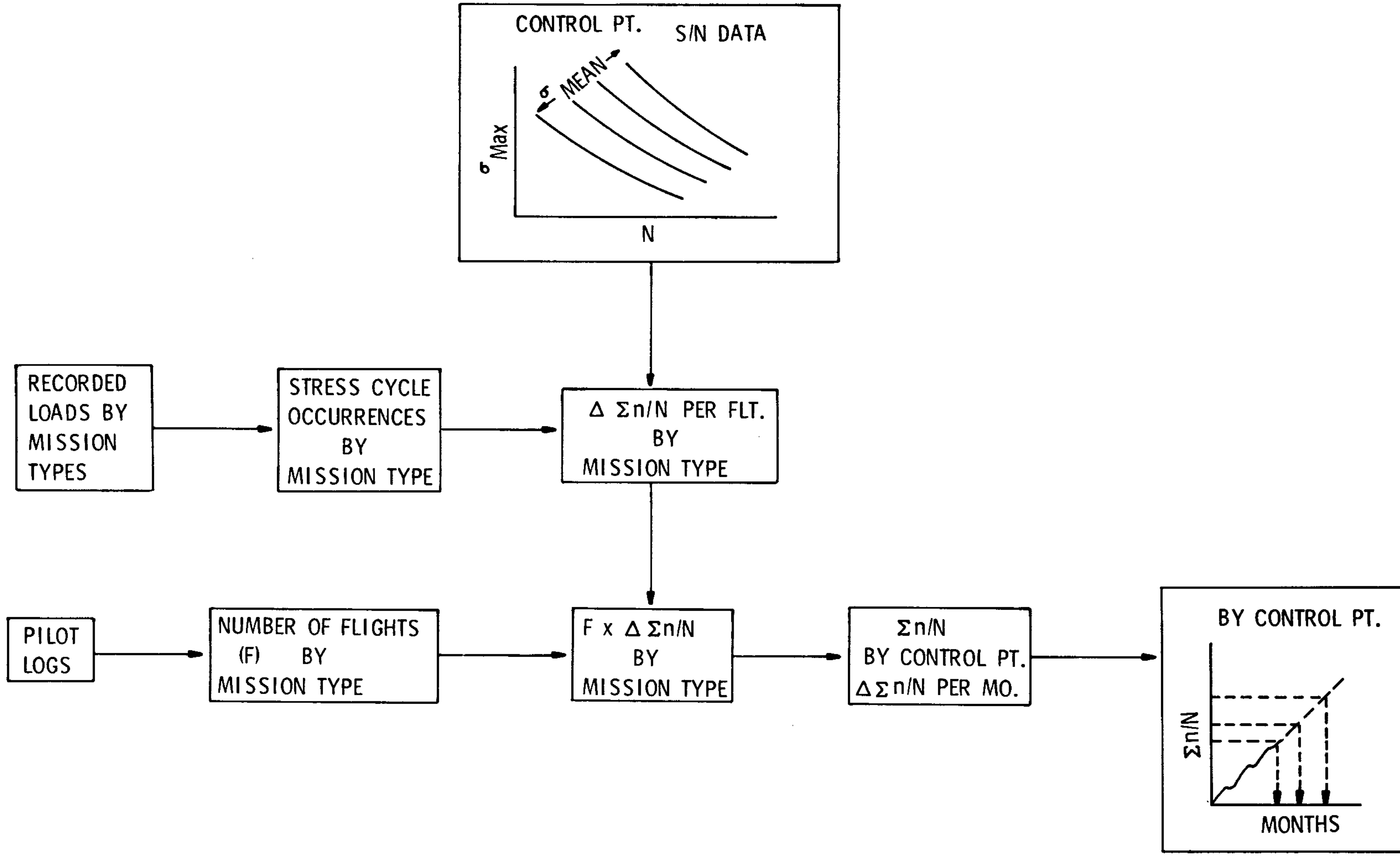

b) Analysis Scheme - METHOD 2

Figure 2.2 (Concluded).




a) Tracking Procedure - METHOD 3

Figure 2.3 METHOD 3 - Mission Fatigue Damage Tables.




(FB-111)

b) Analysis Scheme - METHOD 3

Figure 2.3 (Concluded).

The description of a standard mission may include takeoff gross weight, takeoff fuel weight, flight purpose, and flight profile data (i.e., percentage of time in low level, percentage of time refueling, number of airdrops, etc). Between 50 and 500 standard missions may be required to adequately cover the mission variables. As in METHOD 2, it is assumed that the loads for a given mission category during prolonged operation of an individual aircraft will eventually approximate the average recorded operational data sample.

METHOD 3 represents a significant reduction in the number of fatigue damage calculations required to fill the parametric tables but the data reduction is complicated by the mission classification logic.

#### 2.1.1.4 Method 4 - Parametric Crack Growth Tables

This crack growth tracking method is similar in concept to the fatigue method in METHOD 2. This method is being considered for use by several aircraft systems.

The crack growth analysis differs from the fatigue damage analysis in that it is nonlinear, i.e. crack growth rate is a function of loading sequence and existing crack length. An initial flaw size is assumed to account for material and fabrication defects which initiate cracks. This initial flaw size can be assigned a high value (e.g. 99.9 percent probability level) for a damage tolerance or safety analysis or an average value (e.g. 50 percent probability level) for a durability or economic analysis. Thus, each structural control point can have a "safe" life and an "economic" life. The "safe" life approach is used in scheduling inspections to protect the structural integrity.

From a recorded operational data sample, as shown in Figure 2.4, stress exceedances are derived for each data block and a sequence of stress cycles is generated in some random fashion. A crack growth computer program then generates a crack growth rate as a function of crack length for each data block. These rates become the parametric crack growth tables.

During the operational part of this method, the pilot log data is converted to time spent in each data block. The crack growth for each data block is the product of the time and of the crack growth rate (a function of the data block and the crack length at the start of the data block). The retardation effects of loading sequence are either included in the crack growth rates based on typical sequences or are included in the form of an adjustment after specific flight segments.

2.1.1.5 Method 5 - Mission Crack Growth Tables

This method, described in Figure 2.5, is quite similar to METHOD 4 except the crack growth tables are in the form of crack growth per flight for selected mission categories. The mission categories must include breakdown by mission parameters as takeoff weight, takeoff fuel weight, flight purpose, percentage of time in low level, etc. Between 50 and 500 mission categories would be required to cover the mission parameters.

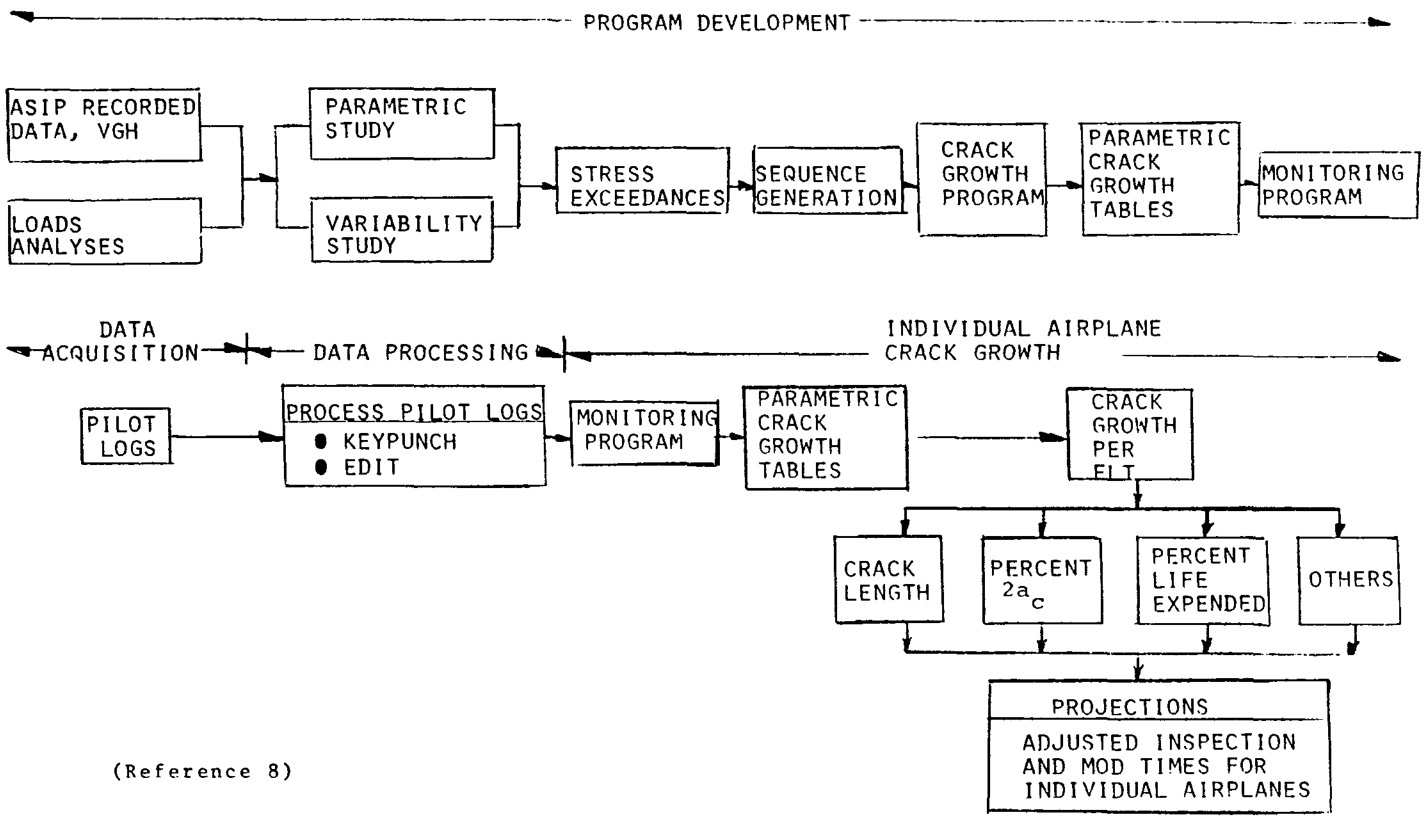
Because of the cost of generating crack growth curves and the reduction in the number of curves to be generated, the cost of the program development is lower for METHOD 5 than for METHOD 4.

An advantage of treating crack growth for an entire flight as in METHOD 5 is that sequence effects within a mission can be accounted for more rigorously for "standard" missions. It is not suitable for non-"standard" sequence, however.

2.1.1.6 Method 6 - Stress Occurrence Tables

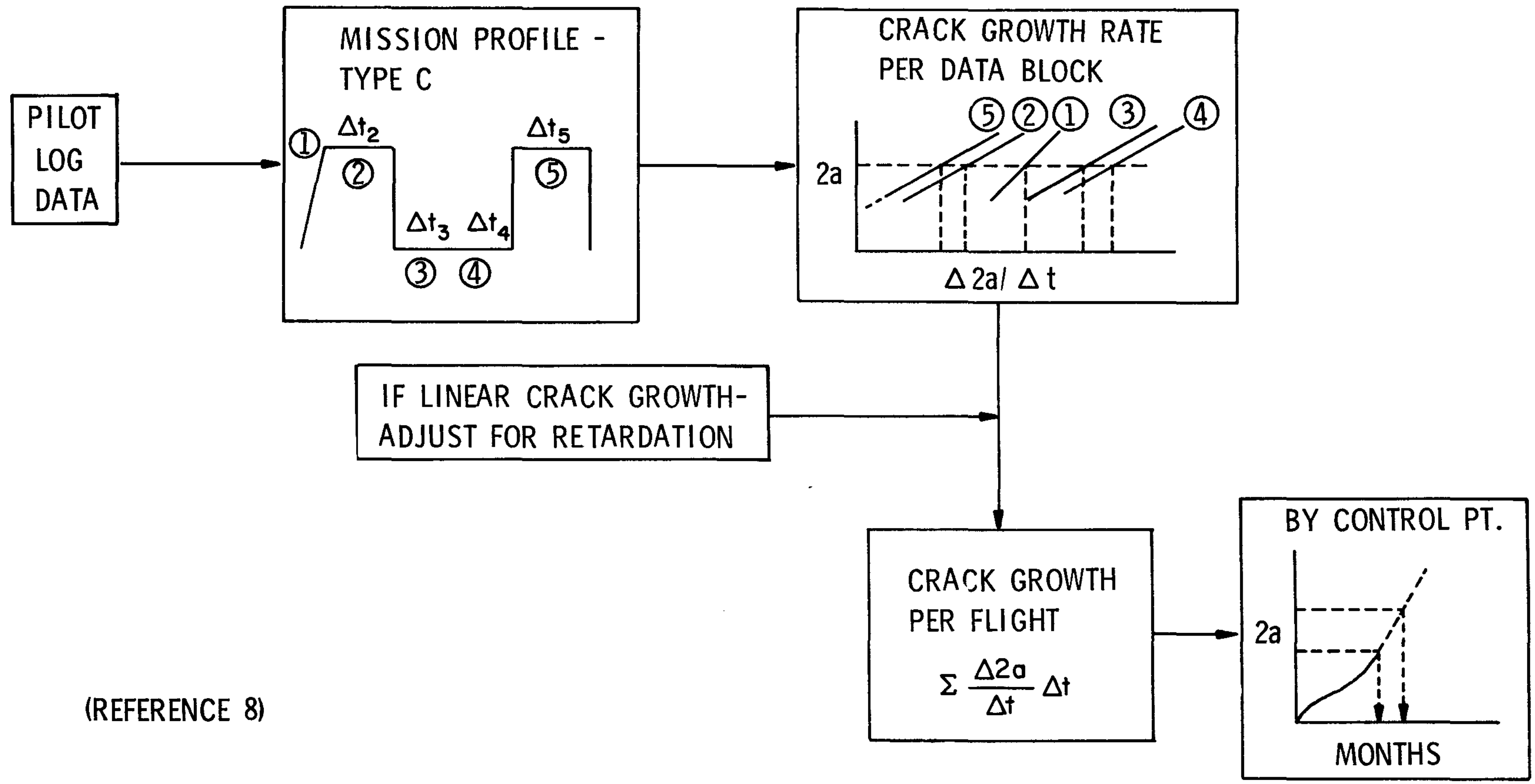
In this method, stress exceedance curves are generated for each data block (or mission segment) and stored in parametric stress occurrence tables as shown in Figure 2.6.

During IAT operation, the pilot log data is converted to time in each data block. The stress occurrence tables for each data block is adjusted for the time spent and a sequence of stress cycles is generated for the flight by summing




a) Tracking Procedure - METHOD 4

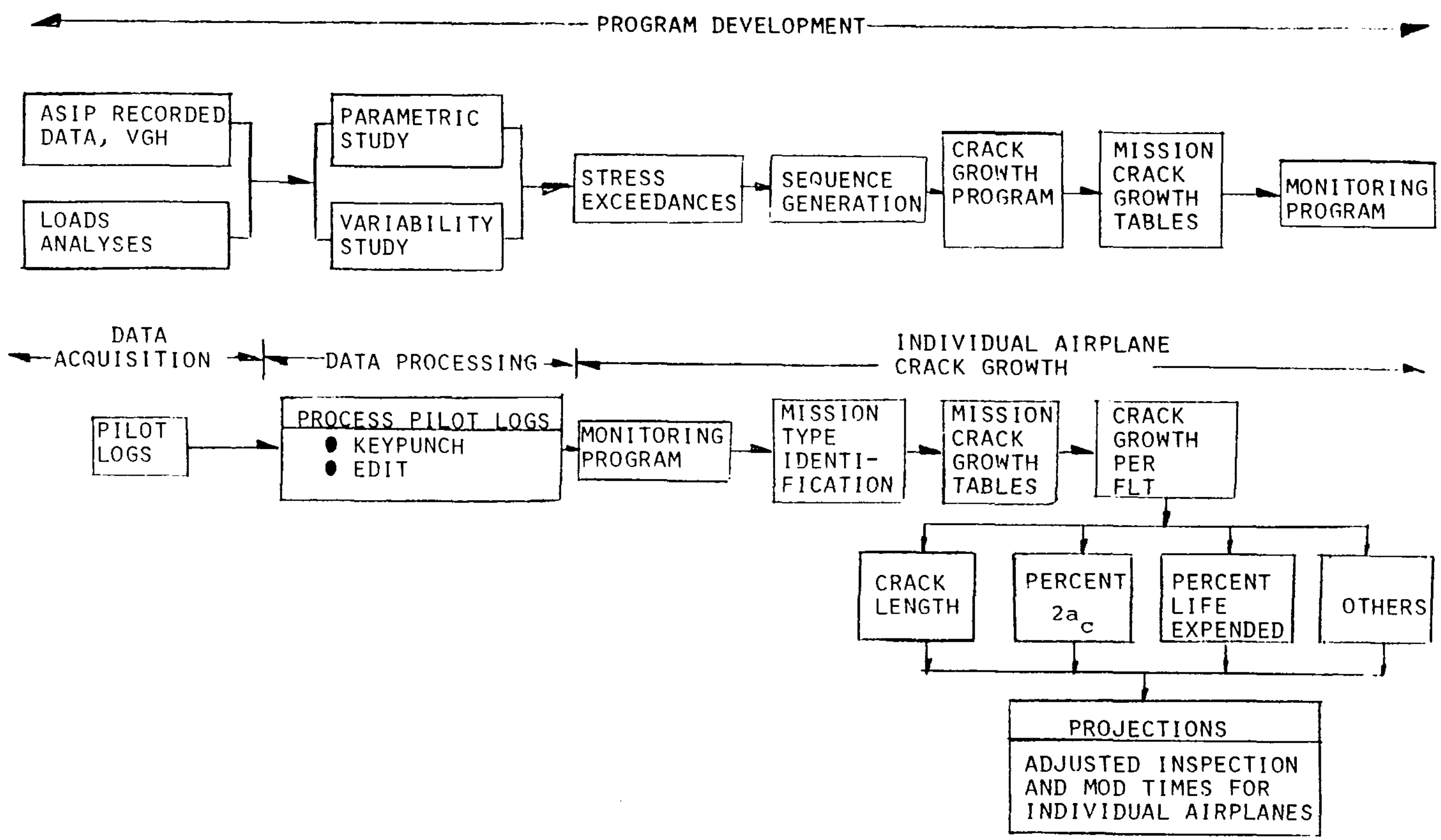
Figure 2.4 METHOD 4 - Parametric Crack Growth Tables.




(REFERENCE 8)

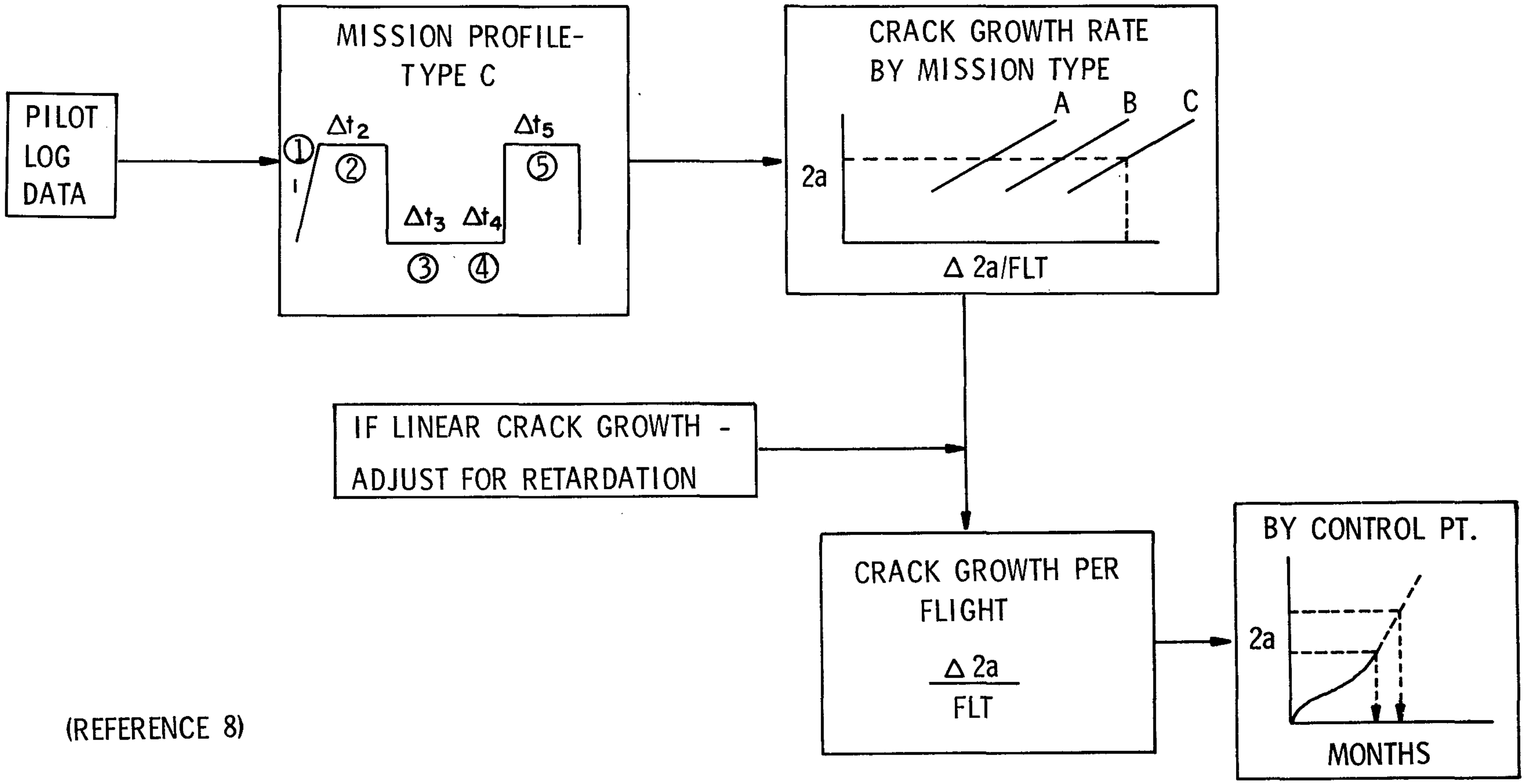
b) Analysis Scheme - METHOD 4

Figure 2.4 (Concluded).



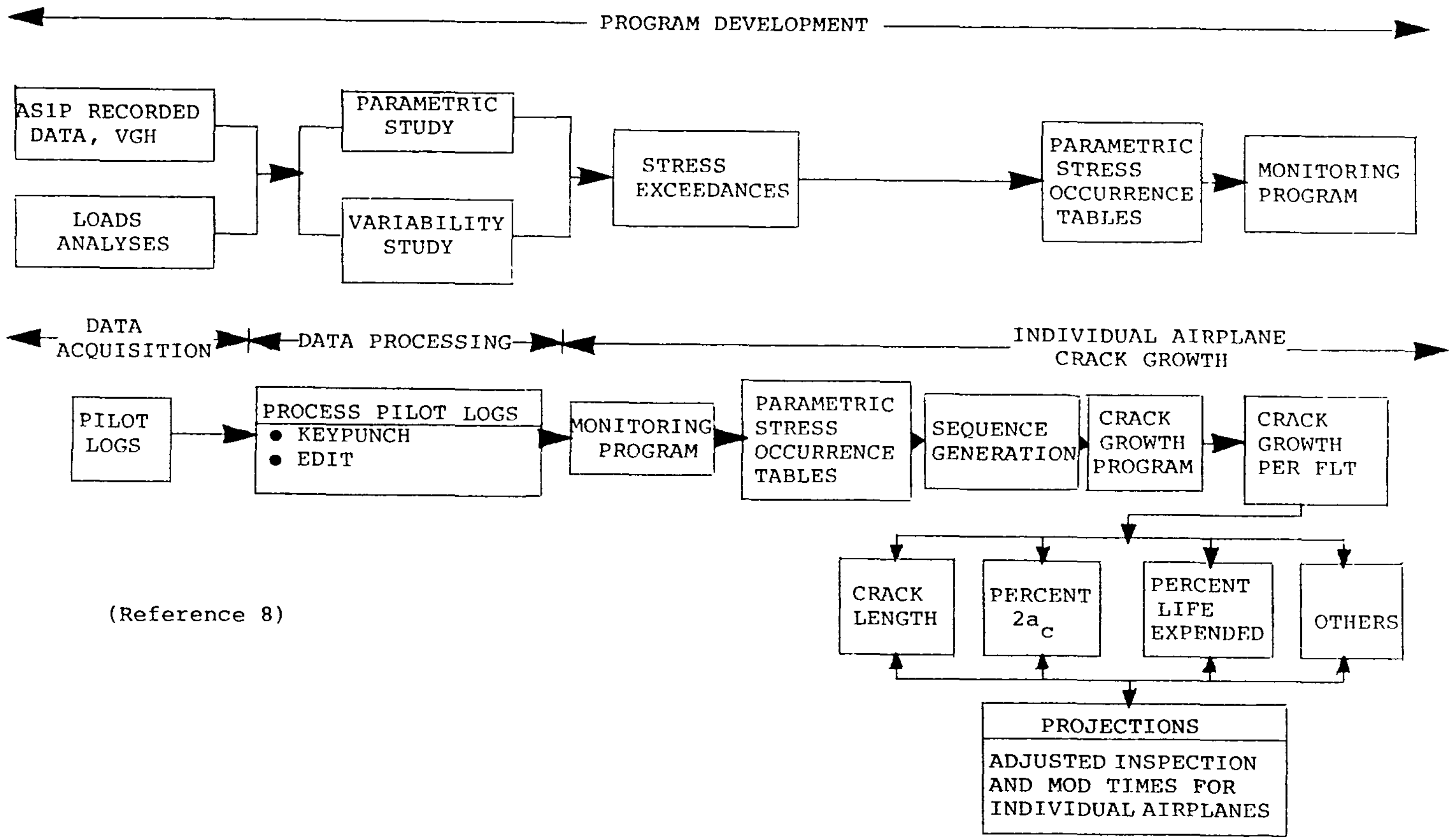

a) Tracking Procedure - METHOD 5

Figure 2.5 METHOD 5 - Mission Crack Growth Tables.



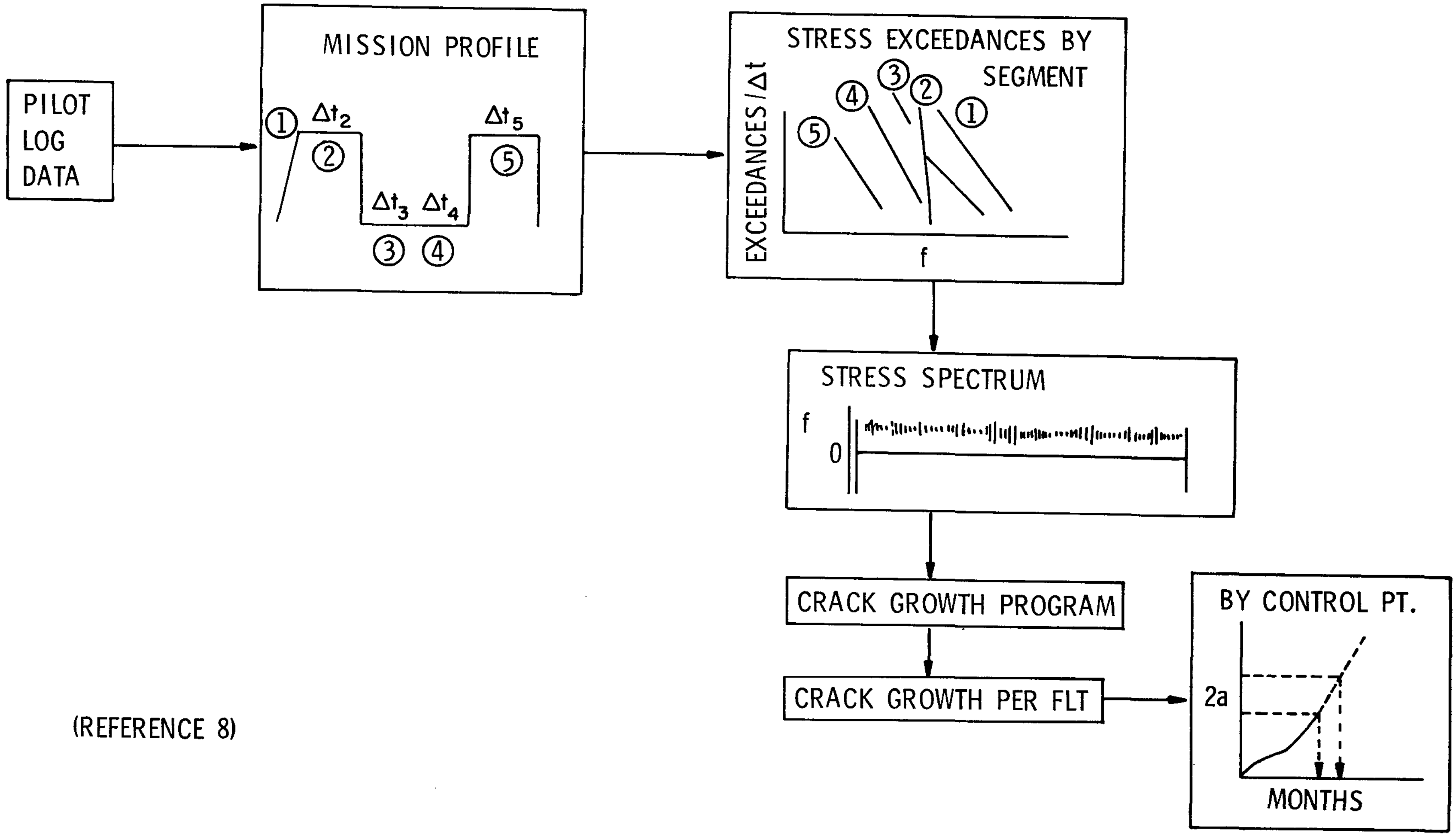

b) Analysis Scheme - METHOD 5

Figure 2.5 (Concluded)




a) Tracking Procedure - METHOD 6

Figure 2.6 METHOD 6 - Stress Occurrence Tables.




(REFERENCE 8)

b) Analysis Scheme - METHOD 6

Figure 2.6 (Concluded).

the data blocks. Then a cycle-by-cycle crack growth computer program computes the crack growth for the flight based on the crack length at the beginning of the flight.

This method allows more flexibility in the sequencing of loads within each flight, but at a significant increase in computer time.

### 2.1.2 Current Attack/Fighter/Trainer IAT Methods

The objective of the IAT program as specified in current requirements is to monitor the usage of each individual airplane and to provide structural inspection and maintenance schedules based on predicted flaw growth. However, before fracture mechanics techniques were available, the objective was the same except it was based on accumulated fatigue damage. This has resulted in the current IAT programs being basically split into two categories, fatigue or crack growth, according to when the aircraft was designed. Some of the aircraft, the F-16 in particular, have been developed under the new requirements and do not currently have all the parts of force management in operation. In these cases, the planned efforts will be considered current state-of-the-art.

In general, there are five steps to IAT:

- Data Source
- Data Collection and Processing
- Damage Calculation
- Results and Presentation
- Use of Results

Five general methods have been described in this section to represent the current IAT methods as shown in Table 2.5. Table 2.6 indicates which of the five general methods is applicable to each A/F/T aircraft. This table also presents the status of the durability and damage tolerance assessment (DADTA) and whether a change in tracking method is expected.

## TABLE 2.5

## ATTACK/FIGHTER/TRAINER IAT TRACKING METHODS

| | |
|---|---|
| METHOD 7 | AFM 65-110 DATA + TIME BY MISSION + MISSION FATIGUE DAMAGE TABLES |
| METHOD 8 | FORMS + TIME BY MISSION + MISSION FATIGUE DAMAGE TABLES |
| METHOD 9 | FORMS/COUNTING ACCEL + $N_z$ COUNTS BY MISSION + PARAMETRIC FATIGUE DAMAGE TABLES |
| METHOD 10 | COUNTING ACCEL + $N_z$ COUNTS BY MONTH + NORMALIZED CRACK GROWTH CURVES |
| METHOD 11 | MSR + STRESS EXCEEDANCES BY 50 HR + NORMALIZED CRACK GROWTH CURVES |

## TABLE 2.6

## ATTACK/FIGHTER/TRAINER IAT SUMMARY

| Aircraft | Current Method | DADTA Status | Pending IAT Revision |
|---|---|---|---|
| A-7D | 10 | Completed | None |
| A-10 | 9 | In Work? | 10 |
| A-37B | 8 | Pending | None |
| F-4 | 10 | Completed | None |
| F-5 | 9 | In Work | Crack Growth |
| F-15 | 9 | Completed | Crack Growth |
| F-16 | 11* | In Work | None |
| F-100 | 7 | None | None |
| F-105 | 7 | Limited | None |
| F-111 | 9 | Completed | None |
| T-37 | None | Pending? | None |
| T-38 | None | In Work | None |

* Planned

There are four sources of IAT data currently being employed:

- o AFM 65-110 Data
- o Special Forms
- o Counting Accelerometers (CA)
- o Mechanical Strain Records (MSR)

A discussion of these data collection methods is described briefly in the following paragraphs and in more detail in Section 2.4.

For two of the older aircraft (i.e. F-100 and F-105) the data source for IAT consists of gathering information from existing 65-110 data tapes. This data, as part of the overall AFM 66-1 reporting system, consists of flight-by-flight information as follows:

- o Data
- o A/C serial number
- o Organization/location (base)
- o Flight time (for this mission)
- o Mission symbol
- o Number of landings

The type of mission codes (categories) specified are:

- o Training - Student
  - Crew
  - Operations
- o Operations - Combat
  - Support
  - Delivery
  - Reconnaissance
- o Functional Check Flight
- o Other Missions

This data is entered into the 65-110 system from the AFTO Form 781.

For most A/F/T aircraft, a unique form for each type aircraft is required to be filled out by flight/ground crew on a flight-by-flight basis or elapsed time period. This form by-passes the

TABLE 2.7

COUNTING ACCELEROMETER PARAMETERS

| | COUNTERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Aircraft | $n_{z_1}$ | $n_{z_2}$ | $n_{z_3}$ | $n_{z_4}$ | $n_{z_5}$ | $n_{z_6}$ | $n_{z_7}$ | Elapsed Time |
| A-7 | 5 | 6 | 7 | 8 | | | | |
| A-10 | 0.3 | 2.5 | 3 | 4 | 5.5 | 7 | | ✓ |
| F-4 | 3 | 4 | 5 | 6 | | | | |
| F-5 | 0.3 | 2.5 | 3 | 4 | 5.5 | 7 | | ✓ |
| F-15 | -2 | -1 | 3 | 3 | 6.5 | 6 | 7.5 | |
| F-111 A/E | 0.5 | 3 | 3.5 | 5 | 6.5 | 8 | | ✓ |
| F-111 D/F | 0.3 | 2.5 | 3 | 4 | 5.5 | 7 | | ✓ |

normal AFM 66-1 procedures and is sent directly to the ALC, ASIMIS, or airframe contractor. This form may include the written information needed for the CA or MSR programs.

To complete the form, substantial data is required such as:

- o Data and base
- o A/C serial number
- o Flight hours
- o Fuel information
- o Mission code
- o Store configuration
- o Landings
- o Refuelings
- o Weights

The information included on the form is generally a function of what the airframe contractor has deemed necessary for damage tracking.

The F-4, F-5, F-15, F-111, A-7, and A-10 aircraft use counting accelerometers for IAT. The CA system consists of a transducer and an indicator which are activated by a "gear up" switch. The system senses and records the number of times each preset airframe vertical acceleration value is equalled or exceeded. The indicator displays these counts. The present levels for each aircraft are listed in Table 2.7. In addition, the indicator for the F-5, F-111, and the A-10 have an elapsed time indication (ETI) window that show the time in flight. Because of the wing sweeping design of the F-111, each aircraft actually has two indicators. One indicator counts only while the wing is swept in the forward position, while the other counts only in the wing aft position.

The MSR (Mechanical Strain Recorder) is a self contained mechanical device capable of sensing and recording total deformation over the effective gage length of the structure to which it is attached. A tensile deformation in the structure causes a stylus to make a scratch on a metal foil tape contained in a cartridge. The magnitude of the scratch is proportional to the deformation. Also, the metal foil advances in proportion to the scratch magnitude. The cartridge is replaced by an unused one and is sent to the data reading facility at ASIMIS along with supplementary cartridge data. This reported data consists of:

- o Date of removal
- o Aircraft serial number
- o Location/Base/Squadron
- o Total aircraft flying hours

Currently, there are no IAT programs using MSR's. There are one hundred MSR's presently being installed in F-5A/B aircraft owned by foreign countries. However, these are only in 20% of the 500 aircraft force. This program is not operational.

There are firm plans to install MSR's in every F-16. Even though this program is not up and going it can be considered current state-of-the-art.

The data processing methods are described in Section 2.5, however, for the A/F/T aircraft IAT systems there are two distinct approaches which should be mentioned here. The first approach is the straightforward flight-by-flight processing which considers the data from each flight independently. Thus, the mission type, the takeoff configuration and weight, and other mission information can be used to define the loading environment for that flight. In the second approach (used for the F-4 and the A-7), the IAT data for an aircraft is reported and processed in monthly units. In this case, it is impossible to assign a specific mission, configuration, or weight to any data unit. Therefore, average load conditions are selected based on a monthly mission mix for each individual aircraft which appears to match the recorded counting accelerometer data during that month for that aircraft.

#### 2.1.2.1 Method 7- Mission Fatigue Damage Tables (AFM 65-110)

The concept of determining the accumulated fatigue damage on several attack/fighter/trainer aircraft is based on the Miner's linear cumulative damage theory. Failure at a point is predicted when the damage summation equals unity ($D=\Sigma n/N=1$), where n is the number of loading cycles and N is the number of cycles to failure at a specified stress level. All of the mentioned aircraft are generally treated in the same manner with only slight variations, each of which will be described. In every case, more than one location in the aircraft structure is considered for fatigue damage accumulation. These "fatigue critical points" (FCP) have usually been identified by lab tests, flight tests, and/or fatigue analyses.

Cumulative fatigue damage, D, can also be determined from the summation of all the various sources of damage, each of which is a product of usage and rate

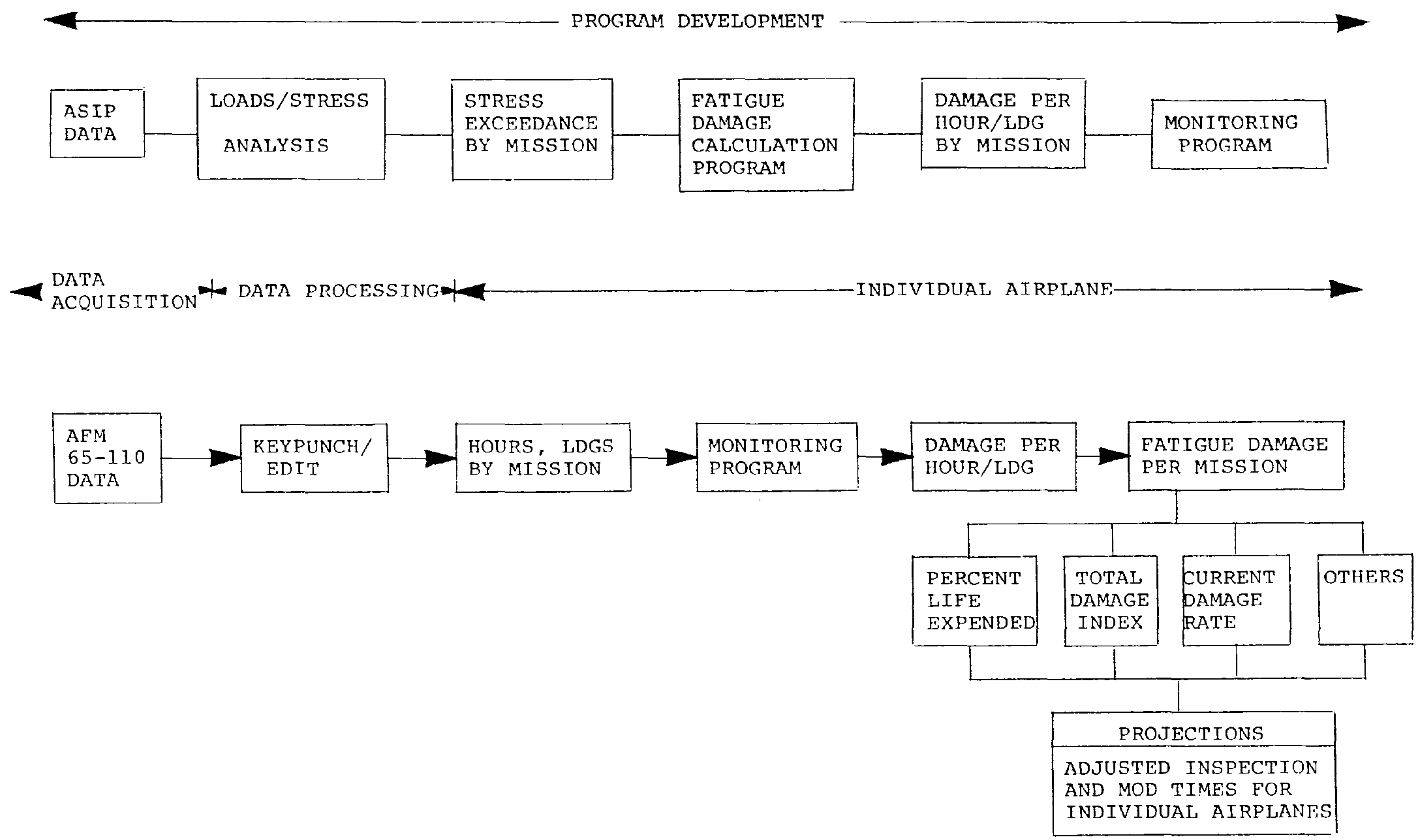
$$D = \Sigma \text{ damage sources} = \Sigma\, U \cdot DR$$

where in the case of the A/F/T aircraft, the usage function U, and damage rate DR, take on meanings such as:

DAMAGE SOURCE

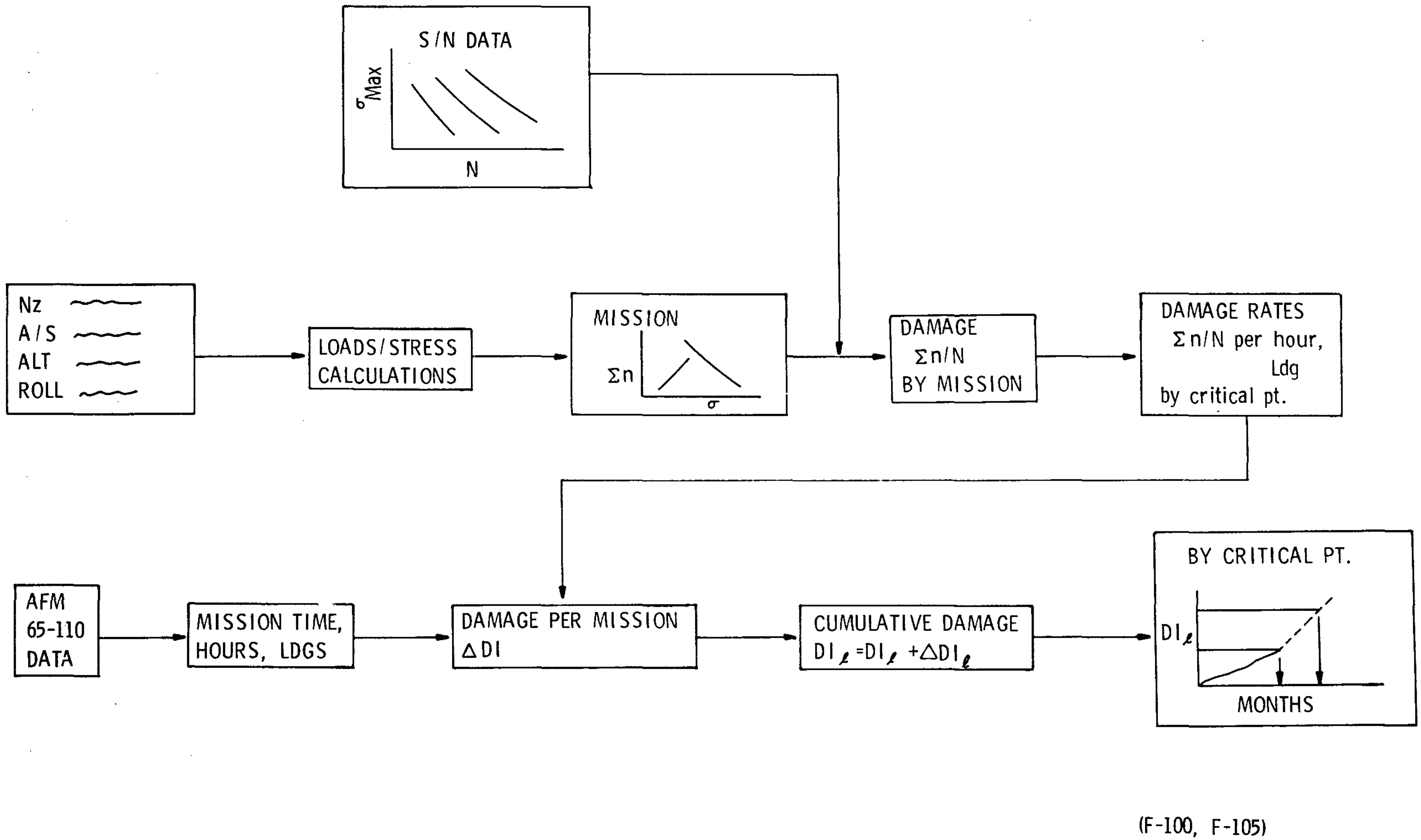
| U | | DR |
|---|---|---|
| number of flight hours | . | damage per flight hour |
| number of landings | . | damage per landing |
| number of flights | . | damage per GAG cycle |
| CA occurrences of g-level | . | damage per g-level occurrence |
| number of equipment cycles | . | damage per cycle |

Each A/F/T aircraft considers various combinations of these damage sources in determining the total accumulated damage. The F-100 and F-105 damages are comprised of ground-air-ground cycles and maneuver cycles only, where the maneuver cycle is the product of flight hours and damage per flight hour.




a) Tracking Procedures

Figure 2.7 METHOD 7 - AFM 65-110 Mission Fatigue Damage Tables.




b) Analysis Scheme - METHOD 7

Figure 2.7 (Concluded).

For Method 7, the accumulated damage is used in conjunction with a scatter factor in determining the appropriate "indicators" or "indices" required to make inspection, maintenance, and modification decisions. The indicators used are:

- o Remaining life (hours, years, or%)
- o Service life (hours or years)
- o Life expended (hours, years, or %)
- o Damage (accumulated damage number itself)

For the F-100 and F-105, the scatter factor used in deriving the indicators is applied to the damage rates (DR) that are determined from the L/ESS analysis. This essentially increases the cumulative damage (D) value before comparison to the allowable damage at a point is made:

$$DR\text{(damage rate)} = \text{actual damage rate} \times \text{scatter factor}$$

$$\text{(damage)} = \Sigma U \cdot DR$$

and

$$RL \text{ (remaining life)} = \frac{1.0 - D}{DR_{FUTURE}}$$

where $DR_{FUTURE}$ is the predicted damage rate (which includes the scatter factor) for the future of the aircraft. This may be in terms of damage per flying hour or per year and may represent base or force wide averages as well as individual aircraft past performance. Then

$$\text{service life} = \text{percent hours (or years)} + RL$$

and

$$\% \text{ life expended} = D \times 100$$

Figure 2.7 summarizes the procedures and analysis used in Method 7 for IAT with AFM 65-110 data. In this method, the damage rate data is developed on a per hour and per landing (or ground-air-ground cycle) basis for each mission type. This method is used for the F-100 and F-105 IAT.

### 2.1.2.2 Method 8 Mission/Configuration Fatigue Damage Tables

Method 8 is summarized in Figure 2.8. This method utilizes a special form for data collection similar to the forms in Method 3. The major difference between Method 8 and Method 3 is that Method 8 considers takeoff configuration as well as mission type as a parameter. This method is used only for the A-37B IAT.

The A-37 accumulates fatigue damage according to the product of number of flights and the damage rate per flight, which includes the taxi and maneuver damage in the rate. The computation of life remaining is essentially the same as that described in Method 9.

### 2.1.2.3 Method 9 - $N_z$ Count Fatigue Damage Rates

Method 9, as shown in Figure 2.9, is an $N_z$ count fatigue damage rate approach. This method uses the recorded counting accelerometer counts as well as flight time and landings as variables to relate damage to individual aircraft operation. This is the most popular current method of using counter accelerometer data, however, the conversion to crack growth tracking will force many A/F/T aircraft away from this approach in the near future.

All of the aircraft using Method 9 (ie. F-5, F-15, F-111, and A-10) use the product of CA occurrences and damage per occurrence. In actuality, the damage rate values (DR's) used in the damage calculations for each critical point are supplied in smaller sub-categories, each identified by mission type and base. Thus, the damage accumulated at each particular structural critical point is:

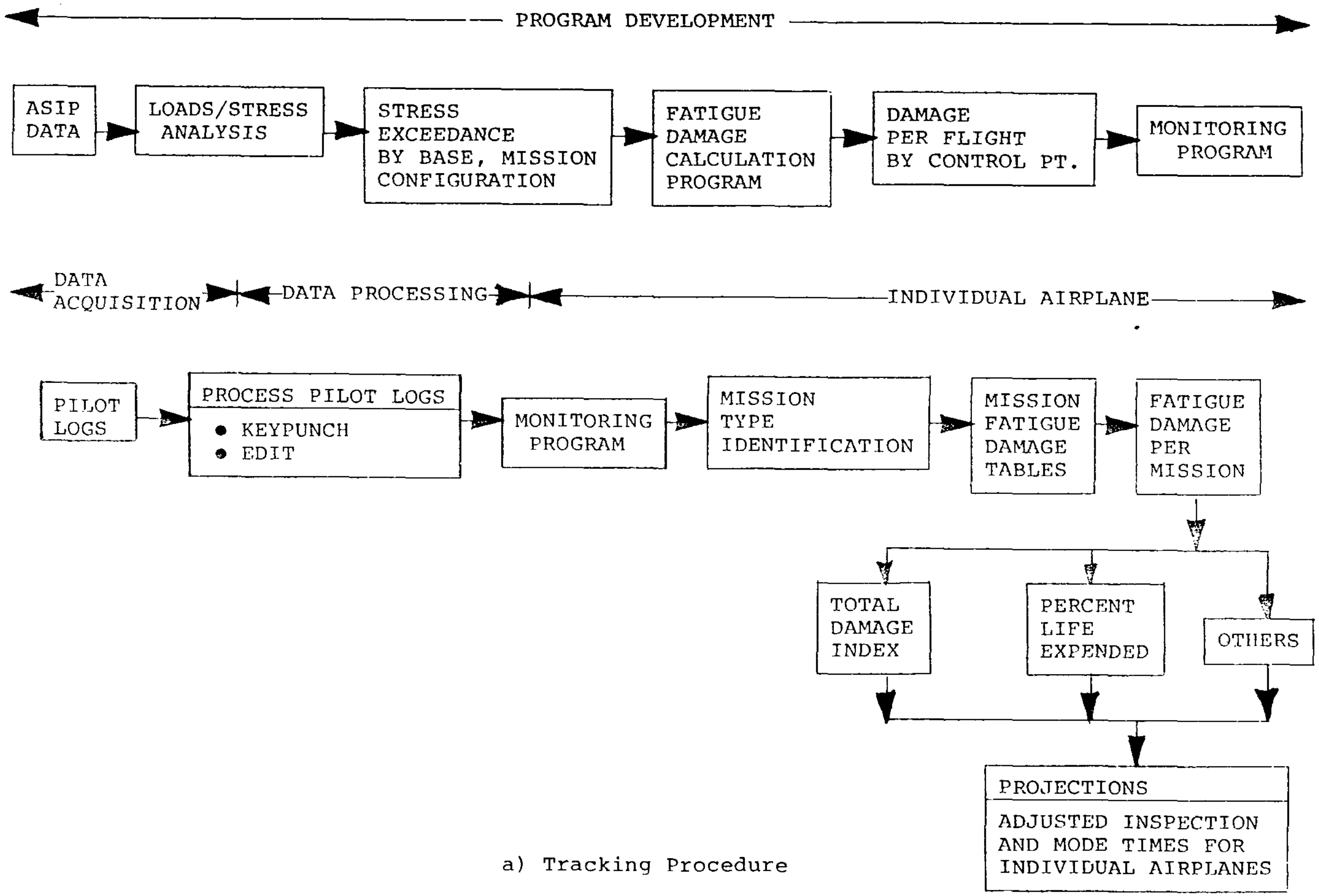
$$D_\ell = \sum_i \sum_j \sum_k U_{ijk} \cdot DR_{ijk\ell}$$

where i is the base identifier

j is the type of mission

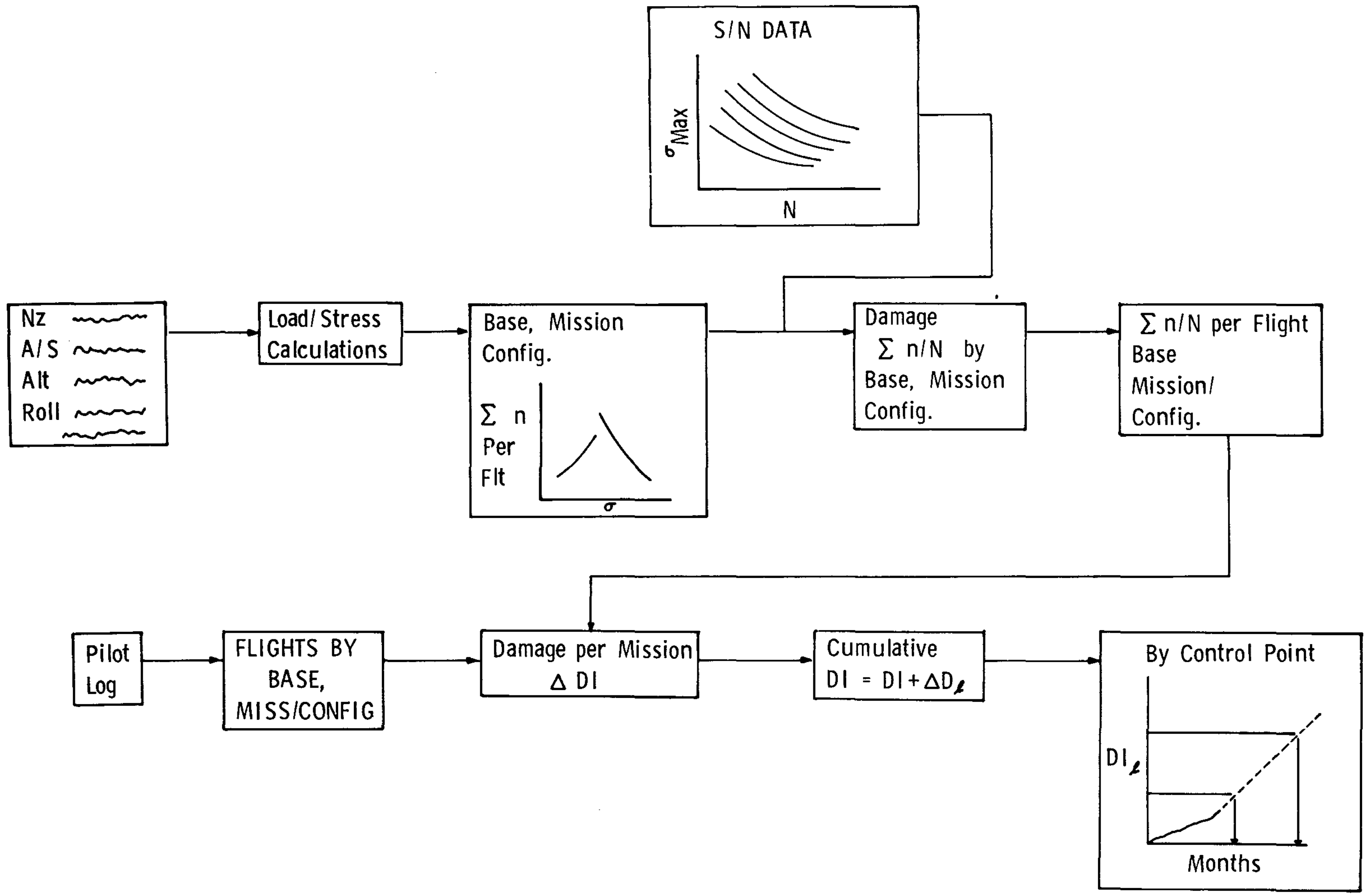
k is the damage source type

$\ell$ is the fatigue critical point identifier



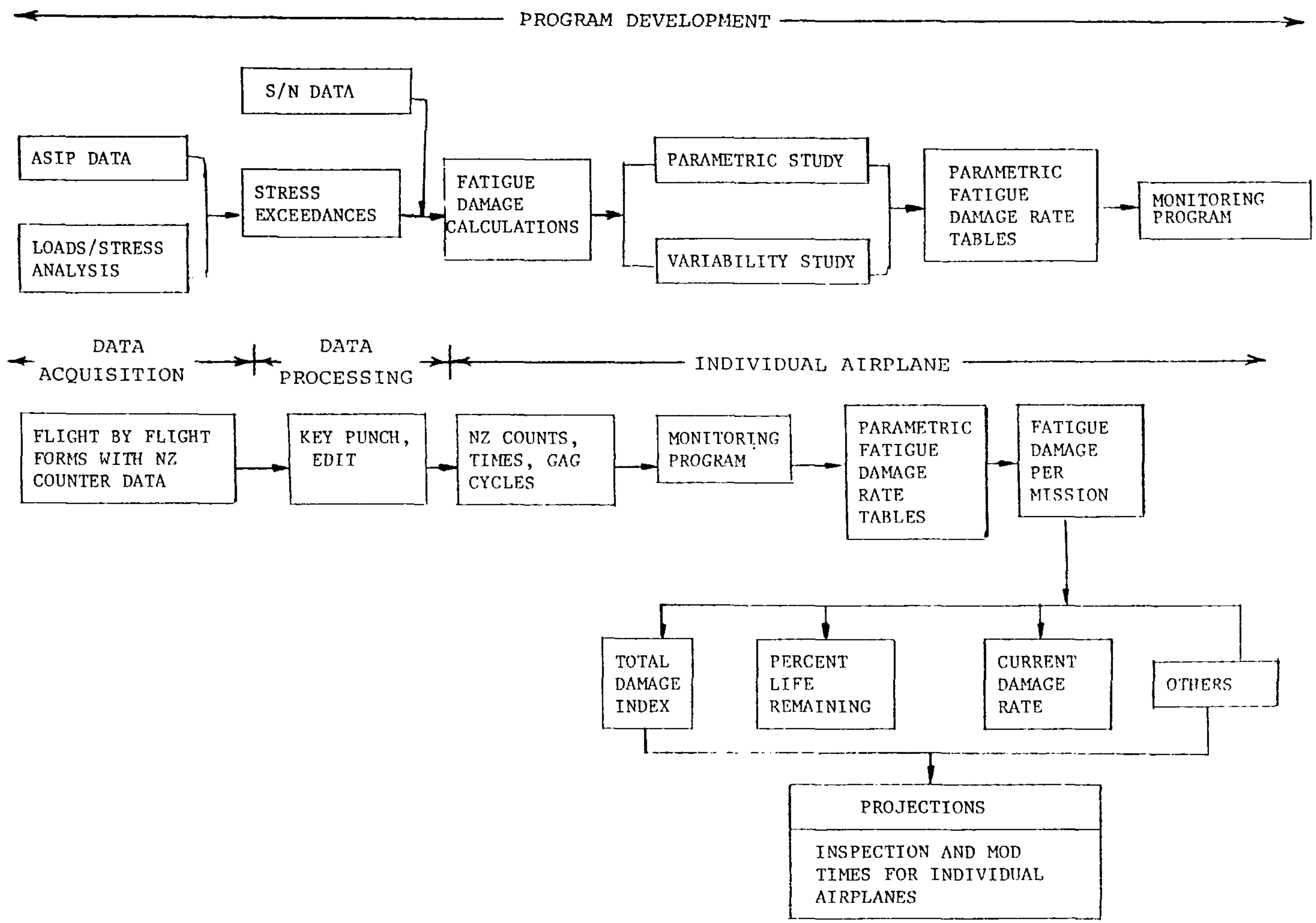

a) Tracking Procedure

Figure 2.8 METHOD 8 - Mission/Configuration Fatigue Damage Tables.



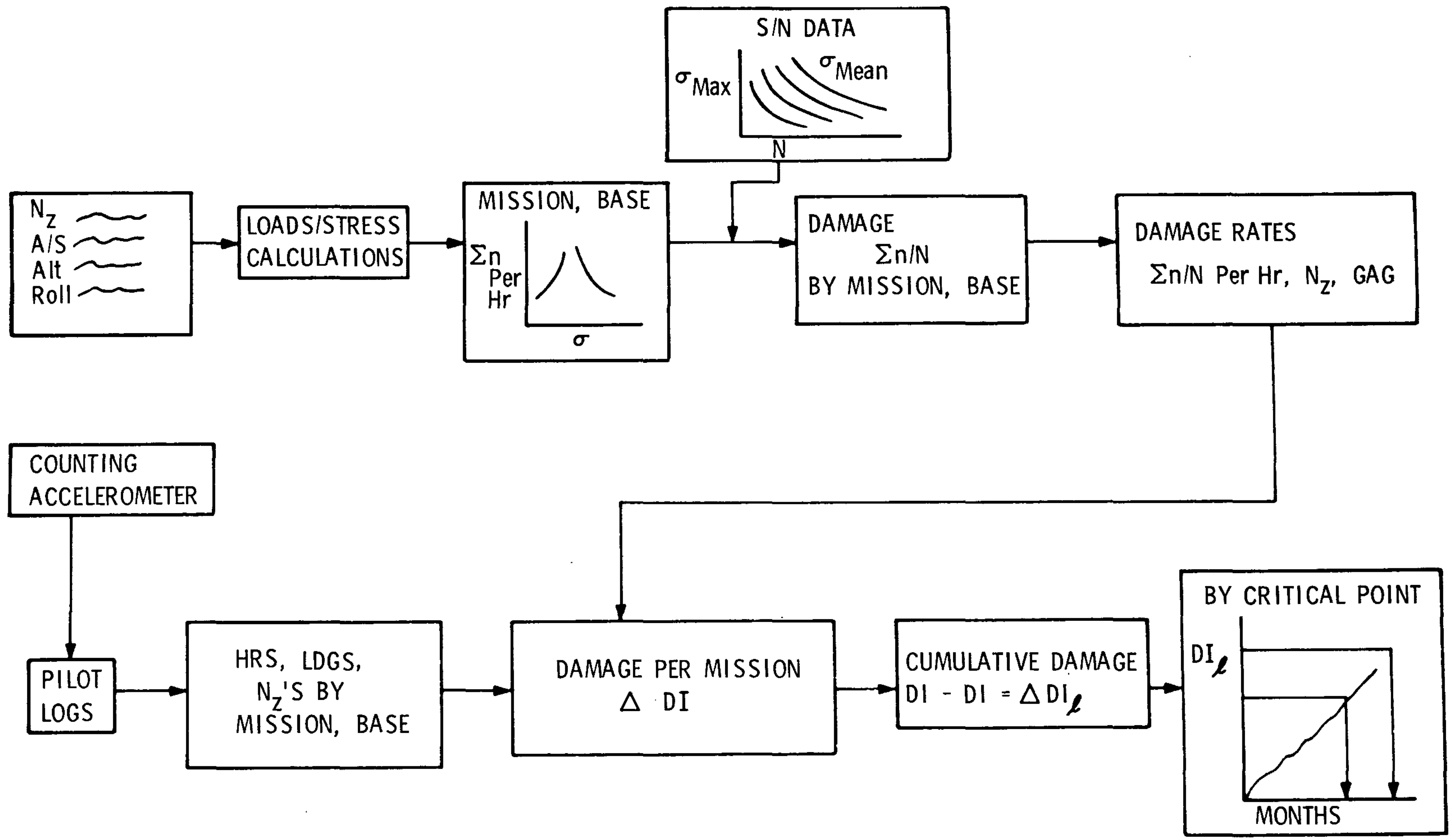

(A-37B)

b) Analysis Scheme - METHOD 8
Figure 2.8 (Concluded)




a) Tracking Procedure

Figure 2.9 METHOD 9 - $N_z$ Count Fatigue Damage Rates.




(F-S, F-15, F-111, A-10)

b) Analysis Scheme - METHOD 9
Figure 2.9 (Concluded).

and

$U_{ijk}$ is the usage function for base i, mission j, and damage source k

$DR_{ijk\ell}$ is the damage rate for base i, mission j, damage source k, and critical point $\ell$

The main purpose of the L/ESS program is to calculate and update these DR's for use in the IAT program. Thus, the IAT usage data collected from the field according to base and mission is combined with the corresponding L/ESS derived damage rate information to arrive at the accumulated damage at each critical point of each individual aircraft.

For the F-5 and F-15 aircraft, the scatter factor is applied to the allowable damage of 1.0, thereby decreasing the damage value at which maintenance actions are required, i.e.:

$$D_A \text{(Damage allowable)} = 1.0 \div \text{scatter factor}$$

Then, as before

$$\text{RL(remaining life)} = \frac{D_A - D}{DR_{FUTURE}}$$

but the damage rates do not have the scatter factor applied. Also:

$$\text{service life} = \text{present} + \text{RL}$$

and

$$\text{\% life expended} = \frac{D}{D_A} \times 100$$

The F-111 and A-10 aircraft, however, used the scatter factor approach described in Method 7.

2.1.2.4 Method 10- Normalized $N_Z$ Exceedance Crack Growth

A general $n_z$ exceedance normalized crack growth IAT method is used to represent the F-4 and A-7 IAT systems as described in Figure 2.10. The data collected is the reported aircraft flying hours and the reported exceedances of the vertical normal load factor at four preset levels.

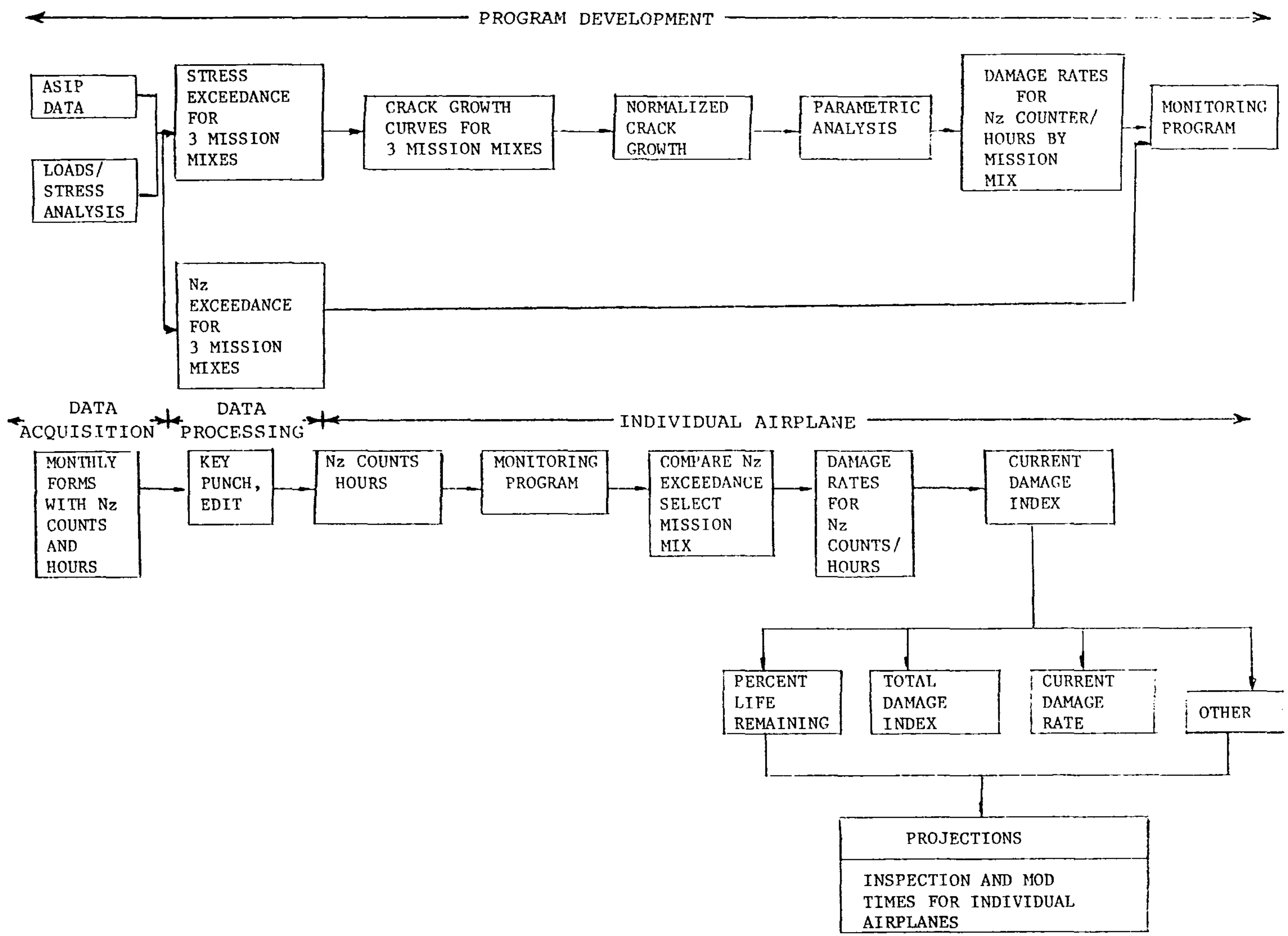
The methods of IAT are based upon the ability to experimentally and analytically grow cracks in a structure given known stress spectra. However, by measuring the $n_z$ counts on each individual aircraft and relating this to stress and finally growing the crack for each individual aircraft would be economically prohibitive. The measured IAT data must be related as closely as possible in some manner to a previously grown crack for determining the predicted crack growth for each individual aircraft. For every crack grown experimentally or analytically, there is a corresponding known spectrum of the $n_z$ counts thus providing the relationships to go from measured $n_z$ counts to crack growth.

For the F-4 and A-7, there are two basic assumptions:

o Crack growth at one location can be correlated with crack growth at a different location through the use of normalized crack growth curves based upon the ratio of the operational limits of the two locations.

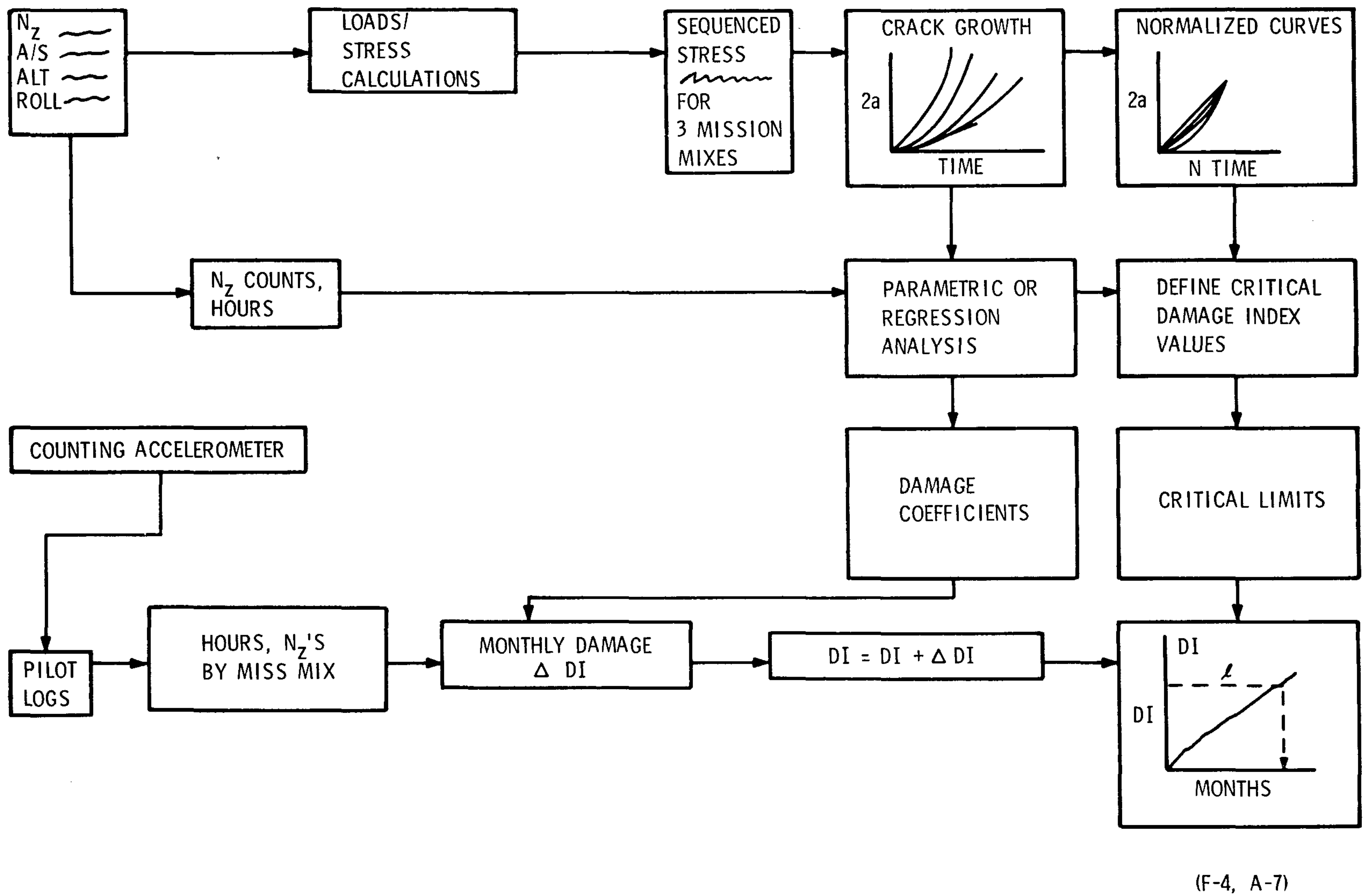
o Crack growth at a location due to a particular usage spectrum can be correlated with the crack growth for a different usage spectrum through the use of normalized crack growth curves based upon the ratio of the operational limits of the two spectra. These relationships are demonstrated in Figure 2.11 where the operational limits are designated by $t_{A_O}$, $t_{B_O}$, $t_{1_O}$, and $t_{2_O}$. The spread or scatter shown in the normalized curves represent the envelope of all structural locations and all usage spectra, thus they can be represented by a single curve with very little error.

Hence, these assumed relationships allow tracking only one location on each aircraft as well as accounting for spectra variations from the baseline spectra (tested spectra). The relationship between damage at the monitoring location and damage at another location is only valid if the spectra at the two locations are both based on the same activity indicator. For the F-4 and A-7, the spectra for the critical locations on the fuselage and wing are all based on $n_z$, therefore these relationships hold. However, for




a) Tracking Procedure

Figure 2.10 METHOD 10 - Normalized $N_z$ Exceedance Crack Growth.




b) Analysis Scheme - METHOD 10

Figure 2.10 (Concluded).

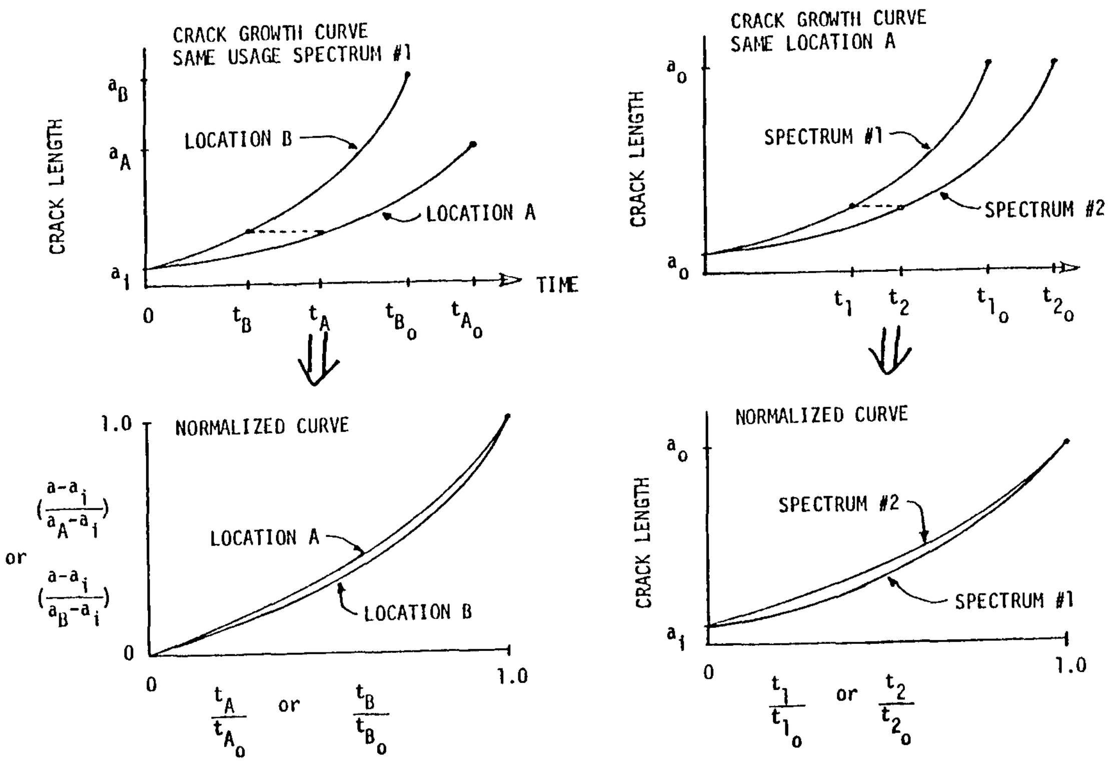



Figure 2.11 Normalized Crack Growth Curves.

more recent generation of A/F/T aircraft, which have more sophisticated control systems such as differential tail augmented roll, variable sweep wings, etc., more than one activity indicator and more than one monitored location may be required.

For a matter of convenience, the F-4 and A-7 tracking programs use an arbitrary "damage index" (D.I.) system instead of hours to specify when maintenance actions are required. Referring to the bottom right hand graph of Figure 2.11 and letting the Spectrum #1 be the baseline spectrum, then the normalized abscissa is scaled by a chosen constant ($DI_{BL_O}$), which is the D.I. that occurs when the baseline spectrum reaches the operational limit at the monitored location. For example, if at the operational limit of the baseline spectra ($t_{1_O}$) a damage index value is assigned to be D.I. = 4.0, then the normalized crack growth curve can be redrawn in terms of D.I. as shown in Figure 2.12.

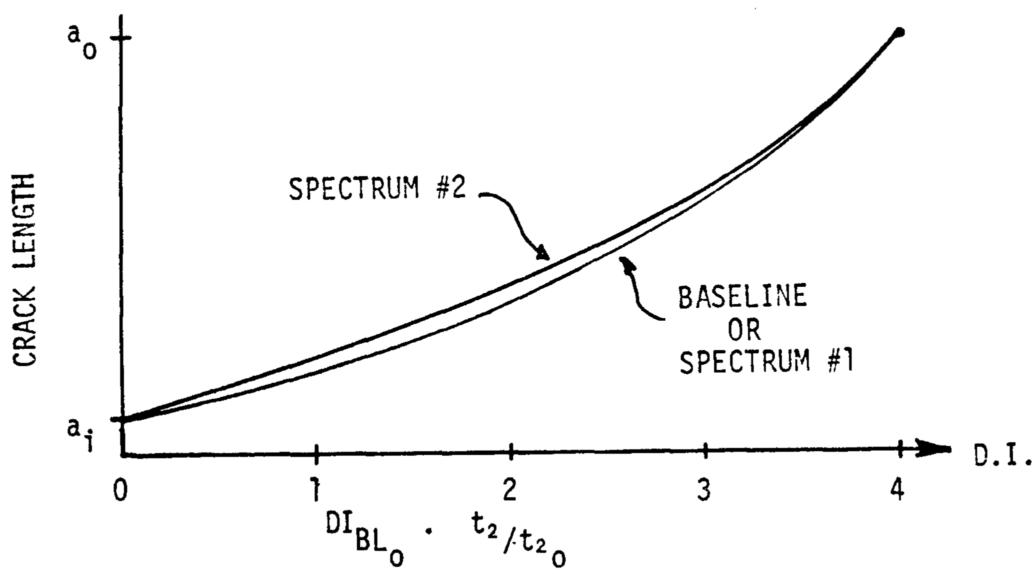



Figure 2.12 Crack Growth Curve Normalized to Damage Index.

If $t_{1_O}$ was the safety limit for the monitored point, then for an aircraft flying Spectrum #2 there would be a requirement to inspect at one-half the safety limit, or at a D.I. of 2.0, which corresponds to Spectrum #2 flying hours of

$$t_2 = \frac{2(t_{2_o})}{DI_{BL_o}} = \frac{2(t_{2_0})}{4} = 1/2(t_{2_o})$$

It may be found that another location (B) in the aircraft is more critical and will have to be inspected at a D.I. of $2.0(t_{B_o}/t_{A_o})$. The term $(t_{B_o}/t_{A_o})$ is the ratio of the operational limits of location B to monitored location A.

For the F-4, a D.I. = 1.0 was assigned to a corresponding baseline operational limit of 3900 hours, thus $DI_{BL_o} = 1.0$ and $t_{1_o} = 3900$. For the A-7, at 4000 hours of baseline spectrum a D.I. of 1.0 was assigned. However, the operational limit for baseline spectrum at the monitored location was 12,200 hours, thus $DI_{BL_o} = \frac{12,200}{4,000} = 3.05$ and $t_{1_o} = 12,200$. For comparison, these assignments called for the first inspection at the most critical location to be held at D.I.= 0.23 for the F-4E and at D.I. = 0.28 for the A-7D.

The methods of determining the damage index (D.I.) for an individual aircraft for the F-4 and the A-7 are similar. Both methods assume a linear relationship between D.I. and the measured activity indicator, $n_z$. In the case of the A-7, flying hours take part in the relationship as well. These are as follows:

$$\text{F-4} \quad D.I. = C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4$$

$$\text{A-7} \quad D.I. = C_oT + C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4$$

where

D.I. is damage index for a time period

$C_o$, $C_1$, $C_2$, $C_3$, $C_4$ are coefficients (constants)

T is flying hours for the time period

$X_1$, $X_2$. $X_3$, $X_4$ are the $n_z$ occurrences or exceedances of the four level counters during time period T

It is noted that the counting accelerometer counts exceedances (E) of four levels of $n_z$, so in the case of the A-7, $X_1 = E_1$, $X_2 = E_2$, $X_3 = E_3$, and $X_4 = E_4$. The F-4 technique uses occurrences of load factor, which mathematically makes no difference, thus: $X_1 = E_1 - E_2$, $X_2 = E_2 - E_3$, $X_3 = E_3 - E_4$, and $X_4 = E_4$.

The difference between the F-4 and A-7 methods of calculating damage is how the coefficients in the D.I. equations are calculated. Basically, they are derived from results of cracks grown to different spectra in coupons representing the monitored location.

For the F-4, pre-cracked fracture specimens simulating the monitored location were cycled to failure (safety limit) for each of three usage spectra defined as baseline, severe, mild. For example, the resulting crack growth curve of the monitored location for the baseline spectra is illustrated below in Figure 2.13.

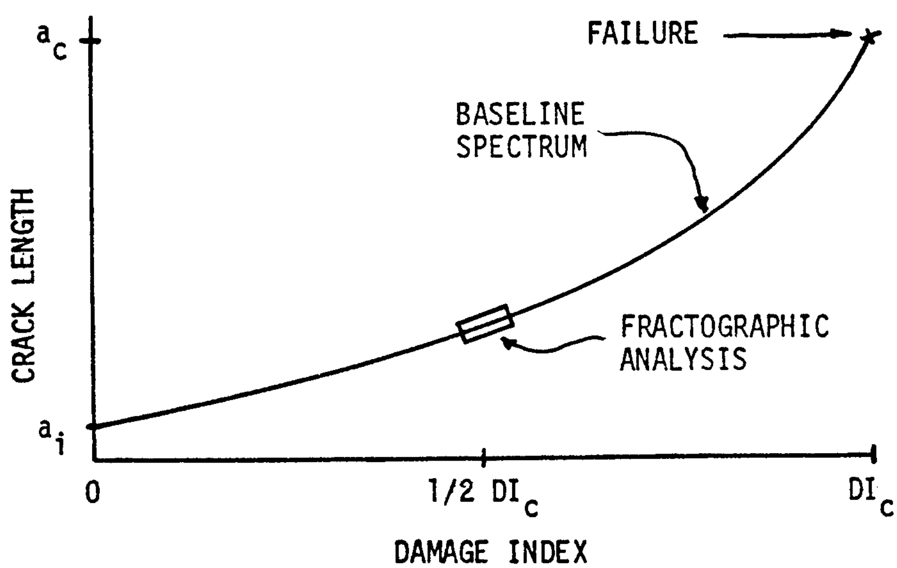



Figure 2.13 Baseline Crack Growth Curve.

Known at the time of failure are the total number of occurrences of each of four levels of $n_z$ (i.e., $X_1$, $X_2$, $X_3$, $X_4$). Also known is the fracture limit, in terms of damage index (i.e., $DI_c = DI_{BL_O}$).

Thus, for this spectrum, all of the parts of the damage index equation is known except the coefficients $C_1$, $C_2$, $C_3$, $C_4$.

$$DI_c = C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4$$

It is assumed that the total $DI_c$ is spread over the four levels measured by the counters. Thus,

$$DI_c = W_1 \ (DI_c) + W_2 \ (DI_c) + W_3 \ (DI_c) + W_4 \ (DI_c)$$

where the $W_1 \ldots W_4$ represent weighting functions giving the relative contribution of each $n_z$ level to the total $DI_c$, with

$$W_1 + W_2 + W_3 + W_4 = 1.0$$

$$W_1 (DI_c) = C_1X_1 \ , \ldots , \ W_4 (DI_c) = C_4X_4$$

and finally:

$$C_1 = \frac{W_1 (DI_c)}{X_1} \qquad C_2 = \frac{W_2 (DI_c)}{X_2}$$

$$C_2 = \frac{W_3 (DI_c)}{X_3} \qquad C_4 = \frac{W_4 (DI_c)}{X_4}$$

After failure of the specimen, scanning electron microscope traces were obtained of a 2100 hour portion of the fracture surface at approximately one-half the fracture limit (i.e., $DI_c/2.0$). (See Figure 2.13). Individual striations of crack growth were then measured corresponding to each load level in the spectrum. Then by relating load level to the four $n_z$ levels, the relative percentage (i.e., $W_1$, $W_2$, $W_3$, $W_4$) of crack growth caused by each $n_z$ level was calculated. For example, in the case of the baseline spectrum:

$$W_1 = .075 \quad W_2 = .135 \quad W_4 = .28 \quad W_4 = .51$$

Using these relative weights with the known $X_1$, $X_2$, $X_3$, $X_4$, and $DI_c$, the coefficients are solved. This solution is plotted in the form of an equivalent S-N curve through the stress levels corresponding to the four $n_z$ levels.

Identically the same procedure is followed in testing the other two specimens to the mild and severe spectra. The same damage index ($DI_c$) at the fracture limit is used along with different occurrences (X's). Fractographic analysis of each specimen present new weighting functions (W's). Consequently, coefficients $C_1 \ldots C_4$ and the equivalent S-N curve are determined for each of the three usage spectra. Rewriting the original F-4 damage index equation for the three usage spectra gives:

$$\text{Mild:} \quad DI = C_{1_M} X_1 + C_{2_M} X_2 + C_{3_M} X_3 + C_{4_M} X_4$$

$$\text{Baseline:} \quad DI = C_{1_B} X_1 + C_{2_B} + C_{3_B} X_3 + C_{4_B} X_4$$

$$\text{Severe:} \quad DI = C_{1_S} X_1 + C_{2_S} X_2 + C_{3_S} X_3 + C_{4_S} X_4$$

During the IAT program, these equations are used to calculate the damage index of an individual F-4 airplane, depending upon which usage spectrum best describes the actual usage of the aircraft for the particular time period T. The choice of equation is established by magnitude of the exceedances of the third level counter ($E_3$) normalized to the period flying hours, T. This is presently determined as follows:

| IF -Then- | USE THE USAGE SPECTRA |
|---|---|
| $E_3/T$ is less than 1.1 | Mild |
| $E_3/T$ is between 1.1 and 2.2 | Baseline |
| $E_3/T$ is greater than 2.2 | Severe |

Once the D.I. is calculated for this time period T, then this D.I. is added to the accumulated damage index for all hours preceding this time period to obtain the present D.I. for that particular F-4 aircraft.

To determine the coefficients in the damage equation for the A-7, eight preflawed specimens representing the monitored location were tested to different usage spectra. Wide variation in spectra were used to represent the envelope of operational usage. Using a combination of test results and crack growth models, cracks were grown for each spectrum to a critical crack size, $a_c$, that corresponds to the fracture limit, identified in Figure 2.14.

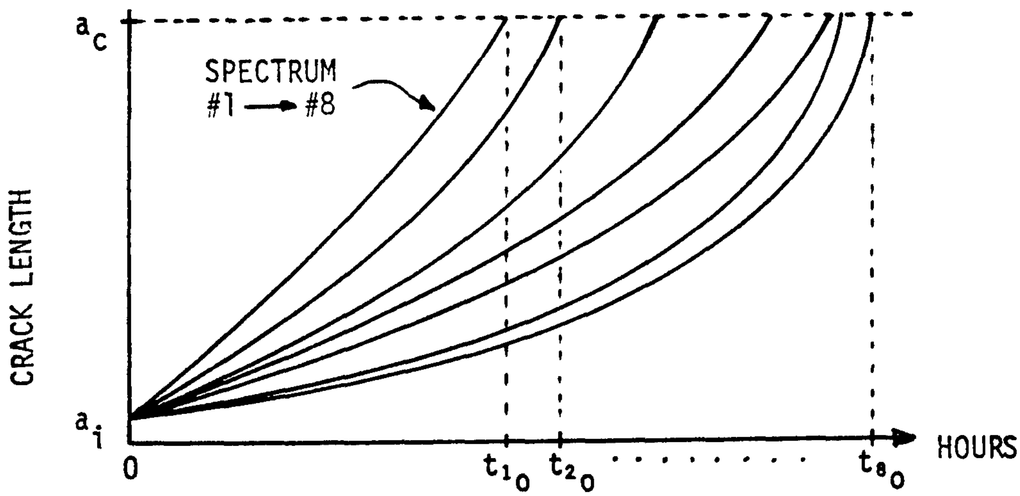


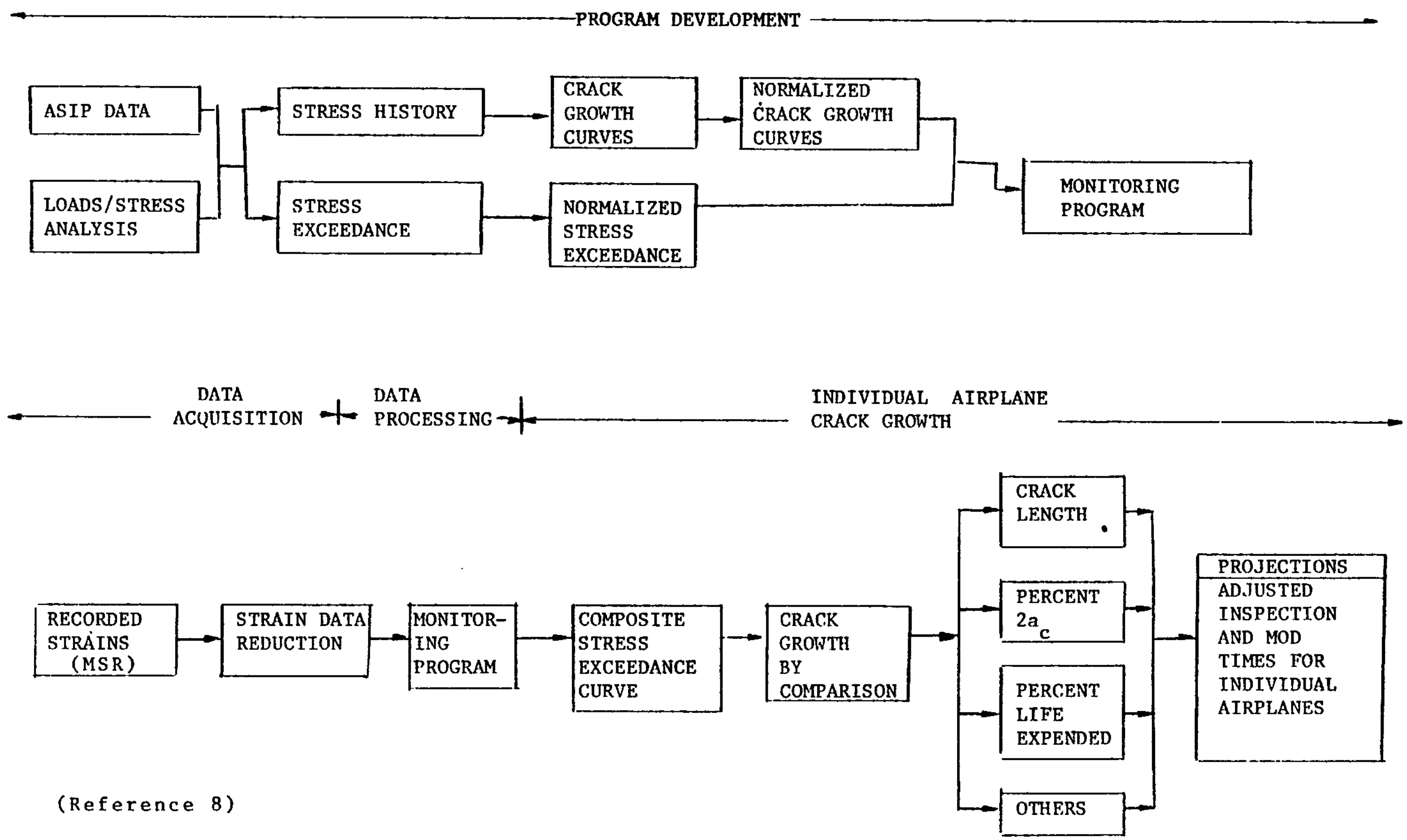

Figure 2.14 Spectrum Crack Growth Curves.

Known at the fracture limit are the flying hours (T) and the total number of exceedances of each of four levels of $n_z$ (i.e., $X_1$, $X_2$, $X_3$, $X_4$) that correspond to the eight spectra. Each curve has the same damage index at the fracture limit (i.e.: $DI_{BL_O}$). Therefore, there is a regression equation of the form

$$DI = C_oT + C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4$$

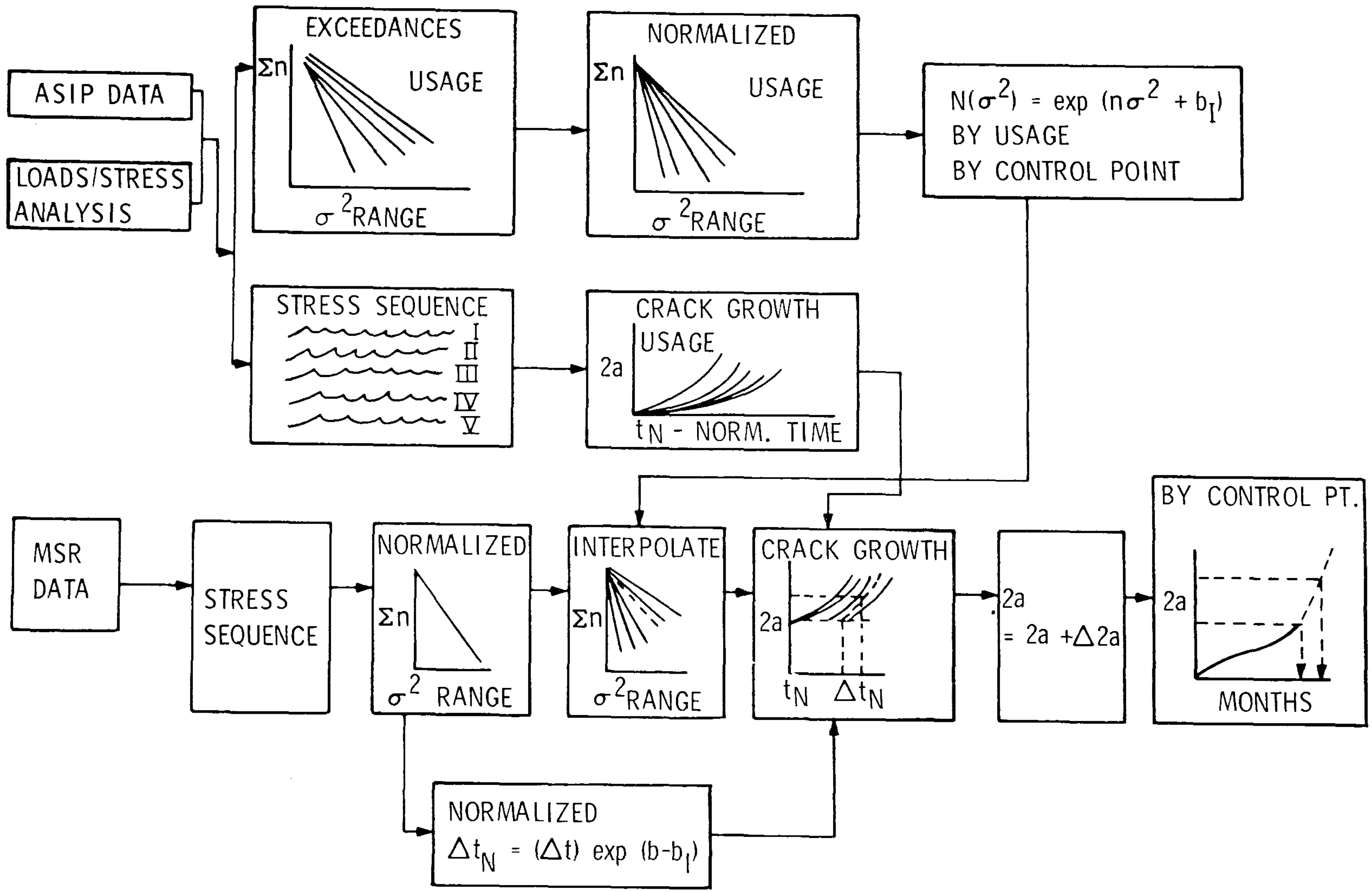
with many observations of the independent variables T, $X_1$, $X_2$, $X_3$, $X_4$. The coefficients $C_0$, $C_1$, $C_2$, $C_3$, $C_4$ are derived by use of regression analysis techniques where the resulting values give the least sum of squares error.

During the IAT program, total flying hours and the total exceedances of each of the four $n_z$ levels are reported on an individual A-7 airplane. These data, representing




a) Tracking Procedure

Figure 2.15 METHOD 11 - Normalized Stress Exceedance Crack Growth.




b) Analysis Scheme

Figure 2.15 (Concluded).

the entire past history of the aircraft, are used in the above equation to calculate the current damage index.

2.1.2.5 Method 11 - Normalized Stress Exceedance Crack Growth

The normalized stress exceedance crack growth method for the F-16 IAT is shown in Figure 2.15. At this stage in the F-16 IAT program, the proposed method is to calculate the predicted crack lengths for every critical location in the airframe. This method is not dependent upon the assumptions required for the F-4 and A-7 pertaining to the "normalization" of the crack growth between different locations and the "normalization" of the crack growth from different spectra. The F-16 activity indicator is measured strain at a location that is predominately sensitive to vertical wing bending.

Crack growth curves are computed for each critical location for each of five usage spectra. These are computed using both analytical models and coupon test results. For each critical point, these crack growth curves can be described as illustrated in Figure 2.16.

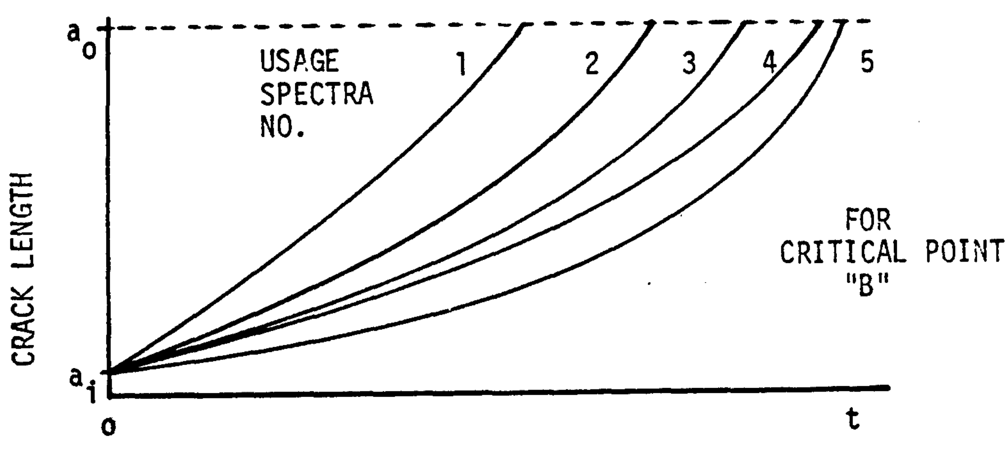



Figure 2.16 Crack Growth Curves for Usage Spectra.

The five variations of the usage spectra are chosen to span the range from the least severe to the most severe expected usage. Corresponding to each of these usage spectra is a spectrum of the activity indicator (strain) at the monitored location. These strain spectra at the monitored location are expressed as normalized exceedances of a derived strain function, f(σ) and appear as shown in Figure 2.17.

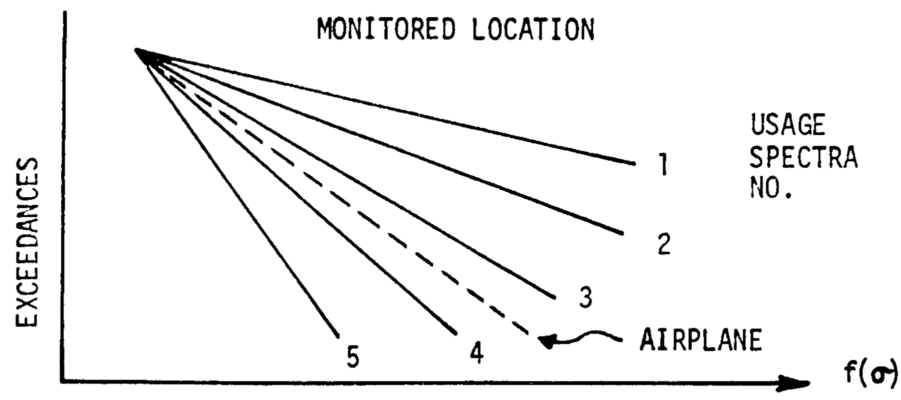



Figure 2.17 Normalized Usage Spectra.

If MSR data is gathered on a particular airplane for a time period Δt, and the strain is expressed in the same normalized exceedance manner, then it may appear as the dashed line in Figure 2.17. Through the use of interpolation methods, this aircraft's usage spectra can be related back to an interpolated crack growth curve (now normalized) for each critical point as shown in Figure 2.18.

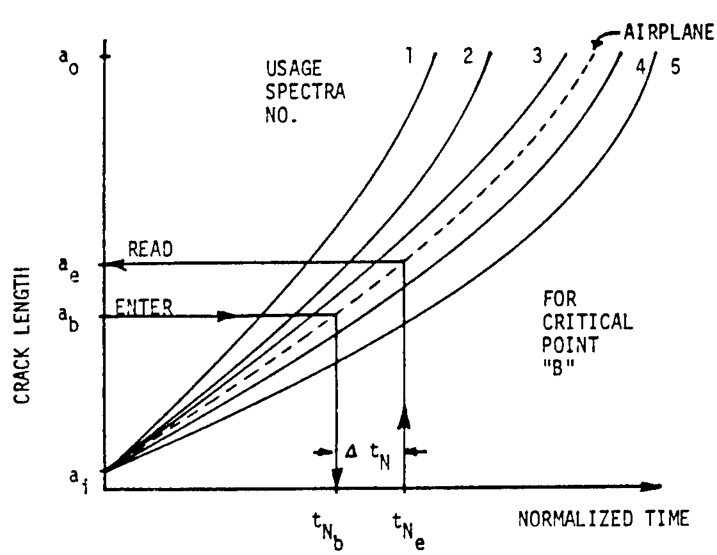



Figure 2.18 Interpolation of Normalized Crack Growth Curve.

The crack length ($a_b$) at the beginning of the period is used to find the time at $t_{N_b}$, to which is added the normalized time period ($\Delta t_N$), arriving at time $t_{N_e}$ at the end of the period. Then finally the crack length ($a_e$) is read corresponding to the time $t_{N_e}$ of the time period end. This is the current crack length at critical point B. The same is done for each critical location for each period.

#### 2.1.2.6 Results and Presentation

The final form in which the IAT damage calculations for the A/F/T aircraft are presented are many and varied. Each contractor has his own unique way, however all basically present the same information. The main difference lies in whether damage is tracked at all critical points in the airframe or only at one control point allowing transfer to other locations. Components, such as individual landing gear, can be tracked for damage and are maintained separate from the airframe tail number.

All of the A/F/T aircraft using cumulative fatigue track the damage at each of the critical points in the structure. IAT output information generally consists of:

- Airplane serial number and base
- Airplane usage statistics and distributions
- Critical point numbers or identification
- Incremental damage, cumulative damage, and remaining damage
- Projected wear-out in years and hours

Some results simply define the service life capability for the most critical point as is the case for the F-100. Some presentations list aircraft serial numbers and their damage for ease of comparison. Projected hours to reach damage levels and projected damage levels for each aircraft are common computer results and are illustrated in Figure 2.19 and Figure 2.20.

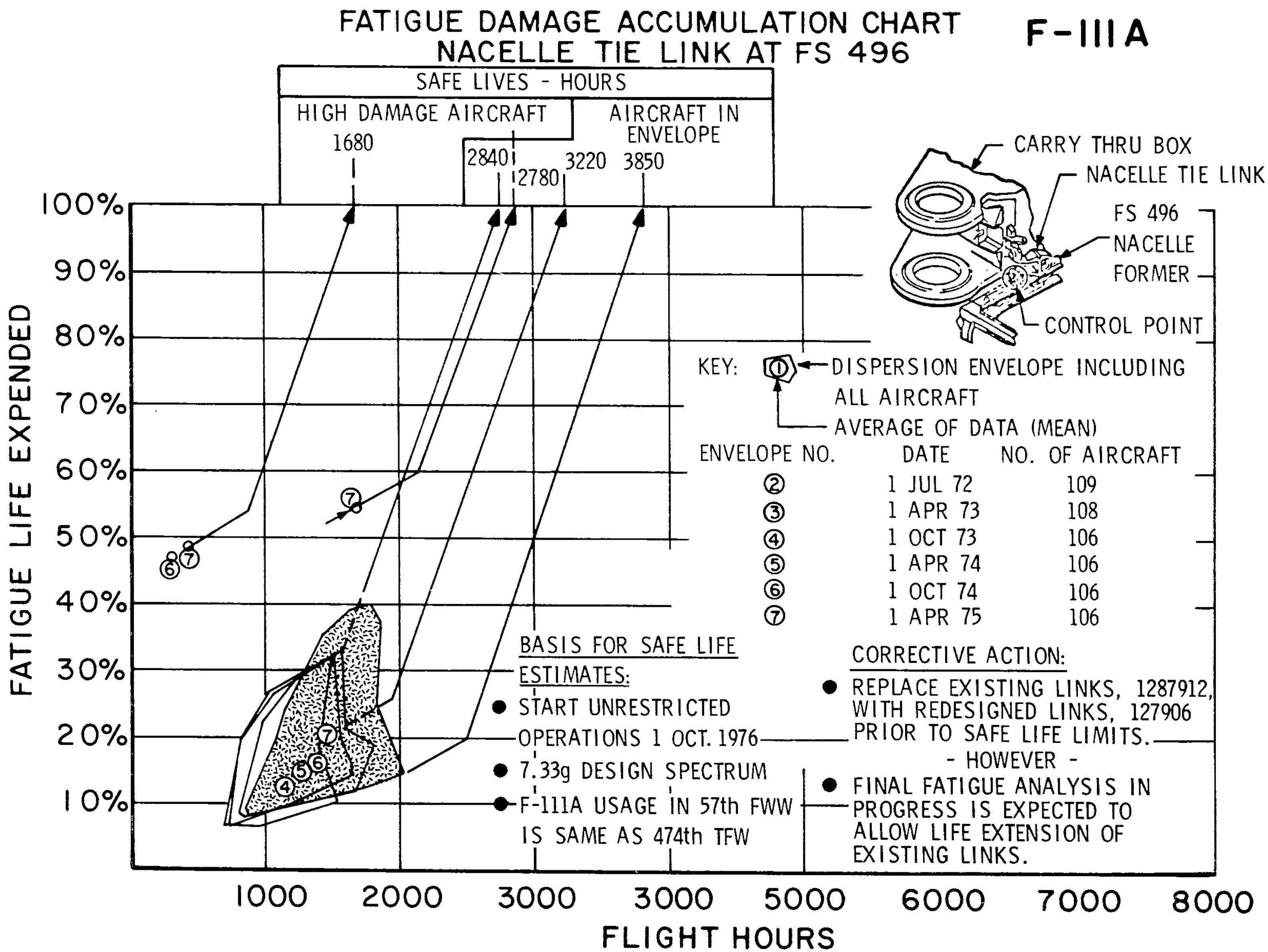



Figure 2.19 Damage Projections versus Flight Hours (F-111A).

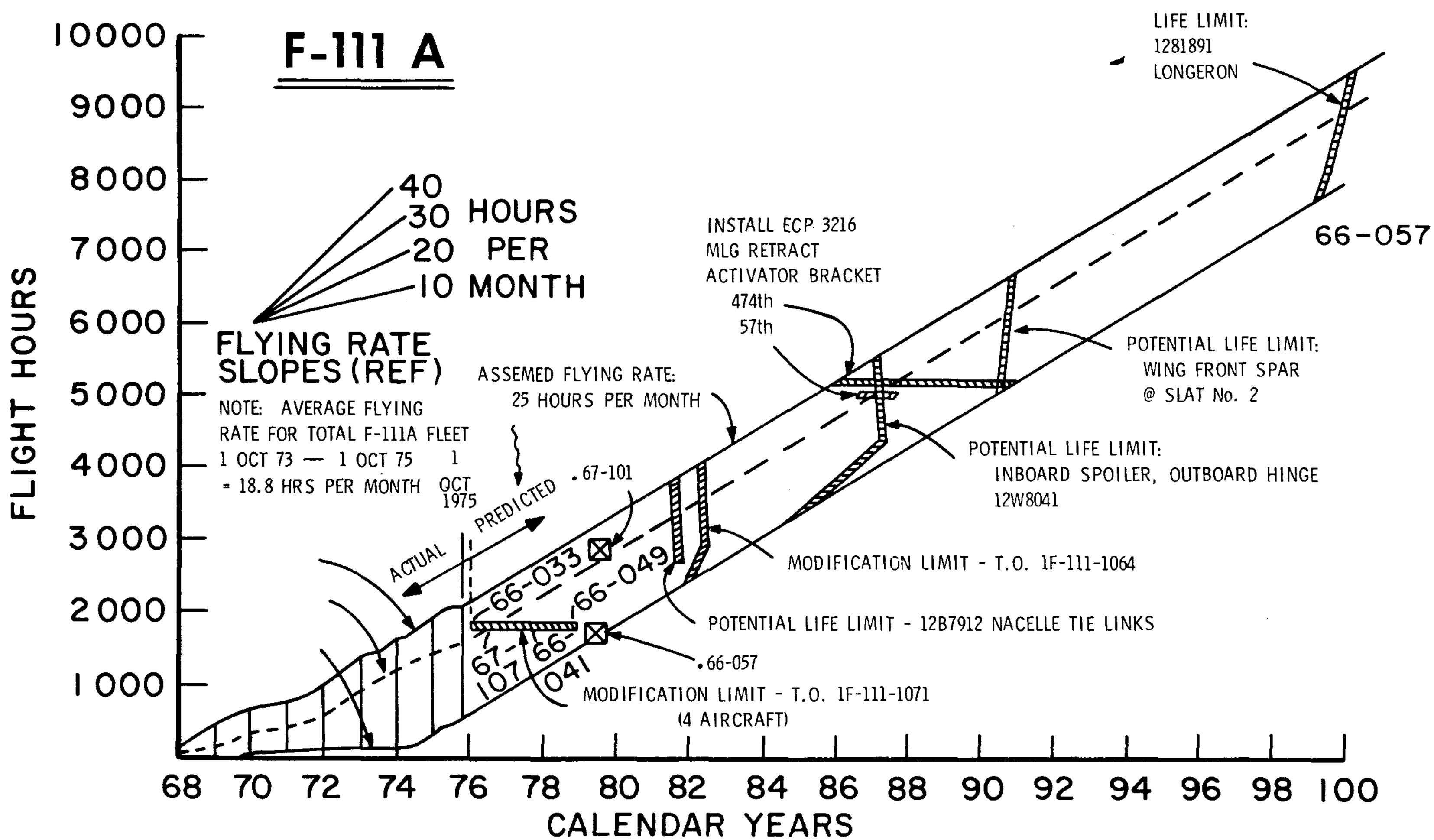



Figure 2.20 Logistics/Maintenance Action Limit Chart.

As mentioned in Paragraph 2.1.2.4, the crack growth methods used for the F-4 and A-7 allow tracking of a damage index at one control point in each individual aircraft. Then, by using operational limit ratios, the damage and amount of life expended at all other critical locations is determined. The program output gives each aircraft's current damage index (D.I.), rate of D.I. increase, and projected date/D.I. to reach a certain D.I./date. This same data, except defined on a month-by-month basis, is supplied to ASIMIS for use by the Structural Maintenance Control Program (SMCP).

The purpose of the component tracking program is to provide damage information for major serialized structural components of the airframe which are likely to be removed, inspected or repaired, and reinstalled on a different airplane. There is no current A/F/T aircraft component tracking program. Planes exist for initiating a landing gear tracking program by the Item Manager since landing gears are frequently replaced and/or traded from aircraft to aircraft. Special handling will be required to maintain the data bank historical record on each component. Presently, damage on landing gears are determined using cumulative fatigue techniques. The gear are treated as one of the fatigue critical points to be tracked. All that is required is to maintain this accumulated damage to a particular serialized landing gear component as it is moved from aircraft to aircraft.

Also presently proposed are airframe component tracking programs for the F-4, F-15, F-16, F-111, and A-10 aircraft. This will entail keeping track of the damage/D.I. on each serialized component. For example, the A-10 will track the damage on:

- center wing panel
- left and right outer wing panels
- horizontal stabilizer
- fuselage
- left and right nacelles

A form to enable component serilization and tracking for the F-15 is presented in Figure 2.21.

2.1.2.7 Use of Results

The objective of the IAT program is to provide the damage information needed to determine the times at which structural maintenance actions are performed on individual aircraft. For the most part, the ASIP managers of the A/F/T aircraft are using the IAT results for their intended purpose as well as for other functions such as detecting usage changes.

In the case of the F-4 and A-7, computer results of damage index calculations flow directly into the Structural Maintenance Control Program (SMCP). This program correlates the reported D.I. from the IAT program with the inspection/modification information of the type supplied by the Force Structural Maintenance Plan to determine the times at which maintenance actions must occur.

For the F-100, F-111, and the A-37, the IAT cumulative fatigue damage results have been manually analyzed by the ASIP manager to aid in making decisions when to:

- modify and replace critical components
- schedule PDM (periodic depot maintenance)
- retire aircraft at life limit
- inspect critical locations

By knowing the cumulative damage or damage index per 1000 hour rate by mission type and by base, the ASIP manager is detecting changes in the general usage of the aircraft. This forewarns the manager of potential problems and allows him to modify early maintenance planning previously made. Early detection of change of usage also allows the ALC to notify the using command what effect this change has on their maintenance/ modification requirements.

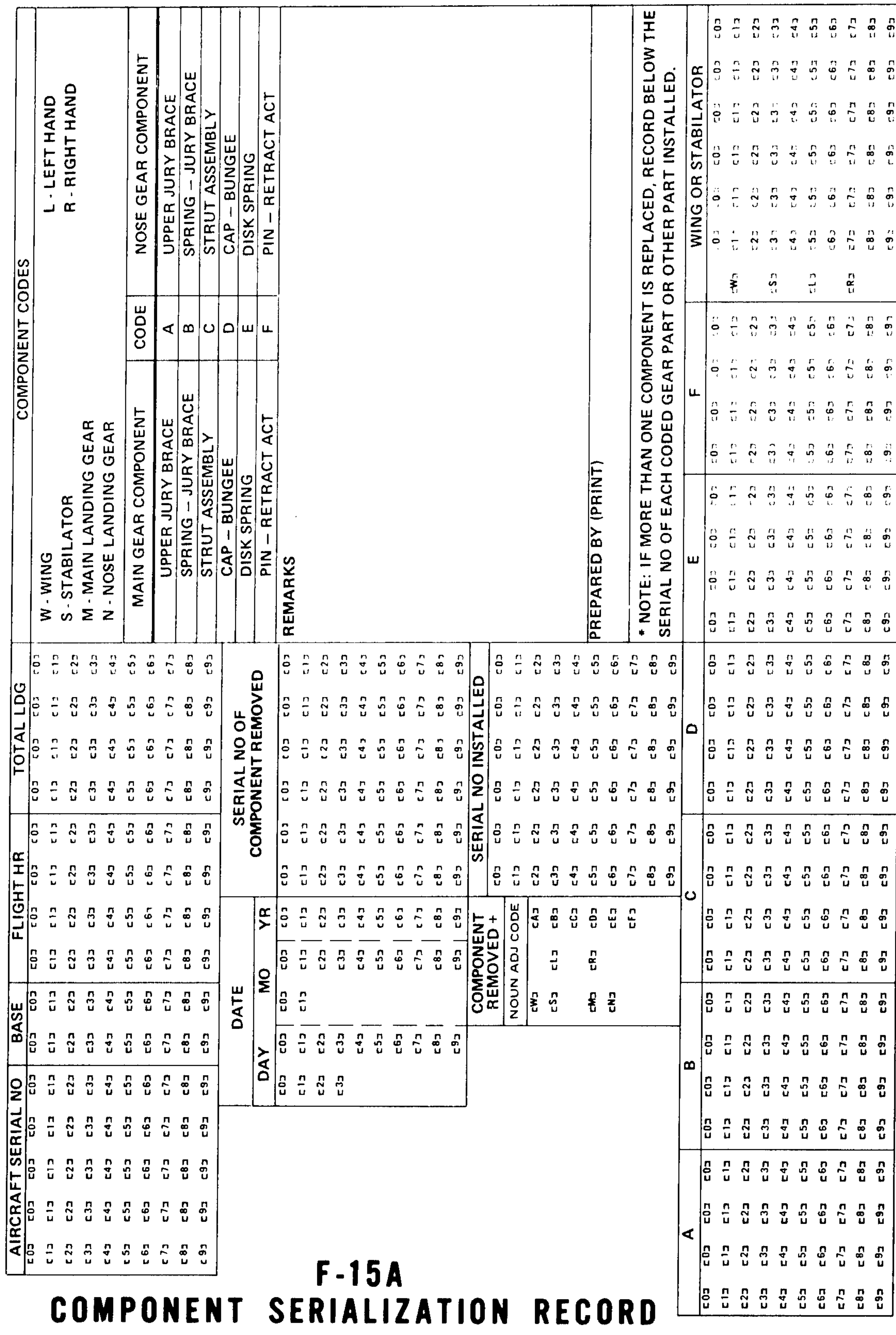



Figure 2.21  Component Serialization Record.

INSTRUCTIONS

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| Aircraft Serial Number | Tail Number – last digit of year plus last four digits of number (75-00032) |
| Base | Two Digit Base Code Number *(See Below)* |
| Flight Hours | Record total hours from AFTO Form 781. Delete tenth of an hour digit. Use zeros to make a four digit number. |
| Total Landings | Record total landings from AFTO Form 781. Use zeros to make a four digit number. |
| Date | Day, month, last digit of year when part(s) are changed. |
| Component Removed | Use letter codes for components. |
| Serial Number of Component Removed<br>Serial Number Installed | All digits of serial number. If serial number is less than six digits, precede it with zeros to make it a six digit number. |
| Remarks | Note any pertinent information. |
| Prepared by | Printed name and grade of person completing this report. |
| NOTE | If more than one component identified in this form is replaced, this space is provided for your convenience. Up to five parts of the *same* gear can be listed, plus one additional wing or stabilator. If parts of a second gear are replaced, or if more wing or stabilator assemblies are replaced, use additional forms as required. If this section is used for additional parts installed, it will be necessary to record serial numbers and codes of corresponding parts removed in remarks. |

BASE CODES

| (CONUS) | (OS BASES) | |
|---|---|---|
| 01 Edwards AFB | 11 | 99 Other (Note Base name in Remarks) |
| 02 Eglin AFB | 12 | |
| 03 Eglin Aux Fld No 9 | 13 | |
| 04 Kirtland AFB | 14 | |
| 05 Langley AFB | 15 | |
| 06 Luke AFB | 16 | |
| 07 Nellis AFB | 17 | |
| 08 Robins AFB | 18 | |
| 09 Williams AFB | 19 | |
| 10 Wright-Patterson AFB | 20 | |

Mail Completed Forms to: Warner Robins ALC/MMAR
Robins AFB, GA 31098

U.S. GOVERNMENT PRINTING OFFICE: 1977-758-335 PS 8434 US A (7443)

Figure 2.21 (Concluded)

In some cases, even though damages for individual aircraft are available, the IAT information has not been used to schedule maintenance actions or detect usage changes. For these aircraft, it has been found that the standard method of structural maintenance (i.e., phased inspections, PDM, ACI, etc.) have been adequate. In most cases, the IAT programs are in the planning and development stage but will be available in the future for use in structural maintenance planning and scheduling.

## 2.2 LOADS/ENVIRONMENTAL SPECTRA SURVEY (L/ESS)

The objective of the L/ESS is to obtain a representative sample of data which can be used to define the operational stress spectra of the force. A review of the current L/ESS programs has shown that they perform much the same function in a variety of ways. The final use of the L/ESS product is so much a function of the IAT method with which it interfaces that it was not appropriate to define separate L/ESS methods. The L/ESS analysis techniques appeared to be related to the loads philosophy of the airframe company.

In general, the most basic decision in L/ESS methods is the choice of monitoring aircraft c.g. motion parameters, local strains, or some combination of motion and strain. This choice is related to the complexity of the aircraft equations of motion and seems to be a matter of local engineering judgement. The next decision is whether to reduce the data into a summation of time and events in data blocks or into a computed sequence of stress peaks and troughs at key locations.

Beyond these two basic differences, the variations in L/ESS methods are not significant. This paragraph presents a summary of the data recording equipment and parameter selection and then describes basic data analysis procedures for several current L/ESS programs. Because most of the current systems are based on fatigue analysis concepts, these methods will not be recommended for incorporation in the force management methods handbook. Finally, the use of L/ESS data for detecting a change in fleet usage is discussed.

### 2.2.1 L/ESS Recording Equipment and Parameter Selection

There are five types of recorders currently in use for L/ESS programs. All five are digital magnetic tape systems and are described in paragraph 2.4.

The systems are as follows:

| Recording System | Description | Manufacturer |
|---|---|---|
| A/A24U-6 | 24-channel magnetic tape | Whittaker(Dynasciences) |
| A/A24U-10 | 3-channel Vgh computer/ recorder | CONRAC |
| A/ASH-28 | 22-channel variant of MXU-553 | CONRAC |
| MXU-553 | 26-channel magnetic tape | CONRAC |
| MADAR | Maintenance computer/ recorder | Lockheed Electronics/ Northrop |

Table 2.8 lists the aircraft with current L/ESS programs and the type of system, number of instrumented aircraft, number of recorded parameters, and percentage of usage recorded data for each. The definition of usable data varies considerably from program to program and these figures are not generally transferable to another system.

In addition to the systems listed, there are a few A/A24U-10 VGH recorders on T-38 and F-100 aircraft and a short L/ESS was conducted on O-2A aircraft using oscillograph recorders. These programs were not considered current.

Each MXU-553 recording system includes a Converter/ Multiplexer unit which converts analog signals to digital and determines the sampling scheme by which the various parameters are sampled and the values are written on tape. The parameters are selected by each airframe manufacturer according to his planned analysis methodology. Table 2.9 lists the parameters for the L/ESS systems with MXU-553 and A/ASH-28 recorders while Tables 2.10 and 2.11 list, respectively, the parameters for the C-5A MADARS system and the FB-111A A/A24U-6 system.

It was noted, during the state-of-the-art review that th timing of USAF requirements generally forced the selection of L/ESS parameters before the analysis had identified critical structural locations and loading conditions. Consequently, many parameters were selected only as a hedge against the possibility that a particular loading condition might later prove to be significant.

TABLE 2.8

CURRENT L/ESS DATA COLLECTION PROGRAMS

| Aircraft | Recorder | Fleet Size | No. With Recorders | No. of Parameters | Percent Usable Data |
|---|---|---|---|---|---|
| A-10 | MXU-553 | 773* | 16 | 15 | 20% |
| A-37B | MXU-553 | 200 | 23 | 21 | 30% |
| 5 | | | | | |
| B-52 | MXU-553 | 349 | 11 | 20 | <2% |
| C-5A | MADARS | 77 | 8 | 24 | 25% |
| C-130 | MXU-553 | 711 | 60 | 20 | 25% |
| C/KC-135 | MXU-553 | 751 | 66 | 20 | |
| C-141 | MXU-553 | 271 | 27 | 20 | 25% |
| E-3A | MXU-553 | 40* | 7 | 7 | 35% |
| F-4 | A/A24U-10 | 1798 | 213 | 3 | 40% |
| F-5 E/F | MXU-553 | 91 | 5 | 13 | 30% |
| F-15 | A/ASH-28 | 749* | 150* | 22 | 85% |
| F-16 | MXU-553 | | 17% | 22 | -- |
| F-100 | MXU-553 | 2292 | 8 | 20 | 60% |
| F-105 | MXU-553 | 200 | 7 | | 40% |
| F/FB-111 | A/A24U-6 | 531 | 71 | 24 | 15-20% |
| T-37 | MXU-553 | 700 | 11 | 13 | 30% |
| T-38 | MXU-553 | 920 | 9 | 11 | |
| T-39 | MXU-553 | 142 | 14 | 15 | 77% |
| T-43 | MXU-553 | 19 | 5 | 8 | 17% |

*Planned

TABLE 2.9

PARAMETER LIST (MXU-553/A AND AN/ASH-28)

| Parameter | A-10 | A-37 | B-52 | C-130 | C/KC-135 | C-141 | E-3 | F-5E/F | F-15 | F-16 | F-100 | F-105 | T-37 | T-38 | T-43 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECU Type | 68 | 68 | 66 | 67 | 66 | 67 | 67 | 68 | - | | 68 | 68 | 68 | 68 | 67 |
| Airspeed | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| $N_z$ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | (1) |
| $N_y$ | X | X | | | | X | X | X | X | X | X | X | X | X | X |
| $N_x$ | | | | | | | | | X | X | | | | | |
| Altitude | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Fuel Flow | | X | X | | X | | | | | | | X | X | | |
| Roll Rate | X | X | | | | | | X | X | X | X | X | X | X | |
| Angle of Attack | | | | | | | | | X | | | | | | |
| Pitch Rate | X | X | | X | | X | X | X | X | X | X | X | X | X | |
| Yaw Rate | X | X | | X | | X | X | X | X | X | X | X | X | X | |
| Roll Accel. | | | | | | | | | X | X | | | | | |
| Elevator | | X | | X | | X | X | X | X | X | X | | X | X | |
| Rudder | | X | | X | | X | X | X | X | X | X | | X | X | |
| Aileron | | X | | | | | | | X | X | X | | X | | |
| Speed Brake | X | | | | | | | | | | | | | | |
| Time | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Fuel Totalizer | X | | X | | X | | | | X | X | X | | | | X |
| No. of Strains | 1 | 1 | 4 | 6 | 4 | 5 | 5 | 1 | | 1 | 1 | | 1 | 1 | |
| Flaps | | | | X | | X | X | X | | X | | | | X | |
| Nose Gear Steer. | | | | X | | X | X | | | | | | | | |
| Rate of Climb | | | | | | | | | X | | | | | | |
| Ground Speed | | | | X | | | X | | | | | | | | |
| Engine RPM | | | | | | | | | | X | | | | | |
| Cabin Pressure | | | | X | | X | | | | | | | | | |
| Event Code: | | | | | | | | | | | | | | | |
| 1 | O | F | E | AC | E | AC | E | C | U | E | O | (2) | D/E | P | E |
| 2 | S | G | Q | E | T | E | Y | C | AC | AC | E | (2) | | | |
| 3 | E | H | R | AD | S | U | Z | | AE | C | F | (2) | | | |
| 4 | F | I | | | U | | AA | | AF | | G | (2) | | | |
| 5 | G | J | | | V | | AB | | | | H | (2) | | | |
| 6 | H | K | | | | | T | | | | J | (2) | | | |
| 7 | I | L | | | | | V | | | | K | (2) | | | |
| 8 | A | M | | | | | | | | | L | (2) | | | |
| 9 | B | E/N | | | | | | | | | | | | D | |

| Event Codes | |
|---|---|
| A | Store Drop (left) |
| B | Store Drop (fus) |
| C | Store Drop (coded) |
| D | Takeoff |
| E | Weight on Wheels |
| F | Store Drop-Pylon L1 |
| G | Store Drop-Pylon L2 |
| H | Store Drop-Pylon L3 |
| I | Store Drop-Pylon L4 |
| J | Store Drop-Pylon R1 |
| K | Store Drop-Pylon R2 |
| L | Store Drop-Pylon R3 |
| M | Store Drop-Pylon R4 |
| N | Refueling |
| O | Gunfire |
| P | Ground Cals |
| Q | Boom Contact |
| R | Flaps Retract |
| S | Flaps Extend |
| T | Autopilot On |
| U | Speedbrake Deployed |
| V | Refuel Door Open |
| Y | 6 RPM Antenna Rotation |
| Z | 1/4 RPM Antenna Rotation |
| AA | Reserve Tank Valve (L) |
| AB | Center Tank Pumps (L) |
| AC | Ldg. Gear Down |
| AD | Ramp Door Open |
| AE | Weapon Count |
| AF | Config. Identification |

Note: (1) Both gust and maneuver $N_z$ derived by analog filter on $N_z$
(2) Information not obtained

TABLE 2.10

C-5A L/ESS PARAMETER DESCRIPTION

| RECORDED PARAMETER | UNITS | MADAR NAME | MADAR P-CODE | RESOLUTION | RECORDING RANGE | SAMPLE RATE (NO./SEC.) |
|---|---|---|---|---|---|---|
| Flap Position | Deg. | Flap | 02 | 1.848 | 0 to 40 | 1 |
| Pressure Altitude | Ft. | PR Alt | 06 | 444.4 | o to 50000 | 1 |
| Mach Number | - | MACH | 08 | 0.01 | o to 1 | 1 |
| Vertical Load Factor | - | VA/CG | 12 | 0.038 | -1.0 to +3.5 | 20 |
| Right Aileron Position | Deg. | Ailer | 24 | 0.504 | +15 to -25 | 10 |
| Ground Speed | Kts. | VG | 28 | 1.575 | 0 to 150 | 2 |
| Wing Stress: | | | | | | |
| Upper Panel (WS577) | psi | Uppnl | 43 | 655.2 | -29040 to 22960 | 20 |
| Lwr Aft Beam (WS197) | psi | Last 2 | 47 | 680.6 | -22375 to 31625 | 20 |
| Lwr Aft Beam (WS330) | psi | Last | 58 | 504.0 | -22325 to 17625 | 20 |
| Upr Aft Beam (WS330) | psi | Uast | 60 | 630.0 | -20430 to 29570 | 20 |
| MADAR Time | HMS | ZULU | 09 | N/A | N/A | 1 |
| LHRP Discrete Word: | | | | | | |
| Aerial Refueling | N/A | AR | 11 | N/A | 0 or 1 | Once Per 5 Sec |
| Aerial Delivery | N/A | AD | 13 | N/A | 0 or 1 | Once Per 5 Sec |
| Touchdown Switch | N/A | TD/SWT | 15 | N/A | 0 or 1 | Once Per 5 Sec |
| Spoilers Deployed | N/A | Spoil | 17 | N/A | 0 or 1 | Once Per 5 Sec |
| Inbd'd Thrust Rev. Deployed | N/A | IN TR | 19 | N/A | 0 or 1 | Once Per 5 Sec |
| Outb'd Thrust Rev. Deployed | N/A | Out Tr | 21 | N/A | 0 or 1 | Once Per 5 Sec |
| Terrain Following Active | N/A | TF | 23 | N/A | 0 or 1 | Once Per 5 Sec |
| Pitch Autopilot Act. | N/A | Pit Eng | 25 | N/A | 0 or 1 | Once Per 5 Sec |
| ALDCS Active | N/A | ALDCS | 27 | N/A | 0 or 1 | Once Per 5 Sec |
| Compressor Speed | % | N2 | N/A | 0.23 | 0 to 110 | 1 |
| Fuel Flow | lb/hr | FF | N/A | 67.4 | 0 to 16000 | 1 |
| Throttle Angle | Deg. | TA | N/A | 0.51 | 0 to 80 | 1 |

TABLE 2.11

F/FB-111 MULTIPLE CHANNEL RECORDER PARAMETERS

| | Parameter | Recording Rate | Signal Source |
|---|---|---|---|
| 1. | Mach Number | 1 sps | CADC, M, 36A (R3-D) |
| 2. | Pressure Altitude | 1 sps | CADC, Hp, 1AC |
| 3. | Outside Air Temperature | 1 sps | Total Temperature Indicator |
| 4. | Wing Position | 1 sps | Wing Sweep Transmitter |
| 5. | Acceleration, Z Axis - (load factor) | 30 sps | |
| 6. | Acceleration, X Axis - (load factor) | 10 sps | *Three Axis Linear Accelerometers |
| 7. | Acceleration, Y Axis - (load factor) | 15 sps | |
| 8. | Roll Rate | 15 sps | |
| 9. | Yaw Rate | 15 sps | Flight Control Sensor Set |
| 10. | Pitch Rate | 15 sps | |
| 11. | Flap Position | 1 sps | Flap Position Transmitter |
| 12. | Landing Gear Position | every other second | From Main Landing Gear Uplock Switch |
| 13. | Sink Speed | 5 sps | *Sink Rate Radar |
| 14. | LH Horizontal Tail Position | 15 sps | LH Horizontal Tail Transmitter |
| 15. | RH Horizontal Tail Position | 15 sps | RH Horizontal Tail Transmitter |
| 16. | Rudder Position | 15 sps | Rudder Position Transmitter |
| 17. | Fuel Flow, Right Engine | 1 sps | RH Engine Fuel Flow Indicator |
| 18. | Fuel Flow, Left Engine | 1 sps | LH Engine Fuel Flow Indicator |
| 19. | True Angle of Attack | 5 sps | CADC, $\alpha$ , 5A |
| 20. | Right Outboard Spoiler Position | 30 sps | *RH Spoiler Transmitter |
| 21. | Left Outboard Spoiler Position | 30 sps | *LH Spoiler Transmitter |
| 22. | Left Main Landing Gear Strut Pressure ⊛ | 1 sps | *Pressure Transducer |
| 23. | Right Main Landing Gear Strut Pressure ⊛ | 1 sps | *Pressure Transducer |
| 24. | Nose Landing Gear Strut Pressure ⊛ | 15 sps | *Pressure Transducer |

sps ~ sample per second

⊛ ~ Pneumatic

*~Peculiar to MCR Installation

Therefore, during the actual L/ESS data analysis, it was discovered that useful results could be obtained from recorded data with as little as three or four parameters. However, most force management engineers were unwilling to eliminate any of the parameters, even though they were not currently required, due to the possibility of a still undiscovered structural problem where they might be useful.

### 2.2.2 L/ESS Data Processing and Analysis

The L/ESS data processing is required to handle large volumes of multiparameter data collected during a relatively small sample (5-20 percent) of the total fleet operation. The MXU recorders generate about $0.86 \times 10^6$ data samples per hour of operation, but the number of significant load excursions on an average flight varies from 40 to 1000. The problem is thus to determine which of the data samples correspond to significant loads and to compute stress at selected structural locations from data samples of the recorded parameters. Some methods determine the significant times first by finding peaks and troughs of the recorded parameters and then computing loads and stresses at these times. Other methods compute a time history of stress from the recorded parameter time histories and then find peaks and troughs of stress. Most methods use some combinations of these approaches.

This paragraph presents many of the detailed data processing and analysis steps for current systems. Several of the transport/bomber aircraft are presented in separate sub-paragraphs while the attack/fighter/trainer methods have been grouped into those using cumulative fatigue analyses and those using crack growth analyses.

#### 2.2.2.1 C-141A L/ESS Methods

A system of data blocks is used to reduce the time history tapes of the C-141A L/ESS. There are two basic reasons why the time history data is reduced to data block form. These reasons are:

1. Data blocking condenses the flight profiles to a compact form and common base so that data may be accumulated and combined for a number of flights.

2. Data blocking reduces the data to a form consistent with the C-141 Individual Aircraft Service Life Monitoring Program (IASLMP) so that comparisons can be made between the C-141 L/ESS and C-141 IASLMP.

The C-141A L/ESS data blocks are defined for both ground and flight operations and the primary parameters defining these data blocks are fuel, cargo, speed, and altitude. Fuel usage for the C-141A LHRP is computed from equations compiled from the C-141A flight manuals. The equations were compiled for normal flight operations including climb, cruise, and descent. The C-141A LHRP computes flight fuel usage once per minute. The altitudes at the beginning and end of each 60 second time period are monitored. A basic cruise fuel is calculated and then this is adjusted according to whether or not a climb or descent has occurred.

The cargo data blocking is accomplished by utilizing the dialed in beginning airplane gross weight and fuel weight in conjunction with the input empty gross weight. The effective cargo weight is calculated as follows:

$$C = GW - F - E$$

where

C = effective cargo weight
GW = dialed in beginning gross weight
F = dialed in beginning fuel weight
E = empty gross weight

The speed and altitude data blocks for the C-141A L/ESS are determined from differential and static pressure measurements. The c.g. load factors, $N_z$ and $N_y$, are separated into gust and maneuver portions in the C-141 L/ESS data reduction program. This separation is accomplished by computing the frequency spectrum of the $N_z$ or $N_y$ time history by performing a Fourier transform, applying a low pass digital filter to the frequency spectrum, and then computing the inverse Fourier transform to obtain a filtered time history. This separation technique is based upon the supposition that the frequency content of the load factor due to maneuver is sufficiently distinct from the frequency content of the load factor due to gusts so that a nominal "cutoff" frequency may be established on the frequency spectrum. It is assumed that all of the power content of the spectrum below this cutoff frequency is due to maneuvers and all of the power content of the spectrum above this cutoff frequency is due to gusts. The vertical load factor as it is digitized by the recorder/multiplexer requires a discrete type Fourier transform. The technique used to perform this discrete Fourier transform is the so called "fast Fourier transform" (FFT).

This technique of gust and maneuver separation is shown in Figure 2.22. The total load factor time history, g (t), in Step A is transformed to the frequency domain via the fast Fourier transform (FFT) to obtain G(W) in step B. The low pass filter function in Step C is multiplied by G(W) to obtain the maneuver spectrum of the load factor shown in Step D, F(W). The inverse Fourier transform is then applied to F(W) to obtain the maneuver time history, step E. The gust time history in Step G may then be computed by subtracting the maneuver portion from the total c.g. load factor.

After the load factor data is separated into its gust and maneuver components, it is peak counted by the data block in which the load factor occurs.

The strain data is peak counted in the form of a tabulation of the number of peaks falling within predetermined band levels located about some instantaneous mean strain value. This data along with an average mean is computed for each flight and ground data block. The peak count routine therefore determines an instantaneous mean value for each data

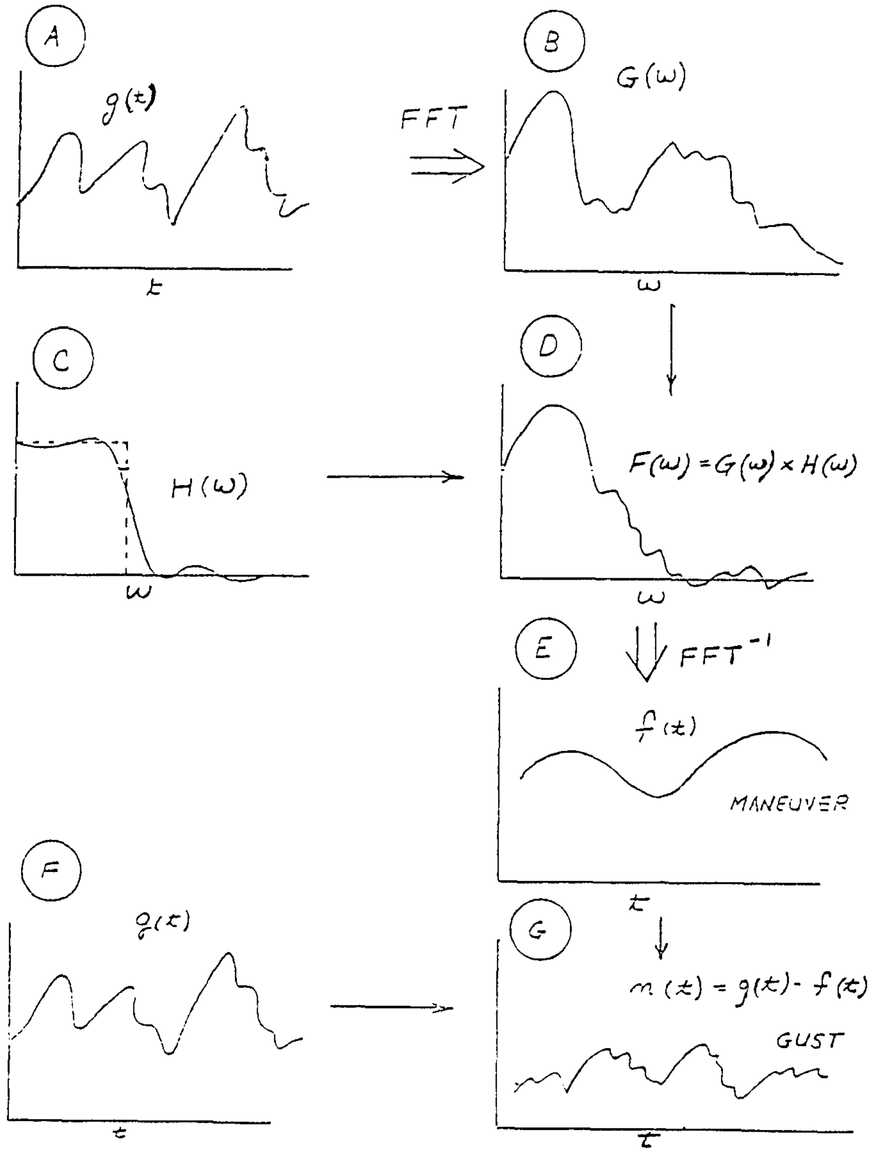



Figure 2.22 Schematic of Gust/Maneuver Separation of C.G. Load Factor.

sample, sets band levels about this value, determines if a peak has occurred and identifies the band level in which the maximum value of the peak occurs.

The mean used for the strain peak counting is a running mean averaged over 6.4 seconds before and after the instantaneous value for which a mean is required. The average mean of the parameter x at point i is:

$$\overline{x_i} = \frac{1}{2M + 1} \sum_{i - M}^{i + M} (x_i)$$

where

M is the number of data points included in 6.4 seconds and M = 6.4 x (parameter sample rate).

The mean averaging time of 12.8 seconds was selected in order to minimize the error in the peak count level of aperiodic peaks as well as in the mean level during step changes in strain level, e.g. during takeoff and landing.

The overall methods of damage calculations for the strain time histories in C-141 L/ESS are presented schematically in Figure 2.23. The S-N data and the quality levels are input to the Damage Chart Program which yields the graphical and analytical representation of S-N data by location. The analytical representations called Damage Charts are input to the C-141A L/ESS software. The strain-stress relations, peak counts, and mean strain per data block per aircraft per sortie per location and the characteristic data for factoring of strain data for IASLMP damage comparison are also the input data to the software.

The programs output a damage report by load source in the form of incremental damage per aircraft by quarter. The damage by data block for each aircraft are

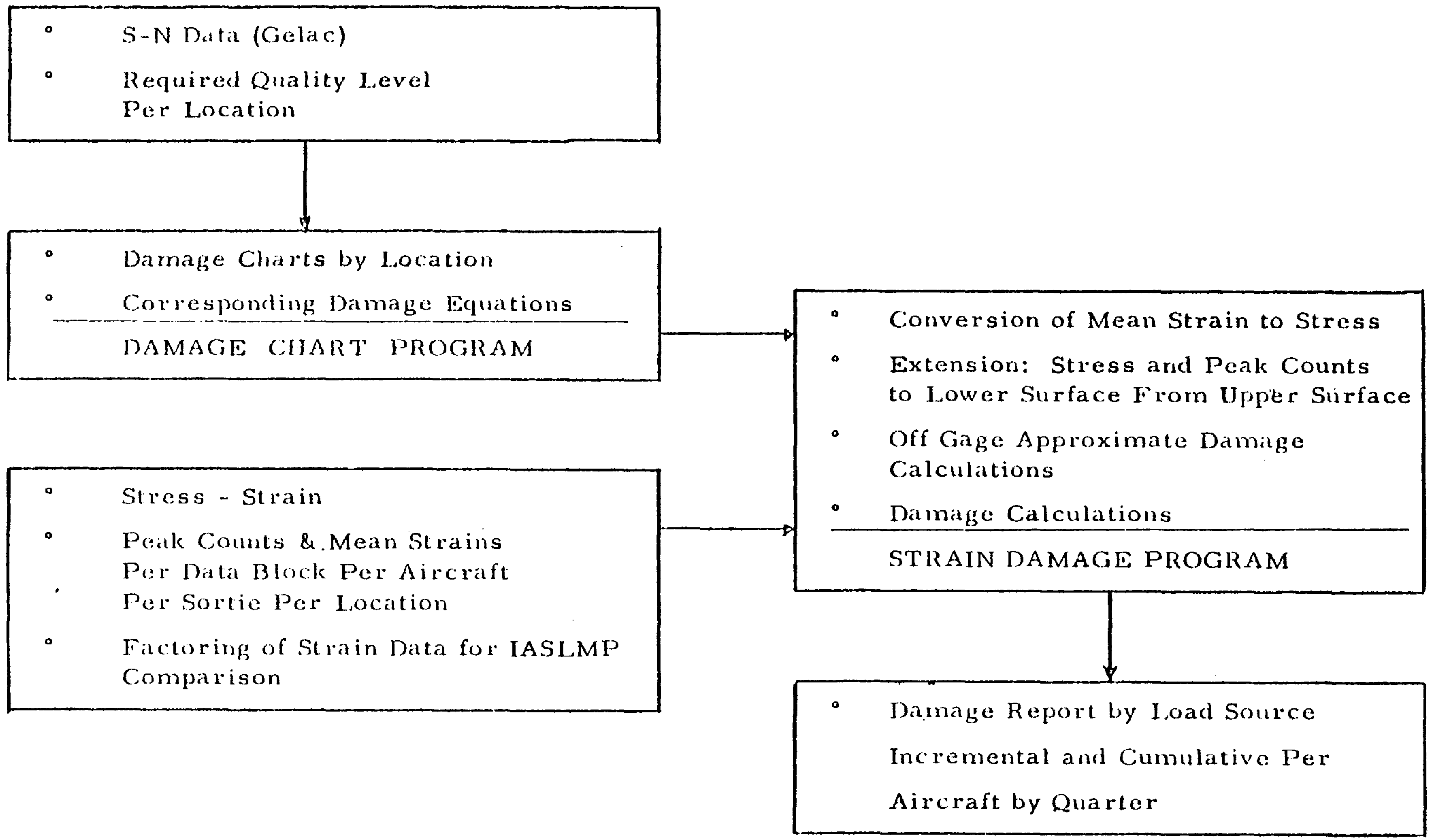



Figure 2.23. Life History Recorder Program Damage Calculations.

calculated using Miner's cumulative rule.

2.2.2.2 F/FB-111 L/ESS Methods

The data reduction of the F/FB-111 L/ESS data is accomplished in two stages; these stages are called (1) Data Processing (performed at ASIMIS), and (2) Data Analysis (performed at General Dynamics) (Figure 2.24).

The Data Processing is divided into three phases. These phases are:

(1) Quick Look Processing - Initial review to select flights with usable information.

(2) Flight Identification - Retrieval of the Flight Usage Card Information (AFTO Form 71324).

(3) Loads Edit Processing - Generation of compressed time histories of the recorder data.

The recorder data are reviewed on a flight-by-flight basis to determine the flights for which the data are usable for updating airframe and landing gear service load spectra. A digital computer procedure (referred to as Quick Look) has been developed to help accomplish this review. The Quick Look Procedure provides a digital listing of the maximum and minimum values for successive 33-second time intervals for each data item. The listing for an entire flight is reviewed for evidence of erroneous data. The following information is determined for individual flights for Loads Edit processing:

a. Null adjustments for data parameters.

b. Data parameters which are to be suppressed because of questionable or erroneous measurements.

c. Data time records for starting and stopping Loads Edit processing.

d. Flight identification and description information (e.g., A/P SN, organization, data of flight, takeoff configuration, takeoff weight, mission purpose, flight profile, aerial refueling duration and weight, and landing weight).

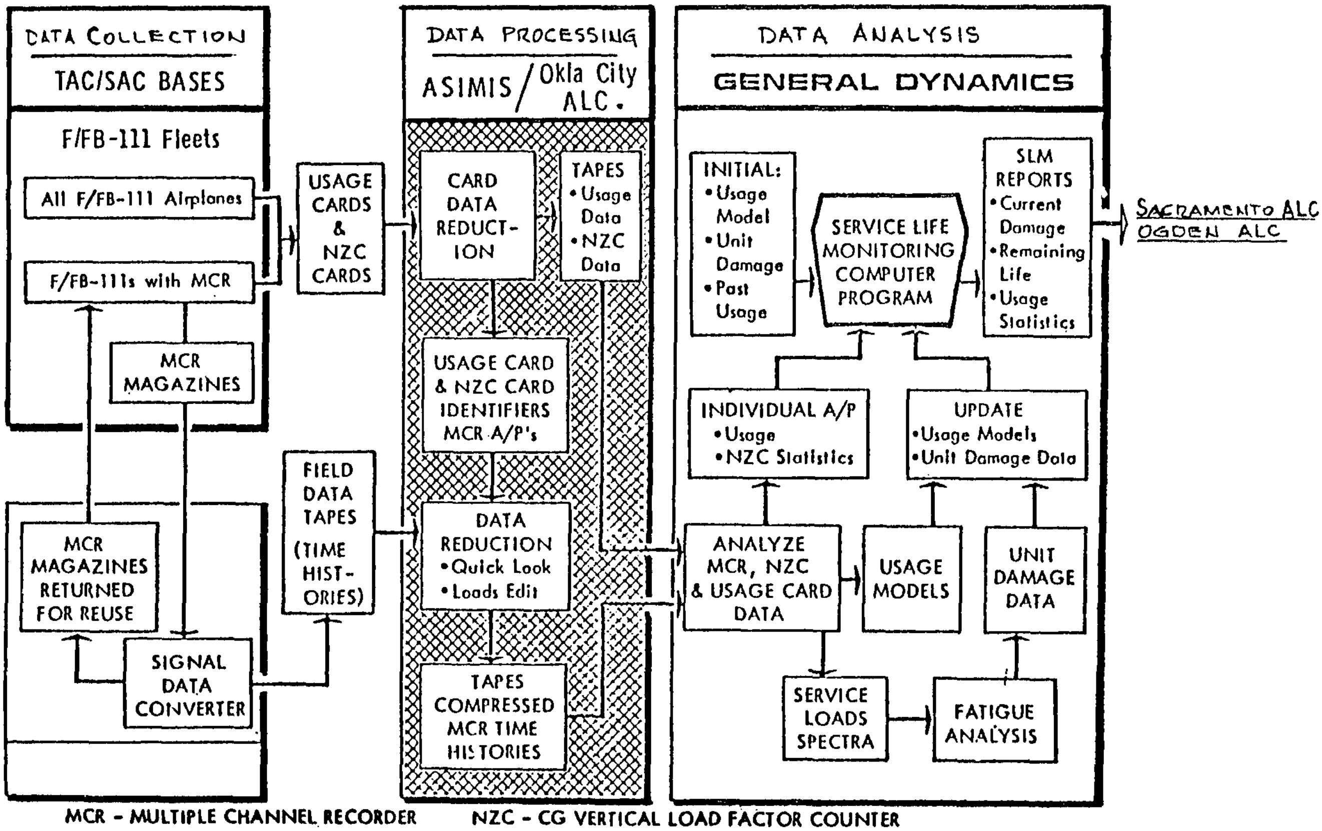



Figure 2.24 F/FB-111 L/ESS Data Flow.

Flight Usage Cards provide the following information needed for (1) selecting flights with usable data and (2) sorting of the usable data according to mission type and calendar period:

- o Date of flight
- o Total airplane hours at end of flight
- o Mission purpose
- o External store configuration
- o Takeoff and landing weights
- o Terrain following radar (TFR) usage
- o Aerial refueling usage information.

Definition of the above information requires identification of the flights for which data were recorded. The magazine labels provide identification of the recording airplane (serial number) and bomb wing and definition of the calendar period of the flights. A Quick Look listing of the data measurements is also available for each flight. This information is used in conjunction with a computer listing of Flight Usage Card information for individual flights to identify the flights with data --- the needed Flight Usage Card information is then read from the listing. This information and that generated during Quick Look processing are subsequently used through Load Edit processing to generate compressed time histories of the usable data.

The MCR Loads Edit Procedure (a digital computer program) is used to generate "compressed time histories" of MCR measurements for selected flights. These histories contain information necessary for updating airframe and landing gear service load spectra (load spectrum analysis) which are in turn used (through fatigue analysis) to update parametric fatigue damage rates for the F/FB-111 SLM program. The compressed time history for a given flight contains only a small percentage of the 240 MCR measurements which are recorded per second of engine operation. During airborne operations, MCR measurements are preserved approximately once a minute during periods of <u>inactivity</u>. A period of activity starts when one or more of certain items (referred to as Maneuver Activity Indicators - MAIs) have values outside of predefined threshold intervals and ends when all have returned to values within these intervals. A diagram using three MAIs to define a Maneuver Activity Period is shown in Figure 2.25 below; the upper and lower values of the threshold interval are denoted as UT and LT, respectively.

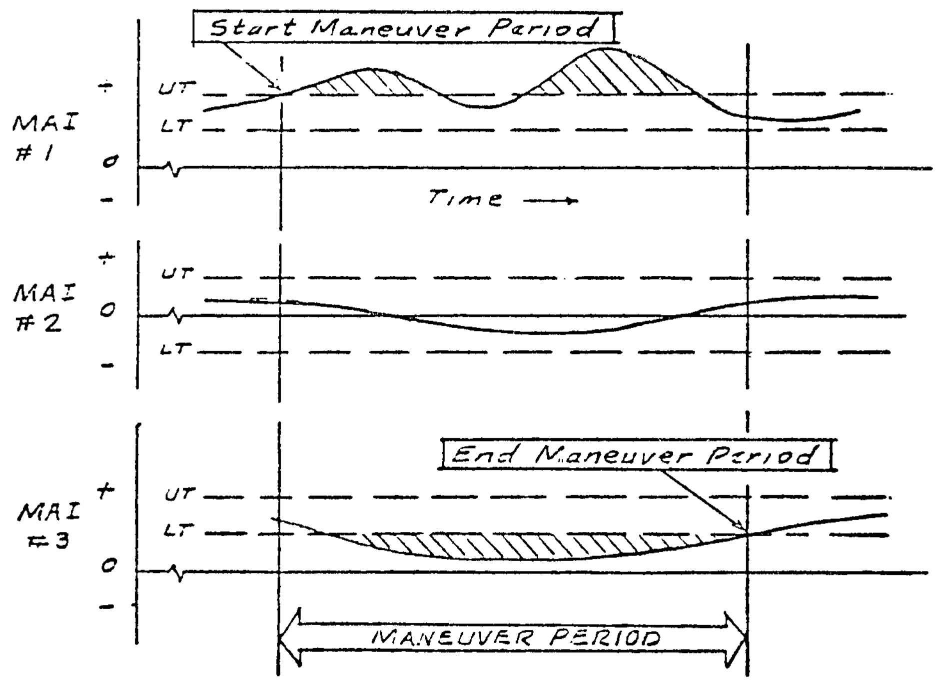



Figure 2.25 Definition of Maneuver Activity Period (F-111).

During a maneuver activity period, "time hacks" of all data measurements are preserved for the following times:

1. Time at start of maneuver activity period approximately 1-g trim data).

2. Times when selected items (referred to as peak indicators -- PIs) have certain maximum values. For a given PI, this is the time it has its maximum value between the time it exceeds its upper threshold (UT) and the next time it returns to its upper reset (UR) as shown in Figure 2.26.

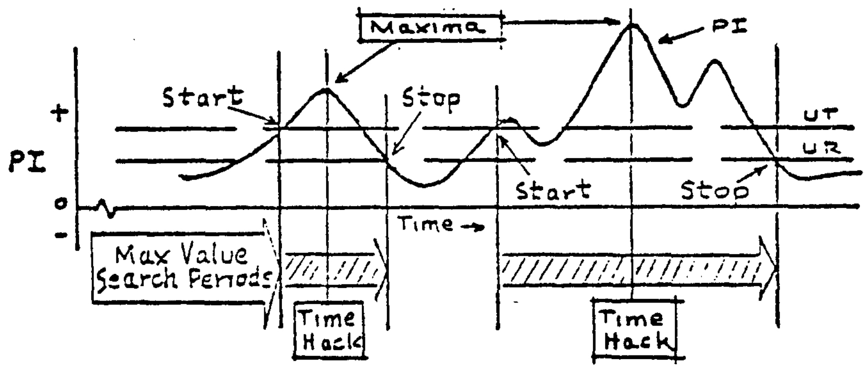



Figure 2.26 Location of Peak Time Hacks (F-111).

3. Times when the PIs have certain minimum values. For a given PI, this is the time it has its minimum value between the time it reduces to values less than its lower threshold (LT) and the next time it returns to its lower reset (LR) as shown in Figure 2.27.

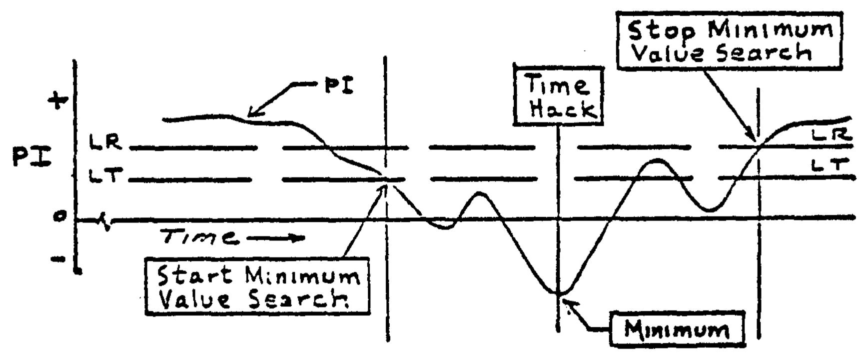



Figure 2.27 Location of Trough Time Hacks (F-111).

4. Time at end of maneuver activity period (return to approximate 1-g trim).

The compressed MCR time history for a given flight also includes time hacks of MCR measurements at selected times during ground operations. These times are selected by using the "peak-indicator" technique described in Items 2 and 3 above. In some case, the PIs for ground operations and flight operations are different. Identification of the PIs and MAIs for flight operations and the PIs for ground operations and definition of their associated threshold and reset levels are shown in Table 2.12. Some of the PIs and MAIs are measured parameters while others are computed from the data measurements.

The Load Edit Procedure classifies the data preserved for the selected times into three categories:

Type 1 Data - Preflight Ground Operations
Type 2 Data - Flight Operations
Type 3 Data - Other Ground Operations (ground operations during touch-and-go landings, taxi-back landings, and ground operations associated with the final landing for a flight).

The resulting compressed time histories of the data (Data Types 1, 2, and 3) for individual flights are written on magnetic tape for subsequent analyses.

The compress time history tapes and the tapes containing the usage data and $N_z$ counts are transmitted to General Dynamics for data analysis. The major data items that are output from this data analysis are:

(1) Current damage
(2) Remaining Life
(3) Usage Statistics

See Figure 2.1.

Equations of the general form shown below were developed for computing maneuver loads for the "times" preserved in the compressed time histories.

$$\text{Load} = C_o + C_1 V_1 + C_2 V_2 + \ldots + C_n V_n$$

C - Constant
V - Variable in terms of MCR parameters

Selection of the variable terms and definition of the constants is accomplished through application of linear multiple-variable regression analysis techniques to concurrent measurements of airplane loads and data parameters recorded during the F/FB-111 Category I Flight Test program.

The following steps highlight the main facets of the maneuver loads data reduction of the FB-111 L/ESS:

- o Maneuver loads are calculated according to maneuver activity period by flight.
- o Maneuver load peaks and valleys are paired sequentially within a maneuver activity period to form load cycles.
- o Each maneuver period is assigned a "Representative $N_Z$" ($N_{Z_{REP}}$) --- the maneuver.
- o All resulting maneuver load cycles are labeled as necessary to preserve identity of
    - o USAF Organization (wing)
    - o Mission Type
    - o Representative $N_z$
    - o Mission Segment, Speed, Wing Sweep, and GW.
- o All maneuver load cycles with like loads and like lables (identifiers) are grouped and written on an output MCR load-cycle history tape.
- o Fatigue damage of individual maneuver load cycle groups are computed; identification labels are retained.
- o Fatigue damage with like identification labels are summed and preserved (with identifiers) on an output history tape.
- o Periodically, to update SLM fatigue UDD due to flight maneuvers, information on the MCR load-cycle history tape is grouped and scaled to define maneuver load spectra and fatigue damage according to
    - o Mission Type and Organization
    - o Mission Type, Organization, and $N_{Z_{REP}}$
    - o Mission Segment and Organization

TABLE 2.12

F/FB-111 MCR MANEUVER ACTIVITY INDICATORS AND PEAK INDICATORS

a) For Flight Operations

| DATA ITEM | MANEUVER ACTIVITY INDICATOR (MAI) THRESHOLDS | | PI~THRESHOLDS AND RESETS | | | | |
|---|---|---|---|---|---|---|---|
| | UPPER | LOWER | PI No. | UPPER | | LOWER | |
| | GT④ | LT④ | | THRESHOLD GT④ | RESET LE④ | THRESHOLD LT④ | RESET GE④ |
| $N_Z$ | 1.313 g | .75 | 1 | 1.5 | 1.125 | .563 | .938 |
| $N_Y$ | .125 g | -.125 | 2 | .125 | .063 | -.125 | -.063 |
| DR | 1.875 g | -1.875 | 3 | 2.813 | .938 | -2.813 | -.938 |
| DA① | 2.344° | -2.344 | 4 | 3.906 | 1.563 | -3.906 | -1.563 |
| $DA_{HL}$② | 2.344° | -2.344 | 4HL② | 7.813 | 1.563 | -7.813 | -1.563 |
| $V_{VT}$③ | NOT USED | NOT USED | 5 | 3300 LBS | 1650 LBS | -3300 LBS | -1650 LBS |
| $V_{HTL}$③ | " " | " " | 6 | 3000 LBS | 1500 LBS | -3000 LBS | -1500 LBS |
| $V_{HTR}$③ | " " | " " | 7 | 3000 LBS | 1500 LBS | -3000 LBS | -1500 LBS |
| $V_{WL}$③ | " " | " " | 8 | 7500 LBS | 3750 LBS | -7500 LBS | -3750 LBS |
| $V_{WR}$③ | " " | " " | 9 | 7500 LBS | 3750 LBS | -7500 LBS | -3750 LBS |
| SPL | 3.516° | N/A | 10 | 6.328 | 3.516 | N/A | N/A |
| SPR | 3.516° | " | 11 | 6.328 | 3.516 | " | " |
| P | 6.25 Deg/Sec. | -6.25 | 12 | 31.25 | 6.25 | -31.25 | -6.25 |
| Q | 1.563 Deg/Sec. | -1.563 | 13 | 4.689 | 1.563 | -4.688 | -1.563 |
| R | 1.563 Deg/Sec. | -1.563 | 14 | 4.688 | 1.563 | -4.688 | -1.563 |
| $\dot{P}$ | .194 Rad/Sec² | -.194 | 15 | .818 | .194 | -.818 | -.194 |
| $\dot{Q}$ | .048 Rad/Sec² | -.048 | 16 | .136 | .048 | -.136 | -.048 |
| $\dot{R}$ | .035 Rad/Sec² | -.035 | 17 | .136 | 0 | -.136 | 0 |

SEE NEXT PAGE FOR NOTES ①, ②, ③ AND ④.

NOTES:

① ~ To compute thresholds and resets for DA, the values shown in this table are to be added to DA trim which is computed every three records in Loads Edit... where DA = HTL - HTR

② ~ Use these values to compute DA peak indicators for high-lift operations (Flap position > 5°).

③ ~ To compute peak indicator thresholds and resets for these load items, add the values shown in this table to tare values as computed by Loads Edit for PI=63 time hacks (MCR data at start of maneuver).

④ ~ GT = greater than, LT = less than, GE = GT or equal, LE = LT or equal to.

TABLE 2.12 (Concluded)

b) FOR GROUND OPERATIONS

| PI No. | DATA ITEM | THRESHOLDS AND RESETS | | | |
|---|---|---|---|---|---|
| | | UPPER | | LOWER | |
| | | THRESHOLD GT | RESET LE | THRESHOLD LT | RESET GE |
| 1 | $N_z$ | 1.313 g | 1.313 | .75 | .75 |
| 2 | $N_Y$ | .125 g | .063 | -.125 | -.063 |
| 3 | $N_X$ | .125 g | .063 | -.125 | -.063 |
| 4 | DR | 15.938 Deg | 14.063 | -15.938 | -14.063 |
| 12 | P | 12.5 Deg/Sec | 6.25 | -12.5 | -6.25 |
| 13 | Q | 3.125 Deg/Sec | 1.563 | -3.125 | -1.563 |
| 14 | R | 3.125 Deg/Sec | 1.563 | -3.125 | -1.563 |
| 15 | $\dot{P}$ | .273 Rad/Sec² | .194 | -.273 | -.194 |
| 16 | $\dot{Q}$ | .136 Rad/Sec² | .048 | -.136 | -.048 |
| 17 | $\dot{R}$ | .051 Rad/Sec² | 0 | -.051 | 0 |
| 5 | NGP ① | 312.5 psi | -390.625 | -312.5 | 390.625 |
| 6 | MGPL ① | 312.5 psi | -390.625 | -312.5 | 390.625 |
| 7 | MGPR ① | 312.5 psi | -390.625 | -312.5 | 390.625 |
| 8 | $F_{YNG}$ | 1000 LBS | 500 LBS | -1000 LBS | -500 LBS |

NOTES: GT - GREATER THAN, LT - LESS THAN, GE - GT OR EQUAL, LE - LT OR EQUAL TO
① ~ THESE PI THRESHOLDS AND RESETS ARE INCREMENTAL FROM THE PREVIOUS PEAK OR VALLEY

The following steps outline the data reduction metodology used for the recorder data ground air-ground loads:

- GAG load cycles are determined and preserved on a flight-by-flight basis according to mission type and organization. The GAG load cycle for a particular flight consists of the maximum and minimum loads for the entire flight considering (1) preflight ground static loads, (2) 1-g trim flight loads, (3) flight maneuver loads, and (4) post flight ground static loads.

- Fatigue damage due to GAG load cycles is computed and preserved according to mission type and organization on an output MCR load-cycle history tape.

- Periodically, to update SLM fatigue UDD, information on the MCR load-cycle history tape is grouped and scaled to define GAG load spectra and GAG fatigue damage according to mission type and organization.

Finally, the analyses of the L/ESS data pertaining to the landing gear loads and the Service Life Monitoring (SLM) Unit Damage Data (UDD) is accomplished as follows:

- Equations with MCR parameters as independent variables were developed for computing the following gear loads:
    - Nose Gear-Vertical loads and side loads
    - Main Gear-Vertical, side, and drag for left and right sides.

- Time sequences of maximum and minimum loads are computed for individual takeoffs, touch-and-go landings, full-stop taxi-back operations, and final landing operations (SLM UDD operations) contained in MCR data sample.

- Each load time sequence is reduced to load cycles by applying the range-pair-range cyclic analysis technique supplemented in a manner to insure definition of maximum-range load cycles for individual SLM UDD operations in the MCR data sample.

- Periodically, to update SLM UDD for landing gear, the MCR gear load cycles are grouped, scaled, and analyzed as necessary to determine load spectra and fatigue damage according to organization (base) and GW for
  - 1000 Initial Takeoffs
  - 1000 Touch-and-Go Landings
  - 1000 Full-Stop Taxi-Back Operations
  - 1000 Final Landings

2.2.2.3 C-5A L/ESS Methods

The data reduction on the C-5A L/ESS is accomplished in two stages, the first at ASIMIS and the second at Lockheed-Georgia. The first stage is called "data processing and reduction" and the second "data analysis". This data flow is shown in Figure 2.28.

Data Processing is the initial function in the C-5A L/ESS. It deals with the procurement and intermediate preparation of flight recorded data for L/ESS analyses and comparisons. The primary goal of Data Processing is to insure that the data which ultimately reach the analysis stage are credible, error free and represent coherent flights. Data processing is composed of the individual operations defined in the following paragraphs.

The initial step in Data Processing is the extraction of L/ESS data from the Central Data Bank (CDB) at OC-ALC utilizing the L/ESS Data Extraction Program. The extraction program extracts onto magnetic tape all flight recorded L/ESS parameter data, MADAR trend messages, LRU messages and MADAR event messages which are used in L/ESS. The input to the program consists of all history tapes in the CDB which contain L/ESS aircraft data sets. The extraction program performs certain validity checks on the data to determine that Mach number, CG load factor, and pressure altitude exist and are basically credible; and determines that the data depict a true flight. That is, that there is a takeoff followed by a landing, etc. A printout of

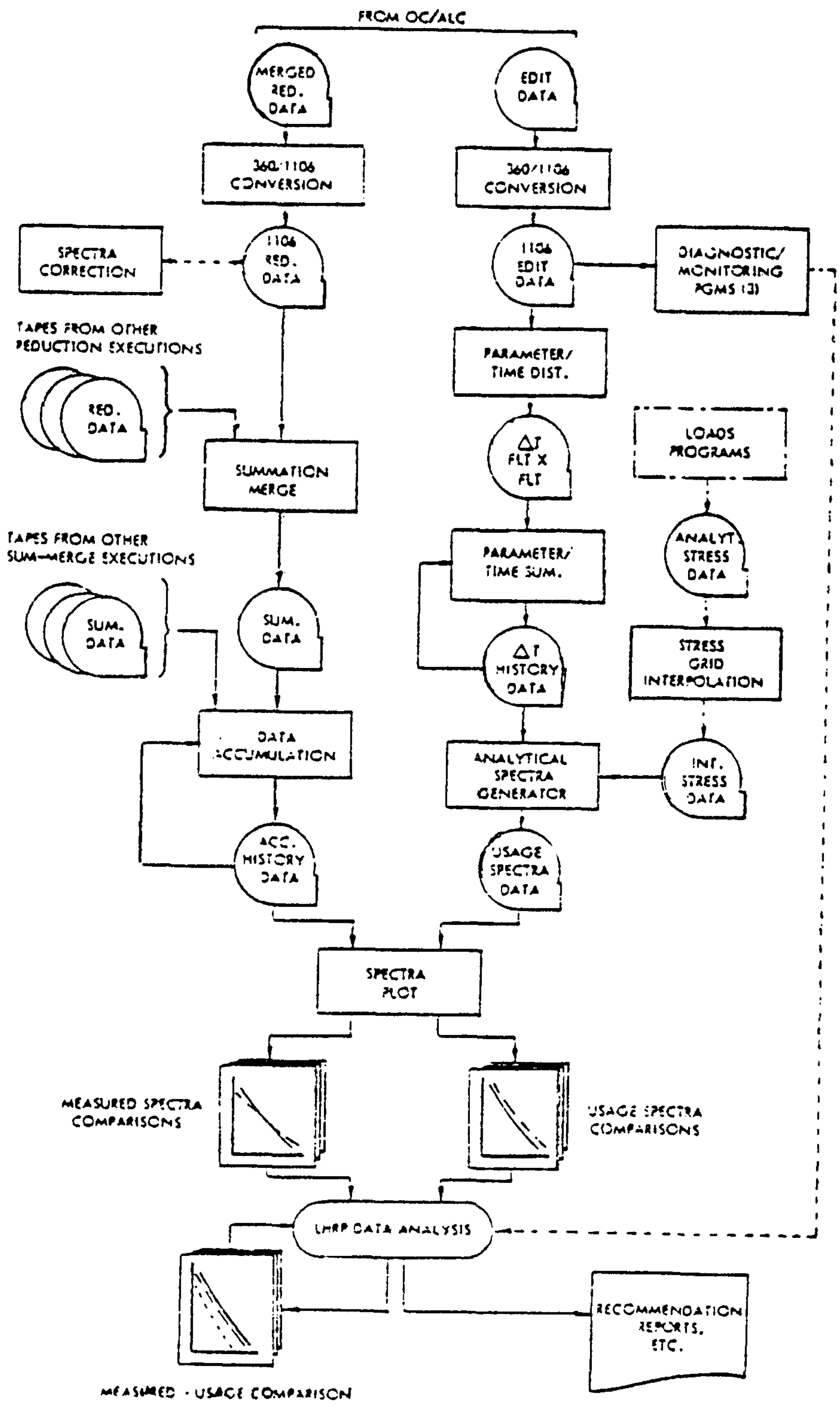



Figure 2.28. C-5A Network of Analysis Operations.

documentary parameter time histories and reduced (periodic time weighted average) time histories of time varying parameters is provided for each flight. The final step in the data extraction process is the merging of extracted tapes from several executions to produce packed tapes prior to Data Processing.

Data Correlation is the manual process whereby MAC Form 89 data required in the L/ESS are identified. The source of this information is the printout from the Individual Aircraft Service Loads Monitoring Program (IASLMP) Combined Usage Program. The salient features of an extracted flight are determined by manual inspection of the Extraction Program time history printout. This information, along with aircraft serial number, airframe hours and flight data from the MADAR header, (also from Extraction printout) are compared with similar information for Combined Usage flights flown in the same approximate time span. When the information for an extracted flight and a MAC 89 flight agree suitably well, the pertinent information are tabulated and card input for the Edit Program is formed.

The extracted data, which are compressed digital time histories of L/ESS flight recorded parameters (and other data) are operated upon by the L/ESS Edit/Correlation Program. This program performs detailed edits on each parameter and removes erroneous or bad data on a point by point basis, or, if severity criteria are exceeded, rejects entire data channels. Entire flights are rejected if a key parameter (Mach number, pressure altitude, C.G. load factor, flap position, ground speed, or aileron position) is failed. A flight profile is constructed for each flight by collectively interpreting the recorded data. The flight profile provides a "road map" of each flight for the programs which process the data further. It consists of a list of aircraft activity indicators (takeoff, taxi, cruise, climb, descent, etc.) and a start time for each. The profile itself is edited following compilation to insure overall flight coherency. MAC Form 89 data are card input to the Edit Program and are combined with the flight recorded data for each flight. This information consists of aircraft and flight identification information, event codes (aerial refueling, contour flying, etc.), cargo weight and the fuel weight history. The MAC Form 89 data are obtained from IASLMP Combined Usage printout as explained previously.

A manual review of the Edit Program output is performed at the completion of each Edit execution. The purpose of this review is to isolate erroneous data or flights which may have eluded the checks and edits built into the Edit Program because of peculiar circumstances in the recorded data. The manual review of edit results proved to be an effective procedure in the SLRP and does not imply that the Edit Program is deficient in checking logic or is otherwise inadequate. A completely automatic editing program would be prohibitively large, considering the number of parameters involved and the possible number of combinations of erroneous data in various combinations of channels. Another unacceptable alternative is a simpler program which fails all flights which contain erroneous or even questionable data. This approach would result in a very small sample of data to analyze.

The results of the manual review and edit are introduced into the machine edited data tapes using the Edit Utility Program. This program allows for changes to be made to the flight profile, header information and the lists of failed or inoperative parameters. Entire flights can also be deleted from the output by using the Edit Utility Program.

The purpose of the Data Reduction phase of L/ESS is to convert the edited data produced within the Data Processing phase to other forms which are more suitable for the analyses and comparisons performed within the Analysis phase. The Data Reduction phase is comprised of the conversion of edited time history data to histogram and event occurrence forms, the review of resulting reduced data for consistency, and the organization of reduced data for subsequent Analysis phase operations. All operations within the Data Reduction phase are performed on a flight-by-flight basis.

The edited time history data of specific parameters are peak counted about calculated mean levels. Histograms are produced from the peak counted data for each applicable parameter for appropriate flight profile segments. The resulting data identify the number of peaks occurring in predetermined magnitude bands during individual flight profile segments. Maximum values of CG vertical load factor (NZCG) and wing stresses are calculated during landing impact, Ground-Air-Ground (GAG) and Air-Ground-Air (AGA) cycles. Additionally, the occurrences of specific events such as In-Flight Thrust Reversal, Engine Run-Up, etc. are counted and each flight is classified according to the IASLMP 64 Representative Missions definition.

The primary purpose of reduction is the peak counting of NZCG, wing stresses, and right aileron angle. A peak is defined as the maximum excursion of a time history trace between successive crossings of a mean (reference) level. Therefore, the peak counting method employed requires a determination of mean level for each of the peak counted parameters. The mean level for NZCG is established at a constant value of 1.0g, however, the mean level for right aileron angle and each of the wing stresses are calculated independently by a variable mean determination method. The determined variable mean for these parameters depends upon the local amplitudes and activity level of the specific parameter recordings and, therefore, varies from peak to peak.

The resulting peak occurrences are banded by specific magnitude ranges and retained by individual occurrence of flight profile segments. NZCG is peak counted for all segments, right aileron angle is peak counted for all in-flight segments, and wing stresses are peal counted for all segments except landing impact. The amount of elapsed time (Δ time) is maintained for each individual segment along with the corresponding banded peak occurrences.

Incremental stress excursions due to impact event are calculated for each operative stress channel for each landing impact. In addition, rate of sink is calculated for each impact event as a function of fuel weight, cargo weight, and impact NZCG. The impact NZCG value is determined within the Data Processing phase for each landing impact segment and is included in the edited time history data.

Calculations are performed to determine peak to peak extreme values of NZCG and wing stresses during each GAG cycle and each AGA cycle. A GAG cycle begins at the start of a flight and terminates at the end of flight. If a flight contains multiple full-stop landings, the number of GAG cycles will equal the number of full-stop landings. An AGA cycle will exist for each touch-and-go landing which is directly preceded by traffic segment. The AGA cycle begins at the start of pre-landing traffic and terminates at the end of post-liftoff traffic.

The cumulative number of specific events is determined by flight. The events that are identified and accumulated are:

- In-flight Thrust
- Ground Thrust Reversal
- Flaps Movements
- Aerial Refueling
- Contour Flying
- Airdrop
- Touch-and-Go Landings
- Full-Stop Landings
- Engine Run-Up
- Take-off Abort

The purpose of the identification of these events is to provide the Analysis phase a condensed history of particular aircraft activity that is not readily available in the normal reduced data. A flow diagram of the data reduction operation is shown in Figure 2.29.

The resulting reduced data of each flight are manually reviewed to insure the completeness and consistency of the data. The data are scanned for obvious errors, mission flights or items and inconsistent trends. Suspect data items or inconsistencies are noted for special scrutiny within the Analysis phase.

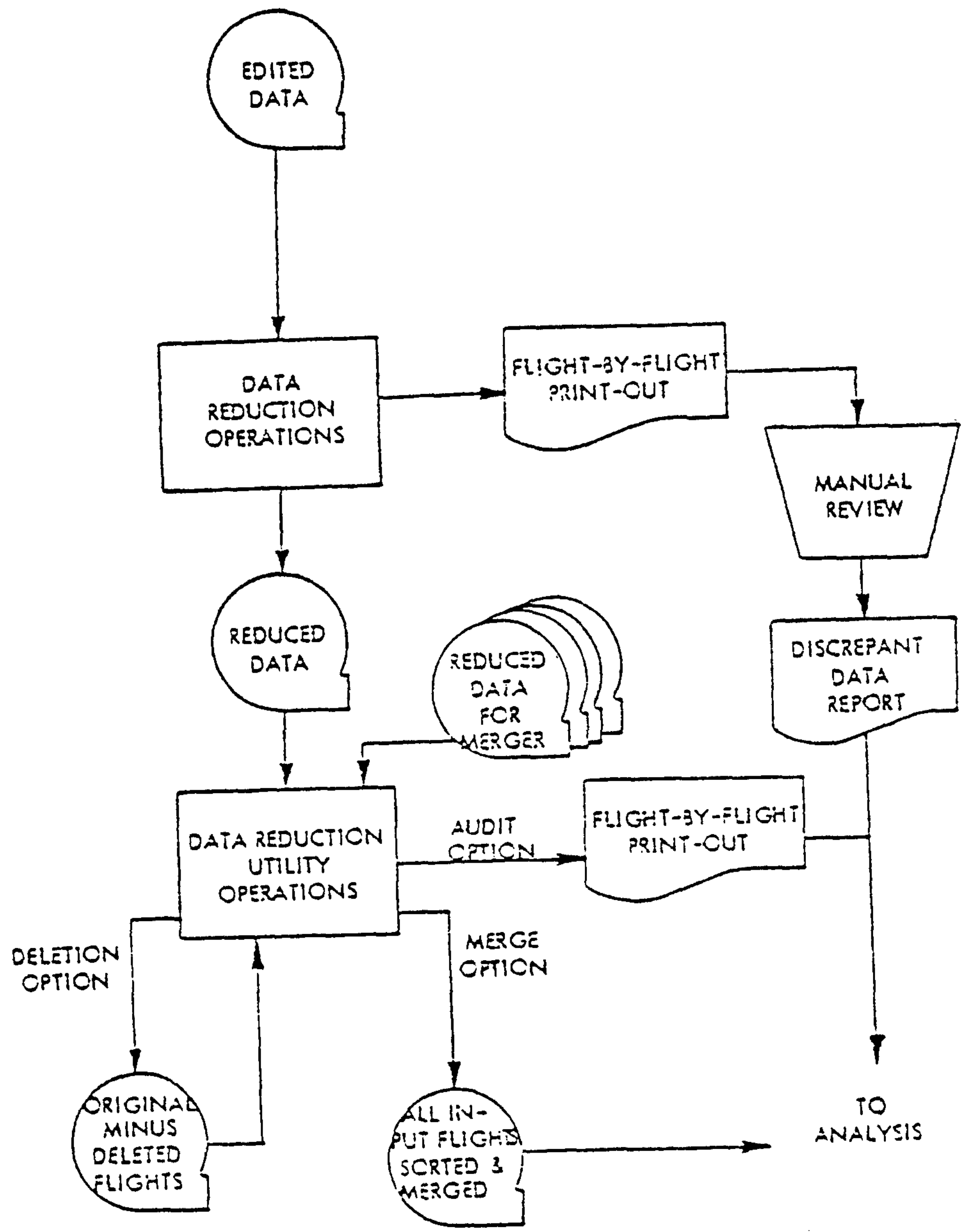



Figure 2.29 C-5A L/ESS Reduction Phase Data Flow.

The reviewed reduction data are organized for subsequent Analysis operations by the execution of several utility operations. Flights determined by manual review to be totally unsatisfactory for Analysis are deleted. Individual sets of reduced data are sorted and merged. Audits of the resulting merged flight-by-flight data are produced for use within the Analysis phase.

The reduction operations are performed through use of the L/ESS Data Reduction Program and the reduced data utility operations are performed through use of the L/ESS Data Reduction Utiility Program. All reduced data are produced on paper printout and magnetic tape. The paper printout is utilized in manual flight-by-flight review. The reduced data are transmitted to the Analysis phase, after utility operations, on magnetic tapes accompanied by corresponding data audits.

Data analysis is the final step in the C-5A L/ESS sequence. It is accomplished at Lockheed-Georgia. The primary goal of data analyses in the L/ESS is to compare information based on measured spectra, i.e., right aileron deflection, load factor and wing stress spectra, for a current time span with previously established information and determine if the loading experience of the aircraft is changing. This procedure will be repeated continually throughout the life of the C-5A fleet.

A secondary analysis consists of the development of spectra based on analytical stresses and usage data derived from measured documentary parameters. Comparisons of the measured stress spectra with the analytical/usage spectra further indicate whether changes in spectra (from one time span to another) are due to operating environment changes or changes in the manner in which the aircraft are being used. The results of these comparisons will be documented periodically in reports and status letters.

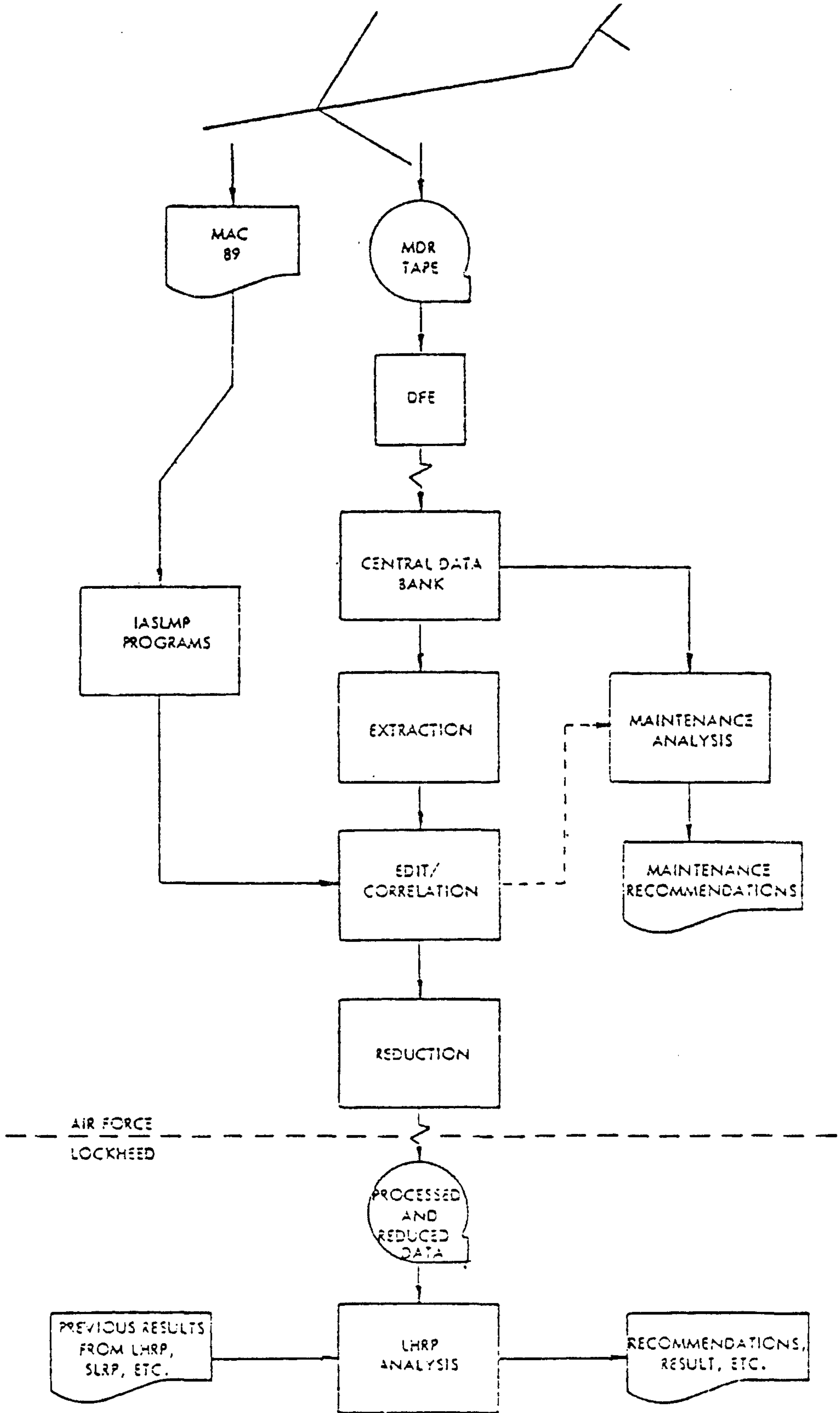



Figure 2.30 C-5A L/ESS Information Flow.

The generation of measured spectra is accomplished by cumulation of flight-by-flight reduced data produced within the Data Reduction phase of L/ESS. Analytical wing stress data are generated by the cumulation of usage information derived from flight-by-flight edited data produced within the L/ESS Data Processing phase.

The generation of measured and analytical spectra are accomplished through a highly computerized network of analyses in which flight-by-flight data are cumulated by category, normalized by time, and produced in plotted or tabular form for comparisons. The network of Analysis phase operations is presented in Figure 2.30.

2.2.2.4 T-43A L/ESS Methods

The T-43A L/ESS uses the MXU-553A recording system. Data processing was originally performed at Boeing-Seattle but has been transitioned to ASIMIS.

Documentary data values are dialed into the recorder at the start of each flight. These data are aircraft serial number, initial gross weight, initial fuel weight, base, mission type, aircraft hours, and data. Parameters whose values are recorded as variables during the flight are altitude, speed, fuel weight, air-ground indication (from R.H. main landing gear squat switch), time, and three channels of c.g. load factor data. These three channels are lateral acceleration ($\Delta n_y$), vertical acceleration ($\Delta n_z$) for frequencies from 0 to 0.2 cps, and vertical acceleration for all frequencies within the recorder system capabilities (0 to 6 cps.). The recorder is activated by release of the parking brake.

The counting accelerometer records numbers of exceedances for six c.g. vertical load factor levels and also records elapsed time. (The counting accelerometer is connected to the squat switch on the R.H. main landing gear, and records only during the time when the gear oleo is extended.) The load factor levels for which counts are made are 0.4, 0.7, 1.3, 1.5, 1.7 and 1.9 g's. Only one count for each level exceeded is made prior to crossing a reset value of either 0.9 or 1.1 g's.

The recorder data are reformatted, transcribed and compressed at the ASIMIS facility at Oklahoma City ALC. Compression is accomplished using the computer program DCCP (Data Compression Computer Program). Three means of compressing the recorder data are utilized. These are:

a. Elimination of most data points having values smaller than prescribed threshold values. The threshold values are $\pm 0.05g$ for $\Delta n_y$, $\pm 0.2$ g for $\Delta n_z$ for flight, and $\pm 0.1g$ for $\Delta n_z$ for ground loads.

b. Elimination of intermediate points between a peak (valley) and the next valley (peak).

c. Elimination of pairs of successive peaks and valleys whose magnitudes differ by less than 0.03g for $\Delta n_y$ and 0.1g for $\Delta n_z$.

The compressed recorder data are reduced using the computer program DRAP (Data Reduction and Analysis Program). The more important features of this program are:

a. The retained peaks and valleys, for each of the three load factor channels, are grouped in blocks of speed, altitude, gross weight and air or ground operational regime. Within each block, the mean values of speed, altitude and gross weight are calculated for all data entered into the block.

b. Within each data block, and for each of the three load factor parameters, the data are reduced by the level crossings method. This method produces one exceedance count of a given value of $\Delta n$ each time that $\Delta n$ level is crossed, with a positive slope, by the compressed $\Delta n$ time-sequence.

c. Within each flight condition data block, the number of counts at each $\Delta n_z$ level for the 0 to 0.2 cps channel (maneuver) is subtracted from the corresponding number of counts for the 0 to 6 cps (gust plus maneuver) channel. The remainder is the number of counts for gusts. It is possible, although rare that this technique can result in a negative number of counts. This could occur for a data block where the amount of flight time is quite small, and/or where the loading activity is very low. It results from a peak on the maneuver channel not being the same as a peak on the gust plus maneuver channel, and from the maneuver peak being displaced enough in time from the nearby gust plus maneuver peak so as to be in a different data block. In this case, there would be no gust plus maneuver count from which to subtract the maneuver count, so a value of minus one would be output for the gust count. If this happens, the minus one should be disregarded, and treated as if it were zero. Another possibility which can result from subtracting maneuver counts from counts of gust plus maneuver, for small data samples involving multiple data blocks, is to have more counts for a higher load factor level than for a lower level. This could possibly show up in the tabulated data, but should disappear when more data are obtained.

d. For ground loadings, the values for the highest peak and lowest valley of the 0 to 6 cps $\Delta n_z$ channel, during the first three seconds from touchdown, are used for level crossing counts for landing impact. If only one point occurs in the three second period, counts are made from one g to the peak or valley. All of the $\Delta n_z$ ground data are used for level crossing counts. The landing impact counts are subtracted from the toral counts to produce $\Delta n_z$ data for taxi. All $\Delta n_y$ data for ground conditions are considered as taxi. The 0 to 0.2 cps $\Delta n_z$ channel data are not used for ground conditions.

e. Selected data blocks are checked for data convergence. Each time new data are reduced, exceedance values in a data block for selected $\Delta n$ levels (normalized to per 1000 hours, per 1000 miles or per 1000 flights) are calculated for all data to date. These values are compared with the comparable values from previous data reductions. These comparisons are plotted in ratio form and are monitored to determine when the data have converged.

f. The results of the computer program operations are displayed in various tabular and/or graphical formats. These are used for data evaluation.

The counting accelerometers are read at approximately five week intervals. The values for each of the load factor levels and for the elapsed time indicator are recorded on the T-43A counting accelerometer forms along with the airplane tail number and the data. The data from the forms are reduced to exceedances per 1000 flight hours for each load factor level and for each airplane. All incremental load factor counts and elapsed time values are from the first counting accelerometer report after the airplane was delivered to the Air Force. Invalid, or suspect, data due to malfunctions in the counting accelerometer system, are not used.

The counting accelerometer data are reduced by the computer program DRAP. The output results are used for data evaluation.

#### 2.2.2.5 E-3A L/ESS Methods

The methodology of the E-3A L/ESS is very much similar to that for the T-43A with a few exceptions. Computer software is currently being written and checked out by the Boeing Company.

The programs will use a crack growth based methodology for 9 to 12 critical locations. The crack growth will be data block based. The data block will not have retardation but instead will use factor to account for retardation. Mission sequencing will not affect retardation. The L/ESS equipment for the E3A does not have a frequency filter for separation of gust and maneuver as does the T-43A; therefore no separation of gust and maneuver is done. There also is no fuel totalizer on the E-3A L/ESS.

Flight loads surveys have shown that gust and maneuver loads do not affect the radome loads. The rotating radomes give larger cyclic loads and rotation is therefore monitored as a measure of these stresses.

#### 2.2.2.6 C/KC-135 L/ESS Methods

In general, all calibrated channels for the C/KC-135 L/ESS are handled in much the same manner, with only the treatment of intercepts differing. Basically, a conversion is first made to voltage from digital levels. This is performed by making a least squares linear fit through the three points determined by the three calibration levels on each channel.

After calibration checks the first step in the strain mean computation is the application of numerical filters to remove the relatively high frequency components from the strain data. Low pass filters of the type developed by Martin and Graham were chosen.

The use of the digital filtering techniques remove frequencies above 0.04 cycles per second from the data. However, it is desired to remove even lower frequency data in some instances. Specifically, it is not thought to be desirable to allow the mean strain to respond to maneuvers lasting up to 10 minutes. This type of mean shift is faired-through by applying a series of 100-second windows to the digital filter mean strains. In essence, the mean strain is examined at intervals of 100 seconds and if the voltage difference exceeds 0.2 volts ( 1250 psi) at each of the six-100 seconds times after the time of interest, it is allowed to follow the shift. If at any of the 100-second windows the value do not exceed the 0.2 volt value, the mean is faired-through the short duration shift.

The positive and negative peaks on the acceleration and strains are basically defined in the same manner. A primary peak count is made in all cases. However, for two different reasons, the method of computing these primary peaks is different for the accelerations from that used for the strains. A primary peak in the C/KC-135 L/ESS is defined as the maximum excursion of the variable between crossing of the mean level of the variable. The difference between the analysis of the strains and of the acceleration is the determination of the mean. The value of the mean acceleration which is strived for is the 1.0g level. The mean strain is not allowed to change for maneuvers but is permitted to change during take-off and landing.

Since the mean value (1.0g) of acceleration is assumed to never change, it is possible to compute a running position of the 1.0g level in terms of digital counts and to subtract this mean level from all peaks detected to obtain the primary acceleration peaks. Primary acceleration peaks are detected by an algorithm which analyzes the samples of acceleration one by one and saves the sample if it is greater or less than the previous sample, depending upon whether the values are increasing or decreasing, respectively. This procedure is started when the data crosses the 1.0g mean, and is terminated with the return of the data to the 1.0g mean. The peak value and the time it occurred are written on a disk, if the peak value exceeded threshold.

The strain mean, however, changes during a flight because of changes in air loading, weight, and autopilot and flap positons. Because of these changes, which are sometimes rather rapid, the running value of the mean cannot be computed. The mean values, as computed by the digital filtering techniques, do not become available until sometime after the strain data is analyzed for peaks. For this reason, all peaks (primary and secondary) on strain are retained until such time as they may be compared with the mean. When this is done the secondary peaks are discarded.

The algorithm for peak determination on the strains analyzes the data point by point, and each time there is a change in direction the sample is saved as a possible peak/valley if the change from the last such peak/valley candidate (change in direction) is greater than threshold. At such time as a new peak/valley candidate is found, the previous peak/valley candidate is established as an actual peak/valley and is output, along with its time of occurrence, to disk.

The output from the C/KC-135 L/ESS, consists of ordered panel records followed by strain records and acceleration records, each containing all strain and acceleration peaks occurring after the panel time and before the panel time. A second program, VGH, which reads the EDIT output tape, outputs a printed tab and a magnetic tape, both of which contain a time history of the flight and statistical distribution of load factor and stress data.

#### 2.2.2.7 Cumulative Fatigue L/ESS Methods for A/F/T Aircraft

The A/F/T aircraft, that treat the data supplied by the L/ESS data collection and processing, using methods of accumulated fatigue damage are: F-5, F-15, F-100, F-105, F-106, F-111, A-10, A/T-37, and T-38. All of the aircraft analysis techniques are basically the same. The analysis requirement is to convert the L/ESS recorded parameters into a form suitable for the fatigue damage cumulation.

For the aircraft with strain measurements, the stress spectra and damage is calculated at the instrumented critical location by first transforming from strain to stress. Stress peaks and valleys are paired sequentially to form a stress cycle. For all other fatigue critical locations as well as all other A/F/T aircraft having no strain measurements, the calculation of stress at each location comes from the L/ESS measured aircraft motion parameters, control deflections, weight, and configuration.

One way this transformation is accomplished is by solving the stress equation:

$$\sigma = C_o + C_1 V_1 + C_2 V_2 + \dots C_n V_n$$

where

$C_i$ are constants

$V_i$ are variables in terms of the recorded parameters. The selection of the variable terms and definition of the constants are found through application of linear multiple-variable regression analysis of flight test data and/or analytical stress derivations.

Another general technique used is to calculate component internal loads through the use of "unit loads" and then calculate the stress at the critical location.

In like manner, stress peaks and valley, are paired sequentially to form a stress cycle. Then, using appropriate S-N curves, the damage is calculated for the stress cycle using the conventional linear cumulative damage theory (ie. $\Sigma n/N = 1$). This calculated damage is added to and grouped according to like identification labels which have corresponding flight hours accompanying. These groups may include possible combinations of:

- o Mission type
- o Base
- o Maneuver, landing, or taxiing
- o Composite

The accumulated damages when normalized to a per hour, or per landing, or per occurrence basis form the damage rates ($DR_{ijkl}$) used in the IAT program as illustrated in Tables 2.13 and 2.14.

The accumulated stress cycles, when considered in each of the possible groupings, form the baseline operational spectra. Typical stress exceedance curves are shown in Figure 2.31. These are compared to the design spectra for determining if analysis update is required.

2.2.2.8 Crack Growth L/ESS Methods for A/F/T Aircraft

For the F-4 current methods of L/ESS analysis, the recorded VGH parameters are first converted into stress values. This is done by a "table look up" approach where the stress at each critical point in the structure is defined by comparing and interpolating the measured data to that combination of airspeed/altitude/ load factor determined from flight test

# TABLE 2.13

## DAMAGE RATES (A-37)

## DAMAGE PER 1000 FLIGHTS
## HANCOCK AFB

| LOCATION / MISSION MIX | WING | | | | ORIGINAL CARRY-THRU | | | | | | | FUS/IMP | | ECP 177 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W.S. 54.28 RSLC | W.S. 91.5 FSLC | W.S. 91.5 FSUC | W.S. 55.16 FSLC POST ECP-171 | B.L. 12.5 PRE ECP-156 | B.L. 24.0 PRE ECP-156 | B.L. 25.8 PRE-ECP-156 | B.L. 37.9 | B.L. 12.5 POST ECP-156 | B.L. 24.0 POST ECP-156 | B.L. 25.8 POST ECP-156 | F.S. 114.68 CANOPY RAIL | F.S. 307.52 BANJO FITTING | B.L. 43.5 ATTACH LUG |
| 1A | .00762 | .01032 | .02052 | .00802 | .00577 | .10379 | .18849 | .18133 | .00351 | .05452 | .02672 | .03269 | .04160 | .00005 |
| 2A | .00760 | .00957 | .00817 | .01064 | .00822 | .12751 | .14033 | .20807 | .00559 | .06106 | .03646 | .04202 | .01846 | .00017 |
| 3A | .00940 | .01253 | .02624 | .01037 | .00863 | .16416 | .24516 | .25056 | .00518 | .07646 | .03586 | .03996 | .04266 | .00018 |
| 4A | .00869 | .00996 | .01528 | .01316 | .01038 | .24725 | .18264 | .27760 | .00659 | .08981 | .04757 | .03111 | .01846 | .00014 |
| | | | | | | | | | | | | | | |
| 1B | .02505 | .02806 | .03148 | .03808 | .02963 | .56584 | .56024 | .12624 | .01861 | .24233 | .13295 | .08059 | .10081 | .00123 |
| 2B | .00966 | .01125 | .00836 | .01329 | .00892 | .11566 | .16859 | .21696 | .00573 | .05912 | .09329 | .08366 | .08018 | .00024 |
| 3B | .02276 | .02862 | .03209 | .02677 | .03014 | .18211 | .29810 | .28184 | .01767 | .08417 | .05247 | .08152 | .08347 | .00522 |
| 4B | .01517 | .01716 | .01497 | .02022 | .02501 | .18577 | .20739 | .23940 | .01558 | .07675 | .05849 | .06493 | .08018 | .00094 |
| | | | | | | | | | | | | | | |
| 1C | .04399 | .05034 | .04585 | .06200 | .06358 | 1.2284 | .99951 | .12196 | .01983 | .37259 | .24738 | .06524 | .21055 | .00731 |
| 2C | .02647 | .02720 | .02807 | .03667 | .02783 | .74908 | .54746 | .27552 | .01774 | .27582 | .13770 | .11711 | .09819 | .00080 |
| 3C | .03764 | .03877 | .06283 | .05750 | .04267 | .74908 | .54746 | .23106 | .02666 | .27582 | .25115 | .06629 | .21055 | .00131 |
| 4C | .03367 | .03315 | .04489 | .04519 | .02533 | 1.3576 | .86801 | .29323 | .01630 | .41860 | .20955 | .10705 | .09819 | .00021 |
| 4H/11 | .03367 | .02025 | .05364 | .04569 | .03834 | .75335 | .65569 | .25089 | .02460 | .30313 | .17328 | .07011 | .09879 | .00053 |

# TABLE 2.14

## DAMAGE RATES (F-111)

**F-111A/E AIRFRAME - SUMMARY OF 10 GRID POINT UNIT DAMAGE DATA FOR 1000 SORTIES OF EACH MISSION PROFILE SHOWN (S.F. = 4.0)**

| MISSION PROFILE \ CONTROL POINT | 01 WING LOWER SKIN TO PIVOT FITTING SPLICE - ALUM. | 02 WING PIVOT FITTING CENTER SPAR FUEL FLOW HOLE | 03 CTB - BULKHEAD FLANGE AT B.L. 60 | 04 CTB - LOWER AFT FLANGE AT BOLT HOLE NO. 8 & 28 | 05 CTB - FWD CORNER OF THE LOWER CAP LUG @ B.L. 60 | 06 F.S. 496 NACELLE FORMER FRAME, BOLT #226 | 07 NACELLE TIE LINK SUPPORT AT F.S. 496 | 08 UNDERWING LONGERON SPLICE AT F.S. 496 | 09 UPPER BOLT ROW IN SKIN @ THE PEDESTAL SPL @ F.S. 770.25 | 10 SANDWICH SKIN ADJACENT TO THE LOWER RUDDER HINGE | 11 BHD. 770.25 HORIZONTAL TAIL PIVOT SHAFT | 12 HOR. STAB. - CENTER BOX SKIN HAND HOLE AREA | 13 SLAT NO. 2-FRONT SPAR LWR LEADING EDGE ATTACHMENT TAB | 14 INB'D SPOILER-INB'D BRACKET ATTACHMENT TO THE REAR SPAR | 15 INB'D SPOILER - INB'D BRACKET - 12W851 | 16 INB'D SPOILER - INB'D HINGE FTG - 12W8039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. TRA-1 | .0314 | .0639 | 0 | 0 | .0001 | 0 | TO BE COMPLETED LATER. | 0 | .0038 | .0417 | .0121 | .0110 | .4211 | .3440 | .0773 | .3516 |
| 2. TRA-2 | .0326 | .0638 | .0003 | 0 | .0010 | 0 | | 0 | .0036 | .0623 | .0156 | .0134 | .4615 | .3503 | .0786 | .3544 |
| 3. TRA-3 | .2713 | .5952 | .0003 | 0 | .1628 | 0 | | .0046 | .0059 | .0320 | .0308 | .0509 | .4963 | .2526 | .0560 | .2596 |
| 4. TRA-4 | .3034 | .6872 | .1345 | 0 | .4016 | .0310 | | .0095 | .0259 | .0250 | .1505 | .1084 | .4320 | .1377 | .0295 | .1400 |
| 5. TRA-5 | .3224 | .7074 | .0561 | 0 | .2905 | .0130 | | .0074 | .0153 | .0417 | .0829 | .0833 | .5391 | .2042 | .0448 | .2098 |
| 6. TRP-1 | .0437 | .0862 | 0 | 0 | .0011 | 0 | | 0 | .0096 | .0706 | .0186 | .0267 | .5870 | .3918 | .0883 | .3996 |
| 7. TRP-2 | .1679 | .3557 | .0006 | 0 | .0547 | 0 | | .0015 | .0050 | .0561 | .0211 | .0275 | .6351 | .3501 | .0786 | .3576 |
| 8. TRP-3 | .3335 | .7110 | .0024 | .0003 | .1334 | 0 | | .0036 | .0068 | .0591 | .0313 | .0477 | .6973 | .3504 | .0787 | .3588 |
| 9. TRP-4 | .5315 | 1.1634 | .0006 | 0 | .3112 | 0 | | .0089 | .0094 | .0404 | .0500 | .0894 | .6435 | .1946 | .0426 | .2012 |
| 10. WSF(A)-1 | .2301 | .4770 | .0002 | .0041 | .1222 | 0 | | .0035 | .0044 | .0310 | .0234 | .0380 | .5240 | .2734 | .0603 | .2796 |
| 11. WSF(A)-2,WSF(P)-1 | .5858 | 1.2383 | .0006 | .0034 | .3093 | 0 | | .0088 | .0097 | .0369 | .0578 | .0988 | .6654 | .3010 | .0674 | .3068 |
| 12. WSF(P)-2,-3,WSF(CR)-1,-2 | .2827 | .5469 | .1343 | .0020 | .3139 | .0310 | | .0070 | .0288 | .0181 | .1795 | .1341 | .6212 | .1188 | .0254 | .1224 |
| 13. WSF(A)-3,WSF(P)-4,-5,WSF(CR)-3 | .3837 | .8163 | .1344 | .0030 | .3506 | .0310 | | .0081 | .0257 | .0419 | .1485 | .0988 | .5266 | .3366 | .0754 | .3424 |
| 14. WSF(A)-4,WSF(P)-6 | .6307 | 1.3791 | .1306 | .0021 | .5124 | .0199 | | .0112 | .0512 | .0257 | .3039 | .2172 | .6665 | .3122 | .0698 | .3156 |
| 15. WSF(CR)-4 | 1.2109 | 3.5217 | 0 | .3128 | 0 | 0 | | .0012 | .0126 | .1500 | .0987 | .0944 | .5194 | .1296 | .0276 | .1356 |
| 16. WSF(A)-5 | .5877 | 1.3643 | .0001 | .0415 | .2370 | 0 | | .0061 | .0487 | .2692 | .2507 | .2363 | .4124 | 1.0618 | .2402 | 1.1916 |
| 17. WSF(CR)-6 | .5877 | 1.3643 | .0001 | .0415 | .2370 | 0 | | .0061 | .0486 | .2689 | .2507 | .2363 | .4124 | 1.0239 | .2323 | 1.1536 |
| 18. WSF(P)-7,WSF(CR)-5 | .0841 | .1577 | .0265 | 0 | .0694 | .0009 | | .0016 | .0158 | .0907 | .0341 | .0503 | .3490 | .5143 | .1162 | .5372 |
| 19. ABORT | .0223 | .0423 | 0 | 0 | .0018 | 0 | | 0 | .0013 | .0219 | .0049 | .0053 | .2250 | .1046 | .0223 | .1076 |
| 20. FUNCT CHECK FLT | .6190 | 1.6330 | .0008 | 0 | .0030 | 0 | | 0 | .0026 | .0444 | .0111 | .0097 | .3731 | .3076 | .0690 | .3064 |

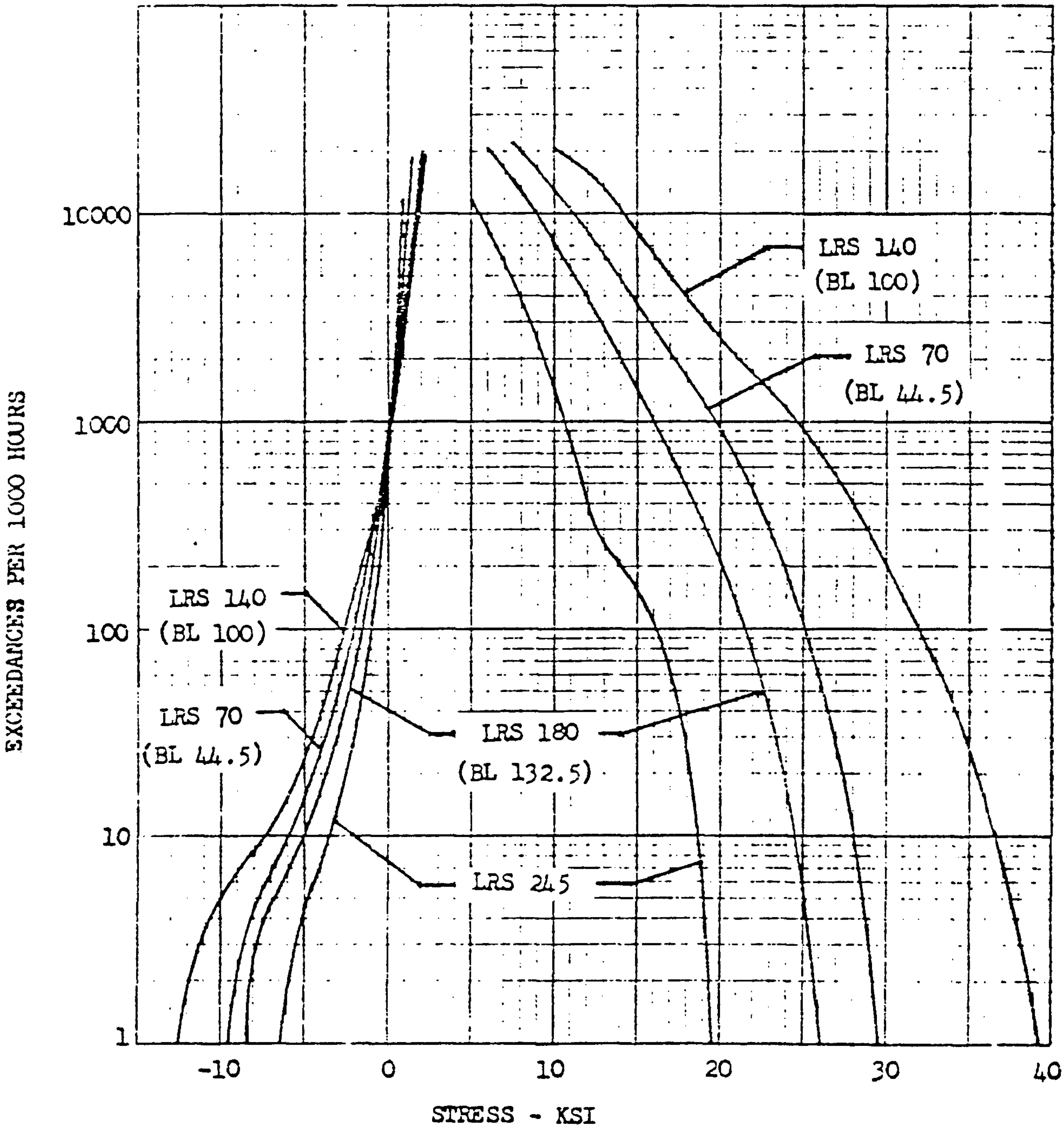
NOTES:
1. THESE GRID POINT UNIT DAMAGE DATA ARE BASED ON FZM-12-10783 PHASE I & II TRAINING OPERATIONS.
2. SEE "LIST OF SYMBOLS & ABBREVIATIONS" FOR EXPLANATION OF MISSION PROFILE ABBREVIATIONS.
3. GRID POINT UNIT DAMAGE DATA SHOWN ARE APPLICABLE FOR EACH SORTIE DESIGNATION LISTED UNDER PROFILE NOS. 11, 12, 13, 14 AND 18.

TABLE 2.14 (Concluded)

**F-111A/E AIRFRAME - SUMMARY OF 10 GRID POINT UNIT DAMAGE DATA FOR 1000 SORTIES OF EACH MISSION PROFILE SHOWN (S.F. = 4.0)**

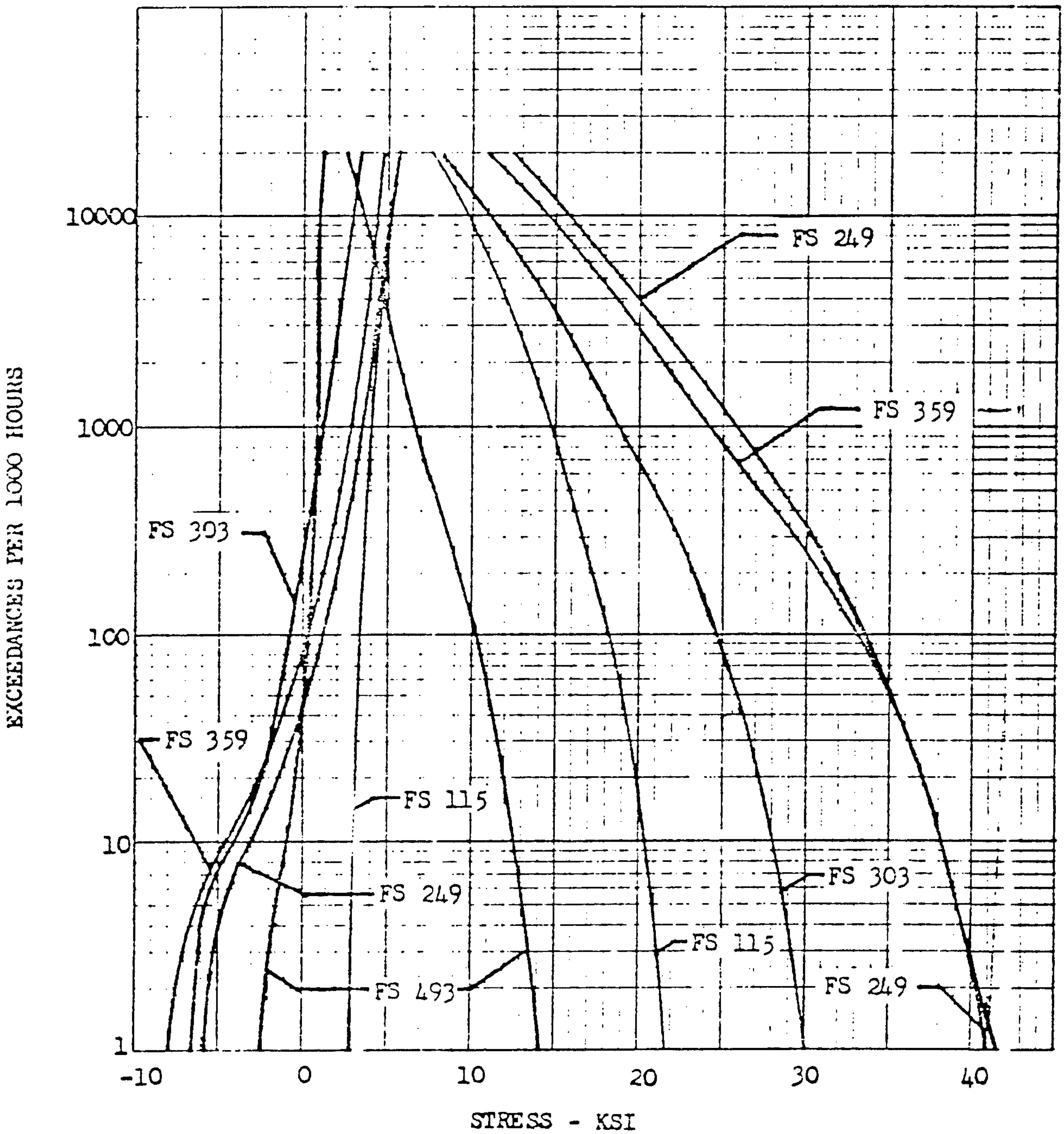
| MISSION PROFILE \ CONTROL POINT | 01 WING LOWER SKIN TO PIVOT FITTING SPLICE - ALUM. | 02 WING PIVOT FITTING CENTER SPAR FUEL FLOW HOLE | 03 CTB - BULKHEAD FLANGE AT B.L. 60 | 04 CTB - LOWER AFT FLANGE AT BOLT HOLE NO. 8 & 28 | 05 CTB - FWD CORNER OF THE LOWER CAP LUG @ B.L. 60 | 06 F.S. 495 NACELLE FORMER FRAME, BOLT 6226 | 07 NACELLE TIE LINK SUPPORT AT F.S. 496 | 08 UNDERWING LONGERON SPLICE AT F.S. 496 | 09 UPPER BOLT ROW IN SKIN @ THE PEDESTAL SPL @ F.S. 770.25 | 10 SANDWICH SKIN ADJACENT TO THE LOWER RUDDER HINGE | 11 BHD. 770.25 HORIZONTAL TAIL PIVOT SHAFT | 12 HOR. STAB. - CENTER BOX SKIN HAND HOLE AREA | 13 SLAT NO. 2-FRONT SPAR LWR LEADING EDGE ATTACHMENT TAB | 14 INB'D SPOILER-INB'D BRACKET ATTACHMENT TO THE REAR SPAR | 15 INB'D SPOILER - INB'D BRACKET - 12W351 | 16 INB'D SPOILER - INB'D HINGE FTG - 12W2033 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. TRA-1 | .0314 | .0639 | 0 | 0 | .0001 | 0 | TO BE COMPLETED LATER. | 0 | .0038 | .0417 | .0121 | .0110 | .4211 | .3540 | .0773 | .3516 |
| 2. TRA-2 | .0326 | .0638 | .0003 | 0 | .0010 | 0 | | 0 | .0036 | .0623 | .0156 | .0134 | .4615 | .3503 | .0786 | .3544 |
| 3. TRA-3 | .2713 | .5952 | .0003 | 0 | .1628 | 0 | | .0046 | .0059 | .0320 | .0308 | .0509 | .4961 | .2526 | .0560 | .2596 |
| 4. TRA-4 | .3034 | .6872 | .1345 | 0 | .4016 | .0310 | | .0095 | .0259 | .0250 | .1505 | .1084 | .4320 | .1377 | .0295 | .1560 |
| 5. TRA-5 | .3224 | .7074 | .0561 | 0 | .2905 | .0130 | | .0074 | .0153 | .0417 | .0829 | .0833 | .5391 | .2042 | .0445 | .2058 |
| 6. TRP-1 | .0437 | .0862 | 0 | 0 | .0011 | 0 | | 0 | .0096 | .0706 | .0186 | .0267 | .5870 | .3916 | .0893 | .3996 |
| 7. TRP-2 | .1679 | .3557 | .0006 | 0 | .0547 | 0 | | .0015 | .0050 | .0561 | .0211 | .0275 | .6351 | .3501 | .0786 | .3576 |
| 8. TRP-3 | .3335 | .7110 | .0024 | .0003 | .1334 | 0 | | .0036 | .0068 | .0591 | .0313 | .0477 | .6973 | .3504 | .0787 | .3565 |
| 9. TRP-4 | .5315 | 1.1634 | .0006 | 0 | .3112 | 0 | | .0089 | .0094 | .0404 | .0500 | .0894 | .6435 | .1946 | .0426 | .2012 |
| 10. WSF(A)-1 | .2301 | .4770 | .0002 | .0041 | .1222 | 0 | | .0035 | .0044 | .0310 | .0234 | .0380 | .5240 | .2734 | .0609 | .2796 |
| 11. WSF(A)-2,WSF(P)-1 | .5858 | 1.2383 | .0006 | .0034 | .3093 | 0 | | .0088 | .0097 | .0369 | .0578 | .0988 | .6654 | .3010 | .0674 | .3068 |
| 12. WSF(P)-2,-3,WSF(CR)-1,-2 | .2827 | .5469 | .1343 | .0020 | .3139 | .0310 | | .0070 | .0288 | .0181 | .1795 | .1341 | .6212 | .1188 | .0254 | .1224 |
| 13. WSF(A)-3,WSF(P)-4,-5,WSF(CR)-3 | .3837 | .8163 | .1344 | .0030 | .3506 | .0310 | | .0081 | .0257 | .0419 | .1485 | .0988 | .5266 | .3366 | .0754 | .3424 |
| 14. WSF(A)-4,WSF(P)-6 | .6307 | 1.3791 | .1306 | .0021 | .5124 | .0199 | | .0112 | .0512 | .0257 | .3039 | .2172 | .6665 | .3122 | .0698 | .3156 |
| 15. WSF(CR)-4 | 1.2109 | 3.5217 | 0 | .3128 | 0 | 0 | | .0012 | .0126 | .1500 | .0987 | .0944 | .5194 | .1296 | .0276 | .1356 |
| 16. WSF(A)-5 | .5877 | 1.3643 | .0001 | .0415 | .2370 | 0 | | .0061 | .0487 | .2692 | .2507 | .2363 | .4124 | 1.0618 | .2402 | 1.1916 |
| 17. WSF(CR)-6 | .5877 | 1.3643 | .0001 | .0415 | .2370 | 0 | | .0061 | .0486 | .2689 | .2507 | .2363 | .4124 | 1.0239 | .2323 | 1.1536 |
| 18. WSF(P)-7,WSF(CR)-5 | .0841 | .1577 | .0265 | 0 | .0694 | .0009 | | .0016 | .0158 | .0907 | .0341 | .0503 | .3490 | .5143 | .1162 | .5372 |
| 19. ABORT | .0223 | .0423 | 0 | 0 | .0018 | 0 | | 0 | .0013 | .0219 | .0049 | .0053 | .2250 | .1046 | .0223 | .1076 |
| 20. FUNCT CHECK FLT | .6190 | 1.6330 | .0008 | 0 | .0030 | 0 | | 0 | .0026 | .0444 | .0111 | .0097 | .3731 | .3076 | .0690 | .3064 |

NOTES:
1. THESE GRID POINT UNIT DAMAGE DATA ARE BASED ON FZM-12-10783 PHASE I & II TRAINING OPERATIONS.
2. SEE "LIST OF SYMBOLS & ABBREVIATIONS" FOR EXPLANATION OF MISSION PROFILE ABBREVIATIONS.
3. GRID POINT UNIT DAMAGE DATA SHOWN ARE APPLICABLE FOR EACH SORTIE DESIGNATION LISTED UNDER PROFILE NOS. 11, 12, 13, 14 AND 18.




a) Wing

Figure 2.31 F-4E(S) Stress Spectra




b) Fuselage

Figure 2.31 (Concluded)

strain survey. The total number of stress occurrences for each stress level for each flight is obtained by summing over the entire range of all airspeed, altitude, and load factor occurrences. These form the stress exceedance spectra for each critical point and each mission type which are compared to those assumed for design. Any difference call for the update of the spectra which now becomes the baseline operational spectra.

The baseline operational spectrum for each critical point, which is to be used for the damage analysis update, is generated from the flight-by-flight stress sequences. These stresses are first grouped into three major mission types, into which are added ground cycles between flights. Within a flight, positive stresses are arranged in a low-high-low sequence. High magnitude stresses, occurring less than once per flight are randomly distributed to different flights. All negative stresses are randomly distributed to different flights and to the position within a flight. The spectrum is repeatable every 100 hours with the exception of a few cycles which occur less than once per 100 hours, and which is randomly placed in a 1000 or 2000 hour block. This cycle by cycle stress spectrum is used in a modified Wheeler method of crack growth prediction.

#### 2.2.3 Detecting Changes in Fleet Usage From L/ESS Data

Many ways are used to help detect a change in the usage of the force. The basic method is to monitor a variable that is descriptive of the usage for a limited period of time and compare the normalized results (based on a per hours, or per flight, or per landing, etc.) to any previous period or composite period. One descriptive variable that is used is the damage rate values that are required for the IAT program. These damage rates, which are per mission type and by base, are calculated for a limited period and are compared to a previous period. If the damage rates are significantly different, then a change in the force usage has occurred.

| USAGE ITEM | 1975 | | | | 1976 | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| 1. Number of F-111 Airplanes | | | | | | | | |
| Assigned at Start of Quarter | 102 | 102 | 100 | 100 | 99 | 98 | 97 | 97 |
| Assigned at End of Quarter | 102 | 100 | 100 | 99 | 98 | 97 | 97 | 97 |
| Flown During Quarter | 89 | 96 | 92 | 91 | 91 | 80 | 38 | 61 |
| 2. Usage Total for Quarter | | | | | | | | |
| Number of Flights | 2060 | 2104 | 1706 | 969 | 1837 | 539 | 475 | 1376 |
| Number of Flight Hours | 5258.1 | 5639.2 | 4251.5 | 2277.8 | 4545.2 | 1300.0 | 1084.9 | 3313.4 |
| 3. Average per Flight | | | | | | | | |
| Duration (Hours) | 2.55 | 2.68 | 2.49 | 2.35 | 2.47 | 2.41 | 2.28 | 2.41 |
| Number of Touch and Go Landings | .25 | .32 | .50 | .58 | .34 | .46 | 1.82 | 1.11 |
| Number of Gear Retractions | 3.02 | 2.89 | 3.03 | 3.14 | 2.61 | 3.04 | 5.34 | 4.29 |
| Number of Landing Touchdowns (Note [2]) | 1.25 | 1.32 | 1.50 | 1.58 | 1.34 | 1.46 | 2.82 | 2.11 |
| 4. Percent of Flights | | | | | | | | |
| With TFR Operations | 65.24 | 54.52 | 60.61 | 60.17 | 60.15 | 62.34 | 55.37 | 51.89 |
| With Aerial Refueling | 9.58 | 12.74 | 7.50 | 7.18 | 12.11 | 7.79 | 6.32 | 9.74 |
| With Barrier Engagement | .05 | .09 | 0 | .10 | 0 | 0 | 0 | 0 |
| Originated Away from Home Base | .05 | 1.08 | .55 | .29 | 1.93 | 0 | 3.16 | .15 |

NOTES: [1] These usage data are based on information from TAC F-111 Flight Usage Cards (AFTO Form 324).

[2] Touch and go landings plus final full stop landings.

[3] Mission cards not received from using command.

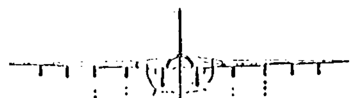
a) F-111A Usage Based on Mission Cards
474 TFW - Nellis Air Force Base

Figure 2.32 F-111A Usage Data.

| USAGE ITEM | 1975 | | | | 1976 | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| 5. Dist of Flights According to TFR Ride (Percent) | | | | | | | | |
| Non-TFR | 34.76 | 45.48 | 39.39 | 38.80 | 39.85 | 37.66 | 44.63 | 48.11 |
| TFR | | | | | | | | |
| Soft | .19 | .52 | .23 | .72 | .33 | 6.86 | .84 | .51 |
| Medium | 58.30 | 47.58 | 52.75 | 53.04 | 55.80 | 50.10 | 50.32 | 46.44 |
| Hard | .19 | .24 | 0 | 0 | .05 | 0 | .21 | 0 |
| Soft-Medium | 3.93 | 3.33 | 3.81 | 3.51 | 2.23 | 2.41 | 1.05 | 1.45 |
| Soft-Hard | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Medium-Hard | 1.75 | 1.47 | 2.05 | .10 | 1.20 | 2.04 | 2.32 | 2.62 |
| Soft-Medium-Hard | .87 | 1.38 | 1.76 | 2.79 | .54 | .93 | .63 | .87 |
| 6. Mission Category - Percent of Flights | | | | | | | | |
| General Flying with TFR | 51.17 | 34.46 | 25.15 | 14.24 | 8.17 | 12.80 | 17.89 | 10.97 |
| General Flying without TFR | 20.29 | 22.34 | 22.45 | 14.45 | 20.14 | 25.60 | 29.05 | 28.85 |
| Weapon Delivery with TFR - L/B | 13.25 | 17.54 | 10.49 | 13.42 | 26.24 | 48.43 | 32.21 | 38.59 |
| Weapon Delivery without TFR - L/B | 3.83 | 6.32 | 4.98 | .64 | 5.77 | 7.42 | 8.84 | 11.56 |
| Weapon Delivery with TFR - D/B | .15 | 1.66 | 24.27 | 31.27 | 25.04 | 0 | .21 | .15 |
| Weapon Delivery without TFR - D/B | .44 | 4.47 | 9.14 | 10.94 | 7.13 | 0 | 0 | 0 |
| Functional Check Flight | .78 | .90 | .70 | 2.37 | .82 | 2.60 | 6.11 | 2.69 |
| Ferry | .19 | 1.52 | .12 | .72 | 1.20 | 1.11 | 1.47 | .22 |
| Abort | .63 | .48 | .35 | .31 | 1.20 | .37 | .84 | .29 |
| Mission Unknown (Note [3]) | 9.27 | 10.31 | 2.34 | 5.88 | 4.30 | 1.67 | 3.37 | 6.69 |

b) F-111A Usage Based on Mission Cards
474 TFW- Nellis Air Force Base

Figure 2.32 (Continued).

| USAGE ITEM | | | | | | 1975 1st | 1975 2nd | 1975 3rd | 1975 4th | 1976 1st | 1976 2nd | 1976 3rd | 1976 4th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. Takeoff Configuration - Percent of Flights | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| Weapon Bay | | | CLEAN | | | 75.0 | 70.53 | 47.66 | 45.3 | 44.53 | 39.70 | 6.11 | 21.80 |
| | | | T T | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | W | | | 0 | 0 | .06 | 0 | 0 | 0 | 0 | 0 |
| | | | G W | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | G | | | 25.0 | 29.47 | 52.29 | 54.7 | 55.47 | 60.30 | 93.89 | 78.20 |
| Wing | | | CLEAN | | | 71.41 | 65.45 | 31.36 | 30.65 | 32.23 | 35.62 | 56.84 | 57.12 |
| | T | T | | T | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | T | | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | T | | T | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | T | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | T | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | T | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | W | W | | W | W | 0 | 1.76 | .06 | .10 | 0 | 0 | .84 | 1.89 |
| | W | | | | W | 6.07 | 17.02 | 37.51 | 36.12 | 42.08 | 13.91 | 3.16 | 5.09 |
| | | W | | W | | 4.51 | 1.0 | .06 | 0 | .05 | 0 | .63 | .29 |
| | | | | | W | 1.70 | .19 | 2.87 | 3.10 | 3.54 | 10.58 | 6.11 | 2.83 |
| T=Tank | W | | | | | 16.31 | 14.59 | 28.08 | 30.03 | 22.05 | 39.89 | 30.74 | 29.65 |
| W=Weapon | | | | W | | 0 | 0 | 0 | 0 | 0 | 0 | .63 | .07 |
| G=Gun | | W | | | | 0 | 0 | .06 | 0 | .05 | 0 | 1.05 | 3.05 |
| | W | T | | T | W | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | T | W | | W | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

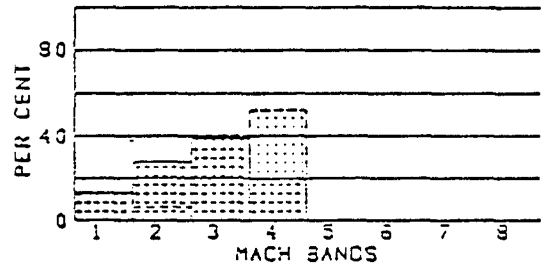
c) F-111A Usage Based on Mission Cards
474 TFW - Nellis Air Force Base

Figure 2.32 (Concluded).

| EC | BS | MC | CF |
|---|---|---|---|
| 2 | 3 | 11 | 1 |

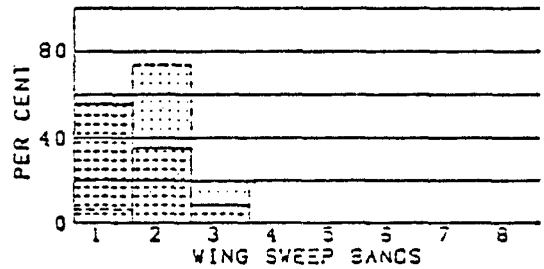
MACH BANDS

| NO. | RANGE | % DAMAGE | % TIME |
|---|---|---|---|
| 1 | 0.00-0.50 | 1.0 | 13.5 |
| 2 | 0.50-0.70 | 6.3 | 29.0 |
| 3 | 0.70-0.80 | 40.4 | 39.1 |
| 4 | 0.80-1.00 | 52.3 | 19.4 |
| 5 | 1.00-1.30 | 0.0 | .0 |
| 6 | 1.30-1.70 | 0.0 | .0 |
| 7 | 1.70-2.00 | 0.0 | .0 |
| 8 | 2.00-3.10 | 0.0 | 0.0 |



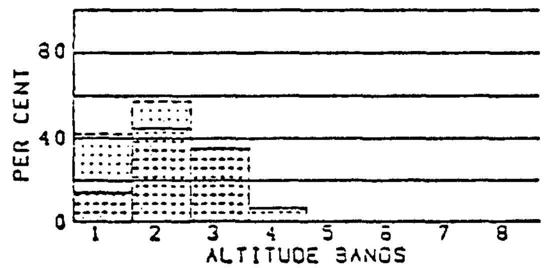

WING SWEEP BANDS

| NO. | RANGE | % DAMAGE | % TIME |
|---|---|---|---|
| 1 | 16.0-29.6 | 6.7 | 55.7 |
| 2 | 29.6-43-2 | 73.6 | 35.4 |
| 3 | 43.2-50.0 | 19.7 | 8.6 |
| 4 | 50.0-63.6 | 0.0 | .3 |
| 5 | 63.6-77.2 | 0.0 | .1 |



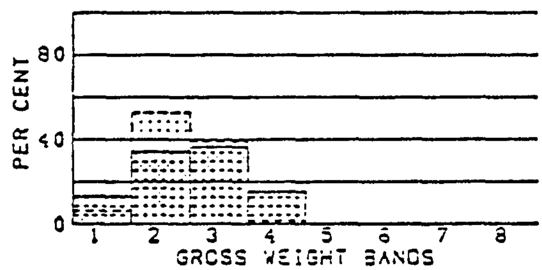

ALTITUDE BANDS

| NO. | RANGE | % DAMAGE | % TIME |
|---|---|---|---|
| 1 | 0.0- 5.0 | 42.0 | 14.1 |
| 2 | 5.0-15.0 | 57.0 | 44.4 |
| 3 | 15.0-25.0 | 1.0 | 35.0 |
| 4 | 25.0-35.0 | 0.0 | 6.5 |
| 5 | 35.0-45.0 | 0.0 | .0 |
| 6 | 45.0-55.0 | 0.0 | .0 |
| 7 | 55.0-80.0 | 0.0 | 0.0 |




GROSS WEIGHT BANDS

| NO. | RANGE | % DAMAGE | % TIME |
|---|---|---|---|
| 1 | 47.5-57.5 | 6.7 | 13.5 |
| 2 | 57.5-67.5 | 52.8 | 34.4 |
| 3 | 67.5-77.5 | 38.9 | 36.4 |
| 4 | 77.5-87.5 | 1.6 | 15.7 |
| 5 | 87.5-97.5 | 0.0 | 0.0 |
| 6 | 97.5- | 0.0 | 0.0 |




% FLIGHT TIME
% DAMAGE (UDD - L/H NACELLE TIE LINK)

Figure 2.33 F-111D Breakdown of Flight Time.

MISSION PHASE VS NZ PEAKS TABLE DATE 05/07/76

| PHASE | LESS | -1.8 | -1.0 | -0.6 | -0.2 | 0.2 | 1.4 | 1.8 | 2.2 | 2.6 | 3.0 | 3.8 | 4.6 | 5.4 | 6.6 | 7.8 | TOTAL | HOURS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REFUELING | | | | | | 3 | 11 | 1 | | | | | | | | | 15 | 1.18 |
| TAKEOFF | | | | | | | | | | | | | | | | | | |
| J ASCENT | | | | | 17 | 693 | 1314 | 118 | 33 | 8 | 2 | | | | | | 2185 | 18.03 |
| CRUISE | | | | 2 | 68 | 2391 | 5755 | 586 | 146 | 55 | 23 | 1 | | | | | 9027 | 102.10 |
| MANEUVER | 2 | 12 | 32 | 137 | 624 | 4360 | 6710 | 2262 | 1739 | 1491 | 2128 | 1339 | 754 | 427 | 54 | 4 | 22075 | 86.83 |
| F DESCENT | | | | | 5 | 568 | 1435 | 115 | 32 | 48 | 38 | 2 | | | | | 2243 | 41.05 |
| O DESCENT | | | | | | 52 | 156 | 14 | 7 | 4 | | | | | | | 233 | 2.86 |
| P LANDING | | | | | 2 | 168 | 403 | 101 | 54 | 27 | 15 | 2 | | | | | 772 | 14.82 |
| LANDING | | | | | | | | | | | | | | | | | | |
| D ASCENT | | | | | | 17 | 44 | 12 | 1 | | | | | | | | 74 | 1.31 |
| TOTAL | 2 | 12 | 32 | 139 | 716 | 8252 | 15828 | 3209 | 2012 | 1633 | 2206 | 1344 | 754 | 427 | 54 | 4 | 36624 | 270.18 |

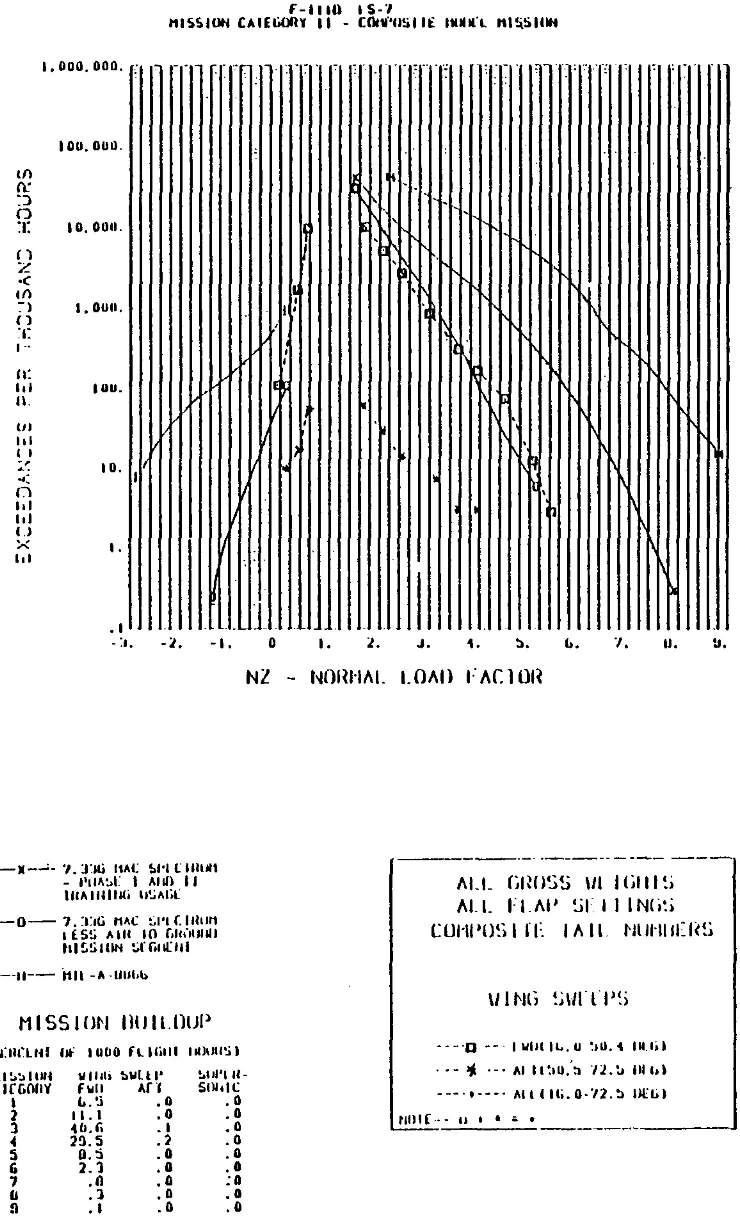
NZ MANEUVER PEAKS FOR NZ VS KIAS

| | LESS | -1.8 | -1.0 | -0.6 | -0.2 | 0.2 | 1.4 | 1.8 | 2.2 | 2.6 | 3.0 | 3.8 | 4.6 | 5.4 | 6.6 | 7.8 | TOTAL | HOURS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LESS | | | | | | | | | | | | | | | | | | .00 |
| 100 | | | | | | | | | | | | | | | | | | .36 |
| 150 | | | 1 | 1 | 6 | 428 | 863 | 60 | 3 | 1 | | | | | | | 1363 | 11.03 |
| 200 | | | 1 | 9 | 22 | 129 | 284 | 47 | 40 | 29 | 4 | 1 | | | | | 566 | 12.80 |
| 250 | | | 2 | 15 | 76 | 326 | 630 | 170 | 84 | 97 | 118 | 36 | 3 | | | | 1557 | 25.65 |
| 300 | | 1 | 5 | 24 | 133 | 1773 | 3290 | 884 | 622 | 432 | 534 | 200 | 91 | 15 | | | 8004 | 110.36 |
| 350 | 2 | 4 | 7 | 40 | 240 | 2520 | 4836 | 1119 | 811 | 679 | 940 | 542 | 194 | 67 | 5 | | 12006 | 73.46 |
| 400 | | 3 | 8 | 26 | 140 | 1525 | 2971 | 551 | 306 | 291 | 452 | 409 | 324 | 199 | 25 | | 7230 | 23.57 |
| 450 | | 2 | 5 | 15 | 76 | 1412 | 2767 | 321 | 112 | 71 | 106 | 128 | 127 | 122 | 18 | 4 | 5286 | 11.66 |
| 500 | | 1 | 2 | 6 | 12 | 118 | 164 | 44 | 23 | 22 | 36 | 19 | 13 | 21 | 2 | | 483 | 1.01 |
| 550 | | 1 | 1 | 1 | 10 | 21 | 23 | 13 | 11 | 10 | 15 | 8 | 2 | 3 | 4 | | 123 | .26 |
| 625 | | | | 2 | 1 | | | | | 1 | 1 | 1 | | | | | 6 | .02 |
| 700 | | | | | | | | | | | | | | | | | | |
| TOTAL | 2 | 12 | 32 | 139 | 716 | 8252 | 15828 | 3209 | 2012 | 1633 | 2206 | 1344 | 754 | 427 | 54 | 4 | 36624 | 270.19 |

NZ MANEUVER PEAKS FOR NZ VS ALTITUDE

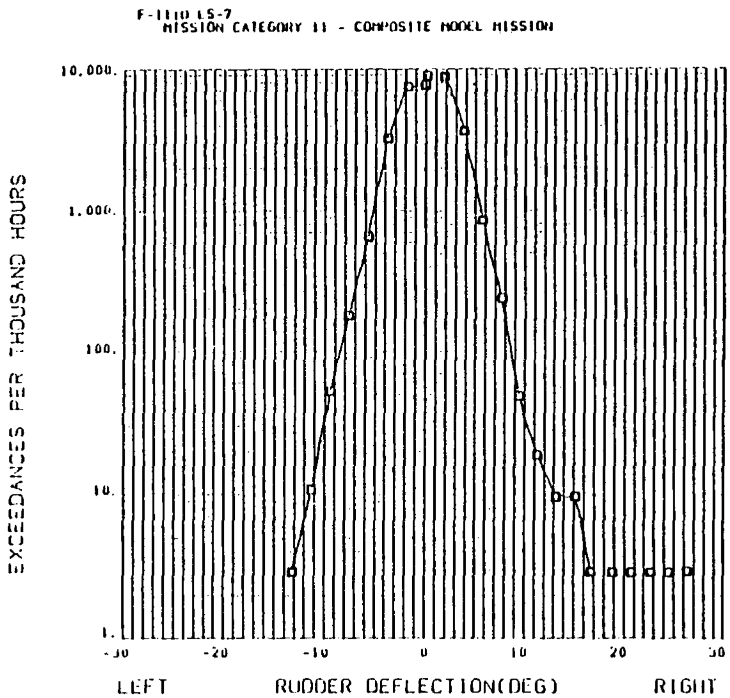
| | LESS | -1.8 | -1.0 | -0.6 | -0.2 | 0.2 | 1.4 | 1.8 | 2.2 | 2.6 | 3.0 | 3.8 | 4.6 | 5.4 | 6.6 | 7.8 | TOTAL | HOURS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BELOW | | | | | 5 | 508 | 898 | 97 | 25 | 6 | 11 | 11 | 2 | | | | 1563 | 3.82 |
| 1000 | | | | 5 | 14 | 353 | 974 | 137 | 40 | 23 | 67 | 140 | 88 | 14 | | | 1855 | 10.56 |
| 2000 | | | 1 | 5 | 85 | 2216 | 4619 | 694 | 444 | 379 | 545 | 315 | 209 | 104 | 4 | | 9620 | 49.65 |
| 5000 | | | | 19 | 193 | 2482 | 5561 | 1052 | 620 | 565 | 770 | 418 | 175 | 140 | 13 | | 12008 | 69.90 |
| 10000 | 1 | 1 | 8 | 17 | 112 | 875 | 1541 | 449 | 340 | 243 | 308 | 165 | 79 | 61 | 19 | 2 | 4221 | 39.59 |
| 15000 | 1 | 10 | 18 | 61 | 187 | 976 | 1153 | 460 | 335 | 281 | 383 | 235 | 153 | 93 | 12 | 2 | 4360 | 39.37 |
| 20000 | | 1 | 5 | 31 | 120 | 826 | 1079 | 319 | 208 | 134 | 122 | 60 | 47 | 15 | 6 | | 2973 | 53.61 |
| 30000 | | | | 1 | | 16 | 3 | 1 | | 2 | | | 1 | | | | 24 | 3.50 |
| 40000 | | | | | | | | | | | | | | | | | | |
| 50000 | | | | | | | | | | | | | | | | | | |
| 60000 | | | | | | | | | | | | | | | | | | |
| TOTAL | 2 | 12 | 32 | 139 | 716 | 8252 | 15828 | 3209 | 2012 | 1633 | 2206 | 1344 | 754 | 427 | 54 | 4 | 36624 | 270.19 |

Figure 2.34 F-4 VGH Data.




a) Cumulative Frequency Distributions of Normal Load Factor

Figure 2.35 F-111 Exceedance Curves.



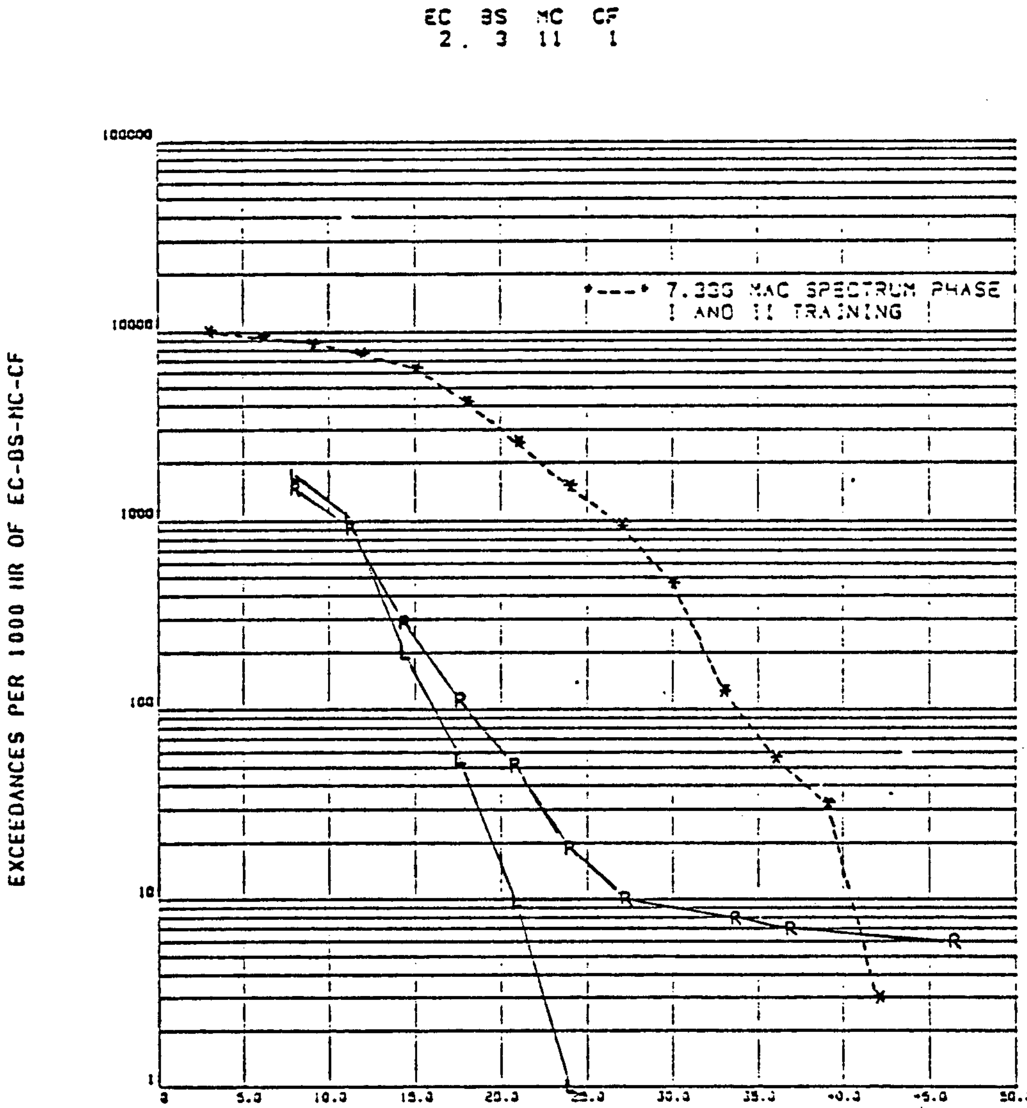

MISSION BUILDUP

(PERCENT OF 1000 FLIGHT HOURS)

| MISSION CATEGORY | WING SWEEP FWD | WING SWEEP AFT | SUPER-SONIC |
|---|---|---|---|
| 1 | 6.5 | .0 | .0 |
| 2 | 11.1 | .0 | ..0 |
| 3 | 46.6 | .1 | .0 |
| 4 | 29.5 | .2 | .0 |
| 5 | 0.5 | .0 | .0 |
| 6 | 2.3 | .0 | .0 |
| 7 | .0 | .0 | .0 |
| 8 | .3 | .0 | .0 |
| 9 | .1 | .0 | .0 |

b) Cumulative Frequency Distributions of Rudder Deflection

Figure 2.35 (Continued)




c) Cumulative Frequency Distribution Left and Right Horizontal Tail Root Shear Double Amplitudes

Figure 2.35 (Concluded).

Other usage variables considered include:

- flight duration
- number of landings
- mission percentages
- distance of flights
- configurations and weights

See Figure 2.32 for examples. Also the breakdown of flight times at various points in the sky is considered (see Figure 2.33). Distributions of flight response parameters, control deflections, and loads (stresses) are compared between recent usage to past usage to determine if changes have occurred as illustrated in Figures 2.34 and 2.35.

## 2.3 FORCE STRUCTURAL MAINTENANCE (FSM) PLAN

In response to MIL-STD-1530A force management data package (Task IV) specifications, aircraft contractors are required to "prepare a force structural maintenance plan to identify the inspection and modification requirements and the estimated economic life of the airframe." Although nearly all currently operational USAF aircraft were contracted before implementation of MIL-STD-1530A, each system is supported by a specified program of scheduled maintenance and inspection activities. The initial FSM plan is based primarily on the aircraft design service life, design usage spectra including environmental effects, determination of safety-of-flight structure, and defined inspection methods and capabilities. Results from full-scale development test programs are also incorporated to form the initial force structural maintenance plan. This initial FSM plan is updated to reflect the baseline operational spectra when it becomes available from the L/ESS program. Subsequent updates may be made to the FSM plan for each significant change in the operational spectra.

The force structural maintenance plan comprises a set of structural maintenance actions and a schedule for performing these actions in a rational sequence which is keyed to individual aircraft usage. Structural maintenance actions can be generally classified as:

Inspection

Repairs

Corrosion Control

Modifications

Inspections are scheduled based on a combination of service and test failure experience, critical areas according to the damage tolerance analysis, and previous maintenance experience on similar types of aircraft. Figures 2.36 and 2.37 are examples of structural maintenance requirements based on analysis and test. Repair and corrosion control actions are usually triggered by specific inspection results. Modifications are scheduled as a result of service or test failure experience correlated with fleet and individual aircraft usage.

Once the maintenance actions are defined, procedures for accomplishing these actions are developed by structural maintenance specialists.

The maintenance organization where specific structural maintenance actions can be performed is dictated by the specific manpower, skill level, tools, equipment, and facilities required to accomplish the action and by overall maintenance policy decisions governing the mission of each maintenance organization. This is generally specified in the form of restrictions on base level maintenance and the referral of specific structural failures to the system manager for disposition.

These what , when , how , and where instructions are the force structural maintenance plan and are documented as the aircraft technical orders. The following paragraphs describe the pertinent technical orders.

2.3.1 <u>Technical Orders</u>

ASIP force structural maintenance operations are implemented through the Air Force Technical Order (T.O.) system as defined by T.O. 00-5-1. Drafts of these documents are usually developed by the contractor as part of the initial aircraft procurement contract requirements and supplied to the user as the

TASK ID OPERATIONAL LIMIT AND INSPECTION PERIOD SUMMARY
EQUIVALENT B.L. SPECTRUM FLIGHT HOURS

| | Item | Economic Limit (Hrs) 0.005 → 0.03 | Inspection Interval (Hrs) .05 → $a_{ip}$/DI | Safety Limit (Hrs) .05 → $a_c$/DI** | Special Considerations |
|---|---|---|---|---|---|
| 1 | WCS Skin at Inbd and Intermediate, pylon posts Fwd. and Aft (No. 3 and 7) | >8,000 | 1,100/ .28 | 2,200/.55 | |
| 2 | Fuse Blkhd 480 Lug d=1.5 (No. 55) | >8,000 | 1,150/ .29 | 2,300/.58 | Apls → 391 |
| | d=1.75 | >8,000 | 1,550/ .39<br>4,000/ 1.00 | 3,100/.78<br>8,000/2.00 | Apls 392 & Sub<br>ai = .022 (1) |
| 3 | WCS Wing Attach Rib Yw=24.6 (No. 14) | 3,800 | 2,500/ .63 | 5,000/1.25 | |
| | WCS Wing Boomerang Strap Yw=24.6 (No. 15) | >8,000 | 2,700/ .68 | 5,400/1.25 | |
| 4 | WCS and OPH Fold Lug (No. 31/40) | >8,000 | 4,900/ 1.23<br>2,800/ .70 | 9,800/2.45<br>5,600/1.40 | Lug Hole<br>Lug Shank |
| 5 | WCS Skin at Rear Spar, Rear Spar Cap Yw 53.7 (No. 18) | 8,000 | 3,050/ .76 | 6,100/1.53 | |
| 6 | WCS BL-0 at R Spar (No. 10) | NR | 4,150*/ 1.04 | 8,300/2.08 | |
| | WCS BL-0 5th Spar (No. 9) | NR | 4,800*/ 1.20 | 9,600/2.40 | Strap Fail at 1,500 hrs. |
| 7 | WCS LWR Skin Y=32 (Item No. 1) | NR | 6,100*/ 1.53 | 12,200/3.05 | |

NR - If safety limit >8,000 rework from economic limit not reqd.
* Requires wing removal
** Damage Index = Flt hrs Equivalent Baseline / 4,000
Damage Index set to equal 1.00 @ 4,000 hours for convenience.

$a_{ip}$ = flaw length @ inspection period
$a_c$ = critical flaw length
(1) Subsequent to inspection

Figure 2.36 A-7D Inspection and Life Limits.

F-4E/S DAMAGE INDEX INSPECTION LIMITS
CLASS I
MODIFIED A/C

| ITEM | S/N 1-755 WITH SLAT KIT INSTALLED | | S/N 1-755 WITH PLANNED MODS INSTALLED | | S/N 756-802 WITH PLANNED MODS INSTALLED | | S/N 803 & UP WITH PLANNED MODS INSTALLED | |
|---|---|---|---|---|---|---|---|---|
| | FIRST INSPECTION | INSPECTION INTERVAL | FIRST INSPECTION | INSPECTION INTERVAL | FIRST INSPECTION | INSPECTION INTERVAL | FIRST INSPECTION | INSPECTION INTERVAL |
| Inner Wing, Lower T.B. Skin | | | | | | | | |
| ℄ Pylon Hole | .10 | .22 | 15.40 | 5.13 | 15.40 | .51 | .63 | .21 |
| ℄ BL 44 | .82 | .28 | .82 | .28 | .82 | .28 | 1.20 | .40 |
| ℄ MLG Trunnion | 3.52 | 1.17 | 3.52 | 1.17 | 3.52 | 1.17 | 3.48 | 1.16 |
| ℄ BL 70 | 1.61 | .54 | 1.61 | .54 | 1.61 | .54 | 2.00 | .67 |
| ℄ BL 132.50 | 3.31 | 1.10 | 3.31 | 1.10 | 3.31 | 1.10 | 3.82 | 1.28 |
| ℄ Fwd. MLG Rib | 2.36 | .98 | 2.37 | .98 | 3.04 | 1.01 | 3.04 | 1.01 |
| ℄ Centerline Rib | 1.79 | .60 | 1.79 | .60 | 1.79 | .60 | 1.79 | .60 |
| ℄ BL 100 | 1.54 | .71 | 1.54 | .71 | 1.83 | .61 | 1.73 | .58 |
| ℄ Fwd SBA Rib | 1.67 | .74 | 1.67 | .74 | 2.11 | .71 | 2.11 | .71 |
| ℄ Torque Rib | 1.95 | .65 | 1.95 | .65 | 1.99 | .66 | 2.17 | .72 |
| ℄ 29% Stiffener | .82 | .46 | .82 | .46 | 1.37 | .46 | 2.11 | .79 |
| ℄ Front Spar | 1.80 | .60 | 1.80 | .60 | 1.80 | .60 | 2.37 | .79 |
| ℄ Drain Hole | .52 | .37 | 6.42 | 2.05 | 6.42 | 2.05 | 1.64 | .55 |
| ℄ Wingfold Rib | 3.22 | 1.27 | 4.82 | 1.60 | 4.82 | 1.60 | 4.82 | 1.60 |
| ℄ 22% Stiffener | 1.45 | .68 | 1.45 | .68 | 1.84 | .62 | 1.84 | .62 |
| ℄ 33% Stiffener | 2.18 | .92 | 2.18 | .92 | 2.40 | .80 | 2.40 | .80 |

INSPECTION/MODIFICATION INTERVALS FOR CRITICAL ITEMS
(EQUIVALENT BASELINE SPECTRA)

| INSPECTION LEVEL: | ORGANIZATIONAL OR INTERMEDIATE | DEPOT LEVEL | ORGANIZATIONAL OR INTERMEDIATE | DEPOT LEVEL | ORGANIZATIONAL OR INTERMEDIATE | DEPOT LEVEL | ORGANIZATIONAL OR INTERMEDIATE |
|---|---|---|---|---|---|---|---|
| DAMAGE INDEX (3): TIME (HOURS): | .25 1000 | .50 2000 | .75 3000 | 1.00 4000 | 1.25 5000 | 1.50 6000 | 1.75 7000 |
| CRITICAL ITEM (2): | | | | | | | |
| Wing Skin @ Pylon Holes | X | X | X | X | X | X | X |
| 400 BHD | | X(1) | | | | X | |
| Yw = 24.6 | | X | | X | | X | |
| Lug Shank | | | X | | | X | |
| Lug Hole | | | | | X | | |
| Yw = 53.7 | | | X | | | X | |
| Yw = 32.2 | | | | | | X | |
| BL-0 | | | | X | | | |

NOTES:

(1) MODIFICATION OF 1.50 DIA. LUG HOLE (AIRPLANES 1 THROUGH 391) IS REQUIRED, FOR AIRPLANES 392 & SUBS INSPECTION OF 1.75 DIA. IS REQUIRED

(2) PYLON = WCS LOWER SKIN, INBOARD PYLON POST (ITEM 3 & ITEM 7)
400 BHD = BULKHEAD STA. 400, WING AFT ATTACH LUG, (ITEM 55) 1.50 DIA. (AIRPLANES 1 THROUGH 391) & 1.75 DIA. HOLE (AIRPLANES 392 & SUBS)
24.6 = WCS LOWER SKIN, WING ATTACH LUG, Yw = 24.6 (ITEM 14 & ITEM 15)
LUG SHANK = WCS, WOP FOLD LUG Yw = 135.2 (ITEM 31/40) LUG SHANK
LUG HOLE = WCS, WOP FOLD LUG Yw = 135.7 (ITEM 31/40) LUG HOLE
Yw = 53.7 = WCS LOWER SKIN, REAR SPAR & REAR SPAR CAP (ITEM 18)
Yw = 32.2 = WCS LOWER SKIN, 5TH SPAR Yw = 32.0 (ITEM 1)
BL-0 = WCS LOWER SKIN, CENTER SPLICE, REAR SPAR (ITEM 10): WCS LOWER SKIN 5TH SPAR SPLICE (ITEM 9)

(3) DAMAGE INDEX = $\frac{\text{TIME (HOURS)}}{4000}$ EQUIVALENT BASELINE

Figure 2.37 F-4 Inspection Limits.

aircraft becomes operational. The purpose of the technical order system is to provide a set of reference manuals which specify methods and requirements for recurring and non-recurring maintenance functions.

The primary documents applicable to ASIP activities are:

- o Structural Repair Instructions (T.O.-3)
- o Aircraft Scheduled Inspection and Maintenance Requirements (T.O.-6)
- o Maintenance Work Unit Codes (T.O.-06)
- o Aircraft Corrosion Control (T.O.-23)
- o Nondestructive Inspection Procedures (T.O.-36)
- o Time-Compliance Technical Orders (T.C.TO.'s)

(NOTE: The T.O. numbers in parentheses are standard for that document throughout the Air Force inventory. The remaining nomenclature is derived from the standard Model/ Design/Series format; e.g., 1C-5A-36, 1B-52D-3, 1T-43A-23, etc.) Each of these technical orders is discussed in detail in the following paragraphs.

2.3.1.1 Structural Repair Manual (T.O.-3)

Since no test or in-service experience exists during the aircraft design phase, the initial structural repairs are generalized concepts designed to repair "typical" cracks in major structure such as skins, spar webs and caps, fuselage frames and stringers. Guidelines for materials selection, repair size, fastener attachments and finishing processes are included, along with installation procedures. As structural development test results become available, specific potential problem areas are identified, and corresponding repairs are designed to "equivalent strength" criteria. Thus, the static strength capability of the repair configuration is equal to or greater than the original structure. In addition to repair designs, general information regarding such items as aerodynamic smoothness requirements, aircraft jacking instructions, control surface balancing, general ship practices, etc. is also included.

An important part of the T.O.-3 is the classification of damage and types of repair. Damage items are separated into three major categories: negligible, repairable and damage necessitating replacement of parts. Repairs are classified as either field level or depot level, depending on the complexity of the task and available materials and facilities. No attempt is made in the T.O. -3 manual to classify the defined repairs due to the variability of these factors. However, emphasis is placed on simplicity of design in order to minimize costly depot level repairs.

2.3.1.2 Scheduled Maintenance Requirements (T.O.-6)

The T.O.-6 defines "complete requirements for accomplishing scheduled maintenance on the aircraft during its entire service life." This is done by initially establishing a schedule of recurring maintenance time intervals, and then defining inspection packages for each interval based on a predetermined rationale agreed upon by the Air Force and the contractor. Initial candidate locations are determined primarily by considering safety-of-flight items, such as skins, spars, frames, etc. Analyses of these areas are performed to determine the inspections required to assure continued structural integrity. In addition, fatigue sensitive areas such as skin cutouts are identified, usually based on past experience on other aircraft or empirical analysis. As in the case of the T.O.-3, development test program results are used to further define inspection items and intervals. Other types of maintenance-related data are included in the T.O.-6, such as component replacement schedules, base level repair restrictions and historical document requirements.

In addition to the Programmed Depot Maintenance (PDM) inspections, most current aircraft have depot-level Controlled Interval Extension (CIE) and Analytical Condition Inspection (ACI) requirements as defined in T.O. 00-25-4 and specified in the T.O.-6 manual. The purpose of the CIE program is to "provide technical data to determine the feasibility of changing PDM intervals and/or work requirements." In this program, a selected number of aircraft are scheduled for PDM inspection at longer-than-normal intervals, with regular base level isochronal maintenance being performed as required. Results of the subsequent PDM inspections (a portion of the CIE sample aircraft also receive ACI's at this time) are then used to retain or modify present PDM intervals. ACI requirements consists of in-depth inspections which are performed on a representative sample of PDM aircraft each year per T.O. 00-25-4. This program is used to "generate data for engineering and technical evaluation of the relative MDS aircraft condition resulting from corrosion, overstress, wear, and other effects caused by aircraft age, operational usage and environmental exposure." The overall intent of the CIE and ACI programs is to reduce depot level maintenance requirements without sacrificing aircraft safety and a substantial reduction in costs and downtime may be realized by the efficient application of these programs.

#### 2.3.1.3 Work Unit Code Manual (T.O.-06)

In conjunction with the T.O.-6 manual, a maintenance work unit code document (T.O.-06) is issued. The function of this manual is to code maintenance information in a manner which can be converted into computer language. This code conversion system, standard throughout the Air Force, allows mechanical compilation and storage of the data to be performed as a part of the AFM 66-1 maintenance data recording system. The codes are used to document information such as type, location and severity of defects, when discovered and action taken.

#### 2.3.1.4 Aircraft Corrosion Control (T.O.-23)

In general, the T.O.-23 manual is an "after-the-fact" document which utilizes service experience to identify corrosion susceptible areas and treatment procedures. Although attempts are made to minimize this problem through the use of optimum detail design, materials selection and surface finish criteria, environmental and usage variabilities preclude its elimination. Thus, accurate feedback from actual force usage is necessary to define adequate corrosion control measures and to provide guidelines for elimination of corrosion in subsequent aircraft modifications. Corrosion related maintenance activities such as interior/exterior cleaning procedures and microbal infestation control are also described in the T.O.-23 manual.

2.3.1.5 Nondestructive Inspection Procedures (T.O.-36)

This document is an outgrowth of the T.O.-6 Inspection manual, and it contains detailed instructions for performing inspections which are not damaging to the structure. Procedures for all T.O.-6 requirements (except most visual inspections) are described in the T.O.-36 manual; therefore its content is determined prmarily by the T.O.-6 items. It is important to note that the T.O.-36 is strictly a "how-to" technical order; its use is triggered by a specified callout in the T.O.-6 manual. In some cases, NDI procedures are defined (usually based on preliminary test or analysis results) for a location where no current inspection requirement exists. These inspections are sometimes performed as a part of normal depot level maintenance activities (PDM, ACI, etc.) at the discretion of the ASIP manager. If cracks are found, a recurring inspection requirement for this location will then be added to the T.O.-6 manual.

The standard Nondestructive Inspection (NDI) techniques utilized throughout the Air Force are Eddy Current (surface probe and bolt hole probe), Ultrasonic, Penetrant, Radiography, and Magnetic Particle. The application frequency of the individual techniques at the various Air Force bases and Air Logistics Centers varies widely, depending on the local inspection requirements. Flaw detection reliability also varies widely due to flaw size, NDI technician, inspection techniques, structure configuration, and many other factors. Until recently, no quantitative values could be applied to inspection reliability. An Air Force sponsored program designed to measure NDI reliability on selected structure types is now nearing completion by Lockheed-Georgia after over two years of field data collection. This program was officially titled "Non-destructive Inspection Reliability Program" and has become widely known as "Have Cracks - Will Travel." Sixteen bases in four commands, MAC, TAC, SAC and ATC, plus the five ALC's participated in the program. Data analyses are now in progress, along with final report preparation. The data and final report will be available in late summer of 1978.

Three new NDI technique variations (two eddy current, one ultrasonic), either newly developed or still being developed, have been/will be evaluated to determine if their application will provide improved NDI reliability. An eddy current automatic bolt-hole technique has been developed and an instrument to perform that NDI is marketed commercially. This technique was evaluated during the field data collection portion of the NDI reliability program and found to improve flaw detection capability, particularly in the smaller flaw sizes. The other two techniques are still being developed. One is a semi-automatic rotary scan ultrasonic unit and the other is a low frequency eddy current unit. Some evaluations of a hand rotational scan ultrasonic unit were carried out during the NDI Reliability Program.

Four of the five NDI methods were evaluated by the Air Force in the "Have Cracks - Will Travel" program at the field and depot levels for inspection reliability. The NDI method not included in the program was magnetic particle, thus no comment on reliability can be made regarding this technique. However, at one time, the Air Force Materials Laboratory (AFML) did conduct an evaluation of industry NDI reliability using the magnetic particle technique. Results were mixed.

The comments made in the following paragraphs in this section are generalizations of preliminary data evaluations. The data are being stored at the Computer Center at Wright-Patterson AFB under contract with AFML, using a system 2000 computer program for data management.

The reliability data were acquired by utilizing structure samples that contained a spectrum of flaw sizes. These samples were inspected by Air Force military and civilian inspection technicians in their NDI shops, along with other routine inspection tasks. All flaw indications found using the four NDI techniques (eddy current, ultrasonic, x-ray, penetrant) were recorded and then graded (flaws found, flaws not found). Three hundred NDI technicians participated in the program and inspected over an accumulated total of 500,000 potential flaw sites.

For comparison purposes, the general Air Force-wide mean value for detection of 0.25" flaws and 0.50" flaws will be given along with the values for the lower 95% confidence bound for each. This should be accepted only as general information, since many factors have been involved that are not included in this discussion. Also, simple and more complex structures have been grouped together along with various task sizes for this general estimate.

NDI procedures provide inspection instructions and illustrations in sufficient detail so that trained NDI technicians can efficiently carry them out. These procedures are developed in accordance with MIL-M-38780, which describes the required content and format for NDI procedures, and are contained in Air Force Tech Orders. For example, the C-5A Air Force T.O. is 1C-5A-36, Nondestructive Inspection Manual. A variety of information is included in the NDI procedures. A description of the area of the aircraft is provided and includes such things as materials of construction, alloys and surface finishes. The type and general location of potential flaws is described, the type NDI technique to be used is specified along with the NDI equipment and standards required, any special factors associated with access to the area to be inspected as specified, and any special preparation of the area to be inspected are described. Special instructions for calibrating the inspection equipment are given and then step-by-step instructions for conducting the inspection are provided, along with any required illustrations. Instructions are also provided for reporting of the inspection results. Normally a back-up NDI procedure is specified, primarily for use in verifying defect indications.

NDI procedures are based on the five basic NDI methods - eddy current, ultrasonic, penetrant, x-ray, and magnetic particle. A brief description of each technique is given in the following paragraphs.

2.3.1.5.1 Eddy Current

Eddy current inspection is effective for the detection of surface or near surface cracks in most nonferrous aircraft parts. The method can be applied to airframe parts or assemblies where the inspection area is accessible for contact by the eddy current probe. An importnat use of eddy current inspection on aircraft is for the detection of cracking caused by fatigue or stress corrosion around fastener holes; however, cracks propagating from fastener holes can be detected by this method only after they extend beyond the fastener head. Special bolt hole probes are available and are used (with the fastener removed) for locating cracks emanating from the wall of the fastener hole. Inspection is accomplished by inducing eddy currents into the part and observing electrical variations in the induced field. The character of the observed field change is interpreted to determine the nature of the defect. A sharp eddy current instrument meter deflection observed as the eddy current probe is moved over the inspection areas will indicate a probable crack in the part.

The mean results of eddy current surface scan inspections generally show that detection probability ranges from 60% to 70% for 0.25" radial length flaws. At the lower 95% confidence level this value drops to less than 50%. For 0.50" flaws the mean detection probability varies from 60% to 80% and the lower 95% confidence level is 50% or less.

For eddy current bolt hole inspections, the mean detection probability for 0.25" axial length flaws is less than 50% and detection probability is less than 25% at the 95% confidence level. For 0.50" flaws the mean is less than 65% and at the 95% confidence level detection probability is less than 35%.

The automatic eddy current bolt hole technique does produce some improvement. The mean flaw detection probability is about 80% for both the 0.25" and 0.50" flaws, and at the 95% confidence level slightly less than 50% for both. This technique appears to help considerably in the smaller flaw sizes. The curve rises rapidly at about 0.10" and then becomes flat at a mean of about 80%.

2.3.1.5.2 Ultrasonic

Ultrasonic inspection uses high-frequency sound waves as a probing medium to provide information as to the state of various materials. This method is effective for the inspection of most metals for surface and sub-surface defects. The method requires that at least one surface of the part be accessible for transducer contact in the vicinity of the area to be examined. The inspection is accomplished by inducing the ultrasound into the part by a contacting transducer and picking up reflections of this sound from within the part. The detected ultrasonic reflections are electronically displayed on an oscilloscope and interpreted for indications of defects.

Ultrasonic results are greatly dependent on task size and inspection difficulty. Detection probability results range from between 15% to 75% for both 0.25" and 0.50" flaws. At the 95% confidence level detection probability results range from 0 to slightly less than 50%.

2.3.1.5.3 Penetrant

The fluorescent penetrant method of inspection requires that the inspection surface be free of surface coating and be thoroughly cleaned. After cleaning, penetrant is applied to the surface to be inspected. After remaining on the surface for a prescribed period of time, it is then cleaned from this surface using a solvent cleaner. A developer is then applied and flaws are detected under black light as the fluorescent penetrant bleeds out of the flaw onto the surface.

Penetrant data were obtained using a fairly simple straight forward structure. However, penetrant, when properly used, normally does well on surface cracks except in cases where the crack is very tight. The mean detection probability is 85% for the 0.25" flaws and 93% for the 0.50" flaws. At the 95% confidence level, the detection probability is 50% for the 0.25 flaws and 58% for the 0.50" flaws. The mean value for penetrant rises rapidly at about 0.10".

2.3.1.5.4 Radiographic (X-ray)

X-ray inspection is used to show internal and external structural details of all types of parts and material. This method is used for the inspection of airframe structure for defects otherwise inaccessible for other methods of nondestructive inspection, or to verify conditions indicated by another method. Inspection is accomplished by passing the X-ray beam through the part or assembly to expose a radiographic film. The processed film shows the structural details of the part by variations in film density. The radiographic is interpreted for indications of defects.

Flaws must be one-quarter inch or longer for the x-ray technique to start to become effective. The mean detection probability for 0.25" flaws is 40% and at the 95% confidence level, the detection probability is 0. For the 0.50" flaws these values become 65% and 15%, respectively. There remains a lot of scatter of the data even in larger flaw sizes.

2.3.1.5.5 Magnetic Particles

Magnetic particle inspection is effective in the detection of surface and near surface defects in ferromagnetic parts. The method may be applied to installed or disassembled parts. The inspection is accomplished by inducing a magnetic field in the part, and applying a liquid suspension of iron particles or dry magnetic powder to the surface to be inspected. Defects in the part cause local bipolar perturbations in the magnetic field which attract the magnetic particles, producing visible indications by color contrast or by fluorescence under "black light." This method requires that the surface under inspection be thoroughly clean.

2.3.1.6 Time Compliance Technical Orders (T.C.T.O's)

Since the technical order system has been established as the official mechanism for defining structural maintenance requirements and procedures, updates to the existing FSM plan are implemented either by revising the applicable T.O. documents or by issuing Time Compliance Technical Orders. (TCTO's). The TCTO system, as suthorized by AFR 8-2 and described by T.O. 00-5-15, provides instructions for accomplishing and/or recording "one time" maintenance operations to aircraft systems, such as inspections, repairs, retrofits, etc. Overall TCTO systems management is the responsibility of AFLC, although the aircraft system manager (AFSC or AFLC) at the time of TCTO approval is responsible for its technical content and adequacy. As the title infers, the requirements of a particular TCTO are to be completed within time limits specified in that TCTO. It is emphasized that the TCTO system is used for "one time" FSM operations; recurring maintenance activities are modified by revisions to the basic T.O. manuals.

### 2.3.2 Reliability-Centered Maintenance Programs

Scheduled maintenance and inspection activities are rapidly becoming more time-consuming and costly. In an effort to streamline these operations, the Air Force has recently implemented the concept of Reliability-Centered Maintenance for most airframe systems. This program is based on the "Airline/ Manufacturer Maintenance Program Planning Document", prepared by the Air Transport Association in 1970. This document, commonly referred to as MSG-2, defines a logical procedure for developing an efficient scheduled maintenance program in order to "prevent deterioration of the inherent design levels of reliability and operating safety of the aircraft, and to accomplish this protection at the minimum practical costs." Review programs in which existing T.O. -6 requirements are tested for applicability using the MSG-2 criteria have been performed or are planned for all transport/bomber aircraft. (Maintenance activities on several commercial derivative aircraft such as the C-9 and the T-43 are performed by airlines; thus, MSG-2 logic is inherent in these programs.) The reviews are usually contracted to the original airframe manufacturer.

In general, the incorporation of MSG-2 philosophy into existing FSM programs has produced favorable results from an economic standpoint. However, basic differences in commercial and military operations and procedures limit the applicability of these criteria to military aircraft. Changes in mission definition and/or mission mix which do not occur commercially can greatly affect maintenance and inspection requirements. Also, even though military aircraft generally accumulate flight hours at a slower rate than commercial fleets, environmental effects (corrosion, stress corrosion, etc.) and the concept of operational readiness may necessitate maintenance actions which are deemed unnecessary by MSG-2 logic. These differences must be recognized by the ASIP manager in order to assure continued force safety and reliability.

### 2.3.3 Structural Maintenance Action Reporting

Since the force structural maintenance plan requires periodic updating based on service failure experience, it is critical that all pertinent failure and defect data be reported when it is discovered in the field.

The mechanism for maintenance data collection and feedback is the AFM66-1 systems. Because of the extensive use of coded information and the generalization necessary to handle all aircraft subsystems, the structural maintenance data collected under the AFM66-1 system is generally not adequate for making changes to the force structural maintenance plan.

Figure 2.38 is an example of an alternate approach where specific structural inspection findings are collected on the same form as the individual aircraft tracking data.

Other aircraft systems attempt to get a more meaningful output from the AFM 66-1 system by providing specific work unit code numbers in the T.O.-06 which are assigned to a particular type of defect at a particular structural location.

Probably the most reliable and informative source of service structure defect data is the airframe manufacturer's records collected by field representatives. These individuals are dedicated to insure trouble-free fleet operation and one generally trained to spot defects which might lead to structural integrity problems. They tend to react more rapidly to a repeated problem and gather relatively detailed information.

Of course, when a structural problem is uncovered, the system manager will gather all the historical data he can and will use each of the available sources to analyze and solve the problem.

## A-37B AIRCRAFT FATIGUE TRACKING RECORD

| AIRCRAFT SERIAL NUMBER | | | | | | | | MONTH | | YEAR | | BASE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 11 | 12 | 13 | 14 | 17 | 18 |
| 6 | 8 | 0 | 0 | 7 | 9 | 2 | 7 | 1 | 0 | 7 | 7 | 1 | 5 |

TOTAL AIRFRAME HOURS PRIOR TO FIRST FLIGHT OF MONTH: 2607.9

### MISSION DATA SUMMARY

| STORES CONF | | | MISSION CODE | | LDGS | | FLIGHT TIME | | | S/C |
|---|---|---|---|---|---|---|---|---|---|---|
| 22 | 23 | 24 | 29 | 30 | 33 | 34 | 37 | 38 | 39 | 47 |
| 1 | 0 | 6 | 1 | 9 | 0 | 1 | | . | 9 | 1 |
| 1 | 0 | 6 | 1 | 9 | 0 | 1 | 1 | . | 5 | 1 |
| 4 | 1 | 1 | 1 | 4 | 0 | 1 | 2 | . | 0 | 1 |
| 4 | 1 | 1 | 1 | 4 | 0 | 1 | 1 | . | 2 | 1 |
| | | | | | | | | . | | 1 |
| | | | | | | | | . | | 1 |
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| | | | | | | | | . | | 1 |
| | | | | | | | | . | | 1 |
| | | | | | | | | . | | 1 |
| | | | | | | | | . | | 1 |

### SPECIAL INSPECTION REPORTING

| LOCATION/DESCRIPTION | DATE C/W | AIRFRAME HOURS | TYPE PROBE | RESULTS |
|---|---|---|---|---|
| BUTT LINE 24.0<br>UPPER FORWARD CARRY THRU | | | ☐ HAND HELD<br>☐ MOTORIZED | ☐ NEGATIVE<br>☐ CRACK |
| BUTT LINE 37.9<br>FORWARD UPPER CARRY THRU | | | ☐ HAND HELD<br>☐ MOTORIZED | ☐ NEGATIVE<br>☐ CRACK |
| BUTT LINE 26.2 & 33.1<br>FORWARD LOWER CARRY THRU | | | ☐ HAND HELD<br>☐ MOTORIZED | ☐ NEGATIVE<br>☐ CRACK |
| BUTT LINE 28.8<br>CANOPY RAIL ATCH FTG | | | ☐ HAND HELD<br>☐ MOTORIZED | ☐ NEGATIVE<br>☐ CRACK |
| WING STATION 43.5<br>LOWER CENTER LUG | | | ☐ HAND HELD<br>☐ MOTORIZED | ☐ NEGATIVE<br>☐ CRACK |
| WING STATION 91.8<br>FRONT SPAR UPPER CAP | | | ☐ HAND HELD<br>☐ MOTORIZED | ☐ NEGATIVE<br>☐ CRACK |
| | | | | |
| | | | | |

REMARKS

Conf - Configuration; S/C - Sorty Count; Ldgs - Landings; C/W - Complied With; Atch - Attach; Ftg - Fitting

AFTO FORM NOV 74 12

Figure 2.38 A-37 Aircraft Fatigue Tracking Record.

### 2.3.4 Summary of Current FSM Programs

Table 2.15 presents a representative tabulation of force structural maintenance program status for each current bomber/transport system. The status of attack/fighter/trainer aircraft force structural maintenance programs is similar. The MSG-2 airlines zonal inspection techniques have been incorporated into most programs. Serialized component tracking procedures are currently being employed only on C-130 outer wings and C-5A pylons. The C-5A PDM inspection/modification packages for individual aircraft are developed using IAT-based damage (or crack growth) indices; use of IAT data to adjust FSM scheduling on other aircraft systems is limited, at best.

TABLE 2.15

FORCE STRUCTURAL MAINTENANCE PROGRAM SUMMARY
TRANSPORT/BOMBER AIRCRAFT

| AIRCRAFT | MSG-2 IMPLEMENTED | SERIALIZED COMPONENT TRACKING | FSM USE OF IAT DATA | COMMENTS |
|---|---|---|---|---|
| C-130 | YES | OUTER WINGS | INSPECTION CANDIDATE PROGRAM | |
| C-140 | YES | NONE | NO IAT PROGRAM | |
| C-141 | YES | NONE | ACI SCHEDULING | |
| C-5A | YES | PYLONS | INSP/MOD SCHEDULING | FEEDBACK OF INSPECTION RESULTS |
| T-39 | IN WORK | NONE | NO IAT PROGRAM | |
| T-43 | * | NONE | NONE | |
| E-3A | PENDING | NONE | NONE | |
| B-52 | YES | NONE | NONE | MSG-2 MONITOR PROGRAM (SECONDARY STRUCTURE) |
| C/KC-135 | YES (A) | NONE | NONE | MSG-2 IN WORK FOR OTHER MODELS |
| FB-111 | YES | NONE | NONE | PROOF TEST PROGRAM IN PROGRESS |
| C-9 | * | NONE | NO IAT PROGRAM | |

*MAINTENANCE OPERATIONS ARE CONTRACTED TO COMMERCIAL AIRLINES

## 2.4 USAGE DATA COLLECTION METHODS

A variety of methods are currently utilized to gather usage information for input into force management activities. This section of the report describes the data collection methods independently from the eventual use of the data. The methods have been grouped by the type of field support required.

### 2.4.1 Aircraft Historical Usage Records

The minimum field effort is achieved by data collection systems which utilize data already recorded as part of the aircraft operations and maintenance records under AFM 65-110 Standard Aerospace Vehicle and Equipment Inventory, Status, and Utilization Reporting. Aircraft users routinely report flying hours, landings, and flight purpose (mission type) code for each mission flown as logged by the crew on the AFTO Form 781.

This information is the basis for most individual aircraft scheduled maintenance done on a flying hour basis. The base maintenance organization keeps a record of flying hours and landings by tail number for scheduling phased maintenance (unless the system utilizes isochronal scheduling).

Although it was used for a period of time to track usage of the A-37 aircraft, the flight purpose code entered on the AFTO Form 781 is neither descriptive of the aircraft structural utilization nor accurate enough for use as a source of ASIP data. However, for those systems where accurate usage data is not a requirement, this data source may be preferable to the alternative of no data at all.

### 2.4.2 Counting Accelerometer Readings

Several types of Air Force aircraft are equipped with counting accelerometers which sense normal accelerations at or near the center-of-gravity, detect peaks in preset acceleration intervals, and accumulate the number of peaks in electromechanical counter registers which can be read through windows in the equipment enclosure. The resulting data represents the total number of acceleration peaks during a specific flight or group of flights with no indication of the sequence in which the peaks occurred.

To minimize the extent of the field support required for data retrievel on F-4 and A-7 aircraft, a mechanic is required to visit the aircraft once each month, to gain access to the indicator, and to write down on a simple form the aircraft tail number, the date of data retrieval, the base, the current aircraft hours, and the current contents of each counter window. A single form, such as the AFTO Form 109 in Figure 2.39, records the monthly data retrieval from as many as twenty F-4 aircraft. The completed monthly forms are mailed to the System Manager (or to ASIMIS)for keypunching. Local records for the counting accelerometer on each F-4 are maintained on an AFTO Form 101, shown in Figure 2.40, which is designed to provide a monthly check of the data for unusually high or low counts in any window. Detection of problems at base level is much more effective than waiting for the data processing checks to locate probable malfunctions.

In case of a problem, the base level mechanic can remove and replace either the accelerometer transducer or the indicator. The removed units can be checked for calibration using a standard rate table available in most instrument shops. Malfunctioning units are sent to the Item Manager for replacement and repair.

### 2.4.3 Counting Accelerometer Readings and Crew Forms

For many of the aircraft types equipped with counting accelerometers, it was decided that the accelerations must be associated with takeoff weight and stores and with the mission types for accurate estimation of damage or crack growth. To make this correlation, the counting accelerometers are read after each flight and the counts are written along with the mission information on new forms.

## MONTHLY COUNTING ACCELEROMETER READINGS REPORT

REPORTS CONTROL SYMBOL NUMBER

| AS OF DATE | UNIT | BASE | MDS |
|---|---|---|---|
| TYPED NAME, RANK, UNIT AND AUTOVON OF DEPUTY COMMANDER FOR MAINTENANCE | | | SIGNATURE |

NOTE: INSTRUCTIONS FOR COMPLETION OF FORM ARE ON REVERSE SIDE.

| AIRCRAFT SERIAL NUMBER | TOTAL ACFT. HRS. | WINDOWS | | | | INDICATOR MFGR & SN. | TRANSDUCER MFGR & SN. | CODE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | #1 | #2 | #3 | #4 | | | | |
| 16 21 | 22 25 | 39 42 | 43 46 | 47 50 | 51 54 | 61 66 | 67 73 | | |

ORIGINAL TO: OC-ALC/AIAA, TINKER AFB, OKLAHOMA 73145

COPY TO: OO-ALC/MMSRA, HILL AFB, UT 84406

COPY TO: MAJOR COMMAND/LGM

Figure 2.39 AFTO Form 109.

## COUNTING ACCELEROMETER COMPARISON RECORD

| AIRCRAFT SERIAL NUMBER | MODEL DESIGN SERIES | UNIT |
|---|---|---|
| | | |

| MONTH OF REPORT | AIRCRAFT HOURS | | INDICATOR #1 | | INDICATOR #2 | | INDICATOR #3 | | INDICATOR #4 | | CODE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CUMUL | THIS MO | READING | ADVANCED | READING | ADVANCED | READING | ADVANCED | READING | ADVANCED | | |
| C/F | | | | | | | | | | | | |
| JAN | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | |
| APR | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | |
| JUN | | | | | | | | | | | | |
| JUL | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | |
| SEP | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | |
| ANNUAL TOTALS | | | | | | | | | | | | |

| INSTRUMENTATION RECORD | | | | | | SYSTEM CALIBRATION RECORD | | |
|---|---|---|---|---|---|---|---|---|
| INDICATOR | | | TRANSDUCER | | | DATE CALIB | COUNTER ADVANCES | REMARKS |
| SERIAL NO. | MFGR | DATE INSTAL | SERIAL NO. | MFGR | DATE INSTAL | | | |
| | | | | | | | | |
| | | | | | | | | |

Figure 2.40 AFTO Form 101.

The pilot, or another crew member, is required to enter the aircraft tail number, base, date, mission type, code, takeoff weight, the number of events (such as refuelings and landings), the flight duration, and the total aircraft hours on a special form after each flight. Following each flight, a mechanic is required to go to the aircraft, gain access to the indicator, and to enter the readings from the counter windows on the crew form. The crew forms are mailed to the System Manager (or to ASIMIS) for keypunching. Figures 2.41,2.42, and 2.43 are examples of these forms.

The F-111 aircraft tracking system uses manual punch cards such as those shown in Figure 2.44, as the crew forms. These cards have perforated slots which the mechanic can punch out in the field using a pencil or some other pointed object which eliminates the need for keypunching. However, these cards have special hole spacings and require a special, low-speed reader at ASIMIS to input the data into the computer. In addition, it is difficult to correct mispunched cards.

### 2.4.4 Crew Forms (Flight Profile)

Large aircraft with more than two crew members can have one crew member available to record flight profile data and events on a crew form during the flight. As shown in Figure 2.45, these crew forms are quite extensive and contain detailed data entries. Since large c.g. accelerations are not the more critical contributors to crack growth or time to crack initiation for large aircraft, these systems do not normally incorporate counting accelerometers.

During each flight a crew member, probably the flight engineer, makes entries on the crew form at the end of each flight segment, i.e., climb, cruise, low-level, refueling descent, etc. The contents of the forms vary according to aircraft type, but most will contain aircraft serial number, flight data, a mission type code, mission duration, total aircraft hours, takeoff and landing gross weights and fuel weights, and - for each flight segment) the fuel and cargo weights, airspeed, altitude,

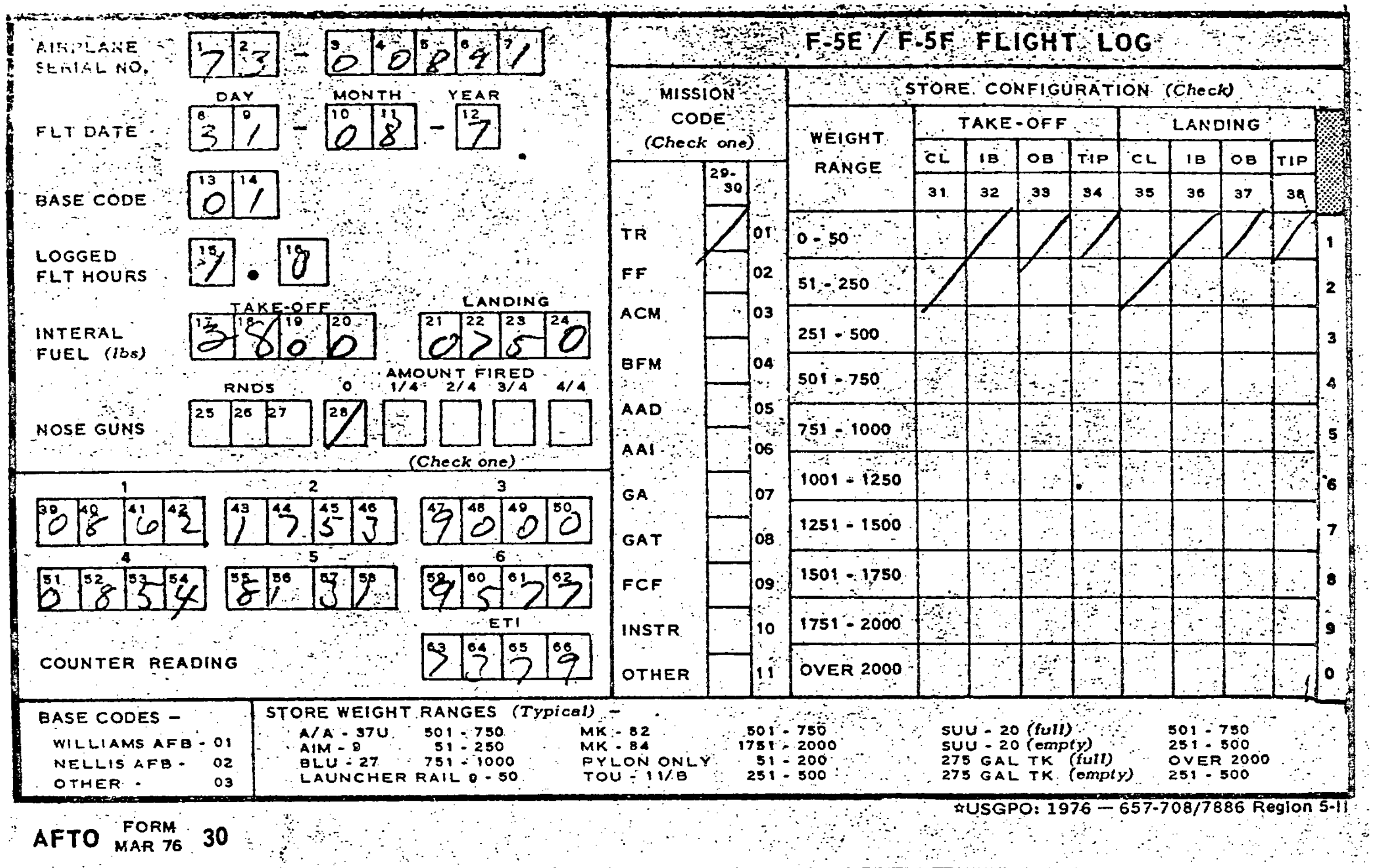


Figure 2.41 AFTO Form 30 (F-5).

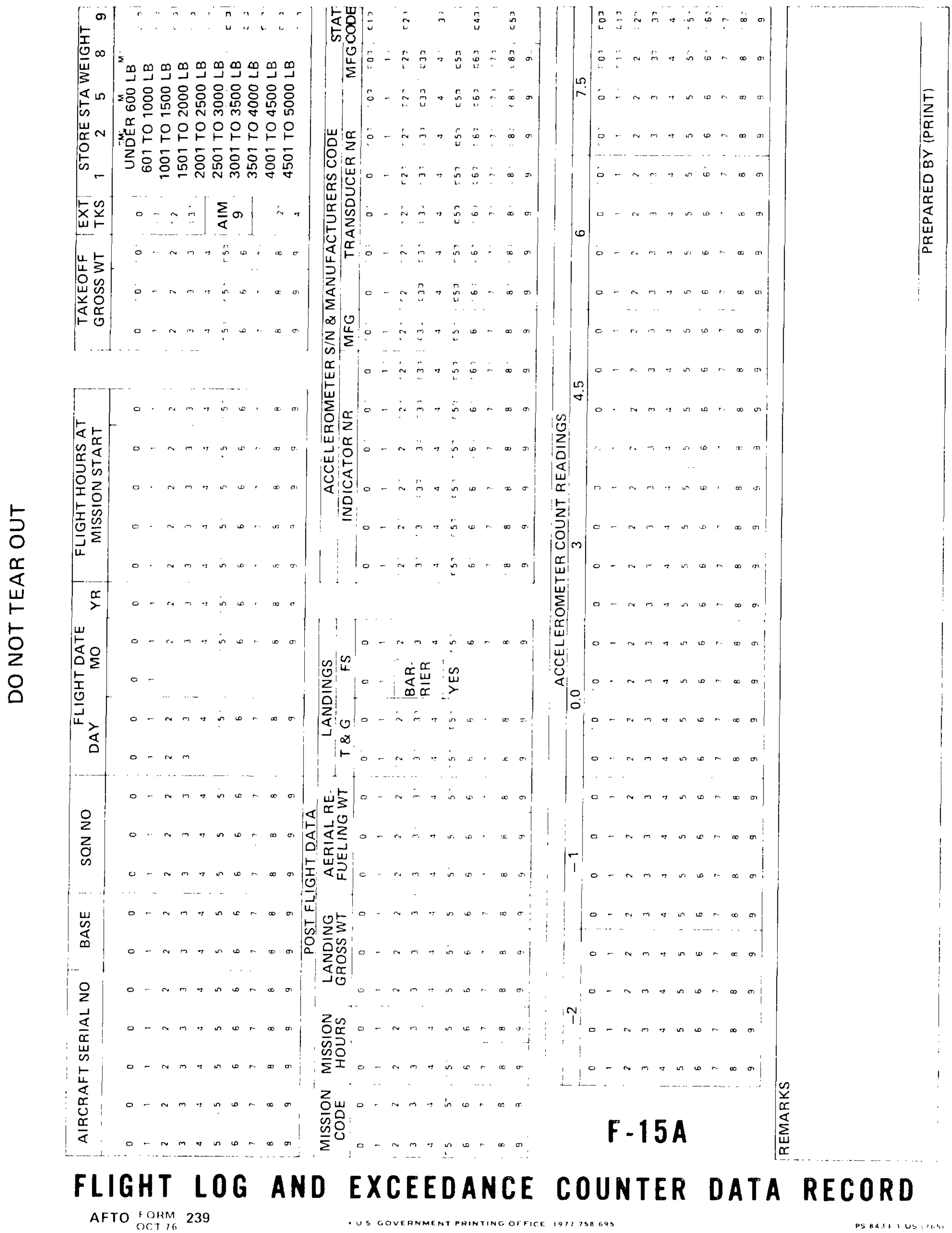


Figure 2. AFTO Form 239 (F-15).

## INSTRUCTIONS

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| **PRE-FLIGHT DATA** | |
| 1. Aircraft Serial Number | Tail Number – last digit of year plus last 4 digits of Nr (75-00032) |
| 2. Base | Two digit base code (see T.O.) |
| 3. Squadron Number | Three digit Maint Squadron Nr |
| 4. Flight Date | Day, Month & last digit of Year |
| 5. Flight Hr at Mission Start | Total time from AFTO Form 781 to nearest tenth of an hour |
| 6. Takeoff Gross Weight | Gross weight at take-off to nearest tenth of a Kip |
| 7. External Tanks | Number of external tanks carried |
| 8. AIM -9 | Mark if AIM-9 missiles carried: 2 or 4, as applicable |
| 9. Store Station Weight | Mark M if MER carried w/stores on pylon station 2, 5, and/or 8. Mark weight range for each store station. Weight is total weight of pylon, MER, launcher, and/or stores. |

**POST-FLIGHT DATA**

1. Mission Codes (Note: Enter 2nd (and 3rd) mission of sortie in Remarks with fraction of total mission time)

| w/o TEWS-Sta 1 & 9 | w/TEWS | |
|---|---|---|
| 01 | 21 | ACM w/guns & ammo, or practice gun-firing pass |
| 02 | 22 | ACM w/missiles installed, or practice missile-firing pass |
| 03 | 23 | Intercept (Practice) |
| 04 | 24 | ACM (Camera Only) |
| 05 | 25 | Bombing & Ground gunnery |
| 06 | 26 | Instrument & Navigation |
| 07 | 27 | Transition & Proficiency |
| 08 | 28 | Functional Check Flight |
| 09 | 29 | Dart Towing |

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| 2. Mission Hours | Mission duration to nearest tenth of an hour |
| 3. Landing-Gross Weight | Gross weight at landing to nearest tenth of a Kip |
| 4. Aerial Refueling Weight | Fuel weight taken on board in flight to nearest tenth of a Kip (1 Kip = 1,000 lbs) |

Mail completed forms to: Warner Robins ALC/MMSRDB
Robins AFB, GA 31098

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| 5. Landings | Number of Touch & Go's (T & G) and Full Stop (FS) Landings |
| 6. Barrier | Mark "Yes" if barrier engagement is used |

**COUNTING ACCELEROMETER DATA**

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| 1. Indicator Number Mfr | Mark Serial Number of Indicator & Manufacturer Code Number Code: 1-Actron Inds 2- |
| 2. Transducer Nr – Mfr | Mark Serial Number of Transducer & Manufacturer Code Number Code: 1-Systron-Donner 2- |
| 3. Status Code | |
| 1 | Counting Accelerometer BIT latch during flight |
| 2 | Indicator or Transducer was removed or disconnected, or Indicator just installed. |
| 3 | Counting Accelerometer not installed |
| 4 | Aircraft has transferred to another Squadron or Base. State new Base or Squadron in Remarks. |
| 5 | Aircraft not available to obtain readings: state reason in Remarks |
| 4. Accelerometer Count Readings | Mark values that are visible in corresponding numbered windows of the indicator. These readings are taken after each flight. If number is less than four digits, precede it with zeros to make it a four digit number. |
| 5. Remarks | Note problems with counting accelerometer and state reasons why blanks were left on this report, or note other pertinent information. |
| 6. Prepared by | Printed name and grade of person completing this form |

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Figure 2.42 (Concluded).

FLIGHT LOG — AIRCRAFT STRUCTURAL INTEGRITY PROGRAM

AIRCRAFT SERIAL NUMBER [ ][ ][ ][ ][ ][ ] DATE (DAY / MONTH / YEAR) [ ][ ][ ][ ][ ][ ]

BASE [ ][ ] USE BASE CODE PER T.O. 1-10A-2-34MS-1

FLIGHT TIME (HRS) [ ][ ][ ].[ ]

TOTAL TIME OF A/C AFTER FLIGHT (HRS) [ ][ ][ ][ ][ ].[ ]

MISSION [ ][ ][ ] USE MISSION CODE PER T.O. 1-10A-2-34MS-1

TAKEOFF WEIGHT (LBS) [ ][ ][ ][ ][ ]

TAKEOFF FUEL (LBS) [ ][ ][ ][ ][ ]

LANDING WEIGHT (LBS) [ ][ ][ ][ ][ ]

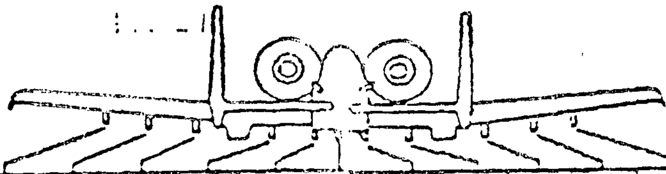
ROUNDS OF AMMO [ ][ ][ ][ ] ENTER NUMBER ON BOARD AT TAKEOFF

IN-FLIGHT REFUELINGS [ ] ENTER NUMBER OF ENGAGEMENTS (WET OR DRY)

LANDINGS [ ][ ] ENTER TOTAL INCLUDING TOUCH AND GO

| COUNTING ACCELEROMETER | |
|---|---|
| COUNTER 1 | [ ][ ][ ][ ] |
| COUNTER 2 | [ ][ ][ ][ ] |
| COUNTER 3 | [ ][ ][ ][ ] |
| COUNTER 4 | [ ][ ][ ][ ] |
| COUNTER 5 | [ ][ ][ ][ ] |
| COUNTER 6 | [ ][ ][ ][ ] |
| ETI | [ ][ ][ ][ ] |

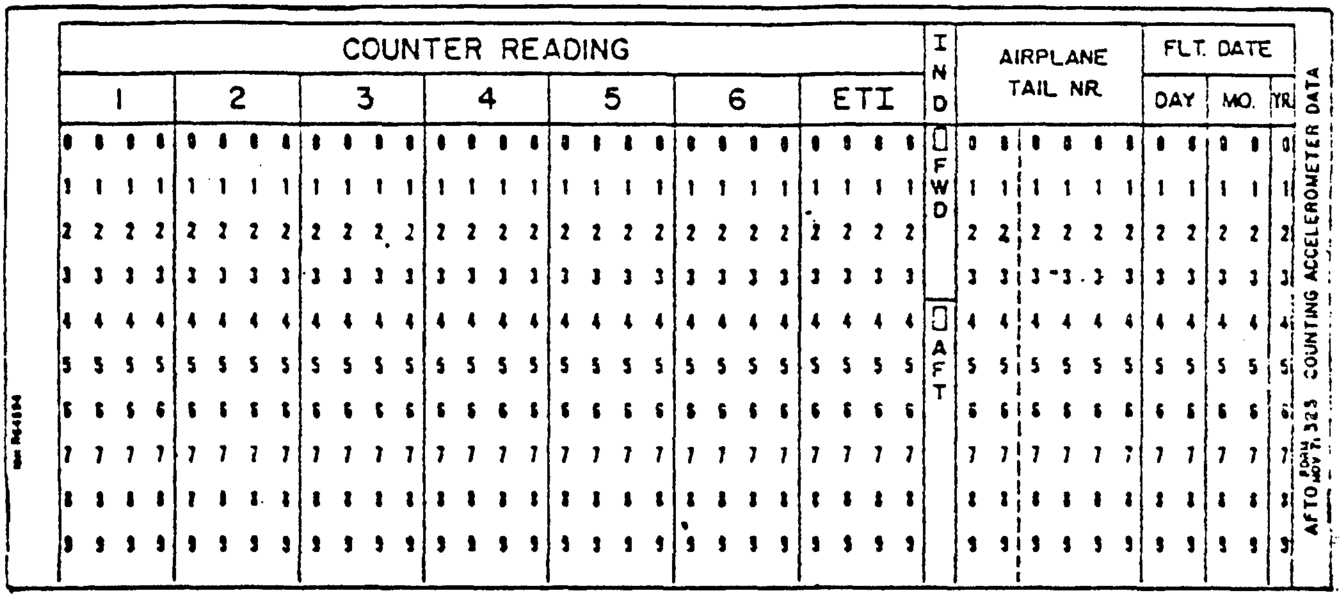
AIRCRAFT CONFIGURATION



| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

[ ][ ][ ] FOR DATA PROCESSING ONLY

Figure 2.43 A-10 Flight/Counting Accelerometer Log.




o F-111A/E/D/F Flight Usage Card

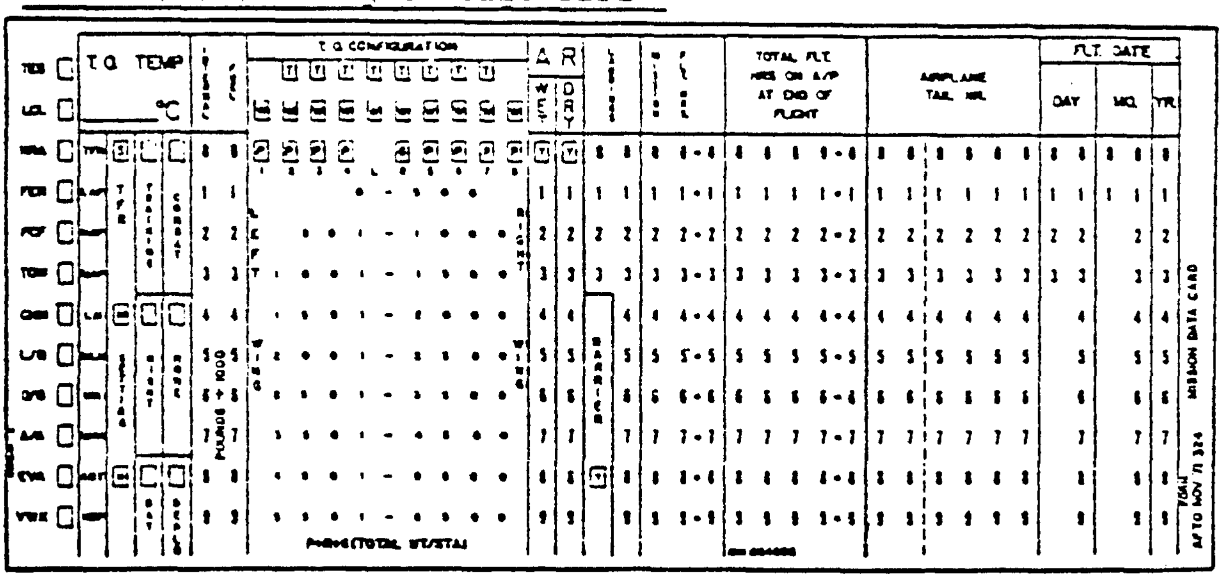
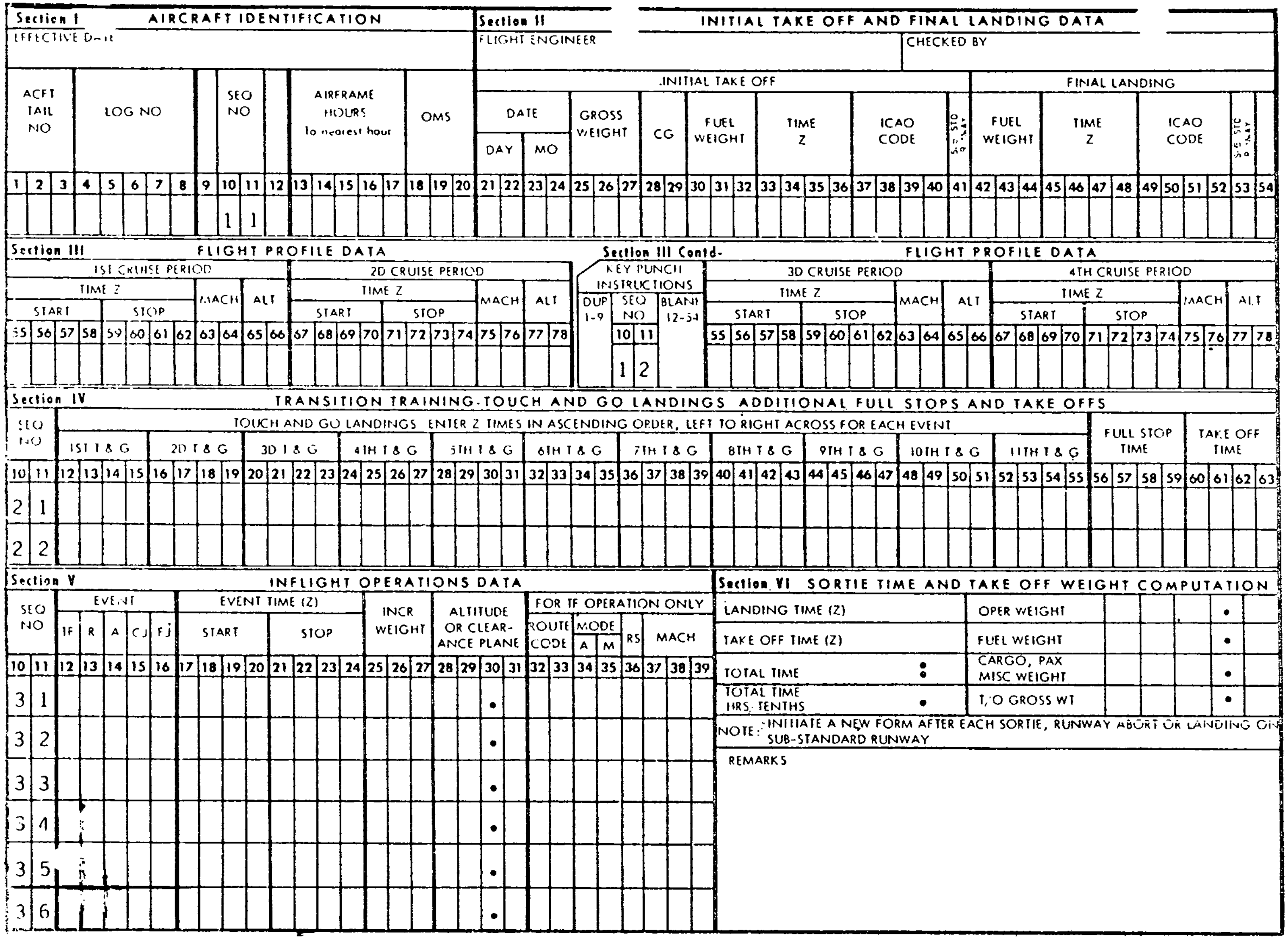



Figure 2.44 F-111 Usage Cards.



**Section I — AIRCRAFT IDENTIFICATION**

EFFECTIVE DATE

ACFT TAIL NO | LOG NO | SEQ NO | AIRFRAME HOURS to nearest hour | OMS

**Section II — INITIAL TAKE OFF AND FINAL LANDING DATA**

FLIGHT ENGINEER | CHECKED BY

INITIAL TAKE OFF: DATE (DAY, MO) | GROSS WEIGHT | CG | FUEL WEIGHT | TIME Z | ICAO CODE | SUB-STD RWY

FINAL LANDING: FUEL WEIGHT | TIME Z | ICAO CODE | SUB-STD RWY

**Section III — FLIGHT PROFILE DATA**

1ST CRUISE PERIOD: TIME Z (START, STOP) | MACH | ALT

2D CRUISE PERIOD: TIME Z (START, STOP) | MACH | ALT

**Section III Contd- FLIGHT PROFILE DATA**

KEY PUNCH INSTRUCTIONS: DUP 1-9 | SEQ NO | BLANK 12-54

3D CRUISE PERIOD: TIME Z (START, STOP) | MACH | ALT

4TH CRUISE PERIOD: TIME Z (START, STOP) | MACH | ALT

**Section IV — TRANSITION TRAINING-TOUCH AND GO LANDINGS ADDITIONAL FULL STOPS AND TAKE OFFS**

SEQ NO

TOUCH AND GO LANDINGS ENTER Z TIMES IN ASCENDING ORDER, LEFT TO RIGHT ACROSS FOR EACH EVENT

1ST T & G | 2D T & G | 3D T & G | 4TH T & G | 5TH T & G | 6TH T & G | 7TH T & G | 8TH T & G | 9TH T & G | 10TH T & G | 11TH T & G | FULL STOP TIME | TAKE OFF TIME

**Section V — INFLIGHT OPERATIONS DATA**

SEQ NO | EVENT (TF, R, A, CJ, FJ) | EVENT TIME (Z) (START, STOP) | INCR WEIGHT | ALTITUDE OR CLEARANCE PLANE | FOR TF OPERATION ONLY: ROUTE CODE, MODE (A, M), RS, MACH

**Section VI — SORTIE TIME AND TAKE OFF WEIGHT COMPUTATION**

LANDING TIME (Z) | OPER WEIGHT

TAKE OFF TIME (Z) | FUEL WEIGHT

TOTAL TIME | CARGO, PAX MISC WEIGHT

TOTAL TIME HRS. TENTHS | T/O GROSS WT

NOTE: INITIATE A NEW FORM AFTER EACH SORTIE, RUNWAY ABORT OR LANDING ON SUB-STANDARD RUNWAY

REMARKS

Figure 2.45 C-5 Aircraft Fatigue Tracking Record (MAC Form 89).

# C-141 AIRCRAFT USAGE LOG

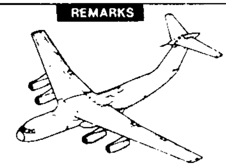
NAME

SQUADRON

| CUMULATIVE AIRFRAME | | |
|---|---|---|
| FLT HRS | F S LDGS | TOTAL LDGS |
| AT START OF SORTIE | | |
| | | |

| PAGE NO | OF | TOTAL PAGES |
|---|---|---|
| 1 | | 1 |
| 2 | | 2 |
| 3 | | 3 |
| 4 | | 4 |
| 5 | | 5 |

REMARKS



AFTO FORM 451, SEPT 71

## AIRCRAFT SERIAL NUMBER

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0 – | 0 | 0 | 0 | 0 | |
| | 1 – | 1 | 1 | 1 | 1 | |
| | 2 – | 2 | 2 | 2 | 2 | |
| | 3 – | 3 | 3 | 3 | 3 | |
| | 4 – | 4 | 4 | 4 | 4 | |
| | 5 – | 5 | 5 | 5 | 5 | |
| 6 | 6 – | 6 | 6 | 6 | 6 | |
| | 7 – | 7 | 7 | 7 | 7 | |
| | | 8 | 8 | 8 | 8 | |
| | | 9 | 9 | 9 | 9 | |

## DATE

| DAY | | MON | YEAR |
|---|---|---|---|
| 0 | 0 | JAN | 72 |
| 1 | 1 | FEB | 73 |
| 2 | 2 | MAR | 74 |
| 3 | 3 | APR | 75 |
| | 4 | MAY | 76 |
| | 5 | JUN | |
| | 6 | JUL | |
| | 7 | AUG | |
| | 8 | SEP | |
| | 9 | OCT | |
| | | NOV | |
| | | DEC | |

## INITIAL TAKE OFF

| FUEL WT BAND | PAY LOAD WT BAND | RWY |
|---|---|---|
| 0 | 0 | SUB STD |
| 12 | 5 | |
| 25 | 10 | |
| 37 | 15 | |
| 50 | 20 | |
| 62 | 27 | |
| 75 | 35 | |
| 87 | 42 | |
| 100 | 50 | |
| 112 | [illegible] | |
| 125 | 70 | |
| 137 | 80 | |

## TERMINATION LANDING

| CLOCK TIME | | | | FUEL WT BAND | LANDING |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | AWLS |
| 1 | 1 | 1 | 1 | 12 | |
| 2 | 2 | 2 | 2 | 25 | |
| | 3 | 3 | 3 | 37 | RWY |
| | 4 | 4 | 4 | 50 | |
| | 5 | 5 | 5 | 62 | SUB STD |
| | 6 | | 6 | 75 | |
| | 7 | | 7 | 87 | |
| | 8 | | 8 | 100 | |
| | 9 | | 9 | 112 | |
| | | | | 125 | |
| | | | | 137 | |

## TOUCH & GO AND STOP & GO LANDINGS

SERIES NO. 1, SERIES NO. 2, SERIES NO. 3, SERIES NO. 4 (each):

| CLOCK TIME | | | | NO | TYPE | LANDING |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | T G | AWLS |
| 1 | 1 | 1 | 1 | 1 | S G | RWY |
| 2 | 2 | 2 | 2 | 2 | | SUB STD |
| | 3 | 3 | 3 | 3 | | |
| | 4 | 4 | 4 | 4 | | |
| | 5 | 5 | 5 | 5 | | |
| | 6 | | 6 | 6 | | |
| | 7 | | 7 | 7 | | |
| | 8 | | 8 | 8 | | |
| | 9 | | 9 | 9 | | |

## FLIGHT SEGMENTS

ALL CLOCK TIMES AT START OF SEGMENT

EVENT: CL, C, CR, DS, ET

| CLOCK TIME | | | |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| | 3 | 3 | 3 |
| | 4 | 4 | 4 |
| | 5 | 5 | 5 |
| | 6 | | 6 |
| | 7 | | 7 |
| | 8 | | 8 |
| | 9 | | 9 |

SEGMENT 1, SEGMENT 2, SEGMENT 3, SEGMENT 4, SEGMENT 5, SEGMENT 6 (each):

| ALT | MACH | FUEL | A/D |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | .37 | 12 | 5 |
| 2 | .45 | 25 | 10 |
| 7 | .54 | 37 | 15 |
| 12 | .61 | 50 | 20 |
| 17 | .71 | 62 | 27 |
| 22 | .80 | 75 | 35 |
| 32 | | 87 | |
| | | 100 | |
| | | 112 | |
| | | 125 | |
| | | 137 | |

PS 7135 US (4981)

*U.S. GOVERNMENT PRINTING OFFICE: 1972-758-763

Figure 2.46 AFTO Form 451 (C-141).

duration, and any special events such as landing, refueling hookups, airdrops, etc. Following the flight, the completed crew forms are mailed to the System Manager (or to ASIMIS) for keypunching.

The C-141 aircraft tracking system has a crew form, Figure 2.46, designed for processing through "mark-sense" reading equipment. This equipment detects pencil marks in specific locations on the page and converts the data directly to a computer formatted tape. The reading equipment has a certain amount of editing capability which detect many types of errors for immediate correction. Errors can be corrected by making a new form with the same tail number, date, and hours and entering only those fields with corrections. The reading equipment then replaces the corrected fields on the data tape. Warner-Robbins ALC presently maintains a mark-sense reader for the C-141 and F-15 aircraft tracking program and intends to broaden its application to other aircraft systems.

### 2.4.5 A/A24U-10 Statistical Recorder (VGH)

This recorder, shown in Figure 2.47, was procured during the early 1960's and has been used to record data on several types of aircraft. The only current application of the A/A24U-10 is the F-4 aircraft spectra survey.

The A/A24U-10 comprises a recorder/computer with integral airspeed and altitude transducers and a remotely located normal acceleration transducer. The data is recorded in a removable hermetically-sealed tape cartridge and can be retrieved at ASIMIS by inserting the cartridge into a special playback device which transcribes the data onto a computer tape. The recorder computer detects positive and negative peaks of normal acceleration and tallies a count of peaks in intervals of normal acceleration, airspeed, and altitude. Elapsed time is also tallied in ranges of airspeed and altitude. The contents of all acceleration level peak counters and the elapsed time counter and the interval of airspeed, altitude, and a spare word are recorded on tape each time airspeed or altitude changes to

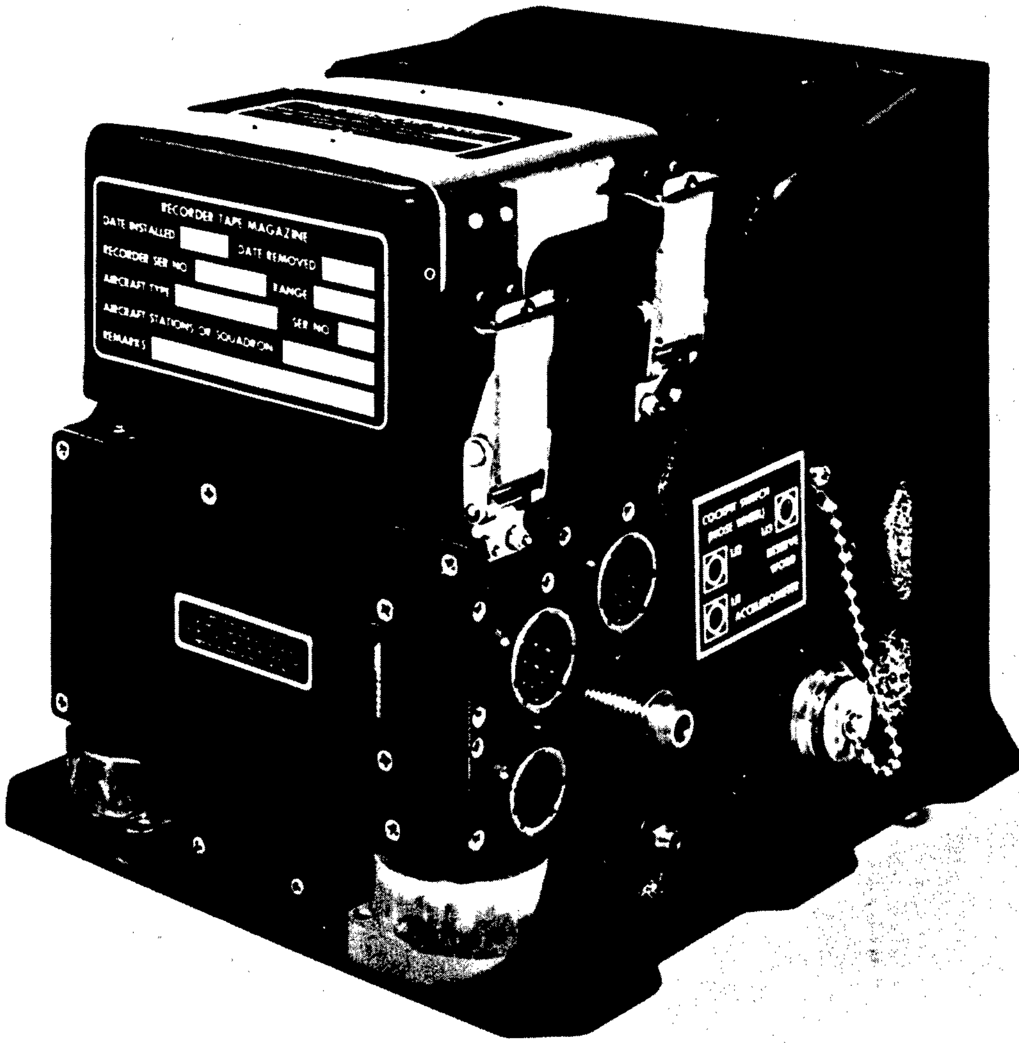



Figure 2.47 A/A24U-10 Flight Data Recorder.

## F/RF-4 VGH FLIGHT DATA RECORDING PROGRAM

| AIRCRAFT MDS | BASE | WING-UNIT | SERIAL NUMBERS: AIRCRAFT | SERIAL NUMBERS: MAGAZINE | SERIAL NUMBERS: RECORDER | SERIAL NUMBERS: ACCELEROMETER | FLIGHT HOURS AT: INSTALL | FLIGHT HOURS AT: REMOVAL | MAG. INSTALL: DAY | MAG. INSTALL: MO | MAG. INSTALL: YR | MAG. REMOVAL: DAY | MAG. REMOVAL: MO | MAG. REMOVAL: YR | BASIC AIRCRAFT WT. (MINUS FUEL AND STORES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |

NOTE: MAKE LINE ENTRY FOR ALL FLIGHTS.

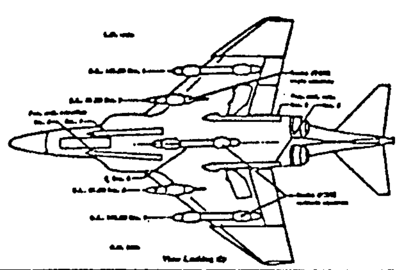
| FLT NO. | JULIAN DATE | MISSION CODE | ZULU TIME: TAKE-OFF | ZULU TIME: LANDING | LANDING BASE | ENGINE START GROSS WEIGHT | FUEL WEIGHTS: ENGINE START UP | FUEL WEIGHTS: ENGINE SHUT DOWN | FUEL WEIGHTS: INFLIGHT REFUELING | TIME INFLIGHT FUEL BEGINS | PERCENT TAPE REMAINING | REMARKS | FLT NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | 1 |
| 2 | | | | | | | | | | | | | 2 |
| 3 | | | | | | | | | | | | | 3 |
| 4 | | | | | | | | | | | | | 4 |
| 5 | | | | | | | | | | | | | 5 |
| 6 | | | | | | | | | | | | | 6 |
| 7 | | | | | | | | | | | | | 7 |
| 8 | | | | | | | | | | | | | 8 |
| 9 | | | | | | | | | | | | | 9 |
| 10 | | | | | | | | | | | | | 10 |
| 11 | | | | | | | | | | | | | 11 |
| 12 | | | | | | | | | | | | | 12 |
| 13 | | | | | | | | | | | | | 13 |
| 14 | | | | | | | | | | | | | 14 |
| 15 | | | | | | | | | | | | | 15 |
| 16 | | | | | | | | | | | | | 16 |

FOR PROCESSING CENTER USE ONLY:
FIELD TAPE#
FIELD SEQ#
RT TAPE #
RT SEQ #

MISSION CODES:
A. AIR-TO-GROUND
B. AIR-TO-AIR
C. INSTRUMENT NAVIGATION
D. TEST
E. RECONNAISANCE
F. AIR-INTERCEPT
G. OTHER (SPECIFY)

WHEN PERCENT TAPE REMAINING IS 10% OR LESS - REMOVE MAGAZINE, TRANSCRIBE AND SEND BOTH TAPE AND THIS FORM TO: OKLAHOMA CITY ALC/AIA TINKER AFB, OKLAHOMA 73145

AFTO FORM JUNE 76 107 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.



NOTE: Events of the sample flight reflected in the E. G. line under the column titles are as follows:
a. The eight 3M 1171 bombs on stations 2 and 8 were dropped on the first pass.
b. The two MK-82 bombs on station 5 were dropped on the second pass.
c. The third and fourth passes were dry runs.
d. The 38 rockets on stations 1 and 9 were launched on the fifth pass.
e. The Sparrow Missiles on stations 3, 4, 6 and 7 were not dropped.

| NUMBER CARRIED | TYPE OF STORE | DROPPED ON PASS NUMBER - IF NO DROP ENTER "N" |
|---|---|---|

| FLT NO. | STATION NO. 1 | | | STATION NO. 2 | | | STATION NO. 3 | | | STATION NO. 4 | | | STATION NO. 5 | | | STATION NO. 6 | | | STATION NO. 7 | | | STATION NO. 8 | | | STATION NO. 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E.G. | 1 | LAU319RX | 5 | 4 | 3M 1171 | 1 | 1 | SPARROW | - | 1 | SPARROW | - | 2 | MK-82 | 2 | 1 | SPARROW | - | 1 | SPARROW | - | 4 | 3M 1171 | 1 | 1 | LAU319RX | 5 |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES: (1) USE DASH ONE OR DASH FIVE HANDBOOK DESIGNATIONS ONLY.
(2) WHEN USING A MER OR TER, LIST ALL STORES BEING USED.
(3) LIST ALL STORES BEING CARRIED INCLUDING THOSE NOT DROPPED.
(4) IF STORE NOT DROPPED ENTER THE LETTER "N" IN PLACE OF PASS NUMBER.
(5) FLT NO. CORRESPOND TO FRONT SIDE OF FORM.

Figure 2.48 VGH Supplemental Data.

a new interval, each time an acceleration level peak counter reaches its maximum capacity, and after ten minutes of elapsed time. After transfer to tape, all counters are set to zero. The spare word is used to record the status of event switches such as gear up/down, store drops, and refueling hookups.

To provide mission type, aircraft weight, and external store configuration, a mechanic is required to fill out a line on a supplemental data form, Figure 2.48, after each recorded flight. After each flight, the mechanic must gain access to the recorder, read the "percentage of tape remaining" from a window in the tape cartridge, and enter this number on the supplemental data form. When the tape has been expended, the mechanic removes the cartridge and replaces it with a fresh one from supply. He then mails the spent cartridge and the corresponding completed supplemental data form to ASIMIS. ASIMIS transcribes the cartridge data to a computer tape, erases and rewinds the cartridge tape, and returns to cartridge to supply for reuse or repair as necessary.

A marginally effective field test unit is being used at the F-4 bases to test the A/A24U-10 recorders. However, most equipment malfunctions are not detected until the data is processed at ASIMIS. An equipment status report is mailed to the base notifying them of the malfunction and the probable cause. The mechanic removes the bad unit and requests a spare from supply. For most A/A24U-10 equipment, spares are stocked at one central location and a considerable amount of time is lost while waiting for the spare to be shipped to the base.

### 2.4.6 Multichannel Digital Magnetic Tape Systems

Most of the L/ESS programs on current USAF aircraft utilize instrumentation systems designed around a multichannel magnetic tape recorder. Currently used recording systems are the MXU-553 Recording Set, the AN/ASH-28 Recording Set, the A/A24U-6 Recording Set, and the MADAR System.

### 2.4.6.1 MXU-553/A Recording Set

The most commonly used multichannel recorder is the CONRAC Corporation MXU-553/A Recording Set (installed in 15 aircraft types). The recorder samples up to 26 input singals at frequencies from 1 to 30 per second as directed by a signal conditioning unit and writes the digital values on tape in a 240-word data format which holds all the samples taken in one second of elapsed time. The data is recorded in a large, removable tape cassette and can be retrieved at ASIMIS by inserting the tape cassette into a special playback device which transcribes the data onto a computer tape. Several "documentary data" values such as aircraft serial number, mission type, weights, date, etc., can be entered via thumb wheels in the front of the recorder or in a remotely located panel. Four different signal conditioning unit configurations are currently available for use in various classes of aircraft or types of recorded parameters.

The ground crew or the pilot is required to gain access to the recorder before each flight to read the percentage of tape remaining and to enter the documentary data via the recorder thumb wheels. On earlier programs the access to the recorder required so much effort that the crew generally neglected to perform this task. On the F-16 aircraft, recorder access has been designed to reduce the effort so that crew members can perform this task quickly.

The ground crew is required to remove the tape cassette after about 12 hours of MXU-553/A operation and to replace it with a fresh cassette from supply. The spent cassette is shipped to ASIMIS where it is transcribed to a computer tape, erased and rewound, and returned to supply for reuse or repair as necessary.

The equipment has some built-in test capability; however, most of the recording system diagnostics are performed during data processing at ASIMIS and the base is notified of each malfunction and the probable cause. The mechanic removes the malfunctioning unit and requests a replacement from supply.

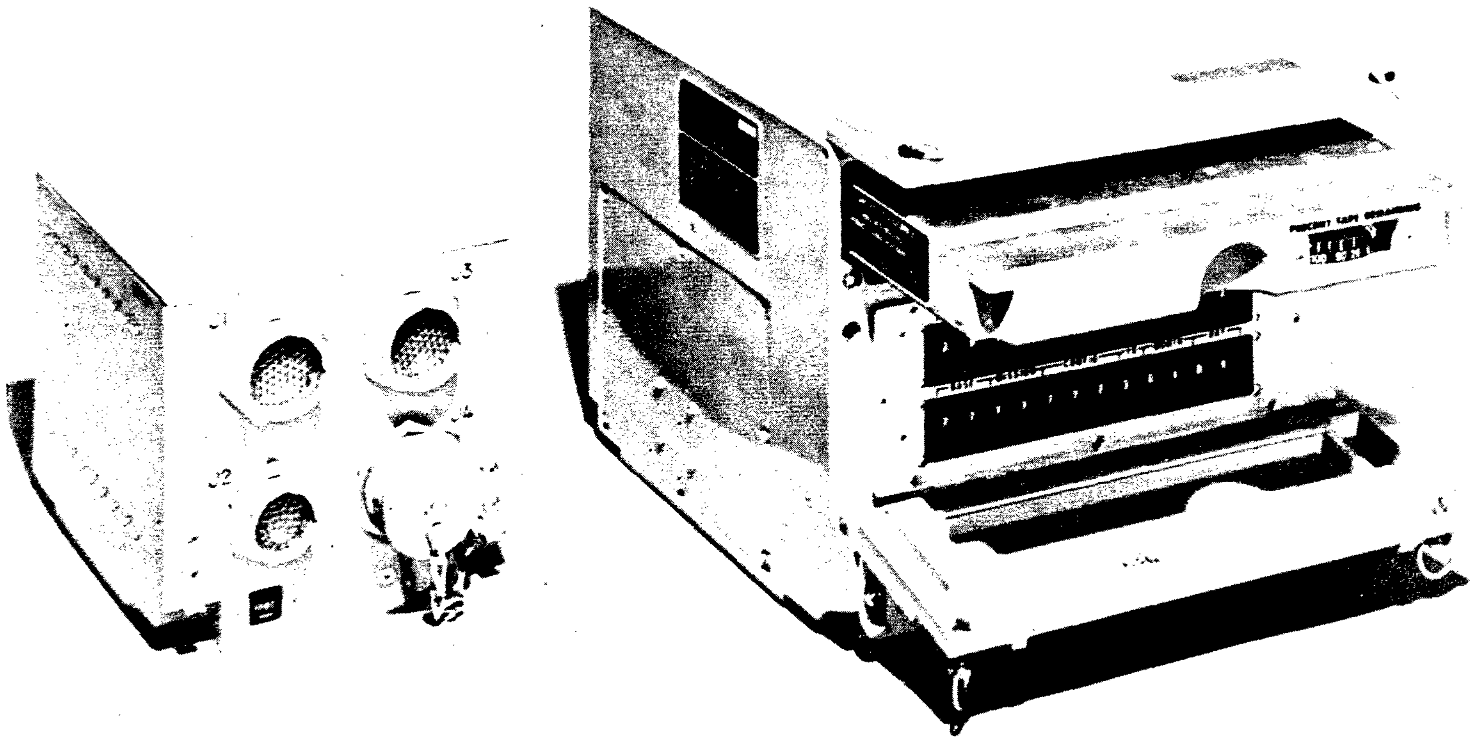



Figure 2.49 MXU-553/A Flight Loads Data Acquisition System.

(Reference 6)

# GENERAL SPECIFICATIONS

## SIGNAL DATA RECORDER

| | |
|---|---|
| Volume | 10" W x 10" D x 8" H maximum |
| Weight | 25 pounds including cartridge & accessories |
| Record Time | 15 hours minimum |
| Cartridge (Size) | 8-1/4" W x 8-19/32" D x 1-7/32" H |
| Cartridge (Weight) | 3.75 pounds |
| Tape Length | 1200 feet, 1/2 inch magnetic tape |
| Number of Tracks | 9 tracks utilizing 1 record head |
| Record Method | Multi-track serial biphase encoded, 8 data bits plus parity/character |
| Power | 115 Volts 400 Hz — 100 watts maximum<br>28 VDC — 20 watts maximum |
| Documentary Encoder | 24 independent data inputs utilizing thumbwheel switches |
| Density | 1000 characters/inch (9 bits/character) |
| BIT | Isolate failure to Converter/Multiplexer, Recorder or Documentary Data Encoder |
| Dropouts/Dropins | Less than 1 in 500,000 bits |

## CONVERTER/MULTIPLEXER

| | |
|---|---|
| Volume | 6" W x 8" D x 5-7/8" H |
| Weight | 7.5 pounds maximum |
| Sampling Rate | 1-30 samples maximum per parameter, 240 samples per second total |
| Number of Parameters | 26 parameters maximum |
| Analog Inputs | DC, AC, strain guage, potentiometric |
| Discrete Inputs | 28 VDC |
| Active Filters | 0 to 1, 2, 3, 4, 6, 8 Hz band-pass |
| Accuracy | ±0.8% F.S. over environmental range |
| Resolution | 8 bits binary |
| Power | Supplied by Signal Data Recorder |
| BIT | Automatic and manual pushbutton |

Figure 2.50 General Specifications of the MXU-553/A Recording System.

Spares are stocked at the central location and a considerable amount of time elapses between ordering a replacement part and receiving it at the base.

A photograph of the MXU-553/A with a typical converter/multiplexer unit is shown in Figure 2.49. The general specifications are shown in Table 2-50. The MXU-553 signal conditioning accuracy is ± 0.8 percent of full scale and the resolution is 8 bits binary (or 1/256 of full scale). Typical transducer accuracies range from ± 0.5 percent of full scale to ± 3 percent of full scale depending on type and cost of the transducer.

As discussed in Section 2.2, most systems are able to obtain usable data from about 20-30 percent of the flight time. Most of the unusable data is the result of transducer malfunctions. The major problem which keeps the usable data percentage down is the delay from the time of malfunction until detection and subsequent corrective action. It is not uncommon for this time to exceed six months during which period the recorder continues to produce unusable data. Current USAF management policy does not assign sufficient priority to the L/ESS data collection effort to allow any improvement in the percentage of usable data.

2.4.6.2 AN/ASH-28 Recording Set

The CONRAC AN/ASH-28 is identical to the MXU-553/A in its basic operation except its components are packaged especially for the F-15 installation and the tape capacity is increased to 25 hours of F-15 operation.

Unlike the MXU-553/A, the AN/ASH-28 system has self contained transducers for measuring angular rates about the three principle axes and linear accelerations along these axes. A special didital terminal interfaces with the aircraft central data bus from which the documentary and several other parameters are derived. Figure 2.51 is a photograph of this recorder. For the F-15 aircraft, the documentary data is entered in the cockpit

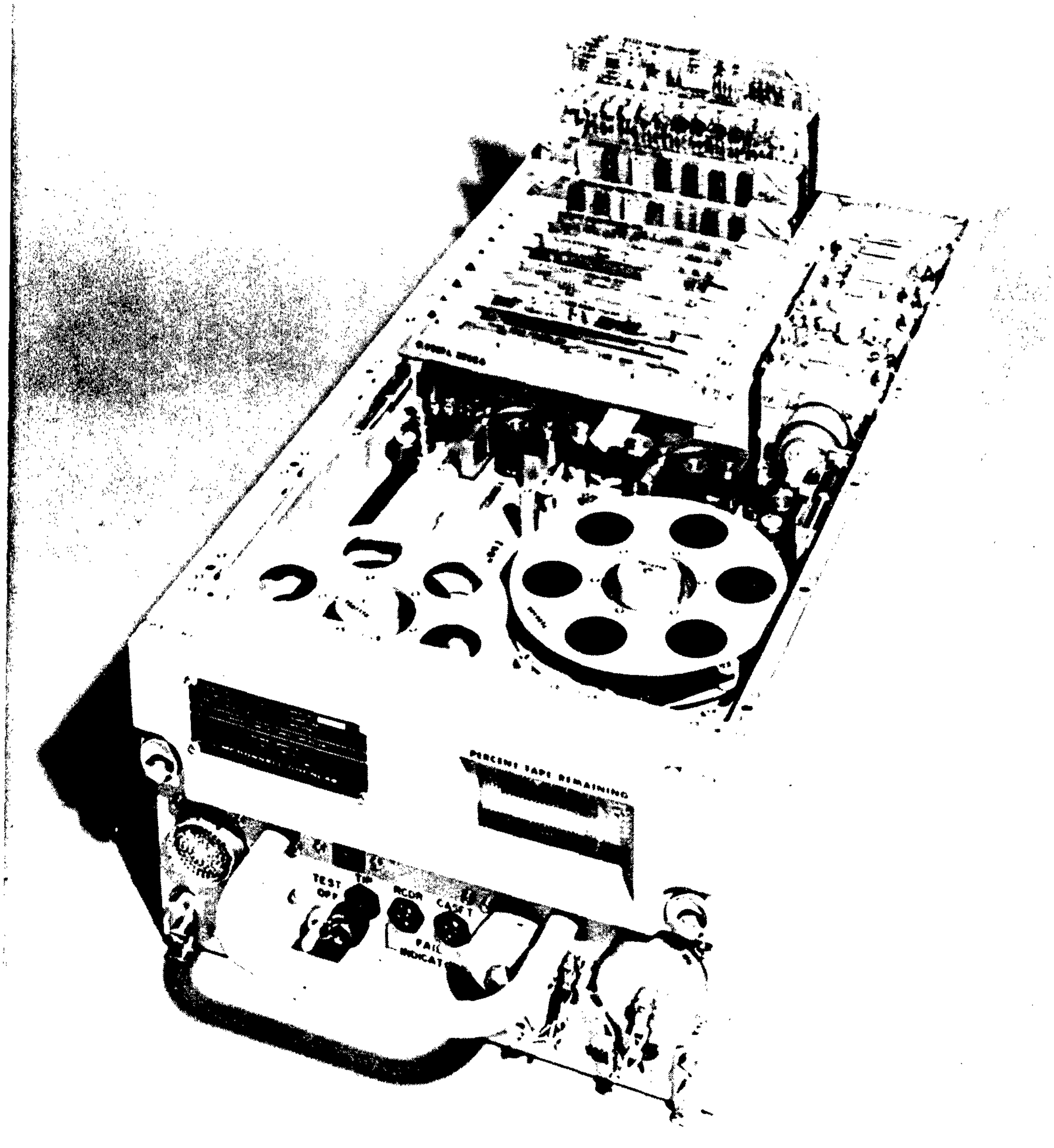



Figure 2.51 AN/ASH-28 Signal Data Recording Set.

via the navigation computer keyboard so the pilot can perform this function during his preflight cockpit check.

### 2.4.6.3 A/A24U-6 Recording Set

The F/FB-111 multiple-channel flight load recorder system consists of a Dynasciences Corporation A/A24U-6 airborne signal data recorder set, source transducers and associated wiring. The recorder receives signals from the source transducers; applies appropriate signal conditioning, filtering, and sampling; converts the measurements into binary values and digitally records the data on a 30-track magnetic tape. The tape is housed in a removable magazine.

The recorder operates continuously while the airplane is on internal electrical power and the access door to the auxiliary ground power receptacle is closed. Capacity of the magazine is approximately 25 hours. Twenty-four parameters (data items) are recorded. The resolution of the recorded data is 6 bits binary (1/64 of full scale).

After a magazine has been installed for 25 flight hours or six flights (five for FB-111As), Air Force personnel remove it from the airplane and sent it to a specified signal data converter (SDC) facility where the data measurements are transcribed onto "field data tapes". Operable magazines are subsequently returned to the sender for reinstallation.

A flight usage card is prepared by Air Force personnel for each F/FB-111 flight. These cards provide mission identification and description information needed for analysis of data and other SLM analysis work.

Additional information about the F/FB-111 MCR system is presented in USAF T.O. 1F-111A-2-1-2 ("F-111 Service Usage Recorder Program --Data Collection and Reporting") and T.O. 1F-111(B) -2-1-2 ("FB-111 Service Usage Program -- Data Collection and Reporting"). The former covers application of the MCR system in F-111A/E/D/F airplanes while the latter covers FB-111A airplanes.

### 2.4.6.4 MADAR System

With the constantly improved capability of electronic recording equipment and the increased interest in recording operational data from engines, electronics, and other aircraft subsystems, it is likely the future recording systems would record other information in addition to structural usage data. In fact, it is also likely that the structural data might be only a minor part of the intended purpose of the recording system.

The C-5A L/ESS signal acquisition/ recording system is a modified Malfuntion,Detection, Analysis and Recording (MADAR) system with other hardware and sensors added as required. The system was modified for the C-5A Service Loads Recording Program (SLRP) and is used with only minor modification in the L/ESS. The basic MADAR is a digital recording system that was designed to assist the flight crew in inspecting the characteristics of airplane Line Replaceable Units (LRU) and subsystems for either degradation or failure while in flight or on the ground. To perform the SLRP, and therefore the L/ESS, MADAR components underwent modifications that resulted in greater memory capacity within the digital computer, a faster recording rate, and additional signal conditioning to handle the new SLRP data signals.

The analog signals output by the various sensors are detected, amplified, filtered, converted and/or otherwise "conditioned" as requried within the signal conditioning components of the MADAR. Signal conditioning results in the operating range of most data parameters being normalized to $\pm$ -5.0 vdc except for a few parameters which are normalized to a lesser voltage. These conditioned signals are then sampled according to an order or sequence controlled by the onboard digital computer. The number of times per second that a particular data signal is sampled is called the "sample rate". Typical sample rates are 1,2,5,10, or 20. Each sampled value is digitized, that is, converted from volts to "counts" (21 millivolts) and compared with the last recorded value of the same parameter. If the new value differs from the last recorded value by more than a prescribed "half window" number of counts, then the new digitized value is recorded, otherwise not. The amount of change necessary to cause recording is called the "resolution" of the data channel. By definition, a resolution is equal to the half window value plus 1 count. This recording concept, illustrated in Figure 2.52 is sometimes called a "moving window" compression technique. The result is data compression, i.e., large quantities of data of analog data can be represented by small quantities of recorded data. The data which meet recording requirements pass into a buffer and then eventually onto the magnetic tape of the MADAR data recorder.

Several minor system modifications were incorporated for the C-5A L/ESS. The onboard computer program software was modified to acquire and process an ALDCS* (Active Lift Distribution Control System) on-off signal using test points which were already accessed by the MADAR. The internal processingof the thrust reverser signals was updated to be more reliable.

A total of twenty-four flight recorded parameters are utilized in the C-5A L/ESS. These include ten "SLRP-type" parameters, MADAR recorded time, the LHRP discrete word and twelve engine trend type parameters. The "SLRP-type" parameters are a portion of the specially processed and encoded MADAR parameters devised specifically for the SLRP program. They form the bulk of the recorded data upon which all C-5A L/ESS operations are based. C-5A L/ESS discrete word combines eight discrete or event type parameters previously recorded for SLRP and one new discrete channel, ALDCS operate mode, into a single recorded message. This message is written on tape once every five seconds and again whenever a change to one of the event channels occurs. The result is a set of nine discrete channel time histories (which can be more effectively edited and interpreted than the previously presented discrete channel data) compressed into a single channel of

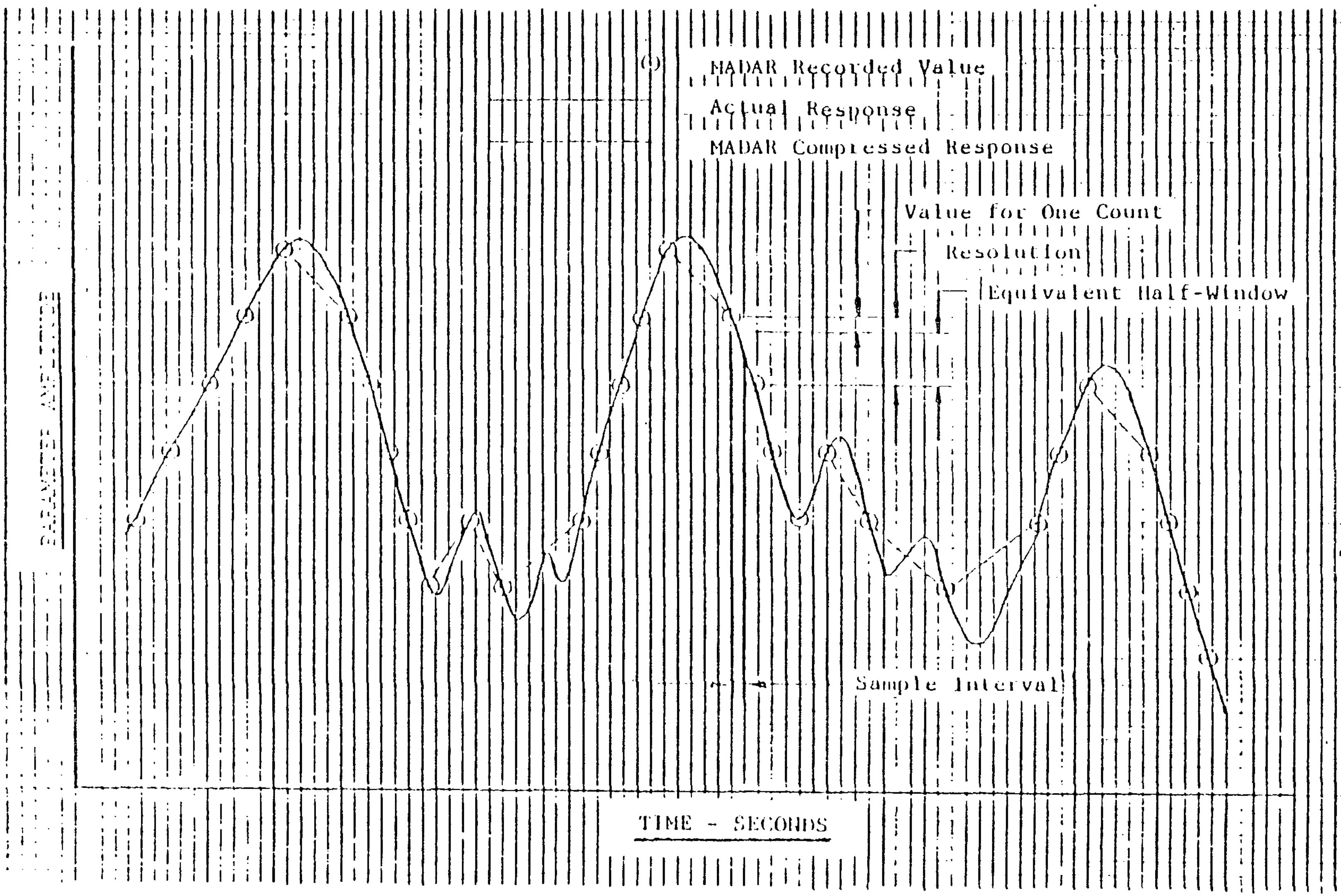



Figure 2.52 Example of MADAR Moving Window Recording Technique.

recorded data. MADAR recorded (ZULU) time and the twelve engine trend parameters (three for each engine) are basic MADAR system parameters used initially for other MADAR applications. They were adopted without change for the SLRP and therefore are retained on the C-5A L/ESS. The engine parameters are fuel flow, compressor speed and throttle angle for each of the four engines.

The MADAR system is maintained in the field. The maintenance diagnostics function of MADAR is flight-essential and is maintained on a priority basis but the structural parameter equipment is not flight-essential and thus maintained accordingly. The recorder has built-in test capability. In addition, a portable programmable test device is available at the bases for diagnosing MADAR equipment malfunctions.

2.4.7 New Recording Systems

Three new types of recording systems are in early stages of development - the mechanical strain recorder (MSR), the crack growth gage, and a microprocessor-based electronic recording system. These systems will be treated in-depth in the Task II report for this contract. However, a look at projected data collection requirements might be useful at this point in time.

The MSR is a mechanical gage which must be attached to the aircraft structure at a location with relatively high stress levels. If the MSR is exposed to the wind stream, it must have a removable protective cover. The current model MSR has a removable cassette which will contain recorded strain cycles for an estimated 50 hours of F-16 operation. (A later model MSR is expected to record 100 hours). Every 50 hours, a mechanic will remove the MSR cassette and mark it with the date and aircraft hours. He will install a fresh cassette from supply. The spent cassette will be mailed to ASIMIS where the metal tape will be removed and the peaks and troughs of the scratched strain time history will be optically measured and written on computer tape by an automatic reader device.

The crack growth gage is a precracked test specimen which is bonded directly to the aircraft structure. The gage is designed so its crack will grow under an applied load environment in direct proportion to a potential crack in the aircraft structure. Thus, a measurement of the gage crack length will indicate when an in-depth inspection of the aircraft structure is necessary to protect its structural integrity. The crack growth gage concept is still under test. Possible crack length measurement techniques include optical measurement by using a magnified viewer, FAX film, or macrophotography; or electrical measurement by using a crack growth resistance gage bonded to the crack growth gage. Gage measurements could be taken during scheduled phase inspections.

The term microprocessor-based recording system is applied to a variety of concepts which use a microprocessor in the signal conditioning circuitry. These devices have a significant amount of computing capability and normally use solid state memory to reduce cost and improve reliability. Although several prototype microprocessor recorders are currently being tested, this type of recorder has not yet seen wide use in force management. The frequency of data retrieval for microprocessor systems will depend on the extent to which this airborne computation capability is used to reduce data storage requirements. Most proposed systems are aiming for data retrievals about once each month. A mechanic will be required to carry a portable data retrieval device to the aircraft where he will connect it to the recorder and dump the recorder memory contents into the playback. The data retrieval device will also perform extensive diagnostic checks on the recorder. The data from the playback unit will either be recorded on a small tape cassette for mailing to ASIMIS or will be sent to ASIMIS via telecommunication lines.

### 2.4.8 Estimated Cost/Accuracy for Current Data Collection Systems

Table 2.16 presents a summary of the current recording system accuracy and cost estimates. The data are estimated based on a "standard" fighter fleet of 750 airplanes flying 400 hours per aircraft per year or transport fleet of 500 airplanes flying 800 hours per aircraft per year. Recorder cost and reliability figures are based on current experience. No attempt was made to adjust equipment costs by an inflation factor to account for the year of purchase.

## TABLE 2.16

## CURRENT RECORDER ACCURACY & COSTS

| | L/ESS RECORDERS | | | | | | IAT RECORDERS | | |
|---|---|---|---|---|---|---|---|---|---|
| | Multichannel Tape | | | | | | | | |
| Parameter | MXU-553 (A/F/T) | MXU-553 (T/B) | AN/ASH-28 | A/A24U-6 | MADAR | VGH A/A24U-10 | Counting Accelerometer Flt x Flt | Counting Accelerometer Monthly | Forms |
| **Fleet Assumptions** | | | | | | | | | |
| No of A/C | 750 | 500 | 750 | 750 | 500 | 750 | 750 | 750 | 500 |
| Utilization Per A/C | 400 Hr/yr | 800 Hr/yr | 400 Hr/yr | 400 Hr/yr | 800 Hr/yr | 400 Hr/yr | 400 Hr/yr | 4000 Hr/yr | 800 Hr/yr |
| No A/C Per Base | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| A/C Life | 6000 Hr (15 yr) | 20,000 Hr (25 yr) | 6000 Hr (15 yr) | 6000 Hr (15 yr) | 20,000 Hr (25 yr) | 6000 Hr (15 yr) | 6000 Hr (15 yr) | 6000 Hr (15 yr) | 20,000 Hr (25 yr) |
| % L/ESS A/C | 10% | 10% | 10% | 10% | 10% | 10% | --- | --- | --- |
| **Equipment Assumptions** | | | | | | | | | |
| Recorder Life | 10 yr | 10 yr | 10 yr | 10 yr | 10 yr | 10 yr | 15 yr | 15 yr | --- |
| Recorder MTBR | 887 hr | 887 hr | 691 hr | 466 hr | | 250 hr | 2000 hr | 2000 hr | --- |
| Transducer Life | 1200 Hr (3 yr) | 2400 Hr 3 Yr) | 1200 Hr 3 Yr) | 1200 Hr (3 Yr) | 1200 Hr (3 Yr) | 1200 Hr (3 Yr) | 15 yr (15 Yr) | 15 yr | --- |
| Data Retrieval Interval | 15 Hr | 15 Hr | 25 Hr | 21 Hr | 25 Hr | 25 Hr | Each Flt. | Each Mo. | Each Flt. |
| System Accuracy* | 1-3% | 1-3% | 1-3% | 1-3% | 1-3% | 1% | 1% | 1% | A/C Indicator Accuracy |
| % Usable Data | 20-30% | 30-40% | 40% | 25% | 25% | 40% | 90-95% | 70-90% | 70-99% |
| System Resolution* | 0.39% | 0.39% | 0.39% | 1.56% | | 16 Discreet Bands | 4-6 Level Crossings | 4-6 Level Crossings | Predetermined Bands |
| **Costs (Per A/C Operating Hour** | | | | | | | | | |
| Equipment Cost | $34.78 | $17.55 | $19.83 | $25.47 | | $19.13 | $0.95 | $0.81 | $0.02 |
| Equipment O&M | 5.30 | 5.30 | 4.63 | 1.14 | | 1.00 | 0.83 | $0.83 | ----- |
| Data Transmittal | 13.00 | $13.00 | $11.80 | 9.63 | | 6.48 | | $0.18 | $0.20 |
| Total Data Collection Costs** | $53.08 | $35.85 | $35.81 | $36.23 | *** | $26.61 | $4.20 | $1.82 | $0.22** |

* Percent of full scale
** Does not include flight crew manhours
*** Information not obtained

The costs in Table 2.16 includes only the cost of equipment and data collection. Similar data processing information is presented in Section 2.5.

The recorder and signal conditioning equipment procurement cost were based on a projected 10 year life for the tape recorders and a 15 year life for the counting accelerometer. Dedicated transducers outside the recorder enclosure and installation costs for L/ESS systems are amortized over a 3 year recording period. Equipment O &M (operating and maintenance) costs include normal repair and upkeep and include spare magazines for tape recorders. Data transmittal includes the time required for data retrieval from the aircraft including manhours by ground crews for completing required forms (but not including flight crew manhours), packaging and shipping costs.

The total data collection costs for the current L/ESS recording systems vary between $35 and $53 when compared on an operating flight hour basis.

The cost for the first counting accelerometer data collection was based on reading the counters after every flight. If monthly counter readings are sufficient, the counting accelerometer total data collection cost would be reduced to $1.82 per aircraft operating hour.

The system accuracies quoted are largely a function of the transducers used. Strain gage circuits, rate gyros, and position transducers are generally accurate to about 3 percent of full scale unless extremely expensive equipment is selected. Accelerometers and pressure transducers have accuracies of 1 percent of full scale or better. The resolution of the digital recorders is fixed by the output binary word size (usually 8 bits or 0.39 percent of full scale).

## 2.5 DATA PROCESSING METHODS

Processing of Air Force ASIP data is the responsibility of the ASIMIS office at Tinker Air Force Base, Oklahoma. The ASIP data processing system for each aircraft system is procured from a contractor by the ASD or ALC System Manager for eventual operation at ASIMIS. Most current operational systems have suffered early problems because ASIMIS was not provided the opportunity to review the processing system requirements prior to procurement. ASIMIS review will insure that the processing system is compatible with ASIMIS computer equipment and that the software contains those features which have proved successful during previous operation on other aircraft systems. This situation appears to have been corrected for some of those systems currently under procurement.

During the design and implementation of the processing system at ASIMIS, the contractor is required to demonstrate proper functioning of the systems by processing a sample of actual data. To adequately test all of the editing checks, it is necessary for the contractor to process a large sample of data, and to implement required improvements to the system logic, before the formal delivery of the software to ASIMIS. Since the initial recording system installations are quite often delayed for one reason or another, and the software is a scheduled delivery, there is a tendency to force software delivery without adequate testing. This generally results in the delivery of inefficient systems with deficient editing capability which requires rework by the contractor or by ASIMIS and causes additional delays in starting the processing of the ASIP data. It is generally desirable for the contractor to process data for one or two years before the system is transitioned to ASIMIS and then to provide consultation to ASIMIS for one or two years after transition. This allows the contractor time to measure and improve system efficiency and provides training for ASIMIS on the new system.

TABLE 2.17

DATA PROCESSING REQUIREMENTS

- FEEDBACK TO MAINTAIN/IMPROVE DATA QUALITY
- PROTECT FILE FROM ERRONEOUS ENTRIES
- PROVIDE INPUT FOR ROUTINE STRUCTURAL MAINTENANCE ANALYSIS
- MAINTAIN FILE FOR ANALYSIS OF FUTURE STRUCTURAL PROBLEMS
- PROVIDE HISTORICAL STRUCTURAL UTILIZATION DATA
- PROVIDE HISTORICAL LOADS FOR STRUCTURAL DESIGN CRITERIA

The requirements of an ASIP data processing system are listed in Table 2.17 . The two ASIP data collection programs, the individual aircraft tracking program and the loads/environmental spectra survey program, individually and collectively are designed to meet these requirements. The data processing systems can be divided into the following steps: data transcription, editing and feedback, and reduction and analysis. The following paragraphs discuss these steps in detail.

### 2.5.1 Data Transcription

Data transcription is that step which converts the raw input data from the field format to a computer compatible form. This step is performed by Air Force personnel at ASIMIS, at an ALC, or at an operational base depending on the particular system. Figure 2.53 illustrates the various data transcription methods in current use. Table 2.18 lists, by aircraft system, the data transcription method and organization.

All of the L/ESS tape recorders use special tape cassettes with high packing densities and special formats to increase tape capacity. Each type of cassette requires a special playback unit called a reformatter/transcriber (R/T) which reads the cassette tape, reformats the data in standard computer tape format, writes the data on a computer tape, and erases and records the cassette tape for reuse. The R/T units for the MXU-553A cassettes, the AN/ASH-28 (F-15) cassettes, and the A/A24U-10 (F-4) cassettes are located at Tinker Air Force Base, ASIMIS. The RT units for the MADAR (C-5) cassettes and the A/A24U-6 (F-111) cassettes are located at operational base to minimize shipping of cassettes and computer compatible tapes are sent to ASIMIS.

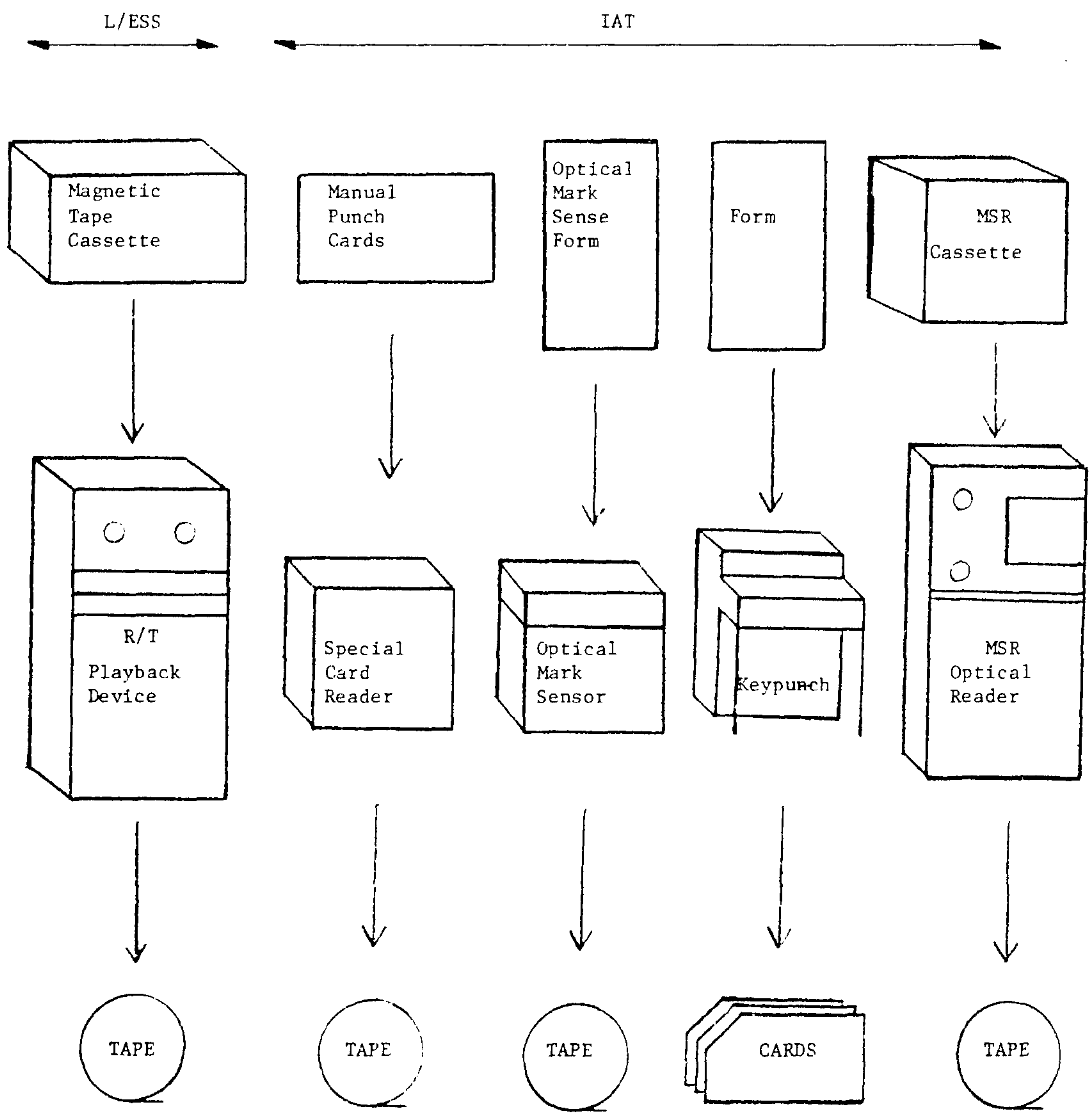



Figure 2.53 Data Transcription Methods.

TABLE 2.18

DATA TRANSCRIPTION METHODS AND ORGANIZATIONS

| System | ASIMIS | OC-ALC | SA-ALC | WR-ALC | Operational Base | Contractor |
|---|---|---|---|---|---|---|
| A-7 | | | | | | |
| A-10 | R/T | | | | | KP |
| A-37 | R/T, KP | | | | | |
| B-52 | | KP | | | | |
| C-5 | | | KP | | R/T | |
| C-130 | R/T | | | KP | | |
| C-135 | R/T | KP | | | | |
| C-141 | R/T | | | OMS | | |
| E-3A | R/T | | | | | KP |
| F-4 | R/T,KP | | | | | |
| F-5 E/F** | R/T | | KP | | | |
| F-15 | R/T,KP | | | OMS | | |
| F-16** | R/T,MSR | | | | | |
| F-111 | MP | | | | R/T, | |
| O-2A | | | | | | VGH* |
| T-37 | R/T | | | | | |
| T-38** | R/T | | | | | |
| T-39** | R/T | | | | | |
| T-43 | R/T | | KP | | | |

* An Oscillograph program conducted by the University of Dayton.

** Considering use of Mechanical Strain Recorder with transcription at ASIMIS.

F-100, F-105, F-106, OV-10, KC-10 Not included.

R/T = Reformatter/Transcriber for Recorder Tape Cassettes
KP = Keypunch
MP = Manual Punch Card Reader
OMS= Optical Mark Sensor
MSR = Mechanical Strain Recorder Optical Reader

SIDE 1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SIDE 2

TO FORM 495 APR 73 FLIGHT RECORDER SYSTEM DATA

| | TYPE AIRCRAFT | AIRCRAFT SERIAL NUMBER | BASE CODE | SQUADRON NUMBER | | DATE INSTALLED YR. MO. DAY | AIRFRAME HOURS | CARTRIDGE SER. NO. | RECORDER SER. NO. | MULTIPLXR SER. NO. | | ACCEL (N) SERIAL NO. | ACCEL (T) SERIAL NO. | TRANSDUCER SERIAL NO. | RATE GYRO SERIAL NO. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 31 32 | 33 34 35 36 37 | 38 39 40 41 | 42 43 44 45 | 46 47 48 49 | 50 51 52 53 54 55 56 57 58 59 60 | 61 62 63 64 | 65 66 67 68 | 69 70 71 72 | 73 74 75 76 | 77 78 79 80 |

**IMMEDIATE ATTENTION**
(COMPLETE AND RETURN)

| TYPE AIRCRAFT | | | | | | AIRCRAFT SERIAL NUMBER | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | | | | | | | | | | | | |

| CARTRIDGE SERIAL NO. | | | | RECORDER SERIAL NO. | | | | MULTIPLXR SERIAL NO. | | | | BLANK | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| | | | | | | | | | | | | | | | | | | | | | | |

| BASE CODE | | | | SQUADRON NUMBER | | | |
|---|---|---|---|---|---|---|---|
| 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| | | | | | | | |

| ACCEL (N) SERIAL NO. | | | | ACCEL (T) SERIAL NO. | | | | TRANSDUCER SERIAL NO. | | | | RATE GYRO SERIAL NO. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |
| | | | | | | | | | | | | | | | |

| DATE INSTALLED YR. | | MO. | | DAY | | AIRFRAME HOURS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| | | | | | | | | | | |

Figure 2.54 AFTO Form 495.

The means by which the individual tape cartridges are obtained by ASIMIS is provided by the Air Force part supply logistics system. When the cartridges are removed from the aircraft, they are exchanged for blank cartridges to be reinstalled in the recorders. The recorded tape cartridges are classified as "repairable parts" and are sent to ASIMIS at Tinker AFB for "repair". At ASIMIS the tapes are processed, erased, and put back into the supply system as "repaired parts".

This method of tape cartridge supply has its shortcomings, however, the most commom complaint being heard was that the recorded tapes are not put into the supply system immediately after removal sometimes for several days, or even weeks. The recorded cartridges apparently lie on a desk until a new supply of blank cartridges are needed, and then the recorded cartridges are turned in. The most serious consequence of this delay is that problems with the recording system are not detected until the data is processed at ASIMIS, and so a delay in processing the data results in a delay in detecting and repairing malfunctioning data channels.

Another problem which ASIMIS has had is properly identifying the data tapes as they come in for processing. Some of the aircraft have provisions for enough data available in the header information for complete identification; some do not. However, even when provisions for enough identification have been made, sometimes the data are erroneous or omitted. In order to provide a supplementary source of tape cartridge information, the AFTO 495 Form has been installed in the ASIP system. A sample of the AFTO 495 Form is shown in Figure 2.54. According to ASIMIS, the AFTO 495 form has helped them identify some data which would otherwise have been discarded.

Since the tape cartridge generated by the MXU-553/A Airborne Digital recorder is not compatible with standard digital computer systems, it must be reformatted and transcribed before processing. The Reformatter/Transcriber (R/T) consists of a

```
HEADER DATA? (Y OR N) Y
TAPE NUMBER? ØØ1Ø21
CARTRIDGE NUMBER? ØØØØ1
INSTALLATION DATE? ØØØØØØ
REMOVAL DATE? ØØØØØØ
TRANSCRIPTION DATE? 12Ø373
AIRCRAFT TAIL NUMBER? ØØØØ
AIRCRAFT TYPE? T-43
AIRCRAFT STATION? ØØØ
MULTIPLEXER TYPE? ECU-67/A
COMMENTS? TAXI TEST TAPE TO BE RUN--?-?

OUTPUT TAPE 7 OR 9 TRACK? 7

START PLAYBACK UNIT

INPUT FRAME TOTAL - Ø2219
OUTPUT BLOCK TOTAL - ØØ223
PARITY ERROR TOTAL - ØØ572
PARITY ERROR FRAME TOTAL - ØØØ47
WRITE ERROR TOTAL - ØØØØØ
RECORD LENGTH ERROR TOTAL - ØØØØØ
SHORT FRAME TOTAL - ØØØ49

SHORT FRAME LIST (FIRST TEN)
       ØØØØ1
       ØØØØ2
       ØØØØ3
       ØØØØ4
       ØØ989
       ØØ99Ø
       ØØ991
       Ø1ØØØ
       Ø1ØØ1
       Ø1Ø31
```

Figure 2.55 Sample Transcription Program Output.

mini-computer equipped with a tape deck to read the tape cartridge from the recorder, a teletype unit, and an output tape drive which writes a tape compatible with most computer systems. The teletype is used to initiate the R/T-stored processing program and to input various information to be included at the beginning of each tape processed.

Basically the function of the R/T is to play back the essentially gapless 1/2 inch, 9-track tape cartridge (actually, there is a one-byte gap every 2 seconds) tape from the MXU-553/A recorder and write a standard computer-compatible 1/2-inch tape containing interrecored gaps (3/4 inch) and an end-of-file mark recognizable to standard digital computer tape drives. The R/T is capable of writing either a standard 7-track or a standard 9-track tape, (800 bpi).

At the completion of processing by the R/T, a history of the transcription is printed on the teletype. This history includes a variety of information, most of which is self-explanatory. A typical output sheet is shown in Figure 2.55. The input block count is a count of the number of input tape records. The output block count is the number of physical records (the data contained between consecutive 3/4-inch interrecord gaps) on the reformatted tape. The input error count is the number of input tape records read which contain parity errors. These parity errors are the results of either a bad write by the recorder or a bad read by the reformatter. The output error count is the number of output physical records containing parity errors that were written by the R/T. It should be noted that these are detected by the R/T, since it immediately reads what it has written, but they are left uncorrected since the R/T cannot stop processing the input tape for the time required to backspace and rewrite the faulty record on the output tape.

Similar data transcription procedures are used for the AN/ASH-28, A/A24U-6, and MADAR recorder cassettes.

To transcribe IAT data from special forms (currently in use on the C-141 and F-15 IAT systems), Warner-Robbins ALC has acquired optical mark sensor equipment with checking and editing capability. This equipment automatically senses marks entered at specific locations on preprinted forms, assigns a specific parameter identification and value to each work, and writes the data on a computer tape. The device can check for missing or conflicting entries and provides a list of errors. Corrections can be made by preparing a corrected form with minimum identification and only the corrected entries which replaces the incorrect entries on the computer tape. This device saves the cost of keypunching and reduces keypunch errors.

All other forms utilized in IAT or L/ESS programs are transcribed to computer card form by a keypunch. The key-punching is performed by the contractor during the initial stages of the program and then the keypunching duties are assumed by the ALC where the System Manager is located except in the case of the F-4 where ASIMIS does the keypunching of the monthly counting accelerometer forms.

One other method of IAT data transcription is currently in the implementation phase for the MSR (mechanical strain recorder) data on the F-16 ASIP. An optical reader is being delivered to ASIMIS in mid-1978. This automatic reader will magnify the recorded scratch on the MSR tape, will advance the tape through the unit, will optically measure the time history of the scratch deflection, will detect and record the amplitudes of each peak and trough deflection, and will write the recorded values on a computer tape. Details on the operation of this unit will be discussed in the Task II report on this contract.

The data must be transmitted in its raw form from the collection site to the organization which performs the data transcription. In the case of inexpensive one-time data collection media, such as forms, this transmittal represents no problem. However, in the case of expensive reusable media such as A/A24U-10, MSR, and other cassettes, a considerable amount of resources are tied up in this supply pipeline. This is further complicated because shipping damage can be a major cause of cassette failure. These considerations have led the C-5 and F-111 systems to go to R/T units located at the bases and the F-4 system to use a portable intermediate tape copier which copies the cassette tape image onto an inexpensive small tape which is mailed back to ASIMIS for input to the R/T.

2.5.2 Editing and Feedback

As mentioned above, the primary objectives of this step of the ASIP data processing, are to protect the data file from errors and to provide feedback to the field to improve data quality.

For the L/ESS program, the elimination of data errors is a complex task because most, if not all, input data tapes have errors or anomalies, which, if allowed to pass into the processing and analysis, would destroy the data files or cause abnormal software run termination. Recorder write errors, as evidenced by tape party errors, are eliminated and counted by the R/T unit. If the parity error count is a large percentage of the total tape records, the remaining data may not adequately represent the usage and the entire tape is eliminated. Occasional intermittent errors, such as spikes to zero on full scale, are replaced by assuming a linear change in value during the replaced period of time. For each aircraft system, some of the L/ESS parameters are not considered critical for the analysis and, if errors are encountered in the data for these parameters, the data is processed without the erroneous non-critical parameters.

Extensive errors in a critical parameter causes the entire flight or data tape to be excluded from further processing. Any data error which appears to be the result of malfunctioning recording equipment or improper data collection procedures is reported to the field via the system manager so that corrective action can be taken.

For the MXU-553A data, ASMIS has a standardized RECAP (Recorder Analysis Program) program which performs fault isolation and prints a fault summary for each cassette on microfiche for use by the ASIP OPR in maintaining the recorder equipment. ASIMIS processes each cassette through the RECAP and sends the output to the ASIP OPR within 48 hours after receipt of the cassette. The ASIP OPR reviews the RECAP output and determines whether any corrective action is needed. Factors which affect his determination include: 1) Is the malfunctioning channel actually critical for the data analysis?; 2) Is replacement hardware available?; 3) Is the planned corrective action likely to be effective?; and 4) Is there an impending structural problem which places a priority on the ASIP data collection effort?

Most ASIP systems also have a separate editing program which has specialized parameter checks and which may perform some preliminary data reduction. For example, it could include the derivation of angular acceleration time histories from the recorded angular rates and the compression of the recorded data to eliminate up to 95 percent of the recorded parameter values found to be uninteresting from a structural analysis standpoint. The output of this program may allow subsequent manual intervention such as the deletion of an erroneous data channel or an entire flight with useless data so the remainder of the tape may be processed.

The objective of data time history compression is to compress the data to a fraction of its original volume with no significant qualitative loss. This is desirable primarily to facilitate storing of data tapes for future processing, particularly of time history data. As many as 252 flight tapes a month could be received from the C-141 alone. Reducing the volume of tapes to be stored is then the primary objective of this effort. A secondary benefit results from the fact that once the data has been unpacked, checked, compressed and reordered, it is then in a form that can be processed through the data program more efficiently.

A typical example of the data compression is that used for the C-141 where each data channel is compressed using a "moving window" method which discards all parameter samples which do not differ from the previous stored sample by more than a predetermined "window".

The data is then grouped by channel and stored for processing by the data reduction program. At the completion of processing, the compressed tables are written on a magnetic tape in a packed form. The resultant tape is the compressed time history data by flight. An example of the data compression realized as a function of the relative activity of all the data is shown in Figure 2.56. Because the time counter values, which indicates the amount of time between the compressed time history samples, must be included with each sample, the data compression operation could conceivably increase the data volume if the active data exceeds 60 percent of the total as shown in Figure 2.56. Fortunately, experience has shown that compression ratios are usually more than 5:1.

### 2.5.3 Data Reduction and Analysis

This section describes, in general, those steps required to determine life remaining and to schedule inspections and maintenance actions from the edited data tapes. A more detailed treatment of the analysis procedures is included in Sections 2.1 and 2.2.

The data reduction and analysis includes those data processing operations which start with the edited recorded data and proceed through the calculation of load cycles, the calculation of stress cycles at structural control points, and the calculation of the rate of life expenditure for critical structural components. This analysis is directed toward the development of the data base for fleet life and maintenance requirement projections and individual aircraft life and maintenance requirement projections from recorded usage tracking data.

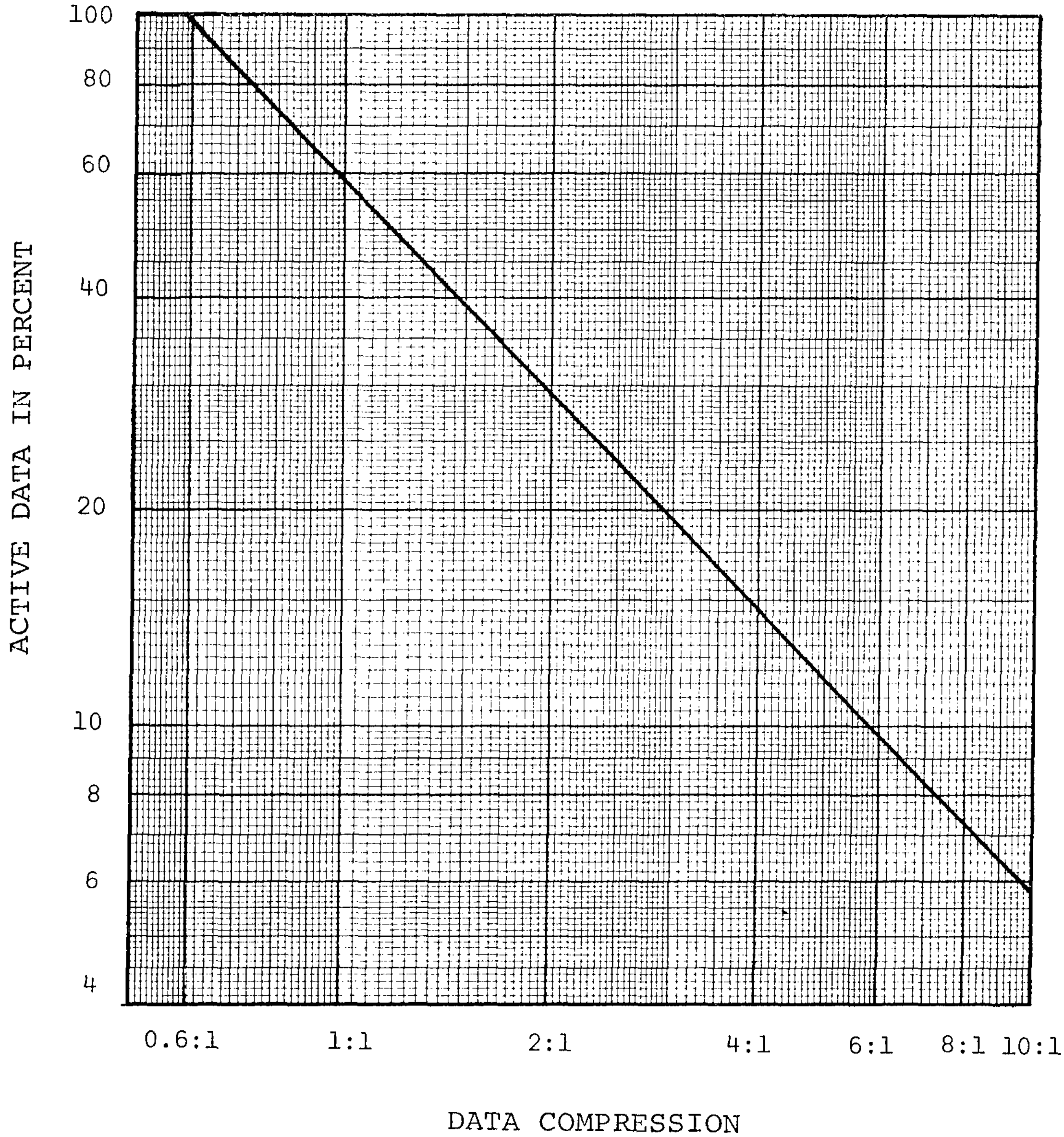



Figure 2.56 Estimated Data Compression.

#### 2.5.3.1 L/ESS Systems

Because of the variations from system to system in those usage factors and structural design details which affect life and because the L/ESS software is purchased as part of the total aircraft system procurement, there is little or no commonality in data reduction and analysis methods. Some systems completely separate the data reduction from the analysis function while other systems combine them into a single set of software. Some systems have the data reduction and analysis performed by ASIMIS, some systems have both tasks performed by the airframe contractor, and many systems divide the two tasks with ASIMIS doing the data reduction and the contractor doing the analysis.

Data reduction is normally performed by selecting from the recorded data specific time slices which are known to contain a peak or trough of a load because one of the key recorded parameters had a peak or trough at that time. Then the value of load is calculated at the selected time slices. An alternate approach consists of calculating a time history of load values during all periods of activity and then selecting the load peaks and troughs from the time history. This alternate approach is used where no key recorded parameter is considered to be an adequate indicator of the load peaks and troughs. The alternate approach has a much higher computational cost.

The load peak and trough occurrences are identified by mission and flight condition parameters so that the load environment can be projected from the anticipated mission data. During a later parametric analysis, the load spectrum is formed for each combination of mission and flight condition parameter values as a function of total time spent in that condition or the number of occurrences of that condition (for landings, pressurizations, etc).

Data reduction includes other operations such as the conversion of the recorded digital data to decimal values of engineering units. Depending on the location of the accelerometers in the aircraft and the magnitude of the angular motion, it may be necessary to correct the recorded accelerations to the aircraft center-of-gravity using rigid body equations of motion.

An alternate use of the L/ESS data is to define aircraft usage by mission type for incorporation into design criteria. This requiement has been ignored in the design of L/ESS software systems. However, the software should be designed to provide an output data tape, following all data editing operations, which can be used as input to a design criteria processing system. ASIMIS, with support from the Aeronautical Systems Division, should provide a standardized output product for use in developing design criteria. This product should be a tape of recorded data, compressed to eliminate inactive data and edited to eliminate data errors and flights with invalid data.

Another approach to collection of design criteria data would be to provide an independent instrumentation and recording system for installation on a smaller percentage of the aircraft. The advantage of an independent design criteria recording system is that it could be designed to record a standard set of parameters without inhibiting the L/ESS parameter selection and the software for reducing this data could be standardized without placing restrictions on the L/ESS software systems or on ASIMIS.

2.5.3.2 IAT Systems

The IAT data reduction consists primarily of the formation of a data base including usage information and projected life and inspection schedules for individual aircraft and their tracked components. These data bases are designed for access by authorized individuals via telecommunications network.

During the data reduction, recorded usage data is transformed into an estimate of minimum time to critical crack length. As described in Section 2.1, there are several variations of this transformation process. In the case of forms data, the time spent in various flight profile categories is converted to a corresponding load or stress history by a parametric analysis. When a load factor or a strain time history is recorded, it is generally necessary to transfer the recorded data to stresses at a critical structural location. The time to critical crack length is computed using the stress history and the initial crack length which is assumed for a new part and then updated for each period of use. The crack length may be reset following an inspection or a repair action.

The analysis portion of the IAT system determines, from the projected time to critical or detectable crack length, what inspection or maintenance actions should be scheduled for each individual aircraft.

### 2.5.4 Estimated Cost of Current Data Processing Systems

Table 2.19 estimates the cost of the data processing and analysis for the current recording systems. All costs have been normalized to dollars per operating hour for the monitored aircraft. It was assumed that invalid data has to be transcribed but is not reduced or analyzed. The cost data was estimated from the resources used during existing programs but was then adjusted to a typical fighter fleet of 750 aircraft flying 400 hours per year or a typical transport fleet of 500 aircraft flying 800 hours per year. The L/ESS sample is assumed to be 10% of the fleet. L/ESS data processing setups costs were amortized over a three-year data sample.

In some cases, the Table 2.19 data reflects the peculiarities of current system methodology. The elaborate data reduction and analysis methods used for the F-111 drives the costs of the A/A34U-6 to a relatively high value when compared to the MXU-553/A systems.

A comparison of the costs of the current L/ESS systems on a hourly basis indicates that the yield of the system in terms of percentage of useful data is the major cost driver.

TABLE 2.19

CURRENT DATA PROCESSING SYSTEM COSTS

| | L/ESS SYSTEMS | | | | | | IAT SYSTEMS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Multichannel Tape | | | | | | | | | |
| Parameter | MXU-553 (A/F/T) | MXU-553 (T/B) | AN/ASH-28 | A/A24U-6 | MADAR | VGH A/A24U-10 | Counting Accelerometer Flt x Flt | Counting Accelerometer Monthly | Forms Keypunch | Forms OP-SCAN |
| DATA SAMPLE: | | | | | | | | | | |
| Input Unit | Cassette | | | | | | Form | | | |
| Units Per Mo. | 167 | 222 | 100 | 100 | 100 | 133 | 12,500 | 760 | 11,000 | 11,000 |
| Hours Per Unit | 15 | 15 | 25 | 25 | 25 | 25 | 2 | 33 | 3 | 3 |
| % Usable Data | 20-30% | 30-40% | 40 | 25% | 25% | 40% | 85% | 85% | 90% | 90% |
| Costs (Per A/C Operating Hr)* | | | | | | | | | | |
| System Setup ** | $3.89 | $2.92 | $3.89 | $2.28 | | $2.22 | $0.17 | $0.17 | $0.13 | $0.13 |
| Transcription | 4.00 | 4.00 | 4.00 | 5.00 | | 0.40 | 0.20 | 0.01 | 1.25 | 0.84 |
| Reduction | 13.00 | 17.50 | 19.52 | 8.67 | | 9.36 | 0.23 | 0.07 | 0.04 | 0.04 |
| Analysis | 3.75 | 3.00 | 4.80 | 66.67 | | 11.67 | 1.67 | 0.83 | 0.70 | 0.70 |
| Total Processing* | $24.64 | $27.42 | $32.21 | $82.62 | *** | $13.65 | $2.26 | $1.08 | $2.12 | $1.71 |

* All costs based on hours flown by instrumented aircraft.
** Assumes major setup revision required every 3 years.
*** Information not obtained.

## SECTION III
## SYSTEMS/COORDINATED FORCE MANAGEMENT

Coordinated force management addresses such items as the compatibility of the FSM, IAT, and L/ESS programs, the organizational interfaces for the Force Management program, and needs for the data for future aircraft design. Under Air Force Regulation 80-13, each of the participating commands (AFSC, AFLC, and operating commands) is assigned specific responsibilities in accomplishing the Force Management tasks of MIL-STD-1530A. AFSC responsibilities include the development of advanced data acquisition, reduction, and analysis techniques for structural data collection programs. Operation of the structural data collection and analysis efforts is under the responsibility of AFLC. AFLC also has responsibility for scheduling and accomplishing force structural maintenance actions. Operating command responsibilities include operation and maintenance of recording system hardware and acquisition of operational usage data. With changes in data systems, data output requirements, and analysis methods occurring continually as the state-of-the-art is advanced, the relationships of many elements including contractor involvement must be considered to produce the best system at a given stage of the aircraft life cycle.

### 3.1 ORGANIZATIONAL INTERFACES

The purpose of the force management program is to accomplish those actions necessary during force operations to ensure the damage tolerance and durability of each airplane. A continuing problem in force management IAT, L/ESS, and FSM interfacing is that the systems tend to operate independently unless a central organization brings them together. Table 3.1 shows some of the organizations involved. The ASIP Manager (OPR) has this responsibility, but the system management moves from ASD

TABLE 3.1

FORCE MANAGEMENT ORGANIZATIONS

| AIRCRAFT | MANUFACTURER | A.L.C. | SPO | PDM BASES |
|---|---|---|---|---|
| A-7D | Vought | *Oklahoma City | ASD | Oklahoma City |
| A-10 | *Fairchild-Republic | Sacramento | *ASD | Sacramento |
| A-37B | Cessna | *San Antonio | -- | -- |
| B-52 | *Boeing-Wichita | *Oklahoma City | -- | Oklahoma City Hayes |
| C-5A | *Lockheed-GA. Co. | *San Antonio | ASD | San Antonio |
| C-9 | McDonnell-Douglas | San Antonio | -- | -- |
| C-130 | Lockheed-GA. Co. | *Warner Robins | Gunship Only | Warner Robins Aero. Corp., Hayes |
| C-140 | Lockheed-GA. Co. | Warner Robins | -- | Warner Robins |
| C-141 | *Lockheed-GA. Co. | *Warner Robins | -- | Warner Robins |
| C/KC -135 | *Boeing-Wichita | *Oklahoma City | -- | -- |
| E-3A | *Boeing-Seattle | Oklahoma City | *ESD,ASD | -- |
| F-4 | *McDonnell | *Ogden | -- | Ogden |
| F-5E/F | *Northrop | *San Antonio | *ASD | -- |
| F-15 | *McDonnell | Warner Robins | *ASD | Warner Robins |
| F-16 | *General Dynamics | Ogden | *ASD | Ogden |
| F-100 | Rockwell | *Sacramento | -- | Sacramento |
| F-105 | Fairchild-Republic | *Sacramento | -- | Sacramento |
| F-111 | *General Dynamics | *Sacramento | -- | Sacramento |
| FB-111A | *General Dynamics | *Sacramento | -- | Sacramento |
| KC-10A | *McDonnell-Douglas | | *ALD | -- |
| T-37 | Cessna | *San Antonio | -- | -- |
| T-38 | *Northrop | *San Antonio | -- | -- |
| T-39 | Rockwell | Sacramento | -- | -- |
| T-43 | Boeing-Seattle | *San Antonio | -- | United Airlines |

* On-going ASIP Activities

NOTE: In addition to the listed organizations, ASIP has on-going activities on all systems.

to AFLC as the aircraft transitions from the design and development phase to service operations. Personnel changes at ALC's and in the using commands make it difficult to maintain the continuing complex interfacing between the force management systems, (IAT, L/ESS, FSM). In addition, the limited number of ALC personnel normally have more direct operational activities which take priority. Finally, the force management systems are continually changing due to changes in aircraft utilization and operational goals and updates of the systems.

### 3.1.1 AFWAL Tasks

Certain ASIP tasks are assigned by AFR 80-13 to the Air Force Wright Aeronautical Laboratories (AFWAL). AFWAL responsibilities include the development of improved recorder systems and equipment, advanced data reduction and analysis techniques, and design criteria and airframe safety and durability methods for future aircraft.

New recording systems should be developed independently from any specific aircraft system so that adequate testing and qualification steps can be planned and executed before application of the new instrumentation to an operational aircraft.

Advanced data reduction and analysis techniques have been developed by the Flight Dynamics Laboratory within AFWAL in collaboration with ASD engineers and airframe contractors.

Structural design criteria are continually updated to reflect current aircraft operating experience. This requires that AFWAL have access to operational data in a useful form. At the present time, very little L/ESS data is being processed to a form suitable for criteria. This problem can be alleviated by requiring the L/ESS software for each system to produce a specific design criteria product or by providing separate design criteria recorders for independent criteria data collection programs.

### 3.1.2 ASD Tasks

AFR 80-13 Paragraph 12 specifies AFSC responsibilities in ASIP programs. The design, development, test verification, and initial force management data package (Tasks I-IVa) are managed and funded by ASD. The entire Aircraft Structural Integrity Program (ASIP) is AFSC responsibility until program management is transferred to AFLC, and ASIP assistance to AFLC is provided thereafter. AFSC also is responsible for the maintenance and revision of MIL-STD-1530 and its referenced military specifications, the development and installation of L/ESS recorders; the development of advanced techniques for handling and evaluating operational and fleet experience data, and the development of structural design criteria and analysis/verification methods.

Obviously, requirements and decisions made by ASD impact both the cost and complexity of a new weapons system and the cost and complexity of the force management operations of that system. With the wide variety of weapons systems involved and the years-long, staggered life cycles, it is inevitable that there will be differences in the ASD activities for different systems. For all systems development having Contractor involvement, ASD has the contractual funding and management functions. The depth of the system requirements activity and technical direction or monitoring will vary, however, depending on the complexity of the system, the experience of the Contractor and the ASD personnel, and the interfacing considered necessary to assure an effective product. In general, active involvement of ASD personnel in the ongoing development of the system, coupled with sufficient flexibility of contract provisions to permit cost-effective tradeoffs and schedule adjustments when necessary, are considered to produce the most desirable overall system.

ASD responsibilities include providing the operational manuals for the weapons systems being developed. The structural maintenance requirements and procedures are included in these manuals. These manuals are generally produced by the Contractor as part of the developmental contract. Subsequent revisions are accomplished by contracts from the Air Logistics Center, or organically by the ALC.

### 3.1.3 AFLC Tasks

For a given weapons system, the primary function of AFLC is to provide support to the using commands which will produce safe, cost-effective operational readiness of the system. This includes scheduling and accomplishing force structural maintenance actions, and specifying maintenance and data acquisition actions to be performed by the using commands. Responsibilities of AFLC, delineated in Paragraphs 13 and 14 of AFR 80-13, include the appointment of an ASIP Manager for each aircraft system for which program management responsibility has been transferred from AFSC. The ASIP manager updates the ASIP Master Plan yearly, obtains concurrence from participating commands, and budgets for, funds, and implements the approved ASIP. AFLC also establishes and operates the Aircraft Structural Integrity Management Inforation System (ASIMIS), and updates the Technical Orders for the aircraft system. The effectiveness of the IAT, L/ESS, and FSM programs and dissemenation of information from these programs are the responsibility of AFLC. AFLC obtains assistance from the manufacturer for some of the ASIP tasks.

The newly formed Air Force Acquisition Logistics Division (ALD) of AFLC is involved in assuring on-the-line availability of aircraft through initial design features as well as addressing the adequacy of spares, support equipment, and technical data in the field. The ALD accent on design for PRAM-Productivity Reliability, Availability, and Maintainability-emphasizes the need for ASD, AFLC, and using command interfacing to see that all ASIP objectives are met. ASD is tasked with new aircraft development; therefore, ASD as well as AFLC has an interest in obtaining and properly using field data.

### 3.1.4 Contractor Involvement

The Force Management data package, Task IV of MIL-STD-1530A, is produced by the Contractor and serves as the initial data base for force management (Task V) activities. The data package uses the results of the design, analysis, and test activities of Tasks I-III. There is also contractor involvement in Task V. Detail tasks and data items are as specified in the contracts, and vary from one airplane to another. Contracts are initially with the AFSC Systems Project Office (SPO/ASD) for development of each weapons system. Following transition, contracts are generally with individual Air Logistics Centers. The activities through Task IV are fairly uniform for various aircraft. Activities of Task V are more diverse due to work still in process at transition; service problems encountered in force operations; and changes in IAT, L/ESS, and FSM technology which impact different aircraft at different stages of the life cycle. Also, Task IV updates must be performed at intervals after transition, and the actions are more diverse due to the different needs and organizations involved.

Contractor tasks associated with force management implementation are dependent on the terms of the contract and the state-of-the-art methods employed at the time the tasks are performed. In general, the requirements of the initial design and development contract are specified by the procuring agency (ASD) and then changes are worked out between the procuring agency and the Contractor as the contract is finalized. Changes generally relate to specifying details of the test program and content of data items. When a later contract extends a procurement program already in effect, such as the purchase of additional aircraft, decisions are necessary regarding the procurement of the new aircraft under former Military Specification requirements or under updated, revised specifications. In most cases, the "hardware" is considered fixed in such cases as the "software" analysis and reports are considered to be in transition. The existing analyses are updated and new analyses to revised specifications are performed, resulting in a dual effort and output in order to address the intent of the new specifications without losing the data base and "history" which have been obtained under former requirements.

At the present time, this transition status of the Force Management Program is apparent in a number of the aircraft, as evidenced by the work in process (Table 3.1). The existing data base is normally maintained while the inclusion of new technology is being effected. The ASIP Office of Primary Responsibility (OPR) determines the extent of desired contractor involvement to support the MIL-STD-1530A Task V Force Management Program.

## 3.2 ANALYSIS DATA INTERFACES

The USAF Aircraft Structural Integrity Program (ASIP) is a "cradle-to-grave" endeavor to provide structural safety and desired operational life at minimum overall cost. Current USAF aircraft were developed at various stages of the development of the USAF ASIP program, some in the time preceding MIL-STD-1530 dated 1 September 1972. All of these aircraft (with the exception of the F-16) were developed prior to the requirements of MIL-STD-1530A dated 11 December 1975, MIL-A-83444 dated 2 July 1974, and the MIL-A-8860B series revisions dated 22 August 1975 which incorporate durability and damage tolerance analyses and tests based on crack growth or fracture mechanics methodology. For example, the C-130A was designed and tested to 1955-R-1803 series specifications; the C-130B and E to MIL-S-5700 series; the C-141A to 1960 MIL-A-8860 series; and the C-5A to the MIL-A-8860 series with recognition of the pending (1971) revision. However, these aircraft were designed and tested to "fail-safe" damage tolerance requirements, providing a significant degree of damage tolerance not required by the Military Specifications at that time.

As updated USAF requirements have been received, the ASIP for each aircraft series has been reviewed to determine elements for which updating is appropriate. In general, the program activities have kept pace or even preceded the updated requirements. Thus, the ASIP's have accomplished the intent of the updated USAF requirements on an ongoing basis.

The most recent update of the USAF military requirements has been a significant exception to the above, however. Limited crack growth studies were in process for several in-service aircraft prior to the issurance of the 1974-1975 series MIL specifications, but the use of crack growth methodology in the ongoing programs was still in the developmental stage when the MIL Spec revisions became effective.

The new Military Specification requirements are a radical departure from earlier requirements. Therefore, Durability and Damage Tolerance Assessments (DADTA) are being performed or are planned to update the existing programs in the light of the new MIL Specs. The objectives of the Durability and Damage Tolerance Assessment are to define inspection and maintenance/retrofit/ replacement requirements for safe operations, and options for the desired durability or, alternatively, to estimate an 'indicated' economic limit for the aircraft. The estimate of economic life is

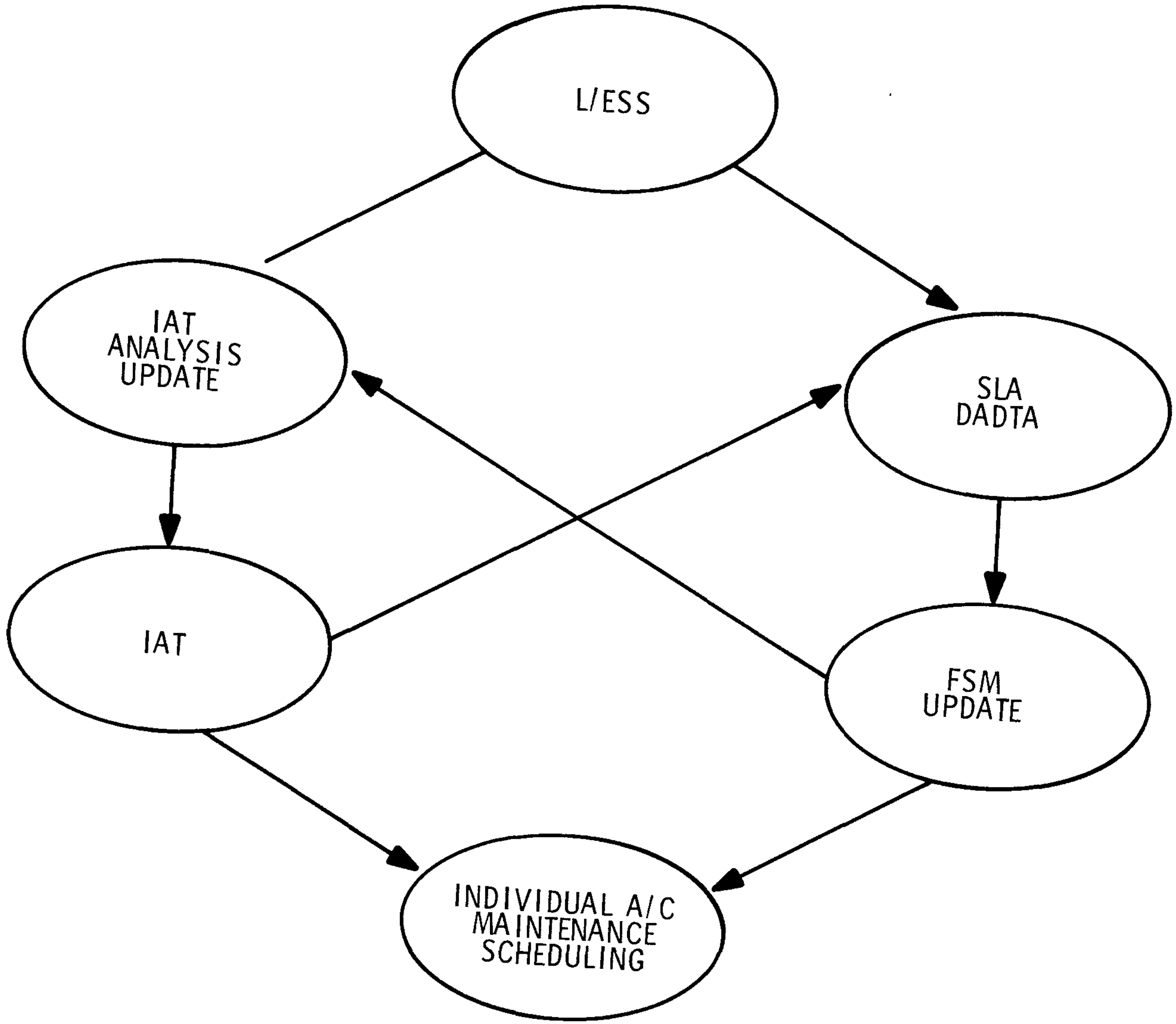



Figure 3.1 Force Management Methods and DADTA Interface.

not well defined technically for the principal reason of what is defined as 'economic'; therefore, the analytic indicator is usually structured to specific criteria for a given airframe.

The Durability and Damage Tolerance Assessments are based on "typical" usage of the aircraft. Sensitivity analyses are included in the DADTA to evaluate the effects of using individual aircraft in non-typical manner such as 100% in training or 100% logistics usage. However, implementation of the results of the assessment into service aircraft actions is covered by follow-on programs. For example, updating of the C-141 IAT, L/ESS, and FSM programs to implement the results of the C-141A DADTA are now in planning or beginning stages.

### 3.2.1 Interface Between Data Elements

Figure 3.1 illustrates the interface between the various force management data elements during the operational phase of the aircraft life. The L/ESS program is designed to feed operational stress spectra into the update of the tracking analysis and into periodic Service Life Analyses (SLA) and durability and damage tolerance assessments (DADTA). These updated analyses then feed the IAT program and are used to generate an updated Force Structural Maintenance (FSM) plan. The IAT and FSM plan then provide individual aircraft inspection and modification scheduling. The average usage and variability in the IAT data must be considered in the SLA and DADTA. The FSM critical areas and defect size limits must be considered in the development of the IAT analysis.

The major problem in interfacing the various force management data elements is the timing. The L/ESS design must be completed for instrumentation of the first production airplanes but the design must be compatible with the IAT and FSM plan which tend to develop later. The timing of the L/ESS data flow and the analyses updates is unclear and is generally left to the initiative of the system manager. Generally, the update of the analyses is performed by the airframe contractor under contract to the system manager.

### 3.2.2 Interface with the ASIMIS ASIP Data System

The ASIMIS ASIP data system is primarily concerned with providing computer data reduction capability for the L/ESS programs and the IAT programs. Following transition to AFLC, the managing Air Logistics Center (ALC) assumes the responsibility of force management feedback and the operation of the L/ESS and IAT programs. In general, the ALC is responsible for collecting the crew log forms and transmitting this information to ASIMIS at Oklahoma City Air Logistics Center (OC/ALC). The tracking programs were generally developed and operated for a short while at the manufacturer's facility and then transferred to the ALC and ASIMIS for in-house operation. ASIMIS Processes the tracking data thereafter, prints the reports, and transmits the reports back to the ALC.

The multichannel L/ESS hardware was generally furnished and installed by the Air Force while the data reduction methodology and software were developed by the manufacturer. The individual tape cassettes are removed from each recorder aircraft as they become filled with data and are transported directly to OC/ALC through the Air Force supply logistics system. The ALC does not act as an intermediary with L/ESS data as it does with the IASLMP data. At OC/ALC the L/ESS data are edited, processed, and reports are produced and transmitted to the ALC.

At the present time there are no general procedures, computer software modules, or whatever, which are interfaced at OC/ALC for an IAT or L/ESS. There does, however, exist a reformatter/transcriber for the C-130/C-141 LHRP to reformat cassette tapes to computer tapes. A general tracking program which is to be developed around the modular concept is in the planning stages presently but it will be several years before this program is operational. For the next few years, then, it seems likely that each IAT or L/ESS for a force of aircraft will be developed individually for each aircraft model with most of the interfacing related only to being compatible with computer facilities at ASIMIS.

### 3.2.3 Interface With the Technical Order System

The Air Force T.O. system, as previously defined, is the official tool for force management implementation and update. Initial contractor requirements usually include generation of the basic T.O. manuals as a part of the aircraft design/ development contract. In addition, results from ongoing structural test or analysis programs (also foreign/commercial aircraft data, where available) are used to generate recommendations regarding update of existing requirements. The role of the contractor in providing input to this process is primarily a function of its contractual involvement with the aircraft system manager (AFSC or AFLC) at the time, and is secondary to USAF. Responsibility for acceptance or rejection of recommended actions lies with the Air Force System Management.

### 3.2.4 Interface With the AFM 66-1 System

Air Force Regulation 66-14 contains an outline of general maintenance program objectives, concepts, policies and responsibilities. The AFM 66-1 maintenance data recording system implements the provisions of AFR 66-14 which pertain to organizational and intermediate level maintenance operations. AFM 66-1 is based on "centralized management of standard maintenance operations" and sets up detailed chains of command for Air Force FSM program implementation. From the contractor's point of view, the prime function of the AFM 66-1 system is to provide a standardized data bank which contains results from field and depot level maintenance activities. This is accomplished through the use of the T.O. -06 work unit codes, which are used to identify the location, type and disposition of structural defects. This information in combination with IAT results, is intended to provide a feedback mechanism for determining the effectiveness of defined FSM operations. In practice, however, the AFM 66-1 system is used by the Air Force as a qualitative problem indicator for base-level maintenance activity, and its output is often inadequate or inaccurate, due to vague or generalized location codes or faulty record keeping. This feedback loop is an integral part of productive FSM programs, and the whole force management program is affected by the lack of complete, accurate structural data.

## 3.3 LESSONS LEARNED

### 3.3.1 Hardware/Procedure Development

The existing tracking programs are providing the Air Force with analytical cumulative damage indices for use in force management operations. These indices reflect changes in utilization severity of each service aircraft and provide an 'indicator' for establishing force inspection times for safe operations. The Air Force is much more concerned about systems and engine reliability than they are about airframe structural reliability where they are having relatively few problems. Thus, with few problems, airframe structural programs are given low priority,and low percentage data return for the IAT and L/ESS programs is not likely to improve. Future IAT programs will need to investigate means to improve the data return from force operations.

In the ideal situation, such as described in paragraph 5.4.5.2 of MIL-STD-1530A, the individual aircraft tracking recording system selected is one that is as simple as possible to support the tracking analysis method developed by the contractor. In theory this would have been the correct sequence in establishing the most efficient method of tracking. However, in almost every case of aircraft tracking development, the tracking methods and onboard instrumentation have been designated and sometimes even gathering operational data long before the required fatigue/durability/damage tolerance analyses have begun. Without knowing the critical structural locations nor even how damage is going to be tracked at these points, it is improbable that the optimum flight measurements or collection procedures were chosen.

This "cart-before-the-horse" has indeed been the situation for both old and new USAF aircraft. Cases in point are:

o The F-4 and A-7 aircraft came to the Air Force ASIP with counting accelerometers already installed with data being gathered monthly. The tracking programs were developed at a later time around these constraints.

o The F-15 has counting accelerometers which are read after each flight and reported with post flight form data such as mission codes, weights, stores, landings, times, etc. Plans have just begun to develop a tracking program based on crack growth.

o The F-16 will have one MSR installed on every production aircraft. At the time of this decision, however, the tracking method had not been developed and analyses showing that damage at the monitoring location can be transferred to all other locations had not been completed.

In like manner, the choice of the L/ESS recording equipment and the parameters to be measured are generally chosen long before the contractor's analysis has determined what would be the optimum. In most cases, the decision has been to record "everything" with the hope that the methods to be developed will have enough to work with. With these parameters available, the analysis method has been tuned to require use of all of them, resulting in a much too complicated collection, reduction, and analysis program.

In conclusion, the IAT and L/ESS have to be developed and implemented as a coordinated system so as to be optimum.

### 3.3.2 Data Reduction Procedures

Another lesson learned is that left to themselves and ASD, without good coordination with ALC and ASIMIS, the airframe contractor may devise data collection, reduction, and analysis methods for IAT and L/ESS that are too time consuming, costly, and complicated for the level of technical sophistication required for planning maintenance actions. As one example, it presently requires about five times the man hours to sustain the F-111 IAT and L/ESS program compared to that of the F-4. This inequity is compounded by the fact that there are approximately five times as many F-4's as there are F-111's. Also, the damage method used by the F-111 is based upon fatigue accumulation with its scatter factor, to cover "unknown variances" of four where the assumed crack growth method is technically more accurate for scheduling maintenance actions.

Most of the current data processing software was procured from the airframe contractor without prior review by ASIMIS. This has, in some cases resulted in the following problems:

a) Inadequate editing checks. Edit programs pass gross errors which are not detected before the major part of the processing is completed.

b) Too severe editing checks. Edit programs will not pass as much as 60 percent of the data which must then be manually edited before further processing.

c) Special equipment requirements. Some programs require equipment which is unavailable at ASIMIS.

d) Inefficient data flow. Some software systems schedule edit checks too late in the processing so that the correction of errors requires rerunning all of the software steps. Some programs require too many normal operations late in the data flow.

e) Inflexible data flow. Many systems have little or no error correction capability at a late stage so that an error in a single entry of the data file may require reprocessing of the entire file.

Improved software systems require the use of qualified data base management programmers for software development.

Data yield can be improved by more direct communications between ASIMIS and the operating units. This would result in more accurate description of problems and would reduce the time between equipment malfunction anc correction. In addition, field test equipment should be deployed at field level to improve the diagnostic capability for the recorder equipment.

Since structural technology is changing rapidly, any analytical system must retain the basic usage data (segment data and segment sequence) because it is very likely that any calculations will have to be revised a time or two in the future due to technology updates. Such major areas as retardation and relaxation between flight, and what type of ground-air-ground or transition cycle to use are yet to be resolved. Programs investigating these areas could require several years to complete.

The past and present history data of the individual aircraft monitoring programs generally do not include specific flight sequence and other data presently considered necessary for crack growth tracking. Therefore, reconstruction of the effects of operations to date must fill in this information in some analytical manner.

### 3.3.3 Structural Engineering/Maintenance Interface

The last observation concerns the interface between the IAT program and the force structural maintenance scheduling as indicated in Figure 3.2. A good, working relationship has not yet been achieved. The maintenance engineers do not know how to effectively use the available IAT data in their scheduling function. In some cases the IAT information has no impact on FSM. Conversely, part of the problem is that the structural engineers developing the methods of FSM do not fully understand the maintenance scheduling and reporting procedures. The result is that the system manager may end up with a set of IAT output which is incompatible with the aircraft structural maintenance program.

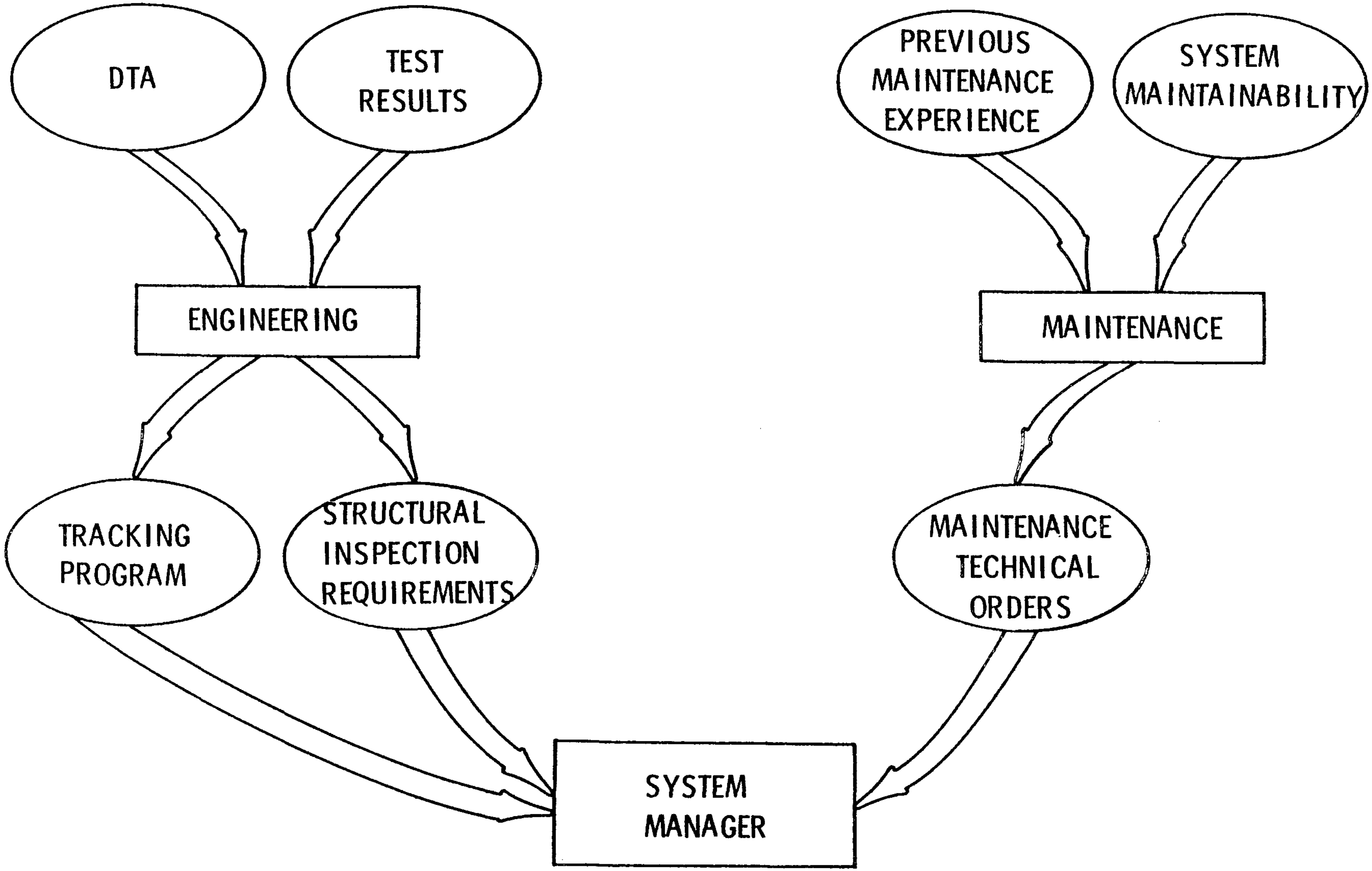



Figure 3.2 Engineering/Maintenance Interface.

### 3.3.4 Standardization

During the program, many of the organizations contacted complained of a lack of standardization of some of the more basic procedures.

The using commands have been assaulted by a barrage of system peculiar forms. Consideration should be given to developing a few standard forms to be used by all systems. This would reduce form inventories and training requirements.

Although a Technical Order number (T.O.-38) has been assigned to ASIP, only one system (the T-39) is currently using this designation. The other systems have the ASIP procedures scattered through the Technical Order system so a potential user may have to go to several technical order indices before he can locate the appropriate procedures. Other systems should convert to the T.O.-38 designation for ASIP manuals.

The reporting of data yield for various systems and instrumentation systems is misleading because of a lack of standards. Some systems report valid data as a percentage of total hours flown by the instrumented aircraft; other systems report valid data as a percentage of total hours processed through the ASIMIS reformatter/transcriber unit. The definition of valid or "usable" data varies from some systems which require only valid airspeed and altitude data to other systems which require nearly all parameters to have valid data. This almost eliminates the value of any comparisons of data yield between systems. Some standard equipment and data reliability parameters should be defined to measure the effectiveness of the data collection programs.

Standardization of data reduction techniques and software appears to have some advantages but will be impeded by the expense of reworking existing software to the extent that the standardization may not be cost effective for some systems.

## SECTION IV

## CRITERIA FOR SELECTION OF RECOMMENDED METHODS

The purpose of this section is to establish the basis for selecting recommended state-of-the-art force management methods that should be included in a force management handbook.

The selection criteria are discussed in the following paragraphs roughly in order of their significance. The reader will find that these criteria will correspond to the selection process of force management methods for each new aircraft system.

### 4.1 REQUIREMENT FOR DAMAGE TOLERANCE ANALYSIS METHODS

Since the overall objective of this program is to develop the force management methods necessary to ensure the damage tolerance and durability of each aircraft and since these methods depend upon developing baseline operational spectra (inputs to final update of analyses based on crack growth) and predicting potential crack growth of individual aircraft, then any method or technique exclusively used for fatigue accumulation will be eliminated from further discussion. Only methods and techniques that can be applied to crack growth damage theory will be considered.

### 4.2 AIRCRAFT SYSTEM CONSTRAINTS

Aircraft system constraints include the design requirements, the design concepts (fail safe versus slow crack growth), the number of structural "hot spots", the anticipated severity of usage and change of overload, and the anticipated utilization variability.

The design requirements will determine the flexibility of the airframe and the dynamic response to high frequency load inputs. This will determine the analysis model and the type of monitored parameters required to feed the model.

The design concepts and number of hot spots will affect the choice of FSM and IAT methods and the requirement for component tracking.

## TABLE 4.1
## RANKING OF CURRENT DATA COLLECTION SYSTEMS BY ACCURACY

TRACKING SYSTEMS - ATTACK/FIGHTER/TRAINER

| Tracking Accuracy Ranking* | Recorder | IAT Method |
|---|---|---|
| 1 | MSR | #11 - Normalized Stress Exceedances |
| 2 | Counting Accel. | #9- Flt x Flt Parametric Fatigue Damage |
| 3 | Counting Accel. | #10- $N_z$ Exceedance |
| 4 | Form | #8 Mission/Config Fatigue Damage |
| 5 | AFM 65-110 | #7- Mission Fatigue Damage |
| 6 | ----- | #1- Flt Hrs/LDGS Damage |

TRACKING SYSTEMS - TRANSPORT/BOMBER

| Tracking Accuracy Ranking* | Recorder | IAT Method |
|---|---|---|
| 1 | MSR | #11 - Normalized Stress Exceedances |
| 2 | FORM | #6 - Estimated Cycle x Cycle Crack Growth |
| 2 | FORM | #5 - Mission Crack Growth |
| 3 | FORM | #4 - Parametric Crack Growth by Data Block |
| 4 | FORM | #3 - Mission Fatigue Damage |
| 5 | FORM | #2 - Parametric Fatigue Damage by Data Block |
| 6 | AFM 65-110 | #7 - Mission Fatigue Damage |
| 7 | ---- | #1 - Flt Hrs/LDGS Damage |

L/ESS SYSTEMS - ALL AIRCRAFT TYPES

| Spectra Accuracy Ranking* | Recorder | L/ESS Approach |
|---|---|---|
| 1 | MXU-553A** | Loads-Derived Stress Spectra |
| 2 | MXU-553A** | Strains-Derived Stress Spectra |
| 3 | A/A24U-10 | VGH-Derived Stress Spectra |

* Ranking is based on a subjective estimate of the system capability to reproduce the stress spectrum at the monitored location. Specific application will involve assumptions and techniques which may alter the ranking shown.

** Also applies to AN/ASH-28 and MADAR recorders. A/A24U-6 recorder is lower because resolution is poorer (6 bits).

The severity and variability of usage will determine the required sample size for the L/ESS program and the extent and accuracy of the IAT program.

4.3 RECORDING SYSTEM AVAILABILITY

The commercial availability of equipment with the desired capabilities is always a factor. The lack of a proven crack growth gage and the difficulty in obtaining non-volatile solid state memory makes the crack growth gage and microprocessor concepts unacceptable as current recording systems.

4.4 OVERALL SYSTEM COMPATIBILITY/ACCURACY

Recommended methods should consider the interfacing between force management elements. For example, a sophisticated, accurate, but costly L/ESS program may not be cost effective if it is not teamed with equally sophisticated IAT and/or FSM programs. Conversely, if the L/ESS program is too simple, it may not provide the updated spectra information required by the IAT, and FSM programs and the L/ESS output may not be used at all.

Table 4.1 ranks the current data collection systems in order of estimated accuracy. The usual concept of accuracy is impossible to apply to these recording systems because it is so dependent on the details of each specific application. Peculiar design details and analysis techniques can enhance or degrade the accuracy capabilities of a specific system. In addition, unusual material properties or variability in the loading conditions can reduce the system effectiveness to determine potential crack growth. To simplify the presentation in Table 4.1, "estimated accuracy" is based on an engineering judgement of each systems capability to faithfully reproduce the applied stress spectra at the monitored location. Crack growth methods were considered more accurate than comparable fatigue methods. Problems associated with transferring loads from a monitored location to a critical location and problems with life prediction were judged to be independent of the recording system and were not considered in the ranking.

# TABLE 4.2

# RANKING OF CURRENT DATA COLLECTION SYSTEMS BY COST

ATTACK/FIGHTER/TRAINER

| SYSTEM TYPE | COST PER FLIGHT HOUR | USABLE DATA YIELD | RECORDER | ANALYSIS METHOD |
|---|---|---|---|---|
| IAT | $0.42 | 90% | ---- | IAT #1 - Flt Hr/Loads Damage |
| IAT | 1.08 | 90% | AFM 65-110 | IAT #7 - Mission Fatigue Damage |
| IAT | 1.35 | 90% | AFM 65-110 | IAT #8 - Mission Fatigue Damage |
| IAT | * | * | MSR | IAT #11 - Normalized Stress Exceedances |
| IAT | 2.90 | 85% | Counting Accel. | IAT #10 - $N_z$ Exceedance |
| IAT | 6.46 | 85% | Counting Accel. | IAT #9 - Flt x Flt Parametric Fatigue Damage |
| L/ESS | 40.26 | 40% | A/A24U-10 | L/ESS-VGH-Derived Stress Spectra |
| L/ESS | 68.02 | 40% | AN/ASH-28 | L/ESS - Loads-Derived Stress Spectra |
| L/ESS | 77.72 | 25% | MXU-553A | L/ESS - Loads-Derived Stress Spectra |
| L/ESS | 118.85 | 25% | A/A34U-6 | L/ESS - Loads-Derived Stress Spectra |

TRANSPORT/BOMBER

| SYSTEM TYPE | COST PER FLIGHT HOUR | USABLE DATA YIELD | RECORDER | ANALYSIS METHOD |
|---|---|---|---|---|
| IAT | $0.42 | 90% | ---- | IAT #1 - Flt Hr/Loads Damage |
| IAT | 1.08 | 90% | AFM 65-110 | IAT #7 - Mission Fatigue Damage |
| IAT | 1.88 | 90% | AFM 65-110 | IAT #3 - Mission Fatigue Damage |
| IAT | 1.93 | 90% | AFM 65-110 | IAT #2 - Parametric Fatigue Damage by Data Block |
| IAT | 2.14 | 90% | FORM | IAT #5 - Mission Crack Growth Fatigue |
| IAT | 2.19 | 90% | FORM | IAT #4 - Parametric Crack Growth by Data Block |
| IAT | 2.89 | 90% | FORM | IAT #6 - Estimated Cycle x Cycle Crack Growth |
| IAT | * | * | MSR | IAT #11 - Normalized Stress Exceedances |
| L/ESS | 63.27** | 35% | MXU-553A | L/ESS-Loads→Derived Stress Spectra |
| L/ESS | 88.58*** | 25% | MXU-553A | L/ESS-Strains→Derived Stress Spectra |
| L/ESS | 118.85 | 25% | A/A24U-6 | L/ESS-Loads-Derived Stress Spectra |

* Data Collection and Automatic Processing Not Yet Operational.

## 4.5 PROGRAM COSTS

Table 4.2 ranks the current data collection/processing systems in order of cost per hour.

Although the low program costs are an important factor, this factor is judged less important than the above factors by many organizations. This is because those force management methods where the data is used extensively generally cost more than methods where the data is not used. Thus, more important than the cost is the effectiveness of the force management data analysis. One of the more important cost considerations is the support required by the using command during data collection.

## 4.6 FORCE MANAGEMENT SYSTEM DATA YIELD

As shown in Table 4.2, most L/ESS recording programs yield about 25 percent usable data and most IAT recording programs yield about 85 percent usable data. Although these percentages seem appallingly low and there are continual efforts to improve the data yield, there is no indication that any aircraft system would chose a different recording method because it would significantly improve the percentage of usable data.

## 4.7 ANALYTICAL COMPLEXITY

Analytical complexity is not an important factor except through its effect on cost. For instance, those systems which require extensive engineering support will have high costs. Such systems are justified only if the maintenance program requires accurate data.

## 4.8 DISTINCTION OF CURRENT AND IMPROVED METHODS

The only methods considered current are those presented in Section 2. The above criteria was applied in the selection of recommended methods which are presented in Section 5.

# SECTION V

# RECOMMENDED FORCE MANAGEMENT METHODS

This section presents current force management methods which show sufficient promise to be included in a force management handbook. Potential improvements to some of these methods will be identified and developed during Task II of the program. In this report, the current methods are presented in their current form.

Several viable methods were eliminated only because they result in a fatigue damage analysis rather than a crack growth analysis. Tracking program revisions already underway on several aircraft systems will surely develop tracking methods which were not considered here. Such methods will be incorporated in the Task II effort.

Methods are presented for IAT and L/ESS systems and for FSM planning. Some recommendations on force management organization coordination are also presented.

## 5.1 RECOMMENDED IAT METHODS

From the current IAT methods included in Paragraph 2.1, the five methods listed in Table 5.1 are recommended for incorporation in the force management handbook. The other methods were not considered for the following reasons:

o Methods 2, 3, 8, and 9 were not considered suitable because they are based on cumulative fatigue damage analyses, however, they could be cost-effective alternatives for non-critical aircraft.

o Method 6 has been eliminated for the present because the derivation of cycle-by-cycle stress spectra for every recorded data block during IAT data reduction was considered overly complex for the accuracy limitation of pilots log data. This method will be reconsidered during Task II.

o Method 7 was eliminated because it was based on cumulative fatigue damage but the concept of data collection via the AFM 65-110 system should be considered as an alternative in Method 1.

TABLE 5.1

RECOMMENDED IAT METHODS

| Method | Data Collection | Tracked Parameter | Analysis |
|---|---|---|---|
| 1 | Aircraft Records | Flt hrs & Landings | Percent Hrs/Ldgs |
| 4 | Pilots Log | Time by Data Block | Parametric Crack Growth Tables |
| 5 | Pilots Log | Equivalent Missions | Mission Crack Growth Tables |
| 10 | Counting Accel | Equivalent $N_z$ Spectra | Normalized Crack Growth Curves |
| 11 | MSR | Equivalent Stress Spectra | Normalized Crack Growth Curves |

Method 10 utilizes counting accelerometer data read once each month. Although not in current use, it is expected that a crack growth method using flight-by-flight counting accelerometer readings will be developed in the near future to replace Method 9.

### 5.1.1 METHOD 1 - Existing Aircraft Records

This tracking method is recommended for aircraft with well-defined and relatively constant missions and for aircraft with lead-the-force structural experience. Some trainer aircraft have very well-defined mission syllabi. Transport aircraft quite often fly regular routes almost like airlines operation. Some military aircraft, such as the C-9 and KC-10 are derivatives of commercial aircraft and all structural problems are discovered during civil fleet operation years before they are encountered by the military versions. In addition, commercial derivative aircraft are normally designed for damage tolerance in excess of USAF requirements.

This method uses information already collected by other organizations for input to the tracking system. Available parameters include:

- Aircraft Tail Numbers
- Flight Hours
- Landings
- Base
- Planned Mission

The structural maintenance program and the economic life can be expressed as functions of one or more of these parameters. The simplest application of this method is to express the structural maintenance intervals in flight hours. This method is schown schematically in Figure 2.1.

Since most of this information is readily available at base level, this tracking program is very responsive to changes in flying rates (hours/month or landings/month).

### 5.1.2 METHOD 4 - Parametric Crack Growth Tables

The Parametric Crack Growth Tables method, described in Figure 2.4, is recommended for large aircraft with variable flight profiles. The aircraft must have crew members with enough free time during the missions to enter data on the pilot log form after each mission segment.

Very simply, this method segments each flight into a series of data blocks described by the amount of time spent in a specified operation (climb, cruise, etc) and a specified flight condition (altitude, Mach number, Fuel weight, Cargo weight). Certain events such as landings and air drops are also identified. Then,the tracking program computes an increment of crack growth for each data block or events based on predetermined crack growth rates for each data block. Sequence effects are estimated for typical load sequences and then included in the rates.

The data collection form should be designed for automatic processing by an optical scanner device. The AFTO Form 451, in Figure 2.46, is an example of this type of form.

The majority of the data editing function should be performed by the optical scanner processing equipment so that corrections can be checked against the original form. This capability is available on the existing forms processing equipment at Warner-Robins ALC.

The form should include an entry for cumulative airframe time so the total recorded time can be checked to detect missing forms without requiring an outside source of data.

The L/ESS method utilized to obtain operational spectra must be capable of identifying the same data block breakdown printed on the pilot log forms. For example, if the form identifies a data block called "cruise" at a specific flight condition, then the L/ESS must produce a stress spectrum (and a crack growth rate) for cruise at the same flight condition. Obviously, the tracking system and L/ESS system designs must be coordinated.

### 5.1.3 METHOD 5- Mission Crack Growth Tables

This method is recommended as an alternative to Method 4 for those aircraft flying several well-defined missions. The use of pilot log forms dictates that this method be considered only for aircraft with a flight crew of three or more. This method requires less computer resources than Method 4 if the number of mission categories (which describes the flight duration, flight profile, take off weight, cargo weight, and aircraft configuration) is an order of magnitude less than the number of data blocks required for Method 4.

Method 5 accepts the same input forms as Method 4 but, instead of segmenting the flight into data blocks, the Method 5 program uses a series of tests to determine which pre-defined mission category most nearly matches the recorded flight. Once the mission category is determined, the crack length for the aircraft is incremented by entering the mission category crack growth curve at the crack length before the flight and determining the growth for one flight.

The L/ESS method again must match the tracking method by determining the stress spectra for each mission category and computing a crack growth curve for each. The crack growth computation by mission allows a better representation of stress sequence effects than does the data block procedure because the entire flight is considered as a single continuous sequence. The accuracy of this method depends, however, on how well the predefined missions match the actual data block sequence on each flight. This method is diagrammed in Figure 2.5.

### 5.1.4 METHOD 10 - Normalized $N_z$ Exceedance

This method, illustrated in Figure 2.10, is recommended for fighter, attack, and trainer aircraft with minimum weight and payload variation from flight-to-flight. Since the recorded data is exceedances of center-of-gravity normal load factor ($n_z$), the stress spectra must be determined by assuming a weight distribution for the aircraft at the $n_z$ peaks. This assumption is valid only if the distribution of weight versus $n_z$ remains fairly constant from flight-to-flight.

The readings from the counting accelerometer windows are written on a form each month along with the current airframe hours and landings (if required), the aircraft tail number, and the base. This represents a very economical data collection program in terms of base level support required.

Method 10 is basically a cumulative damage index approach similar to Miner's rule except a moderate attempt is made to account for sequence and failure is defined by crack growth concepts.

The two basic assumptions of this approach are 1) an $n_z$ exceedance curve is a unique activity indicator which represents a specific stress sequence at a structural control point; and 2) the crack growth curves at all initial structural locations can be normalized by linear transformations of crack length and $n_z$ counts so that structural inspections/modifications at all critical points can be scheduled at a corresponding $\Sigma$ n/N computed for the control point.

The cumulative damage index is defined by an equation of the type

$$D.I. = C_t\, t + \Sigma\, n_i/N_i$$

where D.I. = damage index

t = recorded time

$C_t$ = constant damage rate

$n_i$ = recorded counts of level i

$N_i$ = allowable counts to failure of level i

Failure is defined as a critical crack length. The counts to failure are derived from crack growth test data. This is accomplished by testing specimens to the operational spectrum. The spectrum is applied to the test article until the critical crack is reached and then the spectrum is converted to counts relating to the levels of the counting accelerometer.

Given the test time T to failure and the number of counts $n_i$ applied to the test article, the assumption was made that the crack length of the various cycles can be considered independently, i.e.,

$$DI = DI_1 + DI_2 + \ldots DI_i$$

where $DI_i$ = the damage index (or crack growth) contribution of the counts of level i.

Then a constant $N_i$ is determined by assuming a linear relation between damage index and counts so that

$$\frac{N_i}{DI} = \frac{n_i}{DI_i}$$

or

$$N_i = \frac{n_i}{(DI_i/DI)}$$

The ratios $(DI_i/DI)$ represent the percentage of crack growth attributed to each of the i levels and are estimated from test data based on a combination of fractographic studies and analysis. The fractographic analysis can measure the amount of crack growth during specific portions of the applied spectrum. The proportion of this crack growth caused by the cycles in each range of maximum stress values can be computed with an analytical crack growth model which is tuned to match the measured crack growth.

With the constraint that

$$\Sigma \frac{DI_i}{DI} = 1,$$

the derived equation

$$D.I. = \Sigma \frac{n_i}{N_i}$$

will always reproduce the correct DI when the baseline values of $n_i$ are used.

Another approach to the determination of the $N_i$ values is to execute a regression analysis based on many test observations of D.I. and $n_i$ values. This approach requires skill and caution in the application of statistics because the solutions for the $N_i$ values can be extremely sensitive to the selection of input data.

The requirements for the L/ESS program is only that it be capable of generating operational stress spectra at the critical locations and for several representative mission mixes possibly defined by base. A corresponding $n_z$ exceedance curve must be derived for each stress spectrum.

### 5.1.5 METHOD 11 - Normalized Stress Exceedance

Pending F-16 operational verification of the key assumptions described below, this method, illustrated in Figure 2.15, is recommended for attack/fighter/trainer aircraft with significant variations in maneuver loads and store configuration from flight to flight.

The recording device is a mechanical strain recorder (MSR). The MSR provides a sequence of stress peaks and troughs at the instrumented location covering all phases of the aircraft operation. The data cassette is replaced in the MSR periodically (Monthly or every 50 flight hours) and the spent cassette is sent to ASIMIS for processing. (An automatic reader has been delivered to the Air Force for use on the F-16 tracking program but no operational experience on the reader was available as of this writing). The reader will automatically measure and digitize the stress peaks and troughs in the recorded sequence.

As shown in Figure 5.1, the normalization of the stress exceedance curves is based on the assumption that the following equation is a good fit for all recorded stress spectra:

$$N(\sigma^2) = \exp\,[m\sigma^2 + b]$$

where

$N(\sigma^2)$ = the number of times per unit time that $\sigma^2$ is exceeded,

$\sigma$ = stress range or the difference between a strain trough and the following strain peak

$m$ = the slope of the line (Figure 5.1)

$b$ = the ordinate intercept of the line (Figure 5.1).

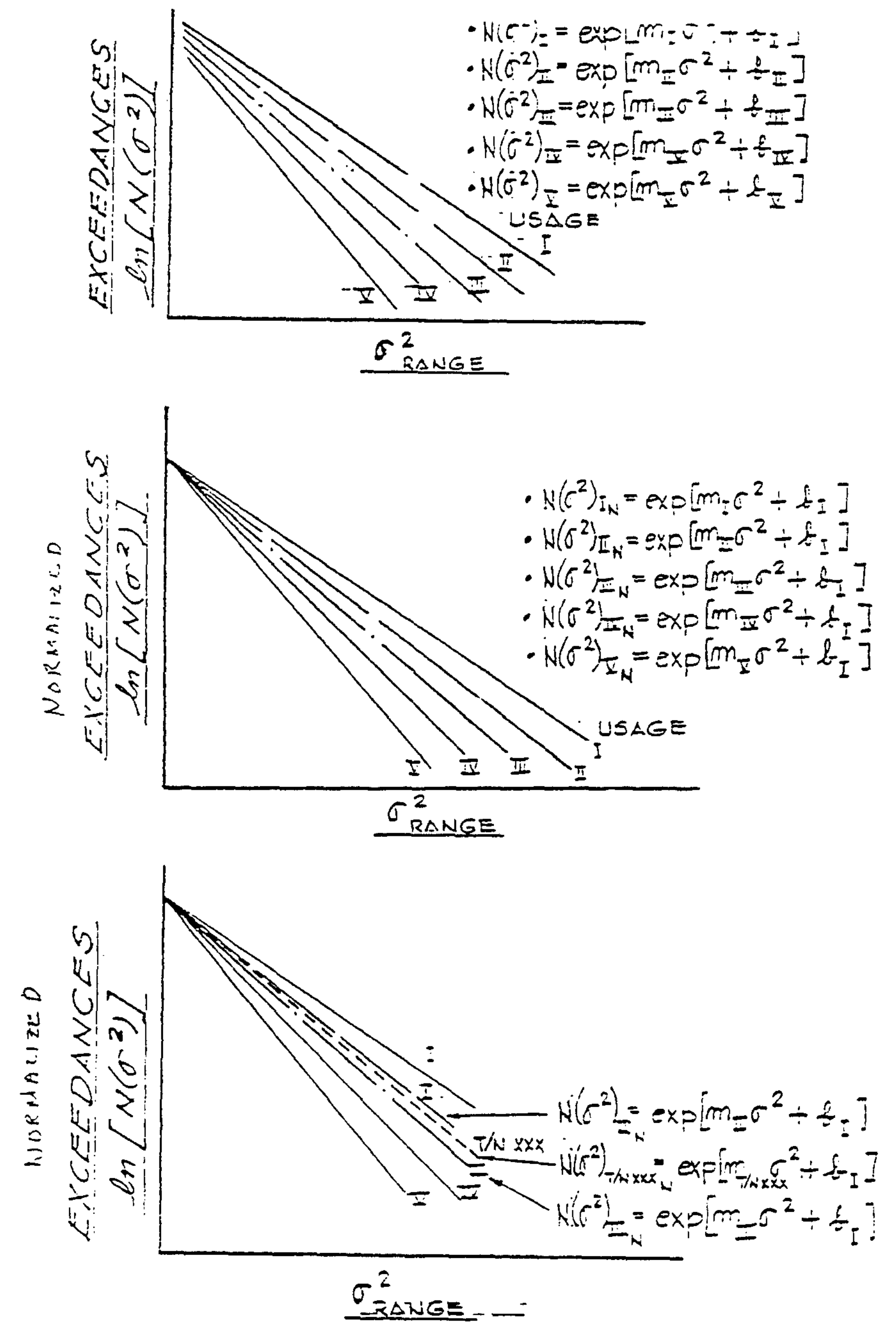
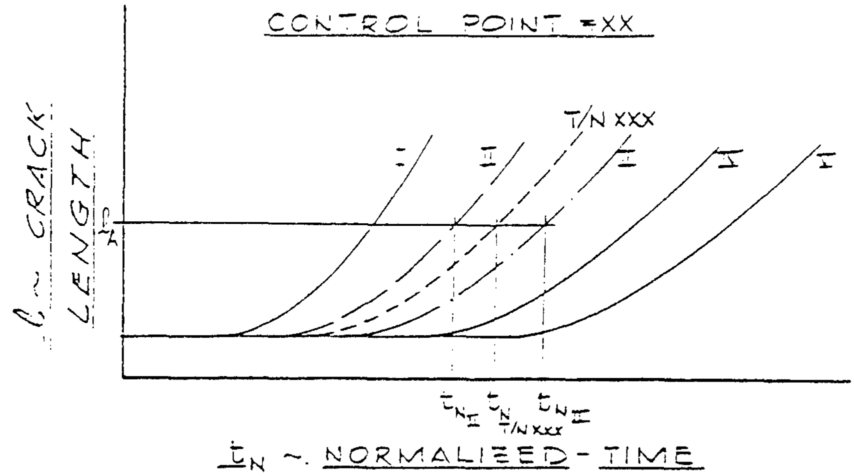


Figure 5.1 Interpolation of Normalized Crack Growth.




GIVEN

- o TAIL #XXX
- o TIME AT BEGINNING OF PERIOD = $t_i$
- o INCREMENTAL TIME FOR PERIOD = $\Delta t$
- o CONTROL POINT #XX
- o CRACK LENGTH AT BEGINNING OF PERIOD = $\ell_i$

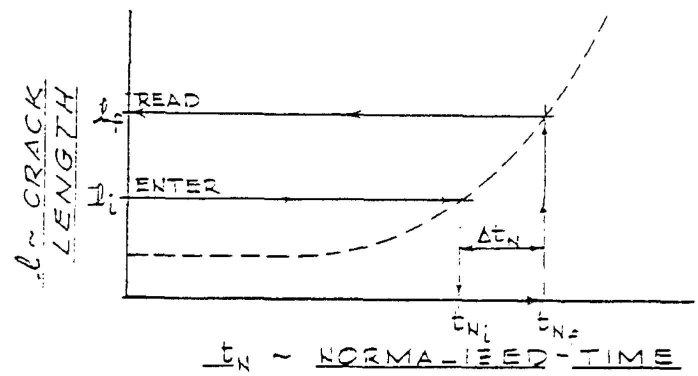



Figure 5.1 (Concluded).

Once this assumption is accepted, it is possible to transform the time scale by the factor exp (K-b), where K is a constant, so that all curves (straight lines on semi-log paper) have the same intercept on the ordinate. This reduces the equations to a single variable, m, which makes it possible to create new exceedance curves from existing curves by interpolating on m as shown in Figure 5.1.

The second key assumption is that all stress spectra which can be fit by the same exceedance curve of the above form will produce the same crack growth curve. In other words, normal operation does not produce stress sequence variations which are significant when computing crack growth over a period of 50 flight hours.

The third key assumption is that the crack growth at all critical structural locations can be related to crack growth at the control point by linear transformations of crack length and time. In other words, structural inspection/modifications at all critical points can be scheduled at some corresponding crack length computed for the control point.

Once these assumptions are accepted, a crack growth curve can be derived, by interpolation, for each 50-hour recorded stress sequence. Then, given the crack length at the beginning of the sequence, the crack growth for the sequence can be computed from the derived curve. The flight time correspnding to each recorded stress sequence must be recorded.

The L/ESS program is required to define the operational stress spectra at the critical points and the transfer functions between the control point and the various critical points.

## 5.2 RECOMMENDED L/ESS METHODS

It is obvious, after reviewing current force management programs, that L/ESS methods cannot be considered independently from the IAT and FSM methods. The objective of the L/ESS is to provide an operational spectra data base for use in the FSM analysis and in the IAT analysis. Thus, the specific L/ESS requirements are dictated by the planned IAT and FSM programs. Therefore, no attempt is made to recommend a type of L/ESS program in this report. Instead, the recommendations center around approaches to specific problems or operations which have been found to work during the current programs.

### 5.2.1 Recommended L/ESS Data Collection Methods

The MXU-553A recording system is recommended for near term L/ESS applications. This system is in widespread use with in-place logistics support within the Air Force. The recording system operation and accuracy are suitable for any forseeable L/ESS requirement.

The primary problem with current MXU-553A systems is in the timely detection of equipment malfunctions. A field test set is available and each potential user should provide these units at each base with procedures for regular recording system functional checks.

Some L/ESS programs use strain gages for measuring stresses in the structure. Experience has shown that the only way to have reasonable success with strain gages is to have quality installations by qualified technicians in a depot or assembly plant environment. One or more backup sets of gages should be installed and periodic calibrations should be planned. With these precautions, the strain gage systems can approach the data yield levels of other transducer types.

If positive identification of touchdown is required for the L/ESS, it is recommended that a taxi-speed transducer be provided to measure main wheel rotational speed. This type measurement is much more positive than a "squat switch" which measures landing gear strut compression.

A fuel totalizer measurement is the only accurate means of providing fuel weight, particularly for aircraft which have inflight refueling.

It is recommended that transducers which are available in other aircraft avionics systems be tapped for use in the L/ESS system whenever possible. Most aircraft avionics systems have diagnostic maintenance priority over the L/ESS equipment and malfunctioning transducers shared with these systems is much more likely to be detected and repaired.

### 5.2.2 Recommended L/ESS Data Processing and Analysis Methods

It is recommended that ASIMIS be tasked to review and approve the statement of work for each new L/ESS program. The contractor, after development of the L/ESS software, should be required to operate the software for a period of one to two years to checkout the software and improve its efficiency.

It is recommended that ASIMIS review and approve all required manual editing procedures to insure a reasonable tradeoff between computer costs for automated editing and manhour costs for manual editing.

Following delivery of the software to ASIMIS, the contractor should be required to provide continuous analysis services to review the L/ESS data for trends and changes in the operational spectra. With his knowledge of the airframe design, the contractor is best qualified to perform this task effectively.

The L/ESS analysis must be matched to the durability test analysis and FSM analysis procedures. If a peak counting routine is used, it should be consistently defined for all of the programs. The identification of load input sources such as gusts, maneuvers, and ground loads should be defined in the L/ESS data reduction to match the structural analysis definitions.

The L/ESS analysis should be designed around the fracture mechanics approach used in the FSM and tracking programs. This means, in general, the reduction of data to a sequence of stress peaks and troughs at critical locations.

## 5.3 RECOMMENDED FSM METHODS

The force structural maintenance (FSM) plan must consider the means of implementing the tracking data into the maintenance schedule (including the capability of various inspection procedures to detect cracks, the risk that certain inspection procedures may induce structural flaws, and the risk of catastrophic failure of undetected cracks) and the mechanism of reporting inspection findings so that the FSM plan can be improved as experience is gained.

### 5.3.1 Recommended FSM Scheduling

The FSM plan must be flexible in design so it can be modified to react to service failure experience as data becomes available. The most likely change would be the addition of new inspection requirements for structural "hot spots" that did not appear significant during analysis and test. The other likely change is in the rate of structural utilization as operational requirements differ from the design utilization.

The structural inspection requirements of the FSM plan will include general area inspections as well as specific critical hot spot inspections. The general area inspections are designed to detect unpredictable flaws such as those caused by foreign object damage,corrosion, or by maintenance actions. These inspections should be included with non-structural work in periodic inspections. The specific critical hot spot inspections are designed to detect flaws or cracks which affect flight safety and have been predicted by analysis, test, or service failure data. This type of structural inspection is addressed by the FSM plan schedule.

Based on analysis, each critical area has a critical crack size where further aircraft operation may cause rapid growth to failure. The potential effect of this failure on flight safety and mission completion defines the risk associated with an undetected crack. Based on the risk, an inspection requirement is established to provide the desired probability of detecting the crack before it reaches the critical size.

The inspection requirements (what is to be inspected) must specify an inspection schedule (when it is inspected), the organization who will do the inspection (where it is inspected), and the procedure for the inspection (how it is inspected).

Depending on the projected time between the time when the crack is large enough to be detected and the time when the crack reaches the critical length, it may be desirable to schedule the inspections according to projected crack growth based on the IAT program. An example of this use of scheduling is shown in the T.O. 1F-4C-6ASI-1 included in Appendix C. Since all other scheduled maintenance requirements are specified in the aircraft TO-6, it is recommended that the FSM schedule be published as part of the TO-6 (or as a supplement such as the TO 1F-4C-6ASI-1). Structural inspection schedules should be projected ahead by 6 to 12 or more months to allow the maintenance units time to schedule these inspections with other periodic maintenance.

The organizations are assigned to do specific inspections based on requirements for special skills, special equipment, or extensive airframe disassembly for access. The inspections are normally assigned to the lowest organizational level having the necessary resources.

The procedure for inspection is basically a function of the type and location of the projected crack and the critical crack length. Most critical structural inspections require some sort of NDI (Nondestructive Inspection) method. The capability of these techniques to detect small cracks in the service environment has been overestimated in some cases. Therefore, it is probably not cost effective to schedule inspections until the potential crack size is large enough so that the inspection has a reasonable ( 25%) probability of detection. If crack detection is critical, it may be desirable to increase the frequency of inspection as the potential crack grows toward the critical length.

When the inspection requires some structural disassembly, such as the removal of fasteners, it is quite likely that the mechanical work performed will induce scratches or flaws into the structure. If this type of inspection is not properly planned and controlled, it is possible that a scheduled inspection can have the net effect of reducing aircraft safety instead of improving it. Thus, it is recommended that the need for an inspection requiring structural disassembly be clearly established and that provisions be made to minimize induced damage before such an inspection is scheduled.

The tracking of individual serialized components is being used or considered for several current aircraft systems. This type of tracking is more difficult than basic airframe tail number tracking by an order of magnitude. Thus, it is recommended that the need for component tracking be evaluated carefully before embarking on such a program. The Advanced Configuration Management System (ACMS) within the AFM 66-1 is the established system for tracking serialized components. It is recommended that this data base be used to identify the location of tracked structural components. ASIMIS support should be committed to establish criteria for setting up each new IAT data base.

### 5.3.2 Recommended FSM Reporting

The AFM 66-1 reporting system will continue to be the prime means of reporting maintenance actions. Judicious selection of work unit codes (WUC) in the TO-06 can reduce the ambiguity of the reported data. For instance, some systems assign a specific WUC to each critical location and inspections and actions are reported against this WUC.

One of the most reliable sources of service failure experience over the years has been contractor field representatives. These individuals have been trained to recognize and investigate significant failures and their reports have provided valuable data to pinpoint the cause of problems. With proper training, USAF personnel designated in each unit could provide similar information to the system manager. Personnel turnover is a deterent to this approach but it could still be fruitful. Of course, when possible, the contractor field representative reports should be used as input to FSM planning.

## 5.4 RECOMMENDATIONS FOR COORDINATED FORCE MANAGEMENT

The coordination of the various elements of force management is the key to a successful program. The most common error is the failure of the System Program Office and Contractor force management personnel to utilize all of the resources available during the system design stage. Another problem is that transition of program responsibility is often too abrupt and complete to take advantage of the existing expertise.

### 5.4.1 Recommended System Design Coordination

ASIMIS should be involved at the outset in the requirements for any force management data reduction procedures and software.

Data collection requirements should be coordinated with the using command. The ASIP data collection requirements should be documented in a TO-38 for each aircraft system. A concerted effort should be made to standardize the use of terminology, equipment descriptions, and forms from system to system to reduce the management and training burden on the using command.

The Air Force and Contractor maintenance specialists should be included in the design of the structural maintenance scheduling system from the outset. This could include co-located engineers during the design of the force management system to improve compatibility of the FSM plan and the overall maintenance requirements.

### 5.4.2 Recommended Operational Coordination

The two key transfers of responsibility of force management are the transfer of ASIP responsibility from the System Command SPO to the Logistics Command SM and the transfer of data reduction responsibility from the Contractor to ASIMIS.

The intent of the Aircraft Structural Integrity Program is that all elements through Task III be completed under ASD funding and management,prior to transition during Task IV from ASD to AFLC. Task IV elements should be developed under ASD management and funding, but the actual performance of the FSM, L/ESS, and IAT elements are accomplished by AFLC in Task V, and any modifications to the programs are funded and managed by AFLC.

An ASIP single-point-of-contact concept should be extended to provide a network of trained individuals throughout the system managers offices and the using commands who can communicate directly to exchange information. This can speed the flow of critical data into the force structural maintenance planning activity.

A training program should be provided for all new ASIP OPR individuals. This program should include fracture mechanics and structural analysis theory from ASD and maintenance requirements, procedures, documentation, and reporting information from AFLC. A force management handbook would serve as a good source of material for such a training program.

When the data reduction task is transferred to ASIMIS, the Contractor should continue to provide software support for a period of about a year to satisfy ASIMIS editing and reporting requirements. The contractor should be retained in an analysis capacity for several years to provide analytical support in the solution of any structural problems.

In practice, the dividing line between ASD and AFLC activities is not and should not be so clearly defined. The data from Task V, and in-depth evaluations of these data, are valuable to ASD in the design specification for future aircraft and in updating ASIP and Military Specification requirements. Continuing communication between ASD and AFLC regarding these needs, and response by AFLC beyond its own Force Management requirements, are necessary for overall benefit to the ASIP. Periodic updates of the Service Life Analysis should be planned and ASD should be kept aware of the results.

When ASD updates the ASIP specifications, this levies a new set of requirements on AFLC which must be applied to its existing aircraft and existing Force Management systems. For a major change such as the inclusion of crack growth durability and damage tolerance evaluations, significant program management, funding, and technical direction must be provided. For the C-141 DADTA, AFLC provided program management and funding; AFLC and (primarily) ASD jointly provided technical direction. This example illustrates the fact both ASD and AFLC involvement are needed for appropriate implementation of revised ASIP requirements to existing programs.

Completion of the Task III structural test program and the Task IV final analyses are intended prior to handoff from ASD to AFLC. However, delays due to test damage or extension in the test program can result in the test schedule lagging the handoff by a number of years. Flexibility at the ASD-AFLC boundary is necessary to produce the best program under these circumstances.

For smooth transition, the interrelationship of ASD and AFLC in the above situations should be recognized. To the extent possible, the management and funding responsibilities should recognize these interfaces. Periodic (yearly) ASD-AFLC-contractor meetings to discuss ASIP activities and interfaces should be conducted throughout the entire program. Smooth transition can also be aided by identifying potential problems and discussing potential solutions between the affected organizations well in advance of the transition.

A list of potential transition problems is provided below:

1. Test program extends beyond transition date.
2. Final analyses not completed when aircraft goes into service.
3. Modifications found necessary by tests and analyses must be accomplished in service.
4. FSM manuals not completed when aircraft enter service.
5. L/ESS equipment or computer programs not operational when required.
6. IAT system not operational when required.
7. Changes in operational or structural requirements.

In addition, the following potential problems may arise during service operations after transition, requiring both ASD and AFLC involvement:

1. Change in ASIP requirements requires reassessment with ASD involvement.
2. Major change in aircraft configuration.
3. Major change in aircraft usage.
4. Major change in technology for IAT, L/ESS, FSM.

## SECTION VI

## GUIDELINES FOR FORCE MANAGEMENT APPLICATION

This section presents some guideline information for the necessary choices which confront the engineer who designs force management programs.

The underlying factors which influence the selection of force management alternatives are the planned fleet size and deployment, the airframe's structural damage tolerance, the aircraft mission and anticipated usage variability, the sources of repeated loads, and the structural inspectability. These factors vary from system to system and each force management system must be designed around the specific system requirements.

The most significant choices to be made are the IAT method and data collection equipment and the L/ESS parameters and recording equipment. Because of the lead time in equipment procurement and in incorporating the installation into the aircraft design, these choices must be made relatively early in the aircraft procurement process. However, these choices are strongly influenced by the results of the durability and damage tolerance analyses and tests which are not normally available until about the time the aircraft enters production. Thus, the situation requires choices of systems which are flexible enough to be adapted to changing requirements.

### 6.1 CHOICE OF AN IAT SYSTEM

The choices of current IAT recording equipment are limited to four systems: 1) no data collection system; 2) pilot log forms; 3) counting accelerometer; and 4) mechanical strain recorder (MSR).

Unless it can be shown in advance that a tracking program will not be beneficial, some type of data collection system must be selected. If the aircraft has a crew member available to complete a form during flight, the pilot log can be considered. These forms must be completed as each segment or event is flown because reliance on the crew members' memory to fill in the form later is not satisfactory. If maneuvers constitute the majority of damage producing loads, a counting accelerometer or an MSR should be selected.

Consideration of the installation requirements is required during the choice of the counting accelerometer or MSR. The counting accelerometer must have its transducer mounted near the aircraft center-of-gravity and its indicator mounted in an electronics bay with access to electrical power and with easy access to read the indicator windows. The MSR requires a flat structural surface 1 inch wide by 8 inches long with significant lengthwise stresses. Although designed with a cover for mounting on an external surface, the MSR should be mounted internally if possible, in an area such as a wheel well or beneath a wing root fairing. Easy access to the MSR installation is required for changing the cassette. It must be possible to derive a transfer function from c.g. acceleration, or MSR strain, to the selected structural damage control points. Multiple MSR installations may be required to cover all control points.

One final consideration in the selection of equipment is the availability of MIL qualified equipment with demonstrated reliability and maintainability. For example, as of this writing, the automatic reading equipment for the MSR has not been demonstrated with the anticipated volume of operational data. Therefore, the MSR should be selected only tentatively until all equipment has been demonstrated.

It is recommended that final choice of the IAT analysis method be delayed until preliminary durability and damage tolerance analyses results are available. This method should be compatible with the force structural maintenance plan and with the mission requirements of the using Command.

The force structural maintenance plan will dictate the output metric (damage index, equivalent mission hours, crack length, etc.), the number of structural damage control points, and the frequency of IAT output required.

The using command will be affected by data collection requirements. Scheduled manual effort should be held to the absolute minimum necessary for the analysis. In other words, don't schedule data retrieval after each flight if once a month will suffice. Forms should be designed in conjunction with the user for minimum work and training.

## 6.2 CHOICE OF AN L/ESS SYSTEM

The L/ESS equipment will be an MXU-553/A recorder for the foreseeable future. The user must select the monitored parameters and the converter/multiplexer unit.

The first choice in parameters is whether or not to record strain data. If appropriate locations can be found in the structure and quality strain gage installations are made, the strain system is a viable approach. However, previous experience has shown that a strain installation can be a risky approach to the extent that little valid data is collected over a data collection period of several years. Aircraft motion and control surface deflections can be recorded instead of, or in addition to, the strains. Depending on the converter/multiplexer, up to 26 parameters can be monitored simultaneously.

In choosing parameters to be recorded, first consideration should be given to the parameters used to define the design static and repeated load conditions. Where possible, use of parameters which can be obtained from existing transducers in other aircraft systems is recommended. For dedicated ASIP transducers, the parameters can be expected to have reliabilities in the following order (from highest to lowest): accelerations and pressures (pilot static and total), angular rates, control surface position, and strains.

To reduce the data processing workload, the F-16 L/ESS system has decided to derive roll angular acceleration electronically from the roll angular rate and then to record it on a separate channel. Since angular accelerations must generally be computed, this approach represents a considerable computational savings if a spare channel is available.

High performance aircraft have such violent angular motion that linear accelerations vary a significant amount as a function of distance from the center-of-gravity. Consequently, several current systems are correcting the measured accelerations from the installed accelerometer locations to the c.g. during data processing. If the installation design can locate these accelerometers closer to the c.g., considerable computer time savings can be achieved.

The design of the L/ESS data reduction and analysis is a function of the particular airplane requirements, the force structural maintenance plan, and the tracking method. Much of this design can be delayed until these requirements have been determined.

## SECTION VII

## RECOMMENDATIONS

This section presents recommendations for development work on force management methods. Some of the recommended work will be included in the Task II effort of this contract.

### 7.1 RECOMMENDED IAT DEVELOPMENT

Some of the following methods are already under development and the remainder appear to have potential. All recommended improved methods should be compared with current methods to justify the cost of implementation.

#### 7.1.1 MSR For Transport/Bomber Aircraft

The MSR is currently in use for the F-16 tracking program. The entire F-16 IAT system, including automatic data reduction, should be operational within the next year. In addition to the application to the smaller aircraft, the MSR may have some potential for transport/bomber tracking. Because of the flexibility of the larger aircraft, several MSR's may be required for each airframe. The sensitivity of the MSR may limit its usefulness for these aircraft because the low-level turbulence stresses are important along with the high-level ground-air-ground stresses. It is recommended that the MSR applicability to transport/bomber tracking be evaluated.

#### 7.1.2 Crack Growth Gage for IAT

The crack growth gage has the potential of "automatically" translating the loads experience of individual aircraft into crack growth from a known initial flaw size, thus providing a direct visual indication of the (relative) crack growth based usage severity of each airplane. However, a sufficiently repeatable gage is still in the developmental stage. It is recommended that the potential monitoring systems which might be based on the crack growth gage be explored.

7.1.3 Tail Load Tracking

A simple IAT instrumentation system and application method which includes a secondary recording device to record unsymmetrical empennage loads for attack/fighter trainer aircraft should be considered. This system could include a counting accelerometer and an MSR, two MSR's, an MSR and a crack growth gage, two crack growth gages, or a multichannel microprocessor recorder.

7.1.4 Microprocessor IAT Recorder

A microprocessor-based recording system appears to have potential as a tracking recorder. This could be a stand-alone recorder which performs some of the tracking data reduction or the IAT recorder could be combined with an engine tracking recorder. It is recommended that potential microprocessor applications to IAT be explored.

7.1.5 Simplified Crack Growth Algorithms

It is recommended that existing and proposed crack growth tracking algorithms based on linearized exceedance curves and normalized crack growth curves be investigated for accuracy and sensitivity to the inherent spectra variables. Linearized exceedance curves, such as that used for the F-16, should be tested for the effect of non-linearity. Curves based on a mission mix should be examined for the effect of mission sequence and the possibility of averaging the effects of extremely severe missions.

Additional simplified approaches for predicting crack growth from usage parameters should be investigated.

7.2 RECOMMENDED L/ESS DEVELOPMENT

The application of improved recording equipment and analysis methods to the L/ESS should be considered as they arise. The following paragraphs include several recommendations.

### 7.2.1 Microprocessor L/ESS Systems

The microprocessor is capable of on-line data reduction which could be used to a) process the recorded data to a reduced form thereby allowing more flight hours to be recorded on the same tape; b) identify certain events and control the operation of the recorder to record only airborne data or change sampling frequencies during maneuvering; and c) perform instrumentation system diagnostics and fault isolation to permit identification of malfunctioning parts. The microprocessor could be built into a preprocessor unit which would be an input device for an MXU-553/A system or it could be designed into a new L/ESS recording system. It is recommended that L/ESS recording system functions be identified where microprocessors might be applied.

### 7.2.2 Applications of MSR to L/ESS

In addition to tracking, the MSR may have applications to L/ESS for specific types of spectra. An MSR is currently being used on F-5A/B aircraft to define the operational stress spectra for use in revised life estimates. A similar program is being considered for the A-7D aircraft. If the operational spectra can be defined by stresses at one or two locations, the MSR could be a very cost effective L/ESS recording system. It is recommended that these current applications be reviewed and evaluated to determine how well the MSR performed in the L/ESS role.

### 7.2.3 L/ESS Sample Requirements

Criteria should be developed to determine the number of L/ESS aircraft required from a force. Current L/ESS samples range from about 5 percent to 20 percent of the force. The sample size should be a function of the intended variation of missions and deployment of the force.

In considering a criteria for sample size, it is possible that, after the operational spectra has been determined, the sample size could be reduced to only detect and define changes in usage.

### 7.2.4 Usage Change Detection

An extensive amount of data processing and analysis is required to define the operational spectra. Following the spectra update, however, the data is reviewed only to detect a usage change. One approach is to record the same data but to store the raw data and to reduce only the amount necessary to verify system operation and to monitor for usage change. This approach could reduce the processing costs and still maintain the data base in the event a requirement for data is encountered. It is recommended that minimum cost data reduction approaches be formulated for continued L/ESS operations.

### 7.2.5 Stress Regression Equations

It is recommended that the use of stress regression equations as an alternative to "table look-up" transfer functions be examined for application to L/ESS parametric analysis. The standard error versus the number of observed data points recorded by the L/ESS program should be examined to determine the data sample required.

### 7.2.6 Independent Design Criteria Recorder

The concept of separating the collection of design criteria data from the collection of L/ESS data should be explored to determine the extent of the costs and benefits to be realized from an independent design criteria recorder. The obvious benefits are the reduction of data reduction requirements in the L/ESS programs and the potential for standardized criteria data formats. The cost of a stand-alone criteria recorder would have to be evaluated.

## 7.3 RECOMMENDED FSM DEVELOPMENT

The improved FSM methods are concerned with the effectiveness of a tracking program for scheduling structural maintenance.

First, the cost of special inspection scheduling may not be offset by any cost savings achieved by scheduling the special inspections less frequently on part of the fleet.

Second, the capability of the NDI techniques to detect cracks may not be sufficient to achieve the desired safety levels regardless of how the inspections are scheduled.

This second problem brings up a third problem, the determination of the risk involved in delaying or not accomplishing an inspection. If this risk is low enough, IAT scheduling of inspections may not be warranted.

It is recommended that the tracking, inspection detection, and crack occurrence uncertainties be quantified and a risk analysis be performed to determine the risks involved in inspection scheduling.

# APPENDIX A

# FORCE MANAGEMENT METHODS HANDBOOK OUTLINE

FORCE MANAGEMENT METHODS HANDBOOK

TENTATIVE OUTLINE

1. SCOPE
2. REFERENCED DOCUMENTS
3. DEFINITIONS AND SYMBOLS
4. FORCE MANAGEMENT METHODS GUIDELINES
   - 4.1 General
   - 4.2 Bomber Aircraft
   - 4.3 Transport/Tanker Aircraft
   - 4.4 Fighter Aircraft
   - 4.5 Attack Aircraft
   - 4.6 Trainer Aircraft
5. FORCE STRUCTURAL MAINTENANCE (FSM) PLAN
   - 5.1 Structural Maintenance Action Determination
   - 5.2 FSM by Individual Aircraft
   - 5.3 FSM by Structural Component
   - 5.4 Interface with Maintenance Scheduling and Reporting Systems
   - 5.5 Economic Life Estimation
   - 5.6 FSM Implementation
   - 5.7 Periodic Update of FSM Plan
6. INDIVIDUAL AIRCRAFT TRACKING (IAT)
   - 6.1 Usage Tracking Utilization/Accuracy Requirements
     - 6.1.1 Maintenance Action Scheduling
     - 6.1.2 Structures Logistics Management
     - 6.1.3 Aircraft Utilization Management
     - 6.1.4 Usage Change Detection
   - 6.2 IAT Methods
     - 6.2.1 Monitoring Techniques
       - 6.2.1.1 Aircraft Flight Hours/Flights/Landings
       - 6.2.1.2 Time or Occurrences by Flight Condition
       - 6.2.1.3 Loads Parameters
       - 6.2.1.4 Strains

- 6.2.2 Verification/Editing Techniques
  - 6.2.2.1 Comparison with Alternate Data Source
  - 6.2.2.2 Comparison with Parameter Boundary Values
  - 6.2.2.3 Gap-Filling Procedures
- 6.2.3 Computation Techniques
  - 6.2.3.1 Transfer Functions
    - 6.2.3.1.1 Rigid Structure
    - 6.2.3.1.2 Flexible Structure
  - 6.2.3.2 Crack Growth Computations
    - 6.2.3.2.1 Cycle-by-Cycle Approach
    - 6.2.3.2.2 Normalized Growth Curve Approach
    - 6.2.3.2.3 Parametric Approach
- 6.2.4 Damage Projection Techniques
  - 6.2.4.1 Based on Aircraft Average
  - 6.2.4.2 Based on Base Average
  - 6.2.4.3 Based on Fleet Average
  - 6.2.4.4 Based on Hypothetical Future Usage

6.3 Tracking Instrumentation Selection

6.4 Tracking Data Collection

6.5 Tracking Data Processing

6.6 Tracking Data Products

6.7 IAT System Implementation

7. LOADS/ENVIRONMENTAL SPECTRA SURVEY

7.1 Sample Size/Accuracy Requirements

7.2 L/ESS Methods

- 7.2.1 Monitoring Techniques
  - 7.2.1.1 Loads Parameters
  - 7.2.1.2 Strains
- 7.2.2 Verification/Editing Techniques
  - 7.2.2.1 Comparison with Parameter Limits
  - 7.2.2.2 Recovery of Invalid Data
- 7.2.3 Baseline Operational Spectra Development
- 7.2.4 Parametric Analysis Update
- 7.2.5 Usage Change Detection
- 7.2.6 Application to Update FSM Plan
- 7.2.7 Application to Structural Design Criteria

## APPENDIX B

## FORCE MANAGEMENT METHODS
## STATE-OF-THE-ART REVIEW

### SUMMARIES

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: A-7D

FLEET INFORMATION

NO. OF AIRCRAFT: ~400 : YEAR SERVICE BEGAN: 1968

SYSTEM MANAGEMENT: AFLC, except ASIP which is AFSC

DATE TRANSFERRED TO AFLC: July 1975

USING COMMAND: TAC, Air National Guard

PRIMARY BASE: Davis Monthan, England, Myrtle Beach

PRIMARY MISSION TYPES: Weapons Delivery, Air Combat, Maneuvering

REMARKS: ASIP program "suffered" from joint USAF/Navy Systems Management

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | yes | | |
| FULL-SCALE CYCLIC TEST: | fatigue only | | Wing only on A-model |
| FULL-SCALE STATIC TEST: | | | |
| DAMAGE TOLERANCE TESTS: | components only | x | Lug testing |
| DADTA INITIAL: | yes | | |
| STRENGTH SUMMARY: | yes | | |
| TRACKING SYSTEM DESIGN: | yes | | CA |
| L/ESS DESIGN: | | | Not planned |
| FSM PLAN: | | | No formal document |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: } DURABILITY ANALYSIS: | 2-53440/7R-5928, Vol. I,II | Vought, Jan. 1977 |
| SERVICE LIFE ANALYSIS: | | |

A/C Type: A-7D (Continued)

IAT PROGRAM

ANALYSIS METHOD: Regression Analysis to determine equation of crack growth vs. CA readings

APPLICABLE REPORT: Vought No. 2-53470/7R-5929 Rev. A

DATA COLLECTION: RECORDER: CA FORM: AFTO 109 (ATTACH DESCRIPTION)

FREQ. OF RETRIEVAL: Levels 5,6,7,8 :TECH.ORDERS: TO 1A-7D-2-10CL-1 (old)

DATE STARTED: May 1972 HRS.RECORDED: 500,000% USABLE DATA: 70%

DATA COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Automatically by computer

TECHNIQUE TO RECOVER MISSING DATA: Gap-fill missing or bad data according to the good data at the same base and at the same time period. See Vought No. 2-53470/7R-5930.

LIST PROCESSING STEPS: (1) raw data is keypunched (2) computer edits and screens data (3) manual card corrections (4) data is gap-filled according to similar usage (5) damage index predicted for future dates (6) tabular and tape output

OUTPUT CONTENTS (ATTACH SAMPLES): Base Summary, Aircraft Exceedance Data, Composite of All Aircraft, Aircraft Damage and Rates, Aircraft Damage by Year

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA? Master File of card images for all previous periods

WHO EVALUATES OUTPUT? ASIMIS and ASD (ENFS)

APPLICATIONS: SCHEDULING? Not being used to schedule maintenance

ANALYSIS UPDATE?

TO DETECT CHANGE IN USAGE?

REMARKS: OCALC/MMSR doesn't believe regression analysis

Method can be used for any CA program with minor changes.

May be applicable to a MSR program.

L/ESS PROGRAM

ANALYSIS METHOD: No present plans for a L/ESS program. A limited service loads recording program was conducted to develop a base-line stress spectra and to develop damage tracking equation

APPLICABLE REPORT: ______

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 9 RECORDING DEVICE: oscillograph (Attach Description)

PARAMETERS RECORDED: VGH, fuel flow, strains (wing, vert hor. tail) (Attach List)

L/ESS START/STOP DATES: N/A HRS. RECORDED: 1256

% USABLE DATA: N/A DATA RETRIEVAL FREQ. N/A

DEFINITION OF USABLE DATA: ______

COLLECTION PROBLEMS: ______

DATA REDUCTION: WHO DOES IT? ______

HOW IS IT CHECKED? ______

LIST STEPS: ______

TECHNIQUE TO RECOVER MISSING PARAMETERS: ______

OUTPUT CONTENTS (Attach Sample): ______

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? ______

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: ______

TO CHECK IAT DATA? ______

TO DETECT CHANGE IN USAGE? ______

REMARKS: ______

A/C TYPE: A-7D (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Phase and TCTO inspections and maintenance actions covered by T.O.'s 1A-7D-3, -6, and -36. There is no PDM. Eleven aircraft per year are pulled in for ACI. Results of DTA have specified the force structural maintenance actions required (when, where, how, and why) but have not been implemented

INSPECTION INTERVALS: 1000 equivalent baseline hours. Same as a delta damage index of 0.25. (see attached sheet)

RANGE OF CRITICAL CRACK LENGTHS: 0.14 up to 1.2 inches

SPECIAL COMPONENT INSPECTIONS: none required

DATA COLLECTION: Standard AFM 66-1 data procedures as well as UR's, etc., covered under AF regs.

DATA EVALUATION: Unknown

APPLICATION OF FEEDBACK DATA: Unknown

REMARKS: At the first wing removal, a rework of the lug hole is required. No other mods are required.

APPLICABLE DOCUMENTS: Vought Report #2-53440/7R-5928, Vol. I dated 31 Jan 1977, "A-7D ASIP Part I, Damage Tolerance and Fatigue Assessment Program."

A/C TYPE: A-7D (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: AFSC is still manager of ASIP. OCALC has system management. Vought is under contract for some ASIP effort to AFSC at the same time to OCALC for logistics functions. ASIMIS is handling the IAT data gathering and damage calculations.

IAT-FSM INTERFACE: Unknown, if any, at this time.

L/ESS-IAT INTERFACE: None

ORGANIZATIONAL CHANGES PENDING: Transfer of ASIP will take place within a year.

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS: None

METHODS WHICH HAVE WORKED WELL: Not defined at this time.

DEFICIENCIES IN CURRENT METHODS: Coordination between the using command and ASIMIS in identifying malfunctioning counting accelerometers and fixing those. Also there is a need for a standard data transmission form.

A-7D BASE SUMMARY

| BASE CODE | TOTAL HRS | *-----COMPOSITE OF ALL GOOD DATA-----* GOOD HRS | HRS /YR | EXC 5G /1000H | EXC 6G /1000H | EXC 7G /1000H | EXC 8G /1000H | *-----BASED ON PAST 12 MONTHS AVERAGE-----* HRS /YR | EXC 5G /1000H | EXC 6G /1000H | EXC 7G /1000H | EXC 8 /1000 | EXC 5 /YR | EXC 6 /YR | EXC 7 /YR | EXC 8 /YR | D.I. /1000 | D.I. /YR | BLHR /1000 | BLHR /YR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FSPM | 4756 | 334 | 182 | 464.1 | 230.5 | 35.93 | 5.99 | 267 | 350.2 | 56.2 | .22 | .04 | 93.6 | 15.0 | .06 | .01 | .121 | .032 | 486 | 129.9 |
| FTFA | 4125 | 1503 | 153 | 716.1 | 167.8 | 13.98 | 2.66 | 208 | 498.5 | 201.6 | 22.89 | 5.72 | 103.8 | 42.0 | 4.77 | 1.19 | .125 | .026 | 502 | 104.4 |
| X | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0.000 | 0 | 0.0 |
| FBNV | 149255 | 95024 | 261 | 1309.7 | 237.4 | 23.17 | 2.38 | 230 | 1224.7 | 195.1 | 21.59 | 3.26 | 281.1 | 44.8 | 4.96 | .75 | .154 | .035 | 614 | 141.0 |
| VNVP | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0.000 | 0 | 0.0 |
| RKMF | 6717 | 4056 | 168 | 2000.9 | 352.8 | 28.60 | 1.48 | 131 | 2567.9 | 646.0 | 62.89 | 3.40 | 337.2 | 84.8 | 8.26 | .45 | .846 | .111 | 3382 | 444.1 |
| RDRD | 113359 | 70777 | 253 | 1194.8 | 253.9 | 28.87 | 3.28 | 221 | 1401.5 | 313.6 | 33.64 | 3.49 | 310.0 | 69.4 | 7.44 | .77 | .182 | .040 | 730 | 161.4 |
| RKME | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0.000 | 0 | 0.0 |
| GAMH | 68513 | 42865 | 242 | 1349.7 | 262.1 | 27.46 | 2.29 | 204 | 1525.7 | 336.0 | 40.12 | 4.29 | 312.0 | 68.7 | 8.20 | .88 | .185 | .038 | 742 | 151.7 |
| XHFA | 1333 | 1025 | 209 | 1989.9 | 211.7 | 7.80 | 0.00 | 209 | 1989.9 | 211.7 | 7.80 | 0.00 | 414.9 | 44.1 | 1.63 | 0.00 | .243 | .051 | 974 | 203.1 |
| MLER | 58382 | 53906 | 402 | 1019.9 | 284.9 | 18.20 | 1.52 | 257 | 1139.1 | 161.6 | 14.57 | .66 | 293.0 | 41.6 | 3.75 | .17 | .155 | .040 | 620 | 159.5 |
| MHMV | 17505 | 16508 | 260 | 1170.8 | 135.8 | 7.45 | 1.27 | 285 | 1495.5 | 194.9 | 12.67 | 1.65 | 425.7 | 55.5 | 3.61 | .47 | .182 | .052 | 727 | 206.9 |
| CRWU | 9583 | 8697 | 233 | 1989.4 | 296.0 | 10.81 | 1.26 | 235 | 2181.8 | 374.2 | 13.55 | .86 | 512.3 | 87.9 | 3.18 | .20 | .424 | .099 | 1694 | 397.8 |
| JLSQ | 4416 | 3845 | 211 | 801.5 | 151.9 | 18.40 | 0.00 | 210 | 827.6 | 160.5 | 11.08 | 0.00 | 173.9 | 33.7 | 2.35 | 0.00 | .148 | .031 | 591 | 124.2 |
| PSTE | 6008 | 4873 | 239 | 1902.9 | 423.8 | 38.17 | .62 | 244 | 1890.1 | 434.5 | 57.86 | .96 | 461.6 | 106.1 | 9.25 | .23 | .305 | .075 | 1221 | 298.1 |
| TUMR | 2589 | 1648 | 196 | 1183.8 | 157.2 | 9.10 | .61 | 196 | 1183.8 | 157.2 | 9.10 | .61 | 231.8 | 30.8 | 1.78 | .12 | .162 | .032 | 647 | 126.8 |
| NLZL | 9754 | 7926 | 253 | 1104.2 | 143.6 | 10.09 | 2.02 | 256 | 1262.8 | 182.7 | 15.26 | 3.39 | 323.5 | 46.8 | 3.91 | .87 | .158 | .041 | 633 | 162.2 |
| F+NV | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0.000 | 0 | 0.0 |
| FFAN | 28 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0.000 | 0 | 0.0 |

Table 12 BASE SUMMARY

AIRCRAFT EXCEEDANCE DATA

| | | GOOD + GAP FILLED DATA | | | | | GOOD DATA ONLY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARCFT SN | LAST BASE | TOTAL HRS | EXC 5G | EXC 6G | EXC 7G | EXC 8G | GOOD HRS | EXC 5G | EXC 6G | EXC 7G | EXC 8G | EX 5G /1000 | EX 6G /1000 | EX 7G /1000 | EX 8G /1000 |
| 674595 | X | 677.6 | 450. | 118.5 | 14.2 | 2.5 | 96.9 | 184 | 4 | 0 | 0 | 1073.3 | 41.3 | 0.00 | 0.00 |
| 674596 | X | 1010.2 | 561. | 129.7 | 2.5 | .0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688220 | FTFA | 915.1 | 601. | 142.3 | 11.4 | 1.8 | 424.0 | 299 | 51 | 1 | 0 | 705.2 | 120.3 | 2.36 | 0.00 |
| 688222 | FSPM | 1629.9 | 722. | 375.5 | 54.9 | 10.5 | 856.8 | 366 | 200 | 27 | 6 | 427.2 | 233.4 | 31.51 | 7.00 |
| 688223 | FSPM | 2184.3 | 1082. | 503.9 | 77.3 | 13.3 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688224 | FTFA | 1194.3 | 846. | 231.7 | 27.7 | 3.8 | 458.9 | 462 | 73 | 5 | 0 | 1006.6 | 159.1 | 10.90 | 0.00 |
| 688225 | VNVP | 1150.1 | 1472. | 264.0 | 25.3 | 2.6 | 44.5 | 17 | 0 | 0 | 0 | 382.0 | 0.0 | 0.00 | 0.00 |
| 688226 | FRNV | 1464.8 | 1932. | 341.0 | 33.4 | 2.9 | 247.4 | 356 | 56 | 5 | 0 | 1439.0 | 226.4 | 20.21 | 0.00 |
| 688227 | X | 1284.0 | 1833. | 334.3 | 59.0 | 4.3 | 341.0 | 594 | 159 | 37 | 2 | 1741.9 | 466.3 | 108.50 | 5.87 |
| 688228 | FRNV | 1505.6 | 2132. | 418.9 | 53.9 | 3.0 | 642.0 | 1003 | 214 | 34 | 1 | 1562.3 | 333.3 | 52.96 | 1.56 |
| 688229 | VNVP | 1138.0 | 1536. | 231.3 | 24.0 | 2.2 | 233.0 | 351 | 77 | 3 | 0 | 1506.4 | 330.5 | 12.88 | 0.00 |
| 688230 | FRNV | 1622.0 | 2136. | 331.7 | 37.7 | 3.7 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688231 | FRNV | 1537.0 | 2135. | 348.0 | 31.1 | 3.1 | 711.2 | 891 | 141 | 11 | 1 | 1252.8 | 198.3 | 15.47 | 1.41 |
| 696188 | FRNV | 1652.8 | 2105. | 388.8 | 39.2 | 3.2 | 244.6 | 245 | 45 | 6 | 0 | 1001.6 | 184.0 | 24.53 | 0.00 |
| 696189 | X | 943.4 | 1219. | 232.3 | 16.3 | 2.2 | 455.4 | 581 | 87 | 5 | 1 | 1275.8 | 191.0 | 10.98 | 2.20 |
| 696190 | FRNV | 1413.0 | 1334. | 337.9 | 41.3 | 5.4 | 103.0 | 159 | 24 | 2 | 0 | 1543.7 | 233.0 | 19.42 | 0.00 |
| 696191 | FRNV | 1204.0 | 1641. | 302.9 | 57.0 | 3.8 | 419.2 | 616 | 117 | 39 | 2 | 1469.5 | 279.1 | 93.03 | 4.77 |
| 696192 | VNVP | 472.1 | 343. | 83.2 | 7.6 | 1.4 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696193 | FRNV | 1298.0 | 1796. | 324.8 | 35.7 | 2.6 | 459.1 | 673 | 137 | 15 | 1 | 1465.9 | 298.4 | 32.67 | 2.18 |
| 696194 | FRNV | 1437.8 | 1909. | 331.9 | 29.9 | 3.0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696195 | FRNV | 1335.0 | 1751. | 321.6 | 31.7 | 3.2 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696196 | VNVP | 926.3 | 1162. | 227.2 | 21.8 | 2.4 | 231.2 | 383 | 86 | 8 | 1 | 1656.6 | 372.0 | 34.60 | 4.33 |
| 696197 | RDRD | 1476.8 | 1924. | 352.9 | 34.4 | 2.5 | 976.7 | 1305 | 229 | 21 | 1 | 1336.1 | 234.5 | 21.50 | 1.02 |
| 696198 | GAMM | 1371.9 | 1673. | 331.3 | 23.4 | 1.5 | 691.8 | 833 | 151 | 9 | 0 | 1204.1 | 218.3 | 13.01 | 0.00 |
| 696199 | RDRD | 1583.3 | 1855. | 361.0 | 42.4 | 2.6 | 723.8 | 912 | 160 | 20 | 0 | 1249.7 | 219.2 | 27.49 | 0.00 |
| 696200 | FRNV | 1286.0 | 1695. | 269.8 | 26.7 | 1.6 | 488.0 | 613 | 83 | 11 | 0 | 1256.1 | 170.1 | 22.54 | 0.00 |
| 696201 | GAMM | 1590.5 | 2110. | 382.2 | 36.5 | 3.3 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696202 | RDRD | 1418.1 | 2043. | 418.4 | 53.9 | 10.1 | 597.6 | 985 | 221 | 35 | 8 | 1647.7 | 369.7 | 58.55 | 13.38 |
| 696203 | XHEA | 1638.5 | 2246. | 405.3 | 38.8 | 3.7 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696205 | RDRD | 1643.3 | 2194. | 330.7 | 33.0 | 3.3 | 1079.8 | 1456 | 197 | 20 | 2 | 1348.4 | 182.4 | 18.52 | 1.85 |
| 696206 | RDRD | 1712.2 | 2243. | 320.8 | 39.5 | 4.5 | 1084.5 | 1428 | 232 | 25 | 7 | 1316.7 | 213.9 | 23.05 | 6.45 |
| 696207 | GAMM | 1682.5 | 2117. | 335.6 | 39.8 | 3.7 | 1057.4 | 1075 | 190 | 16 | 0 | 1016.6 | 179.7 | 15.13 | 0.00 |
| 696208 | RDRD | 1439.0 | 1455. | 271.4 | 27.3 | 7.5 | 979.7 | 907 | 155 | 14 | 6 | 925.8 | 158.2 | 14.29 | 6.12 |
| 696209 | FRNV | 1535.0 | 1948. | 371.1 | 44.4 | 18.5 | 960.5 | 1181 | 223 | 30 | 17 | 1229.6 | 232.2 | 31.23 | 17.70 |
| 696210 | FRNV | 1521.0 | 2205. | 415.9 | 27.9 | 1.3 | 960.7 | 1472 | 273 | 15 | 0 | 1532.2 | 284.2 | 15.61 | 0.00 |
| 696212 | RDRD | 1735.9 | 2516. | 493.3 | 61.8 | 15.4 | 609.0 | 1025 | 227 | 37 | 13 | 1683.1 | 372.7 | 60.76 | 21.35 |
| 696213 | PLRD | 1497.5 | 1817. | 400.4 | 43.6 | 3.8 | 956.4 | 1171 | 263 | 28 | 2 | 1224.4 | 275.0 | 29.28 | 2.09 |
| 696214 | FRNV | 1771.0 | 2287. | 429.8 | 38.6 | 1.4 | 1141.6 | 1516 | 290 | 25 | 0 | 1328.0 | 254.0 | 21.90 | 0.00 |
| 696215 | RDRD | 1411.6 | 1805. | 403.9 | 47.7 | 3.1 | 817.6 | 1089 | 247 | 30 | 1 | 1331.9 | 302.1 | 36.69 | 1.22 |
| 696216 | FRNV | 1537.8 | 2117. | 312.3 | 13.9 | 2.2 | 1080.4 | 1440 | 190 | 7 | 1 | 1332.8 | 175.9 | 6.48 | .93 |
| 696217 | FRNV | 1721.0 | 2126. | 335.5 | 32.1 | 3.2 | 855.1 | 1011 | 188 | 12 | 1 | 1182.3 | 219.3 | 14.03 | 1.17 |
| 696218 | RDRD | 1559.0 | 1901. | 333.7 | 45.2 | 6.5 | 1102.5 | 1349 | 283 | 32 | 5 | 1223.6 | 256.7 | 29.02 | 4.54 |
| 696219 | MHMV | 1332.5 | 1711. | 272.6 | 19.8 | 1.3 | 838.3 | 988 | 142 | 7 | 0 | 1178.6 | 169.4 | 8.35 | 0.00 |
| 696221 | RDRD | 1456.1 | 1763. | 439.7 | 43.3 | 3.8 | 591.5 | 672 | 202 | 16 | 0 | 1136.1 | 341.5 | 27.05 | 0.00 |
| 696222 | RDRD | 1389.2 | 1613. | 319.3 | 24.5 | 3.7 | 893.8 | 1017 | 192 | 10 | 2 | 1137.8 | 214.9 | 11.19 | 2.24 |
| 696223 | RDRD | 1231.6 | 1439. | 342.5 | 47.1 | 7.2 | 829.7 | 948 | 242 | 36 | 6 | 1142.6 | 291.7 | 43.39 | 7.23 |
| 696224 | X | 1145.9 | 1171. | 221.2 | 23.1 | 3.5 | 692.1 | 629 | 106 | 7 | 2 | 908.8 | 153.2 | 10.11 | 2.89 |
| 696225 | RDRD | 1464.2 | 1979. | 407.3 | 43.2 | 3.7 | 569.8 | 567 | 105 | 14 | 1 | 995.1 | 184.3 | 24.57 | 1.76 |
| 696226 | RDRD | 1640.9 | 1981. | 336.0 | 35.5 | 3.0 | 997.9 | 1216 | 234 | 17 | 1 | 1218.6 | 234.5 | 17.04 | 1.00 |
| 696227 | RDRD | 1547.0 | 1813. | 330.1 | 32.3 | 4.2 | 924.8 | 1062 | 170 | 14 | 2 | 1148.4 | 183.8 | 15.14 | 2.16 |
| 696228 | RDRD | 1526.3 | 1940. | 422.7 | 51.3 | 2.7 | 994.3 | 1312 | 288 | 36 | 1 | 1319.5 | 289.7 | 36.21 | 1.01 |
| 696229 | RDRD | 1237.5 | 1567. | 337.6 | 39.3 | 4.8 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696230 | CRWU | 1635.2 | 2175. | 359.0 | 33.6 | 3.3 | 1194.1 | 1643 | 282 | 22 | 2 | 1375.9 | 236.2 | 18.42 | 1.67 |
| 696231 | RDRD | 1287.7 | 1679. | 287.6 | 22.9 | 2.2 | 892.6 | 1194 | 188 | 12 | 1 | 1337.7 | 210.6 | 13.44 | 1.12 |
| 696232 | RDRD | 1555.0 | 1743. | 355.6 | 35.8 | 2.1 | 947.3 | 1017 | 200 | 18 | 0 | 1073.6 | 211.1 | 19.03 | 0.00 |

Table 13 AIRCRAFT EXCEEDANCE DATA

ATTACHMENT TO A-70



COMPOSITE OF ALL AIRCRAFT

TOTAL HOURS = 456322.3 GOOD HOURS = 312987.6

GOOD DATA EXCEEDANCES

| 5G | 6G | 7G | 8G |
|---|---|---|---|
| 392919 | 73636 | 7098 | 703 |

GOOD DATA EXCEEDANCES PER 1000 HRS

| 5G | 6G | 7G | 8G |
|---|---|---|---|
| 1255.38 | 235.27 | 22.68 | 2.25 |

Table 14 COMPOSITE OF ALL AIRCRAFT

AIRCRAFT DAMAGE AND RATES

| | *-----PRESENT STATUS------* | | | | | *-----------------RATE DATA BASED ON PAST 12 MONTHS AVERAGE------------------* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARCFT SN | BASE CODE | LAST DATE | TOTAL HRS | DMG INDEX | R.L. HRS | HR /YR | DI /YR | BLHR /YR | EX-5G /YR | EX-6G /YR | EX-7G /YR | EX-8G /YR | DI /1000 | BLHR /1000 | EX-5G /1000 | EX-6G /1000 | EX-7G /1000 | EX-8G /1000 |
| 674585 | X | 7401 | 677.6 | .088 | 353 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 674586 | X | 7512 | 1019.2 | .144 | 574 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688220 | FTFA | 7609 | 915.1 | .124 | 496 | 208 | .026 | 104 | 103.8 | 42.0 | 4.77 | 1.19 | .125 | 502 | 498.5 | 201.8 | 22.89 | 5.72 |
| 688222 | FSPM | 7609 | 1629.9 | .196 | 735 | 267 | .032 | 130 | 93.6 | 15.0 | .06 | .01 | .121 | 486 | 350.2 | 56.2 | .22 | .04 |
| 688223 | FSPM | 7609 | 2184.3 | .265 | 1059 | 267 | .032 | 130 | 93.6 | 15.0 | .06 | .01 | .121 | 486 | 350.2 | 56.2 | .22 | .04 |
| 688224 | FTFA | 7609 | 119x.x | .160 | 640 | 208 | .026 | 104 | 103.8 | 42.0 | 4.77 | 1.19 | .125 | 502 | 498.5 | 201.8 | 22.89 | 5.72 |
| 688225 | VNVP | 7601 | 1169.1 | .194 | 775 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688226 | FBNV | 7609 | 1464.8 | .249 | 938 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 688227 | X | 7410 | 1234.0 | .210 | 840 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688228 | FBNV | 7609 | 1505.6 | .260 | 1041 | 230 | .035 | 141 | 281.1 | 44.8 | 4.95 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 688229 | VNVP | 7601 | 1132.0 | .208 | 331 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 688230 | FBNV | 7609 | 1622.0 | .278 | 1113 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 688231 | FBNV | 7609 | 1537.0 | .268 | 1070 | 230 | .035 | 141 | 281.1 | 44.8 | 4.95 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696188 | FBNV | 7609 | 1652.3 | .277 | 1110 | 230 | .035 | 141 | 281.1 | 44.8 | 4.95 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696189 | X | 7412 | 943.4 | .160 | 649 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696190 | FBNV | 7609 | 1413.0 | .205 | 819 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696191 | FBNV | 7609 | 1204.0 | .177 | 710 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696192 | VNVP | 7601 | 472.1 | .065 | 259 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696193 | FBNV | 7609 | 1298.0 | .231 | 926 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696194 | FBNV | 7609 | 1437.0 | .248 | 932 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696195 | FBNV | 7609 | 1335.0 | .227 | 909 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696196 | VNVP | 7601 | 826.3 | .150 | 599 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696197 | RDRD | 7608 | 1476.8 | .254 | 1015 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696198 | GAMH | 7609 | 1331.9 | .232 | 929 | 204 | .038 | 152 | 312.0 | 68.7 | 8.20 | .88 | .185 | 742 | 1525.7 | 336.0 | 40.12 | 4.29 |
| 696199 | RDRD | 7609 | 1586.3 | .251 | 1004 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696200 | FBNV | 7609 | 1236.0 | .216 | 863 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696201 | GAMH | 7609 | 1590.6 | .275 | 1099 | 204 | .038 | 152 | 312.0 | 68.7 | 8.20 | .88 | .185 | 742 | 1525.7 | 336.0 | 40.12 | 4.29 |
| 696202 | RDRD | 7608 | 1419.1 | .230 | 920 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696203 | XHEA | 7609 | 1698.5 | .292 | 1167 | 219 | .051 | 203 | 414.9 | 44.1 | 1.63 | 0.00 | .243 | 974 | 1989.9 | 211.7 | 7.80 | 0.00 |
| 696205 | RDRD | 7609 | 1643.3 | .271 | 1083 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696206 | RDRD | 7609 | 1712.2 | .272 | 1087 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696207 | GAMH | 7609 | 1682.5 | .275 | 1102 | 204 | .038 | 152 | 312.0 | 68.7 | 8.20 | .88 | .185 | 742 | 1525.7 | 336.0 | 40.12 | 4.29 |
| 696208 | RDRD | 7609 | 1436.9 | .205 | 819 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696209 | FBNV | 7608 | 1585.0 | .222 | 886 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696210 | FBNV | 7609 | 1521.0 | .306 | 1223 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696212 | RDRD | 7609 | 1735.9 | .275 | 1101 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696213 | RDRD | 7609 | 1437.5 | .249 | 998 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696214 | FBNV | 7609 | 1731.0 | .311 | 1246 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696215 | RDRD | 7609 | 1411.6 | .240 | 959 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696216 | FBNV | 7609 | 1597.8 | .279 | 1117 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696217 | FBNV | 7609 | 1721.0 | .291 | 1166 | 230 | .035 | 141 | 281.1 | 44.8 | 4.96 | .75 | .154 | 614 | 1224.7 | 195.1 | 21.59 | 3.26 |
| 696218 | RDRD | 7609 | 1569.0 | .249 | 997 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696219 | MHMV | 7609 | 1332.5 | .234 | 937 | 285 | .052 | 207 | 425.7 | 55.5 | 3.61 | .47 | .182 | 727 | 1435.5 | 194.9 | 12.67 | 1.65 |
| 696221 | RDRD | 7609 | 1456.1 | .257 | 1028 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696222 | RDRD | 7609 | 1383.2 | .231 | 925 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696223 | RDRD | 7608 | 1231.6 | .184 | 735 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696224 | X | 7506 | 1145.9 | .172 | 686 | 0 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.000 | 0 | 0.0 | 0.0 | 0.00 | 0.00 |
| 696225 | RDRD | 7608 | 1863.2 | .285 | 1152 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696226 | RDRD | 7609 | 1639.9 | .278 | 1110 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696227 | RDRD | 7609 | 1547.0 | .245 | 980 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696228 | RDRD | 7609 | 1526.3 | .258 | 1031 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696229 | RDRD | 7609 | 1297.5 | .205 | 819 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696230 | CRMU | 7607 | 1625.2 | .286 | 1145 | 235 | .099 | 398 | 512.3 | 87.9 | 3.18 | .20 | .424 | 1694 | 2181.8 | 374.2 | 13.53 | .86 |
| 696231 | RDRD | 7609 | 1297.7 | .224 | 896 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |
| 696232 | RDRD | 7608 | 1555.0 | .251 | 1004 | 221 | .040 | 161 | 310.0 | 69.4 | 7.44 | .77 | .182 | 730 | 1401.5 | 313.6 | 33.64 | 3.49 |

Table 15 AIRCRAFT DAMAGE AND RATES

AIRCRAFT DAMAGE BY YEAR

| ARCFT SN | BASE CODE | LAST DATE | 7609 | 7709 | 7809 | 7909 | 8009 | 8109 | 8209 | 8309 | 8409 | 8509 | 8609 | 8709 | 8809 | 8909 | 9009 | 9109 | 9209 | 9309 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DAMAGE INDEX BY YEAR AND MONTH FOR NEXT SEVENTEEN YEARS | | | | | | | | | | | | | | | | | |
| 674585 | X | 7401 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 | .088 |
| 674586 | X | 7512 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 | .144 |
| 688220 | FTFA | 7609 | .124 | .150 | .176 | .202 | .229 | .255 | .281 | .307 | .333 | .359 | .385 | .411 | .437 | .464 | .490 | .516 | .542 | .568 |
| 688222 | FSPM | 7609 | .196 | .229 | .261 | .294 | .326 | .359 | .391 | .424 | .456 | .489 | .521 | .554 | .586 | .618 | .651 | .683 | .716 | .748 |
| 688223 | FSPM | 7609 | .265 | .297 | .330 | .362 | .395 | .427 | .460 | .492 | .525 | .557 | .590 | .622 | .655 | .687 | .719 | .752 | .784 | .817 |
| 688224 | FTFA | 7609 | .160 | .186 | .212 | .238 | .264 | .291 | .317 | .343 | .369 | .395 | .421 | .447 | .473 | .499 | .526 | .552 | .578 | .604 |
| 688225 | VNVP | 7601 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 | .194 |
| 688226 | FBNV | 7609 | .249 | .285 | .320 | .355 | .390 | .426 | .461 | .496 | .531 | .567 | .602 | .637 | .672 | .708 | .743 | .778 | .813 | .849 |
| 688227 | X | 7410 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 | .210 |
| 688228 | FBNV | 7609 | .260 | .296 | .331 | .366 | .401 | .437 | .472 | .507 | .542 | .578 | .613 | .648 | .683 | .719 | .754 | .789 | .824 | .860 |
| 688229 | VNVP | 7601 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 | .208 |
| 688230 | FBNV | 7609 | .278 | .314 | .349 | .384 | .419 | .455 | .490 | .525 | .560 | .596 | .631 | .666 | .701 | .737 | .772 | .807 | .842 | .878 |
| 688231 | FBNV | 7609 | .263 | .303 | .318 | .373 | .409 | .444 | .479 | .514 | .550 | .585 | .620 | .655 | .691 | .726 | .761 | .796 | .832 | .867 |
| 696188 | FBNV | 7609 | .277 | .313 | .348 | .383 | .418 | .454 | .489 | .524 | .559 | .595 | .630 | .665 | .700 | .736 | .771 | .806 | .841 | .877 |
| 696189 | X | 7412 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 | .160 |
| 696190 | FBNV | 7609 | .205 | .240 | .275 | .311 | .346 | .381 | .416 | .452 | .487 | .522 | .557 | .593 | .628 | .663 | .698 | .734 | .769 | .804 |
| 696191 | FBNV | 7609 | .177 | .213 | .248 | .283 | .318 | .354 | .389 | .424 | .459 | .495 | .530 | .565 | .600 | .636 | .671 | .706 | .741 | .777 |
| 696192 | VNVP | 7601 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 | .065 |
| 696193 | FBNV | 7609 | .231 | .267 | .302 | .337 | .372 | .408 | .443 | .478 | .513 | .549 | .584 | .619 | .654 | .690 | .725 | .760 | .795 | .831 |
| 696194 | FBNV | 7609 | .248 | .283 | .319 | .354 | .389 | .424 | .460 | .495 | .530 | .565 | .601 | .636 | .671 | .706 | .742 | .777 | .812 | .847 |
| 696195 | FBNV | 7609 | .227 | .262 | .298 | .333 | .368 | .403 | .439 | .474 | .509 | .544 | .580 | .615 | .650 | .685 | .721 | .756 | .791 | .826 |
| 696196 | VNVP | 7601 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 | .150 |
| 696197 | RDRD | 7608 | .254 | .294 | .334 | .375 | .415 | .456 | .496 | .536 | .577 | .617 | .657 | .698 | .738 | .778 | .819 | .859 | .899 | .940 |
| 696198 | GAMH | 7609 | .232 | .270 | .308 | .346 | .384 | .422 | .460 | .498 | .536 | .574 | .612 | .649 | .687 | .725 | .763 | .801 | .839 | .877 |
| 696199 | RDRD | 7609 | .251 | .291 | .332 | .372 | .412 | .453 | .493 | .533 | .574 | .614 | .654 | .695 | .735 | .776 | .816 | .856 | .897 | .937 |
| 696200 | FBNV | 7609 | .216 | .251 | .286 | .321 | .357 | .392 | .427 | .462 | .498 | .533 | .568 | .603 | .639 | .674 | .709 | .744 | .780 | .815 |
| 696201 | GAMH | 7609 | .275 | .313 | .351 | .389 | .426 | .464 | .502 | .540 | .578 | .616 | .654 | .692 | .730 | .768 | .806 | .844 | .881 | .919 |
| 696202 | RDRD | 7608 | .230 | .270 | .311 | .351 | .392 | .432 | .472 | .513 | .553 | .593 | .634 | .674 | .714 | .755 | .795 | .835 | .876 | .916 |
| 696203 | XMEA | 7609 | .292 | .342 | .393 | .444 | .495 | .546 | .596 | .647 | .698 | .749 | .799 | .850 | .901 | .952 | 1.002 | 1.053 | 1.104 | 1.155 |
| 696205 | KDSD | 7609 | .271 | .311 | .351 | .392 | .432 | .472 | .513 | .553 | .594 | .634 | .674 | .715 | .755 | .795 | .836 | .876 | .916 | .957 |
| 696206 | RDRD | 7609 | .272 | .312 | .352 | .393 | .433 | .473 | .514 | .554 | .595 | .635 | .675 | .716 | .756 | .796 | .837 | .877 | .917 | .958 |
| 696207 | GAMH | 7609 | .275 | .313 | .351 | .389 | .427 | .465 | .503 | .541 | .579 | .617 | .655 | .693 | .731 | .768 | .806 | .844 | .882 | .920 |
| 696208 | RDRD | 7609 | .205 | .245 | .285 | .326 | .366 | .407 | .447 | .487 | .528 | .568 | .608 | .649 | .689 | .729 | .770 | .810 | .850 | .891 |
| 696209 | FBNV | 7608 | .222 | .257 | .292 | .327 | .363 | .398 | .433 | .468 | .504 | .539 | .574 | .609 | .645 | .680 | .715 | .750 | .786 | .821 |
| 696210 | FBNV | 7609 | .306 | .341 | .376 | .412 | .447 | .482 | .517 | .553 | .588 | .623 | .658 | .694 | .729 | .764 | .799 | .835 | .870 | .905 |
| 696212 | RDRD | 7609 | .275 | .316 | .356 | .396 | .437 | .477 | .517 | .558 | .598 | .638 | .679 | .719 | .759 | .800 | .840 | .880 | .921 | .961 |
| 696213 | RDRD | 7609 | .249 | .290 | .330 | .370 | .411 | .451 | .492 | .532 | .572 | .613 | .653 | .693 | .734 | .774 | .814 | .855 | .895 | .935 |
| 696214 | FBNV | 7609 | .311 | .347 | .382 | .417 | .452 | .488 | .523 | .558 | .593 | .629 | .664 | .699 | .735 | .770 | .805 | .840 | .876 | .911 |
| 696215 | RDRD | 7609 | .240 | .280 | .320 | .361 | .401 | .442 | .482 | .522 | .563 | .603 | .643 | .684 | .724 | .764 | .805 | .845 | .885 | .926 |
| 696216 | FBNV | 7609 | .279 | .315 | .350 | .385 | .420 | .456 | .491 | .526 | .561 | .597 | .632 | .667 | .702 | .738 | .773 | .808 | .843 | .879 |
| 696217 | FBNV | 7609 | .291 | .327 | .362 | .397 | .432 | .468 | .503 | .538 | .573 | .609 | .644 | .679 | .714 | .750 | .785 | .820 | .855 | .891 |
| 696218 | RDRD | 7609 | .249 | .290 | .330 | .370 | .411 | .451 | .491 | .532 | .572 | .612 | .653 | .693 | .734 | .774 | .814 | .855 | .895 | .935 |
| 696219 | MHHV | 7609 | .234 | .286 | .338 | .390 | .441 | .493 | .545 | .596 | .648 | .700 | .751 | .803 | .855 | .907 | .958 | 1.010 | 1.062 | 1.113 |
| 696221 | RDRD | 7609 | .257 | .297 | .338 | .378 | .418 | .459 | .499 | .539 | .580 | .620 | .660 | .701 | .741 | .782 | .822 | .862 | .903 | .943 |
| 696222 | RDRD | 7609 | .231 | .272 | .312 | .352 | .393 | .433 | .473 | .514 | .554 | .594 | .635 | .675 | .715 | .756 | .796 | .836 | .877 | .917 |
| 696223 | RDRD | 7608 | .184 | .224 | .265 | .305 | .345 | .386 | .426 | .466 | .507 | .547 | .587 | .628 | .668 | .708 | .749 | .789 | .829 | .870 |
| 696224 | X | 7506 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 | .172 |
| 696225 | RDRD | 7608 | .288 | .328 | .369 | .409 | .449 | .490 | .530 | .570 | .611 | .651 | .692 | .732 | .772 | .813 | .853 | .893 | .934 | .974 |
| 696226 | RDRD | 7609 | .278 | .318 | .358 | .399 | .439 | .479 | .520 | .560 | .600 | .641 | .681 | .721 | .762 | .802 | .843 | .883 | .923 | .964 |
| 696227 | RDRD | 7609 | .245 | .285 | .326 | .366 | .406 | .447 | .487 | .528 | .568 | .608 | .649 | .689 | .729 | .770 | .810 | .850 | .891 | .931 |
| 696228 | RDRD | 7609 | .258 | .298 | .338 | .379 | .419 | .460 | .500 | .540 | .581 | .621 | .661 | .702 | .742 | .782 | .823 | .863 | .903 | .944 |
| 696229 | RDRD | 7609 | .205 | .245 | .285 | .326 | .366 | .406 | .447 | .487 | .528 | .568 | .608 | .649 | .689 | .729 | .770 | .810 | .850 | .891 |
| 696230 | CPRJ | 7607 | .286 | .386 | .485 | .585 | .684 | .784 | .883 | .982 | 1.082 | 1.181 | 1.281 | 1.380 | 1.480 | 1.579 | 1.679 | 1.778 | 1.878 | 1.977 |
| 696231 | RDRD | 7609 | .224 | .264 | .305 | .345 | .385 | .426 | .466 | .506 | .547 | .587 | .627 | .668 | .708 | .749 | .789 | .829 | .870 | .910 |
| 696232 | RDRJ | 7608 | .251 | .291 | .332 | .372 | .412 | .453 | .493 | .534 | .574 | .614 | .655 | .695 | .735 | .776 | .816 | .856 | .897 | .937 |
| 696234 | RDRC | 7609 | .275 | .315 | .355 | .396 | .436 | .476 | .517 | .557 | .597 | .638 | .678 | .718 | .759 | .799 | .840 | .880 | .920 | .961 |

Table 16 AIRCRAFT DAMAGE BY YEARS

TABLE I.7-2 INSPECTION/MODIFICATION INTERVALS FOR CRITICAL ITEMS (EQUIVALENT BASELINE SPECTRA)

| INSPECTION LEVEL: | ORGANIZATIONAL OR INTERMEDIATE | DEPOT LEVEL | ORGANIZATIONAL OR INTERMEDIATE | DEPOT LEVEL | ORGANIZATIONAL OR INTERMEDIATE | DEPOT LEVEL | ORGANIZATIONAL OR INTERMEDIATE |
|---|---|---|---|---|---|---|---|
| DAMAGE INDEX (3): TIME (HOURS): | .25 1000 | .50 2000 | .75 3000 | 1.00 4000 | 1.25 5000 | 1.50 6000 | 1.75 7000 |
| CRITICAL ITEM (2): Wing Skin @ Pylon Holes | X | X | X | X | X | X | X |
| 480 BHD | | X(1) | | | | X | |
| Yw = 24.6 | | X | | X | | X | |
| Lug Shank | | | X | | | X | |
| Lug Hole | | | | | X | | |
| Yw = 53.7 | | | X | | | X | |
| Yw = 32.2 | | | | | | X | |
| BL-0 | | | | X | | | |

NOTES:

(1) MODIFICATION OF 1.50 DIA. LUG HOLE (AIRPLANES 1 THROUGH 391) IS REQUIRED, FOR AIRPLANES 392 & SUBS INSPECTION OF 1.75 DIA. IS REQUIRED

(2) PYLON = WCS LOWER SKIN, INBOARD PYLON POST (ITEM 3 & ITEM 7)
480 BHD = BULKHEAD STA. 480, WING AFT ATTACH LUG, (ITEM 55) 1.50 DIA. (AIRPLANES 1 THROUGH 391) & 1.75 DIA. HOLE (AIRPLANES 392 & SUBS)
24.6 = WCS LOWER SKIN, WING ATTACH LUB, Yw = 24.6 (ITEM 14 & ITEM 15)
LUG SHANK = WCS, WOP FOLD LUG Yw = 135.2 (ITEM 31/40) LUG SHANK
LUG HOLE = WCS, WOP FOLD LUG Yw = 135.7 (ITEM 31/40) LUG HOLE
Yw = 53.7 = WCS LOWER SKIN, REAR SPAR & REAR SPAR CAP (ITEM 18)
Yw = 32.2 = WCS LOWER SKIN, 5TH SPAR Yw = 32.0 (ITEM 1)
BL-0 = WCS LOWER SKIN, CENTER SPLICE, REAR SPAR (ITEM 10): WCS LOWER SKIN 5TH SPAR SPLICE (ITEM 9)

(3) DAMAGE INDEX $= \frac{\text{TIME (HOURS)}}{4000}$ EQUIVALENT BASELINE

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: A-10

FLEET INFORMATION

NO. OF AIRCRAFT: 80 oper at present 733 planned : YEAR SERVICE BEGAN: Nov. 1975

SYSTEM MANAGEMENT: ASD, A-10 SPO

DATE TRANSFERRED TO AFLC: EST May-Oct 1979 Sacramento

USING COMMAND: TAC

PRIMARY BASE: Davis Monthan, Myrtle Beach, Nellis

PRIMARY MISSION TYPES: Ground Attack, Air-Ground, Nav.

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | Fatigue Damage |
| FULL-SCALE CYCLIC TEST: | 2 + LifeTimes | 1979 1/2-2 life-times | Repaired and New Spectrum - CA |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | X | | |
| DADTA INITIAL: | X | | |
| STRENGTH SUMMARY: | Initial | | Update to follow |
| TRACKING SYSTEM DESIGN: | X | | |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | | Start July 80 | |
| BASELINE OPS SPECTRA: | | | No |
| DADTA-FINAL: | | | No |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | SA160R9401 | Fairchild |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| L/ESS Methodology | SR160R0005 | Fairchild |
| Fatigue Load Spectra | SR160R0003 | Fairchild |

A/C Type: A-10 (Continued)

IAT PROGRAM

ANALYSIS METHOD: Fatigue Damage Miner's Rule - Coeff by Mission Type and Nz Level - 10 control points - 8 tracked components - (crack growth analysis being developed)

APPLICABLE REPORT:

DATA COLLECTION: RECORDER: (0.3, 2.5, 3, 4, 5.5, 7) CA CP-106 FORM: Flt. log (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: every flight sent monthly :TECH.ORDERS: T01-10A-2-34MS-1

DATE STARTED: 12/76 HRS.RECORDED: % USABLE DATA: 90%

DATA COLLECTION PROBLEMS: Mission Type Not Completed, Missing Forms.

DATA REDUCTION: WHO DOES IT? Fairchild

HOW IS IT CHECKED? Manual and Automatic Screening

TECHNIQUE TO RECOVER MISSING DATA: Small gaps by estimating mission - large gaps by a mission composite

LIST PROCESSING STEPS: Forms to FRC, Screened, to keypunch forms , keypunch, screening run, accum cycles data base, usage report (quarterly), (done monthly now), damage report (6 mo. or on demand)

OUTPUT CONTENTS (ATTACH SAMPLES): Projected linear basis on dam/hr by aircraft by control point

LIST PERMANENT FILES: RAW DATA? Forms and Tape

PROCESSED DATA? Accum. Cycles (disc and tape)

WHO EVALUATES OUTPUT? FRC

APPLICATIONS: SCHEDULING? No schedules inspections (maybe in future)

ANALYSIS UPDATE? used for revised spectrum

TO DETECT CHANGE IN USAGE? No

REMARKS: No use yet - SPO would like to use MACAIR approach to crack tracking. FRC may prefer a crack growth curve by mission per counter window. Scheduled to decide by April 1979.

L/ESS PROGRAM

ANALYSIS METHOD: Range - Pair - Range to stress to damage, 10 locations, uses analytical stress equation, data compressed about 100-1,

APPLICABLE REPORT:

DATA COLLECTION BASE: (15 now)

NO. OF AIRCRAFT: 20% RECORDING DEVICE: MXU-553 (Attach Description)

PARAMETERS RECORDED: (Attach List)

L/ESS START/STOP DATES: Mid 1976 HRS. RECORDED: ~400

% USABLE DATA: 15-20 DATA RETRIEVAL FREQ. 15 hours

DEFINITION OF USABLE DATA: $N_Z$, V, NY, Miss.,

COLLECTION PROBLEMS: Thumbwheel data bad, tapes not changed

DATA REDUCTION: WHO DOES IT? FRC/ASIMIS

HOW IS IT CHECKED? Mostly Automatic, ASIMIS sends Histograms

LIST STEPS: ASIMIS R/T compressed, tape to FRC

TECHNIQUE TO RECOVER MISSING PARAMETERS: None, excluded from specific tables when parameter is bad.

OUTPUT CONTENTS (Attach Sample):

See SR160R0011, Quarterly Usage Program Report

LIST PERMANENT FILES: RAW DATA? Yes

PROCESSED DATA? Peaks tape, stress tape, (eventually will save peaks and intermediate values)

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:

Planned for future (probably after 3000 hours)

TO CHECK IAT DATA?

TO DETECT CHANGE IN USAGE?

REMARKS: Processing time to peaks 1 hour tape stress to damage ~3min/tape

A/C TYPE: A-10 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Not Completed - A/C is currently on a phase maintenance program. Any cracks are reported and repaired.

INSPECTION INTERVALS: None at present - lower wing skin to be cold worked at 1000 hours (up to 152), to be modified above 152

RANGE OF CRITICAL CRACK LENGTHS:

Initial flaw .01 inch

Critical flaw 1.0 inch

SPECIAL COMPONENT INSPECTIONS: Interchangeable wing panels used ACMS to track components

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS: Strain Survey on D,T E Airplane at Edwards

APPLICABLE DOCUMENTS:

SA160R9412, Fracture Analysis Spectrum Sensitivity Study

A/C TYPE: A-10 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

Software to ASIMIS (1980?) - Documentation to be defined

Transition by May 1980

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE: IAT Forms with MXU Data

ORGANIZATIONAL CHANGES PENDING: 1980 Transition to ALC

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS: None

METHODS WHICH HAVE WORKED WELL: Written Forms worked good

DEFICIENCIES IN CURRENT METHODS:

Flight recorder records too much data

Thumbwheels not used

ATTACHMENT TO A-10 ②

A-10 FLIGHT LOG — AIRCRAFT STRUCTURAL INTEGRITY PROGRAM

AIRCRAFT SERIAL NUMBER ☐☐☐☐☐☐ DATE (DAY | MONTH | YEAR) ☐☐☐☐☐☐

BASE ☐☐ USE BASE CODE PER T.O. 1-10A-2-34MS-1

FLIGHT TIME (HRS) ☐☐☐☐

TOTAL TIME OF A/C AFTER FLIGHT (HRS) ☐☐☐☐.☐

MISSION ☐☐☐ USE MISSION CODE PER T.O. 1-10A-2-34MS-1

TAKEOFF WEIGHT (LBS) ☐☐☐☐☐

TAKEOFF FUEL (LBS) ☐☐☐☐☐

LANDING WEIGHT (LBS) ☐☐☐☐☐

ROUNDS OF AMMO ☐☐☐☐ ENTER NUMBER ON BOARD AT TAKEOFF

IN-FLIGHT REFUELINGS ☐ ENTER NUMBER OF ENGAGEMENTS (WET OR DRY)

LANDINGS ☐☐ ENTER TOTAL INCLUDING TOUCH AND GO

COUNTING ACCELEROMETER

COUNTER 1 ☐☐☐☐

COUNTER 2 ☐☐☐☐

COUNTER 3 ☐☐☐☐

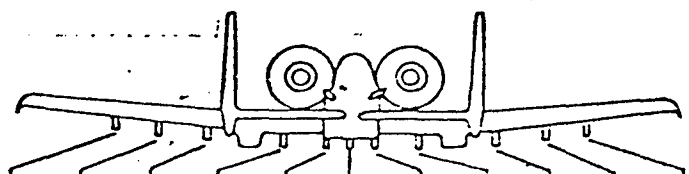
COUNTER 4 ☐☐☐☐

COUNTER 5 ☐☐☐☐

COUNTER 6 ☐☐☐☐

ETI ☐☐☐☐

AIRCRAFT CONFIGURATION



| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

☐☐☐ FOR DATA PROCESSING ONLY

Aircraft Serial Number ______

Base ______

Date ______

Flight Time ______

Total Time of A/C After Flight ______

Mission ______

Takeoff Weight ______

Takeoff Fuel (lb) ______

Rounds of Ammo ______

Ballast ______

In-Flight Refueling (Wet or Dry) ______

Number of Landings ______

Landing Weight ______

| Station | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Store(s) | | | | | | | | | | | |

"g" Counter

| Counter Number | Readings |
|---|---|
| 1 | ______ |
| 2 | ______ |
| 3 | ______ |
| 4 | ______ |
| 5 | ______ |
| 6 | ______ |
| ETI | ______ |

Figure 1-2. Flight Log

## 2.0 SERVICE LOADS RECORDER PROGRAM

### 2.1 GENERAL

The purpose of the service loads recorder is to assess the applicability of the design loads/environment spectrum to actual service usage. In order to accomplish this, 20% of the fleet will be equipped with recorders which is in accordance with the requirement of reference 1. These recorder-equipped aircraft will be distributed throughout the fleet with flexibility to move the recorders to other aircraft as required. To accommodate this flexibility, 50% of the airplanes are provided with complete "Group A" provisions to accept the government furnished recorders and associated multiplexers and transducers. For ease of tracking, it was established that all odd number aircraft (manufacturer's number) will be provided with the aforementioned provisions and the first and seventh aircraft of every ten will receive the recorder system.

In accordance with the above, two DT&E aircraft will receive the recorder systém and one aircraft will receive provisions. The purpose of the service load recorder on these aircraft, primarily, is to check-out the recording system and the data reduction and analysis programs, as well as obtaining usage information.

### 2.2 MEASURED PARAMETERS

The parameters to be recorded during the service load program are the following:

- Pressure Altitude
- Airspeed
- Normal Acceleration
- Lateral Acceleration
- Pitch Rate
- Yaw Rate
- Roll Rate
- One (1) Structural Strain
- Deceleron Position
- Total Fuel
- Time

The following event signals shall also be recorded:

1) Gun firing
2) Trailing-edge flap actuation
3) Aircraft weight on wheels
4) Store separation at all pylon stations on one wing and fuselage stations.

TABLE 4

A10-A USAGE REPORT

BASE = DAVIS-MONTHAN TAIL NO = COMPOSITE

| MISSION | | OCCURRENCES 0.3 | 2.5 | 3.0 | 4.0 | 5.5 | 7.0 | TIME |
|---|---|---|---|---|---|---|---|---|
| SA | (T) | 1267 | 14482 | 10637 | 5112 | 1980 | 521 | 431.37 |
| | (E) | 221 | 1449 | 1079 | 469 | 141 | 28 | 52.12 |
| | (N) | 2937 | 33572 | 24658 | 11850 | 4590 | 1207 | 1000.00 |
| SAT | (T) | 1218 | 8103 | 5641 | 2264 | 569 | 72 | 301.42 |
| | (E) | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| | (N) | 4040 | 26882 | 18714 | 7511 | 1887 | 238 | 1000.00 |
| SAR | (T) | 164 | 2460 | 1822 | 843 | 103 | 6 | 54.58 |
| | (E) | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| | (N) | 3004 | 45071 | 33382 | 15445 | 1887 | 109 | 1000.00 |
| FCF | (T) | 135 | 851 | 630 | 286 | 93 | 17 | 65.03 |
| | (E) | 5 | 146 | 102 | 55 | 26 | 4 | 9.95 |
| | (N) | 2075 | 13086 | 9687 | 4397 | 1430 | 261 | 1000.00 |
| CV | (T) | 6290 | 38052 | 26180 | 11425 | 1895 | 166 | 3264.60 |
| | (E) | 378 | 2620 | 1836 | 804 | 144 | 7 | 275.74 |
| | (N) | 1926 | 11655 | 8019 | 3499 | 580 | 50 | 1000.00 |
| GA | (T) | 4265 | 48400 | 33525 | 17435 | 8885 | 2678 | 1653.68 |
| | (E) | 361 | 4284 | 2880 | 1500 | 697 | 265 | 145.14 |
| | (N) | 2579 | 29268 | 20272 | 10543 | 5372 | 1619 | 1000.00 |
| GAT | (T) | 3948 | 25308 | 17365 | 7789 | 2168 | 340 | 1021.16 |
| | (E) | 390 | 2502 | 1725 | 749 | 183 | 46 | 94.62 |
| | (N) | 3866 | 24783 | 17005 | 7627 | 2123 | 332 | 1000.00 |
| BFM | (T) | 577 | 1870 | 1399 | 681 | 123 | 10 | 74.06 |
| | (E) | 3 | 13 | 10 | 3 | 1 | 0 | 0.0 |

## TABLE 2

SR160R001
31 March 1978

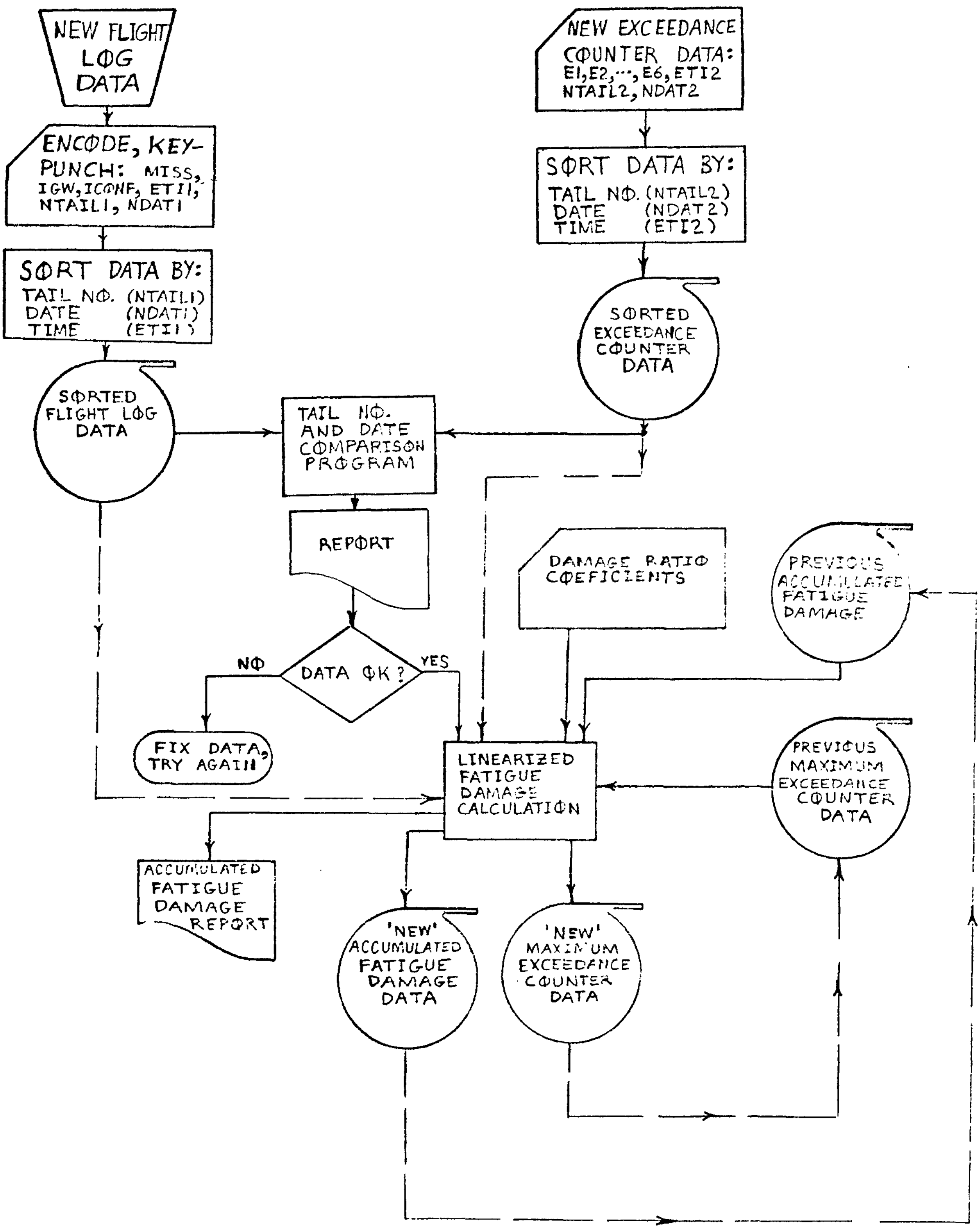
A10-A USAGE REPORT FROM FLIGHT RECORDER DATA

BASE = 03 MYRTLE BEACH TAIL NO = COMP DATE = 03/10/78

| MISSION | | -2.25 | -1.75 | -1.25 | -0.75 | -0.25 | EXCEEDENCES 1.75 | 2.25 | 2.75 | 3.25 | 3.75 | 4.25 | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.25 | 7.75 | TIME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAS | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0. |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| ESC | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| HAR | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0. |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| FCF | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| CV | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| DEP | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| GA | (T) | 6 | 6 | 6 | 6 | 9 | 2776 | 1380 | 1009 | 693 | 477 | 343 | 263 | 202 | 135 | 72 | 37 | 13 | 4 | 46 |
| | (H) | 131 | 131 | 131 | 131 | 196 | 60757 | 30203 | 22083 | 15167 | 10439 | 7616 | 5265 | 4421 | 2954 | 1575 | 809 | 393 | 87 | 1000 |
| GAT | (T) | 6 | 6 | 6 | 6 | 6 | 130 | 29 | 19 | 11 | 8 | 6 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 2. |
| | (H) | 2943 | 2943 | 2943 | 2943 | 2943 | 63777 | 14227 | 9321 | 5396 | 3924 | 2943 | 2452 | 490 | 0 | 0 | 0 | 0 | 0 | 1000 |
| IFM | (T) | 0 | 2 | 2 | 2 | 3 | 597 | 362 | 300 | 219 | 152 | 103 | 61 | 30 | 10 | 1 | 1 | 0 | 0 | 13 |
| | (H) | 0 | 158 | 158 | 158 | 238 | 47449 | 28772 | 23844 | 17406 | 12081 | 8186 | 4843 | 2384 | 794 | 79 | 79 | 0 | 0 | 1000 |
| SA | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0. |
| | (H) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 . | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 |
| SAT | (T) | 1 | 1 | 1 | 1 | 1 | 170 | 78 | 51 | 37 | 26 | 19 | 13 | 5 | 0 | 0 | 0 | 0 | 0 | 2 |
| | (H) | 473 | 473 | 473 | 473 | 473 | 80420 | 36898 | 24126 | 17503 | 12299 | 8988 | 6149 | 2365 | 0 | 0 | 0 | 0 | 0 | 1000 |
| TES | (T) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

ATTACHMENT [illegible]

# DATA FLOW FOR LINEARIZED FATIGUE DAMAGE CALCULATION (VERSION 1)



## LIST OF PROGRAMS

A) Service Life Recorder Programs:

| | ID | NAME | REMARKS |
|---|---|---|---|
| 1) | DD610200 | Pre-processor | Compress Data |
| 2) | D610200Z | Service Life | Recorder Main Program |
| 3) | D610200W | COPY9 | Used to merge new recorder |
| 4) | D610200B | MERGE 9 | Used to merge new recorder into compressed data base |
| 5) | DK610200 | Tape Editor | Used to edit compressed data |
| 6) | DH610200 | Data bank update utility | Prints selected data bank records; clear selected records; changes selected records |
| 7) | DY610200 | Report writer | Generates formatted reports |

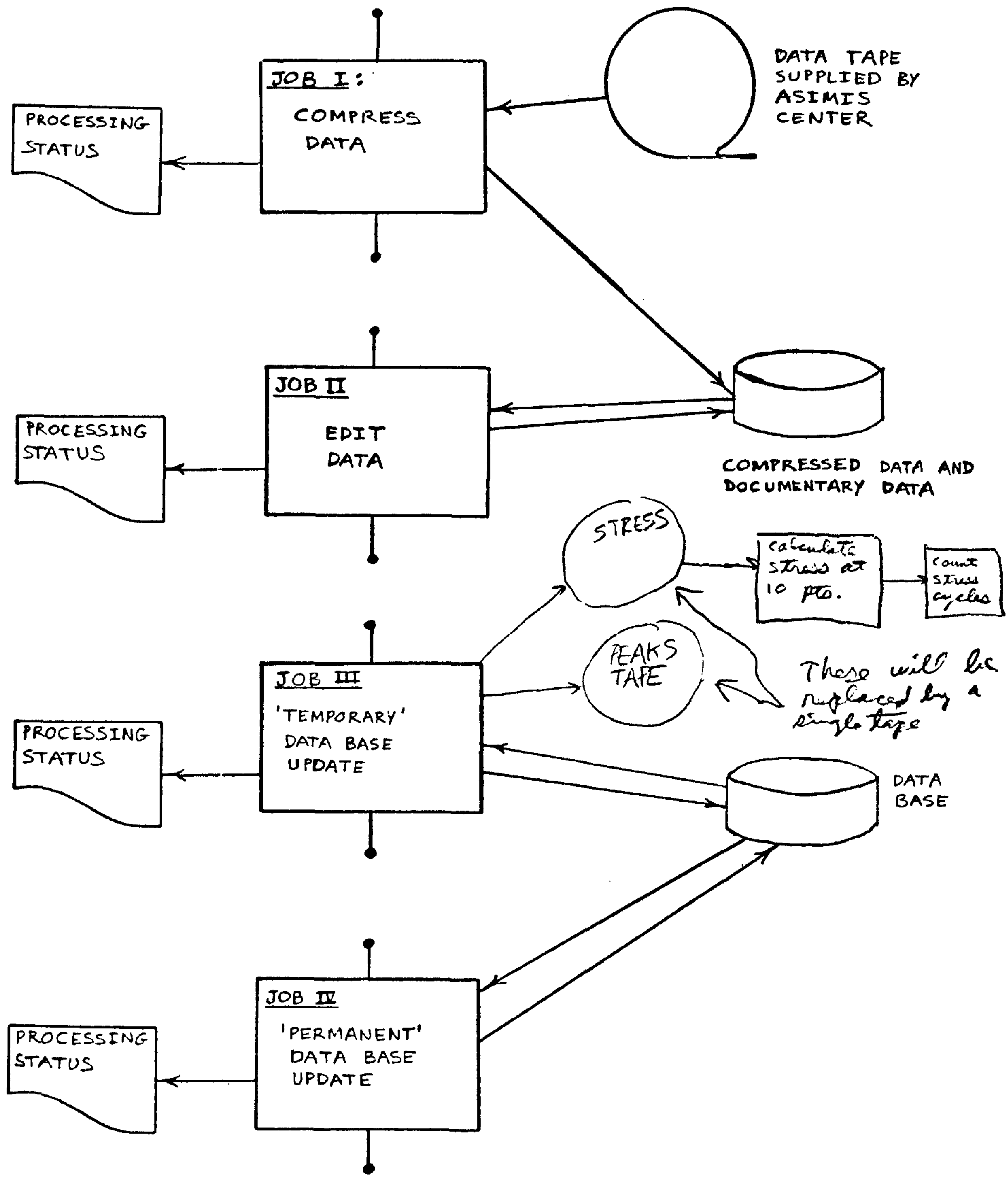
B) Linearized Fatigue Damage Programs

| | ID | NAME | REMARKS |
|---|---|---|---|
| 1) | DS610200 | Fatigue Damage Calculation (Version 1) | Stores accumulated fatigue damage |
| 2) | DJ610200 | Fatigue Damage Calculation (Version 2) | Stores accumulated cycles |

C) General Purpose IBM Utility Programs

1) IEBGENER - copies data sets
2) IEHPROGM - "clears" disk storage
3) IEHDASDR - copies data stored on disks to tape; or restores data to disk from tape.

# FLIGHT RECORDER TAPE PROCESSING



## SAMPLE DECK SET-UPS FOR FLIGHT RECORDER TAPE PROCESSING

### JOB I (COMPRESS DATA)

```
// EXEC PREPRØ,TAPE=RAX31C
```

### JOB II (EDIT DATA)

```
// EXEC EDIT,TAPE=RAX31C
```

⋮

EDIT 'INPUT DATA' SET

### JOB III ('TEMPORARY' DATA BASE UPDATE)

```
// EXEC DBUTM,TAPE=RAX31C
```

⋮

CONTROL DATA SETS

### JOB IV ('PERMANENT' DATA BASE UPDATE)

```
// EXEC PERMUP
```

⋮

CONTROL DATA SET

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: A-37B

FLEET INFORMATION

NO. OF AIRCRAFT: ~200 : YEAR SERVICE BEGAN: 1967

SYSTEM MANAGEMENT: SA ALC

DATE TRANSFERRED TO AFLC:

USING COMMAND: National Guard, AFR

PRIMARY BASE:

PRIMARY MISSION TYPES: Ground Attack, Tactical Training

REMARKS: Design life ~7000 hours

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | x | | ~~flt-by-flt 2 tests~~ |
| FULL-SCALE CYCLIC TEST: | x | | 28,000&42,000 hrs |
| FULL-SCALE STATIC TEST: | x | | |
| DAMAGE TOLERANCE TESTS: | | N/A | |
| DADTA INITIAL: | | proposed | |
| STRENGTH SUMMARY: | x | | |
| TRACKING SYSTEM DESIGN: | x | | |
| L/ESS DESIGN: | x | | |
| FSM PLAN: | x | | |
| BASELINE OPS SPECTRA: | x | | |
| DADTA-FINAL: | | N/A | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| A-37 Wing Fatigue Test | 318E-7516-021 | 22 Dec 75 ASD latest report |
| A-37B LHR Group A Kit | | |
| A-37B LHR Tech. Manual | | |

A/C Type: A-37B (Continued)

IAT PROGRAM

ANALYSIS METHOD: Miner's Damage parametric by mission type.
14 control points

APPLICABLE REPORT:

DATA COLLECTION: RECORDER: FORM: ~~AFTO 12~~ AFTO 781 (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: Each flight :TECH.ORDERS:

DATE STARTED: HRS.RECORDED: % USABLE DATA: 90+

DATA COLLECTION PROBLEMS: Pilots sometimes didn't enter mission type

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Manually checked for missing or conflicting data

TECHNIQUE TO RECOVER MISSING DATA: Average damage per base used for gap-fill

LIST PROCESSING STEPS: Form → Manual review & counted → keypunch → edit check → tape update → damage program quarterly

OUTPUT CONTENTS (ATTACH SAMPLES):

LIST PERMANENT FILES: RAW DATA? Usage data tape

PROCESSED DATA? Damage tape

WHO EVALUATES OUTPUT?

APPLICATIONS: SCHEDULING? Carry-thru mods and inspections

ANALYSIS UPDATE?

TO DETECT CHANGE IN USAGE?

REMARKS: Crude approach but worked fairly well. Of 10 carry-thru's pulled for mod, two had cracks. 781 form were sent in directly from base, info was keypunched, and forms were returned.

L/ESS PROGRAM

ANALYSIS METHOD: Fatigue, 1974 to present

APPLICABLE REPORT: ______

DATA COLLECTION BASE: 5 per base

NO. OF AIRCRAFT: 24→23 RECORDING DEVICE: MXU-553 (Attach Description)

PARAMETERS RECORDED: ______ (Attach List)

L/ESS START/STOP DATES: 1975 (approx) HRS. RECORDED: 2500+

% USABLE DATA: 2-30% of data recd DATA RETRIEVAL FREQ. 12 hr.

DEFINITION OF USABLE DATA: See report

COLLECTION PROBLEMS: Doc. data not entered

DATA REDUCTION: WHO DOES IT? One year at Cessna ASIMIS

HOW IS IT CHECKED? ______

LIST STEPS: ______

TECHNIQUE TO RECOVER MISSING PARAMETERS: ______

OUTPUT CONTENTS (Attach Sample): ______

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? ______

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: ______

TO CHECK IAT DATA? ______

TO DETECT CHANGE IN USAGE? ______

REMARKS: Preferred strains to motion data, particularly for taxi. Recorder response frequency can't get taxi.

Recorder malfunctioned during accelerated stalls.

A/C TYPE: A-37B (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:

INSPECTION INTERVALS: Phase inspections

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS: Carry-through replacement resulting from tracking program

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: A-37B (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: ASIMIS not receiving proper direction from SAALC. Funding appears stalled.

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS:

METHODS WHICH HAVE WORKED WELL: Form programs worked well. F-4 program appears best. Simple methods work best.

DEFICIENCIES IN CURRENT METHODS: MXU data reduction/validation was cumbersome. Delivery of software was a difficult task. Software documentation is difficult. Cycle-by-cycle damage computation is overwhelming.

ATTACHMENT TO A-37B

# A-37B AIRCRAFT FATIGUE TRACKING RECORD

| AIRCRAFT SERIAL NUMBER (1–8) | MONTH (11–12) | YEAR (13–14) | BASE (17–18) | TOTAL AIRFRAME HOURS PRIOR TO FIRST FLIGHT OF MONTH |
|---|---|---|---|---|
| 6 8 0 0 7 9 2 7 | 1 0 | 7 7 | 1 5 | 2608.9 |

## MISSION DATA SUMMARY

| STORES CONF 22 | 23 | 24 | MISSION CODE 29 | 30 | LDGS 33 | 34 | FLIGHT TIME 37 | 38 | 39 | S/C 47 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 6 | 1 | 9 | 0 | 1 | | . | 9 | 1 |
| 1 | 0 | 6 | 1 | 9 | 0 | 1 | 1 | . | 5 | 1 |
| 4 | 1 | 1 | 1 | 4 | 0 | 1 | 2 | . | 0 | 1 |
| 4 | 1 | 1 | 1 | 4 | 0 | 1 | 1 | . | 2 | 1 |
| | | | | | | | | . | | 1 |
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| | | | | | | | | . | | 1 |
| | | | | | | | | . | | 1 |
| | | | | | | | | . | | 1 |

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## SPECIAL INSPECTION REPORTING

| LOCATION/DESCRIPTION | DATE C/W | AIRFRAME HOURS | TYPE PROBE | RESULTS |
|---|---|---|---|---|
| BUTT LINE 24.0 UPPER FORWARD CARRY THRU | | | ☐ HAND HELD ☐ MOTORIZED | ☐ NEGATIVE ☐ CRACK |
| BUTT LINE 37.9 FORWARD UPPER CARRY THRU | | | ☐ HAND HELD ☐ MOTORIZED | ☐ NEGATIVE ☐ CRACK |
| BUTT LINE 26.2 & 33.1 FORWARD LOWER CARRY THRU | | | ☐ HAND HELD ☐ MOTORIZED | ☐ NEGATIVE ☐ CRACK |
| BUTT LINE 25.8 CANOPY RAIL ATCH FTG | | | ☐ HAND HELD ☐ MOTORIZED | ☐ NEGATIVE ☐ CRACK |
| WING STATION 43.5 LOWER CENTER LUG | | | ☐ HAND HELD ☐ MOTORIZED | ☐ NEGATIVE ☐ CRACK |
| WING STATION 91.5 FRONT SPAR UPPER CAP | | | ☐ HAND HELD ☐ MOTORIZED | ☐ NEGATIVE ☐ CRACK |
| | | | | |
| | | | | |

REMARKS

*Conf - Configuration; S/C - Sorty Count; Ldgs - Landings; C/W - Complied With; Atch - Attach; Ftg - Fitting*

AFTO FORM NOV 76 12

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: B-1

FLEET INFORMATION

NO. OF AIRCRAFT: 3 : YEAR SERVICE BEGAN: 1975

SYSTEM MANAGEMENT: B-1 SPO

DATE TRANSFERRED TO AFLC: Production Program Cancelled

USING COMMAND: SAC

PRIMARY BASE:

PRIMARY MISSION TYPES: 4 Training Missions & 1 Simulated Attack Mission.

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | 1977 | | |
| FULL-SCALE CYCLIC TEST: | 1978 | | Wing CT & Aft Fuselage |
| FULL-SCALE STATIC TEST: | 1978 | | Wing CT & Aft Fuselage |
| DAMAGE TOLERANCE TESTS: | 1978 | | |
| DADTA INITIAL: | | | |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | | X | In work at time of |
| L/ESS DESIGN: | | | cancellation of B-1 |
| FSM PLAN: | | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| | | |
| IAT-Crack growth method | | |

proposed Remaining pages were not filled out in view of cancellation of B-1 program.

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: B-52 D-H

FLEET INFORMATION

NO. OF AIRCRAFT: 742 approx. 349 active : YEAR SERVICE BEGAN: 1954

SYSTEM MANAGEMENT: OC/ALC

DATE TRANSFERRED TO AFLC:

USING COMMAND: SAC

PRIMARY BASE: MANY

PRIMARY MISSION TYPES: HIGH & LOW ALTITUDE STORES DELIVERY, AIRBORNE ALERT

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | ECP 1050 Wing ECP 1128/1185 Body&E. |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | | | To Begin 1 May |
| DADTA INITIAL: | | | " |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | X | | |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | No Number | OC/ALC/MMSRHB |
| DAMAGE TOLERANCE ANALYSIS: | To Begin | |
| DURABILITY ANALYSIS: | D3-6831 D3-9572 | |
| SERVICE LIFE ANALYSIS: | | |
| G/H ECP 1050 SLA Summary | D3-6625 | |
| G/G ECP 1128/1185 " | D3-7583 | |
| Final Fat&Fracture,ECP 1050 | D3-7709 | |
| " " " ,ECP1128/1185 | D3-8146 | |
| Parametric Study's, 1050 | D3-6831 | |
| " " , 1195 | D3-8032 | |
| " " , AGM 69 | D3-8033 | |
| " " , 1581 | D3-9572 | |

A/C Type: B52D-H (Continued)

IAT PROGRAM

ANALYSIS METHOD: Parametric Fatigue Analyses, discrete & PSD analysis techniques (D3-6831, D3-8032, D3-8033, D3-9572 & D3-5381) Damage rates & pilot logs.

APPLICABLE REPORT: D3-8003-1 (B-52 fleet fat. dam. mon. prog.)

DATA COLLECTION: RECORDER: No FORM: AFTO 16 (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: Each Flight :TECH.ORDERS: T.O. 1B-52-101

DATE STARTED: A/P Del & ON Each G/H HRS.RECORDED: Spec Latest Mo Rpt % USABLE DATA: Almost All

DATA COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? OC/ALC

HOW IS IT CHECKED? Manually & by computer program

TECHNIQUE TO RECOVER MISSING DATA: Developed manaually during editing based on current usage for each particular airplane (s)

LIST PROCESSING STEPS: 1) AFTO 16's to processing 2) Review & edit 3) Keypunching 4) Additional computer editing 5) Mission data on tape 6) Dam. Monitoring Run 7) Final Rpts (D3-5381 & D3-8003-1 Discusses these in detail)

OUTPUT CONTENTS (ATTACH SAMPLES): See D3-5381 & D3-8003-1 for output examples

LIST PERMANENT FILES: RAW DATA? Yes from ind. AFTO 16's

PROCESSED DATA? Monthly Reports from OC/ALC

WHO EVALUATES OUTPUT? OC/ALC now (BWC if & when we receive copies of reports)

APPLICATIONS: SCHEDULING?

ANALYSIS UPDATE? Update for B-52D reskin

TO DETECT CHANGE IN USAGE?

REMARKS: Since BWC no longer conducts the IAT on B-52 airplanes, OC/ALC should be involved in the completion of this info. OC/ALC about 1 Yr. behind in the tracking reports.

L/ESS PROGRAM

ANALYSIS METHOD: Data not being processed at this time.
No good data.

APPLICABLE REPORT: ______

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 11 RECORDING DEVICE: MXU 553 (Attach Description)

PARAMETERS RECORDED: ______ (Attach List)

L/ESS START/STOP DATES: ______ HRS. RECORDED: ______

% USABLE DATA: ______ DATA RETRIEVAL FREQ. ______

DEFINITION OF USABLE DATA: ______

COLLECTION PROBLEMS: Strain amplifier problem

DATA REDUCTION: WHO DOES IT? OC/ALC

HOW IS IT CHECKED? ______

LIST STEPS: ______

TECHNIQUE TO RECOVER MISSING PARAMETERS: ______

OUTPUT CONTENTS (Attach Sample): ______

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? ______

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: ______

TO CHECK IAT DATA? ______

TO DETECT CHANGE IN USAGE? ______

REMARKS: BWC will probably want some L/ESS data for review to support DADTA analysis on B-52 aircraft.

A/C TYPE: B-52D-H (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Full scale cyclic tests & fleet experience

INSPECTION INTERVALS: Field level isochronals, plus PDM & ACI at depot. PDM interval is being extended from 36 to 48 months.

RANGE OF CRITICAL CRACK LENGTHS: (DADTA not complete)

SPECIAL COMPONENT INSPECTIONS: Secondary structure (fairings, doors, etc.) Inspection program initiated by SAC for 30 aircraft.

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA: Results from secondary structure inspections are used to evaluate effectiveness of MSG-2 criteria.

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: B-52D-H (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: OC/ALC runs all programs

IAT-FSM INTERFACE: NONE TO DATE

L/ESS-IAT INTERFACE: None to date

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: NONE

COMMONALITY WITH OTHER SYSTEMS:

METHODS WHICH HAVE WORKED WELL:

DEFICIENCIES IN CURRENT METHODS:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: C-5A

FLEET INFORMATION

NO. OF AIRCRAFT: 78 : YEAR SERVICE BEGAN: 1970

SYSTEM MANAGEMENT: SA/ALC

DATE TRANSFERRED TO AFLC: Still in progress

USING COMMAND: MAC

PRIMARY BASE: Travis, Dover Altus

PRIMARY MISSION TYPES: Cargo (Logistics), Training, Air Drop

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | X | | |
| DADTA INITIAL: | X | | |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | X | | |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | X | | |
| BASELINE OPS SPECTRA: | X | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | Yes | C-5 SPO |
| DAMAGE TOLERANCE ANALYSIS: | LG77ER0098 | C-5 SPO |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| Parametric Analysis | LG1US667 Vol. II | C-5 SPO |

A/C Type: C-5A (Continued)

IAT PROGRAM

ANALYSIS METHOD:

Presently a data block fatigue analysis (≈ 4000 data blocks).

APPLICABLE REPORT: LG1US611-12

DATA COLLECTION: RECORDER: MADARS(Reference) FORM: MAC 89 (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: :TECH.ORDERS:

DATE STARTED: First flight HRS.RECORDED: 99 % USABLE DATA:

DATA COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? SA/ALC, ASIMIS & Gelac

HOW IS IT CHECKED? MADARS used in some cases to verify data

TECHNIQUE TO RECOVER MISSING DATA: SA/ALC calls squadron and gets flight crew to provide data from memory

LIST PROCESSING STEPS: SA/ALC edits forms. ASIMIS reduces the data which is sent to Gelac for fatigue analysis

OUTPUT CONTENTS (ATTACH SAMPLES): Structural status, safety limits, recurring and special inspection requirements in terms of "representative mission profile" (RMP) hours

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA?

WHO EVALUATES OUTPUT? Gelac & SA-ALC

APPLICATIONS: SCHEDULING? Depot-level inspection and mods are scheduled based on IAT data

ANALYSIS UPDATE?

TO DETECT CHANGE IN USAGE? Can be used to check RMP definitions

REMARKS: Planning to use fracture & fatigue tracking for new wing RMP hours used to determine need for rotation of aircraft between bases-MAC has been cooperative in this program.

L/ESS PROGRAM

ANALYSIS METHOD: Peak counting by mean crossing method of c.g. load factor & wing strains. Load and wing strain spectra are separated by usage and reported.

APPLICABLE REPORT: LG77ER0240

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 26 RECORDING DEVICE: MADARS (Attach Description)

PARAMETERS RECORDED: 17-34 VGH ail. def., strain (Attach List)

L/ESS START/STOP DATES: Mid-72 thru 76 HRS. RECORDED: 12,000 hrs. data 42,000 Flt. hrs

% USABLE DATA: 25 DATA RETRIEVAL FREQ. ______

DEFINITION OF USABLE DATA: Mach, ground speed, altitude, flap position

COLLECTION PROBLEMS: ______

DATA REDUCTION: WHO DOES IT? ASIMIS (ASIMIS reduces data & Gelac process & analyzes it)

HOW IS IT CHECKED? Computerized edit routines

LIST STEPS: 1) ASIMIS-data extration, editing, correlation, and peak counting 2) Gelac-analyses, reporting, recommendations.

TECHNIQUE TO RECOVER MISSING PARAMETERS: None

OUTPUT CONTENTS (Attach Sample): C.G. load factor spectra, wing stress spectra, aileron stress spectra

LIST PERMANENT FILES: RAW DATA? MADARS central data bank

PROCESSED DATA? Flt x Flt peak counts, edited time history tapes, measure spectra tapes, analytical spectra tapes.

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Comparison of measured flight loads spectra from L/ESS with IAT loads & criteria

TO CHECK IAT DATA? NO

TO DETECT CHANGE IN USAGE? LHRP (8a/c) will attempt this.

REMARKS: The C-5A L/ESS is an extension & modification of the C-5A SLRP and has benefited tremendously from this previous program. The C-5A L/ESS has the longest and most complex network of data flow of all the transport/bomber L/ESS's.

A/C TYPE: C-5A (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Fatigue/fracture analyses, full-scale development test results, force experience. MSG-2 revision has been completed.

INSPECTION INTERVALS: PDM-3 yrs., also mid PDM & other isochronal inspections. PDM/ACI internal may be adjusted based on IAT-derived RMP hours.

RANGE OF CRITICAL CRACK LENGTHS: $\approx$ 1 inch

SPECIAL COMPONENT INSPECTIONS: Pylons are tracked using AFTO 95 files to maintain individual histories, although current NDI requirements are not tied to tracking data.

DATA COLLECTION: Mainly TCTO incorporation feedback and word-of-mouth. AFM 66-1 not used for structures.

DATA EVALUATION: SA-ALC with Gelac assistance as required.

APPLICATION OF FEEDBACK DATA: Feedback is used to review existing inspection/mod requirements. Policy is to reduce paperwork by only reporting damage and not reporting inspections which find no damage.

REMARKS: Structural Information Enhancement Program (SIEP) in progress - goal is to provide a wing replacement schedule based on (a) destructive teardown of a high-time C-5A wing, and (b) updated analyses to determine future maintenance requirements.

APPLICABLE DOCUMENTS: 1C-5A-3, -6, -23, -36

A/C TYPE: C-5A (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

IAT-FSM INTERFACE: IAT output is used for depot-level maintenance package planning.

L/ESS-IAT INTERFACE: SLRP data is presently being used in an IAT update.

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS: The MADARS system for L/ESS is peculiar to the C-5A. Otherwise, the tracking program, Life History Recording Program, and Force Structural Maintence programs are similar to those for the C-130 and C-141A.

METHODS WHICH HAVE WORKED WELL: Emphasis and support at contractor, system manager, and user levels has resulted in an effective ASIP.

DEFICIENCIES IN CURRENT METHODS:

## Section I — AIRCRAFT IDENTIFICATION

EFFECTIVE DATE

| ACFT TAIL NO | LOG NO | | SEQ NO | | AIRFRAME HOURS To nearest hour | OMS |
|---|---|---|---|---|---|---|
| 1 2 3 | 4 5 6 7 8 | 9 | 10 11 | 12 | 13 14 15 16 17 | 18 19 20 |
| | | | 1 1 | | | |

## Section II — INITIAL TAKE OFF AND FINAL LANDING DATA

FLIGHT ENGINEER

CHECKED BY

| INITIAL TAKE OFF | | | | | | | | FINAL LANDING | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE DAY | DATE MO | GROSS WEIGHT | CG | FUEL WEIGHT | TIME Z | ICAO CODE | | FUEL WEIGHT | TIME Z | ICAO CODE | | |
| 21 22 | 23 24 | 25 26 27 | 28 29 | 30 31 32 | 33 34 35 36 | 37 38 39 40 | 41 | 42 43 44 | 45 46 47 48 | 49 50 51 52 | 53 | 54 |
| | | | | | | | | | | | | |

## Section III — FLIGHT PROFILE DATA

| 1ST CRUISE PERIOD | | | | 2D CRUISE PERIOD | | | |
|---|---|---|---|---|---|---|---|
| TIME Z START | TIME Z STOP | MACH | ALT | TIME Z START | TIME Z STOP | MACH | ALT |
| 55 56 57 58 | 59 60 61 62 | 63 64 | 65 66 | 67 68 69 70 | 71 72 73 74 | 75 76 | 77 78 |
| | | | | | | | |

## Section III Contd- — FLIGHT PROFILE DATA

| KEY PUNCH INSTRUCTIONS | | | 3D CRUISE PERIOD | | | | 4TH CRUISE PERIOD | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DUP 1-9 | SEQ NO | BLANK 12-54 | TIME Z START | TIME Z STOP | MACH | ALT | TIME Z START | TIME Z STOP | MACH | ALT |
| | 10 11 | | 55 56 57 58 | 59 60 61 62 | 63 64 | 65 66 | 67 68 69 70 | 71 72 73 74 | 75 76 | 77 78 |
| | 1 2 | | | | | | | | | |

## Section IV — TRANSITION TRAINING-TOUCH AND GO LANDINGS ADDITIONAL FULL STOPS AND TAKE OFFS

TOUCH AND GO LANDINGS ENTER Z TIMES IN ASCENDING ORDER, LEFT TO RIGHT ACROSS FOR EACH EVENT

| SEQ NO | 1ST T & G | 2D T & G | 3D T & G | 4TH T & G | 5TH T & G | 6TH T & G | 7TH T & G | 8TH T & G | 9TH T & G | 10TH T & G | 11TH T & G | FULL STOP TIME | TAKE OFF TIME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 11 | 12 13 14 15 | 16 17 18 19 | 20 21 22 23 | 24 25 26 27 | 28 29 30 31 | 32 33 34 35 | 36 37 38 39 | 40 41 42 43 | 44 45 46 47 | 48 49 50 51 | 52 53 54 55 | 56 57 58 59 | 60 61 62 63 |
| 2 1 | | | | | | | | | | | | | |
| 2 2 | | | | | | | | | | | | | |

## Section V — INFLIGHT OPERATIONS DATA

| SEQ NO | EVENT TF | EVENT R | EVENT A | EVENT CJ | EVENT FJ | EVENT TIME (Z) START | EVENT TIME (Z) STOP | INCR WEIGHT | ALTITUDE OR CLEARANCE PLANE | FOR TF OPERATION ONLY ROUTE CODE | MODE A | MODE M | RS | MACH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 11 | 12 | 13 | 14 | 15 | 16 | 17 18 19 20 | 21 22 23 24 | 25 26 27 | 28 29 30 31 | 32 33 | 34 | 35 | 36 | 37 38 39 |
| 3 1 | | | | | | | | | . | | | | | |
| 3 2 | | | | | | | | | . | | | | | |
| 3 3 | | | | | | | | | . | | | | | |
| 3 4 | | | | | | | | | . | | | | | |
| 3 5 | | | | | | | | | . | | | | | |
| 3 6 | | | | | | | | | . | | | | | |

## Section VI — SORTIE TIME AND TAKE OFF WEIGHT COMPUTATION

| | | | |
|---|---|---|---|
| LANDING TIME (Z) | | OPER WEIGHT | . |
| TAKE OFF TIME (Z) | | FUEL WEIGHT | . |
| TOTAL TIME | : | CARGO, PAX MISC WEIGHT | . |
| TOTAL TIME HRS. TENTHS | . | T O GROSS WT | . |

NOTE: INITIATE A NEW FORM AFTER EACH SORTIE, RUNWAY ABORT OR LANDING ON SUB-STANDARD RUNWAY

REMARKS

MAC [illegible]

C-5 AIRCRAFT FATIGUE TRACKING RECORD

69-04019

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: C-9

FLEET INFORMATION

NO. OF AIRCRAFT: 23 : YEAR SERVICE BEGAN: July 68

SYSTEM MANAGEMENT: SA/ALC (L. O. Sutton)

DATE TRANSFERRED TO AFLC: 

USING COMMAND: MAC

PRIMARY BASE: Scott, Clark, Rhein Mein, Andrews

PRIMARY MISSION TYPES: Medical Evac. VIP

REMARKS: DC-9, Series 32

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | | | |
| FULL-SCALE CYCLIC TEST: | Fwd fus & Components (Pylon & Tail) & L.G. | | |
| FULL-SCALE STATIC TEST: | Limit Prod. | | |
| DAMAGE TOLERANCE TESTS: | x | | |
| DADTA INITIAL: | | | |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | | | |
| L/ESS DESIGN: | | | |
| FSM PLAN: | | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |

Only flight hours and landings are recorded.
Maintenance is contracted to commercial airlines

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: Transport C-130

FLEET INFORMATION

NO. OF AIRCRAFT: 714 : YEAR SERVICE BEGAN: 1955

SYSTEM MANAGEMENT: WR/ALC

DATE TRANSFERRED TO AFLC: 1965

USING COMMAND: AFRES, ANG, MAC, AFE, AFSC, MAO, TAC, PACAF

PRIMARY BASE: Little Rock, Dyess, Pope

PRIMARY MISSION TYPES: Logistics Training

REMARKS: Fourteen (14) different Model/Design/Series (MDS) groups based on both structural and mission differences

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | | | Proposed for DADTA |
| DADTA INITIAL: | | X | |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | X | | |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | X | | |
| BASELINE OPS SPECTRA: | X | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | Warner Robins ALC |
| DAMAGE TOLERANCE ANALYSIS: | | None at present |
| DURABILITY ANALYSIS: | | None at present |
| SERVICE LIFE ANALYSIS: | LG73ER0163 | Lockheed-Georgia Co |
| Various static/dynamic test reports listed in ASIP Master Plan | | |

A/C Type: C-130 (Continued)

IAT PROGRAM

ANALYSIS METHOD: Fatigue method using Miner's Cumulative Damage Theory and mission sortie definition using data blocks covering entire range of operational capabilities.

APPLICABLE REPORT: ER9477, LG73ER0012, LG74ER0151

DATA COLLECTION: RECORDER: - FORM: AFTO 151A (ATTACH DESCRIPT:

FREQ. OF RETRIEVAL: 90% :TECH.ORDERS: TO-1C-130-101

DATE STARTED: Jan. 1968 HRS.RECORDED: $3x10^6$ % USABLE DATA: 95%

DATA COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? Warner Robins ALC

HOW IS IT CHECKED? Manually

TECHNIQUE TO RECOVER MISSING DATA: Usage data is factored up to account for missing data internally in computer programs using either quarterly individual acft usage or base usage depending on criteria that is used.

LIST PROCESSING STEPS: Manual editing of forms for typographical errors, data on forms Keypunched, monthly edit by computer of sortie data for check of operational parameters, quarterly sum of sortie data and assignment of data blocks, computation of fatigue damage for monitoring locations by individual aircraft.

OUTPUT CONTENTS (ATTACH SAMPLES): Operational Data Report (ODR) Quarterly operational summary for individual acft, by base, by command and by series. Fatigue Damage Report (FDR) individual aircraft fatigue damage computation for current quarter & total to date.

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA?

WHO EVALUATES OUTPUT? Warner Robins ALC & GELAC

APPLICATIONS: SCHEDULING?

ANALYSIS UPDATE? Factors derived by correlating in-service cracks.

TO DETECT CHANGE IN USAGE? Must be done manually when done.

REMARKS:

L/ESS PROGRAM

ANALYSIS METHOD: Strain data is data blocked, peak counted by moving mean crossing method, and damage computed by Miner's Rule: Load factor data is separated into gust & manv. by frequency filtering, then data blocked, peak counted.

APPLICABLE REPORT: LG74ER0057, LG74ER0112, LG74ER0087

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 60 RECORDING DEVICE: MXU553A (Attach Descriptic

PARAMETERS RECORDED: 20 (Attach Lis

L/ESS START/STOP DATES: Start 1974 HRS. RECORDED: Unknown

% USABLE DATA: Unknown, but low DATA RETRIEVAL FREQ. 15 hrs. max.

DEFINITION OF USABLE DATA: Airspeed altitude, ground speed 2 gear Events.

COLLECTION PROBLEMS: Low data quality, software problems

DATA REDUCTION: WHO DOES IT? WR/ALC & ASIMIS

HOW IS IT CHECKED? By both computer program & manually

LIST STEPS: Cassettes are mailed to ASIMIS. There a reformatter transcriber converts the data onto IBM 360 tapes. The data are checked and then are processed by two computer pgms. to yield usage, load factor & damage data.

TECHNIQUE TO RECOVER MISSING PARAMETERS: Manual editing by ASIMIS people.

OUTPUT CONTENTS (Attach Sample):

1) Usage data similar to C-130 IASLMP
2) C.G. load factor peak count (gust, manv., ground)
3) Fatigue damage at 6 tracking locations.

LIST PERMANENT FILES: RAW DATA? No raw data currently saved

PROCESSED DATA? Unknown

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:

TO CHECK IAT DATA? Yes-Compare quarterly

TO DETECT CHANGE IN USAGE? Yes-Mission profiles output

REMARKS: Data yield is low mostly due to equipment problems. Some problems exist with the first generation computer software. Quality of strain gage data, computer software, load factor data need a complete checkout and evaluation.

A/C TYPE: C-130 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Minor/major inspections per T.O.-1C-130A-6 requirements.

INSPECTION INTERVALS: T.O.-1C-130A-6, minor inspection interval 200 days

RANGE OF CRITICAL CRACK LENGTHS: Damage Tolerance analysis not currently complete.

SPECIAL COMPONENT INSPECTIONS: Automated by Special Inspection Candidate Computer Program using accumulation of fatigue damage since last inspection as selection criteria for T.O. issuance

DATA COLLECTION: AFM66-1, AFTO Form 22, Wing interchange and skin panel/spar cap replacement data from IRAN facilities.

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA: Correlation of in-service cracks for monitoring locations, addition of monitoring locations based on in-service experience.

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: C-130 Transport (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

IAT-FSM INTERFACE: Yes through Special Inspection Program

L/ESS-IAT INTERFACE: Validity of L/ESS data not sufficient to affect IAT.

ORGANIZATIONAL CHANGES PENDING: None

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS: Similar to C-141A

METHODS WHICH HAVE WORKED WELL:

DEFICIENCIES IN CURRENT METHODS: More reliable feedback information from IRAN facilities on in-service crack information that necessitated skin panel/spar cap replacement.

LIST OF C-130 LHRP PARAMETERS

1. Airspeed
2. Nz
3. Ramp open/closed
4. Altitude
5. Pitch rate
6. Yaw rate
7. Elevator deflection
8. Rudder deflection
9. Cabin pressure
10. Flap deflection
11. Wheels down event
12. Liftoff event
13. Nose gear steering angle
14. Ground Speed
15. Strain #1
16. Strain #2
17. Strain #3
18. Strain #4
19. Strain #5
20 Strain #6

REPORT | TROL SYMBOL

| 1. AIRCRAFT SERIAL NUMBER | | | | | | | 2. DATE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YR. | | — | | | | | DAY | | MONTH | | YEAR | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |

RUNWAY-TAXIWAY CODE
SS-1
SR-2
US-3
UR-4
UX-5

3. COMMAND ______

4. WING/SQN. ______

5. AIRFRAME HOURS ______

6. HOME STATION ______

WRITE YOUR NUMBERS LIKE THIS

0 1 2 3 4 5 6 7 8 9

| 7. | | 8. | | | | TAXI - TAKEOFF - LANDING | | | | | | | | | | | | | FUEL WEIGHT | | | | | | | | | | FLIGHT CRUISE | | | | | | | | 23. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 9. EVENT | | | | 10. TYPE | | 11. | 12. | 13. | | 14. | | | 15. | | 16. | | 17. | | 18. | | 19. | | 20. | | | 21. | | | 22. | | BASE |
| SORTIE | NUMBER | CLOCK TIME | | | | TAKEOFF | LANDING | T&G(NO.) | S&G(NO.) | NOR. | MAX. | RUNWAY CODE | TAXIWAY CODE | TAXI TIME | | GROSS WEIGHT | | | OUTBOARD | | INBOARD | | AUXILIARY | | EXTERNAL | | FUSELAGE | | AIRSPEED | | | ALTITUDE CONTOUR | | | AIRDROP REFUEL WEIGHT | | TAKEOFF LANDING |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | |

# PRE-CRACK DAMAGE PROGRAM

## FLIGHT HOUR DISTRIBUTION

## SAMPLE OUTPUT

C-130 IASLMP
DAMAGE SUMMARY
AS OF 1 JANUARY 1973

C-130

ER-11142
FOR 23

NUMBER OF AIRCRAFT

| FLIGHT HOUR DISTRIBUTION | A | DCA | RCA | ACA | D | B |
|---|---|---|---|---|---|---|
| 0- 999 | - | - | - | - | - | - |
| 1000- 1999 | - | - | - | - | - | - |
| 2000- 2999 | - | - | - | - | - | - |
| 3000- 3999 | - | - | - | - | - | - |
| 4000- 4999 | 6 | - | - | - | - | - |
| 5000- 5999 | 2 | 2 | - | 1 | 2 | - |
| 6000- 6999 | 4 | 1 | - | - | 4 | 3 |
| 7000- 7999 | 23 | - | 6 | 4 | 4 | 18 |
| 8000- 8999 | 35 | 2 | 10 | 4 | 1 | 39 |
| 9000- 9999 | 26 | - | - | 1 | - | 4 |
| 10000-10999 | 2 | - | - | 2 | - | 2 |
| 11000-11999 | 1 | - | - | 2 | - | 7 |
| 12000-12999 | 2 | - | - | - | - | 3 |
| 13000-13999 | 5 | - | - | - | - | - |
| 14000-14999 | - | - | - | - | - | - |
| 15000-15999 | - | - | - | - | - | - |
| 16000-16999 | - | - | - | - | - | - |
| 17000-17999 | - | - | - | - | - | - |
| 18000-18999 | - | - | - | - | - | - |
| 19000-19999 | - | - | - | - | - | - |
| 20000-20999 | - | - | - | - | - | - |
| 21000-21999 | - | - | - | - | - | - |
| 22000-22999 | - | - | - | - | - | - |
| 23000-23999 | - | - | - | - | - | - |
| 24000-24999 | - | - | - | - | - | - |
| 25000-25999 | - | - | - | - | - | - |
| 26000-26999 | - | - | - | - | - | - |
| 27000-27999 | - | - | - | - | - | - |
| 28000-28999 | - | - | - | - | - | - |
| 29000- + | - | - | - | - | - | - |

| | A | DCA | RCA | ACA | D | B |
|---|---|---|---|---|---|---|
| HRS-HIGH TIME ACFT | 13902 | 8586 | 8993 | 11712 | 8531 | 12658 |
| HRS-LOW TIME ACFT | 4066 | 5624 | 7199 | 5271 | 5026 | 6781 |
| HRS-TOTAL ACFT TIME | 906808 | 34232 | 130775 | 122961 | 75051 | 664472 |
| HRS-AVERAGE ACFT TIME | 8554 | 6846 | 8173 | 8782 | 6822 | 8743 |
| AVERAGE FLTHR RATE PER MONTH | 34 | 40 | 43 | 76 | 43 | 23 |

# PRE-CRACK DAMAGE PROGRAM

## FATIGUE DAMAGE REPORT

## SAMPLE OUTPUT

8 28
C-130 IASLMP C-130B
FATIGUE DAMAGE REPORT
ER-11142
FDR 23

| SERIAL NUMBER | LOC. CODE | CURRENT REPORT ( DAM. | CURRENT REPORT FLT HRS | CUM. TOTAL ( DAM. | CUM. TOTAL FLT HRS | TIME TO CRACK INIT. FLIGHT HOURS CUR. RATE | TIME TO CRACK INIT. FLIGHT HOURS BASE RATE | TIME TO CRACK INIT. YEARS BASE RATE | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| ACFT 5800711 | 1 | 0.0 | 0.0 | 0.3 | 203.0 | 0. | 0. | 0. | 5 |
| 3506 | 6 | 0.0 | | 0.4 | 203.0 | 0. | 0. | 0. | 5 |
| R-WING 3506 | 21 | 0.0 | 0.0 | 7.4 | 8103.0 | 0. | 0. | 0. | 1 |
| | 22 | 0.0 | | 13.0 | 8103.0 | 0. | 0. | 0. | 1 |
| | 23 | 0.0 | | 7.3 | 8103.0 | 0. | 0. | 0. | 1 |
| | 25 | 0.0 | | 17.3 | 8103.0 | 0. | 0. | 0. | 1 |
| | 26 | 0.0 | | 14.5 | 8103.0 | 0. | 0. | 0. | 1 |
| | 28 | 0.0 | | 13.2 | 8103.0 | 0. | 0. | 0. | 1 |
| | 29 | 0.0 | | 10.8 | 8103.0 | 0. | 0. | 0. | 1 |
| | 31 | 0.0 | | 50.0 | 8103.0 | 0. | 0. | 0. | 1 |
| L-WING 3506 | 21 | 0.0 | 0.0 | 7.4 | 8103.0 | 0. | 0. | 0. | 1 |
| | 22 | 0.0 | | 13.0 | 8103.0 | 0. | 0. | 0. | 1 |
| | 23 | 0.0 | | 7.3 | 8103.0 | 0. | 0. | 0. | 1 |
| | 25 | 0.0 | | 17.3 | 8103.0 | 0. | 0. | 0. | 1 |
| | 26 | 0.0 | | 14.5 | 8103.0 | 0. | 0. | 0. | 1 |
| | 28 | 0.0 | | 13.2 | 8103.0 | 0. | 0. | 0. | 1 |
| | 29 | 0.0 | | 10.8 | 8103.0 | 0. | 0. | 0. | 1 |
| | 31 | 0.0 | | 50.0 | 8103.0 | 0. | 0. | 0. | 1 |
| ACFT 5800715 | 1 | 0.0 | 0.0 | 0.4 | 307.0 | 0. | 99999. | 549. | 5 |
| 3510 | 6 | 0.0 | | 0.6 | 307.0 | 0. | 52074. | 286. | 5 |
| R-WING 3510 | 21 | 0.0 | 0.0 | 11.9 | 8402.0 | 0. | 91795. | 504. | 1 |
| | 22 | 0.0 | | 21.0 | 8402.0 | 0. | 47520. | 261. | 1 |
| | 23 | 0.0 | | 12.2 | 8402.0 | 0. | 87403. | 480. | 1 |
| | 25 | 0.0 | | 42.8 | 8402.0 | 0. | 9950. | 55. | 1 |
| | 26 | 0.0 | | 36.1 | 8402.0 | 0. | 13367. | 73. | 1 |
| | 28 | 0.0 | | 33.0 | 8402.0 | 0. | 15444. | 85. | 1 |
| | 29 | 0.0 | | 28.1 | 8402.0 | 0. | 18958. | 104. | 1 |
| | 31 | 0.0 | | 74.8 | 8402.0 | 0. | 6055. | 33. | 1 |
| L-WING 3510 | 21 | 0.0 | 0.0 | 11.9 | 8402.0 | 0. | 91795. | 504. | 1 |
| | 22 | 0.0 | | 21.0 | 8402.0 | 0. | 47520. | 261. | 1 |
| | 23 | 0.0 | | 12.2 | 8402.0 | 0. | 87403. | 480. | 1 |
| | 25 | 0.0 | | 42.8 | 8402.0 | 0. | 9960. | 55. | 1 |
| | 26 | 0.0 | | 36.1 | 8402.0 | 0. | 13367. | 73. | 1 |
| | 28 | 0.0 | | 33.0 | 8402.0 | 0. | 15444. | 85. | 1 |
| | 29 | 0.0 | | 28.1 | 8402.0 | 0. | 18958. | 104. | 1 |
| | 31 | 0.0 | | 74.8 | 8402.0 | 0. | 6055. | 33. | 1 |

# PRE-CRACK DAMAGE PROGRAM
# HOURS REMAINING TO CRACK INITIATION
# BY MDS AND BY LOCATION
# SAMPLE OUTPUT

C-130 IASLMP
DAMAGE SUMMARY
AS OF 1 JANUARY 1973

C-130B

ER-11142
FDR 23

NUMBER OF AIRCRAFT

| HOURS REMAINING (BASE RATE) / LOCATION | 1 | 6 |
|---|---|---|
| 0. | - | - |
| 1.- 999. | - | - |
| 1000.-1999. | - | - |
| 2000.-2999. | - | - |
| 3000.-3999. | - | - |
| 4000.-4999. | - | - |
| 5000.-5999. | - | - |
| 6000.-6999. | - | - |
| 7000.-7999. | - | - |
| 8000.-8999. | - | - |
| 9000.- + | 66 | 66 |

NUMBER OF RIGHT OUTER WINGS

| HOURS REMAINING (BASE RATE) / LOCATION | 21 | 22 | 23 | 25 | 26 | 28 | 29 | 31 |
|---|---|---|---|---|---|---|---|---|
| 0. | - | - | - | - | - | - | - | - |
| 1.- 999. | - | - | - | - | - | - | - | - |
| 1000.-1999. | - | - | - | - | - | - | - | - |
| 2000.-2999. | - | - | - | - | - | - | - | - |
| 3000.-3999. | - | - | - | - | - | - | - | 4 |
| 4000.-4999. | - | - | - | - | - | - | - | 15 |
| 5000.-5999. | - | - | - | 5 | - | - | - | 8 |
| 6000.-6999. | - | - | - | 1 | - | - | - | 11 |
| 7000.-7999. | - | - | - | 1 | 3 | - | - | 6 |
| 8000.-8999. | - | - | - | 2 | 3 | 4 | - | 1 |
| 9000.- + | 66 | 66 | 66 | 56 | 60 | 62 | 66 | 21 |

NUMBER OF LEFT OUTER WINGS

| HOURS REMAINING (BASE RATE) / LOCATION | 21 | 22 | 23 | 25 | 26 | 28 | 29 | 31 |
|---|---|---|---|---|---|---|---|---|
| 0. | - | - | - | - | - | - | - | - |
| 1.- 999. | - | - | - | - | - | - | - | - |
| 1000.-1999. | - | - | - | - | - | - | - | - |
| 2000.-2999. | - | - | - | - | - | - | - | - |
| 3000.-3999. | - | - | - | - | - | - | - | 4 |
| 4000.-4999. | - | - | - | - | - | - | - | 15 |
| 5000.-5999. | - | - | - | 5 | - | - | - | 8 |
| 6000.-6999. | - | - | - | 1 | - | - | - | 11 |
| 7000.-7999. | - | - | - | 1 | 3 | - | - | 6 |
| 8000.-8999. | - | - | - | 2 | 3 | 4 | - | 1 |
| 9000.- + | 66 | 66 | 66 | 56 | 60 | 62 | 66 | 21 |

PRE-CRACK DAMAGE PROGRAM

LEFT OUTER WING DAMAGE DISTRIBUTION

SAMPLE OUTPUT

C-130B
DAMAGE DISTRIBUTION
LEFT OUTER WING STATIONS

| | LOC 21 STATUS 1 | LOC 21 STATUS 3 | LOC 21 STATUS 4 | LOC 22 STATUS 1 | LOC 22 STATUS 3 | LOC 22 STATUS 4 |
|---|---|---|---|---|---|---|
| .00- .09 | 40 | 15 | 0 | 10 | 2 | 0 |
| .10- .19 | 21 | 0 | 0 | 46 | 13 | 0 |
| .20- .29 | 0 | 0 | 0 | 5 | 0 | 0 |
| .30- .39 | 0 | 0 | 0 | 0 | 0 | 0 |
| .40- .49 | 0 | 0 | 0 | 0 | 0 | 0 |
| .50- .59 | 0 | 0 | 0 | 0 | 0 | 0 |
| .60- .69 | 0 | 0 | 0 | 0 | 0 | 0 |
| .70- .79 | 0 | 0 | 0 | 0 | 0 | 0 |
| .80- .89 | 0 | 0 | 0 | 0 | 0 | 0 |
| .90- .99 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.00-1.09 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.10-1.19 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.20-1.29 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.30-1.39 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.40-1.49 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.50-1.59 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.60-1.69 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.70-1.79 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.80-1.89 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.90-1.99 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.00-2.09 | 0 | 0 | 0 | 0 | 0 | 0 |

| | LOC 23 STATUS 1 | LOC 23 STATUS 3 | LOC 23 STATUS 4 | LOC 25 STATUS 1 | LOC 25 STATUS 3 | LOC 25 STATUS 4 |
|---|---|---|---|---|---|---|
| .00- .09 | 33 | 15 | 0 | 0 | 0 | 0 |
| .10- .19 | 28 | 0 | 0 | 6 | 2 | 0 |
| .20- .29 | 0 | 0 | 0 | 4 | 3 | 0 |
| .30- .39 | 0 | 0 | 0 | 6 | 9 | 0 |
| .40- .49 | 0 | 0 | 0 | 18 | 1 | 0 |
| .50- .59 | 0 | 0 | 0 | 23 | 0 | 0 |
| .60- .69 | 0 | 0 | 0 | 3 | 0 | 0 |
| .70- .79 | 0 | 0 | 0 | 0 | 0 | 0 |
| .80- .89 | 0 | 0 | 0 | 0 | 0 | 0 |
| .90- .99 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.00-1.09 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.10-1.19 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.20-1.29 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.30-1.39 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.40-1.49 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.50-1.59 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.60-1.69 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.70-1.79 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.80-1.89 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.90-1.99 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.00-2.09 | 0 | 0 | 0 | 0 | 0 | 0 |

PRE-CRACK DAMAGE PROGRAM

LEFT OUTER WINGS WITH LOCATIONS HAVING LESS

THAN 1000 HOURS REMAINING LIFE

SAMPLE OUTPUT

C-130 IASLMP
DAMAGE SUMMARY
AS OF 1 JANUARY 1973

C-130E

ER-11142
FDR 23

LEFT OUTER WINGS WITH LESS THAN 1000 FLIGHT HOURS REMAINING C-130E

| L-WING SERIAL | ACFT SERIAL | LOC | HOURS TO CRACK | L-WING SERIAL | ACFT SERIAL | LOC | HOURS TO CRACK |
|---|---|---|---|---|---|---|---|
| 3712 | 6102367 | 27 | 838. | 3760 | 6201806 | 27 | 195. |
| 3715 | 6102370 | 31 | 0. | 3761 | 6201807 | 27 | 0. |
| 3720 | 6102373 | 31 | 0. | 3762 | 6201808 | 31 | 0. |
| 3729 | 6201784 | 27 | 343. | 3772 | 6201811 | 31 | 0. |
| 3731 | 6201786 | 27 | 0. | 3778 | 6201816 | 31 | 0. |
| 3732 | 6201787 | 27 | 0. | 3779 | 6201817 | 27 | 0. |
| 3737 | 6201790 | 27 | 211. | 3780 | 6201818 | 27 | 775. |
| 3744 | 6201794 | 27 | 0. | 3786 | 6201823 | 31 | 0. |
| 3746 | 6201795 | 27 | 0. | 3789 | 6201826 | 31 | 491. |
| 3752 | 6201798 | 27 | 0. | 3791 | 6201828 | 27 | 289. |
| 3755 | 6201801 | 31 | 0. | 3796 | 6201833 | 31 | 0. |
| 3757 | 6201803 | 31 | 0. | 3797 | 6201834 | 27 | 0. |

# STATE-OF-THE-ART REVIEW
# FORCE MANAGEMENT METHODS

A/C TYPE: C/KC-135

## FLEET INFORMATION

NO. OF AIRCRAFT: 751 : YEAR SERVICE BEGAN: 1956

SYSTEM MANAGEMENT: OC-ALC

DATE TRANSFERRED TO AFLC:

USING COMMAND: 10 Commands (SAC, TAC, etc), 1 Fed. Agency

PRIMARY BASE: 53 Bases

PRIMARY MISSION TYPES: 51 Different MDS with many mission types

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | KC-135A 1962 & 1972 C.T. |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | | X | |
| DADTA INITIAL: | | X | Began Oct. 1977 |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | X | X | Damage System currently being upd |
| L/ESS DESIGN: | X | X | Problems with recor data |
| FSM PLAN: | X | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN ----Dated | 10 June 1977 | 1 OC/ALC |
| DAMAGE TOLERANCE ANALYSIS: | In work | |
| DURABILITY ANALYSIS: | D3-8704-2 D3-9944 | |
| SERVICE LIFE ANALYSIS: | | |
| MSG-2 DOC'S | D3-11100-1 thru 8 | |
| C/KC-135 ASID Doc's 1 | D3-9040-1 thru-13 | Series for AF Blue Bird Reviews |
| Fatigue Analysis | D6-7328 | |
| Comparative Fat. Analysis | D3-8704-1 | |
| Full Scale C.T. 1972 | D3-10103 | |
| Presently conducting | | |
| A 707/-135 comp. study | | |

PREPARED BY: ____ CHECKED BY: ____

IAT PROGRAM

ANALYSIS METHOD: Parametric fatigue analyses, discrete & PSD analysis techniques, damage rates & pilot logs 24 critical points

APPLICABLE REPORT: D3-8704-2 (Damage rates)

DATA COLLECTION: RECORDER: No FORM: AFTO 76 (ATTACH DESCRIPT

FREQ. OF RETRIEVAL: Each flight :TECH.ORDERS: 1C-135-101

DATE STARTED: '68-'74 HRS.RECORDED: See latest Mo. Rpt. % USABLE DATA: -

DATA COLLECTION PROBLEMS: Poor quality & missing Forms, Keypunch errors

DATA REDUCTION: WHO DOES IT? OC/ALC (3 technicians)

HOW IS IT CHECKED?

TECHNIQUE TO RECOVER MISSING DATA: Ratio of hours - Doesn't work

LIST PROCESSING STEPS: 1) AFTO 76's to processing 2) Review and edit 3) Keypunching 4) card to Tape 5) Additional computer editing 6) damage Prog. 7) intermediate program 8) aircraft status prog. 9) Final rpts.

OUTPUT CONTENTS (ATTACH SAMPLES): Present Format 1 page/(A/P) (Microfiche) will be changed by current update-format change & some change in summary.

LIST PERMANENT FILES: RAW DATA? Yes, from AFTO 76's

PROCESSED DATA? Edited tapes, monthly Rpts.

WHO EVALUATES OUTPUT? OC/ALC

APPLICATIONS: SCHEDULING? Ref. OC-ALC & SAC

ANALYSIS UPDATE? Update for C/KC-135 reskin

TO DETECT CHANGE IN USAGE?

REMARKS: The damage monitoring system is currently being updated by Boeing Wichita to cover C/KC-135 Reskinned airplanes. Scheduled completion is August 1978. IAT data needs to be reprocessed to eliminate errors in existing output.

L/ESS PROGRAM

ANALYSIS METHOD: Data processed for manual review. No program to convert measured data into damage or crack growth rates as yet

APPLICABLE REPORT: UDRI TR-73-55 Vol. 1-8

DATA COLLECTION BASE: (2 attrited)

NO. OF AIRCRAFT: 66 RECORDING DEVICE: MXU 553 (Attach Descriptic

PARAMETERS RECORDED: ________ (Attach Lis-

L/ESS START/STOP DATES: ________ HRS. RECORDED: ________

% USABLE DATA: ________ DATA RETRIEVAL FREQ. ________

DEFINITION OF USABLE DATA: ________

COLLECTION PROBLEMS: Strains, Mltiplexers, Switch Wiring-Spoilers

DATA REDUCTION: WHO DOES IT? OC/ALC

HOW IS IT CHECKED? ________

LIST STEPS: Reference ASIMIS Master Plan for data reduction

TECHNIQUE TO RECOVER MISSING PARAMETERS: ________

OUTPUT CONTENTS (Attach Sample): ________

LIST PERMANENT FILES: RAW DATA? ________

PROCESSED DATA? ________

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: ________

TO CHECK IAT DATA? ________

TO DETECT CHANGE IN USAGE? ________

REMARKS: BWC is now reviewing L/ESS data to verify C/KC-135 environment. Manual evaluated to compare $U_{de}$ & $\Delta n$ cycles with old data.

A/C TYPE: KC-135A (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: 1972 Full scale cyclic test, fleet experience & commercial service bulletins, Recent teardown inspections of 1972 C.T. article.

INSPECTION INTERVALS: 100 Hr. - 600 Hr. phase, PDM @ 4 yr intervals, ACI @ 4 yr intervals, used to have a L-T-F inspection which was considered most probable to uncover problems (has been suspended)

RANGE OF CRITICAL CRACK LENGTHS: .07" to 30"

SPECIAL COMPONENT INSPECTIONS: Yes - @ phase, PDM, ACI special inspections have been conducted in past.

DATA COLLECTION: 66-1 but inadequate-broad work unit codes.

DATA EVALUATION: MSG-2 - once so far - Total A/P, specific areas as problems reported to BWC.

APPLICATION OF FEEDBACK DATA: Into MSG-2 decision logic.

REMARKS: AF reporting to BWC is very inadequate. BWC currently under contract to develop MSG-2 for other C/KC-135 aircraft.

APPLICABLE DOCUMENTS: MSG-2, D3-11100-1 thru -8 for KC-135A.

A/C TYPE: C/KC-135 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: OC/ALC runs all programs

IAT-FSM INTERFACE: Mod control program keeps mods & status

L/ESS-IAT INTERFACE: At present, no interface except for special analyses.

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS: Boeing commercial fleet (707 & 747 inwork)

METHODS WHICH HAVE WORKED WELL: MSG-2

DEFICIENCIES IN CURRENT METHODS: No continuing update, no feedback, work unit codes too broad (commercial plan includes feedback.) Boeing at mercy of OC/ALC for incorporation of plan (Budget off-on)

# 135 AIRCRAFT STRUCTURAL ASSESSMENT DATA

| 1. AIRCRAFT SERIAL NUMBER | 2. DEPARTURE BASE (ICAO IDENT) | 3. DATE FLIGHT ORIGINATED (YR / MO / DAY) | REPORTS CONTROL SYMBOL |
|---|---|---|---|
| – | | | |

| 4. AIRCRAFT FLIGHT HOURS AT TAKEOFF | 5. TAKEOFF WEIGHTS IN POUNDS: GROSS | CARGO | FUEL | 6. FLIGHT DURATION: HRS | MIN | |
|---|---|---|---|---|---|---|
| . | ,00 | ,00 | ,00 | | | 1 |

| 7. OPERATIONAL PHASE: CLIMB | CRUISE | FULL ON LOAD | FULL OFF LOAD | DESCENT | TRAFFIC PATTERN | 8. CLOCK TIME (Z) | 9. ALTITUDE IN FEET (START OF PHASE) | 10. FUEL WEIGHT IN POUNDS (START OF PHASE) | 11. INDICATED AIRSPEED IN KNOTS | 12. | 13. RESERVE FUEL: FULL | EMPTY | 14. NUMBER OF PRACTICE LANDINGS: T AND G | FULL STOP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ,00 | ,00 | | | | | | | 2 |
| | | | | | | | ,00 | ,00 | | | | | | | 3 |
| | | | | | | | ,00 | ,00 | | | | | | | 4 |
| | | | | | | | ,00 | ,00 | | | | | | | 5 |
| | | | | | | | ,00 | ,00 | | | | | | | 6 |
| | | | | | | | ,00 | ,00 | | | | | | | 7 |
| | | | | | | | ,00 | ,00 | | | | | | | 8 |
| | | | | | | | ,00 | ,00 | | | | | | | 9 |
| | | | | | | | ,00 | ,00 | | | | | | | 10 |
| | | | | | | | ,00 | ,00 | | | | | | | 11 |
| | | | | | | | ,00 | ,00 | | | | | | | 12 |
| | | | | | | | ,00 | ,00 | | | | | | | 13 |
| | | | | | | | ,00 | ,00 | | | | | | | 14 |
| ENTER CLOCK TIME, FUEL WT, AND TOTAL LANDINGS AT END OF MISSION THIS ROW | | | | | | | | ,00 | | | FINAL LANDING | | 0 | 1 | |
| | | | | | | | | | | | TOTAL LANDINGS | | | | |

15. REMARKS

| 16. PRINTED NAME AND RANK OF AIRCRAFT COMMANDER | 17. PRINTED NAME AND RANK OF CREW MEMBER COMPLETING FORM | DUTY AF BASE | DUTY PHONE (AUTOVON) |
|---|---|---|---|
| | | | |

AFTO FORM JAN 78 76 PREVIOUS EDITION IS OBSOLETE

608647200 KC-135 ACCUMULATION LISTING 06/26/77

S/N 61-0320 MDS - 3 KC-135A TANKER UNIT 542 STATUS -04/30/76 FLT HRS - 7141. FLT HRS/YEAR - 761.

A/C FLIGHT HOURS FROM STRUCTURAL MODIFICATION PROGRAM - 7203. DELTA FLT HRS FROM MONITORING PROG - 53.7

CURRENT DAMAGE STATUS OF ALL APPLICABLE DETAILS

| DETAIL | W1 | W1A | W1C | W1E | W1G | W2 | W2CC | W2D | W2E | W2I | W2F | W2L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAMAGE | 0.1520 | 0.1877 | 0.1505 | 0.0478 | 0.1476 | 0.1811 | 0.2352 | 0.1617 | 0.2182 | 0.1497 | 0.1168 | 0.0222 |
| FLT HRS | 12853. | 10083. | 12998. | 44429. | 13290. | 10485. | 7695. | 11940. | 8473. | 13032. | 17157. | 15874. |
| YR .25 D | JAN 84 | MAY 80 | MAR 84 | DEC 99 | JUL 84 | NOV 80 | MAR 77 | OCT 82 | MAR 78 | MAR 84 | AUG 89 | DEC 87 |

| DETAIL | W2M | W2N | W3 | W3A | W3C | W3D | W3E | W4 | W4A | W4C | W5 | W5A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAMAGE | 0.0731 | 0.0131 | 0.1223 | 0.1359 | 0.1235 | 0.1390 | 0.1073 | 0.1412 | 0.1130 | 0.1009 | 0.0539 | 0.0539 |
| FLT HRS | 14508. | 18637. | 17428. | 15414. | 17226. | 15011. | 22246. | 14234. | 18510. | 20756. | 11602. | 11602. |
| YR .25 D | MAR 86 | AUG 91 | JAN 90 | MAY 87 | OCT 89 | NOV 86 | SEP 93 | OCT 85 | MAR 91 | MAY 94 | MAY 82 | MAY 82 |

| DETAIL | W5B | W5C | W5D | W6 | W6A | W6B | W6D | W7B | W8 | W9 | W10A | W11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAMAGE | 0.0257 | 0.0197 | 0.0151 | 0.1614 | 0.1598 | 0.1598 | 0.0127 | 0.1021 | 0.2173 | 0.1364 | 0.0583 | 0.1153 |
| FLT HRS | 17858. | 21498. | 26162. | 10874. | 10992. | 10992. | 32609. | 18045. | 7751. | 13996. | 34130. | 17455. |
| YR .25 D | JUL 90 | MAY 95 | DEC 99 | JUN 81 | JUL 81 | JUL 81 | DEC 99 | NOV 90 | APR 77 | JUL 85 | DEC 99 | JAN 90 |

| DETAIL | W12 | W13 | W14 | W15 | W16 | W17 | W18 | W18A | W18B | B1 | B2 | B5A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAMAGE | 0.2129 | 0.0259 | 0.1318 | 0.2132 | 0.1504 | 0.0555 | 0.0915 | 0.0294 | 0.0707 | 0.0340 | 0.0357 | 0.0134 |
| FLT HRS | 8718. | 14401. | 14995. | 8545. | 13765. | 35737. | 21531. | 68918. | 29044. | 61285. | 58832. | 20851. |
| YR .25 D | JUL 78 | JAN 86 | OCT 86 | MAY 78 | MAR 85 | DEC 99 | MAY 95 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | JUN [illegible] |

| DETAIL | B5B | B8 | M1 | V1 | V5 | B9A |
|---|---|---|---|---|---|---|
| DAMAGE | 0.1112 | 0.0204 | 0.0378 | 0.0139 | 0.0219 | 0.0877 |
| FLT HRS | 19441. | 90828. | 49945. | 101686. | 29692. | 6561. |
| YR .25 D | AUG 92 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | SEP 95 |

DETAILS REPAIRED IN FATIGUE PACKAGE 1 (INSTALLED 3752. HOURS )

DETAIL W2A W8

DETAILS REPAIRED IN FATIGUE PACKAGE 2 (INSTALLED 6395. HOURS )

DETAIL W2B W2N W5 W5A W5B W5C W5D W6D W18B B5 B5A

DETAILS SCHEDULED FOR REPAIR IN FATIGUE PACKAGE 3 (ESTIMATED 7203. HOURS )

| DETAIL | W1A | W2CC | W2E | W8 | W12 | W15 |
|---|---|---|---|---|---|---|
| FLT HRS | 19910. | 11873. | 17271. | 11861. | 17826. | 18256. |
| YR .25 D | FEB 92 | SEP 82 | OCT 89 | SEP 82 | JUL 90 | FEB 91 |

DETAILS SCHEDULED FOR REPAIR IN FATIGUE PACKAGE 4 (ESTIMATED 7203. HOURS )

| DETAIL | W2 | W2D | W4 | W8 |
|---|---|---|---|---|
| FLT HRS | 19334. | 20789. | 23507. | 11861. |
| YR .25 D | JUL 92 | JUN 94 | JAN 98 | SEP 82 |

ECP 342 DETAIL W2L HOURS INSTALLED 6394.
DETAIL W13
TO 1C-135-924 DETAIL W2M HOURS INSTALLED 6720.
ECP 345/ECP 345-1 DETAIL V5A HOURS INSTALLED 5408.
ECP 345R1-2/ECP 371 DETAIL V5B HRS EST 5408. HRS TO 0.25 DAM 73653. YR AT 0.25 DAM DEC 99
ECP 330-11 NOT CURRENTLY SCHEDULED FOR INSTALLATION
TO 1C-135(W)B-518 NOT CURRENTLY SCHEDULED FOR INSTALLATION

DETAILS SCHEDULED FOR REPAIR IN ECP 330-10 (ESTIMATED 11500. HOURS )

| DETAIL | W1 | W1A | W1C | W1G | W2 | W2CC | W2D | W2E | W2I | W2F | W2L | W2M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLT HRS | 26076. | 23307. | 26222. | 26514. | 35761. | 20841. | 25086. | 21568. | 26178. | 30302. | 21083. | 19991. |
| YR .25 D | DEC 99 | SEP 97 | DEC 99 | DEC 99 | DEC 99 | JUL 94 | DEC 99 | JUN 95 | DEC 99 | DEC 99 | OCT 94 | MAY 93 |



| DETAIL | W2N | W3 | W3A | W3C | W3D | W3E | W4 | W4A | W4C | W5 | W5A | W5B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLT HRS | 23831. | 31675. | 29622. | 31434. | 29219. | 34454. | 27804. | 31880. | 34325. | 17188. | 17188. | 23444. |
| YR .25 D | MAR 98 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | SEP 89 | SEP 89 | DEC 97 |

| DETAIL | W5C | W5D | W6 | W6A | W6B | W6D | W7B | W8 | W9 | W11 | W12 | W13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLT HRS | 27084. | 31748. | 22044. | 22170. | 27769. | 38333. | 29969. | 30131. | 26855. | 30642. | 22123. | 19598. |
| YR .25 D | DEC 99 | DEC 99 | FEB 96 | MAR 96 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | DEC 99 | MAR 96 | NOV 92 |

| DETAIL | W14 | W15 | W16 |
|---|---|---|---|
| FLT HRS | 28117. | 22553. | 28128. |
| YR .25 D | DEC 99 | OCT 96 | DEC 99 |

TO 1C-135-1102 NOT CURRENTLY SCHEDULED FOR INSTALLATION

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: C-140

FLEET INFORMATION

NO. OF AIRCRAFT: 15 : YEAR SERVICE BEGAN: 1961

SYSTEM MANAGEMENT: WR/ALC

DATE TRANSFERRED TO AFLC:

USING COMMAND: SAM (11), AFCS (4)

PRIMARY BASE: Andrews

PRIMARY MISSION TYPES: VIP Transport

REMARKS: C-140A & C/VC-140B are military version of the Lockheed -6 & -8 JetStar

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | FAA |
| FULL-SCALE CYCLIC TEST: | | | |
| FULL-SCALE STATIC TEST: | X | | PROOF (FAA) |
| DAMAGE TOLERANCE TESTS: | | | |
| DADTA INITIAL: | | | |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | | | No IAT |
| L/ESS DESIGN: | | | No L/ESS |
| FSM PLAN: | X | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |

(Air Force purchased C-140's as off-the-shelf items from Lockheed-Georgia Company)

A/C TYPE: C-140 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:
Tech Orders based on commercial JetStar FAA requirements and force experience.

INSPECTION INTERVALS: PDM is a 3 Phase ACI. Each a/c goes through the system every 3 yearss

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION: Failed items are logged.

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS: Max time a/c is over 12000 hr. all but 4 are over 10,000 hr. one commercial a/c just phassed 10,000 hr., but average if 5000 hr.

APPLICABLE DOCUMENTS: T.O. 1C-140A-3, 6, 36

A/C TYPE: C-140 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

IAT-FSM INTERFACE: NO IAT

L/ESS-IAT INTERFACE: NO L/ESS

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: NONE TO DATE

COMMONALITY WITH OTHER SYSTEMS: COMMERCIAL JETSTAR

METHODS WHICH HAVE WORKED WELL: Conservative design and low stress levels have kept fatigue problems to a minimum.

DEFICIENCIES IN CURRENT METHODS: No tracking system or L/ESS at all. Wings are moved from a/c to a/c with no attempt to track them.

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: C-141A

FLEET INFORMATION

NO. OF AIRCRAFT: 271 : YEAR SERVICE BEGAN: 1966

SYSTEM MANAGEMENT: C-141 System Mgr WR/ALC

DATE TRANSFERRED TO AFLC: 1971

USING COMMAND: MAC

PRIMARY BASE: Norton, Travis, Altus, Charleston, McGuire

PRIMARY MISSION TYPES: Airlift, Training, Airdrop

REMARKS: Total of 14 Missions. Recent emphasis on low level training.

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | 120,000 of 130,000 |
| FULL-SCALE CYCLIC TEST: | | X | 99,000/150,000 Test Hrs Completed* |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | X | | To FAA/Lockheed Requirements** |
| DADTA INITIAL: | 1977 | | |
| STRENGTH SUMMARY: | 1966? | | |
| TRACKING SYSTEM DESIGN: | Fatigue | Crack Growth | Tracking Under Study |
| L/ESS DESIGN: | 1972 | | |
| FSM PLAN: | MSG-2 | Addtl Changes under discussi | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | LG76ER0119 | WR/ALC |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| Initial Quality Assessment | -0120 | " |
| Stress Spectra Development | -0121 | " |
| OPS Limits & MOD/USAGE OPTIONS | -0122 | " |
| Airframe Corrosion/Proposed MOD | -0176 | " |

*1969-71 Service Loads Spectrum. Block Spectrum for first 90,000 hrs. FLT-BY-FLT in Process Now.

** 92% Limit Load with one major element severed.

A/C Type: C-141A (Continued)

IAT PROGRAM

ANALYSIS METHOD: Fatigue by Σ of 3204 Data Blocks of Usage at 12 Monitored Locations. Mean-to-Mean G-A-G Definition. Study of Potential Change to Crack Growth Prediction is in Process

APPLICABLE REPORT:

DATA COLLECTION: RECORDER: N/A FORM: AFTO 451 (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: Every Flight :TECH.ORDERS: T.O.1C-141A-102

DATE STARTED: 1968 HRS.RECORDED: ALL % USABLE DATA: 70%

DATA COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? WR/ALC & ASIMIS

HOW IS IT CHECKED? By a simple edit program at WR/ALC

TECHNIQUE TO RECOVER MISSING DATA: Errors & missing data are entered on blank form and rerun. Each Quarter Software Factors recorded data up to Flt.Hrs, Full-Stop & Total LOGS Entered on MAC A38 Airframe (Usage) Report.

LIST PROCESSING STEPS: Forms →WR/ALC OPSCAN →EDIT →OPSCAN →USAGE TAPE→ ASIMIS→ COMPUTER PROCESS →OUTPUT/TAPE/LISTING. ASIMIS SOFTWARE HAS DATA VALIDITY CHECKS.

OUTPUT CONTENTS (ATTACH SAMPLES): Usage Data, calculated fatigue damage, predicted time to cracking at control points. Statistical Base for histograms. Usage by base by mission.

LIST PERMANENT FILES: RAW DATA? Usage tapes at ASIMIS

PROCESSED DATA? Output Tapes

WHO EVALUATES OUTPUT? WR/ALC

APPLICATIONS: SCHEDULING? ACI Aircraft & Special Inspections

ANALYSIS UPDATE? No

TO DETECT CHANGE IN USAGE? No

REMARKS: Damage indicates relative severity & Longevity by tail No. IAT data used in evaluation of service cracks & subsequent action. IAT program was conducted and evaluated in 1970-73 by Lockheed; Then assimilated in-house by WR/ALC and ASIMIS. Also see remarks Page 6.

LHRP PROGRAM

ANALYSIS METHOD: Peak-count, mean-crossing method; gust/maneuver separation by Freq filtering; fatigue damage using Miner's cum. rule Σ n/N.

APPLICABLE REPORT: LG74ER0058, LG74ER0112, LG74ER0087

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 26 RECORDING DEVICE: MXU-553A (Attach Description)

PARAMETERS RECORDED: 20-See Attached (Attach List)

L/ESS START/STOP DATES: 1974→ HRS. RECORDED: UNK.

% USABLE DATA: UNK DATA RETRIEVAL FREQ. 12-15 Hrs.

DEFINITION OF USABLE DATA: A/S, ALT, Ground Speed, 2 Events

COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Parity, Parameter Activity & Limits

LIST STEPS: Cassette → Mailed to ASIMIS → R/T → Raw Data Tape Edit Program → Compressed Data Tape → Reduction Program → Printout → WR/ALC

TECHNIQUE TO RECOVER MISSING PARAMETERS: Manual editing by ASIMIS people.

OUTPUT CONTENTS (Attach Sample): Usage output in same form as IAT output. Load factor data by A/C model, Weight, Altitude.

LIST PERMANENT FILES: RAW DATA? Input tapes at ASIMIS

PROCESSED DATA? History usage tape, history damage by data block tape.

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: N/A

TO CHECK IAT DATA? Yes. Compared Quarterly

TO DETECT CHANGE IN USAGE? No.

REMARKS: Programs can output data block info by FLT, Quarter, year, etc. Oscillograph VGH Data (27,024 Flt Hrs, 1964 Ground Hrs, 16,911LDGS) is Basis of damage calculation. LHRP is intended to check IAT data accuracy.

A/C TYPE: C-141A (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Initial analyses and tests; later tests and service experience; MSG-2 system review- Implemented in 1977; update of FSM to include DADTA analysis results is being considered. FSM to date is based on fatigue.

INSPECTION INTERVALS: PREFLT-THRUFLT-HSC @ 10 days; minor phase @ 150 days; major phase @ 300 days; PDM @ 3 yrs; ACI @ 18 ACFT/YR (WR/ALC). (These intervals were originally 7,30,90 days & 3 years). Additional controlled internal extension (CIE) have been considered by WR/ALC.

RANGE OF CRITICAL CRACK LENGTHS: 1" to 6"

SPECIAL COMPONENT INSPECTIONS: NONE

DATA COLLECTION: AFM 66-1; Unsatisfactory Reports (UR's); Informal WR/ALC and Lockheed records

DATA EVALUATION: Informal by WR/ALC. ON-CALL Assistance by Lockheed.

APPLICATION OF FEEDBACK DATA: Used to determine service inspection, restriction, MOD actions.
AFM 66-1 data is not definitive enough to contribute to maintenance program evaluation.

REMARKS: A formal definitive data feedback system is needed. NDI systems presently being developed will affect inspection requirements and intervals.

APPLICABLE DOCUMENTS: TO 1C-141A-06
TO 1C-141A-6
TO 1C-141A-23
TO 1C-141A-36

A/C TYPE: C-141A (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: ASD began program, transferred to W.R. ALC in 1971; test program still in process. W.R. ALC funded DADTA 1975-1977; technical management by Lockheed-W.R.-ASD Triad. W.R. ALC is program manager with support from Lockheed (primarily) and other organizations (small amount).

IAT-FSM INTERFACE: Change to crack growth tracking should change this interface.

LHRP-IAT INTERFACE: LHRP has not yet been carried far enough to address accuracy of IAT, as it is intended to do.

ORGANIZATIONAL CHANGES PENDING: Lockheed analysis & test completion scheduled for 1981. C-141B stretch production will affect Lockheed WR/ALC activities.

AFLC/ALD INTERFACE: None to Date on C-141.

COMMONALITY WITH OTHER SYSTEMS: C-130 and C-141 IAT, LHRP are essentially the same systems. C-5 is very closely related. C-141B modification will impact all elements of ASIP; not all of these have been considered yet.

METHODS WHICH HAVE WORKED WELL: ASD-Contractor Team or W.R./ALC-Contractor Team has worked well. Any other arrangement has suffered from lack of continuity and direct system involvement.

DEFICIENCIES IN CURRENT METHODS: IAT and LHRP are still not up to intended performance. No provision yet for evaluation of IAT from LHRP. Need yearly update working sessions between ASD and ALC ASIP managers.

# C-141 AIRCRAFT USAGE LOG

NAME

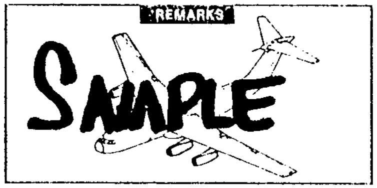
SQUADRON

## CUMULATIVE AIRFRAME

| FLT HRS | F S LDGS | TOTAL LDGS |
|---|---|---|
| AT START OF SORTIE | | |
| | | |

| PAGE NO. | OF | TOTAL PAGES |
|---|---|---|
| 1 | | 1 |
| 2 | | 2 |
| 3 | | 3 |
| 4 | | 4 |
| 5 | | 5 |

REMARKS




## AIRCRAFT SERIAL NUMBER

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0 | – | 0 | 0 | 0 | 0 |
| | 1 | – | 1 | 1 | 1 | 1 |
| | 2 | – | 2 | 2 | 2 | 2 |
| | 3 | – | 3 | 3 | 3 | 3 |
| | 4 | – | 4 | 4 | 4 | 4 |
| | 5 | – | 5 | 5 | 5 | 5 |
| 6 | 6 | – | 6 | 6 | 6 | 6 |
| | 7 | – | 7 | 7 | 7 | 7 |
| | | | 8 | 8 | 8 | 8 |
| | | | 9 | 9 | 9 | 9 |

## DATE

| DAY | | MON | YEAR |
|---|---|---|---|
| 0 | 0 | JAN | 72 |
| 1 | 1 | FEB | 73 |
| 2 | 2 | MAR | 74 |
| 3 | 3 | APR | 75 |
| | 4 | MAY | 76 |
| | 5 | JUN | |
| | 6 | JUL | |
| | 7 | AUG | |
| | 8 | SEP | |
| | 9 | OCT | |
| | | NOV | |
| | | DEC | |

## INITIAL TAKE OFF

| FUEL WT BAND | PAYLOAD WT BAND | |
|---|---|---|
| 0 | 0 | SUB STD |
| 12 | 5 | |
| 25 | 10 | |
| 37 | 15 | |
| 50 | 20 | |
| 62 | 27 | |
| 75 | 35 | |
| 87 | 42 | |
| 100 | 50 | |
| 112 | 60 | |
| 125 | 70 | |
| 137 | 80 | |

## TERMINATION LANDING

| CLOCK TIME | | | | FUEL WT BAND | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | AWLS |
| 1 | 1 | 1 | 1 | 12 | |
| 2 | 2 | 2 | 2 | 25 | |
| | 3 | 3 | 3 | 37 | |
| | 4 | 4 | 4 | 50 | |
| | 5 | 5 | 5 | 62 | |
| | 6 | | 6 | 75 | |
| | 7 | | 7 | 87 | |
| | 8 | | 8 | 100 | |
| | 9 | | 9 | 112 | SUB STD |
| | | | | 125 | |
| | | | | 137 | |

## TOUCH & GO AND STOP & GO LANDINGS

(Four identical blocks)

| CLOCK TIME | | | | NO | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | T/G | AWLS |
| 1 | 1 | 1 | 1 | 1 | S/G | |
| 2 | 2 | 2 | 2 | 2 | | |
| | 3 | 3 | 3 | 3 | | |
| | 4 | 4 | 4 | 4 | | |
| | 5 | 5 | 5 | 5 | | |
| | 6 | | 6 | 6 | | |
| | 7 | | 7 | 7 | | |
| | 8 | | 8 | 8 | | |
| | 9 | | 9 | 9 | | SUB STD |

## FLIGHT SEGMENTS

ALL CLOCK TIMES AT START OF SEGMENT

(Segments 1–6, each preceded by an EVENT block)

EVENT: CL, C, CR, DS, ET

| CLOCK TIME | | | |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| | 3 | 3 | 3 |
| | 4 | 4 | 4 |
| | 5 | 5 | 5 |
| | 6 | | 6 |
| | 7 | | 7 |
| | 8 | | 8 |
| | 9 | | 9 |

SEGMENT 1 / SEGMENT 2 / SEGMENT 3 / SEGMENT 4 / SEGMENT 5 / SEGMENT 6

| ALT | MACH | FUEL | A/D |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | .37 | 12 | 5 |
| 2 | .45 | 25 | 10 |
| 7 | .54 | 37 | 15 |
| 12 | .61 | 50 | 20 |
| 17 | .71 | 62 | 27 |
| 22 | .80 | 75 | 35 |
| 32 | | 87 | |
| | | 100 | |
| | | 112 | |
| | | 125 | |
| | | 137 | |

AFTO FORM 451
SEPT 71

★U.S. GOVERNMENT PRINTING OFFICE: 1972-755-563

LIST OF C-141 LHRP PARAMETERS

1. Airspeed
2. $N_z$
3. $N_y$
4. Altitude
5. Pitch rate
6. Yaw rate
7. Elevator Deflection
8. Rudder Deflection
9. Cabin Pressure
10. Flap Deflection
11. Wheels Down Event
12. Liftoff Event
13. Spoiler Deflection
14. Nose Gear Steering Angle
15. Ground Speed
16. Strain #1
17. #2
18. #3
19. #4
20. #5

# STATE-OF-THE-ART REVIEW
# FORCE MANAGEMENT METHODS

A/C TYPE: CT-39A

## FLEET INFORMATION

NO. OF AIRCRAFT: 142 : YEAR SERVICE BEGAN: 1957

SYSTEM MANAGEMENT: AFLC

DATE TRANSFERRED TO AFLC: 1964

USING COMMAND: USAF (MAC), AFSC, PACAF

PRIMARY BASE: McClellan AFB, Sacramento (26 Bases)

PRIMARY MISSION TYPES: Utility & VIP Transport. Cross country-

REMARKS: passengers/cargo; Local training & pilot proficiency. Transition training more severe than VIP transport mission 10-17000 acft. flt. hr.; 14,000 avg. service life now 22,500 flt. hr. 80 hr.mo. flying time.

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | Wing 1964&1973 fuselage 1961 |
| FULL-SCALE STATIC TEST: | X | | to approx.90,000 hrs |
| DAMAGE TOLERANCE TESTS: | X | | 3 frame bay fus.pane |
| DADTA INITIAL: | | X | Objective-to extend life to 45,000 hrs. |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | | X | |
| L/ESS DESIGN: | X | | May be modified to convert to fracture |
| FSM PLAN: | | X | |
| BASELINE OPS SPECTRA: | | X | |
| DADTA-FINAL: | | X | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | SM-ALC/MMS 73-508 Change 5, 30 June 77<br>NA-77-549 | DADTA (SOW) |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | NA-77-599 | In work |
| SERVICE LIFE ANALYSIS: | | |
| Wing Teardown & Inspection | NA-77-5951 | |
| Fuselage Teardown & Inspec. | NA-77-595-2 | |
| Corrosion Analysis Rpt. | NA-77-628 | |
| Tracking Program Proposal | NA-77-596 | |
| TECH Orders Update Proposal | NA-78-403 | |
| Fuselage 30000 hr Fatigue Test | NA-68-517 | |
| Wing SLEP fatigue Test | NA-74-564<br>SR-75-002 | |
| Wing Fatigue Test | NA-67-238 | |
| MPIP Report | | |

A/C Type: CT-39A (Continued)

IAT PROGRAM - Proposed

ANALYSIS METHOD: Crack growth analysis - MSR data with stress transfer functions for location and using pilot reporting from data for number and type of flight

APPLICABLE REPORT: NA-77-596

DATA COLLECTION: RECORDER: MSR FORM: Pilot Rpt. (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: :TECH.ORDERS:

DATE STARTED: HRS.RECORDED: % USABLE DATA:

DATA COLLECTION PROBLEMS: ASIMIS is developing a MSR reduction program for F-16 which will be modified for T-39. Approx. 3 mo to 6 mo. for project go-ahead.

DATA REDUCTION: WHO DOES IT? RI/LAD-OCALC-Leigh Inst.

HOW IS IT CHECKED?

TECHNIQUE TO RECOVER MISSING DATA:

LIST PROCESSING STEPS: MSR Data put on tape by OCALC - Produce stress spectrum at selected locations. Compute incremental crack growth using spectra, test correction factors. Update individual aircraft history.

OUTPUT CONTENTS (ATTACH SAMPLES):

LIST PERMANENT FILES: RAW DATA? MSR Tape -Tape record from OCALC

PROCESSED DATA? Individual a/c record of crack growth

WHO EVALUATES OUTPUT? RI/LAD

APPLICATIONS: SCHEDULING? Inspection Periods

ANALYSIS UPDATE?

TO DETECT CHANGE IN USAGE? Automatic Survey of Pilot Forms all detect usage change.

REMARKS: The CT-39 does not currently have an IAT. The above outlined program has been proposed in NA-77-596 to meet the intents and objectives of MIL-STD-1530. Initial planning & decision-making is scheduled to occur between July-Nov. 1978, with the first output planned for Jan. 1980.

MSR decision is planned in May 1978.

$831.00 for Leigh MSR.
$200.00 Cassette (Initial)
$67.00 Refurbished Cassette

Present System:

MXU 553 on 14 A/C-10% of fleet
$\Sigma n/N$ No pilot logs to date. VGH on 28 A/C for 11/2 yr. until '72.
No tracking at all on other than 14 A/C

L/ESS PROGRAM

ANALYSIS METHOD: Obtain load factor exceedance data and mission profile data from FLDRS. Combine this data with anayltic load conditions to produce flight-by-flight spectra.

APPLICABLE REPORT: ______

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 14 RECORDING DEVICE: MXU-553 ECU-697/A MUX (Attach Description)

PARAMETERS RECORDED: Nz,Ny, Roll Vel.Wt.Speed Alt+8 Strain (Attach List)

L/ESS START/STOP DATES: Jan 1976 HRS. RECORDED: 4530(31Dec.77

% USABLE DATA: 77 DATA RETRIEVAL FREQ Every 15 Hr.

DEFINITION OF USABLE DATA: Alt.Airspeed,$N_z$,timing word,supplemental data.

COLLECTION PROBLEMS: → Hardware shortages, supplemental data, maintenance scheduling, high failure rate of strain gage amplifiers.

DATA REDUCTION: WHO DOES IT? RI/LAD-OCAMA

HOW IS IT CHECKED? → Parameter values & rate change compared by RI with pre-selected acceptable values.

LIST STEPS: Establish flight profiles, generate load factor exceed. dat for flight segments of each profile. Generate flight by flight spectrum(load factor)& bending moment spectra using approp. analytical conditions Software & data reduction both by RI

Fault isolation pgm at ASIMIS to detect malfunctioning parameters Questionable data also verfied by SM-ALC thru A-/MIS terminal. Strain gage readings checked by SM/ALC

TECHNIQUE TO RECOVER MISSING PARAMETERS: Operational bases are contacted by telephone/letter/TWX on all malfunctions in accordance with AFLC 80-2 Par. 3c(3)e(2).

OUTPUT CONTENTS (Attach Sample): Compressed data tapes are forwarded to RI on a Mo. basis. Mission profiles (5 types) exceedance data (gust & maneuver) separated by frequency period (1.5 sec on vert. gus & lateral) each of 5 mission segments. Load factor (flight by flight) spectrum each profile stress or bending moment spectra (flight by flight for each profile average spectra by a/c by base, by mission type.

LIST PERMANENT FILES: RAW DATA? Tapes from OCAMA. Raw data tapes are filed for one year at ASIMIS.

PROCESSED DATA? Load factor data, mission profiles flight-by-flight spectra (load factor & bending moments or stress) processed tapes are forwarded by ASIMIS to RI on a monthly basis.

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Upgraded as data is available.

TO CHECK IAT DATA? Comparison with MSR on Wing. Used as IAT basis for Vert. Tail.

TO DETECT CHANGE IN USAGE? Output for individual A/C will reflect change.

REMARKS: Program has built in checks to remove "bad" data. Raw data from A/C is processed by OCAMA. Also tracks damage fraction at 9 locations. If the basis for the IAT is to be fracture, this program will need to be realigned accordingly. 15,000 hr. VGH data also acquired.

A/C TYPE: CT-39A (Continued'

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:
To be determined by DADTA and MPIP

INSPECTION INTERVALS: To be determined by DADTA and MPIP. Presently Phased Inspection Interval of 200 flight hours. No depot level inspection except ACI at Navy NARF Pensacola.

RANGE OF CRITICAL CRACK LENGTHS: 0.2 to 10 inches

SPECIAL COMPONENT INSPECTIONS: To be determined by DADTA and MPIP.

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS:

APPLICABLE DOCUMENTS: T.O. T39-3 Structural Repair
T.O. T39-6 Inspection
T.O. T39-23 Corrosion
T.O. T39-36 NDI
MPIP Report

A/C TYPE: CT-39A (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: Most CT-39's are assigned to MAC, however maintenance functions are, in some cases, conducted by other agencies. MAC co-operation is excellent & response if made to telephone calls; maintenance at SAC is handled by SAC personnel & they will respond only to TWX's.

IAT-FSM INTERFACE: N/A

L/ESS-IAT INTERFACE: L/ESS spectra will be used to derive the crack growth on the vertical tail for IAT.

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: Copies of quarterly reports are submitted to AFALD/PTE

COMMONALITY WITH OTHER SYSTEMS: The MXU-553/A system is utilized in majority of AF aircraft. The ECU-69/A multi-plexer (strain gage system) is unique to the T-39A.

METHODS WHICH HAVE WORKED WELL: 1) Briefings to O&M personnel at each base prior to implementing program 2) Frequent telecons to base, even if no corrective action is required. 3) Reports to field on program status were begun (prior to issuance of AFLC 80-2) with delivery of initial aircraft.

DEFICIENCIES IN CURRENT METHODS: 1) No spares are authorized at bases. Once a malfunction has been detected, the base verifies failure & then requisitions sensor. Replacement time varies from 2-6 months. 2) are removed from a/c & returned to ASIMIS via supply channels The average time from removal to processing is 3 wks. The CT-39 has a high usagerate; hence if a malfunction is detected there are all ready 4-5 tapes in the pipe line with the same malfunction

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: E-3A

FLEET INFORMATION

NO. OF AIRCRAFT: 22-40 programmed : YEAR SERVICE BEGAN: 1977

SYSTEM MANAGEMENT: ESD*

DATE TRANSFERRED TO AFLC: 1981 (estimated) to OC-ALC

USING COMMAND: TAC

PRIMARY BASE: Tinker

PRIMARY MISSION TYPES: Airborne alert, training

REMARKS: *ASD is technical consultant for ASIP-related functions

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | x | | Most structure common to 707 |
| FULL-SCALE CYCLIC TEST: | x | | |
| FULL-SCALE STATIC TEST: | x | | |
| DAMAGE TOLERANCE TESTS: | | | |
| DADTA INITIAL: | | x | |
| STRENGTH SUMMARY: | x | | |
| TRACKING SYSTEM DESIGN: | | x | |
| L/ESS DESIGN: | | x | |
| FSM PLAN: | | x | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | D204-10560-1 | Boeing-Seattle |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| Methodology Plan for E-3A Fleet Mgt. Program | D204-12536-1 | Boeing Seattle |

IAT PROGRAM

ANALYSIS METHOD: -PROPOSED

Unit crack growth for 10 control points using approx. 3000 data blocks.
Average retardation factor within segments-no retardation from segment to segment.

APPLICABLE REPORT: D204-1002-1

DATA COLLECTION: RECORDER: ______ FORM: ~~Modified~~ T-43 form (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: ______ :TECH.ORDERS: ______

DATE STARTED: ______ HRS.RECORDED: ______ % USABLE DATA: ______

DATA COLLECTION PROBLEMS: ______

DATA REDUCTION: WHO DOES IT? 1980-82: Boeing Seattle 1982-ON: ASIMIS

HOW IS IT CHECKED? ______

TECHNIQUE TO RECOVER MISSING DATA: Ratio up individual aircraft by total flight hours per quarter.

LIST PROCESSING STEPS: ______

OUTPUT CONTENTS (ATTACH SAMPLES): Calculated crack length based on safety & economic limit $a_i$; time remaining to inspection & $a_{cr}$ based on safety limit $a_i$

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA? ______

WHO EVALUATES OUTPUT? ______

APPLICATIONS: SCHEDULING? ______

ANALYSIS UPDATE? ______

TO DETECT CHANGE IN USAGE? ______

REMARKS: This program is expected to be operational at Boeing-Seattle by 1 March 1980. Transfer to ASIMIS is scheduled for 1 June 1982.

L/ESS PROGRAM (PLANNED)

ANALYSIS METHOD: Crack growth analyses with flight to flight retardation factors.

APPLICABLE REPORT: D204-10021-1

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 7 RECORDING DEVICE: ______ (Attach Description)

PARAMETERS RECORDED: Programmed ______ (Attach List)

L/ESS START/STOP DATES: ______ HRS. RECORDED: ______

% USABLE DATA: 35 (Target) DATA RETRIEVAL FREQ. 15hrs/tape

DEFINITION OF USABLE DATA: ______

COLLECTION PROBLEMS: Remote location of recorder may discourage cassette changing.

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Data reduction methodology and software

~~LIST STEPS:~~ are currently under development

TECHNIQUE TO RECOVER MISSING PARAMETERS: ______

OUTPUT CONTENTS (Attach Sample): ______

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? ______

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: ______

TO CHECK IAT DATA? IAT unit crack growth rates will be updated

TO DETECT CHANGE IN USAGE? ______

REMARKS: ______

A/C TYPE: E-3A (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Commercial 707 analyses, tests, airlines experience, teardown inspections.

INSPECTION INTERVALS: Isochronal field-level requirements- no depot-level PDM requirement currently exists (Reference T.O. 00-25-4)

RANGE OF CRITICAL CRACK LENGTHS: To be determined by DADTA

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA: Teardown of TWA "Las Vegas" 707 with 44,000 ± hours proved beneficial for fatigue analysis verification.

REMARKS: Existing commercial-based FSM program will be updated to incorporate E-3A DADTA results.

APPLICABLE DOCUMENTS: ASIP Master Plan, Tech. Order

A/C TYPE: E-3A (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: ASD- specified ASIP tasks must be funded by ESD

IAT-FSM INTERFACE: None to date - IAT not yet operational

L/ESS-IAT INTERFACE: L/ESS results will be used to update unit crack growth rates for IAT program.

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS: IAT data block system and L/ESS program are similar to T-43.

METHODS WHICH HAVE WORKED WELL:

DEFICIENCIES IN CURRENT METHODS:

## E-3A FLIGHT LOADS RECORDER PARAMETERS

| ITEM | SAMPLES PER SECOND |
| --- | --- |
| Documentary Data | |
| Tail Number | 1 |
| Initial Gross Weight | 1 |
| Initial Fuel Weight | 1 |
| Base | 1 |
| Mission Type | 1 |
| Aircraft Hours | 1 |
| Date | 1 |
| Events | |
| Flight or Ground Mode | 1 |
| Antenna Pedestal Rotation, 6 RPM | 1 |
| Antenna Pedestal Rotation, 1/4 RPM | 1 |
| Reserve Tank Valve | 1 |
| Center Tank Pump | 1 |
| Autopilot | 1 |
| Refuel Doors Position | 1 |
| Altitude | 1 |
| Airspeed | 1 |
| Vertical Acceleration, c.g. | 30 |
| Lateral Acceleration, c.g. | 10 |
| Pitch Rate | 20 |
| Yaw Rate | 20 |
| Stabilizer Position | 10 |
| Flap Position | 5 |
| Elevator Position | 10 |
| Nose Gear Steering Angle | 5 |
| Fin Root Strain | 30 |
| Antenna Pedestal Strut Strain, R.F. | 20 |
| Antenna Pedestal Strut Strain, R.R. | 20 |
| Antenna Pedestal Strut Strain, L.F. | 20 |
| Antenna Pedestal Strut Strain, L.R. | 20 |
| Time | 1 |

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-4C/D, RF-4C, F-4E

FLEET INFORMATION All models-USAF

NO. OF AIRCRAFT: 1832 : YEAR SERVICE BEGAN: 1961

SYSTEM MANAGEMENT: OOALC

DATE TRANSFERRED TO AFLC: 1 Oct 1975

USING COMMAND: TAC, USAFE, PACAF, AAC, AFSC, ADC, ATC, ANG

PRIMARY BASE: see attached

PRIMARY MISSION TYPES: A-A, A-G, Recon (RF)

REMARKS: 4000 hrs - extension to 8000 is proposed with retrofits

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | x | | |
| FULL-SCALE CYCLIC TEST: | E(slat) | C&D | |
| FULL-SCALE STATIC TEST: | none | | |
| DAMAGE TOLERANCE TESTS: | x | | |
| DADTA INITIAL: | x | | 40-60 locations |
| STRENGTH SUMMARY: | x | | |
| TRACKING SYSTEM DESIGN: | x | | |
| L/ESS DESIGN: | x | | |
| FSM PLAN: | none | | |
| BASELINE OPS SPECTRA: | | x | continuous |
| DADTA-FINAL: | x | | continuous |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | no number | OO-ALC/MMSRA |
| DAMAGE TOLERANCE ANALYSIS: | A2883, A3390 | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| Monthly CA Readings Report | Form AFTO 109 | |
| Data Collection & Reporting | TO 1F-4-101 | |
| CA Comparison Report | AFTO Form 101 | |
| | TO 1F-4C-6 | |
| A/C Struc. Integrity Program | TO 1F-4C-6ASI-1 | |

IAT PROGRAM

ANALYSIS METHOD: Crack growth - normalized curves using $\Sigma n/N$ based on crack growth

APPLICABLE REPORT: A2883, A3390, MCAIR 76-015 Rev A at ~~AIAA~~ AIAA in 9/76, 76-904

DATA COLLECTION: RECORDER: Systron-Donner FORM: AFTO 109 (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: Monthly :TECH.ORDERS: TO 1F-4-101

DATE STARTED: 1965 HRS.RECORDED: 100,000% USABLE DATA: 99 approx

DATA COLLECTION PROBLEMS: ASN/469 test set breaks down frequently SAALC is home for test set. No spares stocked at base levels. Some errors in transcription of window data

DATA REDUCTION: WHO DOES IT? ASIMIS does it all

HOW IS IT CHECKED? At base by AFTO 101, at ASIMIS

TECHNIQUE TO RECOVER MISSING DATA: Use average at base OOALC checks lists ranked by D.I. ASIMIS has automatic checks.

LIST PROCESSING STEPS: AFTO 109 ASIMIS Keypunched Processed Printouts of tapes mailed to OOALC quarterly.

OUTPUT CONTENTS (ATTACH SAMPLES):
Diagnostic printouts Damage Index printouts
40 Locations F-4C/D
60 Locations F-4E(S)

LIST PERMANENT FILES: RAW DATA? On tape at OOALC

PROCESSED DATA? Tape sent to OOALC for special studies

WHO EVALUATES OUTPUT? OOALC

APPLICATIONS: SCHEDULING? Update-6ASI-1; Sched. Mods { ~~TAC has~~ reassigned A/C to other bases based on D.I.

ANALYSIS UPDATE? Mgmt. studies: do all A/C need mod?

TO DETECT CHANGE IN USAGE?

REMARKS: Lack of base level understanding of tracking and what it does. (Film TS 825 F-4 Struc. Integ. Program)
OOALC have reduced inspections of holes to reduce maintenance-induced flaws caused by removing fasteners.

L/ESS PROGRAM

ANALYSIS METHOD: Process data to tables. Occasionally converted to damage. (Recorder type prevents any accurage knowledge on $n_z$ sequence)

APPLICABLE REPORT:

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 10% RECORDING DEVICE: A/A24U-10 (Attach Description)

PARAMETERS RECORDED: VGH + Pilot Log AFTO 107 (Attach List)

L/ESS START/STOP DATES: 1966 HRS. RECORDED: 100,000

% USABLE DATA: 40 DATA RETRIEVAL FREQ. 25 hr approx.

DEFINITION OF USABLE DATA: All VGH + weight + Mission (AFTO form)

COLLECTION PROBLEMS: Forms; test set TTU 226; command disinterest

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED?

LIST STEPS: Tape cassettes to ASIMIS → checked → processed → tabular data to OOALC.

TECHNIQUE TO RECOVER MISSING PARAMETERS: none

OUTPUT CONTENTS (Attach Sample): Tables to MCAIR occasionally to perform revision of damage equations

Monthly, quarterly, yearly

LIST PERMANENT FILES: RAW DATA? Tape

PROCESSED DATA? Tape

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: N/A, VGH is not sequenced.

TO CHECK IAT DATA? Yes - MCAIR changes equations of DI vs $n_z$.

TO DETECT CHANGE IN USAGE? Yes based on $n_z$ exceedance values

REMARKS: Study at MCAIR to review VGH program (need for new equipment). Equations updated in 1971 and another update is in work.

A/C TYPE: F-4 (all) (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: TO-6 and -6ASI-1 (derived from IAT)

INSPECTION INTERVALS: Mostly flight hours 100, 300, 600 hrs., some 7-day

F-4C: 36 mo; F-4D/E: 48 mo; RF-4E: 54 mo.

4

RANGE OF CRITICAL CRACK LENGTHS:

Initial crack 0.01 inch

Economic repair 0.03 inch

SPECIAL COMPONENT INSPECTIONS: Wing tracking. PDM contract will require reporting wing changes. ASIMIS is rewriting tracking program and will probably include wing tracking.

DATA COLLECTION: ACI, CIE data

DATA EVALUATION: Not much

APPLICATION OF FEEDBACK DATA: Don't see AFM 66-1 data

Problems are brought to their attention by informal contacts

REMARKS: MSF-2 was applied to systems. Not structure.

There is no formal FSM plan. No formal documentation of changes in maint. requirements. They are probably deficient here.

CIE program has not extended any intervals.

APPLICABLE DOCUMENTS: TO 1F-4C-6; TO 1F-4C-6ASI-1

A/C TYPE: F-4 (all) (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: No basic problems. Do away with TRC concept for specialized equipment such as the test sets. Informal contacts with MCAIR. Some contractural work under engineering services contract. Only two people at OOALC working on F-4 ASIP.

IAT-FSM INTERFACE: OK as is. In general ASIP does not schedule inspections, but could use IAT.

L/ESS-IAT INTERFACE: When there is time.

ORGANIZATIONAL CHANGES PENDING: Decision on concept of SM's at AF/ALD will affect transition of F-16.

AFLC/ALD INTERFACE: N/A

COMMONALITY WITH OTHER SYSTEMS: None

METHODS WHICH HAVE WORKED WELL: Combination of crack initiation (fatigue damage) and crack growth has worked well on F-4.

DEFICIENCIES IN CURRENT METHODS: AFFDL documents are too technical for ALC's. See Lockheed report - Fatique and Stress Corrosion Guidelines.

MCAIR would use F-15 method if starting the F-4 at present. Too frequently PDM's may cause more defects than they cure.

F-4 AIRCRAFT INVENTORY AS OF: 1 FEBRUARY 1978

| COMMAND | BASE ACCT | LOCATION | F-4C | F-4D | F-4E | F-4F | F-4G | RF-4C | GRF-4C | YRF-4C | RF-4E | GYF-4E | YF-4E | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PACAF | FB5250 | Clark | | | 55 | | | | | | | | | 55 |
| | FB5270 | Kadena | 20 | 57 | | | | 20 | | | | | | 97 |
| | FB5284 | Kunsan | | 39 | | | | | | | | | | 39 |
| | FB5294 | Osan | | | 27 | | | | | | | | | 27 |
| | | Total | 20 | 96 | 82 | | | 20 | | | | | | 218 |
| USAFE | FB5643 | Alconbury | | | | | | 18 | | | | | | 18 |
| | FB5644 | Bentwaters | | 74 | | | | | | | | | | 74 |
| | FB5688 | Camp New Amsterdam | | | 20 | | | | | | | | | 20 |
| | FB5620 | Hahn | | | 84 | | | | | | | | | 84 |
| | FB5612 | Ramstein | | | 39 | | | | | | | | | 39 |
| | FB5621 | Spangdahlem | 19 | 48 | | | | | | | | | | 67 |
| | FB5573 | Torrejon | 61 | | | | | | | | | | | 61 |
| | FB5529 | Zweibrucken | | | | | | 40 | | | | | | 40 |
| | | Total | 80 | 122 | 143 | | | 58 | | | | | | 403 |
| TAC | FB4857 | Bergstrom | | | | | | 38 | | | | | | 38 |
| | FB2823 | Eglin | | 3 | 60 | | | 2 | | | | | | 65 |
| | FB4812 | George | 30 | | 47 | | 2 | | | | | | | 79 |
| | FB2029 | Hill | | 57 | | | | | | | | | | 57 |
| | FB4801 | Holloman | | 42 | | | | | | | | | | 42 |
| | FB4829 | Homestead | | | 78 | | | | | | | | | 78 |
| | FB4887 | Luke | 91 | | | | | | | | | | | 91 |
| | FB4814 | MacDill | | 31 | 77 | | | | | | | | | 108 |
| | FB4830 | Moody | | | 52 | | | | | | | | | 52 |
| | FB4852 | Nellis | | 80 | 29 | | | | | | | | | 109 |
| | FB4809 | Seymour Johnson | | | 74 | | | | | | | | | 74 |
| | FB4803 | Shaw | | | | | | 90 | | | | | | 90 |
| | | Total | 121 | 213 | 417 | | 2 | 130 | | | | | | 883 |
| AAC | FB5000 | Elmendorf | | | 35 | | | | | | | | | 35 |
| ADC | FB2647 | Keflavik | 13 | | | | | | | | | | | 13 |
| | FB2586 | Tyndall | 7 | | | | | | | | | | | 7 |
| | | Total | 20 | | | | | | | | | | | 20 |
| ATC | FB3020 | Sheppard | | | | | | | 6 | | | 1 | | 7 |

PREPARED BY MMSPB/5291

ATTACHMENT TO F-4

| COMMAND | BASE ACCT | LOCATION | F-4C | F-4D | F-4E | F-4F | F-4G | RF-4C | GRF-4C | YRF-4C | RF-4E | GYF-4E | YF-4E | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANG | FB6011 | Birmingham | | | | | | 20 | | | | | | 20 |
| | FB6112 | Boise | | | | | | 19 | | | | | | 19 |
| | FB6123 | Capital | 20 | | | | | | | | | | | 20 |
| | FB6012 | Dannelly | | | | | | 19 | | | | | | 19 |
| | FB6232 | Duluth | | | | | | 20 | | | | | | 20 |
| | FB6341 | Hector | | 20 | | | | | | | | | | 20 |
| | FB6530 | Hickam | 20 | | | | | | | | | | | 20 |
| | FB6271 | Lincoln | | | | | | 18 | | | | | | 18 |
| | FB6281 | Reno | | | | | | 20 | | | | | | 20 |
| | FB6161 | Standiford | | | | | | 19 | | | | | | 19 |
| | | Total | 40 | 20 | | | | 135 | | | | | | 195 |
| | | SUB TOTAL | 281 | 451 | 677 | | 2 | 343 | 6 | | | 1 | | 1761 |
| AFSC | FB2805 | Edwards | 3 | | 7 | 1 | | 9 | | | | | 1 | 21 |
| | FB2823 | Eglin | 6 | 12 | 4 | | | 4 | | | | | | 26 |
| | | McDonnell | 1 | | 1 | | | | | 1 | | | | 3 |
| | EY8194 | Westinghouse | | 1 | | | | | | | | | | 1 |
| | | Total | 10 | 13 | 12 | 1 | | 13 | | 1 | | | 1 | 51 |
| CBD | | | | 4 | 3 | | | 3 | | | | | | 10 |
| LOG | | | | | 8 | | | | | | | | | 8 |
| LOG (ENGR) | | | 1 | 1 | | | | 1 | | | | | | 3 |
| | | TOTAL USAF | 292 | 469 | 700 | 1 | 2 | 360 | 6 | 1 | | 1 | 1 | 1833 |
| ATTR | | | 254 | 287 | 138 | | | 137 | | | | | 1 | 817 |
| | Total Delivered USAF | | 546 | 756 | 838 | 1 | 2 | 497 | 6 | 1 | | 1 | 2 | 2650 |
| ILP | | GR | | | 38 | | | | | | | | | 38 |
| | | GY | | | | 174 | | | | | 88 | | | 262 |
| | | IR | | 32 | 175 | | | | | | 14 | | | 221 |
| | | IS | | | 204 | | | | | | 12 | | | 216 |
| | | KS | | 36 | 16 | | | | | | | | | 52 |
| | | JA | | | | | | | | | 14 | | | 14 |
| | | SP | 36 | | | | | | | | | | | 36 |
| | | TK | | | 40 | | | | | | | | | 40 |
| | | Total Delivered ILP | 36 | 68 | 473 | 174 | | | | | 128 | | | 879 |
| | Total F-4 Aircraft Delivered | | 582 | 824 | 1311 | 175 | 2 | 497 | 6 | 1 | 128 | 1 | 2 | 3529 |

ATTACHMENT TO F-4



## F/RF-4 VGH FLIGHT DATA RECORDING PROGRAM

| AIRCRAFT MDS | BASE | WING-UNIT | SERIAL NUMBERS | | | | FLIGHT HOURS AT: | | MAG. INSTALL | | | MAG. REMOVAL | | | BASIC AIRCRAFT WT. (MINUS FUEL AND STORES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | AIRCRAFT | MAGAZINE | RECORDER | ACCELEROMETER | INSTALL | REMOVAL | DAY | MO | YR | DAY | MO | YR | |
| | | | | | | | | | | | | | | | |

NOTE: MAKE LINE ENTRY FOR ALL FLIGHTS.

| FLT NO. | JULIAN DATE | MISSION CODE | ZULU TIME | | LANDING BASE | ENGINE START GROSS WEIGHT | FUEL WEIGHTS | | | TIME INFLIGHT FUEL BEGINS | PERCENT TAPE REMAINING | REMARKS | FLT NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TAKE OFF | LAND-ING | | | ENGINE START UP | ENGINE SHUT DOWN | INFLIGHT REFUELING | | | | |
| 1 | | | | | | | | | | | | | 1 |
| 2 | | | | | | | | | | | | | 2 |
| 3 | | | | | | | | | | | | | 3 |
| 4 | | | | | | | | | | | | | 4 |
| 5 | | | | | | | | | | | | | 5 |
| 6 | | | | | | | | | | | | | 6 |
| 7 | | | | | | | | | | | | | 7 |
| 8 | | | | | | | | | | | | | 8 |
| 9 | | | | | | | | | | | | | 9 |
| 10 | | | | | | | | | | | | | 10 |
| 11 | | | | | | | | | | | | | 11 |
| 12 | | | | | | | | | | | | | 12 |
| 13 | | | | | | | | | | | | | 13 |
| 14 | | | | | | | | | | | | | 14 |
| 15 | | | | | | | | | | | | | 15 |
| 16 | | | | | | | | | | | | | 16 |

FOR PROCESSING CENTER USE ONLY:

FIELD TAPE=

FIELD SEQ=

RT TAPE =

RT SEQ =

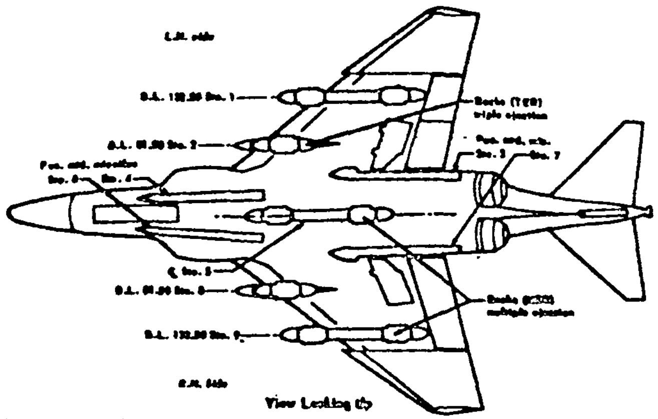
MISSION CODES:

A. AIR-TO-GROUND
B. AIR-TO-AIR
C. INSTRUMENT NAVIGATION
D. TEST
E. RECONNAISANCE
F. AIR-INTERCEPT
G. OTHER (SPECIFY)

WHEN PERCENT TAPE REMAINING IS 10% OR LESS - REMOVE MAGAZINE, TRANSCRIBE AND SEND BOTH TAPE AND THIS FORM TO: OKLAHOMA CITY ALC/AIA
TINKER AFB, OKLAHOMA 73145

AFTO FORM 107 JUNE 76 PREVIOUS EDITION OF THIS FORM IS OBSOLETE

Attachment to F-4



NOTE: Events of the sample flight reflected in the E. G. line under the column titles are as follows:

a. The eight 3M 1171 bombs on stations 2 and 8 were dropped on the first pass.
b. The two MK-82 bombs on station 5 were dropped on the second pass.
c. The third and fourth passes were dry runs.
d. The 38 rockets on stations 1 and 9 were launched on the fifth pass.
e. The Sparrow Missiles on stations 3, 4, 6 and 7 were not dropped.

NUMBER CARRIED | TYPE OF STORE | DROPPED ON PASS NUMBER - IF NO DROP ENTER "N"

| FLT NO. | STATION NO. 1 | | | STATION NO. 2 | | | STATION NO. 3 | | | STATION NO. 4 | | | STATION NO. 5 | | | STATION NO. 6 | | | STATION NO. 7 | | | STATION NO. 8 | | | STATION NO. 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E.G. | 1 | LAU319RX | 5 | 4 | 3M 1171 | 1 | 1 | SPARROW | - | 1 | SPARROW | - | 2 | MK-82 | 2 | 1 | SPARROW | - | 1 | SPARROW | - | 4 | 3M 1171 | 1 | 1 | LAU319RX | 5 |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES: (1) USE DASH ONE OR DASH FIVE HANDBOOK DESIGNATIONS ONLY.
(2) WHEN USING A MER OR TER, LIST ALL STORES BEING USED.
(3) LIST ALL STORES BEING CARRIED INCLUDING THOSE NOT DROPPED.
(4) IF STORE NOT DROPPED ENTER THE LETTER "N" IN PLACE OF PASS NUMBER.
(5) FLT NO. CORRESPOND TO FRONT SIDE OF FORM.

# COUNTING ACCELEROMETER COMPARISON RECORD

| AIRCRAFT SERIAL NUMBER | MODEL DESIGN SERIES | UNIT |
|---|---|---|
| | | |

| MONTH OF REPORT | AIRCRAFT HOURS | | INDICATOR #1 | | INDICATOR #2 | | INDICATOR #3 | | INDICATOR #4 | | CODE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CUMUL | THIS MO | READING | ADVANCED | READING | ADVANCED | READING | ADVANCED | READING | ADVANCED | | |
| C/F | | | | | | | | | | | | |
| JAN | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | |
| APR | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | |
| JUN | | | | | | | | | | | | |
| JUL | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | |
| SEP | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | |
| ANNUAL TOTALS | | | | | | | | | | | | |

| INSTRUMENTATION RECORD | | | | | | SYSTEM CALIBRATION RECORD | | |
|---|---|---|---|---|---|---|---|---|
| INDICATOR | | | TRANSDUCER | | | DATE CALIB | COUNTER ADVANCES | REMARKS |
| SERIAL NO. | MFGR | DATE INSTAL | SERIAL NO. | MFGR | DATE INSTAL | | | |
| | | | | | | | | |
| | | | | | | | | |

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ATTACHMENT TO F-4

## INSTRUCTIONS FOR PREPARATION OF COUNTING ACCELEROMETER COMPARISON REPORT

| | |
|---|---|
| AIRCRAFT SERIAL NUMBER | ENTER ALL DIGETS OF TAIL NUMBER. |
| MODEL DESIGN SERIES | EXAMPLE: F-4E. |
| UNIT | EXAMPLE: 35TFW. |
| AIRCRAFT HOURS CUM. | EXACT ACFT HOURS TO THE NEAREST HOUR THAT READINGS WERE TAKEN. |
| AIRCRAFT HOURS THIS MONTH | DIFFERENCE BETWEEN CURRENT MONTH AND PREVIOUS MONTH. |
| INDICATOR READING | VALUES THAT ARE VISIBLE IN CORRESPONDING NUMBERED WINDOWS OF THE INDICATOR. THESE READINGS MUST BE TAKEN CONCURRENTLY WITH REPORTED TOTAL AIRCRAFT TIME. |
| INDICATOR ADVANCED | DIFFERENCE BETWEEN CURRENT MONTH AND PREVIOUS MONTH. |
| CODE | ENTER APPLICABLE CODE (SEE CODE EXPLANATION). |
| REMARKS | AS APPROPRIATE. |
| INSTRUMENTATION RECORD | RECORD REMOVAL AND INSTALLATION DATES. |
| SYSTEM CALIBRATION RECORD | RECORD ANY AN/ASM CALIBRATION ACTIONS. |

| CODE | EXPLANATION |
|---|---|
| 1 | COUNTER WAS OPERATIONAL THROUGHOUT THE ENTIRE REPORTING PERIOD. |
| 2 | THE INDICATOR AND/OR TRANSDUCER WAS REMOVED OR DISCONNECTED FOR ANY REASON DURING ANY FLIGHTS FOR THIS PERIOD. EXPLAIN IN REMARKS. |
| 3 | THE INDICATOR AND/OR TRANSDUCER WAS REMOVED OR DISCONNECTED FOR ANY REASON DURING THE ENTIRE TIME PERIOD. |
| 4 | AIRCRAFT WAS TRANSFERRED TO OR FROM THIS UNIT DURING THIS REPORTING PERIOD, AND STATE WHERE TO OR FROM IN REMARKS. |
| 5 | AIRCRAFT WAS NOT AVAILABLE TO OBTAIN READING AND STATE REASONS IN REMARKS. |
| 6 | INDICATOR OR TRANSDUCER REPLACED DURING REPORTING PERIOD. ENTER TWO READINGS IN REPORT GIVING:<br>(A) S/N OF REMOVED UNIT.<br>(B) FLIGHT HOURS AT REMOVAL.<br>(C) READING AT REMOVAL.<br>(D) S/N OF NEW UNIT.<br>(E) READINGS AT INSTALLATION FOR NEW UNIT. |
| 7 | SYSTEM TESTED DURING THE TIME PERIOD - ENTER BEFORE AND AFTER READINGS. |

## MONTHLY COUNTING ACCELEROMETER READINGS REPORT

REPORTS CONTROL SYMBOL NUMBER

| AS OF DATE | UNIT | BASE | MDS |
|---|---|---|---|
| | | | |

| TYPED NAME, RANK, UNIT AND AUTOVON OF DEPUTY COMMANDER FOR MAINTENANCE | SIGNATURE |
|---|---|
| | |

NOTE: INSTRUCTIONS FOR COMPLETION OF FORM ARE ON REVERSE SIDE.

| AIRCRAFT SERIAL NUMBER | TOTAL ACFT. HRS. | WINDOWS | | | | INDICATOR MFGR & SN. | TRANSDUCER MFGR & SN. | CODE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | #1 | #2 | #3 | #4 | | | | |
| 16 21 | 22 25 | 39 42 | 43 46 | 47 50 | 51 54 | 61 66 | 67 73 | | |
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ORIGINAL TO: OC-ALC/AIAA, TINKER AFB, OKLAHOMA 73145

COPY TO: OO-ALC/MMSRA, HILL AFB, UT 84406

COPY TO: MAJOR COMMAND/LGM

AFTO FORM 109 JUNE 76 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

# MONTHLY COUNTING ACCELEROMETER READINGS REPORT

| | | | |
|---|---|---|---|
| AS OF DATE | UNIT | BASE | REPORTS CONTROL SYMBOL NUMBER<br>MDS |
| TYPED NAME, RANK, UNIT AND AUTOVON OF DEPUTY COMMANDER FOR MAINTENANCE | | | SIGNATURE |

NOTE: INSTRUCTIONS FOR COMPLETION OF FORM ARE ON REVERSE SIDE.

| AIRCRAFT SERIAL NUMBER 16–21 | TOTAL ACFT. HRS. 22–25 | WINDOWS #1 39–42 | WINDOWS #2 43–46 | WINDOWS #3 47–50 | WINDOWS #4 51–54 | INDICATOR MFGR & SN. 61–66 | TRANSDUCER MFGR & SN. 67–73 | CODE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
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ORIGINAL TO: OC-ALC/AIAA, TINKER AFB, OKLAHOMA 73145

COPY TO: OO-ALC/MMSRA, HILL AFB, UT 84406

COPY TO: MAJOR COMMAND/LGM

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-5 E/F

FLEET INFORMATION 71 DACT 9 Navy
20 Williams AFB FMS all others

NO. OF AIRCRAFT: 750→1000+ : YEAR SERVICE BEGAN: 1971

SYSTEM MANAGEMENT: F-5 (fighter Attack SPO)

DATE TRANSFERRED TO AFLC: In process to SAALC

USING COMMAND: TAC; TAC(Williams); Many foreign countries (20+)

PRIMARY BASE: Nellis, Williams - Foreign

PRIMARY MISSION TYPES: A-A, A-G, (DACT)

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | Complete A/C Flt-by-Flt at Northrop 24,000 |
| FULL-SCALE STATIC TEST: | X | | Complete Teardown |
| DAMAGE TOLERANCE TESTS: | X | | 20 specimens |
| DADTA INITIAL: | | | Limited analysis on failures |
| STRENGTH SUMMARY: | X | | CA at Williams<br>CA on DACT |
| TRACKING SYSTEM DESIGN: | | X | CA on Navy<br>CA on SAUDI |
| L/ESS DESIGN: | X | | ACMR data analysis |
| FSM PLAN: | | Proposal Stage | |
| BASELINE OPS SPECTRA: | | Not Done | SAP Willy AFB securit assistance program |
| DADTA-FINAL: | X | | DACT NOR 67-167 |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | NOR 70-59 | Northrop |
| DAMAGE TOLERANCE ANALYSIS: | See Attached lists | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |

IAT PROGRAM

ANALYSIS METHOD: Unit loads applied to $n_z$ counts for each mission random sequence of $n_z$'s within a flight. Range Pair counting.

APPLICABLE REPORT:

DATA COLLECTION: RECORDER: Gen Time(.3, 2.5, 3, 4.5, 6, 7) 6-windows FORM: AFTO 30 (ATTACH DESCRIPTIO[N]

FREQ. OF RETRIEVAL: Each Flight :TECH.ORDERS: TO 1-F-5E-12 TO 1-F-5E-14

DATE STARTED: 1975 HRS.RECORDED: 3180 + % USABLE DATA:

DATA COLLECTION PROBLEMS: Failure to submit AFTO30 Invalid Config., Errors in Miss & Counts, Multiple Flights on one card.

DATA REDUCTION: WHO DOES IT? ASIMIS (checkout at Northrop)

HOW IS IT CHECKED? $N_z$ Edit Software NOR 74 225

TECHNIQUE TO RECOVER MISSING DATA: Extrapolated Based on Actual A/C usage.

LIST PROCESSING STEPS: (Damage Software NOR 74-226 Usage Nor 75-127)

Forms → SAALC Punched → Data Line → ASIMIS → EDA RUN → SAALC → Corrections → ASIMIS → Processing → Master Tape

OUTPUT CONTENTS (ATTACH SAMPLES): Usage by 11 missions & tail. Service life & damage by missions & tail no.

LIST PERMANENT FILES: RAW DATA? tape

PROCESSED DATA? tape

WHO EVALUATES OUTPUT? ASD

APPLICATIONS: SCHEDULING? NO

ANALYSIS UPDATE? NO

TO DETECT CHANGE IN USAGE? NO

REMARKS:

ASD (Davenport & Guilfooo) is preparing a film for training and PR.

L/ESS PROGRAM

ANALYSIS METHOD: By mission, reproduces corrected accul. counts computes corresponding load. Computer average ratio.

APPLICABLE REPORT: To 1-F-5E-12

DATA COLLECTION BASE: 6 Williams

NO. OF AIRCRAFT: (25% USAF) RECORDING DEVICE: MXU-553 (no forms) (Attach Description)

PARAMETERS RECORDED: T-38 Params + $\delta_{HT}$ + $\delta_{FLAP}$ + Config (Attach List)

L/ESS START/STOP DATES: ______ HRS. RECORDED: 400+

% USABLE DATA: 85 for wing 50% vert. tail, 15-20% hor. tail. DATA RETRIEVAL FREQ. 15 hours

DEFINITION OF USABLE DATA: $n_z$ A/S, Alt(wing) $\delta_{HT}$(hor. tail), $\delta_{ring}$ (vert. tail)

COLLECTION PROBLEMS: Thumbwheel Date Not Set

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? ASIMIS Edit Software/Northrop software does nothing.

LIST STEPS: Tapes →ASIMIS R/T →ASIMIS Edit →Northrop Process →Output List/Tape (optional listings)

TECHNIQUE TO RECOVER MISSING PARAMETERS:

NONE

OUTPUT CONTENTS (Attach Sample):

Damage Statistics

Stress & Loads Spectra at each FCL

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA?

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:

Produces updated Unit Loads for IAT Analysis

TO CHECK IAT DATA? Not used. Could be done

TO DETECT CHANGE IN USAGE? Statistical check per Berens technique

REMARKS: No anticipated termination of L/ESS

ACMI data will be formatted and processed through ASIMIS MXU software

A/C TYPE: F-5E/F (Continued)

FSM PLAN - In proposal stage

MAINTENANCE REQUIREMENTS BASE:

INSPECTION INTERVALS:

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS: No provisions for tracking wings
This is a problem and Northrop has pointed it out to the USAF

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: F-5E/F (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

Some direct correspondence directly from ASIMIS instead of thru SAALC

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING: ASD →SAALC

AFLC/ALD INTERFACE: Not at Northrop

COMMONALITY WITH OTHER SYSTEMS:

METHODS WHICH HAVE WORKED WELL:

DEFICIENCIES IN CURRENT METHODS:

Need separate methods for current systems and new systems

ATTACHMENT TO F-5

# F-5E / F-5F FLIGHT LOG

AIRPLANE SERIAL NO. 7 3 - 0 0 8 9 1

FLT DATE (DAY - MONTH - YEAR): 3 1 - 0 8 - 7

BASE CODE: 0 1

LOGGED FLT HOURS: 1 . 0

INTERAL FUEL (lbs): TAKE-OFF 3 8 0 0; LANDING 0 7 5 0

NOSE GUNS: RNDS (blank); AMOUNT FIRED (Check one): 0 checked; 1/4, 2/4, 3/4, 4/4 blank

COUNTER READING

| 1 | 2 | 3 | 4 | 5 | 6 | ETI |
|---|---|---|---|---|---|---|
| 0 8 6 2 | 1 7 5 3 | 9 3 3 0 | 3 2 3 4 | 8 1 3 1 | 9 5 7 7 | 5 7 7 9 |

| MISSION CODE (Check one) | 29-30 | | WEIGHT RANGE | TAKE-OFF CL 31 | IB 32 | OB 33 | TIP 34 | LANDING CL 35 | IB 36 | OB 37 | TIP 38 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR | / | 01 | 0 - 50 | | / | / | / | | / | / | / | 1 |
| FF | | 02 | 51 - 250 | / | | | | / | | | | 2 |
| ACM | | 03 | 251 - 500 | | | | | | | | | 3 |
| BFM | | 04 | 501 - 750 | | | | | | | | | 4 |
| AAD | | 05 | 751 - 1000 | | | | | | | | | 5 |
| AAI | | 06 | 1001 - 1250 | | | | | | | | | 6 |
| GA | | 07 | 1251 - 1500 | | | | | | | | | 7 |
| GAT | | 08 | 1501 - 1750 | | | | | | | | | 8 |
| FCF | | 09 | 1751 - 2000 | | | | | | | | | 9 |
| INSTR | | 10 | | | | | | | | | | |
| OTHER | | 11 | OVER 2000 | | | | | | | | | 0 |

BASE CODES –
WILLIAMS AFB - 01
NELLIS AFB - 02
OTHER 03

STORE WEIGHT RANGES (Typical) –

| | | | | | |
|---|---|---|---|---|---|
| A/A - 37U | 501 - 750 | MK - 82 | 501 - 750 | SUU - 20 (full) | 501 - 750 |
| AIM - 9 | 51 - 250 | MK - 84 | 1751 - 2000 | SUU - 20 (empty) | 251 - 500 |
| BLU - 27 | 751 - 1000 | PYLON ONLY | 51 - 200 | 275 GAL TK (full) | OVER 2000 |
| LAUNCHER RAIL 0 - 50 | | TOU - 11/B | 251 - 500 | 275 GAL TK (empty) | 251 - 500 |

*USGPO: 1976 — 657-708/7886 Region 5-11

AFTO FORM MAR 76 30

ATTACHMENT TO F-5

PRELIMINARY DATA

# 7.0 BIBLIOGRAPHY

## CONTRACTOR REPORT LIST

### 7.1 F-5E AND F-5E/F

The following reports are applicable to the F-5E or the F-5E/F models. Those reports unique to the F-5F are listed in Section 7.2.


TASK I - DESIGN INFORMATION

NOR 69-35 "Structural Design Criteria for the F-5E Aircraft"

NOR 70-62 "Corrosion Prevention and Control Program"

NOR 71-109 "Structural Description Report"

NOR 71-214 "Structural Fatigue Criteria"

NOR 76-70 "Structural Fatigue Criteria for Saudi Arabian F-5E/F"

TASK II - DESIGN ANALYSES AND DEVELOPMENT TESTS

NOR 71-118 "Structural Design Loads"

NOR 71-151 "Dynamic Gust Analysis"

NOR 71-155 "Flutter and Divergence Analysis"

NOR 71-162 "Flutter Model Test"

NOR 71-170 "Fuselage Internal Loads"

NOR 71-171 "Fuselage Stress Analysis"

NOR 71-172 "Wing Internal Loads"

NOR 71-173 "Wing Stress Analysis"

NOR 71-174 "Horizontal Tail Internal Loads and Stress Analysis"

NOR 71-175 "Vertical Tail Internal Loads and Stress Analysis"

NOR 71-176 "Control Surfaces Stress Analysis"

NOR 71-177 "Control Systems Stress Analysis"

NOR 71-178 "Pylon Stress Analysis"

NOR 71-179 "Ejection Seat Stress Analysis"

ATTACHMENT TO F-5

PRELIMINARY DATA

7.1 F-5E AND F-5E/F (CONTINUED)

TASK II - DESIGN ANALYSES AND DEVELOPMENT TESTS (CONTINUED)

| | |
|---|---|
| NOR 71-192 | "Nose Landing Gear Shock Strut Stress Analysis" |
| NOR 71-193 | "Landing Gear Mechanism Stress Analysis" |
| NOR 71-194 | "Main Landing Gear Shock Strut Stress Analysis" |
| NOR 71-196 | "Canopy Mechanism Stress Analysis" |
| NOR 71-198 | "Windshield and Canopy Stress Analysis" |
| NOR 71-200 | "Fatigue Design Analysis" |
| NOR 71-233 | "Dynamic Landing Loads" |
| NOR 71-234 | "Ejection Load Analysis" |
| NOR 72-28 | "Fatigue Loads Spectra" |
| NOR 72-183 | "Static Tests of Castings for the F-5E Airplane" |
| NOR 73-85 | "Moment of Inertia and Mass Distribution" |
| NOR 76-163 | "F-5E/F Critical Area Evaluation" |
| NOR 76-164 | "F-5E/F Fatigue Loads for the Damage Tolerance Assessment" |
| NOR 76-165 | "F-5E/F Damage Tolerance Testing" |
| NOR 76-166 | "F-5E/F Damage Tolerance Assessment" |
| NOR 76-172 | "Ground Rules for Damage Tolerance Assessment of F-5E/F Aircraft (CP 233)" |
| NOR 77-31 | "Swiss F-5E/F Internal Loads and Stress Analysis" |
| NOR 77-62 | "Structural Fatigue Loads for Saudi Arabian F-5E/F" |
| NOR 78-13 | "Saudi F-5E/F Fatigue Analysis" |
| NOR 78-14 | "Saudi F-5E/F Damage Tolerance Analysis and Inspection Requirements" |
| NOR 78-16 | "F-5E/F Swiss Fatigue Loads and Criteria" |

ATTACHMENT TO F-5

PRELIMINARY DATA

7.1 F-5E AND F-5E/F (CONTINUED)

TASK III - FULL SCALE TESTING

| | |
|---|---|
| NOR 70-60 | "Fatigue Test Plan" |
| NOR 70-65 | "Flight Loads Survey and Demonstration Flight Test Plan" |
| NOR 70-67 | "Category I Test Plan/Procedures" |
| NOR 70-70 | "Structural Static Test Plan" |
| NOR 71-159 | "F-5E Complete Airframe Fatigue Test" |
| NOR 71-160 | "Flight Flutter Test" |
| NOR 71-161 | "F-5E Final Loads Flight Data for Initial and Final Phase Tests" |
| NOR 73-54 | "Nose Landing Gear Component Fatigue Test" |
| NOR 73-169 | "Main Landing Gear Component Fatigue Test" |
| NOR 73-181 | "Structural Static Test of the F-5E Airframe" |
| NOR 74-44 | "Dynamic Response Tests" |
| NOR 74-59 | "Ground Vibration Test" |
| NOR 75-115 | "F-5E Comparison of Flight Test and Fatigue Structural Loads" |
| NOR 76-3 | "F-5E Fatigue Test Airframe Final Inspection Results" |
| NOR 77-48 | "Test Plan, Swiss Hoist Fitting Static Test" |
| NOR 77-121 | "F-5E/F Saudi Fatigue Test Plan" |

ATTACHMENT TO F-5

PRELIMINARY DATA

7.1 F-5E AND F-5E/F (CONTINUED)

TASK IV - FORCE MANAGEMENT DATA PACKAGE

| | |
|---|---|
| NOR 74-225 | "F-5 Usage Card Edit Program User's Manual" |
| NOR 74-226 | "Counting Accelerometer Fatigue Damage Computer Program and User's Manual" |
| NOR 74-321 | "F-5E Strength Summary and Operating Limitations" |
| NOR 75-127 | "Analysis of F-5E Counting Accelerometer Data" |
| NOR 75-142 | "F-5E Service Life Analysis" |
| NOR 76-69 | "Parametric Fatigue and Loads Analysis Computer Program" |
| NOR 76-99 | "Analysis of First Year of F-5E Counting Accelerometer Data" |
| NOR 76-167 | "F-5E/F Final Fatigue Analysis" |
| NOR 78-27 | "Analysis of F-5E MXU-553 Data" |
| TBE | "Quarterly Analysis of Suadi Arabian F-5E/F Counting Accelerometer Data" |
| TBE | "Final Analysis of Saudi Arabian F-5E/F Counting Accelerometer Data" |

ATTACHMENT TO. F-5

PRELIMINARY DATA

7.2 F-5F

TASK I - DESIGN INFORMATION

| | |
|---|---|
| NOR 73-63 | "Structural Design Criteria for the F-5F Aircraft" |

TASK II - DESIGN ANALYSES AND DEVELOPMENT TESTS

| | |
|---|---|
| NOR 73-126 | "Fuselage Internal Loads" |
| NOR 73-127 | "Fuselage Stress Analysis" |
| NOR 74-16 | "Moment of Inertia and Mass Distribution" |
| NOR 75-91 | "Fatigue Design Analysis" |

TASK III - FULL SCALE TESTING

| | |
|---|---|
| NOR 73-128 | "Structural Static Test Plan" |
| NOR 74-54 | "Structural Static Test of the F-5F Airframe" |
| NOR 74-99 | "Flight Loads Survey and Demonstration Flight Test Plan" |
| NOR 74-137 | "F-5F W1002 Ground Vibration Test" |

TASK IV - FORCE MANAGEMENT DATA PACKAGE

| | |
|---|---|
| NOR 75-98 | "Service Life Analysis" |
| NOR 75-187 | "F-5F Strength Summary and Operating Limitations" |
| NOR 76-102 | "F-5F Comparison of Flight Test and Fatigue Structural Loads" |
| NOR 76-135 | "Damage Tolerance Analysis" |

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-15

FLEET INFORMATION

NO. OF AIRCRAFT: 250 delivered 749 (1984) : YEAR SERVICE BEGAN: 1974

SYSTEM MANAGEMENT: AFSC~F-15 SPO

DATE TRANSFERRED TO AFLC: AFTER 1984 to WRALC

USING COMMAND: TAC

PRIMARY BASE: Nellis, Longley, Bitburg, Luke, Holomon

PRIMARY MISSION TYPES: Air-Air (Air-to-ground - maybe)

REMARKS: Design life 4000 hours, 8000 hour economic life
Designed for 32,000 hours and then added taperlocks.

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | 16,000 hours, No crack in primary structure |
| FULL-SCALE STATIC TEST: | X | | 150% limit |
| DAMAGE TOLERANCE TESTS: | X | | To design matts & NDI requirements |
| DADTA INITIAL: | X | | Testing and models |
| STRENGTH SUMMARY: | X | | Determined Desired - |
| TRACKING SYSTEM DESIGN: | X | | $a_i$ |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | | | |
| BASELINE OPS SPECTRA: | | 1979 | SDR Data to be used |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | In Process | Lt. Heil - F-15 SPO |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | MDC A1456 | McAir |
| Fatigue Design Analysis | MDC A0928 | McAir |
| Fatigue Loads Report | MDC A0833 | McAir |
| Fracture Mechanics Report | MDC A0913 | McAir |
| Safe "Service Aircraft Fatigue Estimate" Quarterly reports | | |

IAT PROGRAM

ANALYSIS METHOD: Crack INITIATION "life to a .01-inch crack." Residual stress using a strain-life analysis

APPLICABLE REPORT:

DATA COLLECTION: RECORDER: CA - 7g levels (-2, -1, 0, 3, 4.5, ~~6, 7.5~~) FORM: AFTO 239 (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: every flight :TECH.ORDERS: T01F-15A-2-2-4

DATE STARTED: HRS.RECORDED: 70,000 hours % USABLE DATA: 90%+

DATA COLLECTION PROBLEMS: Missing forms; transducer malf.

DATA REDUCTION: WHO DOES IT? WRALC/McAir

HOW IS IT CHECKED? Sequence

TECHNIQUE TO RECOVER MISSING DATA: Use Avg wing usage by Base from SDR

LIST PROCESSING STEPS: Forms sent in monthly →WRACL OPSCAN →Sort by ALC & Date →Tape→McAir (quarterly)

OUTPUT CONTENTS (ATTACH SAMPLES): Quarterly Damage by tail no. by location. First report due January 1980

LIST PERMANENT FILES: RAW DATA? Tape (assumed)

PROCESSED DATA? Quarterly Reports

WHO EVALUATES OUTPUT? McAir

APPLICATIONS: SCHEDULING? to select ACI, Plan special Insp. at Dam=0.25

ANALYSIS UPDATE? to rotate A/C, to inform user of high damage missions in MSG - 2 analysis

TO DETECT CHANGE IN USAGE?

REMARKS: OPSCAN equip OK WRALC Sort & Edit Software still has problems.

McAir is discussing with SPO the requirements for changing to crack growth.

L/ESS PROGRAM

ANALYSIS METHOD: Loads →Stress →Damage
Eleven monitored locations.

APPLICABLE REPORT:

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 20% RECORDING DEVICE: ASH-28 (Attach Description)

PARAMETERS RECORDED: (see attached list) (Attach List)

L/ESS START/STOP DATES: HRS. RECORDED:

% USABLE DATA: 90% DATA RETRIEVAL FREQ.

DEFINITION OF USABLE DATA: all except vert. vel, rudder deft, DOC data

COLLECTION PROBLEMS: Lack of SDR spares

DATA REDUCTION: WHO DOES IT? ASIMIS/McAir

HOW IS IT CHECKED?

LIST STEPS: Cassette→ASIMIS R/T Edits out data in threshhold (95%)
→ RECAP/Modify Tape→Operational Fat Loads program
(extra loads time history, initial loads at 11 lcoations) internal loads

TECHNIQUE TO RECOVER MISSING PARAMETERS: NONE

OUTPUT CONTENTS (Attach Sample): Stress time histories, summary data, Vgh tables, avg stress & gross weight tables

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA?

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:
proposed method will compare damage from SDR and CA

TO CHECK IAT DATA? Uses same transducer

TO DETECT CHANGE IN USAGE?

REMARKS: SDR is installed and checked during production
Aerodynamic and inertia data matrix stored on Disc.
Records when power is on to engine

A/C TYPE: F-15 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: List of critical areas based on eng. judgement, validated by analysis. Initial flaw size based on NDT method, time to grow critical. Inspection set at time to grow crack. Put on next lower phase.

INSPECTION INTERVALS: Phased Insp. 50, 100, 200, 400, 600, 1200 NEW
50, 75, 100, 150, 300, 600, 1200 (PDM) Orig.
PDM may not be required. ACI being done at WRALC.
All NDT at 1200 except for a few cases. Based on hours only.
Factor of 4 accounts for variability

RANGE OF CRITICAL CRACK LENGTHS: 1" → 3"
Initial flaw is 0.15 → 0.20 inch.

SPECIAL COMPONENT INSPECTIONS: Horizontal tail, wing (maybe landing gear)

DATA COLLECTION: USAF UR's reviewed by McAir maintenance for MSG-2

DATA EVALUATION: Done by McAir

APPLICATION OF FEEDBACK DATA:

REMARKS: MSG-2 Analysis is currently being proposed. (may use sampling) will use results of cyclic test & field data.

APPLICABLE DOCUMENTS:

A/C TYPE: F-15 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: Engr. vs Maintenance (must communicate
ASIMIS Manpower was low for a while (Paul Davidson)
Initial problem in responsibility of WRALC to edit tracking data. Processing transition too early. Prior to adequate check out.

IAT-FSM INTERFACE: None yet. IAT will probably schedule some inspections

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: N/A

COMMONALITY WITH OTHER SYSTEMS: NONE

METHODS WHICH HAVE WORKED WELL:
Long life design has reduced problem areas.

DEFICIENCIES IN CURRENT METHODS: SDR is special pilot duty & pilot didn't know he was in SDR aircraft. Contract said to assume all SDR data was valid. ECP turnaround is too long. Annual Funding practice causes long term transfer problems. ECP turn around time is too long.

ATTACHMENT TO F-15

# F-15A COMPONENT SERIALIZATION RECORD

359

| AIRCRAFT SERIAL NO | | | | | BASE | | FLIGHT HR | | | | TOTAL LDG | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

## COMPONENT CODES

W - WING
S - STABILATOR
M - MAIN LANDING GEAR
N - NOSE LANDING GEAR

L - LEFT HAND
R - RIGHT HAND

| MAIN GEAR COMPONENT | CODE | NOSE GEAR COMPONENT |
|---|---|---|
| UPPER JURY BRACE | A | UPPER JURY BRACE |
| SPRING – JURY BRACE | B | SPRING – JURY BRACE |
| STRUT ASSEMBLY | C | STRUT ASSEMBLY |
| CAP – BUNGEE | D | CAP – BUNGEE |
| DISK SPRING | E | DISK SPRING |
| PIN – RETRACT ACT | F | PIN – RETRACT ACT |

| DATE: DAY | | MO | | YR | SERIAL NO OF COMPONENT REMOVED | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | 5 | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | 6 | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 7 | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | 8 | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| | 9 | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

| COMPONENT REMOVED +: NOUN | ADJ | CODE | SERIAL NO INSTALLED | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | 1 | 1 | 1 | 1 | 1 | 1 |
| W | | A | 2 | 2 | 2 | 2 | 2 | 2 |
| S | L | B | 3 | 3 | 3 | 3 | 3 | 3 |
| | | C | 4 | 4 | 4 | 4 | 4 | 4 |
| M | R | D | 5 | 5 | 5 | 5 | 5 | 5 |
| N | | E | 6 | 6 | 6 | 6 | 6 | 6 |
| | | F | 7 | 7 | 7 | 7 | 7 | 7 |
| | | | 8 | 8 | 8 | 8 | 8 | 8 |
| | | | 9 | 9 | 9 | 9 | 9 | 9 |

REMARKS

PREPARED BY (PRINT)

* NOTE: IF MORE THAN ONE COMPONENT IS REPLACED, RECORD BELOW THE SERIAL NO OF EACH CODED GEAR PART OR OTHER PART INSTALLED.

| A | | | | B | | | | C | | | | D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

| E | | | | F | | | | WING OR STABILATOR | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | W | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | S | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | 4 | 4 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | L | 5 | 5 | 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | 6 | 6 | 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | R | 7 | 7 | 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | | 8 | 8 | 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | | 9 | 9 | 9 | 9 | 9 | 9 |

AFTO FORM OCT 76 238

*U.S. GOVERNMENT PRINTING OFFICE: 1977-758-335
PS 8434 US (7445)

ATTACHMENT TO F-15

AIRCRAFT SERIAL NO | BASE | SQN NO | FLIGHT DATE (DAY, MO, YR) | FLIGHT HOURS AT MISSION START | TAKEOFF GROSS WT | EXT TKS | AIM 9 | STORE STA WEIGHT (1, 2, 5, 8, 9)

Store station weight categories: UNDER 600 LB; 601 TO 1000 LB; 1001 TO 1500 LB; 1501 TO 2000 LB; 2001 TO 2500 LB; 2501 TO 3000 LB; 3001 TO 3500 LB; 3501 TO 4000 LB; 4001 TO 4500 LB; 4501 TO 5000 LB

POST FLIGHT DATA

MISSION CODE | MISSION HOURS | LANDING GROSS WT | AERIAL RE-FUELING WT | LANDINGS (T & G, FS) | BAR-RIER | YES

ACCELEROMETER S/N & MANUFACTURERS CODE

INDICATOR NR | MFG | TRANSDUCER NR | MFG | STAT CODE

ACCELEROMETER COUNT READINGS

-2 | -1 | 0.0 | 3 | 4.5 | 6 | 7.5

F-15A

REMARKS

PREPARED BY (PRINT)

# FLIGHT LOG AND EXCEEDANCE COUNTER DATA RECORD

AFTO FORM 239
OCT 76



• U.S. GOVERNMENT PRINTING OFFICE: 1977-758-695

# INSTRUCTIONS

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| **PRE-FLIGHT DATA** | |
| 1. Aircraft Serial Number | Tail Number – last digit of year plus last 4 digits of Nr (75-00032) |
| 2. Base | Two digit base code (see T.O.) |
| 3. Squadron Number | Three digit Maint Squadron Nr |
| 4. Flight Date | Day, Month & last digit of Year |
| 5. Flight Hr at Mission Start | Total time from AFTO Form 781 to nearest tenth of an hour |
| 6. Takeoff Gross Weight | Gross weight at take-off to nearest tenth of a Kip |
| 7. External Tanks | Number of external tanks carried |
| 8. AIM -9 | Mark if AIM-9 missiles carried: 2 or 4, as applicable |
| 9. Store Station Weight | Mark M if MER carried w/stores on pylon station 2, 5, and/or 8. Mark weight range for each store station. Weight is total weight of pylon, MER, launcher, and/or stores. |

## POST-FLIGHT DATA

1. Mission Codes (Note: Enter 2nd (and 3rd) mission of sortie in Remarks with fraction of total mission time)

| w/o TEWS-Sta 1 & 9 | w/TEWS | |
|---|---|---|
| 01 | 21 | ACM w/guns & ammo, or practice gun-firing pass |
| 02 | 22 | ACM w/missiles installed, or practice missile-firing pass |
| 03 | 23 | Intercept (Practice) |
| 04 | 24 | ACM (Camera Only) |
| 05 | 25 | Bombing & Ground gunnery |
| 06 | 26 | Instrument & Navigation |
| 07 | 27 | Transition & Proficiency |
| 08 | 28 | Functional Check Flight |
| 09 | 29 | Dart Towing |

| | |
|---|---|
| 2. Mission Hours | Mission duration to nearest tenth of an hour |
| 3. Landing-Gross Weight | Gross weight at landing to nearest tenth of a Kip |
| 4. Aerial Refueling Weight | Fuel weight taken on board in flight to nearest tenth of a Kip (1 Kip = 1,000 lbs) |

Mail completed forms to: Warner Robins ALC/MMSRDB
Robins AFB, GA 31098

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| 5. Landings | Number of Touch & Go's (T & G) and Full Stop (FS) Landings |
| 6. Barrier | Mark "Yes" if barrier engagement is used |

## COUNTING ACCELEROMETER DATA

| | |
|---|---|
| 1. Indicator Number Mfr | Mark Serial Number of Indicator & Manufacturer Code Number Code: 1-Actron Inds 2- |
| 2. Transducer Nr – Mfr | Mark Serial Number of Transducer & Manufacturer Code Number Code: 1-Systron-Donner 2- |
| 3. Status Code | |
| 1 | Counting Accelerometer BIT latch during flight |
| 2 | Indicator or Transducer was removed or disconnected, or Indicator just installed. |
| 3 | Counting Accelerometer not installed |
| 4 | Aircraft has transferred to another Squadron or Base. State new Base or Squadron in Remarks. |
| 5 | Aircraft not available to obtain readings: state reason in Remarks |
| 4. Accelerometer Count Readings | Mark values that are visible in corresponding numbered windows of the indicator. These readings are taken after each flight. If number is less than four digits, precede it with zeros to make it a four digit number. |
| 5. Remarks | Note problems with counting accelerometer and state reasons why blanks were left on this report, or note other pertinent information. |
| 6. Prepared by | Printed name and grade of person completing this form |

ATTACHMENT TO F-15

# INSTRUCTIONS

| BLOCK HEADING | INFORMATION REQUIRED |
|---|---|
| Aircraft Serial Number | Tail Number – last digit of year plus last four digits of number (75-00032) |
| Base | Two Digit Base Code Number *(See Below)* |
| Flight Hours | Record total hours from AFTO Form 781. Delete tenth of an hour digit. Use zeros to make a four digit number. |
| Total Landings | Record total landings from AFTO Form 781. Use zeros to make a four digit number. |
| Date | Day, month, last digit of year when part(s) are changed. |
| Component Removed | Use letter codes for components. |
| Serial Number of Component Removed<br>Serial Number Installed | All digits of serial number. If serial number is less than six digits, precede it with zeros to make it a six digit number. |
| Remarks | Note any pertinent information. |
| Prepared by | Printed name and grade of person completing this report. |
| NOTE | If more than one component identified in this form is replaced, this space is provided for your convenience. Up to five parts of the *same* gear can be listed, plus one additional wing or stabilator. If parts of a second gear are replaced, or if more wing or stabilator assemblies are replaced, use additional forms as required. If this section is used for additional parts installed, it will be necessary to record serial numbers and codes of corresponding parts removed in remarks. |

## BASE CODES

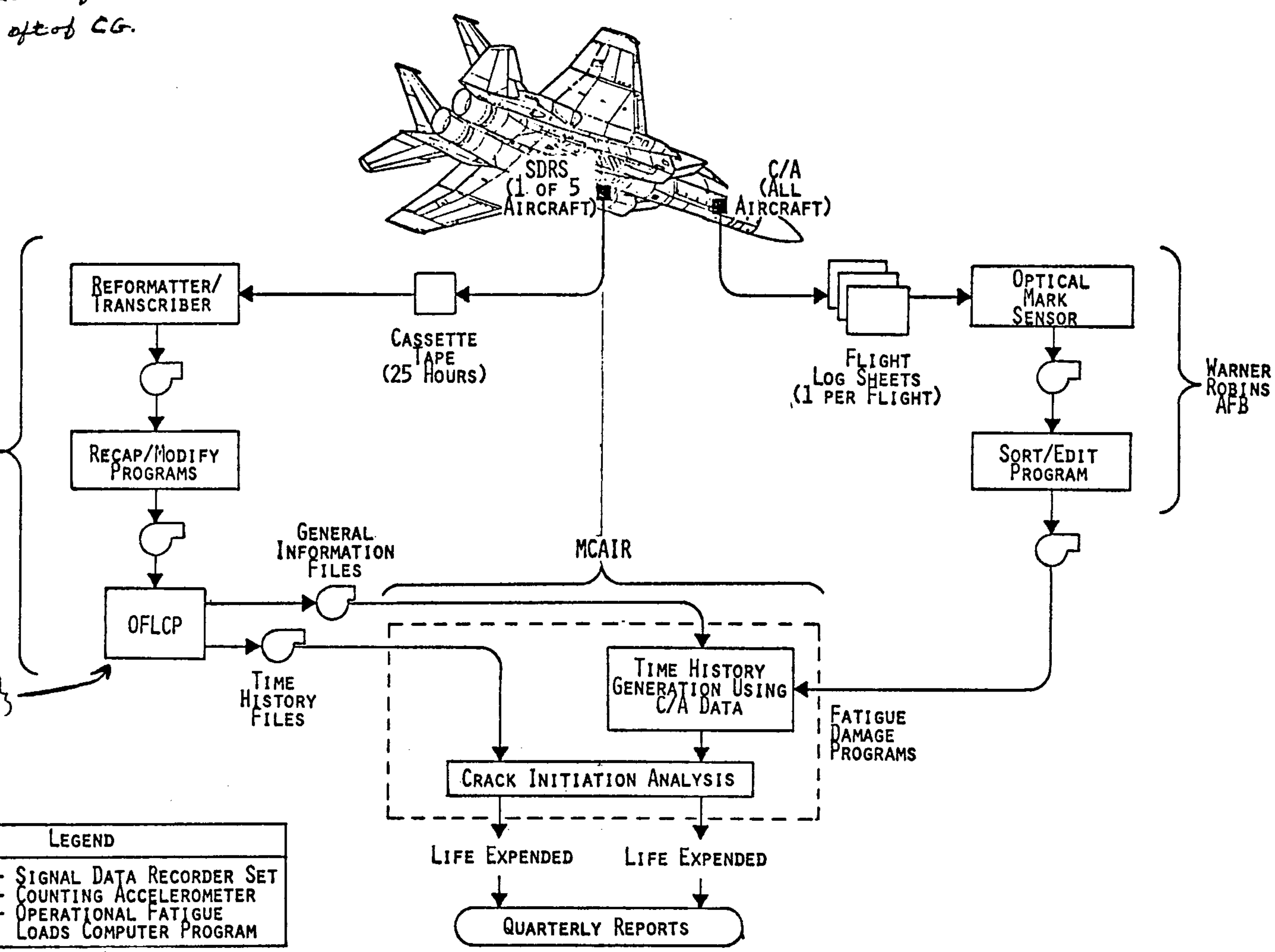
| (CONUS) | (OS BASES) | |
|---|---|---|
| 01 Edwards AFB | 11 | 99 Other (Note Base name in Remarks) |
| 02 Eglin AFB | 12 | |
| 03 Eglin Aux Fld No 9 | 13 | |
| 04 Kirtland AFB | 14 | |
| 05 Langley AFB | 15 | |
| 06 Luke AFB | 16 | |
| 07 Nellis AFB | 17 | |
| 08 Robins AFB | 18 | |
| 09 Williams AFB | 19 | |
| 10 Wright-Patterson AFB | 20 | |

Mail Completed Forms to: Warner Robins ALC/MMAR
Robins AFB, GA 31098

Attachment to F-15

$n_z$ accel is 18-20 in of ℄ & 2' aft of C.G.

## F-15 FLIGHT LOADS MONITORING FOR USAF




30 min CPU IBM 370 (at MCAIR)

| Legend | |
|---|---|
| SDRS | - Signal Data Recorder Set |
| C/A | - Counting Accelerometer |
| OFLCP | - Operational Fatigue Loads Computer Program |

ATTACHMENT TO F-15

f-15

| Symbol | Sampling Rate/Sec | A/C Parameter | Linear Conversions 255 Counts | 0 Counts | Unit |
|---|---|---|---|---|---|
| Nz* | 30 | Vertical Acceleration | +12 | -- | G's |
| δar* | 30 | Right Aileron Deflection | +20 | -20 | Degrees |
| δal* | 30 | Left Aileron Deflection | +20 | -20 | Degrees |
| P* | 30 | Roll Rate | 300 cw | 300 ccw | Degrees/sec |
| Ṗ* | 30 | Roll Acceleration | +20 (cw) | -20 (ccw) | Radians/sec |
| Q* | 15 | Pitch Rate | 120 cw | 120 ccw | Degrees/sec |
| α | 10 | Angle of Attack | +44.65 | -45 | Degrees |
| R* | 10 | Yaw Rate | 120 cw | 120 ccw | Degrees/sec |
| δsr* | 10 | Right Stabilator Deflection | +15 | -29 | Degrees** |
| δsl* | 10 | Left Stabilator Deflection | +15 | -29 | Degrees** |
| δr* | 10 | Rudder Deflection | +30 | -30 | Degrees*** |
| Vz | 5 | Vertical Velocity | +127 | -128 | Feet/sec |
| Ny* | 5 | Lateral Acceleration | +3 | -3 | G's |
| Nx* | 5 | Longitudinal Acceleration | +3 | -3 | G's |
| H | 1 | Altitude | 65,280 | 0 | Feet |
| Vt | 1 | True Airspeed | 1020 | 0 | Knots |
| F* | 1 | Fuel Quantity | 100 | 0 | % **** |
| T | 1 | Time Word | 255 | 0 | Seconds |

* Analog Signals that are calibrated during each test made.

** Positive is leading edge up (LEU). Negative is leading edge down (LED).

*** Positive is a deflection to the right. Negative is a deflection to the left.

**** Amount of fuel remaining.

Positive Aileron deflection (⟶255) is in what direction?

Positive Roll Acceleration is in what direction?

Positive angle of attack is in what direction?

+Vertical Velocity is in what direction?

+Lateral Acceleration is in what direction?

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-16

FLEET INFORMATION

NO. OF AIRCRAFT: 0 : YEAR SERVICE BEGAN: 1978

SYSTEM MANAGEMENT: AFSC Brian Archer/ AFLC Art Johnson

DATE TRANSFERRED TO AFLC:

USING COMMAND: TAC

PRIMARY BASE: Hill AFB

PRIMARY MISSION TYPES: Training/Air-Air/Air-Ground

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | X | | |
| DADTA INITIAL: | X | | |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | | X | |
| L/ESS DESIGN: | | X | |
| FSM PLAN: | | | Planned (CCP 5065) |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | 16PP029 A | |
| DAMAGE TOLERANCE ANALYSIS: | 16PR378, 16PR379, 16PR380, 16PR370 | |
| DURABILITY ANALYSIS: | 16PR308 | |
| SERVICE LIFE ANALYSIS: | | |
| Durability Spectrum Analysis | 16PR356 | |

A/C Type: F-16 (Continued)

IAT PROGRAM

ANALYSIS METHOD: Airframe parametric crack growth Tracking Program

APPLICABLE REPORT:

DATA COLLECTION: RECORDER: A/A-32A-37 MSR FORM: NA (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: 100 hr. Phase Insp: TECH.ORDERS: Gen. Dynamics (16AE1-55-1003A)

DATE STARTED: Aug. 78 HRS.RECORDED: % USABLE DATA:

DATA COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? ASIMIS & GEN DYN.

HOW IS IT CHECKED? Review of Distribution of cycles

TECHNIQUE TO RECOVER MISSING DATA:

LIST PROCESSING STEPS: (1) Transcribed from scratch tape to magnetic tape at ASIMIS (2) Converted to stress, counted, exceedance & Cyclic Distr. Made, and stored on magnetic tape @ GD

OUTPUT CONTENTS (ATTACH SAMPLES): (1) Distribution of cycles shown; (2) range exceedance plot

LIST PERMANENT FILES: RAW DATA? Yes mag. tape

PROCESSED DATA? Yes

WHO EVALUATES OUTPUT? Engineering (GD)

APPLICATIONS: SCHEDULING?

ANALYSIS UPDATE? Planned 6 months intervals

TO DETECT CHANGE IN USAGE? NA

REMARKS:

L/ESS PROGRAM

ANALYSIS METHOD: Flight by Flight Loads Spectra

APPLICABLE REPORT:

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 16% 90A/C RECORDING DEVICE: MXU-553/A (Attach Description)

PARAMETERS RECORDED: Attached (Attach List)

L/ESS START/STOP DATES: Aug 1978 HRS. RECORDED:

% USABLE DATA: DATA RETRIEVAL FREQ.

DEFINITION OF USABLE DATA:

COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? ASIMIS & GEN DYN(Tom White

HOW, IS IT CHECKED? Print of events & Measurement histograms

LIST STEPS: (1) Ref/tran @ ASIMIS (2) "Quicklook" proc. for fault isolation, bad frames, etc. @ GD (3) Time history compression (4) final corrections

TECHNIQUE TO RECOVER MISSING PARAMETERS:

OUTPUT CONTENTS (Attach Sample): (1) printed data from "Quicklook" contains event summary, parity and possible spike frames, time history & histogram (2) compression & correction procedures will have printed summaries & time histories on mag tape

LIST PERMANENT FILES: RAW DATA? Not planned for "permanent" storage

PROCESSED DATA?

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:

TO CHECK IAT DATA?

TO DETECT CHANGE IN USAGE? Requirement of software

REMARKS:

A/C TYPE: F-16 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:

INSPECTION INTERVALS:

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: F-16 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS:

METHODS WHICH HAVE WORKED WELL:

DEFICIENCIES IN CURRENT METHODS:

ATTACHMENT TO F-16

# DESCRIPTION OF THE F-16 IAT RECORDER

## MECHANICAL STRAIN RECORDER

The Mechanical Strain Recorder (MSR) is being installed on each F-16 for the Individual Aircraft Tracking program.

The installation consists of an A/A-32A-37 Mechanical Strain Recorder installed on the lower-righthand flange of the F.S. 325.8 bulkhead. The selected location primarily senses right wing bending.

The plan is to remove the recording cassette at each 100 hour phase inspection. An automatic transcription system will be used to store the MSR response onto a computer compatible magnetic tape.

Methods and procedures are being developed for processing and analyzing the strain data.

ATTACHMENT TO F-16

GENERAL DYNAMICS CORPORATION    CENTRAL DATA SYSTEMS CENTER    01/25/78 PAGE 0007
FORT WORTH DIVISION    6600 PROCEDURE ABX    PROBLEM 267504-01

MEAN-AMPLITUDE DISTRIBUTION OF COUNTED CYCLES

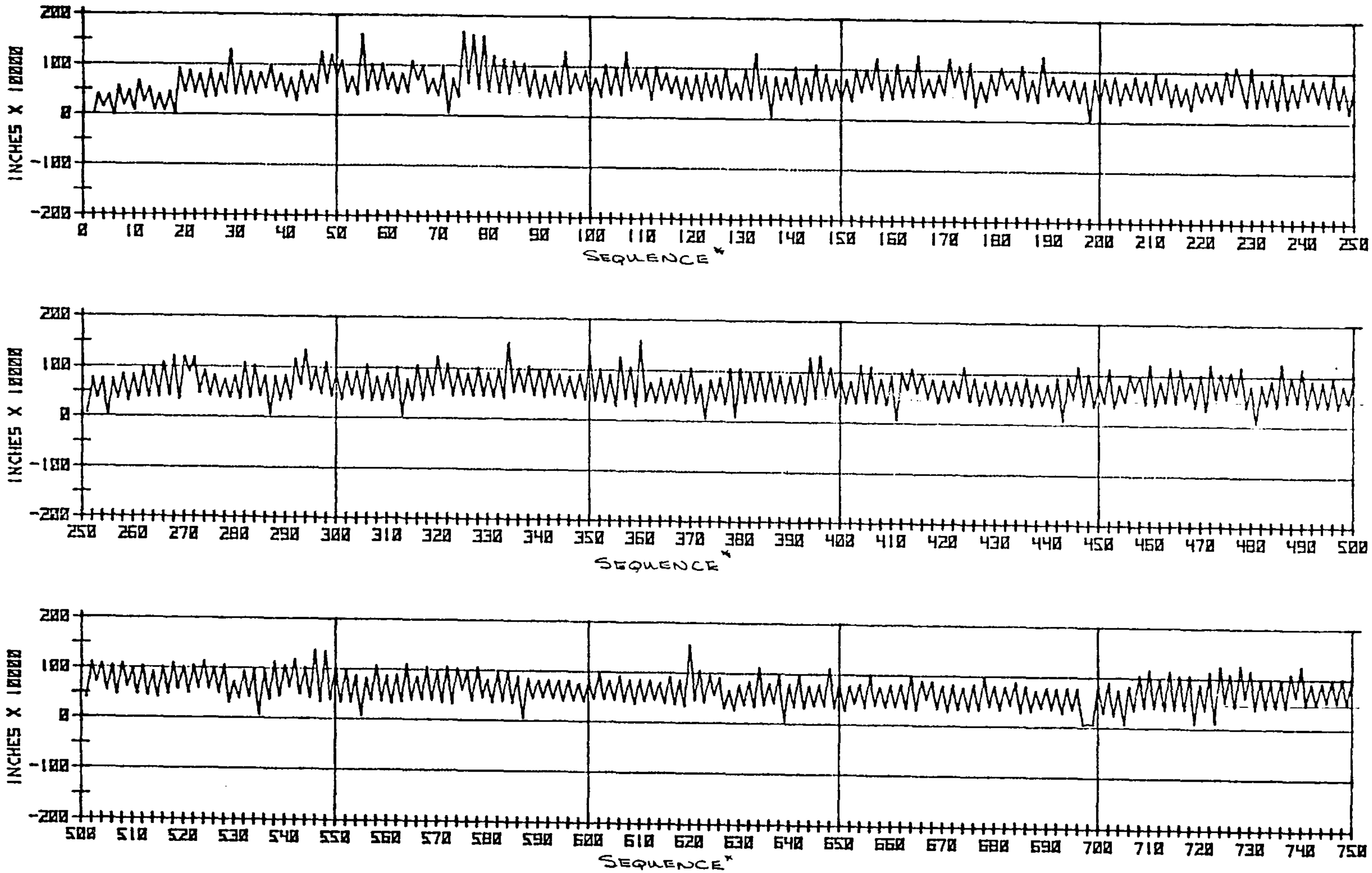
TAIL NUMBER - 750747    INSTALLATION ~~DATE~~ 0 HRS    REMOVAL ~~DATE~~ 122 HRS    3823 GOOD CCS
GAGE LENGTH= 8.000    MODULUS OF ELASTICITY= 10.20E+06    INTERCEPT= -1000.000    F16A NO 3 121.9 HRS FLT 0-70

AMPLITUDE (1000 PSI)

| MEAN (PSI) | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | >19.0 | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OVERFLOW | | | | | | | | | | | | | | | | | | | | | 0 |
| -10501 TO -11500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -9501 TO -10500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -8501 TO -9500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -7501 TO -8500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -6501 TO -7500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -5501 TO -6500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -4501 TO -5500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -3501 TO -4500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -2501 TO -3500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -1501 TO -2500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -501 TO -1500 | | | | | | | | | | | | | | | | | | | | | 0 |
| -500 TO 500 | 1 | | | | | | | | | | | | | | | | | | | | 1 |
| 501 TO 1500 | | | 1 | | | | | | | | | | | | | | | | | | 1 |
| 1501 TO 2500 | | 7 | 2 | | | | | | | | | | | | | | | | | | 9 |
| 2501 TO 3500 | | 4 | | 1 | 1 | | | | | | | | | | | | | | | | 6 |
| 3501 TO 4500 | | 1 | | | 2 | | | | | | | | | | | | | | | | 3 |
| 4501 TO 5500 | | | 1 | 2 | 1 | 1 | | | | | | | | | | | | | | | 5 |
| 5501 TO 6500 | | 2 | 48 | 10 | 1 | 6 | 4 | | | | | | | | | | | | | | 71 |
| 6501 TO 7500 | | 18 | 264 | 111 | 13 | | 14 | 5 | | | | | | | | | | | | | 425 |
| 7501 TO 8500 | | 16 | 180 | 150 | 87 | 3 | 1 | 7 | 7 | | | | | | | | | | | | 451 |
| 8501 TO 9500 | | 6 | 83 | 108 | 100 | 24 | 4 | | 1 | 6 | | | | | | | | | | | 332 |
| 9501 TO 10500 | | 7 | 55 | 34 | 42 | 53 | 21 | 2 | | 1 | 2 | 1 | | | | | | | | | 218 |
| 10501 TO 11500 | | 2 | 29 | 14 | 20 | 25 | 19 | 6 | | | | 1 | | | | | | | | | 116 |
| 11501 TO 12500 | | 4 | 12 | 7 | 4 | 4 | 7 | 14 | 2 | | | 3 | 2 | | | | | | | | 59 |
| 12501 TO 13500 | | 2 | 14 | 9 | 5 | 2 | 6 | 11 | 2 | 5 | | | | 2 | | | | | | | 58 |
| 13501 TO 14500 | | 1 | 7 | 5 | 2 | 2 | 1 | 3 | 4 | 3 | | | 1 | | 1 | | | | | | 30 |
| 14501 TO 15500 | | 4 | 7 | 4 | | 2 | 2 | | 2 | 7 | 2 | 1 | | | | | | | | | 31 |
| 15501 TO 16500 | | 1 | 7 | 3 | 2 | 1 | 1 | | 1 | 1 | 4 | 2 | | 1 | | | | | | | 24 |
| 16501 TO 17500 | | | 2 | 4 | | | 1 | | 1 | 1 | | | | | | | | 1 | | | 10 |
| 17501 TO 18500 | | | 2 | 1 | | | | | | 1 | | | | | | | | | | | 4 |
| 18501 TO 19500 | | | 1 | 1 | | | | | 1 | | | | | | | | | | | | 3 |
| 19501 TO 20500 | | | 2 | | 2 | 2 | | | 1 | | | | | | | | | | | | 7 |
| 20501 TO 21500 | | | 2 | | 1 | | | | | | | | | | | | | | | | 3 |
| 21501 TO 22500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 22501 TO 23500 | | | 2 | | | | | | | | | | | | | | | | | | 2 |
| 23501 TO 24500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 24501 TO 25500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 25501 TO 26500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 26501 TO 27500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 27501 TO 28500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 28501 TO 29500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 29501 TO 30500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 30501 TO 31500 | | | | | | | | | | | | | | | | | | | | | 0 |
| 31501 TO 32500 | | | | | | | | | | | | | | | | | | | | | 0 |
| OVERFLOW | | | | | | | | | | | | | | | | | | | | | 0 |
| TOTALS | 1 | 75 | 721 | 504 | 283 | 125 | 81 | 48 | 22 | 25 | 8 | 8 | 3 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 1569 |

MSR RESPONSE - CYCLE DISTRIBUTION

# MSR RESPONSE




FIGA #3 - 0 TO 122 HRS - FLTS 1 TO 70

(0289)

PAGE 1

FIRST 750 DATA POINTS
FROM A 3823 DATA
POINT RECORD.

ATTACHMENT TO F-16

# DESCRIPTION OF THE F-16 FLIGHT LOADS RECORDER DATA BASE

Flight loads recorders are being installed on one of every 6th F-16 to record flight-by-flight time histories of load significant parametric data.

The installation consists of an MXU-553/A recorder, a converter/multiplexer and associated source transducers. The recording system receives signals from the source transducers and applies the appropriate signal conditioning, filtering, sampling and data conversion. The data is recorded in digital form on a 9-track magnetic tape cartridge.

The recorded data items are described in Table I. Most of the data items are derived from aircraft system sensors, however, such items as rudder, horizontal tail and flaperon position measurements and longitudinal acceleration require peculiar sensors.

The recorder cartridge has a recording capacity of 15 hours. When the cartridge supply is expended, it is removed from the aircraft and transcribed to a 9-track computer compatible magnetic tape through the use of a signal data converter.

Currently, data from the recorder is being collected from the full scale development aircraft, and the necessary methods and procedures for processing and analyzing this data are being developed.

ATTACHMENT TO F-16

TABLE I

| SIGNAL INPUTS | | | |
|---|---|---|---|
| **SIGNAL** | **SYMBOL** | **FILTER (Hz)** | **SAMPLE RATE (Samples/Sec)** |
| Pressure altitude | $H_p$ | - | 1 |
| Calibrated airspeed | $V_c$ | - | 1 |
| Pitch rate | $q$ | 3 | 15 |
| Yaw rate | $r$ | 3 | 15 |
| Roll rate | $p$ | 6 | 30 |
| Roll acceleration | $\mathring{p}$ | - | 30 |
| Normal acceleration | $n_z$ | 6 | 15 |
| Lateral acceleration | $n_y$ | 6 | 15 |
| Longitudinal acceleration | $n_x$ | 1.5 | 5 |
| Fuel quantity | $F_q$ | - | 1 |
| Engine rotor speed | $N_2$ | - | 1 |
| Rudder position | $\delta_R$ | 6 | 15 |
| Left horiz. tail position | $\delta_{HL}$ | 6 | 15 |
| Right horiz. tail position | $\delta_{HR}$ | 6 | 15 |
| Left flaperon position | $\delta_{FL}$ | 6 | 15 |
| Right flaperon position | $\delta_{FR}$ | 6 | 15 |
| Leading edge flap position | $\delta_{LE}$ | - | 5 |
| Structural strain | $\sigma$ | 3 | 15 |
| Weight on wheels event | $E_1$ | - | 1 |
| Ldg. gear position event | $E_2$ | - | 1 |
| Weapons release event | $E_3$ | - | 1 |
| Documentary data | DD | - | 1 |
| Timing word/gap | T | - | 1 |

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-100

FLEET INFORMATION

as of Feb. 1978
NO. OF AIRCRAFT: 259 In ANG : YEAR SERVICE BEGAN: 1954 (approx)
SYSTEM MANAGEMENT: SM-ALC/MMS
DATE TRANSFERRED TO AFLC: 1958
USING COMMAND: ANG. FMS & MAP Turkey; China, Taiwan
PRIMARY BASE: 14 ANG Bases in CONUS
PRIMARY MISSION TYPES: TACTICAL (FIGHTER-BOMBER)
REMARKS: F-100D/F will be phased out of ANG by FY79, 4th qtr.

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | 1953-1956 | NA | NA |
| FULL-SCALE CYCLIC TEST: | 1968-1969 | NA | |
| FULL-SCALE STATIC TEST: | 1954 approx. | NA | |
| DAMAGE TOLERANCE TESTS: | NA | NA | NA |
| DADTA INITIAL: | NA | NA | NA |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | X | | |
| L/ESS DESIGN: | X | | Continuous |
| FSM PLAN: | X | | NA |
| BASELINE OPS SPECTRA: | X | | |
| DADTA-FINAL: | NA | NA | NA |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | ALC/MMS 73-514 | SM-ALC/MMS |
| DAMAGE TOLERANCE ANALYSIS: | NA | NA |
| DURABILITY ANALYSIS: | NA | NA |
| SERVICE LIFE ANALYSIS: | NA75-182- | Rockwell (6mo report) |
| | | |
| | | |
| F-100 Life Capability | MMSRB-77-1 | |
| | | |
| F-100 ASIP Final Report | NA-70-69 | |
| Phase I Program Plan | NA-66-353 | |
| Phase II ASIP Plan | NA-65-922 | |
| Phase III ASIP Test Plan | NA-66-399 | |
| | | |

A/C Type: F-100 (Continued)

IAT PROGRAM

ANALYSIS METHOD: Miner's Rule Fatigue Analysis

Damage = (usage) x (VGH Recorder Damage Rate)

Damage rate by mission

APPLICABLE REPORT: RI Report NA75-182 - Service Life

DATA COLLECTION: RECORDER: NONE FORM: NONE (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: :TECH.ORDERS:

DATE STARTED: C 1973 HRS.RECORDED: % USABLE DATA:

DATA COLLECTION PROBLEMS: Individual Aircraft usage is determined from 65-110 data

DATA REDUCTION: WHO DOES IT? Rockwell International

HOW IS IT CHECKED?

TECHNIQUE TO RECOVER MISSING DATA: Comparison of 65-110 hours with ANG monthly K-2 maintenance reports.

LIST PROCESSING STEPS: 65-110 hours are sorted by mission type and married with proper VGH recorder produced damage rates. Damage is then calculated by simple cummation of usage times damage rate.

OUTPUT CONTENTS (ATTACH SAMPLES): Periodic RI report identifies damage accumulation and remaining life for each individual aircraft

LIST PERMANENT FILES: RAW DATA? NO

PROCESSED DATA? Final Periodic Reports

WHO EVALUATES OUTPUT? SM-ALC/MMSRBA

APPLICATIONS: SCHEDULING? YES 1. Sched insp. with 600 hours remaining, schedule Retirement

ANALYSIS UPDATE? YES

TO DETECT CHANGE IN USAGE YES

REMARKS: Program is to be terminated on 30 Apr. 1978 as the F-100 is being phased out of the inventory.

L/ESS PROGRAM

ANALYSIS METHOD: Fatigue using Miners Rule. VGH data converted to BM spectra using analytical load conditions.

APPLICABLE REPORT: NA-73-502-12

DATA COLLECTION BASE: 10

NO. OF AIRCRAFT: 5 RECORDING DEVICE: A/AZ4U-10 MXU-553/A ECU 68/A (Attach Description)

PARAMETERS RECORDED: VGH (A/AZ4U-10) V,G,H, Ny, R, P, Y, strain (Attach List)

L/ESS START/STOP DATES: May 72 - present HRS. RECORDED: VGH 15,400 MXU 2,870

% USABLE DATA: MXU- 62%, VGH 63% DATA RETRIEVAL FREQ. per cartridge

DEFINITION OF USABLE DATA: V,G, H, + timing word

COLLECTION PROBLEMS: hardware shortage, supplemental data sheets

DATA REDUCTION: WHO DOES IT? ASIMIS/RI

HOW IS IT CHECKED? Fault Isolation Program

LIST STEPS: 1. ASIMIS list runs tape thru failt isolation to detect malfunctioning parameters 2. Questionable data is verified by SM-ALC through ASIMIS terminal 3. Strain gage reading are checked by SM-ALC

TECHNIQUE TO RECOVER MISSING PARAMETERS: Operational bases are contacted by telephone/letter/TWX on all malfunctions IAW P3 c(3) e(2) of AFLR 80-2

OUTPUT CONTENTS (Attach Sample): Compressed data tapes are forwarded to RI corp. every 4 months. BM exceedance data for 3 missions at 2 locations. Damage rates for 5 locations and 9 missions updated every 6 months.

LIST PERMANENT FILES: RAW DATA? Filed for 1 yr. at ASIMIS

PROCESSED DATA? Compressed data tapes are forwarded to RI every 4 months. BM exceedance data and tape of damage rates

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Analysis does not consider flight-by-flight sequence

TO CHECK IAT DATA? VGH rates are used in IAT damage calculations

TO DETECT CHANGE IN USAGE? YES

REMARKS: Program is gradually being phased down as the F-100 is phased out of the inventory. Data sent to RI is similar to typical flight loads report. Time in A/S, ACT blocks is available.

A/C TYPE: F-100 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:

INSPECTION INTERVALS: Per 1F-100-6 Inspection manual

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA: Lack of records on hardware interchange has hurt feedback. Component tracking has been hindered as a large individual effort is required to follow wings and airframes.

REMARKS: ASIP has resulted in one-time modifications i.e.
1F-100-1028 wing carry through
1F-100-1035 wing outer panel
1F-100-1053 Fuselage upper longer

APPLICABLE DOCUMENTS: T.O. F-100-3 structural repair manual
T.O. F-100-6 Inspection manual
T.O. F-100-36 NDI

A/C TYPE: F-100 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: NONE ANG is extremely co-operative

IAT-FSM INTERFACE: IAT data is one factor used in selecting aircraft for phase-out. Also, as aircraft approach the predicted life capability for each control point, a periodic inspection of the control point is required at base level.

L/ESS-IAT INTERFACE: The VGH data provides the basic damage rates required to calculate individual damage in the IAT. The MXU-553 data was intended to eventually replace or supplement the VGH rates, however, with pending phaseout, that change was not accomplished.

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: None regarding F-100 SLMP

COMMONALITY WITH OTHER SYSTEMS: The A/A-24U-10 is also used in F-4 aircraft. The MXU-553/A EW-68/A is used in majority of AF fighter aircraft.

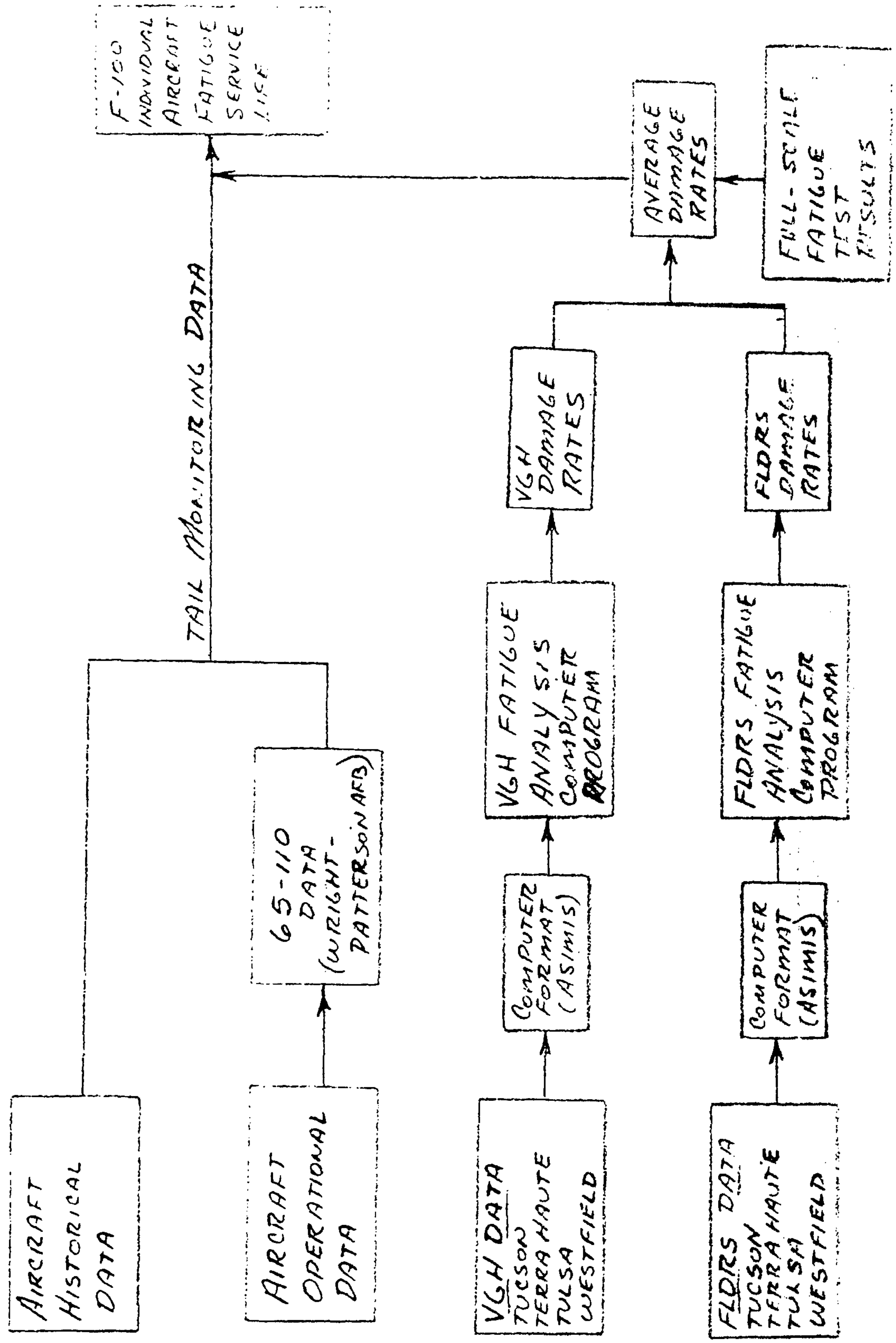
METHODS WHICH HAVE WORKED WELL: During implementation of program, a major (F-105 combat pilot) briefed all ANG bases where recording systems were installed. He flew several missions at each location and established strong relations at each base. When a fighter pilot talks to fighter pilots, they listen!

DEFICIENCIES IN CURRENT METHODS: The IAT is essentially based on the maintenance tapes (61-110) which does not record the number of flights. It must be checked with pilot reporting forms to update the 61-110 tapes. The reports were in complete structural tracking. Lack of agreement between missions defined for L/ESS and IAT. Lack of believability of L/ESS when only one aircraft at a base.

ATTACHMENT TO F-100

FIGURE 1 · F-100 SERVICE LIFE MONITORING PROGRAM

· DATA COLLECTION, PROCESSING, & ANALYSIS



ATTACHMENT TO F-100

103 TFG | BRADLEY IAP | WINSOR LOCKS CT

| ACFT S/N | FLT. HOURS K2 REPORT 31 DEC 76 | FLT. HOURS SLM REPORT 31 DEC 76 | CALCULATED RSL SLM REPORT 31 DEC 76 | CRITICAL STRUCTURE | SERVICE LIFE CAPABILITY FLT. HOURS |
|---|---|---|---|---|---|
| 55002853 | 4746.2 | 4528.4 | 2605.8 | #7 Hole | 7134.2 |
| 55002873 | 5608.8 | 5404.2 | 1289.5 | WCS | 6693.7 |
| 55002925 | 5020.9 | 4852.0 | 2241.4 | Upper Longeron | 7093.4 |
| 55002939 | 5357.5 | 5188.3 | 2125.8 | #7 Hole | 7314.1 |
| 55002945 | 4789.4 | 4644.8 | 2169.0 | WCS | 6813.8 |
| 55003665 | 4996.0 | 4837.8 | 2340.5 | Upper Longeron | 7178.3 |
| 55003805 | 3065.5 | 2861.8 | See Note (1) Par. 3.1.6 | #7 Hole | 4000 |
| 56002932 | 4759.5 | 4632.2 | 1801.9 | WCS | 6434.1 |
| 56002981 | 4675.7 | 4546.4 | 2816.5 | Upper Longeron | 7362.9 |
| 56003022 | 4968.0 | 4812.7 | 2198.8 | Upper Longeron | 7011.5 |
| 56003033 | 4609.0 | 4441.3 | 1910.2 | WCS | 6351.5 |
| 56003306 | 4617.0 | 4465.3 | 2182.4 | Upper Longeron | 6647.7 |
| 56003318 | 4198.7 | 4033.9 | 1288.0 | WCS | 5321.9 |
| 56003333 | 4593.1 | 4468.5 | 1573.0 | WCS | 6041.5 |
| 56003413 | 5299.0 | 5151.4 | 2190.2 | #7 Hole | 7341.6 |
| 56003443 | 5445.8 | 5318.5 | 1740.7 | WCS | 7059.2 |
| 56003732 | 4605.7 | 4420.4 | 4342.4 | #7 Hole | 8762.8 |
| 56003801 | 5046.5 | 4955.0 | 4305.8 | #7 Hole | 9260.8 |
| 56004001 | 5069.4 | 4913.6 | 4124.6 | #7 Hole | 9038.2 |

AFLC FORM SEP 63 192E — GENERAL PURPOSE DATA SHEET (25 LINES – 5 COLUMNS) — PREVIOUS EDITIONS OF THIS FORM WILL BE USED.

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-105 B/D/F/G

FLEET INFORMATION

NO. OF AIRCRAFT: 833 (orig.): 43 TAC, 80 ANG, 80 AFRES YEAR SERVICE BEGAN: 1959

SYSTEM MANAGEMENT: SM-ALC/MMS

DATE TRANSFERRED TO AFLC:

USING COMMAND: ANG AFRES TAC

PRIMARY BASE: ANG: Andrews, Byrd, McConnel, McGuire, AFRES, Carswell Hill, Tinker, TAC George

PRIMARY MISSION TYPES: Interdiction Fighter-bomber

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | |
| FULL-SCALE STATIC TEST: | X | | (ASD Joe Reiman) |
| DAMAGE TOLERANCE TESTS: | | X | FS442 Frame Log Test |
| DADTA INITIAL: | X | Limited to FS442 Frame Logs | |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | | X | |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | X | | Continuous |
| BASELINE OPS SPECTRA: | X | X | |
| DADTA-FINAL: | | | Not Planned |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | 77-516 | SM-ALC/MMS |
| DAMAGE TOLERANCE ANALYSIS: | | Fairchild - Republic |
| DURABILITY ANALYSIS: | | " " |
| SERVICE LIFE ANALYSIS: | | " " |

IAT PROGRAM

ANALYSIS METHOD: Fatigue Analysis

Damage = $\Sigma$(Usage [hours]) x (Recorder Program Damage Rates)

APPLICABLE REPORT: Pending Completion of Initial Effort

DATA COLLECTION: RECORDER: NONE FORM: NONE (ATTACH DESCRIPTION)

FREQ. OF RETRIEVAL: :TECH.ORDERS:

DATE STARTED: 1977 HRS.RECORDED: % USABLE DATA:

DATA COLLECTION PROBLEMS: Individual aircraft usage is based only on 65-110 hours sorted by base, and operation period, i.e. peacetime training, sea combat, etc.

DATA REDUCTION: WHO DOES IT? Fairchild-Republic

HOW IS IT CHECKED?

TECHNIQUE TO RECOVER MISSING DATA: Flight hours are checked against available contractor/Air Force Records.

LIST PROCESSING STEPS: Usage for each individual aircraft is sorted by usage categories. Past usage in peacetime training and sea combat is multiplied times damage rates from past recorder programs. Current CONUS usage is derived from 65-110 data and multiplied times current L/ESS damage rates.

OUTPUT CONTENTS (ATTACH SAMPLES): Initial reports from Republic will identify damage accumulation for each aircraft and identify modification/inspection requirements to achieve the life goal of good hours

LIST PERMANENT FILES: RAW DATA? NO

PROCESSED DATA? Final reports

WHO EVALUATES OUTPUT? SM-ALC/MMSRBA

APPLICATIONS: SCHEDULING? Planned

ANALYSIS UPDATE? Planned

TO DETECT CHANGE IN USAGE? Planned - couner/MXU Data

REMARKS: This program, using an Engineering report to project maintenance requirements, started in 1977. The initial reports by model will be received in 1978 and early 1979. A continuous update of the data is planned following the initial program. Intend to repeat process every 6-12 months.

L/ESS PROGRAM

ANALYSIS METHOD: Fatigue

APPLICABLE REPORT:

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 28 (35) RECORDING DEVICE: ABU-12 Exc. Counter (Attach Description)

PARAMETERS RECORDED: $N_z$ [To GW, Fuel, Stress, Lndg. G.W. Time] (Attach List)

L/ESS START/STOP DATES: Mar 75 - Restart Hrs. Recorded 5825

% USABLE DATA: 99% DATA RETRIEVAL FREQ. Weekly

DEFINITION OF USABLE DATA: Valid recorded data + supplemental Data sheets

COLLECTION PROBLEMS: None (lack of hardware initially)

DATA REDUCTION: WHO DOES IT? SM-ALC

HOW IS IT CHECKED? Manually

LIST STEPS: Checked for accuracy, validity, summarized by base - mission - configuration

TECHNIQUE TO RECOVER MISSING PARAMETERS: Base contacted by telephone

OUTPUT CONTENTS (Attach Sample):
Tabulations of exceedance data sorted by base-mission-configurations

LIST PERMANENT FILES: RAW DATA? Held at McClellan

PROCESSED DATA? Copy forwarded to Fairchild-Republic every 6 months

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Not applicable

TO CHECK IAT DATA? Provides primary damage rate data

TO DETECT CHANGE IN USAGE? Yes

REMARKS:

A/C TYPE: F-105 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:

INSPECTION INTERVALS:

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: F-105 B/D (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: None. Ang & Res are exceptional in their co-operation

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE: L/ESS recording system provides basic damage rate data for the IAT damage calculations

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: None on F-105 SLMP

COMMONALITY WITH OTHER SYSTEMS: The ABV 12 exceedance counter system is used in the A-7 and F-4

METHODS WHICH HAVE WORKED WELL: 1. Briefings to organizations at implementation of program. 2. Briefings by Fairchild personnel on fatigue problems with F-105

DEFICIENCIES IN CURRENT METHODS: None-units responed to telephone calls and are quick to detect malfunctions.

L/ESS PROGRAM

ANALYSIS METHOD: Fatigue

APPLICABLE REPORT:

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 7 RECORDING DEVICE: MXU-553/A ECU-68/A (Attach Description)

PARAMETERS RECORDED: Vel,Alt,Nz,$N_y$, R,P,Y, Stores (Attach List)

L/ESS START/STOP DATES: Jan 76-Present HRS. RECORDED: 1553 (Dec 77)

% USABLE DATA: 36 DATA RETRIEVAL FREQ.

DEFINITION OF USABLE DATA: Vel,Alt,$N_z$ + timing word

COLLECTION PROBLEMS: (1) No maintenance action for the equipment (2) lack of supplemental data

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Fault Isolation Program

LIST STEPS: (1) ASIMIS first runs tape thru fault isolation to detect malfunctioning parameters 2) Questionable data is also vented by SM-ALC thru ASIMIS terminal

TECHNIQUE TO RECOVER MISSING PARAMETERS: Operational base is contacted by telephone and letter (or MUX) on all malfunctions IAW ¶ 3 C/(3) e(2) of AFLCR 80-2

OUTPUT CONTENTS (Attach Sample): Compressed data tapes are forwarded to Fairchild Republic Co. on a quarterly basis.

LIST PERMANENT FILES: RAW DATA? Raw data tapes held for 1 year at ASIMIS.

PROCESSED DATA? Compressed data forwarded to Fairchild on quarterly basis.

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Not Applicable

TO CHECK IAT DATA? Provides primary damage rate data

TO DETECT CHANGE IN USAGE?

REMARKS:

A/C TYPE: F-105G (Concluded)

Recorder Systems

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: All aircraft are presently assigned to the TAC, 35 TFW, George AFB GA. There have been 3 different individuals responsible for programs at George in the past 18 months.

IAT-FSM INTERFACE: L/ESS recording systems provide basic damage rate data for the IAT damage calculations.

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: None on F-105 SLMP

COMMONALITY WITH OTHER SYSTEMS: The MXU-553/A system is used in majority of AF aircraft.

METHODS WHICH HAVE WORKED WELL: The 35 TFW took no corrective actions on hardware malfunctions until a message was sent to HQ TAC

DEFICIENCIES IN CURRENT METHODS: 1) Turn-over of personnel at George 2) Response to malfunction notifications.

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: F-111 A/E/D/F

FLEET INFORMATION

NO. OF AIRCRAFT: 455 : YEAR SERVICE BEGAN: 1970

SYSTEM MANAGEMENT: Sacramento (Bill Sutherland) Warren Toone Ogden-Log Gear

DATE TRANSFERRED TO AFLC: 1974

USING COMMAND: TAC

PRIMARY BASE: Mountan Home/upper Heyford/Cannon/Lakenheath

PRIMARY MISSION TYPES: Training, A-G, I&N (All W/& w/o TFR)

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | - | | F-111 Recovery PGM* |
| DADTA INITIAL: | - | | " |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | X | | |
| L/ESS DESIGN: | X | | |
| FSM PLAN: | X | | |
| BASELINE OPS SPECTRA: | X | | |
| DADTA-FINAL: | - | | F-111 Recovery PGM* |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN No Formal Document | ECP 0315 | Plan for developing TAC SLM |
| DAMAGE TOLERANCE ANALYSIS: | FZM-12-13467 | |
| DURABILITY ANALYSIS: | ---- | |
| SERVICE LIFE ANALYSIS: | | |
| Final Fatigue Analysis | FZS-12-6087 | |
| F-111A Airframe/Gearudd | FZS-12-343 | |
| F-111E " | FZS-12-343 | |
| F-111D " | FZS-12-8007 | |
| F-111F " | FZS-12-8007 | |
| F-111A/E Airframe/Gearudd | FZS-12-345 | |
| F-111D/F " | FZS-17-8008 | |
| | | |
| MSG-2 Revision to -6 TO | | Available June/July 78 |

*Proof Test at $-40^{o}$ at 3 conditions to check steel wing carry thru

A/C Type: F-111 A/E/D/F (Continued)

IAT PROGRAM

ANALYSIS METHOD: Monitor vertical load factor & usage on individual aircraft and obtain control point damage from FLR aircraft through NZ ratio by mission type

APPLICABLE REPORT: **FZS-12-12014 & FZM-12-6531

DATA COLLECTION: RECORDER: CONRAC Model TRU-138/A Gen. Gen.Time Model TRU-114/A FORM: Attachment A (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: After every flt. TECH.ORDERS: T.O.-1F-111A-2-1-2

DATE STARTED: Nov. 1971 HRS.RECORDED: 577,871 Usage 577,871 NZC % USABLE DATA: 90% 25%

DATA COLLECTION PROBLEMS: 1. cards not filled out and sent in 2. Errors on cards 3. Hardware maintenance

DATA REDUCTION: WHO DOES IT? ASIMIS*

HOW IS IT CHECKED? NZC-Direction of motion & thresholds USAGC-OPS. logs & flight summaries-compared with AFM 66-1

TECHNIQUE TO RECOVER MISSING DATA: NZC-None Usage-fill in incorrect & missing data as it can be obtained from A/F records (65-110) (factored up to Match hours)

LIST PROCESSING STEPS: 1. Using commands punch cards and relay to ASIMIS 2. ASIMIS checks data & puts it on computer compatible tapes 3. ASIMIS runs the data through the appropriate processing & analysis programs that provide usage & DAFS for damage computation.

OUTPUT CONTENTS (ATTACH SAMPLES): Usage per tail number & damage adjustment factors per tail number (Attachment B)

LIST PERMANENT FILES: RAW DATA? Usage & NZC tapes

PROCESSED DATA? Usage/NZC/DAF Tapes

WHO EVALUATES OUTPUT? ASIMIS

APPLICATIONS: SCHEDULING? By Sacramento & Ogden

ANALYSIS UPDATE? Once per year

TO DETECT CHANGE IN USAGE? Once per year

*REMARKS: This description applies to the F-111 TAC SLM system as it will operate following the current transfer to ASIMIS which is scheduled to be completed in late 1975.

** Good summary report (see ASD)

L/ESS PROGRAM

ANALYSIS METHOD: Measure airplane response parameters & compute critical control point loads/stresses and damage, unit damages, use scatter factor = 4

APPLICABLE REPORT: FZS-12-12014 & FZM-12-6531

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 71 RECORDING DEVICE: A/A24U-6 Whittaker/Dynasciences P/N630436 (AttachmentC ~~Description~~)

PARAMETERS RECORDED: 24 parameters (attachment) (Attach List)

L/ESS START/STOP DATES: EC2-Oct'70-1 Oct '70 EC4-1 Oct '76- HRS. RECORDED: 41,085/90,173

% USABLE DATA: 15% DATA RETRIEVAL FREQ. 21 Hrs.

DEFINITION OF USABLE DATA: Good for loads & damage computation

COLLECTION PROBLEMS: Reluctance to remove magazines & lack of hardware maintenance

DATA REDUCTION: WHO DOES IT? ASIMIS & GD

HOW IS IT CHECKED? Via quick look & loads edit software procedures (Attachment 8)

LIST STEPS: 1. Run & scan quick look for max-min.

2. Run & scan loads edit parameters

See attached figure for additional parameters

TECHNIQUE TO RECOVER MISSING PARAMETERS: Adjust for null changes & compute spoiler position if it is bad.

OUTPUT CONTENTS (Attach Sample): (See Attachment F) Quick look summary tape available for data storage. Loads edit program provides compressed time history tapes which are submitted to Gen.Dynamics for input to loads spectra program.

LIST PERMANENT FILES: RAW DATA? Field data tapes stores

PROCESSED DATA? Tapes stored, quick look summary, and loads summary data, annual damage rates

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Loads Spectra & damage periodically updated (No flt-by-flt) - Proof test is scheduled on individual aircraft based on fracture analysis by model

TO CHECK IAT DATA? --

TO DETECT CHANGE IN USAGE? Usage/NZC/loads/damage all used

REMARKS: A/24U-6 has some evidence of record dropout during high-g buffett as found during compariosn tests between counters and MCR.

(See Jerry Sutherland for documentation)
"Environmental Code" refers to usage periods when operations were restricted.

A/C TYPE: F-111 A/E/D/F (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Bill Sutherland & Warren Toone MSG-2 Analysis, experience, all F-111 depot work done at SMALC.

INSPECTION INTERVALS: Phased insp at 125 hr, majors at 200 hrs, see T.O.-00-25-4 Table I. Will go to Table II for 48 mo. insp. Proof test at 1500 hrs done at depot.

RANGE OF CRITICAL CRACK LENGTHS: Fatigue not fracture. Inspecting for 0.02 inch

SPECIAL COMPONENT INSPECTIONS: Airframe & gear components 4 life-limited airframe parts; 34 Ldg. gear life limited locations.

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA: AFM 66-1 used for configuration changes.

Feasibility study for tracking serialized components- Results to Sutherland. Wing changes are being tracked by hand.

REMARKS: AFM 66-1 is not useful. Feedback is desirable for some special inspections. Requirement for feedback is included in -6 or TCTO procedures.

APPLICABLE DOCUMENTS:

A/C TYPE: F-111 A/E/D/F (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: Response at the bases concerning SLM equipment repairs, data collection and handling problems and tape removal replacement has been minimal.

IAT-FSM INTERFACE: Sacramento/Ogden ALC's

L/ESS-IAT INTERFACE: GD/ASIMIS. L/ESS recorder provides the basic mission type damage rates (unit damage data - UDD) used in IAT to calculate damage accumulation on each individual aircraft.

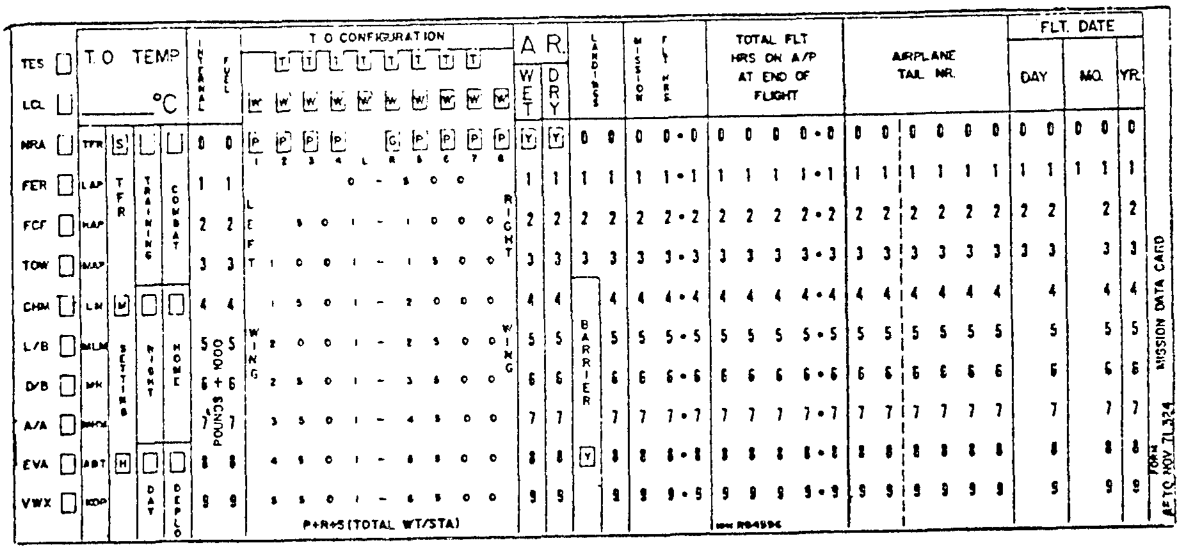
ORGANIZATIONAL CHANGES PENDING: Transfer to ASIMIS all functions except analysis of recorder data (UDD)

AFLC/ALD INTERFACE: None on SLMP

COMMONALITY WITH OTHER SYSTEMS: TAC & SAC F-111 Programs, NZ counters on other aircraft, A-10 uses gen time counting accelerometer.

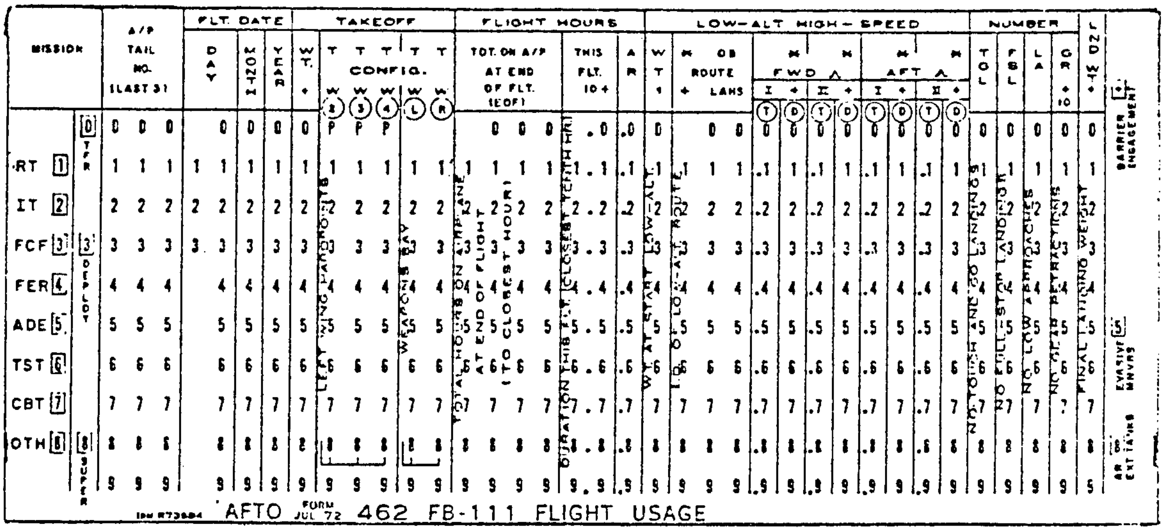
METHODS WHICH HAVE WORKED WELL: Early involvement of AFLC ASIP engineer with SPO.

DEFICIENCIES IN CURRENT METHODS: Lack of understanding by ASD of AFLC problems and procedures. There is a basic separation of the ASIP and maintenance organizations at most contractors, SPO and AFLC organizations.



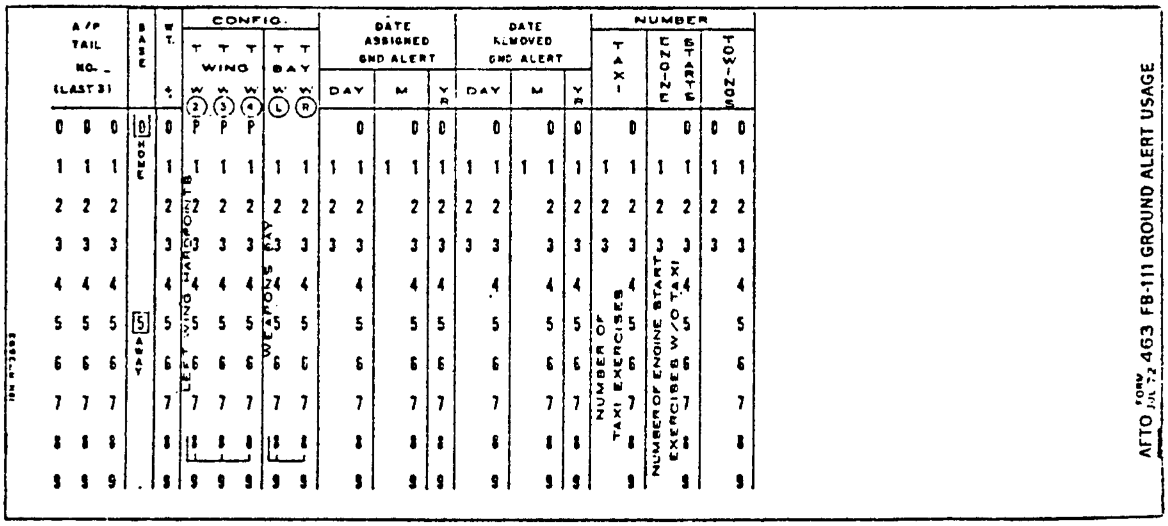

TAC MISSION USAGE DATA CARD

FIGURE 2-9



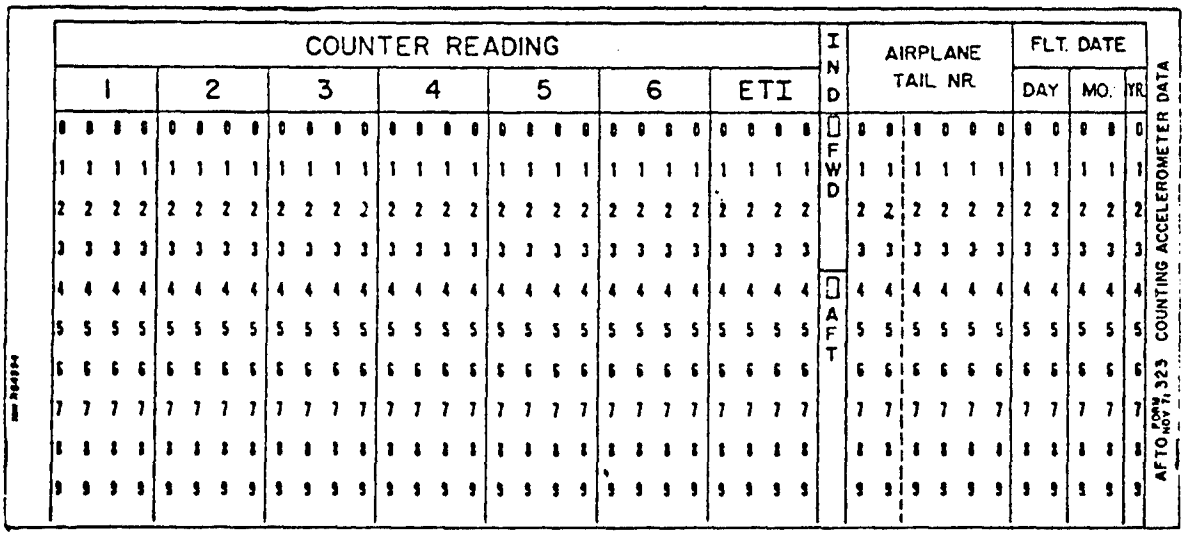

SAC FLIGHT USAGE DATA CARD

FIGURE 2-10




SAC GROUND ALERT USAGE DATA CARD

FIGURE 2-11




COUNTING ACCELEROMETER (NZC) DATA CARD

FIGURE 2-12

ATTACHMENT B TO F-111

# SUMMARY

## Summary of Operational Usage

There are four service usage parameters which are of particular significance for monitoring the fatigue service life of an F-111 airplane. These usage parameters are:

- o Number of flights
- o Number of flight hours
- o Number of landing touchdowns (includes both Touch-and-Go and Full-Stop Landings)
- o Number of gear retraction and extension (R&E) operations

Section 1.0, p. 2 presents the total usage through 31 December 1977 in bargraph and histogram form for each F-111 fleet.

Section 2.0, p. 17 presents the incremental quarterly usage for each F-111 wing in table and histogram form. These usage statistics were developed through analysis of the TAC F-111 Mission Data Card (AFTO Form 324). Study of this usage information will provide general overviews as to (1) how a given tactical fighter wing used their assigned F-111 airplanes during a given three-month period and (2) how this usage has varied with calendar time.

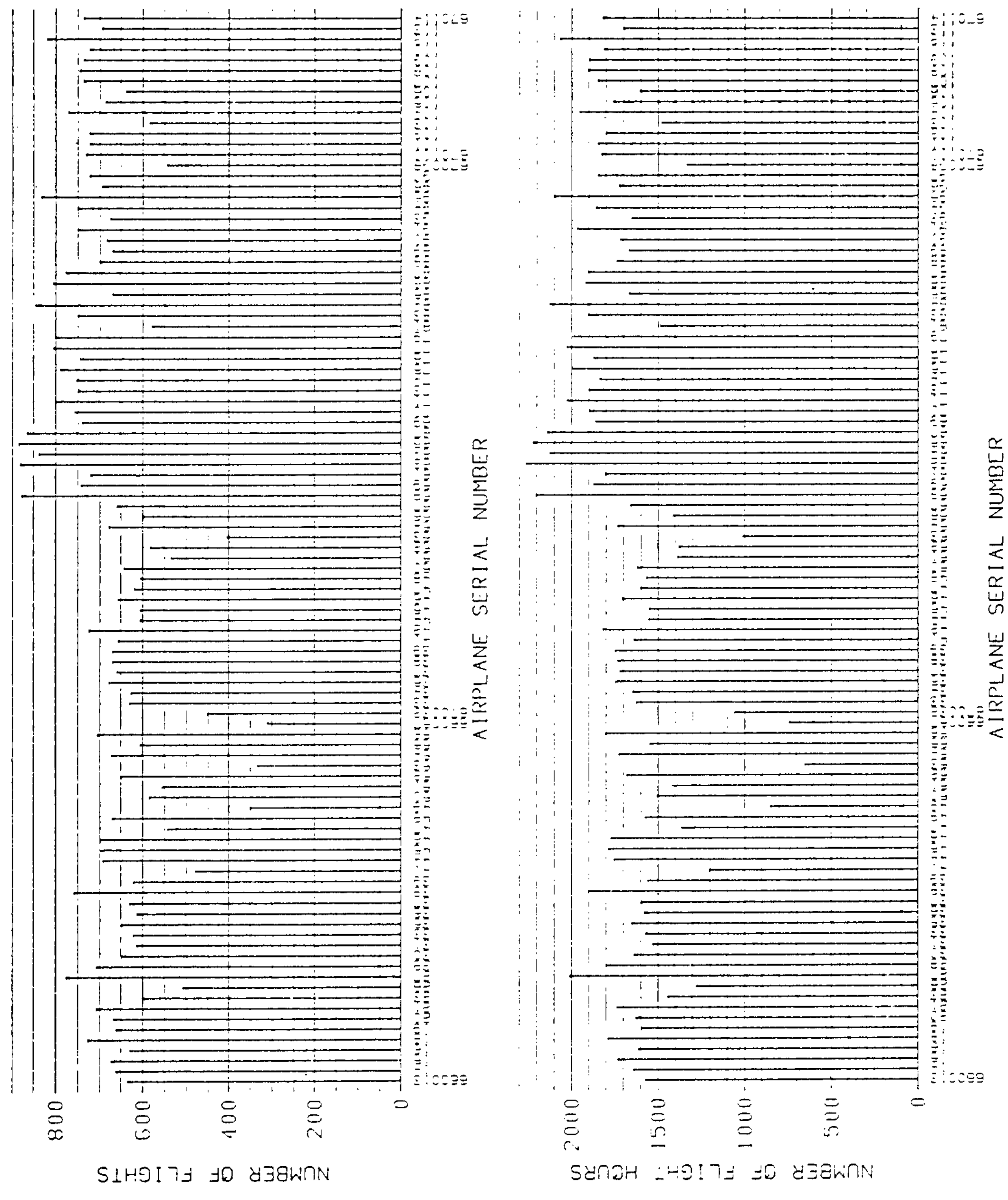
Section 3.0, p. 58 presents usage trends for Takeoff and Landing Gross Weights. This information is presented in histogram form showing the gross weight distributions for takeoff, final landing, and touch-and-go landings. Takeoff and landing weights are important usage parameters when computing landing gear fatigue damage. Takeoffs at weights greater than 82,500 lbs are considered to be "heavy-weight takeoffs." Landing weights greater than 62,500 lbs are considered to be "heavy-weight landings."

## 1.0 TOTAL USAGE

This section provides the total usage thru 31 December 1977 for all F-111 tactical fighter weapons wings. The usage is presented in bargraph and histogram form.

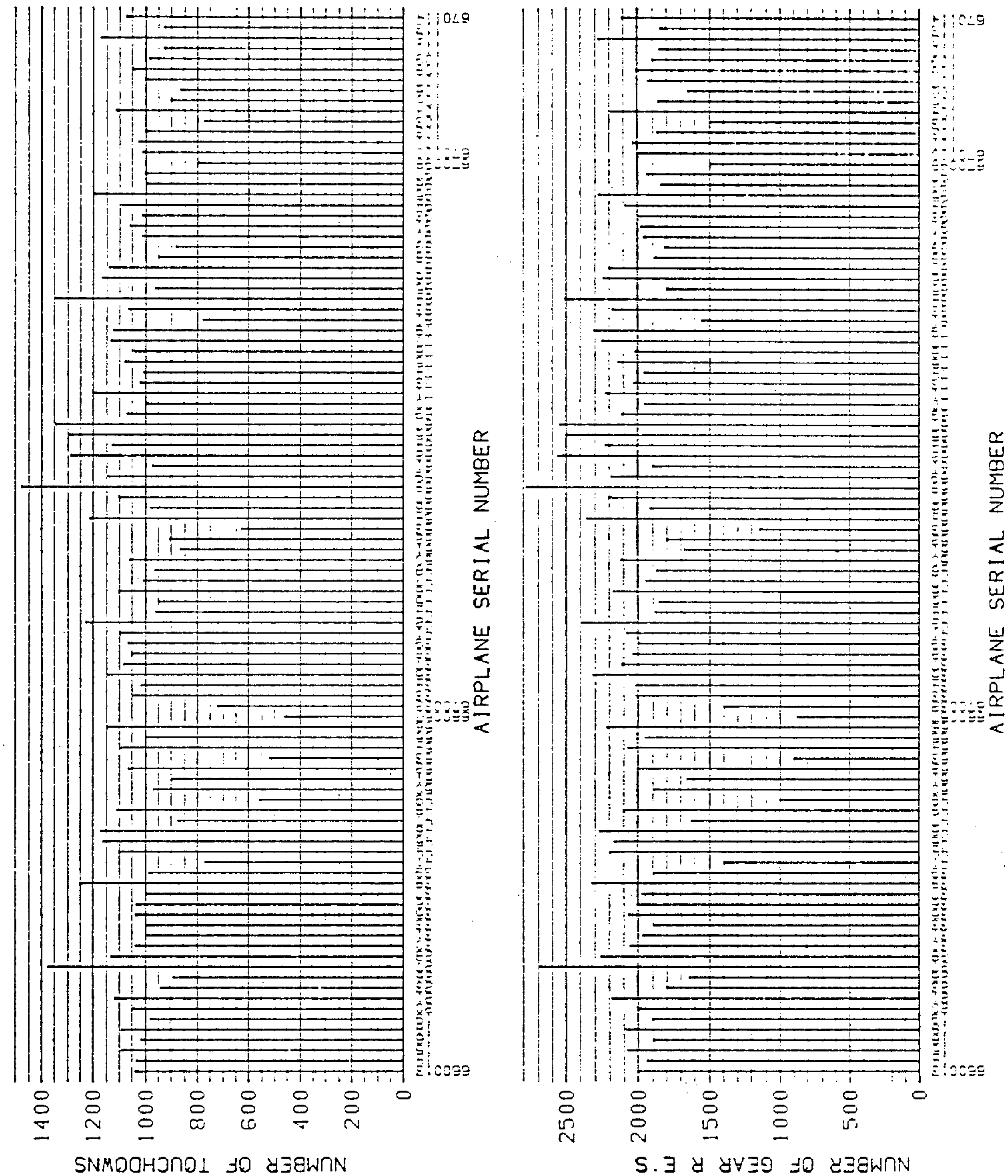
Attachment B to F-111

F-111A BARGRAPHS OF USAGE UP TO 31 DECEMBER 1976

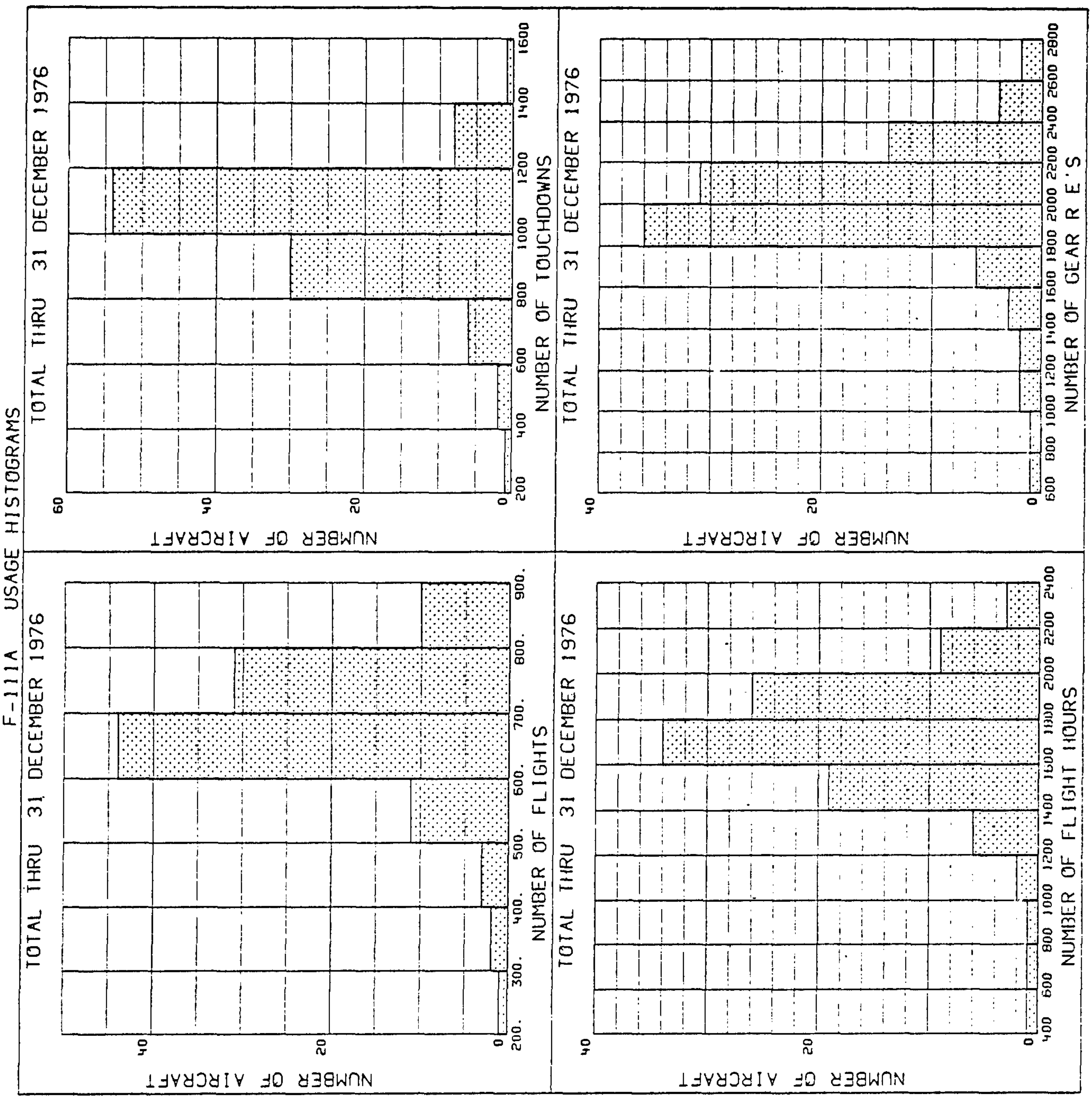


ATTACHMENT B TO F-111

F-111A BARGRAPHS OF USAGE UP TO 31 DECEMBER 1976



ATTACHMENT B TO F-111



Attachment B to F-111

F-111A USAGE BASED ON MISSION CARDS [1]
474 TFW - NELLIS AFB

| USAGE ITEM | 1975 1st | 1975 2nd | 1975 3rd | 1975 4th | 1976 1st | 1976 2nd | 1976 3rd | 1976 4th |
|---|---|---|---|---|---|---|---|---|
| 1. Number of F-111 Airplanes | | | | | | | | |
| Assigned at Start of Quarter | 102 | 102 | 100 | 100 | 99 | 98 | 97 | 97 |
| Assigned at End of Quarter | 102 | 100 | 100 | 99 | 98 | 97 | 97 | 97 |
| Flown During Quarter | 89 | 96 | 92 | 91 | 91 | 80 | 38 | 61 |
| 2. Usage Total for Quarter | | | | | | | | |
| Number of Flights | 2060 | 2104 | 1706 | 969 | 1837 | 539 | 475 | 1376 |
| Number of Flight Hours | 5258.1 | 5639.2 | 4251.5 | 2277.8 | 4545.2 | 1300.0 | 1084.9 | 3313.4 |
| 3. Average per Flight | | | | | | | | |
| Duration (Hours) | 2.55 | 2.68 | 2.49 | 2.35 | 2.47 | 2.41 | 2.28 | 2.41 |
| Number of Touch and Go Landings | .25 | .32 | .50 | .58 | .34 | .46 | 1.82 | 1.11 |
| Number of Gear Retractions | 3.02 | 2.89 | 3.03 | 3.14 | 2.61 | 3.04 | 5.34 | 4.29 |
| Number of Landing Touchdowns (Note [2]) | 1.25 | 1.32 | 1.50 | 1.58 | 1.34 | 1.46 | 2.82 | 2.11 |
| 4. Percent of Flights | | | | | | | | |
| With TFR Operations | 65.24 | 54.52 | 60.61 | 60.17 | 60.15 | 62.34 | 55.37 | 51.89 |
| With Aerial Refueling | 9.58 | 12.74 | 7.50 | 7.18 | 12.11 | 7.79 | 6.32 | 9.74 |
| With Barrier Engagement | .05 | .09 | 0 | .10 | 0 | 0 | 0 | 0 |
| Originated Away from Home Base | .05 | 1.08 | .55 | .29 | 1.93 | 0 | 3.16 | .15 |

NOTES:
[1] These usage data are based on information from TAC F-111 Flight Usage Cards (AFTO Form 324).

[2] Touch and go landings plus final full stop landings.

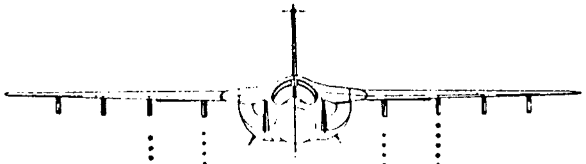
[3] Mission cards not received from using command.

Atachment B to F-111

F-111A USAGE BASED ON MISSION CARDS [1]
474 TFW - NELLIS AFB

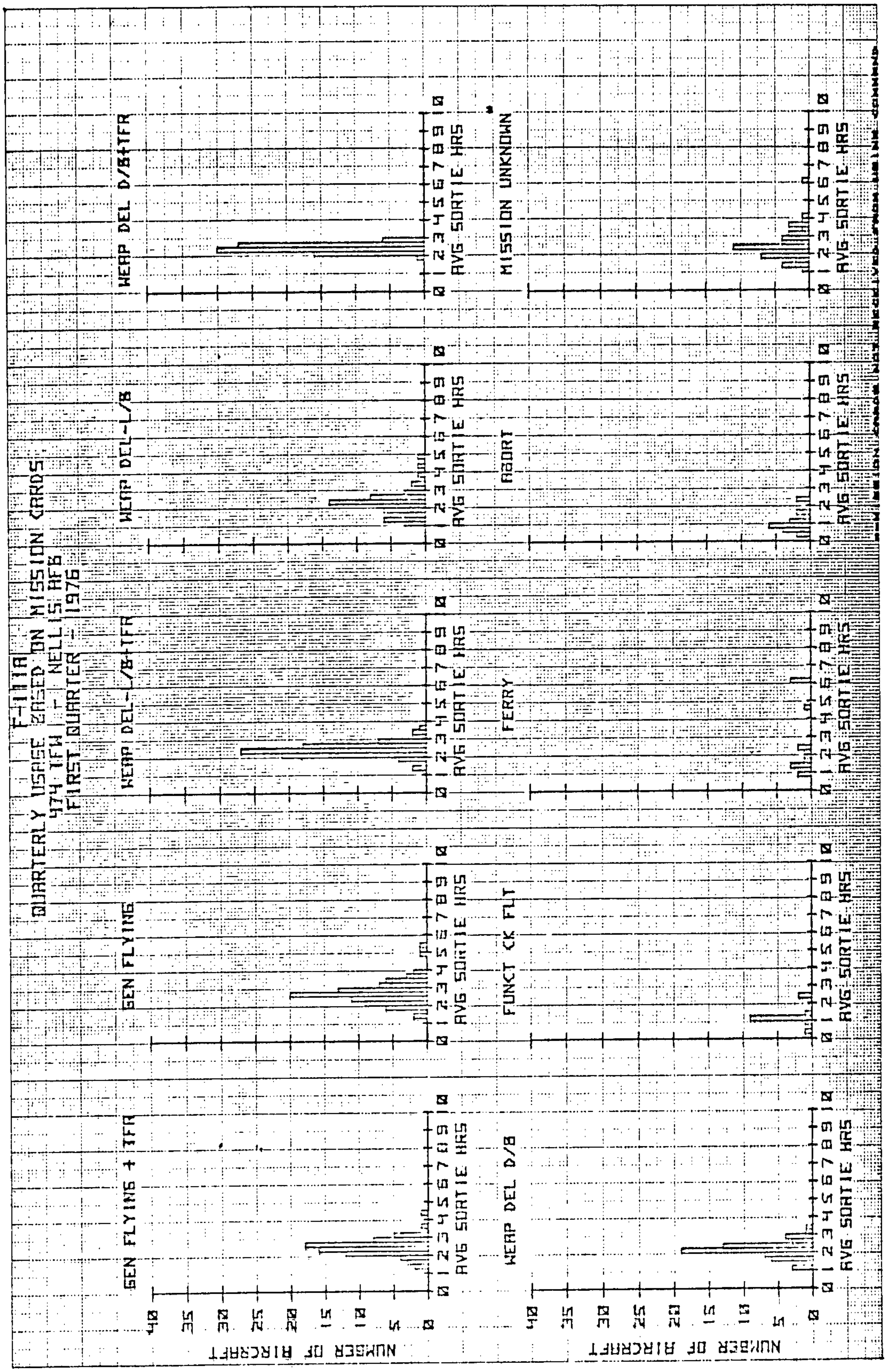
| USAGE ITEM | 1975 | | | | 1976 | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| 5. Dist of Flights According to TFR Ride (Percent) | | | | | | | | |
| Non-TFR | 34.76 | 45.48 | 39.39 | 38.80 | 39.85 | 37.66 | 44.63 | 48.11 |
| TFR | | | | | | | | |
| Soft | .19 | .52 | .23 | .72 | .33 | 6.86 | .84 | .51 |
| Medium | 58.30 | 47.58 | 52.75 | 53.04 | 55.80 | 50.10 | 50.32 | 46.44 |
| Hard | .19 | .24 | 0 | 0 | .05 | 0 | .21 | 0 |
| Soft-Medium | 3.93 | 3.33 | 3.81 | 3.51 | 2.23 | 2.41 | 1.05 | 1.45 |
| Soft-Hard | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Medium-Hard | 1.75 | 1.47 | 2.05 | .10 | 1.20 | 2.04 | 2.32 | 2.62 |
| Soft-Medium-Hard | .87 | 1.38 | 1.76 | 2.79 | .54 | .93 | .63 | .87 |
| 6. Mission Category - Percent of Flights | | | | | | | | |
| General Flying with TFR | 51.17 | 34.46 | 25.15 | 14.24 | 8.17 | 12.80 | 17.89 | 10.97 |
| General Flying without TFR | 20.29 | 22.34 | 22.45 | 14.45 | 20.14 | 25.60 | 29.05 | 28.85 |
| Weapon Delivery with TFR - L/B | 13.25 | 17.54 | 10.49 | 13.42 | 26.24 | 48.43 | 32.21 | 38.59 |
| Weapon Delivery without TFR - L/B | 3.83 | 6.32 | 4.98 | .64 | 5.77 | 7.42 | 8.84 | 11.56 |
| Weapon Delivery with TFR - D/B | .15 | 1.66 | 24.27 | 31.27 | 25.04 | 0 | .21 | .15 |
| Weapon Delivery without TFR - D/B | .44 | 4.47 | 9.14 | 10.94 | 7.13 | 0 | 0 | 0 |
| Functional Check Flight | .78 | .90 | .70 | 2.37 | .82 | 2.60 | 6.11 | 2.69 |
| Ferry | .19 | 1.52 | .12 | .72 | 1.20 | 1.11 | 1.47 | .22 |
| Abort | .63 | .48 | .35 | .31 | 1.20 | .37 | .84 | .29 |
| Mission Unknown (Note [3]) | 9.27 | 10.31 | 2.34 | 5.88 | 4.30 | 1.67 | 3.37 | 6.69 |

F-111A USAGE BASED ON MISSION CARDS [1]
474 TFW - NELLIS AFB

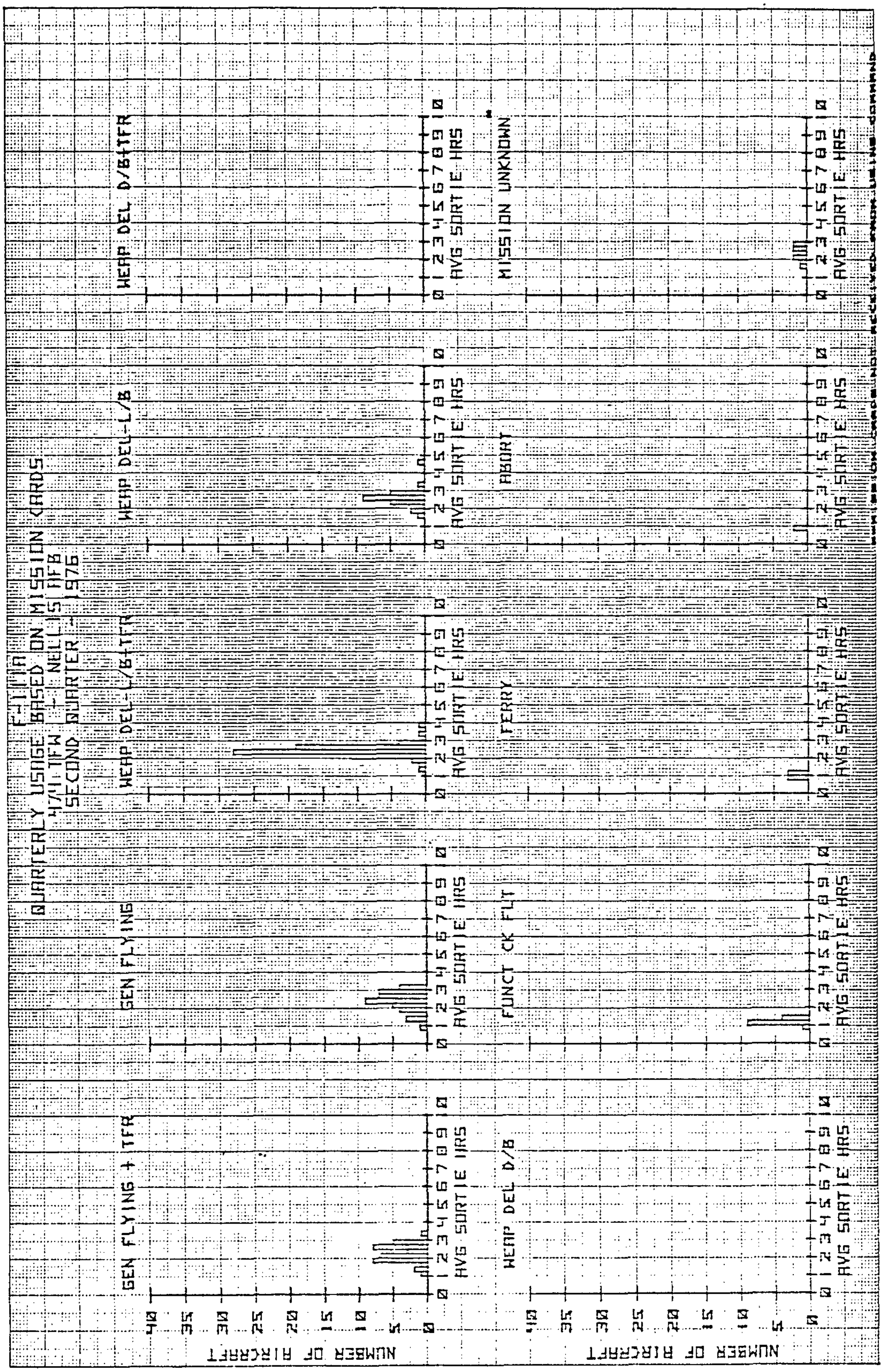


| USAGE ITEM | | | | | | 1975 1st | 1975 2nd | 1975 3rd | 1975 4th | 1976 1st | 1976 2nd | 1976 3rd | 1976 4th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. Takeoff Configuration - Percent of Flights | | | | | | | | | | | | | |
| Weapon Bay | | | CLEAN | | | 75.0 | 70.53 | 47.66 | 45.3 | 44.53 | 39.70 | 6.11 | 21.80 |
| | | | T T | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | W | | | 0 | 0 | .06 | 0 | 0 | 0 | 0 | 0 |
| | | | G W | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | G | | | 25.0 | 29.47 | 52.29 | 54.7 | 55.47 | 60.30 | 93.89 | 78.20 |
| Wing | | | CLEAN | | | 71.41 | 65.45 | 31.36 | 30.65 | 32.23 | 35.62 | 56.84 | 57.12 |
| | T | T | | T | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | T | | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | T | | T | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | T | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | T | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | T | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | W | W | | W | W | 0 | 1.76 | .06 | .10 | 0 | 0 | .84 | 1.89 |
| | W | | | | W | 6.07 | 17.02 | 37.51 | 36.12 | 42.08 | 13.91 | 3.16 | 5.09 |
| | | W | | W | | 4.51 | 1.0 | .06 | 0 | .05 | 0 | .63 | .29 |
| | | | | | W | 1.70 | .19 | 2.87 | 3.10 | 3.54 | 10.58 | 6.11 | 2.83 |
| T=Tank | W | | | | | 16.31 | 14.59 | 28.08 | 30.03 | 22.05 | 39.89 | 30.74 | 29.65 |
| W=Weapon | | | | W | | 0 | 0 | 0 | 0 | 0 | 0 | .63 | .07 |
| G=Gun | | W | | | | 0 | 0 | .06 | 0 | .05 | 0 | 1.05 | 3.05 |
| | W | T | | T | W | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | T | W | | W | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

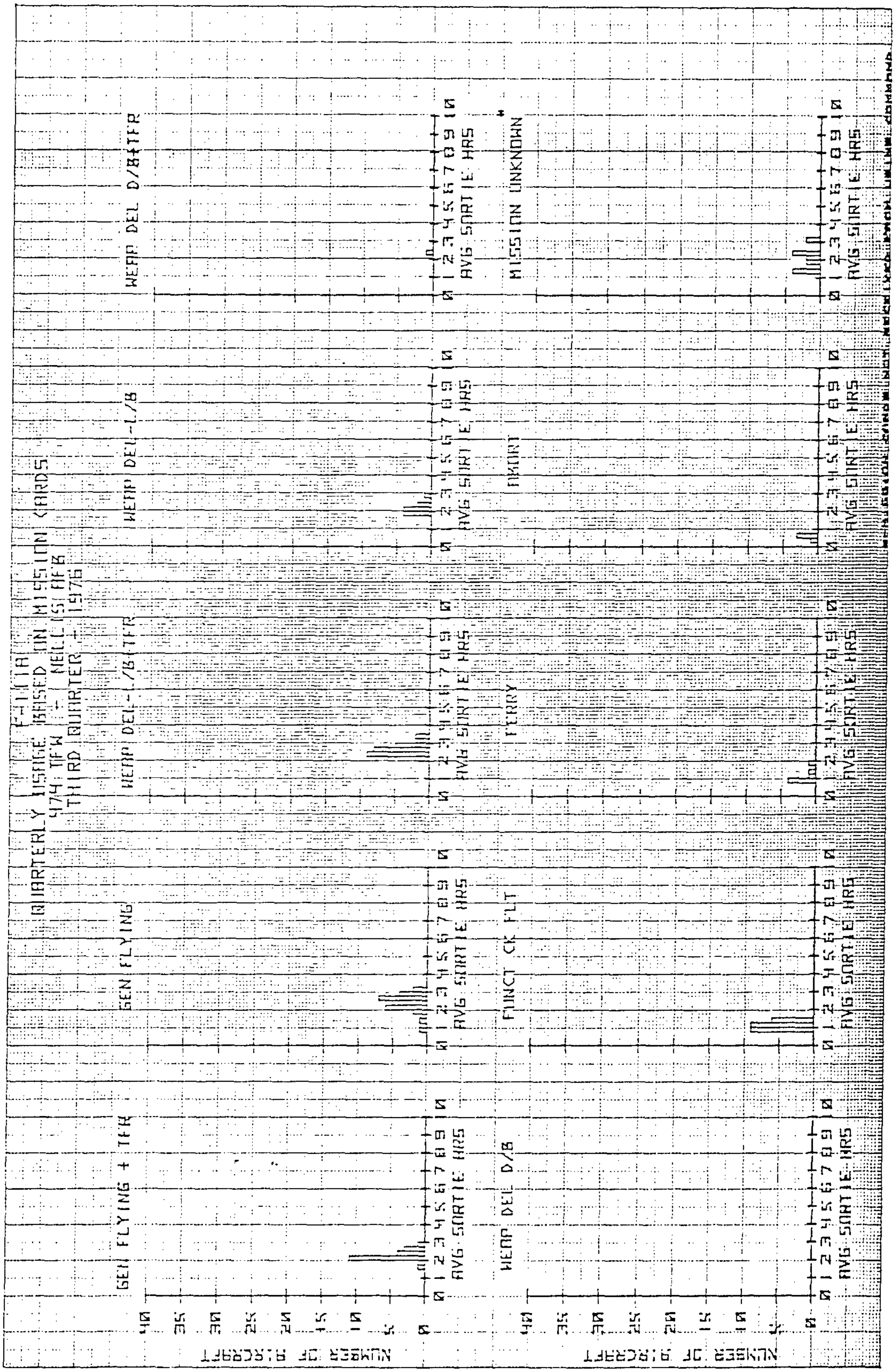
ATTACHMENT B to F-111



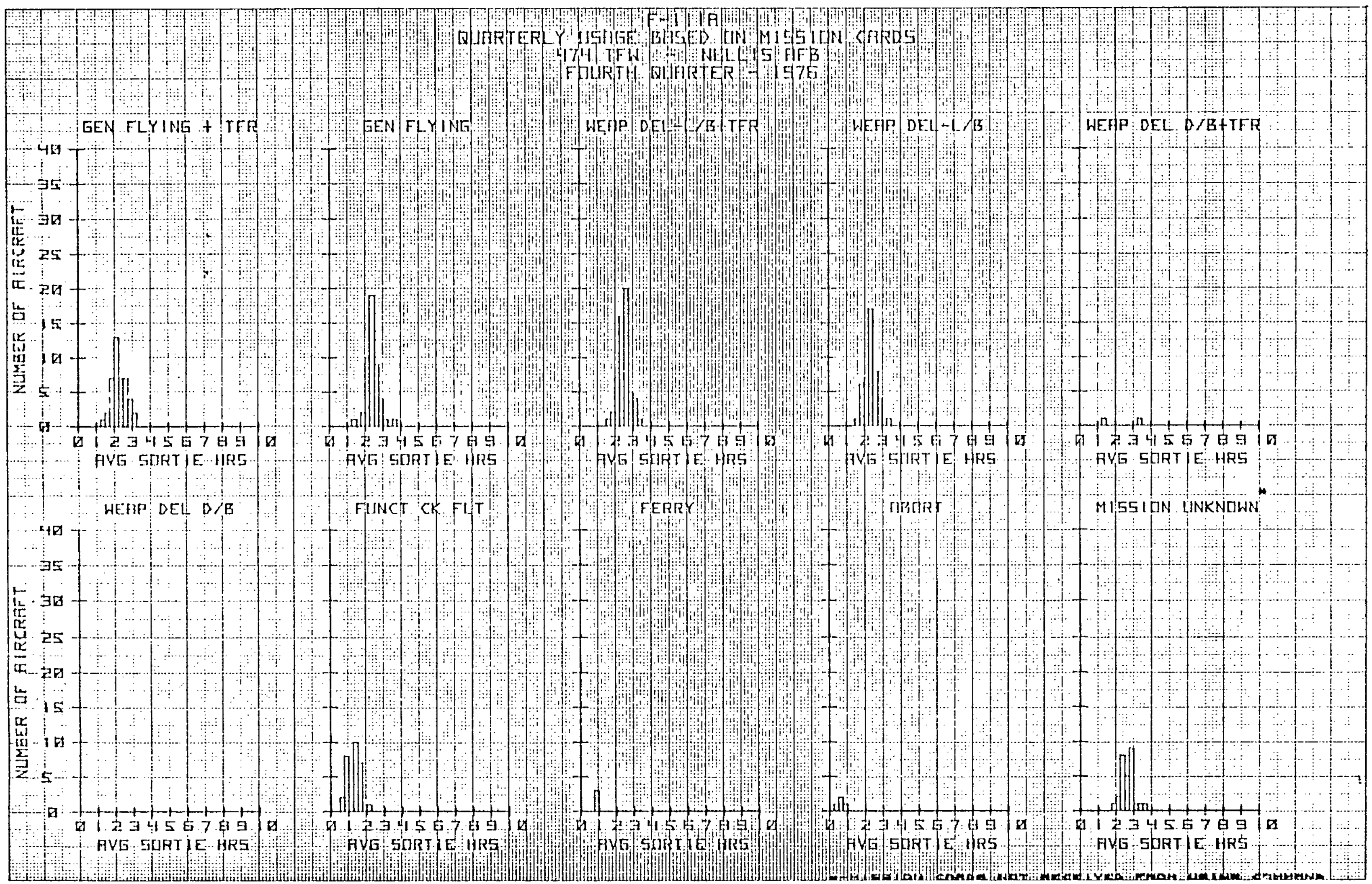
ATTACHMENT B TO F-111



Attachment B to F-111



Attachment B to F 111



## 3.2 MULTICHANNEL RECORDER SYSTEM

The Multichannel Recorder installation consists of an A/A24U-6 Signal Data Recording Set and associated source transducers. The system is manufactured by Whittaker Corporation/Dynasciences Division and is installed on approximately 18% of the fleet aircraft. Recorders are located in the right hand forward electronics bay on the F-111A/E/F aircraft and in the left hand side of the weapons bay on F-111D and FB-111A aircraft (Figure 3-6).

The Signal Data Recording Set is made up of a Recorder Assembly (P.N. 703055). The Magazine is mechanically and electrically interfaced to the Recorder Assembly. The Recorder receives signals from the source transducers, applies appropriate signal conditioning, filtering, sampling and data conversion. The data is recorded on magnetic tape contained within the Magazine. Normal operation of the Recorder is controlled by a switch located in the external power recepticle. Closure of the access door activates input circuits to provide normal aircraft electrical system power to the set. The recorder is turned off when the aircraft electrical system is lost or turned off. In addition, the Recorder will automatically shut off when the Magazine tape is expended.

The recorded parameters are listed along with sampling rate and signal type in Table 3-4 and general locations of sensors are shown in Figure 3-7. All data items are derived from aircraft system sensors except for the three-axis linear accelerations, spoiler positions, sink rate radar, and landing gear strut pressures. These items are obtained from peculiar transducers installed as a part of the Recorder System Installation.

Data is recorded on the Magazine 30 track magnetic tape in digital form as a seven bit word (i.e., 6 bit word plus odd parity). The data is recorded in four 7 track parallel channels occupying tracks 2 thru 29. Tracks 1 and 30 are reserved for frame reference. The Recorder generates a total of 240 data samples per second with individual sampling rates varying in accordance with pre-determined logic internal to the Recorder.

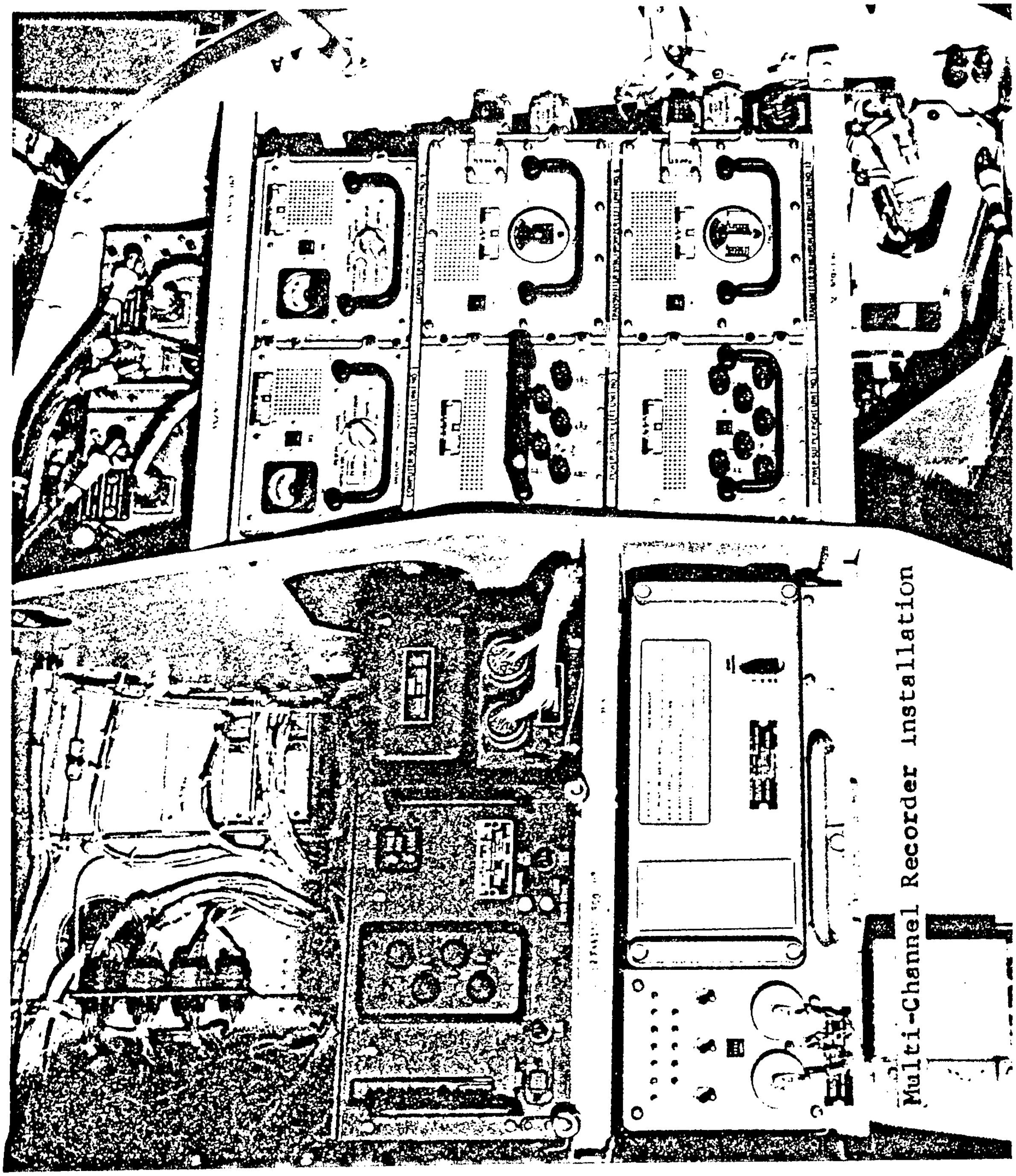
The Magazine has an approximate recording capacity of 25 hours. When the tape supply is expended or after a specific number of flights, the Magazine is removed from the aircraft in accordance with TOs 1F-111A-2-1-2 and 1F-111A(B)-2-1-2 (References 1 and 2 ) and transcribed to a 7 track computer compatible magnetic field data tape through use of a Signal Data

Converter. The Magazine is then reinstalled in the Signal Data Recording Set for recording additional MCR data.

Photographs of the Airborne Signal Data Recording Set installation and some of the sensor locations as installed on an F-111F aircraft are presented in Figures 3-8 thru 3-17.

ATTACHMENT C TO F-111

FZS-12-12014




Multi-Channel Recorder Installation
Electronics Bay
FIGURE 3-8

| SIGNAL TYPE | PARAMETER | SAMPLE RATE (Samples/Sec) | PARAMETER RANGE | WIDTH |
|---|---|---|---|---|
| Synchro (3 Wire AC) | Pressure Altitude | 1 | 0 to 80K ft | 0.2 Hz |
| | Wing Position | 1 | 16 to 72.5 | 0.2 |
| | Flaps Position | 1 | 0 to $40^0$ | 0.2 |
| | Left Horizontal Tail Position | 15 | -20 to $+30^0$ | 3.0 |
| | Right Horizontal Tail Position | 15 | -20 to $+30^0$ | 3.0 |
| | Rudder Position | 15 | -30 to $+30^0$ | 3.0 |
| | Left Spoiler Position<br>Right Spoiler Position | 30<br>30 | 0 to $45^0$<br>0 to $45^0$ | 6.0 |
| | Attack Angle | 5 | -9 to $+25^0$ | 1.0 |
| Gyro (1 Wire AC) | Yaw Rate | 15 | -50 to $+50^0$/Sec | 3.0 |
| | Pitch Rate | 15 | -50 to $+50^0$/Sec | 3.0 |
| | Roll Rate | 15 | -200 to $+200^0$/Sec | 3.0 |
| Accelerometer (DC) | X Axis Acceleration | 10 | -2 to +2 g | 2.0 |
| | Y Axis Acceleration | 15 | -2 to +2 g | 3.0 |
| | Z Axis Acceleration | 30 | -3 to +9 g | 6.0 |
| Strain Gage (DC) | Nose Landing Gear Oleo | 15 | 0 to 5000 psi | 3.0 |
| | Left Landing Gear Oleo<br>Right Landing Gear Olio | 1<br>1 | 0 to 5000 psi<br>0 to 5000 psi | 0.2 |
| Indicator Potentiometer (AC) | Left Engine Fuel Flow<br>Right Engine Fuel Flow | 1<br>1 | 0 to 80K lbs/hr<br>0 to 80K lbs/hr | 0.2 |
| Indicator Potentiometer (DC) | Outside Air Temperature | 1 | -50 to $+250^0$C | 0.2 |
| Radar (DC) | Vertical Sink Speed | 5 | 0 to 20 fps | 1.0 |
| CADC (DC) | Mach Number | 1 | 0 to 2.80 | 0.2 |
| Switch | Landing Gear Position (Up and Locked) | ½ | Discrete (0 to 28 VDC) | N/A |

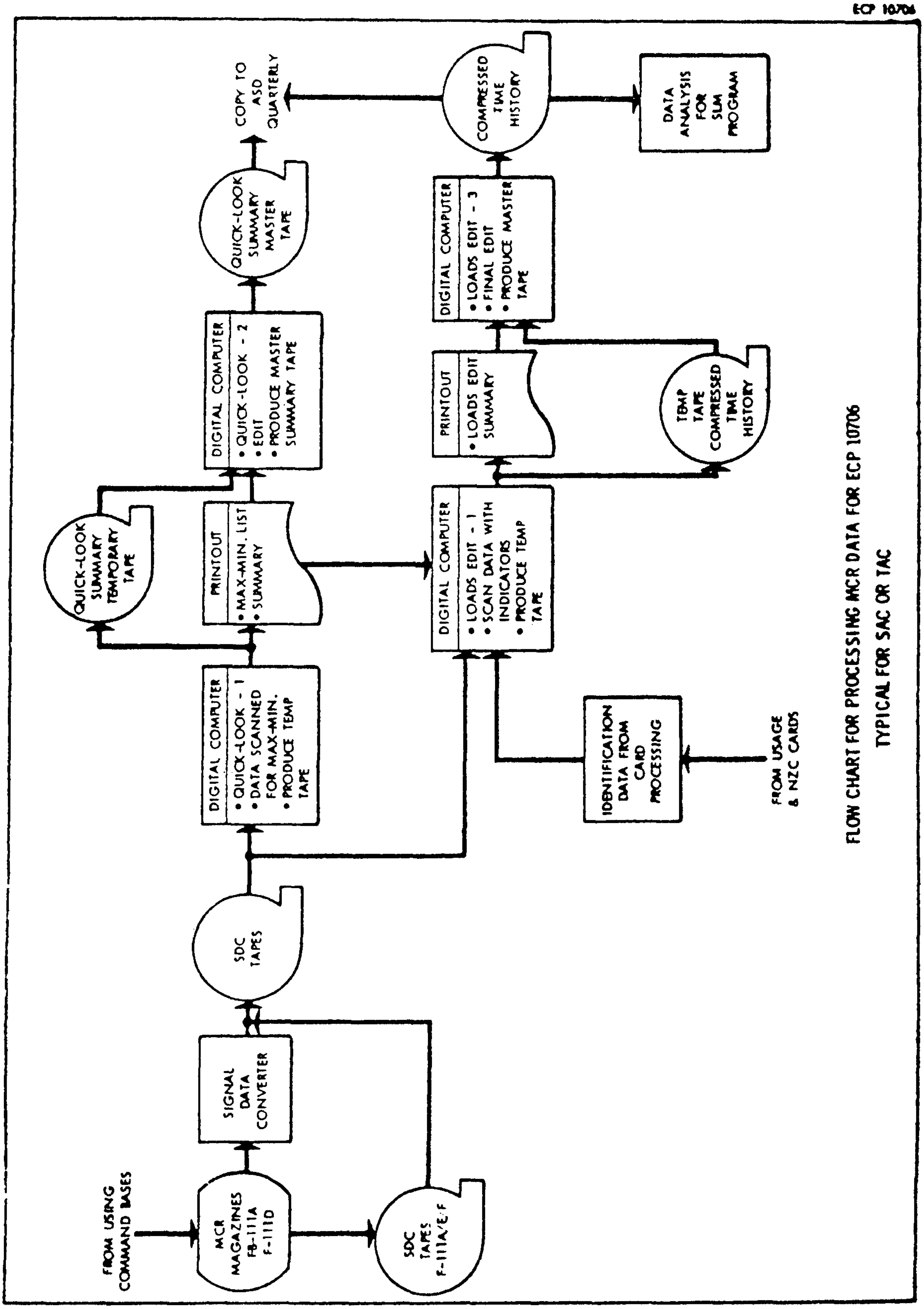
SERVICE LIFE MONITORING
RECORDED PARAMETERS (AIRBORNE RECORDER SYSTEM)

TABLE 3-4

Attachment E to F-111



ECP 10706




FLOW CHART FOR PROCESSING MCR DATA FOR ECP 10706
TYPICAL FOR SAC OR TAC

FIGURE 2-15

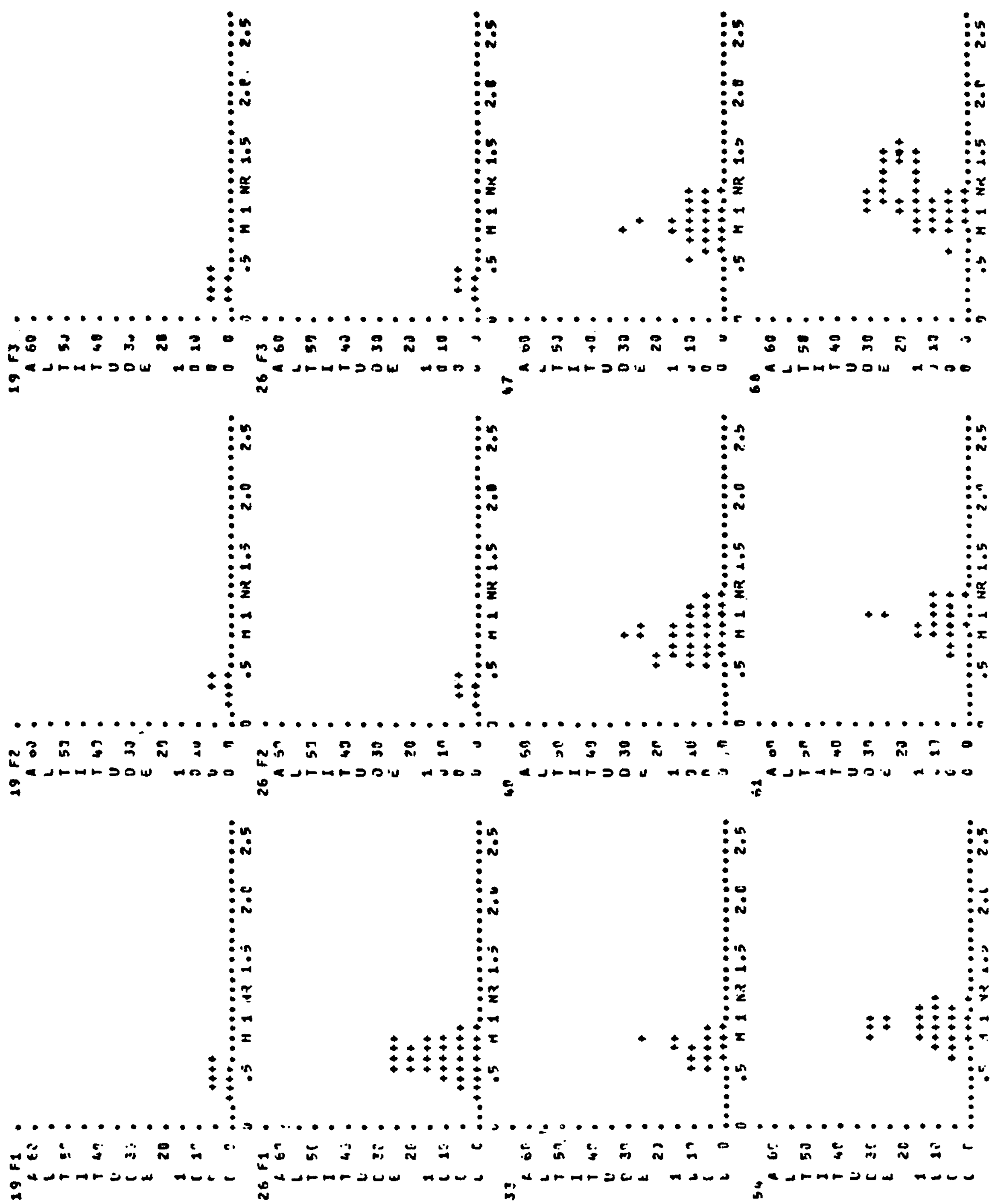
FW72-468-16 3329
22 SEP '72

ATTACHMENT F TO F-111



FIGURE 2-19 (Sheet 3 of 5)

QUICK LOOK SUMMARY PRINTOUT

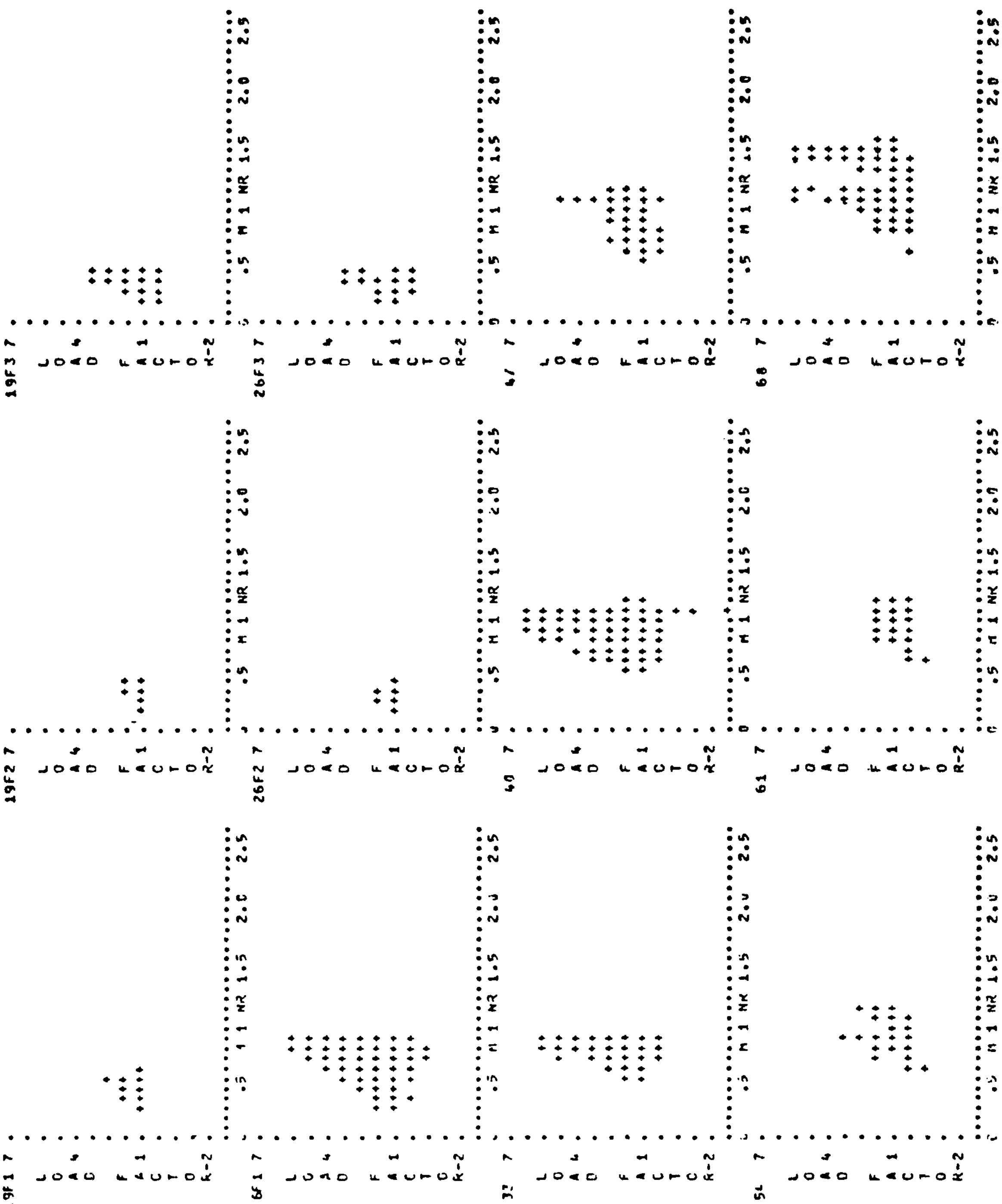


ATTACHMENT F TO F-111

FZS-12-12014

FIGURE 2-19 (Sheet 4 of 5)

QUICK LOOK SUMMARY PRINTOUT



ATTACHMENT F TO F-111

FIGURE 2-21 (Sheet 1 of 4)
LOADS EDIT PRINTOUT

FZS-12-12014

CAL FACTOR CHANGE, GROUND AND FLIGHT: NZ, NY, NX, DR, HTL, HTR, SPL, SPR, P, Q, R, FFL, FFR, IRFF, MGPL, MGPR

| NZ | NY | NX | DR | HTL | HTR | SPL | SPR | P | Q | R | FFL | FFR | IRFF | MGPL | MGPR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -1 | -1 | -2 | 1 | 0 | 0 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| TAILNR | BASE | SQUAD | M. TYPE | PROFILE | TOGW | CONFIG | FLT HRS | FLT DATE | ST REC | SP REC |
|---|---|---|---|---|---|---|---|---|---|---|
| 660057 | 11 | 0 | 10000 | 92111 | 82000 | 2000010000 | 988 | 16- 5-2 | 1127 | 1874 |

TOTAL MISSION FLIGHT HOURS = 1.58 SUPERSONIC TIME (HRS) = .08

TOTAL ENG HRS = 2.28 TOTAL HRS WNG FWD = 1.49 TOTAL HRS WNG AFT = .09

TOTAL FUEL USED (EST. IN LBS) =29268.7 LNDG GW = 55000.0

MISSION SEQ NR = 1 FILE REC NR = 17 NR OF REJ OR BAD REC = 0 NR OF REC BUFFER OUT = 1 TO 17

MAIN GEAR EXTENSIONS AND RETRACTIONS (TOTAL NR) = 8

LEFT SPOILER CYCLES +/-2.8 DEG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.8 | 8.4 | 14.0 | 19.6 | 25.3 | 30.9 | 36.5 | 42.1 |
| 32 | 9 | 4 | 1 | 5 | 3 | 0 | 4 |

RIGHT SPOILER CYCLES +/-2.8 DEG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.8 | 8.4 | 14.0 | 19.6 | 25.3 | 30.9 | 36.5 | 42.1 |
| 5 | 5 | 9 | 3 | 6 | 0 | 0 | 5 |

RUDDER CYCLES +/-.9 DEG

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -29.0 | -27.2 | -25.3 | -23.5 | -21.6 | -19.7 | -17.9 | -16.0 | -14.1 | -12.2 | -10.3 | -9.5 | -6.5 | -4.7 | -2.8 | -1.0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 2 | 0 | 6 | 12 | 0 |
| 1.0 | 2.9 | 4.7 | 6.6 | 8.5 | 10.3 | 12.2 | 14.1 | 16.0 | 17.8 | 19.7 | 21.6 | 23.5 | 25.3 | 27.2 | 29.0 |
| 0 | 18 | 21 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

HOR TAIL DIFFERENTIAL CYCLES +/-.75 DEG

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -48.4 | -46.9 | -45.3 | -43.7 | -42.2 | -40.6 | -39.1 | -37.5 | -35.9 | -34.4 | -32.8 | -31.2 | -29.7 | -28.1 | -26.5 | -25.0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -23.4 | -21.9 | -20.3 | -18.7 | -17.2 | -15.6 | -14.0 | -12.5 | -10.9 | -9.3 | -7.8 | -6.2 | -4.7 | -3.1 | -1.5 | 0.0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 3 | 10 | 15 | 33 | 0 | 0 | 0 |
| 1.5 | 3.1 | 4.7 | 6.2 | 7.8 | 9.3 | 10.9 | 12.5 | 14.0 | 15.6 | 17.2 | 18.7 | 20.3 | 21.9 | 23.4 | 25.0 |
| 0 | 9 | 24 | 13 | 7 | 6 | 2 | 3 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 26.6 | 28.1 | 29.7 | 31.2 | 32.8 | 34.4 | 35.9 | 37.5 | 39.1 | 40.6 | 42.2 | 43.7 | 45.3 | 46.9 | 48.4 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

```
TO W CYC = 07700000000000000000000000000000000000000000000000000000000000000000000000000002  NR=  2
MI W CYC = 01144113311773377337733110011331000000000000000000000000000000000000000000000020  NR= 15
LG W CYC = 17744007000000000000000000000000000000000000000000000000000000000000000000000004  NR=  4

TO F CYC = 05000000000000000000000000000000000000000000000000000000000000000000000000000001  NR=  1
MI F CYC = 50665005060600000000000000000000000000000000000000000000000000000000000000000006  NR=  6
LG F CYC = 60605000000000000000000000000000000000000000000000000000000000000000000000000003  NR=  3
```

FIGURE 2-21 (Sheet 2 of 4)
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NOSE GEAR PRESSURE CHANGES MATRIX +/-80.PSI

| 90. | 235. | 392. | 548. | 704. | 860. | 1017. | 1173. | 1329. | 1485. | 1642. | 1798. | 1954. | 2110. | 2267. | 2423. | 2579. | 2735. | 2892. | 3048. | 3204. | 3360. | 3517. | 3673. | 3829. | 3985. | 4142. | 4298. | 4454. | 4610. | 4767. | 4923. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | X | 634 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | X | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | X | 25 | 6 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | X | 45 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 55 | 39 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 63 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *000*000*000*000*000 | | | | | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 1 | 0 | 2*000 | | 27 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1*000 | | 16 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 2 | 4*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 3 | 3*000 | | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1*000*000 | | | *000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 5*000 | | 0 | 4*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 3 | 10*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 1*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 1 | 1*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 1*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| 0 | 0 | 0 | 0*000 | | 0 | 0*000 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X |

LEFT AND RIGHT HOR TAIL DEFLECTION CHANGES MATRICES (LEFT H T IS UPPER RIGHT / RIGHT H T IS LOWER LEFT) +/-1.5 DEG

| -18.4 | -15.3 | -12.2 | -9.1 | -5.9 | -2.8 | 0.3 | 3.4 | 6.5 | 9.7 | 12.8 | 15.9 | 19.1 | 22.2 | 25.3 | 28.4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | X | 3 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 3 | X | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | X | 37 | 9 | 8 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 28 | X | 71 | 15 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 2 | 0 | 8 | 126 | X | 48 | 6 | 5 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 1 | 5 | 22 | 69 | X | 56 | 15 | 0 | 2 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 5 | 9 | 41 | X | 12 | 4 | 1 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 18 | 26 | X | 3 | 2 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 6 | 2 | 5 | X | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | X | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | X | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X |

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FLIGHT AND GROUND CYCLE MATRICES OF WING SWEEPS +/-.9 DEG

| 15.8 | 18.6 | 20.4 | 22.1 | 23.9 | 25.7 | 27.4 | 29.2 | 31.0 | 32.7 | 34.5 | 35.3 | 38.3 | 39.8 | 41.6 | 43.3 | 45.1 | 46.9 | 49.5 | 50.6 | 52.1 | 53.9 | 55.7 | 57.4 | 59.2 | 61.0 | 62.7 | 64.5 | 56.3 | 58.0 | 69.8 | 71.6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | X | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 2 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X |

VERTICAL LOAD FACTOR SPECTRUM

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 3 | 9 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 3 | 13 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 6 | 25 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| 3 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

.24 .72 1.2 1.68 2.17 2.65 +/-.24

LATERAL LOAD FACTOR SPECTRUM

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 12 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 11 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ATTACHMENT F TO F-111

FIGURE 2-21 (Sheet 4 of 4)  FZS-12-12014

LOADS EDIT PRINTOUT

VERTICAL LOAD FACTOR SPECTRUM

| | | | | |
|---|---|---|---|---|
| 8.05 | 0 | C | | 0 |
| 7.50 | 0 | | | 0 |
| 7.12 | 0 | | GT | 0 |
| 6.56 | 0 | C | | 0 |
| 6.00 | 1 | | | 0 |
| 5.43 | 2 | | GT | 0 |
| 5.06 | 2 | C | | 1 |
| 4.50 | 4 | | | 1 |
| 3.93 | 5 | | GT | 1 |
| 3.55 | 5 | C | | 1 |
| 3.00 | 9 | C | GT | 1 |
| 2.44 | 14 | | GT | 1 |
| 2.05 | 19 | | | 2 |
| 1.68 | 35 | | | 3 |
| .55 | 21 | C | | 3 |
| .37 | 7 | | GT | 1 |
| .00 | 2 | | | 0 |
| -.56 | 0 | | | 0 |
| -1.11 | 0 | | | 0 |
| -1.68 | 0 | | | 0 |
| -2.25 | 0 | | | 0 |
| | 0-50.4 | | | 50.5-72.5 |

LATERAL LOAD FACTOR SPECTRUM

| | | |
|---|---|---|
| -.56 | 3 | 1 |
| -.50 | 5 | 1 |
| -.44 | 5 | 1 |
| -.38 | 6 | 1 |
| -.31 | 6 | 1 |
| -.25 | 6 | 1 |
| -.19 | 8 | 1 |
| -.13 | 15 | 1 |
| .13 | 15 | 1 |
| .19 | 11 | 1 |
| .25 | 6 | 1 |
| .31 | 4 | 1 |
| .38 | 3 | 1 |
| .44 | 2 | 1 |
| .50 | 1 | 1 |
| .56 | 0 | 1 |

| VERTICAL LOAD FACTOR SPECTRUM | | GW>65K FP UP | FP PL | FP DN | GW<65K FP UP | FP PL | FP DN |
|---|---|---|---|---|---|---|---|
| 8.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.00 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5.43 | 2 | 0 | 0 | 0 | 2 | 0 | 0 |
| 5.06 | 3 | 1 | 0 | 0 | 2 | 0 | 0 |
| 4.50 | 5 | 3 | 0 | 0 | 2 | 0 | 0 |
| 3.93 | 6 | 4 | 0 | 0 | 2 | 0 | 0 |
| 3.56 | 6 | 4 | 0 | 0 | 2 | 0 | 0 |
| 3.00 | 10 | 6 | 0 | 0 | 3 | 0 | 1 |
| 2.44 | 15 | 7 | 0 | 0 | 5 | 0 | 3 |
| 2.06 | 21 | 11 | 0 | 0 | 7 | 0 | 3 |
| 1.68 | 38 | 20 | 0 | 0 | 14 | 0 | 4 |
| .56 | 24 | 11 | 0 | 0 | 11 | 0 | 2 |
| .37 | 8 | 5 | 0 | 0 | 1 | 0 | 2 |
| .00 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| -.56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1.68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -2.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

LATERAL LOAD FACTOR SPECTRUM

| | |
|---|---|
| -.56 | 4 |
| -.50 | 6 |
| -.44 | 7 |
| -.38 | 7 |
| -.31 | 7 |
| -.25 | 7 |
| -.19 | 9 |
| -.13 | 16 |
| .13 | 16 |
| .19 | 12 |
| .25 | 7 |
| .31 | 5 |
| .38 | 4 |
| .44 | 3 |
| .50 | 2 |
| .56 | 1 |

NR. OF TOUCHDOWNS = 3

(0 IS VSS MEAS; NOT 0 IS VSS ESTIMATED) = 0

VSS1 THRU VSSNRLG (IN FT PER SEC) = , 3.6, 1.4, 4.5,

TAPE USED IS 0.0 TO 8.7 FEET

NR OF TARE LOADS = 507

Attachment G to F-111

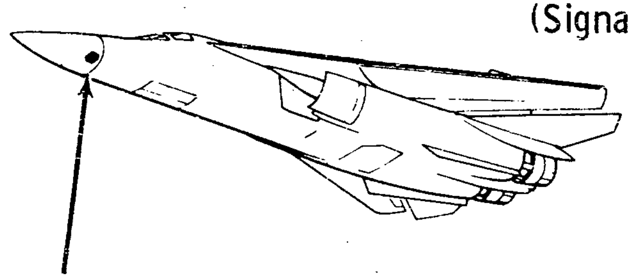
FZS-12-12014

# SERVICE LIFE MONITORING

## PROGRAM HARDWARE

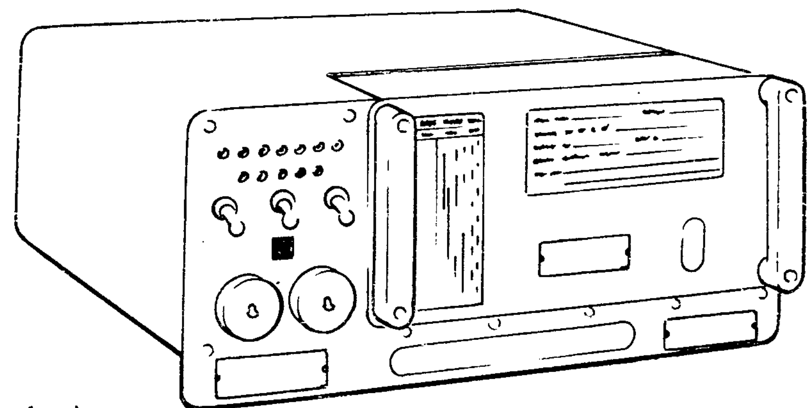
## AIRBORNE MULTI-CHANNEL RECORDER

(Signal Data Recording Set)



- F-111D LOCATION - WEAPONS BAY L H SIDE
- FB-111A - WEAPONS BAY L H SIDE
- F-111A/E/F - R H FWD ELECTRONICS BAY
- NUMBER - Approximately 20% of Aircraft in Each Operational Wing
- RECORDS
  - Airplane Configuration Parameters (Geometry)
  - Flight Parameters
  - Airplane Motion
  - Control Surface Positions
  - Engine Fuel Flows
  - Gear Strut Pressures

AIRBORNE RECORDER



FW74-468-VG5872A
6 May '74

FIGURE 2-4

# SERVICE LIFE MONITORING PROGRAM PROCEDURES

## F-111 AIRBORNE RECORDER DATA COLLECTION

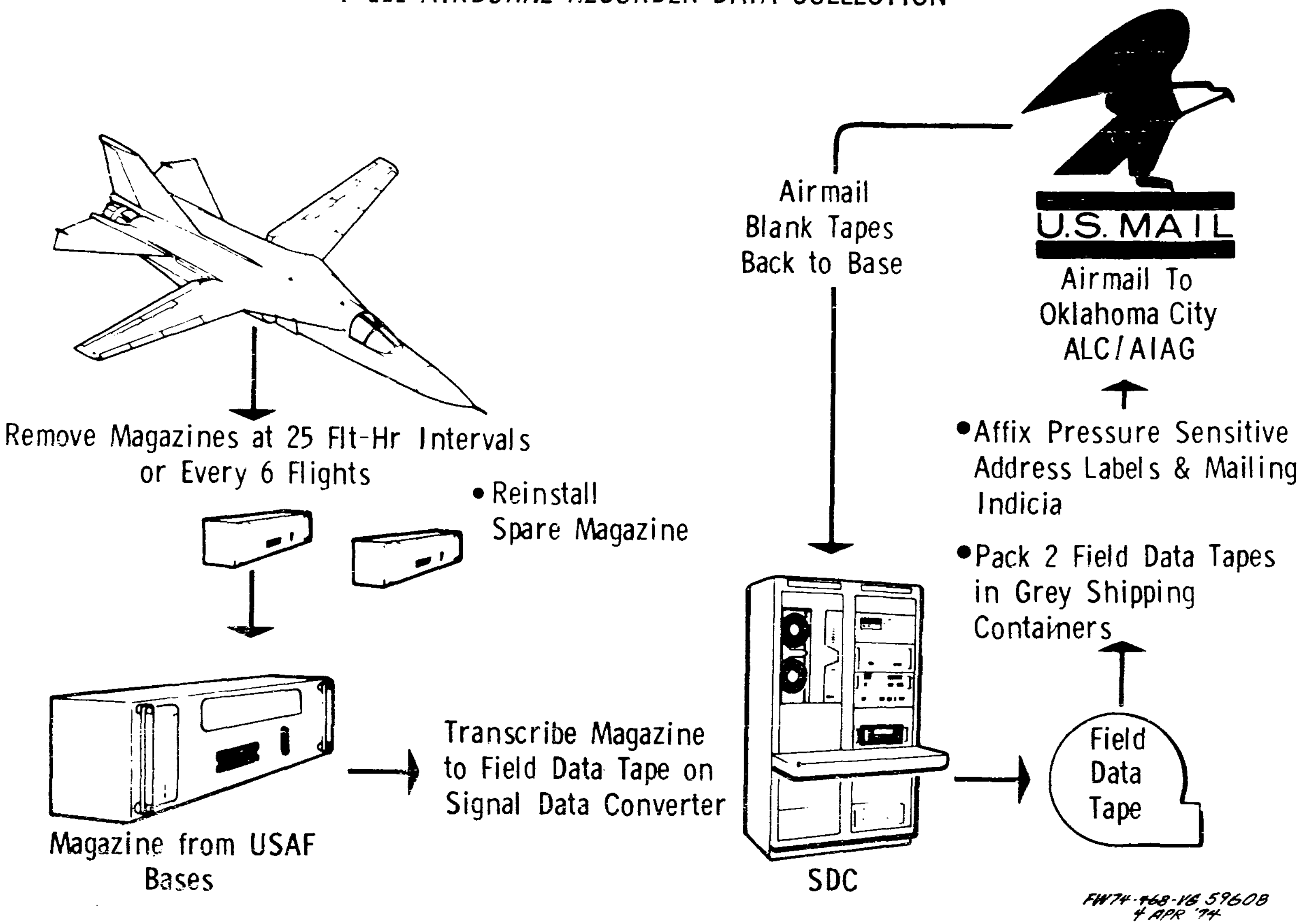
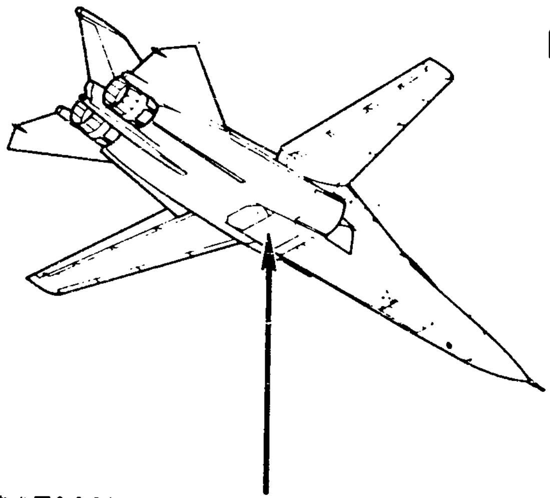



FIGURE 2-5

# SERVICE LIFE MONITORING

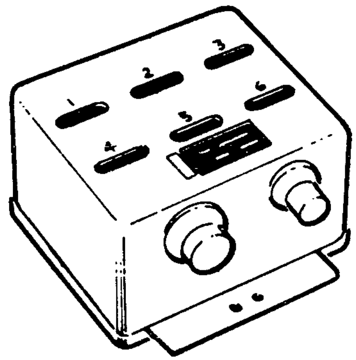
● PROGRAM HARDWARE

F-111A/E AIRCRAFT

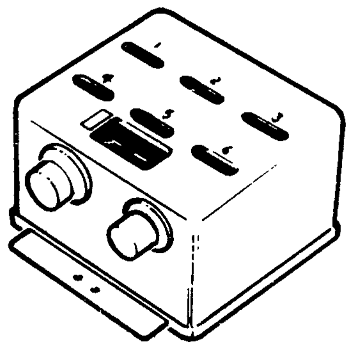


- **LOCATION**
  - Main Landing Gear Wheel Well
- **NUMBER**
  - Every Airplane
- **RECORDS**
  - Load Factor Exceedances of:
    - One Negative "g" Level
    - Five Positive "g" Levels

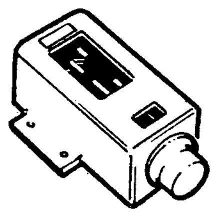
"CONRAC"
COUNTING ACCELEROMETERS



● Wing Forward Indicator



● Wing Aft Indicator



● Transmitter

FW74-468-NC5938A
29 MAR 1974

FIGURE 2-6

ATTACHMENT G TO F-111

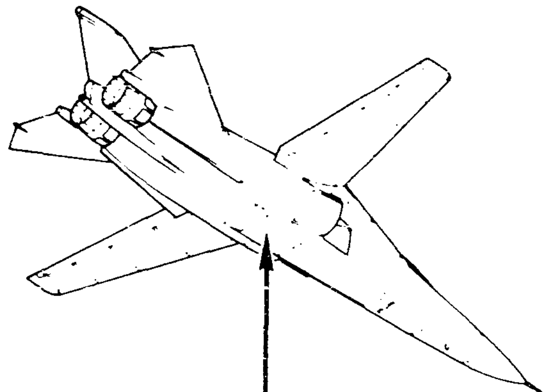
FZS-12-12014

# SERVICE LIFE MONITORING

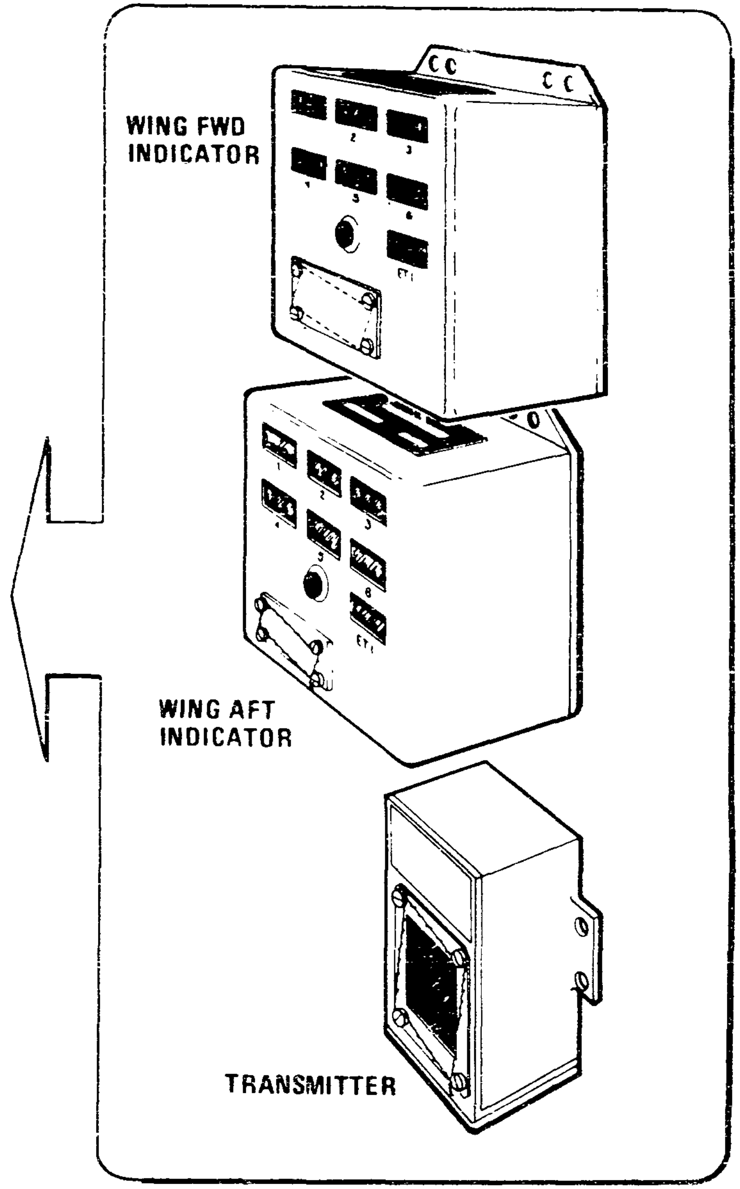
## PROGRAM HARDWARE

## "GENERAL TIME" COUNTING ACCELEROMETERS

## F-111D, F-111F & FB-111A Aircraft



- LOCATION
  - Main Landing Gear Wheel Well
- NUMBER
  - Every Airplane
- RECORDS
  - Load Factor Exceedances of:
    - One Negative "g" Level
    - Five Positive "g" Levels
  - Time in Flight




FW 75-468-VG 6276 A
10-OCT-'75

FIGURE 2-7

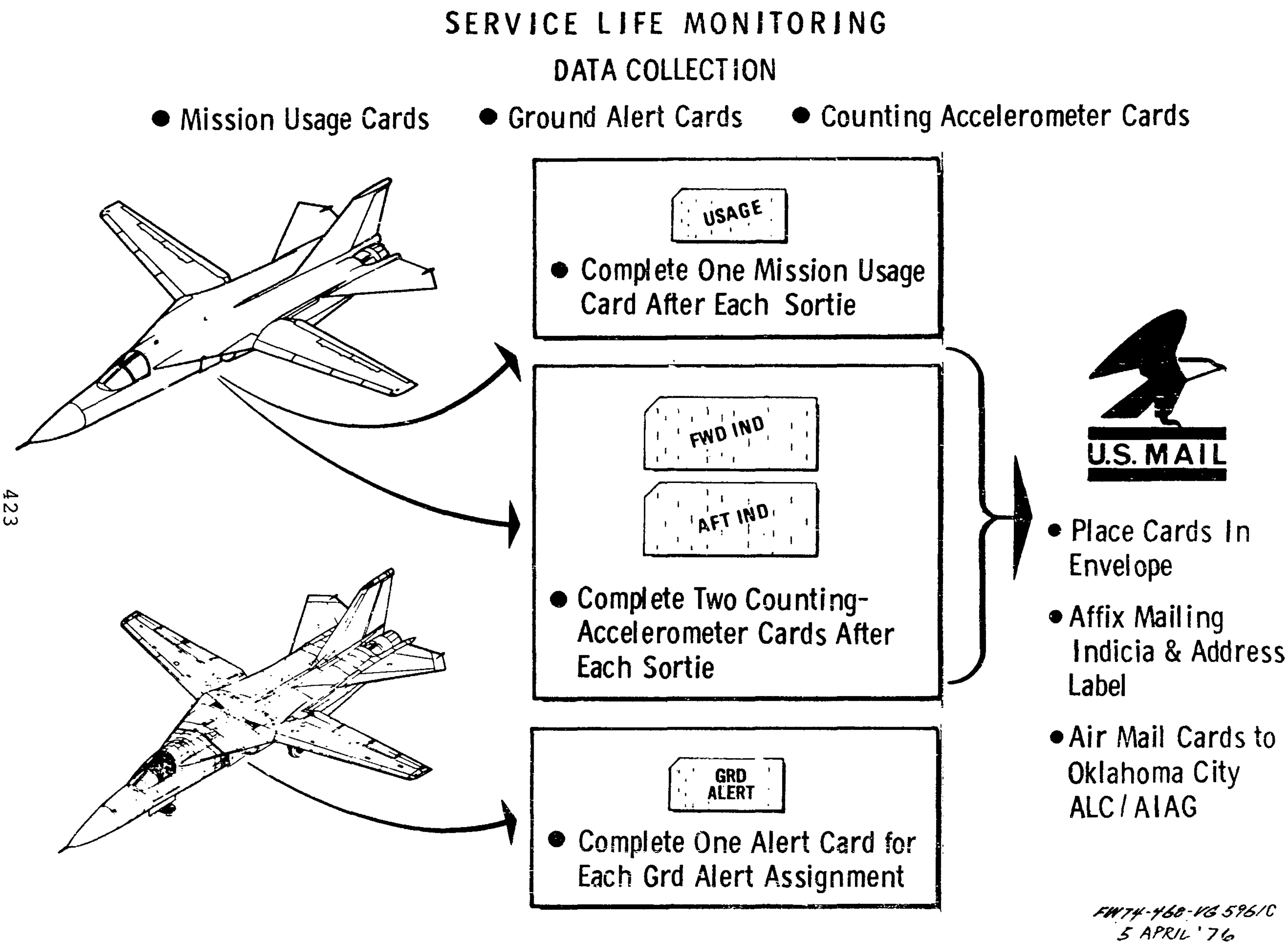

SERVICE LIFE MONITORING
DATA COLLECTION
● Mission Usage Cards
● Ground Alert Cards
● Counting Accelerometer Cards
USAGE
● Complete One Mission Usage Card After Each Sortie
FWD IND
AFT IND
● Complete Two Counting-Accelerometer Cards After Each Sortie
GRD ALERT
● Complete One Alert Card for Each Grd Alert Assignment
U.S. MAIL
● Place Cards In Envelope
● Affix Mailing Indicia & Address Label
● Air Mail Cards to Oklahoma City ALC/AIAG
FW74-468-VG 596/C
5 APRIL '76

FIGURE 2-8

# STATE-OF-THE-ART REVIEW
# FORCE MANAGEMENT METHODS

A/C TYPE: FB-111A

## FLEET INFORMATION

NO. OF AIRCRAFT: 67 : YEAR SERVICE BEGAN: 1971

SYSTEM MANAGEMENT: Sacramento ALC

DATE TRANSFERRED TO AFLC: 1974

USING COMMAND: SAC

PRIMARY BASE: Pease AFB, Plattsburg AFB

PRIMARY MISSION TYPES: Low-Alt. High-speed (with and w/o TFR)

REMARKS:

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | x | | |
| FULL-SCALE CYCLIC TEST: | x | | |
| FULL-SCALE STATIC TEST: | x | | |
| DAMAGE TOLERANCE TESTS: | | | F/FB 111 Recovery |
| DADTA INITIAL: | - | | Pgm |
| STRENGTH SUMMARY: | x | | |
| TRACKING SYSTEM DESIGN: | x | | |
| L/ESS DESIGN: | x | | |
| FSM PLAN: | x | x | Continuous |
| BASELINE OPS SPECTRA: | | x | |
| DADTA-FINAL: | - | Planned but not scheduled. | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | SLM Plan ECP 2312 | GD/FW |
| DAMAGE TOLERANCE ANALYSIS: | FZM-12-13467 | GD/FW |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| FB-111A Final Fatigue Analysis | FZS-12-6087 | GD/FW |
| FB-111A SLM Report | FZS-12-6066 | GD/FW |
| FB-111A UDD Airframe/Landing Gear | FZS-1206963 | GD/FW |
| MSG-2 Revision to T.O.-6 | | Available June/July 78 |

IAT PROGRAM

ANALYSIS METHOD: 1) Individual airplane usage-tracked "by" using usage card 2) Individual airplane maneuver activity-NZC counting accelerometer 3) Individual airplane ground alert activity-grnd/alert activity card

APPLICABLE REPORT: FZM-12-6531

DATA COLLECTION: RECORDER: ________ FORM: See Attach. (1) (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: Flight/Flight :TECH.ORDERS: ________

DATE STARTED: ________ HRS.RECORDED *71428 % USABLE DATA: *95

DATA COLLECTION PROBLEMS: NZC Recorder malfunctions, and missing NZC cards

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Usage cards are compared to the operations log

TECHNIQUE TO RECOVER MISSING DATA: None

LIST PROCESSING STEPS: 1) Review and edit card data 2) prepare magnetic tape of card information sorted by T/N, date of flight and end of flight hours.

OUTPUT CONTENTS (ATTACH SAMPLES): See Attachment (2)

LIST PERMANENT FILES: RAW DATA? Magnetic Tape

PROCESSED DATA? Magnetic Tape

WHO EVALUATES OUTPUT? ASIMIS/GD/FW

APPLICATIONS: SCHEDULING? Yes-Mods & component replacements

ANALYSIS UPDATE? SLM, usage model, NZ spectra, base usage

TO DETECT CHANGE IN USAGE? Data is compared on an annual basis

REMARKS: Generate damage for - 20 mission types (pre-computed) Usage comes from cards (Attach #2). NZC are not used for IAT purposes.

*USAGE CARD INFORMATION

L/ESS PROGRAM

ANALYSIS METHOD: Response parameters are recorded during FB-111 fleet activity. This information is used in conjunction with load Eq's developed thru use of regression analysis techniques to compute loads spectra.

APPLICABLE REPORT: FZM-12-6531

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 10 RECORDING DEVICE: Attachment(3) (Attach Descriptio

PARAMETERS RECORDED: ATTACHMENT (3) (Attach List

L/ESS START/STOP DATES: 1 Jan 74 HRS. RECORDED: 470(Usable)

% USABLE DATA: 10 DATA RETRIEVAL FREQ. 5Flts/Mag.

DEFINITION OF USABLE DATA: Suitable for solution of load Eq's

COLLECTION PROBLEMS: recorder & sensor malfunction's failure of SAC personnel to remove Mag's

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? Response trends & exceedance spectra

LIST STEPS: (1) Quick Look (2) Loads edit - develops and stores on magnetic tape a compressed time history (Peak search)

TECHNIQUE TO RECOVER MISSING PARAMETERS: -

OUTPUT CONTENTS (Attach Sample): See Attachment (4)

LIST PERMANENT FILES: RAW DATA? Field data tapes

PROCESSED DATA? Loads edit summary tapes

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:

Flight-by-flight sequence not used

TO CHECK IAT DATA?

TO DETECT CHANGE IN USAGE? Compare results from the annual updates

REMARKS:

A/C TYPE: FB-111A (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: Fatigue test & force experiences; MSG-2 analysis. Proof tests are scheduled for individual aircraft based on fracture analyses by model.

INSPECTION INTERVALS: Isochronals at 125 hrs. & 250 hrs. PDM interval based on mod incorporations per T.O. 00-25-4, Table I; will go to 48 mo. Cycle per Table II. PDM/ACI & crew module pyrotechnics done at SM-ALC

RANGE OF CRITICAL CRACK LENGTHS: Approx. .02" in D6AC steel

SPECIAL COMPONENT INSPECTIONS: No component tracking program - Trace system for wings would be desirable.

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS: AFM 66-1 is not useful for ASIP. Feedback is desirable for some special inspections. Requirements for feedback is included in TCTO or T.O. -6 procedures where possible.

APPLICABLE DOCUMENTS: Tech Orders

A/C TYPE: FB-111A (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS:

IAT-FSM INTERFACE: IAT not used to schedule FSM actions.

L/ESS-IAT INTERFACE: L/ESS recorder provides the unit damage rates used in IAT to calculate individual aircraft damage.

ORGANIZATIONAL CHANGES PENDING: All SLMP functions except analysis of L/ESS recorder data are being transferred to ASIMIS.

AFLC/ALD INTERFACE: None on F/FB-111 SLMP

COMMONALITY WITH OTHER SYSTEMS: Whittaker MCR is unique to F/FB-111. A-10 uses General Time counting accelerometer systems.

METHODS WHICH HAVE WORKED WELL: 1) Early involvement of AFLC ASIP engineer with SPO; 2) Effective AFLC/contractor and AFLC/user interfaces

DEFICIENCIES IN CURRENT METHODS: 1) Lack of understanding by ASD of AFLC problems & procedures. 2) Separation of ASIP & maintenance organizations at contractor, SPO, and AFLC.

DEPARTMENT 05
FWP 2645-1-71

ATTACHMENT (1)

## FLIGHT USAG CARD AFTO FORM 462

| MISSION | A/P TAIL NO. (LAST 3) | FLT DATE: DAY | MO | YEAR | W.T. + | TAKEOFF CONFIG. W(2)P W(3)P W(4)P | W(L) W(R) | FLIGHT HOURS: TOT ON A/P AT END OF FLT. (EOF) | THIS FLT. 10+ | A R | LOW-ALT HIGH-SPEED: W T + | OB ROUTE + LAHS | FWD ∧ I + II + (T)(D)(T)(D) | AFT ∧ I + II + (T)(D)(T)(D) | NUMBER: TGL | FSL | LA | OR + 10 | +½ DZ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [5] TER | 0 0 0 | 0 | 0 | 0 | 0 | P P P | | 0 0 0 | .0 | .0 | 0 | 0 0 | 0 0 0 0 | 0 0 0 0 | 0 | 0 | 0 | 0 | 0 | [7] BARRIER ENGAGEMENT |
| RT [1] | 1 1 1 | 1 1 | 1 | 1 | 1 | 1 1 1 | 1 1 | 1 1 1 1 | 1 .1 | .1 | 1 | 1 1 1 | .1 1 .1 1 | .1 1 .1 1 | 1 | 1 | 1 | 1 | 1 | |
| IT [2] | 2 2 2 | 2 2 | 2 | 2 | 2 | 2 2 2 | 2 2 | 2 2 2 2 | 2 .2 | .2 | 2 | 2 2 2 | .2 2 .2 2 | .2 2 .2 2 | 2 | 2 | 2 | 2 | 2 | |
| FCF [3] | 3 3 3 | 3 3 | 3 | 3 | 3 | 3 3 3 | 3 3 | 3 3 3 3 | 3 .3 | .3 | 3 | 3 3 3 | .3 3 .3 3 | .3 3 .3 3 | 3 | 3 | 3 | 3 | 3 | |
| FER [4] | 4 4 4 | 4 | 4 | 4 | 4 | 4 4 4 | 4 4 | 4 4 4 4 | 4 .4 | .4 | 4 | 4 4 4 | .4 4 .4 4 | .4 4 .4 4 | 4 | 4 | 4 | 4 | 4 | |
| ADE [5] | 5 5 5 | 5 | 5 | 5 | 5 | 5 5 5 | 5 5 | 5 5 5 5 | 5 .5 | .5 | 5 | 5 5 5 | .5 5 .5 5 | .5 5 .5 5 | 5 | 5 | 5 | 5 | 5 | [5] EVASIVE MNVRS. |
| TST [6] | 6 6 6 | 6 | 6 | 6 | 6 | 6 6 6 | 6 6 | 6 6 6 6 | 6 .6 | .6 | 6 | 6 6 6 | .6 6 .6 6 | .6 6 .6 6 | 6 | 6 | 6 | 6 | 6 | |
| CBT [7] | 7 7 7 | 7 | 7 | 7 | 7 | 7 7 7 | 7 7 | 7 7 7 7 | 7 .7 | .7 | 7 | 7 7 7 | .7 7 .7 7 | .7 7 .7 7 | 7 | 7 | 7 | 7 | 7 | |
| OTH [8] [8] SCRAM | 8 8 8 | 8 | 8 | 8 | 8 | 8 8 8 | 8 8 | 8 8 8 8 | 8 .8 | .8 | 8 | 8 8 8 | .8 8 .8 8 | .8 8 .8 8 | 8 | 8 | 8 | 8 | 8 | [8] AR EXT. TANKS |
| | 9 9 9 | 9 | 9 | 9 | 9 | 9 9 9 | 9 9 | 9 9 9 9 | 9 .9 | .9 | 9 | 9 9 9 | .9 9 .9 9 | .9 9 .9 9 | 9 | 9 | 9 | 9 | 9 | |

Column legends (printed vertically): LEFT WING HARDPOINTS; WEAPONS BAY; TOTAL HOURS ON AIRPLANE AT END OF FLIGHT (TO CLOSEST HOUR); DURATION THIS FLT. (CLOSEST TENTH HR); WT AT START LOW-ALT; LOC OF LOW-ALT ROUTE; NO. TOUCH AND GO LANDINGS; NO. FULL-STOP LANDINGS; NO. LOW APPROACHES; NO. GEAR RETRACTIONS; FINAL LANDING WEIGHT; TO (3) OBE 3 TOP

UMC26885

SAC FB-111 FLIGHT USAGE CARD

## NZG COUNTING ACCELEROMETER CARD AFTO FORM - 323

| COUNTER READING 1 | 2 | 3 | 4 | 5 | 6 | ETI | IND | AIRPLANE TAIL NR. | FLT. DATE: DAY | MO. | YR. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | [ ] FWD | 0 0 0 0 0 0 | 0 0 | 0 0 | 0 |
| 1 1 1 1 | 1 1 1 1 | 1 1 1 1 | 1 1 1 1 | 1 1 1 1 | 1 1 1 1 | 1 1 1 1 | | 1 1 1 1 1 1 | 1 1 | 1 1 | 1 |
| 2 2 2 2 | 2 2 2 2 | 2 2 2 2 | 2 2 2 2 | 2 2 2 2 | 2 2 2 2 | 2 2 2 2 | | 2 2 2 2 2 2 | 2 2 | 2 2 | 2 |
| 3 3 3 3 | 3 3 3 3 | 3 3 3 3 | 3 3 3 3 | 3 3 3 3 | 3 3 3 3 | 3 3 3 3 | | 3 3 3 3 3 3 | 3 3 | 3 3 | 3 |
| 4 4 4 4 | 4 4 4 4 | 4 4 4 4 | 4 4 4 4 | 4 4 4 4 | 4 4 4 4 | 4 4 4 4 | [ ] AFT | 4 4 4 4 4 4 | 4 4 | 4 4 | 4 |
| 5 5 5 5 | 5 5 5 5 | 5 5 5 5 | 5 5 5 5 | 5 5 5 5 | 5 5 5 5 | 5 5 5 5 | | 5 5 5 5 5 5 | 5 5 | 5 5 | 5 |
| 6 6 6 6 | 6 6 6 6 | 6 6 6 6 | 6 6 6 6 | 6 6 6 6 | 6 6 6 6 | 6 6 6 6 | | 6 6 6 6 6 6 | 6 6 | 6 6 | 6 |
| 7 7 7 7 | 7 7 7 7 | 7 7 7 7 | 7 7 7 7 | 7 7 7 7 | 7 7 7 7 | 7 7 7 7 | | 7 7 7 7 7 7 | 7 7 | 7 7 | 7 |
| 8 8 8 8 | 8 8 8 8 | 8 8 8 8 | 8 8 8 8 | 8 8 8 8 | 8 8 8 8 | 8 8 8 8 | | 8 8 8 8 8 8 | 8 8 | 8 8 | 8 |
| 9 9 9 9 | 9 9 9 9 | 9 9 9 9 | 9 9 9 9 | 9 9 9 9 | 9 9 9 9 | 9 9 9 9 | | 9 9 9 9 9 9 | 9 9 | 9 9 | 9 |

AFTO FORM 323 NOV 71 COUNTING ACCELEROMETER DATA

IBM R64594

## SAC GROUND ALERT USAGE CARD AFTO FORM 463

| A/P TAIL NO. (LAST 3) | BASE | W.T. + | CONFIG. WING W(2)P W(3)P W(4)P | BAY W(L) W(R) | DATE ASSIGNED GND ALERT: DAY | M | YR | DATE REMOVED GND ALERT: DAY | M | YR | NUMBER: TAXI | ENG START | 20-WOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 0 0 | [0] HOME | 0 | P P P | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 0 |
| 1 1 1 | | 1 | 1 1 1 | 1 1 | 1 1 | 1 1 | 1 | 1 1 | 1 1 | 1 | 1 1 | 1 1 | 1 1 |
| 2 2 2 | | 2 | 2 2 2 | 2 2 | 2 2 | 2 | 2 | 2 2 | 2 | 2 | 2 2 | 2 2 | 2 2 |
| 3 3 3 | | 3 | 3 3 3 | 3 3 | 3 3 | 3 | 3 | 3 3 | 3 | 3 | 3 3 | 3 3 | 3 3 |
| 4 4 4 | | 4 | 4 4 4 | 4 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 5 5 5 | [5] | 5 | 5 5 5 | 5 5 | 5 | 5 | 5 | 5 | 5 | 5 | | 5 | 5 |
| 6 6 6 | | 6 | 6 6 6 | 6 6 | 6 | 6 | 5 | 6 | 6 | 6 | | 8 | 6 |
| 7 7 7 | | 7 | 7 7 7 | 7 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 8 8 8 | | 8 | 8 8 8 | 8 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 9 9 9 | | 9 | 9 9 9 | 9 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

Column legends (printed vertically): LEFT WING HARDPOINTS; WEAPONS BAY; NUMBER OF TAXI EXERCISES; NUMBER OF ENGINE START EXERCISES W/O TAXI

(NOT USED FOR IAT)

SAC FB-111 GROUND ALERT USAGE CARD

GENERAL DYNAMICS
Convair Aerospace Division
TABULATION SHEET

ATTACHMENT(2) PG 1/2

SAC FB-111A FLIGHT USAGE CARD DATA    15 AUG 75

| | SQD | MISSION | | DATE | T.O. WT | CONFIGURATION | | | | | FLIGHT HRS TOT EFF | MTS | AR | LOW ALTITUDE-HIGH SPEED WT KLB | RTE | FWD WS | FWD WS | AFT WS | AFT WS | NUMBER T | F | L | G | L WT KLB | EVENT | CAE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 107 | 7 0T | | 25022 | 02 | 1 | TA | 01 | 1 | 1 | 561 | 3.5 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 65 | | 0 |
| 2 | 107 | 7 0T | Y | 28022 | 02 | 1 | TA | 01 | 1 | 1 | 567 | 5.5 | .3 | 82 | 0023 | .1 X 37 .7 | .0 | .2 X 59 .8 | .9 X 59 .8 | 0 | 2 | 3 | 4 | 61 | Y | 1 |
| 3 | 107 | 7 0T | | 29022 | 05 | 01 | TA | 1 | 1 | 1 | 573 | 6.3 | .2 | 90 | 0023 | .3 X 37 .8 | .0 | .0 | .0 | 0 | 1 | 3 | 4 | 60 | Y | 0 |
| 4 | 107 | 7 0T | | 01032 | 02 | 12 | TA | 01 | 1 | 1 | 578 | 5.3 | .3 | 95 | 0023 | .3 X 37 .7 | .0 | .2 X 57 .9 | .0 | 0 | 2 | 0 | 2 | 55 | Y | 0 |
| 5 | 107 | 7 0T | | 01032 | 100 | TA | TA | 01 | 1 | 1 | 582 | 4.0 | .2 | | | .0 | .0 | .0 | .0 | 0 | 1 | 1 | 2 | 82 | Y | 0 |
| 6 | 107 | 7 0T | | 10032 | 02 | 1 | TA | 01 | 1 | 1 | 584 | 1.7 | .3 | | | .0 | .0 | .0 | .0 | | 1 | 0 | 1 | 87 | Y | 0 |
| 7 | 107 | 7 0T | | 10032 | 75 | 1 | T2 | 01 | 1 | 1 | 585 | .7 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 0 | 55 | | 0 |
| 8 | 107 | 7 0T | | 10032 | 85 | 1 | T2 | 01 | 1 | 1 | 585 | .7 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 75 | | 0 |
| 9 | 107 | 7 0T | | 10032 | 72 | 1 | T2 | 01 | 1 | 1 | 588 | 2.3 | .0 | | | .0 | .0 | .0 | .0 | 5 | 2 | 3 | 10 | 55 | | 0 |
| 10 | 107 | 7 0T | | 20032 | 02 | 1 | TA | 01 | 1 | 1 | 593 | 5.2 | .2 | | | .0 | .0 | .0 | .0 | 4 | 2 | 9 | 13 | 62 | | 0 |
| 11 | 107 | 7 0T | | 29032 | 02 | 01 | TA | 1 | 1 | 1 | 599 | 6.0 | .3 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 0 | 65 | Y | 0 |
| 12 | 107 | 7 0T | | 30032 | 02 | 1 | TA | 01 | 1 | 1 | 602 | 3.5 | .3 | | | .0 | .0 | .0 | .0 | 0 | 1 | 1 | 1 | 62 | Y | 0 |
| 13 | 107 | 7 ET | | 03042 | 82 | 1 | 1 | 1 | 1 | 1 | 609 | 6.2 | .4 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 60 | | 0 |
| 14 | 107 | 7 ET | | 16052 | 82 | 1 | 1 | 1 | 1 | 1 | 612 | 2.9 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 60 | | 2 |
| 15 | 107 | 7 ET | | 23052 | 80 | 1 | 1 | 1 | 1 | 1 | 615 | 3.2 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 55 | | 0 |
| 16 | 107 | 7 0T | | 14062 | 102 | TA | TA | 1 | 1 | 1 | 619 | 4.1 | .2 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 82 | Y | 2 |
| 17 | 107 | 7 0T | | 21062 | 102 | TA | TA | W6 | W2 | W2 | 623 | 4.4 | .2 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 87 | Y | 0 |
| 18 | 107 | 7 0T | | 22062 | 101 | TA | TA | 1 | 1 | 1 | 625 | 2.1 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 87 | | 1 |
| 19 | 107 | 7 0T | | 26062 | 102 | TA | TA | 1 | 1 | 1 | 634 | 8.6 | .3 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 87 | | 2 |
| | 195 | 7 0T | | 29022 | 05 | 1 | TA | 01 | 1 | 1 | 497 | 3.3 | .0 | 82 | 0023 | .0 | .0 | .2 X 59 .8 | .0 | 0 | 1 | 0 | 1 | 52 | | 0 |
| | 195 | 7 0T | | 07032 | 102 | TA | TA | 01 | 1 | 1 | 499 | 2.0 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 82 | | 0 |
| | 195 | 7 0T | | 08032 | 02 | 1 | TA | 01 | 1 | 1 | 505 | 6.6 | .3 | 85 | 0023 | .5 X 37 .7 | .7 X 49 .7 | .0 | .0 | 0 | 1 | 0 | 1 | 60 | Y | 0 |
| | 195 | 7 EE | Y | 09032 | 85 | 1 | T2 | 01 | 1 | 1 | 510 | 4.7 | .0 | | | .0 | .0 | .0 | .0 | 2 | 2 | 5 | 9 | 50 | | 0 |
| | 195 | 7 0T | Y | 20032 | 02 | 1 | TA | 01 | 1 | 1 | 516 | 6.3 | .1 | 82 | 0023 | .8 M 49 .7 | .0 | .8 M 59 .8 | .0 | 1 | 1 | 1 | 3 | 55 | Y | 0 |
| | 195 | 7 0T | | 21032 | 02 | 1 | TA | 01 | 1 | 1 | 518 | 1.2 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 2 | 3 | 80 | | 0 |
| | 195 | 7 ET | | 22032 | 02 | 1 | TA | 01 | 1 | 1 | 525 | 7.0 | .4 | 87 | 0077 | .5 X 37 .7 | .0 | .2 X 59 .8 | .0 | 0 | 1 | 1 | 2 | 62 | Y | 0 |
| | 195 | 7 0T | | 23032 | 02 | 1 | TA | 01 | 1 | 1 | 526 | .5 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 87 | | 2 |
| | 195 | 7 0T | | 27032 | 02 | 1 | TA | 1 | 1 | 1 | 532 | 6.3 | .3 | 87 | 0023 | .9 X 37 .7 | .1 X 37 .7 | .1 X 59 .3 | .0 | 0 | 1 | 0 | 1 | 60 | Y | 0 |
| | 195 | 7 0T | | 29032 | 02 | 1 | TA | 01 | 1 | 1 | 535 | 3.6 | .0 | | | .0 | .0 | .0 | .0 | 0 | 2 | 9 | 12 | 65 | | 0 |
| | 195 | 7 0T | | 28032 | 00 | 1 | TA | 01 | 1 | 1 | 536 | .5 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 1 | 1 | 87 | | 0 |
| | 195 | 7 0T | | 10042 | 02 | 1 | TA | 01 | 1 | 1 | 539 | 3.0 | .0 | | | .0 | .0 | .0 | .0 | 0 | 3 | 9 | 12 | 67 | | 0 |
| | 195 | 7 0T | | 13042 | 02 | 1 | TA | 01 | 1 | 1 | 543 | 4.0 | .2 | | | .0 | .0 | .0 | .0 | 0 | 1 | 8 | 8 | 75 | Y | 0 |
| | 195 | 7 0T | | 13042 | 02 | 1 | TA | 01 | 1 | 1 | 547 | 1.1 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 85 | | 2 |
| | 195 | 7 0T | Y | 18042 | 02 | 1 | TA | 01 | 1 | 1 | 550 | 6.3 | .3 | 90 | 0023 | .4 X 37 .7 | .0 | .2 X 59 .8 | .0 | 1 | 1 | 0 | 2 | 50 | Y | 0 |
| | 195 | 7 0T | | 19042 | 97 | 1 | TA | 01 | 1 | 1 | 556 | 5.7 | .2 | 87 | 0011 | .8 X 37 .7 | .0 | .2 X 59 .8 | .0 | 0 | 1 | 0 | 1 | 65 | Y | 0 |
| | 195 | 7 0T | | 24042 | 02 | 1 | TA | 01 | 1 | 1 | 556 | 1.0 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 85 | | 2 |
| | 195 | 7 0T | Y | 02052 | 02 | 1 | TA | 01 | 1 | 1 | 562 | 4.9 | .2 | 82 | 0023 | .9 X 37 .7 | .2 X 37 .7 | .0 | .0 | 0 | 0 | 0 | 0 | 67 | Y | 0 |
| | 195 | 7 0T | | 04052 | 02 | 1 | TA | 01 | 1 | 1 | 565 | 5.6 | .2 | | | .0 | .0 | .0 | .0 | 0 | 1 | 3 | 4 | 55 | | 0 |
| | 195 | 7 0T | | 04052 | 08 | 1 | TA | 01 | 1 | 1 | 577 | 5.7 | .3 | 90 | 0011 | .9 X 49 .9 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 62 | Y | 0 |
| | 195 | 7 EE | | 02052 | 82 | 1 | 1 | 1 | 1 | 1 | 576 | 3.4 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 65 | | 2 |
| | 195 | 7 EE | | 15052 | 82 | 1 | 1 | 1 | 1 | 1 | 579 | 2.8 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 62 | | 2 |
| | 195 | 7 EE | | 16052 | 82 | 1 | 1 | 1 | 1 | 1 | 582 | 3.7 | .0 | | | .0 | .0 | .0 | .0 | 0 | 1 | 0 | 1 | 60 | | 0 |

ATTACHMENT(2) 2/2

FB-111A COUNTING ACCELEROMETER CARDS FORWARD WING SWEEP 30 OCT 73

| A/C S/N | FLT DAY | DATE MO | YR | LEVEL 1 | DELTA 1 | LEVEL 6 | DELTA 6 | LEVEL 5 | DELTA 5 | LEVEL 2 | DELTA 2 | LEVEL 3 | DELTA 3 | LEVEL 4 | DELTA 4 | ETI | DELTA ETI | BASE | C | REC ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67-7192 | 17 | 05 | 3 | 0895 | 0 | 1065 | 59 | 1794 | 16 | 0727 | 2 | 1496 | 0 | 1133 | 0 | 9427 | 684 | 8 | 0 | 410 |
| 67-7192 | 22 | 05 | 3 | 0895 | 0 | 1084 | 19 | 0797 | 3 | 0727 | 0 | 1496 | 0 | 1133 | 0 | 0477 | * | 8 | 0 | 415 |
| 67-7192 | 22 | 05 | 3 | 0896 | 1 | 1105 | 21 | 0911 | 13 | 0727 | 0 | 1496 | 0 | 1133 | 0 | 0942 | 465 | 8 | 0 | 419 |
| 67-7192 | 31 | 05 | 3 | 0896 | 0 | 1106 | 1 | 0911 | 0 | 0727 | 0 | 1496 | 0 | 1133 | 0 | 1021 | 79 | 8 | 0 | 423 |
| 67-7192 | 31 | 05 | 3 | 0900 | 4 | 1112 | 6 | 0913 | 3 | 0728 | 1 | 1496 | 0 | 1133 | 0 | 1472 | 451 | 8 | 0 | 426 |
| 67-7192 | 04 | 06 | 3 | 0900 | 0 | 1114 | 2 | 0913 | 0 | 0728 | 0 | 1496 | 0 | 1133 | 0 | 1753 | 281 | 8 | 0 | 442 |
| 67-7192 | 04 | 06 | 3 | 0901 | 1 | 1128 | 14 | 0916 | 3 | 0728 | 0 | 1496 | 0 | 1133 | 0 | 2080 | 327 | 8 | 0 | 441 |
| 67-7192 | 06 | 06 | 3 | 0902 | 1 | 1130 | 10 | 0921 | 5 | 0729 | 1 | 1496 | 0 | 1133 | 0 | 2390 | 310 | 8 | 0 | 439 |
| 67-7192 | 06 | 06 | 3 | 0903 | 1 | 1142 | 4 | 0922 | 1 | 0729 | 0 | 1496 | 0 | 1133 | 0 | 2682 | 292 | 8 | 0 | 444 |
| 67-7192 | 11 | 06 | 3 | 0903 | 0 | 1158 | 16 | 0929 | 7 | 0730 | 1 | 1497 | 1 | 1133 | 0 | 3120 | 438 | 8 | 0 | 484 |
| 67-7192 | 11 | 06 | 3 | 0903 | 0 | 1158 | 0 | 0929 | 0 | 0730 | 0 | 1497 | 0 | 1133 | 0 | 3120 | 0 | 7 | 0 | 597 |
| 67-7192 | 13 | 06 | 3 | 0903 | 0 | 1182 | 24 | 0937 | 8 | 0730 | 0 | 1497 | 0 | 1133 | 0 | 3754 | 634 | 8 | 0 | 467 |
| 67-7192 | 22 | 06 | 3 | 0910 | 7 | 1248 | 66 | 0956 | 19 | 0731 | 1 | 1497 | 0 | 1133 | 0 | 4861 | 1107 | 8 | 0 | 50? |
| 67-7192 | 25 | 06 | 3 | 0910 | [illegible] | 1257 | 9 | 0958 | 2 | 0731 | 0 | 1497 | 0 | 1133 | 0 | 5087 | 226 | 8 | 0 | 532 |
| 67-7192 | 02 | 07 | 3 | 0910 | 0 | 1291 | 34 | 0969 | 11 | 0731 | 0 | 1497 | 0 | 1133 | 0 | 7645 | 2559 | 8 | 0 | 579 |
| 67-7192 | 05 | 07 | 3 | 0911 | 1 | 1333 | 42 | 0985 | 16 | 0732 | 1 | 1497 | 0 | 1133 | 0 | 8736 | 1091 | 8 | 0 | 526 |
| 67-7192 | 05 | 07 | 3 | 0911 | 0 | 1335 | 2 | 0986 | 1 | 0732 | 0 | 1497 | 0 | 1133 | 0 | 9165 | 429 | 8 | 0 | 537 |
| 67-7192 | 17 | 07 | 3 | 0912 | 1 | 1367 | 32 | 0992 | 6 | 0732 | 0 | 1497 | 0 | 1133 | 0 | 9557 | 392 | 8 | 0 | 574 |
| 67-7192 | 13 | 07 | 3 | 0920 | 8 | 142[illegible] | 53 | 0911 | 19 | 0735 | 3 | 1497 | 0 | 1133 | 0 | 0054 | * | 8 | 0 | 547 |
| 67-7192 | 24 | 07 | 3 | 0926 | 6 | 1462 | 42 | 0915 | 5 | 0735 | 0 | 1497 | 0 | 1133 | 0 | 0956 | 902 | 7 | 0 | 544 |
| 67-7192 | 25 | 07 | 3 | 0926 | 0 | 1483 | 21 | 0928 | 12 | 0736 | 1 | 1497 | 0 | 1133 | 0 | 1438 | 482 | 7 | 0 | 641 |
| 67-7192 | 28 | 07 | 3 | 0927 | 1 | 1487 | 4 | 0928 | 0 | 0736 | 1 | 1497 | 0 | 1133 | 0 | 1775 | 337 | 7 | 0 | 640 |
| 67-7192 | 06 | 08 | 3 | 0939 | 12 | 1567 | 80 | 0949 | 21 | 0739 | 3 | 1497 | 0 | 1133 | 0 | 5222 | 3447 | 7 | 0 | 613 |
| 67-7192 | 09 | 08 | 3 | 0940 | 1 | 1570 | 3 | 0949 | 0 | 0779 | 0 | 1497 | 0 | 1133 | 0 | 5410 | 188 | 7 | 0 | 655 |
| 67-7192 | 09 | 08 | 3 | 0940 | 0 | 1570 | 0 | 0949 | 0 | 0739 | 0 | 1497 | 0 | 1133 | 0 | 5410 | 0 | 7 | 0 | 657 |
| 67-7192 | 13 | 09 | 3 | 0944 | 4 | 1610 | 40 | 0954 | 5 | 0739 | 0 | 1497 | 0 | 1137 | 0 | 6508 | 1098 | 7 | 0 | 693 |
| 67-7192 | 13 | 09 | 3 | 0944 | 0 | 1631 | 21 | 0960 | 6 | 0741 | 2 | 1497 | 0 | 1133 | 0 | 6894 | 375 | 7 | 0 | 697 |
| 67-7192 | 21 | 09 | 3 | 0947 | 3 | 1664 | 33 | 0981 | 21 | 0742 | 1 | 1497 | 0 | 1133 | 0 | 7949 | 1065 | 8 | 0 | 759 |
| 67-7192 | 24 | 09 | 3 | 0949 | 2 | 1770 | 106 | 0997 | 16 | 0744 | 2 | 1497 | 0 | 1133 | 0 | 0810 | * | 8 | 0 | 760 |
| 67-7192 | 26 | 09 | 3 | 0950 | 1 | 1771 | 1 | 0997 | 0 | 0744 | 0 | 1497 | 0 | 1133 | 0 | 1440 | 630 | 8 | 0 | 743 |
| 67-7192 | 06 | 09 | 3 | 0951 | 1 | 1779 | 8 | 0997 | 0 | 0744 | 0 | 1497 | 0 | 1133 | 0 | 2029 | 589 | 8 | 0 | 761 |
| 67-7192 | 17 | 09 | 3 | 0952 | 1 | 1821 | 42 | 1010 | 13 | 0747 | 3 | 1497 | 0 | 1133 | 0 | 2500 | 471 | 8 | 0 | 762 |
| 67-7192 | 13 | 09 | 3 | 0953 | 1 | 1832 | 11 | 1013 | 3 | 0747 | 0 | 1497 | 0 | 1133 | 0 | 2614 | 114 | 8 | 0 | 745 |
| 67-7192 | 13 | 09 | 3 | 0954 | 1 | 1833 | 1 | 1014 | 1 | 0747 | 0 | 1497 | 0 | 1133 | 0 | 3582 | 968 | 8 | 0 | 739 |
| 67-7192 | 20 | 09 | 3 | 0954 | 0 | 1888 | 55 | 1031 | 17 | 0749 | 2 | 1497 | 0 | 1133 | 0 | 4752 | 1170 | 8 | 0 | 741 |
| 67-7194 | 17 | 08 | 3 | 7421 | | 1527 | | 7674 | | 2145 | | 0205 | | 1398 | | 2855 | | 7 | 0 | 684 |
| 67-7194 | 20 | 09 | 3 | 7422 | 1 | 1578 | 11 | 7675 | 1 | 2145 | 1 | 0205 | 0 | 1398 | 0 | 4505 | 1650 | 7 | 0 | 718 |
| 67-7195 | 23 | 07 | 3 | 1527 | | 0244 | | 8581 | | 7192 | | 8643 | | 5463 | | 9497 | | 7 | 0 | 626 |
| 67-7195 | 24 | 07 | 3 | 1528 | 5 | 0314 | 70 | 8610 | 29 | 7396 | 4 | 8643 | 0 | 5463 | 0 | 0481 | * | 7 | 0 | 625 |
| 67-7195 | 27 | 07 | 3 | 1529 | 1 | 0717 | 3 | 8510 | 0 | 7396 | 0 | 8643 | 0 | 5463 | 0 | 0999 | 518 | 7 | 0 | 631 |
| 67-7195 | 01 | 08 | 3 | 1534 | 5 | 0779 | 62 | 8637 | 25 | 7399 | 3 | 8643 | 0 | 5463 | 0 | 2230 | 1231 | 7 | 0 | 632 |
| 67-7195 | 03 | 08 | 3 | 1534 | 0 | 0781 | 2 | 8677 | 0 | 7399 | 0 | 8643 | 0 | 5463 | 0 | 2730 | 470 | 7 | 0 | 669 |
| 67-7195 | 07 | 08 | 3 | 1574 | | 0797 | 16 | 8643 | 8 | 7102 | 3 | 8643 | 0 | 5463 | 0 | 3108 | 408 | 7 | 0 | 672 |
| 67-7196 | 18 | 01 | 3 | 4279 | | 7881 | | 459 | | 5975 | | 9562 | | 4365 | | 5441 | | 8 | 0 | 361 |
| 67-7195 | 14 | 02 | 3 | 4244 | 5 | 7943 | 62 | 4696 | 6 | 5976 | 1 | 3562 | 0 | 4365 | 0 | 8790 | 3349 | 8 | 0 | 362 |

## 2. THE MCR RECORDER SYSTEM

The multiple-channel recorder system installed in selected FB-111A airplanes consists of a Dynasciences Corporation A/A24U-6 airborne signal data recorder set, source transducers and associated wiring. The recorder receives signals from the source transducers; applies appropriate signal conditioning, filtering, and sampling; converts the measurements into MCR counts (defined later in this section); and digitally records the MCR counts on a 30-track magnetic tape. The tape is housed in a removable magazine.

The recorder operates continuously while the airplane is on internal electrical power and the access door of the auxilliary ground power receptacle is closed. Capacity of the magazine is approximately 25 hours.

Twenty-four parameters (data items) are recorded. Identity of these parameters and their associated recording rates are shown in Table 2-1.

Standard F/FB-111 system sensors provide measurements for all data items except the three linear accelerations near the c.g., spoiler positions, rate of sink, and landing gear strut pressures. Measurements for these items are obtained from transducers installed as part of the recorder system. Sensor locations are shown in Figure 2-1.

The sign conventions and engineering units of the MCR measurements are shown in Table 2-2. However, as previously stated, these MCR measurements are recorded in terms of "MCR counts". Each measurement is classified according to 64 predefined class intervals. Each interval has a preassigned identification number (0 thru 63) herein referred to as an "MCR Count Number". The MCR Count Number of the interval containing a given MCR measurement is recorded on the MCR magnetic tape. Mid-point values of these class intervals (defined in terms of the sign conventions and units shown in Table 2-2) are shown in Table 2-3.

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10 MAY 1976

The additional provisions necessary to record MCR data were initially divided into two groups:

- Group A provisions include wiring, switches, circuit breakers, brackets, a replacement total temperature indicator (FB-111A only), and spoiler position transmitters.
- Group B provisions include the remaining required sensors (tri-axial linear accelerometer, sink rate radar, and landing gear pressure transducers) and the signal data recorder set (the MCR set).

Group A provisions are installed in the following 19 airplanes:

| AF Ser. No. | Mfg. Ser. No. | AF Ser. No. | Mfg. Ser. No. |
|---|---|---|---|
| 67-7193 | 7 | *68-244 | 16 |
| *67-7194 | 8 | 68-245 | 17 |
| 67-7195 | 9 | *68-246 | 18 |
| *67-7196 | 10 | 68-247 | 19 |
| 67-239 | 11 | *68-248 | 20 |
| *68-240 | 12 | 68-249 | 21 |
| 68-241 | 13 | *68-250 | 22 |
| *68-242 | 14 | 68-251 | 23 |
| 68-243 | 15 | *68-252 | 24 |
| | | *68-254 | 26 |

Initially, Group B provisions were installed in the ten FB-111A airplanes identified above with an asterisk (*). Subsequently, nine more ship-sets of Group B provisions <u>less the MCR sets</u> were supplied to Sacramento ALC under Proposal 111-P-1452 (Reference 11) for future installation into the remaining nine FB-111A airplanes which are equipped with Group A provisions. After installation of the additional Group B provisions, the available ten MCR sets can be used to gather MCR data with any ten of the above 19 airplanes.

Additional information about the F/FB-111 MCR system is presented in T.O. 1F-111(B)A-2-1-2 (Reference 3).

ATTACHMENT (3) PG 3/6

FZS-12-6085

## SERVICE LIFE MONITORING
## AIRBORNE RECORDER INSTALLATION
F/FB-111

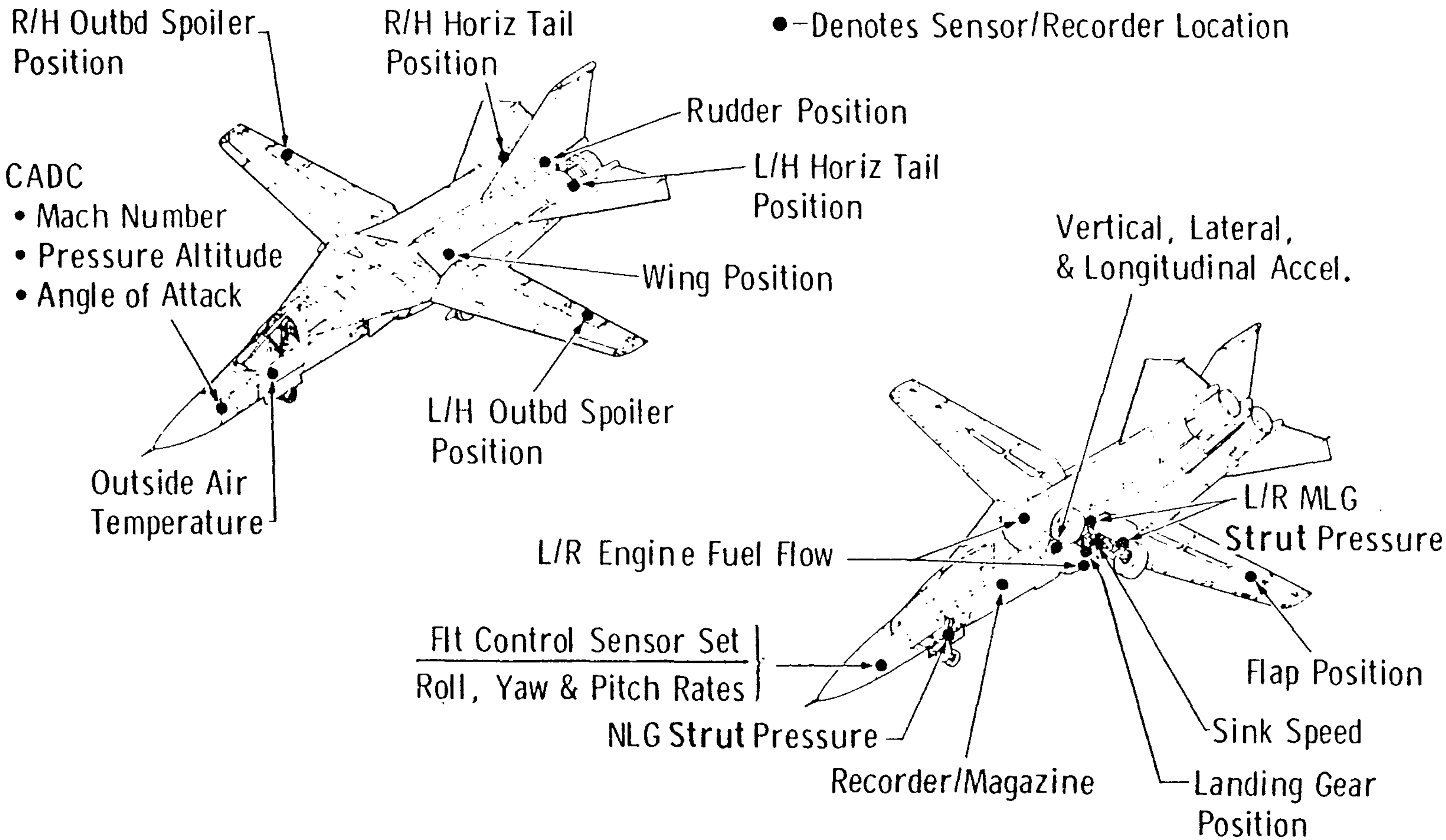



FIGURE 2-1

ATTACHMENT (3) PG 4/6

FZS-12-6085

## TABLE 2-1

## F/FB-111 MULTIPLE CHANNEL RECORDER PARAMETERS

| | Parameter | Recording Rate | Signal Source |
|---|---|---|---|
| 1. | Mach Number | 1 sps | CADC, M, 36A (R3-D) |
| 2. | Pressure Altitude | 1 sps | CADC, Hp, 1AC |
| 3. | Outside Air Temperature | 1 sps | Total Temperature Indicator |
| 4. | Wing Position | 1 sps | Wing Sweep Transmitter |
| 5. | Acceleration, Z Axis - (load factor) | 30 sps | |
| 6. | Acceleration, X Axis - (load factor) | 10 sps | *Three Axis Linear Accelerometers |
| 7. | Acceleration, Y Axis - (load factor) | 15 sps | |
| 8. | Roll Rate | 15 sps | |
| 9. | Yaw Rate | 15 sps | Flight Control Sensor Set |
| 10. | Pitch Rate | 15 sps | |
| 11. | Flap Position | 1 sps | Flap Position Transmitter |
| 12. | Landing Gear Position | every other second | From Main Landing Gear Uplock Switch |
| 13. | Sink Speed | 5 sps | *Sink Rate Radar |
| 14. | LH Horizontal Tail Position | 15 sps | LH Horizontal Tail Transmitter |
| 15. | RH Horizontal Tail Position | 15 sps | RH Horizontal Tail Transmitter |
| 16. | Rudder Position | 15 sps | Rudder Position Transmitter |
| 17. | Fuel Flow, Right Engine | 1 sps | RH Engine Fuel Flow Indicator |
| 18. | Fuel Flow, Left Engine | 1 sps | LH Engine Fuel Flow Indicator |
| 19. | True Angle of Attack | 5 sps | CADC, $\alpha$ , 5A |
| 20. | Right Outboard Spoiler Position | 30 sps | *RH Spoiler Transmitter |
| 21. | Left Outboard Spoiler Position | 30 sps | *LH Spoiler Transmitter |
| 22. | Left Main Landing Gear Strut Pressure (*) | 1 sps | *Pressure Transducer |
| 23. | Right Main Landing Gear Strut Pressure (*) | 1 sps | *Pressure Transducer |
| 24. | Nose Landing Gear Strut Pressure (*) | 15 sps | *Pressure Transducer |

sps ~ sample per second
(*) ~ Pneumatic

*~Peculiar to MCR Installation

# TABLE 2-2

## F/FB-111 MCR SIGN CONVENTIONS AND UNITS

| MCR CHANNEL NO. | PARAMETER | SYMBOL | MCR DATA DESCRIPTION Units | MCR DATA DESCRIPTION Sign Convention |
|---|---|---|---|---|
| 1 | Mach No. | MN | N/A | N/A |
| 2 | Pressure Alt. | HP | Feet | N/A |
| 3 | Air Temp. (Total) | TOAT | °C | N/A |
| 4 | Wing Position | LAM | Deg | N/A |
| 5 | Vertical Acc. | $N_z$ | g's | + Up |
| 6 | Longitudinal Acc. | $N_x$ | g's | + Forward |
| 7 | Lateral Acc. | $N_y$ | g's | + Right |
| 8 | Roll Rate | P | Deg/Sec | + Right Wing Up |
| 9 | Pitch Rate | Q | Deg/Sec | + Nose Down |
| 10 | Yaw Rate | R | Deg/Sec | + Nose Left |
| 11 | Flap Position | FP | Deg | + Trailing Edge Down |
| 12 | Landing Gear Pos. | | (Code) | N/A |
| 13 | Sink Speed | VSS | Ft/Sec | + Down |
| 14 | Left. Hor. Tail Pos. | HTL | Deg | + Trailing Edge Up |
| 15 | Right Hor. Tail Pos. | HTR | Deg | + Trailing Edge Up |
| 16 | Rudder Position | DR | Deg | + Trailing Edge Right |
| 17 | Fuel Flow (R) | FFR | Lbs/Hr | N/A |
| 18 | Fuel Flow (L) | FFL | Lbs/Hr | N/A |
| 19 | True Angle of Att | ALP | Deg | + Nose Up |
| 20 | Right Outbd. Spoiler | SPL | Deg | + Up |
| 21 | Left Outbd. Spoiler | SPR | Deg | + Up |
| 22 | Left Main Strut Press.* | MGPL | PSI | N/A |
| 23 | Right Main Strut Press.* | MGPR | PSI | N/A |
| 24 | Nose Strut Pressure* | NGP | PSI | N/A |

* ~ Pneumatic

TABLE 2-3

SCHEDULE FOR CONVERTING F/FB-111 MCR COUNTS INTO ENGINEERING UNITS⊛

| MCR CT | HN | HP | LAM | FP | TOAT | HGPL | HGPR | FFR | FFL | NZ | NY | NX | P | Q | R | * $\dot{P}$ | * $\dot{Q}$ | * $\dot{R}$ | SPL | SPR | HTL | HTR | DR | ALP | VSB | HGP | MCR CT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .02 | -367. | 16.4 | .3 | -47.6 | 39. | 39. | 625. | 625. | -2.91 | -1.97 | -1.97 | -106.9 | -49.2 | -49.2 | -9.817 | -2.454 | -2.454 | .4 | .4 | -19.6 | -19.6 | -29.5 | -9.7 | .2 | 39. | 0 |
| 1 | .07 | 898. | 17.3 | .9 | -42.9 | 117. | 117. | 1875. | 1875. | -2.72 | -1.91 | -1.91 | -100.0 | -47.7 | -47.7 | -8.999 | -2.250 | -2.250 | 1.1 | 1.1 | -18.8 | -18.8 | -28.6 | -9.2 | .5 | 117. | 1 |
| 2 | .11 | 2164. | 18.2 | 1.6 | -38.2 | 195. | 195. | 3125. | 3125. | -2.53 | -1.84 | -1.84 | -181.4 | -46.1 | -46.1 | -8.181 | -2.045 | -2.045 | 1.8 | 1.8 | -18.0 | -18.0 | -27.7 | -8.6 | .8 | 195. | 2 |
| 3 | .15 | 3430. | 19.1 | 2.2 | -33.5 | 273. | 273. | 4375. | 4375. | -2.34 | -1.78 | -1.78 | -178.1 | -44.5 | -44.5 | -7.363 | -1.841 | -1.841 | 2.5 | 2.5 | -17.3 | -17.3 | -26.7 | -8.1 | 1.1 | 273. | 3 |
| 4 | .20 | 4695. | 20.0 | 2.8 | -28.8 | 352. | 352. | 5625. | 5625. | -2.16 | -1.72 | -1.72 | -171.9 | -43.0 | -43.0 | -6.545 | -1.636 | -1.636 | 3.2 | 3.2 | -16.5 | -16.5 | -25.8 | -7.5 | 1.4 | 352. | 4 |
| 5 | .21 | 5961. | 20.9 | 3.4 | -24.1 | 430. | 430. | 6875. | 6875. | -1.97 | -1.66 | -1.66 | -165.6 | -41.4 | -41.4 | -5.727 | -1.432 | -1.432 | 3.9 | 3.9 | -15.7 | -15.7 | -24.8 | -7.0 | 1.7 | 430. | 5 |
| 6 | .28 | 7227. | 21.7 | 4.1 | -19.4 | 508. | 508. | 8125. | 8125 | -1.78 | -1.59 | -1.59 | -159.4 | -39.8 | -39.8 | -4.909 | -1.227 | -1.227 | 4.6 | 4.6 | -14.9 | -14.9 | -23.9 | -6.4 | 2.0 | 508. | 6 |
| 7 | .33 | 8492. | 22.6 | 4.7 | -14.7 | 586. | 586. | 9375. | 9375. | -1.59 | -1.53 | -1.53 | -153.1 | -38.3 | -38.3 | -4.091 | -1.023 | -1.023 | 5.3 | 5.3 | -14.1 | -14.1 | -23.0 | -5.9 | 2.3 | 586. | 7 |
| 8 | .37 | 9758. | 23.5 | 5.3 | -10.0 | 664. | 664. | 10625. | 10625. | -1.41 | -1.47 | -1.47 | -146.9 | -36.7 | -36.7 | -3.272 | -.818 | -.818 | 6.0 | 6.0 | -13.4 | -13.4 | -22.0 | -5.4 | 2.7 | 664. | 8 |
| 9 | .42 | 11023. | 24.4 | 5.9 | -5.4 | 742. | 742. | 11875. | 11875. | -1.22 | -1.41 | -1.41 | -140.6 | -35.2 | -35.2 | -2.454 | -.614 | -.614 | 6.7 | 6.7 | -12.6 | -12.6 | -21.1 | -4.8 | 3.0 | 742. | 9 |
| 10 | .46 | 12289. | 25.3 | 6.6 | -.7 | 820. | 820. | 13125. | 13125. | -1.03 | -1.34 | -1.34 | -134.4 | -33.6 | -33.6 | -2.045 | -.511 | -.511 | 7.4 | 7.4 | -11.8 | -11.8 | -20.2 | -4.3 | 3.3 | 820. | 10 |
| 11 | .50 | 13555. | 26.1 | 7.2 | 3.9 | 898. | 898. | 14375. | 14375. | -.84 | -1.28 | -1.28 | -128.1 | -32.0 | -32.0 | -1.636 | -.409 | -.409 | 8.1 | 8.1 | -11.0 | -11.0 | -19.2 | -3.7 | 3.6 | 898. | 11 |
| 12 | .55 | 14820. | 27.0 | 7.8 | 8.6 | 977. | 977. | 15625. | 15625. | -.66 | -1.22 | -1.22 | -121.9 | -30.5 | -30.5 | -1.227 | -.307 | -.307 | 8.8 | 8.8 | -10.2 | -10.2 | -18.3 | -3.2 | 3.9 | 977. | 12 |
| 13 | .59 | 16086. | 27.9 | 8.4 | 13.3 | 1055. | 1055. | 16875. | 16875. | -.47 | -1.16 | -1.16 | -115.6 | -28.9 | -28.9 | -1.023 | -.256 | -.256 | 9.5 | 9.5 | -9.5 | -9.5 | -17.3 | -2.6 | 4.2 | 1055. | 13 |
| 14 | .63 | 17352. | 28.8 | 9.1 | 18.0 | 1133. | 1133. | 18125. | 18125. | -.28 | -1.09 | -1.09 | -109.4 | -27.3 | -27.3 | -.921 | -.231 | -.231 | 10.2 | 10.2 | -8.7 | -8.7 | -16.4 | -2.1 | 4.5 | 1133. | 14 |
| 15 | .68 | 18617. | 29.7 | 9.7 | 22.7 | 1211. | 1211. | 19375. | 19375. | -.09 | -1.03 | -1.03 | -103.1 | -25.8 | -25.8 | -.818 | -.205 | -.205 | 10.9 | 10.9 | -7.9 | -7.9 | -15.5 | -1.5 | 4.8 | 1211. | 15 |
| 16 | .72 | 19883. | 30.6 | 10.3 | 27.4 | 1289. | 1289. | 20625. | 20625. | .09 | -.97 | -.97 | -96.9 | -24.2 | -24.2 | -.682 | -.171 | -.171 | 11.6 | 11.6 | -7.1 | -7.1 | -14.5 | -1.0 | 5.2 | 1289. | 16 |
| 17 | .77 | 21148. | 31.4 | 10.9 | 32.0 | 1367. | 1367. | 21875. | 21875. | .28 | -.91 | -.91 | -90.6 | -22.7 | -22.7 | -.545 | -.136 | -.136 | 12.3 | 12.3 | -6.3 | -6.3 | -13.6 | -.4 | 5.5 | 1367. | 17 |
| 18 | .81 | 22414. | 32.3 | 11.6 | 36.7 | 1445. | 1445. | 23125. | 23125. | .47 | -.84 | -.84 | -84.4 | -21.1 | -21.1 | -.477 | -.119 | -.119 | 13.0 | 13.0 | -5.5 | -5.5 | -12.7 | .1 | 5.6 | 1445. | 18 |
| 19 | .85 | 23680. | 33.2 | 12.2 | 41.4 | 1523. | 1523. | 24375. | 24375. | .66 | -.78 | -.78 | -70.1 | -19.5 | -19.5 | -.409 | -.102 | -.102 | 13.7 | 13.7 | -4.8 | -4.8 | -11.7 | .7 | 6.1 | 1523. | 19 |
| 20 | .90 | 24945. | 34.1 | 12.8 | 46.1 | 1602. | 1602. | 25625. | 25625. | .84 | -.72 | -.72 | -71.9 | -18.0 | -18.0 | -.368 | -.092 | -.092 | 14.4 | 14.4 | -4.0 | -4.0 | -10.8 | 1.2 | 6.4 | 1602. | 20 |
| 21 | .94 | 26211. | 35.0 | 13.4 | 50.8 | 1680. | 1680. | 26875. | 26875. | 1.03 | -.66 | -.66 | -65.6 | -16.4 | -16.4 | -.327 | -.082 | -.082 | 15.1 | 15.1 | -3.2 | -3.2 | -9.8 | 1.8 | 6.7 | 1680. | 21 |
| 22 | .98 | 27477. | 35.9 | 14.1 | 55.5 | 1758. | 1758. | 28125. | 28125. | 1.22 | -.59 | -.59 | -59.4 | -14.8 | -14.8 | -.300 | -.075 | -.075 | 15.8 | 15.8 | -2.4 | -2.4 | -8.9 | 2.3 | 7.0 | 1758. | 22 |
| 23 | 1.03 | 28742. | 36.7 | 14.7 | 60.2 | 1836. | 1836. | 29375. | 29375. | 1.41 | -.53 | -.53 | -53.1 | -13.3 | -13.3 | -.273 | -.068 | -.068 | 16.5 | 16.5 | -1.6 | -1.6 | -8.0 | 2.9 | 7.3 | 1836. | 23 |
| 24 | 1.07 | 30008. | 37.6 | 15.3 | 64.9 | 1914. | 1914. | 30625. | 30625. | 1.59 | -.47 | -.47 | -46.9 | -11.7 | -11.7 | -.254 | -.063 | -.063 | 17.2 | 17.2 | -.9 | -.9 | -7.0 | 3.4 | 7.7 | 1914. | 24 |
| 25 | 1.12 | 31273. | 38.5 | 15.9 | 69.6 | 1992. | 1992. | 31875. | 31875. | 1.78 | -.41 | -.41 | -40.6 | -10.2 | -10.2 | -.234 | -.058 | -.058 | 17.9 | 17.9 | -.1 | -.1 | -6.1 | 3.9 | 8.0 | 1992. | 25 |
| 26 | 1.16 | 32539. | 39.4 | 16.6 | 74.2 | 2070. | 2070. | 33125. | 33125. | 1.97 | -.34 | -.34 | -34.4 | -8.6 | -8.6 | -.220 | -.054 | -.054 | 18.6 | 18.6 | .7 | .7 | -5.2 | 4.5 | 8.3 | 2070. | 26 |
| 27 | 1.20 | 33805. | 40.3 | 17.2 | 78.9 | 2148. | 2148. | 34375. | 34375. | 2.16 | -.28 | -.28 | -28.1 | -7.0 | -7.0 | -.205 | -.051 | -.051 | 19.3 | 19.3 | 1.5 | 1.5 | -4.2 | 5.0 | 8.6 | 2148. | 27 |
| 28 | 1.25 | 35070. | 41.2 | 17.8 | 83.6 | 2227. | 2227. | 35625. | 35625. | 2.34 | -.22 | -.22 | -21.9 | -5.5 | -5.5 | -.194 | -.048 | -.048 | 20.0 | 20.0 | 2.3 | 2.3 | -3.3 | 5.6 | 8.9 | 2227. | 28 |
| 29 | 1.29 | 36336. | 42.0 | 18.4 | 88.3 | 2305. | 2305. | 36875. | 36875. | 2.53 | -.16 | -.16 | -15.6 | -3.9 | -3.9 | -.142 | -.035 | -.035 | 20.7 | 20.7 | 3.0 | 3.0 | -2.3 | 6.1 | 9.2 | 2305. | 29 |
| 30 | 1.33 | 37602. | 42.9 | 19.1 | 93.0 | 2383. | 2383. | 38125. | 38125. | 2.72 | -.09 | -.09 | -9.4 | -2.3 | -2.3 | -.091 | -.022 | -.022 | 21.4 | 21.4 | 3.8 | 3.8 | -1.4 | 6.7 | 9.5 | 2383. | 30 |
| 31 | 1.38 | 38867. | 43.8 | 19.7 | 97.7 | 2461. | 2161. | 39375. | 39375. | 2.91 | -.03 | -.03 | -3.1 | -.8 | -.8 | 0 | 0 | 0 | 22.1 | 22.1 | 4.6 | 4.6 | -.5 | 7.2 | 9.8 | 2461. | 31 |
| 32 | 1.42 | 40133. | 44.7 | 20.3 | 102.4 | 2539. | 2539. | 40625. | 40625. | 3.09 | .03 | .03 | 3.1 | .8 | .8 | .091 | .022 | .022 | 22.9 | 22.9 | 5.4 | 5.4 | .5 | 7.8 | 10.2 | 2539. | 32 |
| 33 | 1.47 | 41398. | 45.6 | 20.9 | 107.1 | 2617. | 2617. | 41875. | 41875. | 3.28 | .09 | .09 | 9.4 | 2.3 | 2.3 | .142 | .035 | .035 | 23.6 | 23.6 | 6.2 | 6.2 | 1.4 | 8.3 | 10.5 | 2617. | 33 |
| 34 | 1.51 | 42664. | 46.5 | 21.6 | 111.7 | 2695. | 2695. | 43125. | 43125. | 3.47 | .16 | .16 | 15.6 | 3.9 | 3.9 | .194 | .048 | .048 | 24.3 | 21.3 | 7.0 | 7.0 | 2.3 | 8.9 | 10.8 | 2695. | 34 |
| 35 | 1.55 | 43930. | 47.3 | 22.2 | 116.1 | 2773. | 2773. | 44375. | 44375. | 3.66 | .22 | .22 | 21.9 | 5.5 | 5.5 | .205 | .051 | .051 | 25.0 | 25.0 | 7.7 | 7.7 | 3.3 | 9.4 | 11.1 | 2773. | 35 |
| 36 | 1.60 | 45195. | 48.2 | 22.8 | 121.1 | 2852. | 2852. | 45625. | 45625. | 3.84 | .28 | .28 | 28.1 | 7.0 | 7.0 | .220 | .054 | .054 | 25.7 | 25.7 | 8.5 | 8.5 | 4.2 | 10.0 | 11.4 | 2852. | 36 |
| 37 | 1.64 | 46461. | 49.1 | 23.4 | 125.8 | 2930. | 2930. | 46875. | 46875. | 4.03 | .34 | .34 | 34.4 | 8.6 | 8.6 | .234 | .058 | .058 | 26.4 | 26.4 | 9.3 | 9.3 | 5.2 | 10.5 | 11.7 | 2930. | 37 |
| 38 | 1.68 | 47727. | 50.0 | 24.1 | 130.5 | 3008. | 3008. | 48125. | 48125. | 4.22 | .41 | .41 | 40.6 | 10.2 | 10.2 | .254 | .063 | .063 | 27.1 | 27.1 | 10.1 | 10.1 | 6.1 | 11.1 | 12.0 | 3008. | 38 |
| 39 | 1.73 | 48992. | 50.9 | 24.7 | 135.2 | 3086. | 3086. | 49375. | 49375. | 4.41 | .47 | .47 | 46.9 | 11.7 | 11.7 | .273 | .068 | .068 | 27.8 | 27.8 | 10.0 | 10.9 | 7.0 | 11.6 | 12.3 | 3086. | 39 |
| 40 | 1.77 | 50528. | 51.7 | 25.3 | 139.0 | 3164. | 3164. | 50625. | 50625. | 4.59 | .53 | .53 | 53.1 | 13.3 | 13.3 | .300 | .075 | .075 | 28.5 | 28.5 | 11.6 | 11.6 | 8.0 | 12.1 | 12.7 | 3164. | 40 |
| 41 | 1.82 | 51523. | 52.6 | 25.9 | 144.6 | 3242. | 3242. | 51875. | 51875. | 4.78 | .59 | .59 | 59.4 | 14.8 | 14.8 | .327 | .082 | .082 | 29.2 | 29.2 | 12.4 | 12.4 | 8.9 | 12.7 | 13.0 | 3242. | 41 |
| 42 | 1.86 | 52789. | 53.5 | 26.6 | 149.2 | 3320. | 3320. | 53125. | 53125. | 4.97 | .66 | .66 | 65.6 | 16.4 | 16.4 | .368 | .092 | .092 | 29.9 | 29.9 | 13.2 | 13.2 | 9.8 | 13.2 | 13.3 | 3320. | 42 |
| 43 | 1.90 | 54055. | 54.4 | 27.2 | 153.9 | 3398. | 3398. | 54375. | 54375. | 5.16 | .72 | .72 | 71.9 | 18.0 | 18.0 | .409 | .102 | .102 | 30.6 | 30.6 | 14.0 | 14.0 | 10.8 | 13.8 | 13.6 | 3398. | 43 |
| 44 | 1.95 | 55370. | 55.3 | 27.8 | 158.6 | 3477. | 3477. | 55625. | 55625. | 5.34 | .78 | .78 | 78.1 | 19.5 | 19.5 | .477 | .119 | .119 | 31.3 | 31.3 | 14.8 | 14.8 | 11.7 | 14.3 | 13.9 | 3477. | 44 |
| 45 | 1.99 | 56586. | 56.2 | 28.4 | 163.3 | 3555. | 3555. | 56875. | 56875. | 5.53 | .84 | .84 | 84.4 | 21.1 | 21.1 | .545 | .136 | .136 | 32.0 | 32.0 | 15.5 | 15.5 | 12.7 | 14.9 | 14.2 | 3555. | 45 |
| 46 | 2.03 | 57852. | 57.0 | 29.1 | 168.0 | 3633. | 3633. | 58125. | 58125. | 5.72 | .91 | .91 | 90.6 | 22.7 | 22.7 | .682 | .171 | .171 | 32.7 | 32.7 | 16.3 | 16.3 | 13.6 | 15.4 | 14.5 | 3633. | 46 |
| 47 | 2.08 | 59117. | 57.9 | 29.7 | 172.7 | 3711. | 3711. | 59375. | 59375. | 5.91 | .97 | .97 | 96.9 | 24.2 | 24.2 | .018 | .205 | .205 | 33.4 | 33.4 | 17.1 | 17.1 | 14.5 | 16.0 | 14.8 | 3711. | 47 |
| 48 | 2.12 | 60383. | 58.8 | 30.3 | 177.4 | 3789. | 3789. | 60625. | 60625. | 6.09 | 1.03 | 1.03 | 103.1 | 25.8 | 25.8 | .021 | .231 | .231 | 34.1 | 34.1 | 17.9 | 17.9 | 15.5 | 16.5 | 15.2 | 3789. | 48 |
| 49 | 2.17 | 61648. | 59.7 | 30.9 | 182.1 | 3867. | 3867. | 61875. | 61875. | 6.28 | 1.09 | 1.09 | 109.4 | 27.3 | 27.3 | 1.023 | .256 | .256 | 34.8 | 34.8 | 18.7 | 18.7 | 16.4 | 17.1 | 15.5 | 3867. | 49 |
| 50 | 2.21 | 62914. | 60.6 | 31.6 | 186.8 | 3945. | 3945. | 63125. | 63125. | 6.47 | 1.16 | 1.16 | 115.6 | 28.9 | 28.9 | 1.227 | .307 | .307 | 35.5 | 35.5 | 19.5 | 19.5 | 17.3 | 17.6 | 15.8 | 3945. | 50 |
| 51 | 2.25 | 64180. | 61.5 | 32.2 | 191.4 | 4023. | 4023. | 61375. | 61375. | 6.66 | 1.22 | 1.22 | 121.9 | 30.5 | 30.5 | 1.636 | .409 | .409 | 36.2 | 36.2 | 20.2 | 20.2 | 18.3 | 18.2 | 16.1 | 4023. | 51 |
| 52 | 2.30 | 65445. | 62.3 | 32.8 | 196.1 | 4102. | 4102. | 65625. | 65625. | 6.84 | 1.28 | 1.28 | 128.1 | 32.0 | 32.0 | 2.045 | .511 | .511 | 36.9 | 36.9 | 21.0 | 21.0 | 19.2 | 18.7 | 16.4 | 4102. | 52 |
| 53 | 2.34 | 66711. | 63.2 | 33.4 | 200.8 | 4180. | 4180. | 66875. | 66875. | 7.03 | 1.34 | 1.34 | 134.4 | 33.6 | 33.6 | 2.454 | .614 | .614 | 37.6 | 37.6 | 21.8 | 21.8 | 20.2 | 19.3 | 16.7 | 4180. | 53 |
| 54 | 2.38 | 67977. | 64.1 | 34.1 | 205.5 | 4258. | 4258. | 68125. | 68125. | 7.22 | 1.41 | 1.41 | 140.6 | 35.2 | 35.2 | 3.272 | .818 | .818 | 38.3 | 38.3 | 22.6 | 22.6 | 21.1 | 19.8 | 17.0 | 4258. | 54 |
| 55 | 2.13 | 69212. | 65.0 | 34.7 | 210.2 | 4336. | 4336. | 69375. | 69375. | 7.41 | 1.47 | 1.47 | 146.9 | 36.7 | 36.7 | 4.091 | 1.023 | 1.023 | 39.0 | 39.0 | 23.4 | 23.4 | 22.0 | 20.4 | 17.3 | 4336. | 55 |
| 56 | 2.17 | 70508. | 65.9 | 35.3 | 214.9 | 4414. | 4414. | 70625. | 70625. | 7.59 | 1.53 | 1.53 | 153.1 | 38.3 | 38.3 | 4.909 | 1.227 | 1.227 | 39.7 | 39.7 | 24.1 | 24.1 | 23.0 | 20.9 | 17.7 | 4414. | 56 |
| 57 | 2.52 | 71773. | 66.8 | 35.9 | 219.6 | 4492. | 4492. | 71875. | 71875. | 7.78 | 1.59 | 1.59 | 159.4 | 39.8 | 39.8 | 5.727 | 1.432 | 1.432 | 40.4 | 40.4 | 24.9 | 24.9 | 23.9 | 21.4 | 18.0 | 4492. | 57 |
| 58 | 2.56 | 73039. | 67.6 | 36.6 | 224.3 | 4570. | 4570. | 73125. | 73125. | 7.97 | 1.66 | 1.66 | 165.6 | 41.4 | 41.4 | 6.545 | 1.636 | 1.636 | 41.1 | 41.1 | 25.7 | 25.7 | 24.8 | 22.0 | 18.3 | 4570. | 58 |
| 59 | 2.60 | 74305. | 68.5 | 37.2 | 228.9 | 4648. | 4618. | 74375. | 74375. | 8.16 | 1.72 | 1.72 | 171.9 | 43.0 | 43.0 | 7.363 | 1.841 | 1.841 | 41.8 | 41.8 | 26.5 | 26.5 | 25.8 | 22.5 | 16.0 | 4648. | 59 |
| 60 | 2.65 | 75570. | 69.4 | 37.8 | 233.6 | 4727. | 4727. | 75625. | 75625. | 8.34 | 1.78 | 1.78 | 178.1 | 44.5 | 44.5 | 8.181 | 2.045 | 2.045 | 42.5 | 42.5 | 27.3 | 27.3 | 26.7 | 23.1 | 18.9 | 4727. | 60 |
| 61 | 2.69 | 76836. | 70.3 | 38.4 | 238.3 | 4805. | 4805. | 76875. | 76875. | 8.53 | 1.84 | 1.84 | 184.4 | 46.1 | 46.1 | 8.999 | 2.250 | 2.250 | 43.2 | 43.2 | 28.0 | 28.0 | 27.7 | 23.6 | 19.2 | 4805. | 61 |
| 62 | 2.73 | 78102. | 71.2 | 39.1 | 243.0 | 4883. | 4883. | 78125. | 78125. | 8.72 | 1.91 | 1.91 | 190.6 | 47.7 | 47.7 | 9.817 | 2.454 | 2.454 | 43.9 | 43.9 | 28.8 | 28.8 | 28.6 | 24.2 | 19.5 | 4883. | 62 |
| 63 | 2.78 | 79367. | 72.1 | 39.7 | 247.7 | 4961. | 4961. | 793.5. | 79375. | 8.91 | 1.97 | 1.97 | 196.9 | 49.2 | 49.2 | 10.636 | 2.659 | 2.659 | 44.6 | 44.6 | 29.6 | 29.6 | 29.5 | 24.7 | 19.8 | 4961. | 63 |

⊛ Mid-points of MCR class intervals are shown---see Table 2-2 for sign conventions and units.

* Computed from MCR angular velocities---computed values (not mid-points) are shown.

# 4. DATA REDUCTION

Reduction of MCR data is divided into three major phases:

- Initial editing of the MCR data to select flights with usable information (Quick Look Analysis - Subsection 4.1).
- Retrieval of Flight Usage Card information for individual MCR flights (Flight Usage Card Data - Subsection 4.2).
- Generation of compressed time histories of usable MCR data (Loads Edit Analysis - Subsection 4.3).

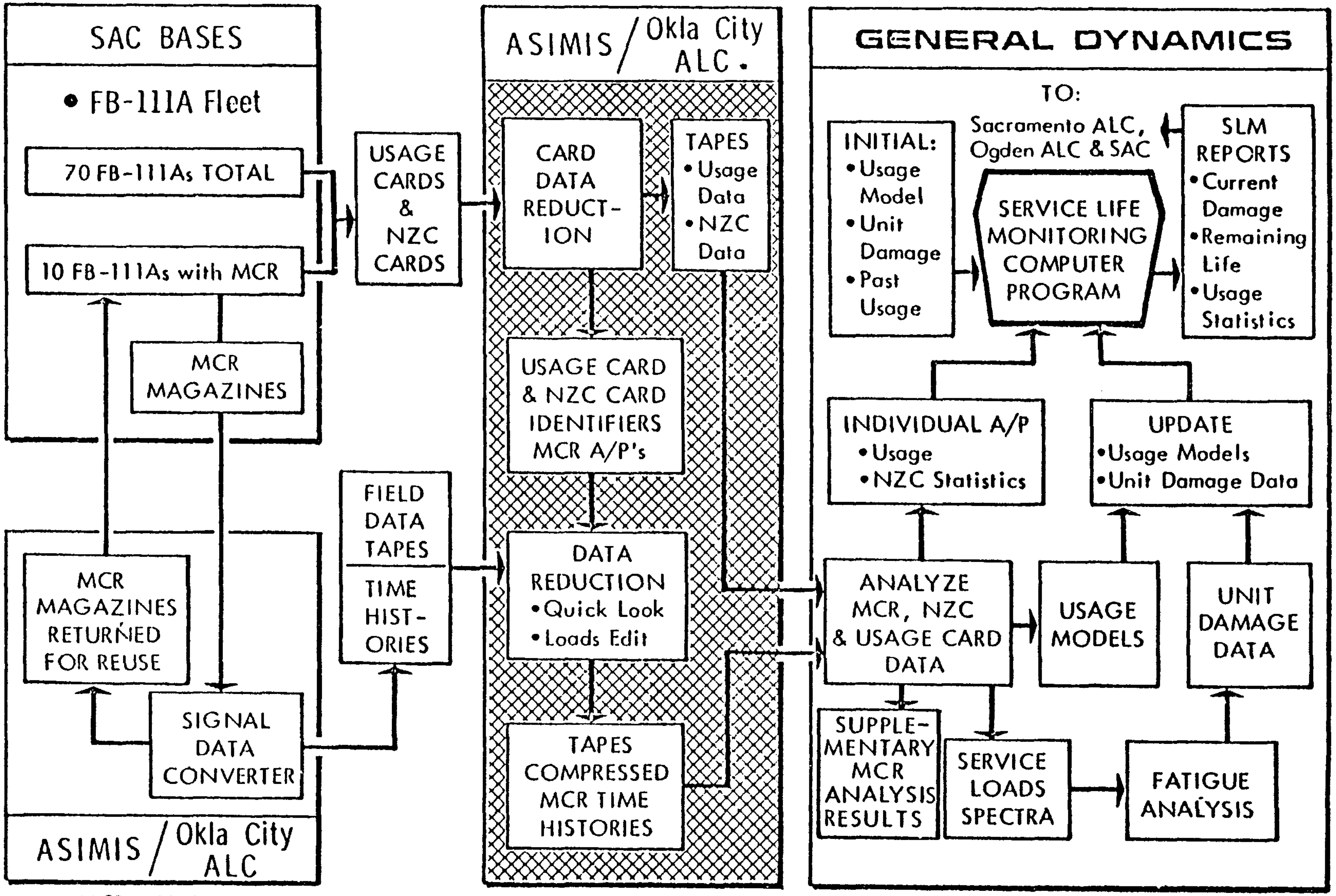
These major phases are high-lighted in the SLM information flow chart presented in Figure 4-1.

## 4.1 Quick Look Analysis

MCR data are reviewed on a flight-by-flight basis to determine the flights for which the MCR data are usable for updating airframe service load spectra. A digital computer procedure (referred to as Quick Look) was developed to facilitate this review. The Quick Look procedure provides a digital listing of the maximum and minimum values for successive 33-second time intervals for each MCR data item. The listing for an entire flight is reviewed for evidence of erroneous MCR data. Criteria for selection of flights with usable MCR data are presented in FZM-12-13524B (Reference 4). Quick Look information is also used to establish certain information needed for the subsequent Loads Edit Analysis which is described later in this section. For a given flight, this information includes such items as (1) null corrections for selected MCR parameters, (2) MCR parameters which are to be suppressed because of erroneous measurements, and (3) the MCR time records for starting and stopping the Loads Edit Analysis.

FIGURE 4-1

FB-111A SAC SLM DATA FLOW




MCR - MULTIPLE CHANNEL RECORDER    NZC - CG VERTICAL LOAD FACTOR COUNTER

## 4.3 Loads Edit Analysis

To facilitate storage and analysis of the usable MCR data and to reduce the associated costs, MCR measurements for periods of inactivity are not preserved. As will be shown in Subsection 5.2, the periods of inflight maneuver activity sum to approximately 15% of the total flight time. Also, as explained later in this section, MCR measurements are preserved for only certain selected times during these maneuver activity periods. Thus, this data reduction technique results in preserving MCR measurements for only a small percentage of the total number of readings (240 per second) of MCR measurements that are recorded. The computer procedure developed to generate these "compressed time histories" of MCR data for individual flights is referred to as the Loads Edit Procedure.

The Load Edit Procedure is designed to preserve the MCR data necessary for subsequent analyses to generate (1) airframe and landing gear service loads, (2) flight profile and ground handling usage statistics, and (3) airplane response statistics for flight and ground operations. Specifically, MCR measurements are preserved for those times when selected items have extreme values (maximum or minimum) between successive crossings of predefined thresholds. These items are referred to hereinafter as peak indicators (PI's). In some cases the PI's used to preserve MCR data for ground operations are different than those used for preserving MCR data for flight operations. The PI's for ground operations and their associated identification code numbers and thresholds are presented in Table 4-1. This information for the PI's for flight operations is shown in Table 4-2. Some of the PI's are MCR parameters (e.g., $N_y$, $N_z$, DR, P, Q, and R) while others are computed from the MCR measurements. Examples of this latter group are DA, $\dot{P}$, $\dot{Q}$, $\dot{R}$, nose gear side force, and wing, horizontal tail and vertical tail root shears. Additionally, MCR measurements are also preserved for the following times:

- Time at start of each flight maneuver (approximately 1g trim data) -- denoted as a PI No. 63.
- Time at end of each flight maneuver -- PI No. 64.
- Time at 66-second intervals between flight maneuvers -- PI No. 60.

A maneuver starts when one or more of a group of selected items have values outside of predefined thresholds. The maneuver ends when all of these items return to values within their thresholds. The items used to detect these periods of flight maneuver activity are referred to as maneuver activity indicators (MAI's). They are identified in Table 4-2 along with their associated thresholds. All MAI's except DA, $\dot{P}$, $\dot{Q}$, and $\dot{R}$ are MCR parameters. DA and the angular accelerations $\dot{P}$, $\dot{Q}$, and $\dot{R}$ are computed by the Loads Edit Procedure.

During periods of flight maneuver activity, as defined by using the MAI's, the peak indicators for flight operations (Table 4-2) are used in the manner previously described to search for the times at which "time-hacks" of the MCR measurements are to be preserved. MCR measurements for flight operations outside of the maneuver activity periods are not examined for such time-hacks. The following information is preserved for the time-hacks generated by the flight PI's:

- Identity and magnitude of the PI which generated the time-hack.
- Time of the time-hack (when it occurred).
- Measurements for all MCR parameters except gear pressures and sink speed.
- Computed values of GW, $\dot{P}$, $\dot{Q}$, and $\dot{R}$.
- Identification of the maneuver type (discussed next).

Definition of the maneuver type (MT) for a given inflight time-hack is based on which MAI's are out of their respective thresholds at the time of the time-hack; the criteria is shown below:

| MANEUVER TYPE (MT) ID CODE NO. | DESCRIPTION OF MANEUVER | MAI's OUT OF THRESHOLD INTERVAL |
|---|---|---|
| 0 | Pitch | NZ, Q, $\dot{Q}$ (Note *) |
| 1 | Yaw | NY, DR, R, $\dot{R}$ (Note *) |
| 2 | Roll | DA, SPL, SPR, P, $\dot{P}$ (Note *) |
| 3 | Combined | Any combination of those for MT's 0, 1 or 2 |

Note *—Any one of these or any combination of two or more of them.

The information preserved for the time-hacks generated by the peak indicators for ground operations (Table 4-1) includes

- Identity and magnitude of the peak indicator which generated the time-hack.
- Time of the time-hack.
- Measurements for all MCR parameters except sink speed and left and right horizontal tail positions.
- Computed values of GW, $\dot{P}$, $\dot{Q}$, and $\dot{R}$.

Further, the Loads Edit Procedure classifies the MCR data preserved for the time-hacks into three categories:

Type 1 Data - Pre-flight Ground Operations

Type 2 Data - Flight Operations

Type 3 Data - Other Ground Operations--- ground operations during touch-and-go landings, taxi-back landings and ground operations associated with the final landing for a flight.

In addition to preserving information for selected time-hacks (Types 1, 2, and 3 Data), the following information (referred to as Type 4 - Summary Data) is also generated and preserved by the Loads Edit Procedure for individual flights:

- Frequency distributions of rudder and left and right spoiler deflection peaks.
- Frequency distributions of left and right horizontal tail position changes.
- Sequence of wing sweep position changes.
- Sequence of wing flap position changes.

- Frequency distributions of vertical and lateral load factor peaks for flight operations.
- Frequency distributions of ground turns according to direction and amount of heading change.
- Frequency distributions of longitudinal NX peaks for ground operations.

The Type 4 Summary Data also contain the sink speed for each landing that occurred during the given MCR flight. This information is determined during the Quick Look Analysis and is input into the Loads Edit Procedure for record keeping purposes.

Compressed time histories of MCR data (Data Types 1, 2, and 3) and Type 4 Summary Data for individual MCR flights are written on magnetic tape for subsequent analyses.

Additional information about MCR data reduction and about the Loads Edit Procedure are contained in FZS-12-13524B , Supplement 1 (Reference 5).

TABLE 4-1

F/FB-111 MCR PEAK INDICATORS FOR GROUND OPERATIONS

| PI No. | DATA ITEM | THRESHOLDS AND RESETS (MCR COUNTS) | | | |
|---|---|---|---|---|---|
| | | UPPER | | LOWER | |
| | | THRESHOLD GT | RESET LE | THRESHOLD LT | RESET GE |
| 1 | $N_Z$ | 22 | 22 | 20 | 20 |
| 2 | $N_Y$ | 33 | 32 | 30 | 31 |
| 3 | $N_X$ | 33 | 32 | 30 | 31 |
| 4 | DR | 48 | 46 | 15 | 17 |
| 12 | P | 33 | 32 | 30 | 31 |
| 13 | Q | 33 | 32 | 30 | 31 |
| 14 | R | 33 | 32 | 30 | 31 |
| 15 | $\dot{P}$ | 39 | 34 | 23 | 28 |
| 16 | $\dot{Q}$ | 45 | 34 | 17 | 28 |
| 17 | $\dot{R}$ | 35 | 31 | 27 | 31 |
| 5 | NGP ① | 4 | -5 | -4 | 5 |
| 6 | MGPL ① | 4 | -5 | -4 | 5 |
| 7 | MGPR ① | 4 | -5 | -4 | 5 |
| 8 | $F_{YNG}$ | 1000 LBS | 500 LBS | -1000 LBS | -500 LBS |

NOTES: GT = GREATER THAN, LT = LESS THAN, GE = GT OR EQUAL, LE = LT OR EQUAL TO
① ~ THESE PI THRESHOLDS AND RESETS ARE INCREMENTAL FROM THE PREVIOUS PEAK OR VALLEY

# TABLE 4-2
## F/FB-111 MCR MANEUVER ACTIVITY INDICATORS AND PEAK INDICATORS FOR FLIGHT OPERATIONS
(PAGE 1 OF 2)

| DATA ITEM | MANEUVER ACTIVITY INDICATOR (MAI) THRESHOLDS | | PI~THRESHOLDS AND RESETS (MCR COUNTS) | | | | |
|---|---|---|---|---|---|---|---|
| | UPPER | LOWER | PI No. | UPPER | | LOWER | |
| | GT ④ | LT ④ | | THRESHOLD GT ④ | RESET LE ④ | THRESHOLD LT ④ | RESET GE ④ |
| $N_Z$ | 22 | 20 | 1 | 23 | 21 | 19 | 21 |
| $N_Y$ | 33 | 30 | 2 | 33 | 32 | 30 | 31 |
| DR | 33 | 30 | 3 | 34 | 32 | 29 | 31 |
| DA ① | 3 | -3 | 4 | 5 | 2 | -5 | -2 |
| $DA_{HL}$ ① | 3 | -3 | 4HL ② | 10 | 2 | -10 | -2 |
| $V_{VT}$ ③ | NOT USED | NOT USED | 5 | 3300 LBS | 1650 LBS | -3300 LBS | -1650 LBS |
| $V_{HTL}$ ③ | " " | " " | 6 | 3000 LBS | 1500 LBS | -3000 LBS | -1500 LBS |
| $V_{HTR}$ ③ | " " | " " | 7 | 3000 LBS | 1500 LBS | -3000 LBS | -1500 LBS |
| $V_{WL}$ ③ | " " | " " | 8 | 7500 LBS | 3750 LBS | -7500 LBS | -3750 LBS |
| $V_{WR}$ ③ | " " | " " | 9 | 7500 LBS | 3750 LBS | -7500 LBS | -3750 LBS |
| SPL | 4 | N/A | 10 | 8 | 4 | N/A | N/A |
| SPR | 4 | " | 11 | 8 | 4 | " | " |
| P | 32 | 31 | 12 | 36 | 32 | 27 | 31 |
| Q | 32 | 31 | 13 | 34 | 32 | 29 | 31 |
| R | 32 | 31 | 14 | 34 | 32 | 29 | 31 |
| $\dot{P}$ | 34 | 28 | 15 | 47 | 34 | 15 | 28 |
| $\dot{Q}$ | 34 | 28 | 16 | 45 | 34 | 17 | 28 |
| $\dot{R}$ | 33 | 29 | 17 | 45 | 31 | 17 | 31 |

SEE NEXT PAGE FOR NOTES ①, ②, ③ AND ④.

TABLE 4-2 (Cont.)

F/FB-111 MCR MANEUVER ACTIVITY INDICATORS AND PEAK INDICATORS FOR FLIGHT OPERATIONS

(PAGE 2 OF 2)

NOTES:

① ~ TO COMPUTE THRESHOLDS AND RESETS FOR DA, THE VALUES SHOWN IN THIS TABLE ARE TO BE ADDED TO DA TRIM WHICH IS COMPUTED EVERY THREE RECORDS IN LOADS EDIT.

② ~ USE THESE VALUES TO COMPUTE DA PEAK INDICATORS FOR HIGH-LIFT OPERATIONS (DELTA FLAP 75°).

③ ~ TO COMPUTE PEAK INDICATOR THRESHOLDS AND RESETS FOR THESE LOAD ITEMS, ADD THE VALUES SHOWN IN THIS TABLE TO TARE VALUES AS COMPUTED BY LOADS EDIT FOR PI=63 TIME-HACKS (MCR DATA AT START OF MANEUVER).

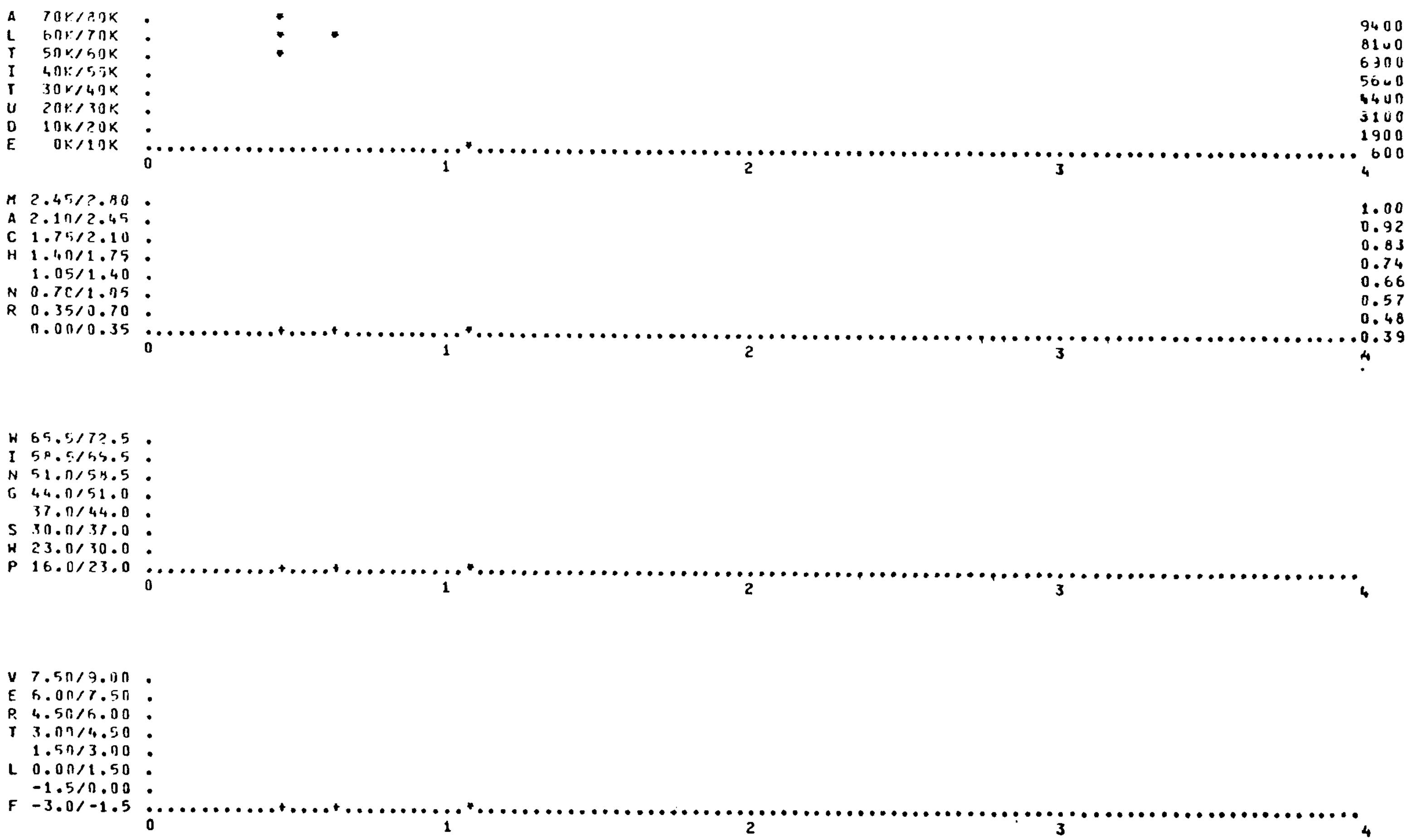
④ ~ GT = GREATER THAN, LT = LESS THAN, GE = GT OR EQUAL, LE = LT OR EQUAL TO.

QUICK LOOK

| MN | HP | LAM | FP | TOAT | MGPL | MGPR | G* | FFR | FFL | NZ | NY | NX | P | O | R | SPL | SPR | HTL | HTR | DR | ALP | VSS | NGP | GSFS | NREC | GH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 2 | 0 0. | 0 0 | 0 0 | 1415 | 2626 | 2525 | 6353 | 0 0 | 0 0 | 2222 | 3333 | 3737 | 3030 | 3030 | 2930 | 0 1 | 0 0 | 2839 | 2537 | 3132 | 3337 | 0 0 | 0 | 0Y12 0A | 69 | 0 |
| 1 2 | 0 0 | 0 0 | 0 0 | 1415 | 2626 | 2575 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3737 | 2730 | 930 | 2951 | 0 1 | 0 0 | 3040 | 1738 | 1646 | 3387 | 0 0 | 0 | 0525 0P | 72 | 0 |
| 1 2 | 0 1 | 0 0 | 0 0 | 1415 | 2626 | 2525 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3637 | 3030 | 3050 | 2930 | 063 | 063 | 2940 | 1438 | 1648 | 3337 | 0 0 | 0 | 0 33 0A | 75 | 0 |
| 1 2 | 0 1 | 0 0 | 0 0 | 1415 | 2626 | 2525 | 6563 | 0 0 | 0 0 | 2222 | 3333 | 3637 | 3030 | 3030 | 2930 | 063 | 063 | 3036 | 2835 | 3032 | 3337 | 020 | 0 | 0529 0A | 78 | 0 |
| 147 | 053 | 055 | 057 | 1457 | 2551 | 2549 | 6553 | 054 | 056 | 2257 | 3357 | 3657 | 3030 | 3054 | 2951 | 0 1 | 0 0 | 2533 | 2250 | 3057 | 3356 | 056 | 048 | 33 0F | 81 | 0 |
| 255 | 056 | 2757 | 057 | 1457 | 2656 | 2557 | 6363 | 057 | 056 | 2257 | 2657 | 2557 | 2657 | 2757 | 2657 | 057 | 057 | 2157 | 1957 | 2857 | 2757 | 057 | 057 | Y13 0A | 84 | 0 |
| 2 2 | 0 1 | 4245 | 0 0 | 1415 | 2626 | 2525 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3637 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2023 | 1921 | 3132 | 3337 | 0 0 | 0 | 0Y22 0K | 87 | 0 |
| 2 2 | 0 1 | 4560 | 0 0 | 1415 | 2626 | 2526 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3637 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2023 | 1922 | 3032 | 3337 | 0 0 | 0 | 0 33 0P | 90 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2526 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2023 | 1922 | 3132 | 3337 | 0 0 | 0 | 0S11 0P | 93 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2526 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 0 | 2152 | 2052 | 3032 | 2535 | 0 0 | 0 | 0N14 0A | 96 | 0 |
| 1 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2526 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 3243 | 3141 | 3132 | 2428 | 0 0 | 0 | 0 33 0A | 99 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2626 | 6353 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 3859 | 3656 | 3136 | 2428 | 0 0 | 0 | 0 33 0 | 102 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2526 | 2626 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 3859 | 3756 | 3132 | 2528 | 0 0 | 0 | 0S26 0A | 105 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2626 | 6353 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2839 | 2638 | 3132 | 2428 | 0 0 | 0 | 0 25 0 | 108 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2626 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2429 | 2328 | 3132 | 2428 | 0 0 | 0 | 0S24 0A | 111 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2626 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2427 | 2325 | 3132 | 2428 | 0 0 | 0 | 0 33 0 | 114 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2626 | 2626 | 5363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2427 | 2325 | 2932 | 2528 | 0 0 | 0 | 0Y11 0R | 117 | 0 |
| 2 2 | 0 1 | 6050 | 0 0 | 1415 | 2527 | 2626 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3537 | 3030 | 3030 | 2930 | 0 1 | 0 1 | 2632 | 2530 | 2341 | 2528 | 0 0 | 0 | 0Y19 0R | 120 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1415 | 2629 | 2627 | 6363 | 0 0 | 0 0 | 2222 | 3334 | 3536 | 3030 | 3030 | 2430 | 0 0 | 0 1 | 3238 | 3037 | 2254 | 2428 | 0 0 | 0 | 0S25 0F | 123 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1415 | 2527 | 2727 | 6353 | 0 0 | 0 0 | 2122 | 3334 | 3436 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 3740 | 3639 | 3132 | 2429 | 0 0 | 0 | 0S30 0P | 125 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 3338 | 3237 | 3132 | 2529 | 0 0 | 0 | 0S24 0A | 129 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6353 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2733 | 2633 | 3132 | 2529 | 0 0 | 0 | 0S27 0A | 132 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2428 | 2328 | 3132 | 2529 | 0 0 | 0 | 0 33 0 | 135 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3636 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2326 | 2225 | 3133 | 2529 | 0 0 | 0 | 0 33 0P | 138 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6353 | 0 0 | 0 0 | 2222 | 3333 | 3536 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2336 | 2335 | 2337 | 2529 | 0 0 | 0 | 0S30 0P | 141 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2526 | 2728 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3536 | 3030 | 3030 | 2930 | 0 1 | 0 1 | 3640 | 3539 | 2440 | 2529 | 0 0 | 0 | 0S25 0A | 144 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2525 | 2728 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3536 | 3030 | 3030 | 2930 | 0 0 | 0 1 | 3841 | 3639 | 2436 | 2529 | 0 0 | 0 | 0S25 0F | 147 | 0 |
| 2 2 | 0 1 | 6060 | 0 0 | 1515 | 2528 | 2629 | 6353 | 0 0 | 0 0 | 2222 | 3334 | 3536 | 3030 | 3030 | 2730 | 0 0 | 0 1 | 3840 | 3739 | 3043 | 2728 | 0 0 | 0 | 0Y 7 0A | 150 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2528 | 2627 | 6363 | 0 0 | 0 0 | 2222 | 3334 | 3436 | 3030 | 3030 | 2830 | 0 0 | 0 0 | 3740 | 3639 | 3140 | 2529 | 0 0 | 0 | 0S25 0P | 153 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3535 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 3140 | 3136 | 3132 | 2529 | 0 0 | 0 | 0 25 0F | 156 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3535 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2735 | 2632 | 3132 | 2529 | 0 0 | 0 | 0 33 0 | 159 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1516 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3535 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2329 | 2228 | 3132 | 2529 | 0 0 | 0 | 0S32 0A | 162 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1516 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3535 | 3030 | 3030 | 3030 | 0 0 | 0 1 | 2126 | 2022 | 3132 | 2529 | 0 0 | 0 | 0 22 0P | 165 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1516 | 2626 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3515 | 3030 | 3030 | 3030 | 0 1 | 0 1 | 2123 | 1922 | 3132 | 2529 | 0 0 | 0 | 0S29 0A | 168 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1516 | 2628 | 2627 | 6353 | 0 0 | 0 0 | 2222 | 3334 | 3536 | 3030 | 3030 | 2230 | 0 0 | 0 1 | 2033 | 2033 | 3161 | 2529 | 0 0 | 0 | 0 33 0 | 171 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1516 | 2728 | 2627 | 6363 | 0 0 | 0 0 | 2222 | 3334 | 3535 | 3030 | 3030 | 2630 | 0 0 | 0 1 | 3340 | 3340 | 2646 | 2629 | 0 0 | 0 | 0 33 0 | 174 | 0 |
| 2 2 | 0 1 | 5061 | 0 0 | 1515 | 2627 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3535 | 3030 | 3030 | 2930 | 0 0 | 0 1 | 3740 | 3739 | 2636 | 2529 | 0 0 | 0 | 0 33 0F | 177 | 0 |
| 2 2 | 0 1 | 6061 | 0 0 | 1515 | 2629 | 2428 | 6363 | 0 0 | 0 0 | 2222 | 3334 | 3535 | 3030 | 2930 | 2633 | 0 0 | 0 1 | 3740 | 3539 | 1743 | 2529 | 0 0 | 0 | 0 33 0 | 180 | 744 |
| 1 2 | 0 1 | 6060 | 0 0 | 1515 | 2627 | 2728 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3435 | 3030 | 3030 | 2931 | 0 0 | 1 1 | 3840 | 3739 | 2135 | 2529 | 0 0 | 0 | 0S27 0F | 183 | 744 |
| 2 2 | 0 1 | 6060 | 0 0 | 1515 | 2629 | 2527 | 6363 | 0 0 | 0 0 | 2222 | 3335 | 3435 | 3030 | 3030 | 2230 | 0 0 | 0 1 | 3840 | 3739 | 3257 | 2529 | 0 0 | 0 | 0 22 0 | 186 | 743 |
| 2 2 | 0 0 | 6060 | 0 0 | 1515 | 2625 | 2727 | 6363 | 0 0 | 0 0 | 2222 | 3333 | 3535 | 3030 | 3030 | 3030 | 0 0 | 1 1 | 3939 | 3838 | 3232 | 2727 | 0 0 | 0 | 0 0 0 | 187 | 743 |

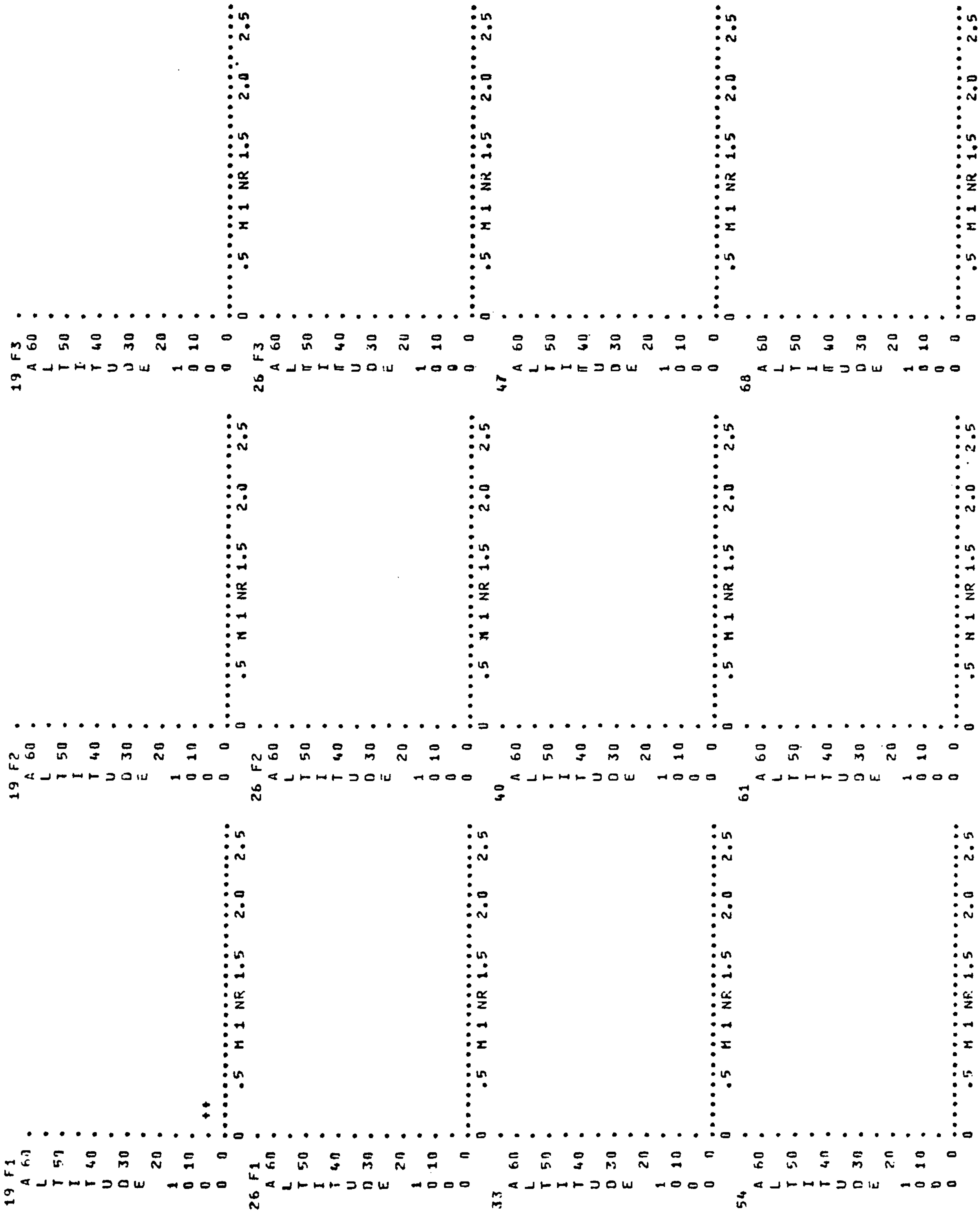
ATTACHMENT (4)
Pg 10 of 18

ATTACHMENT (4)
Pg 11 of 18

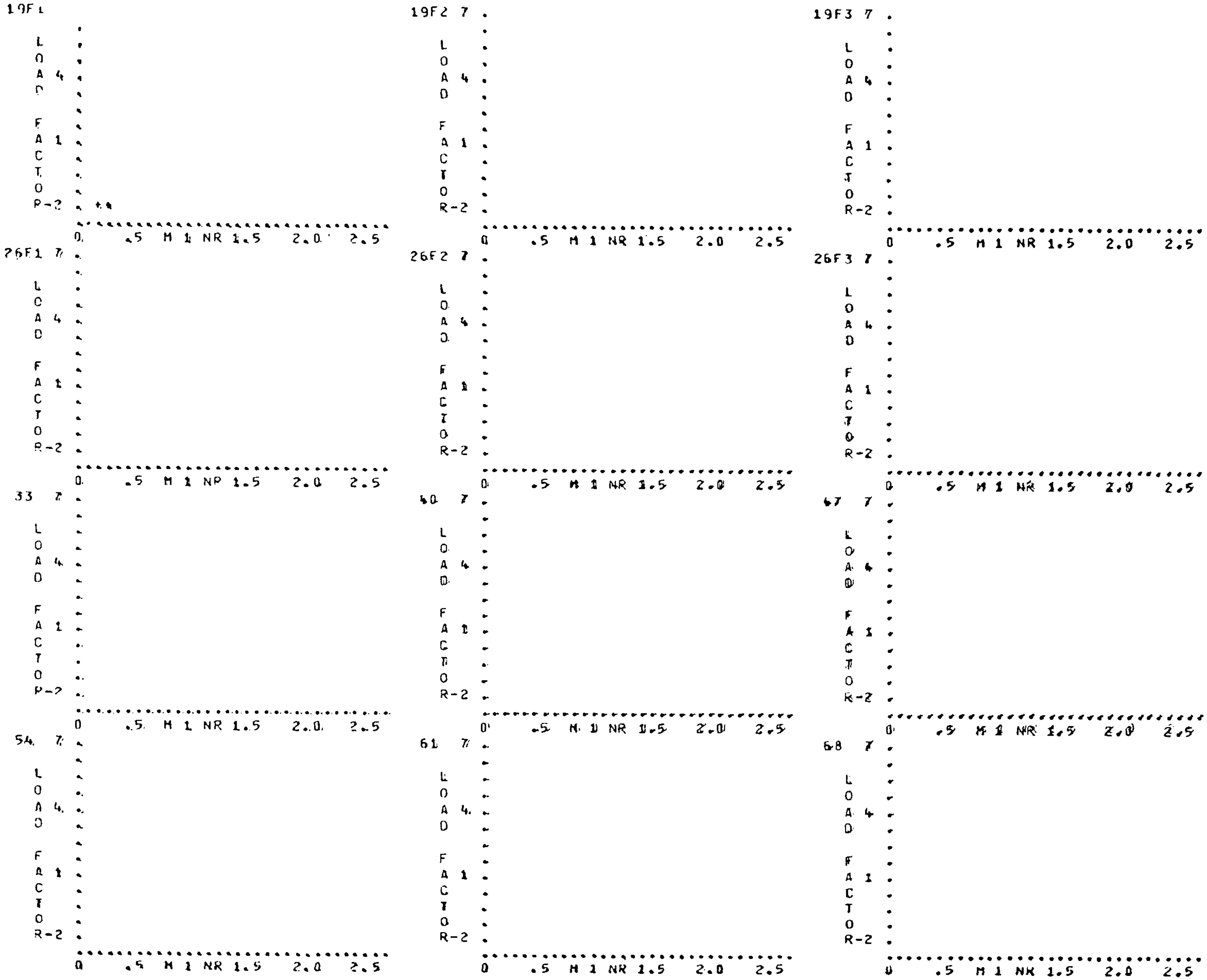



ENGINE TIME OF 0 HOURS + TIME SHOWN

QUICK LOOK


19 F1
19 F2
19 F3
26 F1
26 F2
26 F3
33
40
47
54
61
68
ALTITUDE 1000
60 50 40 30 20 10 0
0 .5 M 1 NR 1.5 2.0 2.5

QUICK LOOK


19F1
19F2 7
19F3 7
26F1 7
26F2 7
26F3 7
33 7
40 7
47 7
54 7
61 7
68 7
LOAD FACTOR
4
1
-2
0 .5 M 1 NR 1.5 2.0 2.5

ATTACHMENT (4)
Pg. 14 of 18

QUICK LOOK

FLIGHT NR = 1

| | TEMP1 L1 | TEMP1 L2 | TEMP1 L3 | TEMP2 L1 | TEMP2 L2 | TEMP2 L3 | TEMP3 L1 | TEMP3 L2 | TEMP3 L3 | TEMP4 L1 | TEMP4 L2 | TEMP4 L3 | TEMP5 L1 | TEMP5 L2 | TEMP5 L3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LF GT 5.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 4.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 3.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 2.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT -0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | LF SPECTRA L1 | LF SPECTRA L2 | LF SPECTRA L3 | TIME LF GT L1 | TIME LF GT L2 | TIME LF GT L3 |
|---|---|---|---|---|---|---|
| LF GT 5.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 4.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 3.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 2.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 1.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.4 | 0 | 0 | 0 | 9 | 0 | 0 |
| LF LT 0.0 | 0 | 0 | 0 | 9 | 0 | 0 |
| LF LT -0.6 | 0 | 0 | 0 | 9 | 0 | 0 |

AMBIENT TEMPS AND LAMDAS
TEMP1 = LT -40 DEG F
TEMP2 = -40 TO 0 DEG F
TEMP3 = 1 TO 40 DEG F
TEMP4 = 41 TO 80 DEG F
TEMP5 = GT 81 DEG F
L1 = WG SWP LE 29 DEG
L2 = WG SWP 30 - 57 DEG
L3 = WG SWP GE 58 DEG

| NY SPECTRA | >.94 | >.76 | >.57 | >.38 | >.19 | <-.19 | <-.38 | <-.57 | <-.76 | <-.94 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

PEAK LF AND TOTAL MANEUVER TIME

| | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | SUM TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| LF GT 5.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 4.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 3.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 2.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT -0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

T1 = MANEUVER TIME 1 SEC
T2 = MANEUVER TIME 2 SEC
T3 = MANEUVER TIME 3-4 SEC
T4 = MANEUVER TIME 5-10 SEC
T5 = MANEUVER TIME 11-30 SEC
T6 = MANEUVER TIME 31-50 SEC
T7 = MANEUVER TIME 51-70 SEC
T8 = MANEUVER TIME 71-120 SEC
T9 = MANEUVER TIME GT-121 SEC

| | L1 T1 | L1 T2 | L1 T3 | L1 T4 | L1 T5 | L1 T6 | L1 T7 | L1 T8 | L1 T9 | L2 T1 | L2 T2 | L2 T3 | L2 T4 | L2 T5 | L2 T6 | L2 T7 | L2 T8 | L2 T9 | L3 T1 | L3 T2 | L3 T3 | L3 T4 | L3 T5 | L3 T6 | L3 T7 | L3 T8 | L3 T9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LF GT 5.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 4.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 3.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 2.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT -0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | L1 AND L2 T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | L2 AND L3 T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | L1 AND L2 AND L3 T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LF GT 5.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 4.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 3.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 2.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF GT 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LF LT -0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

T(L19)= 9 T(L26)= 0 T(L33)= 0 T(L40)= 0 T(L47)= 0 T(L54)= 0 T(61)=, 0 T(L68)= 0
T(L19)= .00 T(L26)= 0.00 T(L33)= 0.00 T(L40)= 0.00 T(L47)= 0.00 T(L54)= 0.00 T(L61)= 0.00 T(L68)= 0.00
REC= 348 RED REC= 1 BAD R= 10 PAR R= 67 MIS FLT HRS = .01 GR HOURS = 1.05 BUF OUT 1 TO 0 GEAR CYC = 0

ATTACHMENT (4)
Pg. 15 of 18

LOADS EDIT OUT GROUND DATA

GENERAL DYNAMICS CORPORATION CENTRAL DATA SYSTEMS CENTER 04/07/78 PAGE 0001
FORT WORTH DIVISION 6600 PROCEDURE R3U PROBLEM 270883-01

TYPE 1 DATA STARTING AT 0/ 0/ 0/0.00

| A/P NO. | BASE CODE | WING IDENT. | MISSN PURP. | NO. TO. | NO. LA. | NO. GP. | FLT. PROF | AP TIME | AR ET | TFR | SUPER SONIC | GW CODE | HP-WT 2 3 4 | B-WT L R | T/O CONF | BAY L R | EOF HPS | DATE DD/MM/Y | T/O GROSS WEIGHT | MISSN SEQ | CORR. FACTOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 680248 | 8 | 380 | 2 | 1 | 7 | 8 | 2 | 3 | 1 | 1 | 0 | 1 | 0 6 0 | 0 0 | 2 | 1 1 | 16660 | 11 15 7 | 91033 | 2 | 4 |

DATA QUALITY INDEX - ZERO IS GOOD DATA ONE IS BAD DATA.

| NZ | NY | NX | OR | HTL | HTR | SPL | SPR | P | Q | R | FFL | FFR | IRFF | MGL | MGR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| TIME | DYP | MN | HP | LM | FP OT | GW | NZ | NY | NX | DA | NCP | GPL | GPR | SL | SR | DR | ALP | FL | FR | P | Q | R | PA | QA | RA | LA1 | A2 | PSG | ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 0-15.53 | 7 | .07 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 207 | 3 | 0 | 0 | 11 | 2 | 1 | 3 | 3 | 0 | -3 | 0.00 | 0.00 | -.06 | 0 | 0 | 1 | 20 |
| 0- 0-15.47 | 7 | .07 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 207 | 3 | 0 | 0 | 12 | 2 | 1 | 3 | 3 | 0 | -2 | 0.00 | 0.00 | -.07 | 0 | 0 | 1 | 17 |
| 0- 0-16.00 | 7 | .07 | 1 | 16 | 25-47 | 91 | 1.03 | .09 | .03 | 0 | 269 | 207 | 3 | 0 | 0 | 8 | 1 | 1 | 3 | 3 | 0 | -3 | 0.00 | 0.00 | -.05 | 27 | 0 | 1 | 8 |
| 0- 0-19.00 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .09 | .03 | 0 | 261 | 214 | 3 | 0 | 0 | 8 | 1 | 1 | 3 | 3 | 0 | -3 | -.09 | 0.00 | -.02 | 22 | 0 | 101 | 8 |
| 0- 0-24.20 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .09 | .03 | 0 | 269 | 214 | 3 | 0 | 0 | 8 | 1 | 1 | 1 | 3 | 0 | -7 | 0.00 | 0.00 | 0.00 | 17 | 0 | 1 | 8 |
| 0- 0-24.73 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 214 | 3 | 0 | 0 | 11 | 2 | 1 | 1 | 3 | 0 | -5 | 0.00 | 0.00 | .06 | 0 | 0 | 101 | 17 |
| 0- 0-24.20 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .09 | .03 | 0 | 269 | 214 | 3 | 0 | 0 | 8 | 1 | 1 | 1 | 3 | 0 | -7 | 0.00 | 0.00 | 0.00 | 0 | 0 | 1 | 14 |
| 0- 0-34.73 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 199 | 3 | 0 | 0 | -1 | 2 | 1 | 1 | 3 | 0 | -0 | 0.00 | 0.00 | .10 | 0 | 82 | 1 | 21 |
| 0- 0-34.67 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 199 | 3 | 0 | 0 | -1 | 2 | 1 | 1 | 3 | 0 | -2 | 0.00 | 0.00 | .14 | -32 | 0 | 1 | 8 |
| 0- 0-34.67 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 199 | 3 | 0 | 0 | -1 | 2 | 1 | 1 | 3 | 0 | -2 | 0.00 | 0.00 | .14 | 0 | 0 | 101 | 17 |
| 0- 0-37.20 | 7 | .07 | 1 | 16 | 25-47 | 91 | 1.03 | -.03 | .03 | 0 | 264 | 199 | 3 | 0 | 0 | -10 | 1 | 1 | 1 | -3 | 0 | 3 | .09 | 0.00 | 0.00 | 0 | 0 | 101 | 20 |
| 0- 0-38.73 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | -.03 | .03 | 0 | 269 | 191 | 3 | 0 | 0 | -8 | 1 | 1 | 1 | 3 | 0 | 3 | 0.00 | 0.00 | 0.00 | 0 | 0 | 101 | 14 |
| 0- 0-39.07 | 7 | .07 | 1 | 16 | 25-47 | 91 | 1.03 | -.03 | .03 | 0 | 261 | 191 | 3 | 0 | 0 | -9 | 1 | 1 | 1 | -3 | 0 | 0 | -.14 | 0.00 | -.08 | 0 | 7 | 101 | 21 |
| 0- 0-39.00 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | -.03 | .03 | 0 | 261 | 191 | 3 | 0 | 0 | -9 | 1 | 1 | 1 | 3 | 0 | 2 | -.09 | 0.00 | -.14 | 32 | 0 | 1 | 8 |
| 0- 0-39.00 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | -.03 | .03 | 0 | 261 | 191 | 3 | 0 | 0 | -9 | 1 | 1 | 1 | 3 | 0 | 2 | -.09 | 0.00 | -.14 | 0 | 0 | 1 | 17 |
| 0- 0-46.60 | 17 | .11 | 1 | 16 | 25-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 199 | 3 | 0 | 0 | 4 | 2 | 1 | 1 | 3 | 0 | -0 | 0.00 | 0.00 | -.02 | 12 | 0 | 1 | 8 |
| 0- 2-40.93 | 7 | .07 | 0 | 16 | 24-47 | 91 | .84 | -.03 | .03 | 0 | 269 | 191 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | 3 | 0 | 3 | 0.00 | 0.00 | .02 | 0 | 0 | 101 | 20 |
| 0- 2-40.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | .03 | 0 | 269 | 191 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | 3 | 0 | 2 | 0.00 | 0.00 | .02 | -22 | 0 | 1 | 8 |
| 0- 2-41.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | .03 | 0 | 269 | 183 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | -3 | 0 | 3 | 0.00 | 0.00 | .05 | -27 | 0 | 1 | 8 |
| 0- 2-42.27 | 7 | .07 | 0 | 16 | 24-47 | 91 | .84 | -.09 | -.03 | 0 | 269 | 183 | 3 | 0 | 39 | -5 | 1 | 1 | 0 | 3 | 0 | 5 | 0.00 | 0.00 | .02 | -22 | 0 | 1 | 8 |
| 0- 2-42.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | .84 | -.09 | .03 | 0 | 269 | 183 | 3 | 0 | 39 | -6 | 1 | 1 | 0 | 3 | 0 | 3 | 0.00 | 0.00 | .03 | -27 | 0 | 1 | 8 |
| 0- 2-44.27 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | -.03 | 0 | 269 | 175 | 3 | 0 | 39 | -8 | 1 | 0 | 0 | 3 | -0 | 3 | 0.00 | 0.00 | .02 | -22 | 0 | 1 | 8 |
| 0- 2-45.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | .84 | -.09 | -.03 | 0 | 269 | 175 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | 3 | 0 | 3 | 0.00 | 0.00 | .02 | -22 | 0 | 1 | 8 |
| 0- 2-47.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | .03 | 0 | 269 | 175 | 3 | 0 | 39 | -6 | 1 | 1 | 1 | 3 | 0 | 5 | 0.00 | 0.00 | .05 | -27 | 0 | 1 | 8 |
| 0- 2-48.27 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | -.03 | 0 | 269 | 175 | 3 | 0 | 39 | -4 | 1 | 1 | 0 | -3 | 0 | 5 | 0.00 | 0.00 | .03 | -27 | 0 | 1 | 8 |
| 0- 2-48.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.03 | .03 | 0 | 269 | 175 | 3 | 0 | 39 | -6 | 1 | 1 | 0 | -3 | 0 | 5 | .09 | .02 | -.06 | 0 | 0 | 1 | 17 |
| 0- 2-49.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | -.03 | 0 | 269 | 183 | 3 | 0 | 39 | -7 | 1 | 1 | 0 | -3 | 0 | 3 | 0.00 | 0.00 | .02 | -22 | 0 | 1 | 8 |
| 0- 2-48.40 | 7 | .07 | 0 | 16 | 24-47 | 91 | .84 | -.03 | -.03 | 0 | 269 | 175 | 3 | 0 | 39 | -3 | 1 | 1 | 0 | -3 | 0 | 7 | 0.00 | -.02 | -.02 | 0 | 0 | 101 | 14 |
| 0- 2-51.07 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.03 | .03 | 0 | 269 | 183 | 3 | 0 | 39 | -2 | 1 | 1 | 0 | -3 | -0 | 0 | 0.00 | .02 | -.08 | 0 | 42 | 101 | 21 |
| 0- 2-51.20 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | .03 | .03 | 0 | 269 | 183 | 3 | 0 | 39 | -5 | 1 | 1 | 0 | -3 | 0 | 0 | 0.00 | 0.00 | -.08 | 27 | 0 | 1 | 8 |
| 0- 2-51.40 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.03 | .03 | 0 | 269 | 183 | 3 | 0 | 39 | -6 | 1 | 1 | 0 | -3 | 0 | 0 | 0.00 | 0.00 | -.08 | 0 | 0 | 1 | 17 |
| 0- 3- 1.93 | 7 | .07 | 0 | 16 | 24-47 | 91 | .84 | -.03 | -.03 | 0 | 269 | 191 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | -3 | 0 | 3 | 0.00 | 0.00 | 0.00 | 0 | 0 | 101 | 20 |
| 0- 3- 1.80 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.03 | -.03 | 0 | 269 | 191 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | 3 | -0 | 2 | 0.00 | .02 | .10 | 0 | 0 | 101 | 17 |
| 0- 3- 1.80 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.03 | -.03 | 0 | 269 | 191 | 3 | 0 | 39 | -8 | 1 | 1 | 1 | 3 | -0 | 2 | 0.00 | .02 | .10 | -32 | 0 | 1 | 8 |
| 0- 3- 3.87 | 7 | .07 | 0 | 16 | 24-47 | 91 | 1.03 | -.09 | -.03 | 0 | 269 | 183 | 3 | 0 | 39 | -5 | 1 | 1 | 0 | -3 | 0 | 3 | 0.00 | .02 | .02 | -22 | 0 | 101 | 8 |

LOADS EDIT OUTPUT FLIGHT DATA

ATTACHMENT (4)
Pg. 16 of 18

GENERAL DYNAMICS CORPORATION CENTRAL DATA SYSTEMS CENTER 04/07/78 PAGE 0004
FORT WORTH DIVISION 6600 PROCEDURE R3U PROBLEM 270883-01

TYPE 2 DATA STARTING AT 0/27/33/ .07

| A/P NO. | BASE CODE | WING IDENT. | MISSN PURP. | NO. TO. | NO. LA. | NO. GP. | FLT. PRCF | AR TIME | AR ET | TFR | SUPER SONIC | GW CODE | HP-WT 2 3 4 | B-WT L R | T/O CONF | DAY L R | EOF HRS | DATE DD/MM/Y | T/O GROSS WEIGHT | MISSN SEQ | CORR. FACTOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68024R | 8 | 380 | 2 | 1 | 7 | 8 | 2 | 3 | 1 | 1 | 0 | 1 | 0 6 0 | 0 0 | 2 | 1 1 | 16660 | 11 15 7 | 91033 | 2 | 4 |

DATA QUALITY INDEX - ZERO IS GOOD DATA ONE IS BAD DATA.

| NZ | NY | NX | DR | HTL | HTR | SPL | SPR | P | Q | R | FFL | FFR | IPFF | MGL | MGR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| TIME | DYP | MN | HP | LM | FP OT | GW | NZ | NY | NX | DA | HTL | HTR | SL | SR | DR | ALP | FL | FR | P | Q | R | PA | QA | RA | LA1 | A2 | PSG | ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-27-33.07 | 82 | .24 | 0 | 16 | 24-47 | 89 | 1.22 | -.03 | .53 | -58 | 3.8 | 15.5 | 0 | 0 | 0 | 13 | 55 | 56 | 3 | 0 | 0 | -.09 | -.02 | 0.00 | 0 | 0 | 1 | 63 |
| 0-27-33.07 | 82 | .24 | 0 | 16 | 24-47 | 89 | 1.03 | -.03 | .47 | -58 | 3.8 | 15.5 | 0 | 0 | 0 | 12 | 55 | 55 | -3 | -0 | -0 | -.14 | -.02 | 0.00 | 0 | 0 | 1 | 204 |
| 0-27-33.67 | 82 | .24 | 0 | 16 | 24-47 | 89 | 1.03 | -.03 | .47 | -7 | 7.0 | 8.5 | 0 | 0 | -1 | 12 | 55 | 55 | -3 | 0 | -0 | -.09 | C.00 | 0.00 | 2 | 2 | 101 | 64 |
| 0-27-57.13 | 252 | .42 | 0 | 16 | 0-47 | 88 | 1.03 | -.03 | .47 | 11 | 3.8 | 1.5 | 0 | 0 | -1 | 8 | 58 | 56 | -3 | -0 | -0 | 0.00 | .02 | -.02 | 0 | 0 | 0 | 63 |
| C-27-57.27 | 252 | .42 | 0 | 16 | 0-47 | 88 | 1.03 | -.03 | .47 | 15 | 3.8 | .7 | 0 | 0 | -1 | 8 | 58 | 56 | 3 | 0 | -0 | 0.00 | .26 | .03 | 0 | 0 | 100 | 316 |
| 0-27-57.60 | 252 | .42 | 0 | 16 | C-47 | 88 | 1.03 | .03 | .47 | 11 | 3.8 | 1.5 | 0 | 0 | -0 | 8 | 58 | 56 | 3 | 0 | -0 | 0.C0 | 0.00 | 0.00 | 2 | 2 | 100 | 64 |
| 0-27-58.80 | 252 | .42 | 0 | 16 | 0-47 | 88 | 1.03 | .03 | .47 | 3 | 2.3 | 1.5 | 0 | 0 | -0 | 7 | 58 | 56 | -3 | 0 | -0 | 0.00 | .05 | .02 | 0 | 0 | 0 | 63 |
| 0-28- 0.40 | 303 | .46 | 0 | 16 | 0-47 | 88 | 1.03 | .03 | .47 | 23 | 4.6 | -.1 | 0 | 0 | -0 | 6 | 58 | 58 | 3 | -0 | 0 | 0.CC | C.00 | -.02 | 0 | 0 | 100 | 204 |
| 0-28- 1.C7 | 303 | .46 | 0 | 16 | 0-47 | 88 | 1.03 | -.03 | .47 | 11 | 3.0 | .7 | 0 | 0 | -1 | 7 | 58 | 56 | 3 | 0 | -0 | 0.00 | 0.00 | -.02 | 7 | 2 | 100 | 64 |
| C-28-10.47 | 358 | .50 | 0 | 16 | 0-47 | 88 | .84 | .C3 | .28 | 15 | 3.0 | -.1 | 0 | 0 | -1 | 5 | 58 | 55 | -3 | 0 | -0 | 0.C0 | 0.CC | 0.00 | 0 | 0 | 0 | 63 |
| 0-28-12.27 | 342 | .50 | 2 | 16 | 0-47 | 88 | 1.03 | .03 | .22 | 27 | 4.6 | -.9 | 0 | 0 | -1 | 5 | 55 | 44 | 3 | -0 | -0 | 0.00 | .02 | .03 | 0 | 0 | 100 | 204 |
| 0-28-13.33 | 414 | .55 | 2 | 16 | 0-47 | 88 | 1.03 | .C9 | .22 | 15 | 3.0 | -.1 | 0 | 0 | -1 | 5 | 54 | 34 | 3 | 0 | 0 | 0.00 | 0.00 | .02 | 7 | 2 | 100 | 64 |
| 0-29-15.33 | 413 | .59 | 5 | 24 | 0-47 | 87 | .84 | .03 | .16 | 19 | 5.4 | 1.5 | 0 | 0 | -1 | 5 | 9 | 8 | 3 | 0 | -0 | 0.00 | C.00 | 0.00 | 0 | 0 | 0 | 63 |
| 0-29-17.33 | 413 | .59 | 5 | 24 | C-47 | 87 | 1.03 | .03 | .22 | 31 | 7.0 | .7 | 0 | 0 | -0 | 6 | 9 | 8 | 9 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0 | 0 | 100 | 204 |
| 0-29-17.60 | 413 | .59 | 5 | 24 | C-47 | 87 | 1.C3 | .03 | .16 | 19 | 6.2 | 2.3 | 0 | 0 | -0 | 5 | 9 | 8 | 3 | -0 | 0 | 0.C0 | 0.00 | C.00 | 12 | 2 | 100 | 64 |
| 0-31-52.67 | 408 | .68 | 13 | 24 | 0-47 | 87 | .84 | -.03 | .09 | -7 | 3.0 | 4.6 | 0 | 1 | -1 | 5 | 6 | 6 | -3 | -0 | -0 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 63 |
| 0-31-53.73 | 408 | .68 | 13 | 24 | 0-47 | 87 | .84 | -.03 | .16 | -19 | 1.5 | 5.4 | 0 | 0 | -1 | 6 | 6 | 6 | -15 | 0 | -0 | 0.C0 | 0.00 | 0.00 | 0 | 0 | 0 | 204 |
| 0-31-54.93 | 408 | .68 | 13 | 24 | 0-47 | 87 | 1.03 | .03 | .09 | -3 | 3.8 | 4.6 | 0 | 0 | -0 | 5 | 6 | 6 | -3 | -0 | -0 | 0.C0 | C.00 | .02 | 2 | 22 | 0 | 64 |
| 0-32-25.00 | 435 | .72 | 14 | 24 | C-47 | 87 | 1.03 | .03 | .16 | 7 | 4.6 | 3.0 | 0 | 0 | -0 | 5 | 6 | 6 | -3 | 0 | -0 | 0.00 | -.02 | -.02 | 0 | 0 | 0 | 63 |
| 0-32-26.53 | 388 | .68 | 14 | 24 | 0-47 | 87 | 1.03 | .03 | .09 | 39 | 7.0 | -.9 | G | 0 | -0 | 5 | 6 | 6 | 21 | 0 | -0 | 0.00 | -.02 | 0.00 | 5 | 0 | 100 | 2C7 |
| 0-32-27.80 | 388 | .68 | 14 | 24 | 0-47 | 87 | 1.03 | .09 | .C9 | 35 | 7.0 | -.1 | 0 | 0 | -0 | 5 | 6 | 6 | 9 | 0 | 0 | 0.C0 | 0.00 | 0.00 | -4 | 0 | 0 | 206 |
| 0-32-26.53 | 388 | .68 | 14 | 24 | 0-47 | 87 | 1.03 | .03 | .09 | 39 | 7.0 | -.9 | C | 0 | -0 | 5 | 6 | 6 | 21 | 0 | -0 | 0.00 | -.02 | 0.00 | 0 | 0 | 100 | 204 |
| 0-32-28.60 | 388 | .68 | 14 | 24 | 0-47 | 87 | 1.03 | .03 | .16 | 12 | 5.4 | 3.0 | 0 | 0 | -0 | 5 | 6 | 6 | 3 | 0 | 0 | 0.00 | 0.00 | 0.00 | 37 | 2 | 100 | 64 |
| 0-32-36.80 | 435 | .72 | 14 | 24 | 0-47 | 87 | .84 | .03 | .09 | 7 | 3.8 | 2.3 | 0 | 0 | -0 | 5 | 6 | 6 | 3 | 0 | 0 | 0.00 | .02 | 0.00 | 0 | 0 | 0 | 63 |
| 0-32-37.40 | 388 | .68 | 14 | 24 | 0-47 | 87 | .84 | .03 | .09 | 3 | 4.6 | 3.8 | 0 | 0 | -0 | 5 | 6 | 6 | -3 | 0 | 0 | 0.00 | -.21 | 0.00 | 0 | 0 | 0 | 16 |
| 0-32-37.53 | 388 | .68 | 14 | 24 | 0-47 | 87 | .84 | -.03 | .09 | 3 | 3.8 | 3.0 | 0 | 0 | -1 | 4 | 6 | 6 | -3 | -0 | 0 | 0.00 | -.02 | 0.00 | 2 | 2 | 0 | 64 |
| 0-33-45.07 | 393 | .72 | 17 | 24 | 0-47 | 86 | .84 | .03 | .16 | 3 | 2.8 | 3.0 | 0 | C | -0 | 5 | 6 | 6 | 3 | 0 | -0 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 60 |
| 0-34-51.07 | 426 | .77 | 18 | 24 | C-47 | 86 | 1.03 | .03 | .09 | 3 | 4.6 | 3.8 | 0 | 0 | -0 | 5 | 6 | 6 | -3 | -0 | -0 | 0.C0 | 0.00 | 0.00 | 0 | 0 | 0 | 60 |
| 0-35-11.87 | 404 | .77 | 19 | 24 | 0-47 | 86 | 1.22 | .03 | .03 | 7 | 5.4 | 3.8 | 0 | 0 | -0 | 6 | 1 | 1 | 3 | -0 | -0 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 63 |
| 0-35-17.33 | 404 | .77 | 19 | 24 | C-47 | 86 | 1.59 | .03 | .09 | 3 | 6.2 | 5.4 | 0 | 0 | -0 | 7 | 1 | 3 | 3 | 0 | -0 | 0.00 | -.02 | 0.00 | 0 | 0 | 100 | 1 |
| 0-35-19.07 | 404 | .77 | 19 | 24 | 0-47 | 86 | 1.22 | .03 | .03 | 11 | 6.2 | 3.8 | 0 | 0 | -0 | 7 | 1 | 3 | 3 | 0 | -0 | 0.00 | 0.00 | 0.00 | 2 | 2 | 0 | 64 |
| 0-35-20.27 | 404 | .77 | 19 | 24 | 0-47 | 86 | 1.22 | .03 | .03 | 4 | 5.4 | 4.6 | 0 | 0 | -0 | 6 | 1 | 3 | 3 | -0 | -0 | 0.C0 | C.00 | 0.00 | 0 | 0 | 0 | 63 |
| C-35-22.53 | 404 | .77 | 19 | 24 | 0-47 | 86 | 1.59 | .03 | .09 | 7 | 6.2 | 4.6 | C | 0 | -0 | 8 | 1 | 3 | 3 | -0 | -C | 0.00 | C.00 | 0.00 | 0 | 0 | 100 | 1 |
| C-35-26.13 | 404 | .77 | 19 | 24 | 0-47 | 86 | 1.22 | .03 | .16 | 11 | 6.2 | 3.8 | 0 | 0 | -0 | 7 | 5 | 4 | 3 | 0 | -0 | 0.C0 | C.00 | 0.00 | 2 | 2 | 0 | 64 |
| 0-36-1C.60 | 404 | .77 | 19 | 24 | C-47 | 86 | 1.22 | .03 | .09 | 15 | 6.2 | 3.C | 0 | 0 | -0 | 6 | 4 | 4 | 3 | 0 | -0 | 0.00 | C.0C | 0.00 | 0 | 0 | 0 | 63 |

LOADS EDI SUMMARY DATA

GENERAL DYNAMICS CORPORATION CENTRAL DATA SYSTEMS CENTER. 04/07/78 PAGE 0135
FORT WORTH DIVISION 6600 PROCEDURE R3U PROBLEM 270883-01

TYPE 4 DATA STARTING AT 4/12/ 5/ .13

| A/P NO. | BASE CODE | WING IDENT. | MISSN PURP. | NO. TO. | NO. LA. | NO. GP. | FLT. PROF | AP TIME | AR ET | TFP | SUPER SONIC | GW CODE | HP-WT 2 3 4 | L R | T/M CONF | BAY L R | EOF HRS | DATE DD/MM/Y | T/O GROSS WEIGHT | MISSN SEQ | CORR. FACTOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 680248 | 8 | 380 | 1 | 1 | 3 | 4 | 3 | 1 | 1 | 1 | 0 | 1 | 0 6 0 | 0 0 | 2 | 1 1 | 16680 | 11.15 7 | 91033 | 3 | 4 |

DATA QUALITY INDEX = ZERO IS GOOD DATA ONE IS BAD DATA.

| NZ | NY | NX | CR | HIL | HTR | SPL | SPR | P | Q | R | FFL | FFR | IREF | MGL | MGR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

LEFT SPOILER CYCLES +/-2.8 DEG

| 2.8 | 8.4 | 14.0 | 19.6 | 25.3 | 30.9 | 36.5 | 42.1 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

RIGHT SPOILER CYCLES +/-2.8 DEG

| 2.8 | 8.4 | 14.0 | 19.6 | 25.3 | 30.9 | 36.5 | 42.1 |
|---|---|---|---|---|---|---|---|
| 15 | 7 | 0 | 0 | 0 | 0 | 0 | 1 |

RUDDER CYCLES +/-.9 DEG

| -29.0 | -27.2 | -25.3 | -23.5 | -21.6 | -19.7 | -17.6 | -16.0 | -14.1 | -12.2 | -10.3 | -8.5 | -6.6 | -4.7 | -2.8 | -1.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 15 | 21 | 0 |
| 1.0 | 2.8 | 4.7 | 6.6 | 8.5 | 10.3 | 12.2 | 14.1 | 16.0 | 17.6 | 19.7 | 21.6 | 23.5 | 25.3 | 27.2 | 29.0 |
| 0 | 98 | 70 | 21 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

LEFT AND RIGHT HOR TAIL DEFLECTION CHANGES (LEFT H T IS UPPER RIGHT /RIGHT H T IS LOWER LEFT) +/-1.5 DEG

| -18.4 | -15.3 | -12.2 | -9.1 | -5.9 | -2.8 | .3 | 3.4 | 6.6 | 9.7 | 12.8 | 15.9 | 19.1 | 22.2 | 25.3 | 28.4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *000000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | *000000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | C | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | *000000 | 0 | 0 | 0 | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | *000000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | *000000 | 0 | 0 | 0 | 0 | 0 | C | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | *000000 | 3 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 3 | *000000 | 94 | 51 | 10 | 0 | 0 | 0 | C | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 4 | 189 | *000000 | 201 | 43 | 17 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 3 | 55 | 236 | *000000 | 164 | 80 | 17 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 5 | 56 | 184 | *000000 | 62 | 7 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 | 22 | 59 | 36 | *000000 | 5 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 2 | *000000 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | *000000 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | *000000 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | *000000 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | C | 0 | 0 | 0 | 0 | 0 | 0 | 1 | C | *000000 |

```
TO W CYC =00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000CCC00   NR=   0
MI W CYC =0113311221133112211000000000000000000000000000000000000000000000000000000000000000000000000000000000CCCCC12   NR=  10
LG W CYC =000000000C00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000C0000000   NR=   0

TO F CYC =00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000CC0CCCCCCC0   NR=   0
MI F CYC =400660066006600600000000000000000000000000000000000000000000000000000000000000000000000000000000000000000010   NR=   8
LG F CYC =000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000CCCCCCCCC0   NR=   0
```

NR. OF TOUCHDOWNS = 1
NR. OF GEAR CYCLES = 8

(0 IS VSS MEASURED~ NOT 0 IS VSS ESTIMATED) = 0
VSS1 THRU VSSNPLG (IN FT PER SEC) = .2,

ATTACHMENT (4)
Pg 17 of 18

LOADS ED, SUMMARY [illegible]

GENERAL DYNAMICS CORPORATION CENTRAL DATA SYSTEMS CENTER 04/07/78 PAGE 0136
FORT WORTH DIVISION 6600 PROCEDURE R3U PROBLEM 270883-01

ATTACHMENT (4)
Pg. 18 of 18

VERTICAL LOAD FACTOR SPECTRUM

| | 0-50.4 | | | 50.5-72.5 |
|---|---|---|---|---|
| 8.06 | 0 | C | | 0 |
| 7.50 | C | | | 0 |
| 7.12 | 0 | | GT | 0 |
| 6.56 | 0 | C | | 0 |
| 6.00 | 0 | | | 0 |
| 5.43 | 0 | | GT | 0 |
| 5.06 | 0 | C | | 0 |
| 4.50 | 0 | | | 0 |
| 3.93 | 0 | | GT | 0 |
| 3.56 | 0 | C | | 0 |
| 3.00 | 0 | C | GT | 0 |
| 2.44 | 0 | | GT | 0 |
| 2.06 | 0 | | | 0 |
| 1.68 | 6 | | | 0 |
| .56 | 6 | C | | 0 |
| .37 | 0 | | GT | 0 |
| 0.00 | 0 | | | 0 |
| -.56 | 0 | | | 0 |
| -1.11 | 0 | | | 0 |
| -1.68 | 0 | | | 0 |
| -2.25 | 0 | | | 0 |

LATERAL LOAD FACTOR SPECTRUM

| | 0-50.4 | 50.5-72.5 |
|---|---|---|
| -.560 | 0 | 0 |
| -.500 | 0 | 0 |
| -.440 | 0 | 0 |
| -.375 | 0 | 0 |
| -.310 | 0 | 0 |
| -.250 | 0 | 0 |
| -.190 | 0 | 0 |
| -.125 | 0 | 0 |
| .125 | 0 | 0 |
| .190 | 0 | 0 |
| .250 | 0 | 0 |
| .310 | 0 | 0 |
| .375 | 0 | 0 |
| .440 | 0 | 0 |
| .500 | 0 | 0 |
| .560 | 0 | 0 |

| VERTICAL LOAD FACTOR SPECTRUM | | GW-65K FP UP | FP PL | FP DN | GW>65K FP UP | FP PL | FP DN |
|---|---|---|---|---|---|---|---|
| 8.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.56 | 0 | 0 | 0 | 0 | C | 0 | 0 |
| 6.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.68 | 6 | 5 | 1 | 0 | 0 | 0 | 0 |
| .56 | 6 | 4 | 0 | 2 | 0 | 0 | 0 |
| .37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -.56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1.68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -2.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| LATERAL LOAD FACTOR SPECTRUM | |
|---|---|
| -.560 | 0 |
| -.500 | 0 |
| -.440 | 0 |
| -.375 | 0 |
| -.310 | 0 |
| -.250 | 0 |
| -.190 | 0 |
| -.125 | 0 |
| .125 | 0 |
| .190 | 0 |
| .250 | 0 |
| .310 | 0 |
| .375 | 0 |
| .440 | 0 |
| .500 | 0 |
| .560 | 0 |

GRND TIME .40 FLT TIME 3.79 TOTAL TIME 4.19
WNG FWD TIME 3.79 WNG AFT TIME .00 SUPERSONIC TIME .00

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: KC-10A

FLEET INFORMATION

NO. OF AIRCRAFT: 20± : YEAR SERVICE Begins ~~BEGAN:~~ 1980

SYSTEM MANAGEMENT: AF ALD

DATE TRANSFERRED TO AFLC: ____________

USING COMMAND: SAC

PRIMARY BASE: ____________

PRIMARY MISSION TYPES: Cargo; Aerial Refueling

REMARKS: Can receive fuel via UARRSI as well as off loading fuel to other aircraft.

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | | | |
| FULL-SCALE CYCLIC TEST: | | | |
| FULL-SCALE STATIC TEST: | | | |
| DAMAGE TOLERANCE TESTS: | | | |
| DADTA INITIAL: | | | |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | | | |
| L/ESS DESIGN: | | | |
| FSM PLAN: | | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | In process-McD-Douglas |
| DURABILITY ANALYSIS: | | FAA Certification |
| SERVICE LIFE ANALYSIS: | | |

Commercial derivative based on the DC-10-30 convertible freighter.
FAA certification is to be maintained.
IAT and L/ESS are under study regarding need & extent of programs.
Maintenance is to be contracted out to airlines.

Small scale DADTA is in process.

See visit Summaries (Appendix D)

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: T-37

FLEET INFORMATION

NO. OF AIRCRAFT: ~700 : YEAR SERVICE BEGAN: ______

SYSTEM MANAGEMENT: SAALC

DATE TRANSFERRED TO AFLC: ______

USING COMMAND: ATC (Some TAC, ALC)

PRIMARY BASE: ______

PRIMARY MISSION TYPES: Basic Training Primary UPT

REMARKS: Right out of T-41 (172) Design Life 15,000

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | |
| FULL-SCALE CYCLIC TEST: | X | | Block loading 72,000 test hours |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | | | |
| DADTA INITIAL: | | Proposed | In hours at SAALC |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | | | |
| L/ESS DESIGN: | | | |
| FSM PLAN: | | | |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |

A/C Type: T-37 (Continued)

IAT PROGRAM

ANALYSIS METHOD: ______

APPLICABLE REPORT: ______

DATA COLLECTION: RECORDER: ______ FORM: N/A (ATTACH DESCRIPTION

FREQ. OF RETRIEVAL: ______ :TECH.ORDERS: ______

DATE STARTED: ______ HRS.RECORDED: ______ % USABLE DATA: ______

DATA COLLECTION PROBLEMS: ______

DATA REDUCTION: WHO DOES IT? ______

HOW IS IT CHECKED? ______

TECHNIQUE TO RECOVER MISSING DATA: ______

LIST PROCESSING STEPS: ______

OUTPUT CONTENTS (ATTACH SAMPLES): ______

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? ______

WHO EVALUATES OUTPUT? ______

APPLICATIONS: SCHEDULING? ______

ANALYSIS UPDATE? ______

TO DETECT CHANGE IN USAGE? ______

REMARKS: AFTO Form 781 tracking was discontinued due to homogeneous usage. Was based on Miner's damage per each mission as defined in training syllabus. CESSNA was performing data reduction from forms ASIMIS was generating damage reports. Reference: CESSNA Report 318B-7319-006, May, 1973.

L/ESS PROGRAM

ANALYSIS METHOD: Same as A-37 except without store config.

APPLICABLE REPORT: ______

DATA COLLECTION BASE: 1 installed - Airborne Data Only

NO. OF AIRCRAFT: ______ RECORDING DEVICE: MXU-553 (Attach Description)

PARAMETERS RECORDED: Same as A-37 (Attach List)

L/ESS START/STOP DATES: 1978 HRS. RECORDED: 0

% USABLE DATA: ______ DATA RETRIEVAL FREQ. ______

DEFINITION OF USABLE DATA: ______

COLLECTION PROBLEMS: ______

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? ______

LIST STEPS: 5-Modules

TECHNIQUE TO RECOVER MISSING PARAMETERS: ______

OUTPUT CONTENTS (Attach Sample): ______

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? ______

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: ______

TO CHECK IAT DATA? ______

TO DETECT CHANGE IN USAGE? ______

REMARKS: Program was delivered to ASIMIS. Check out has indicated that some system clean-up is necessary.

A/C TYPE: T-37 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:

INSPECTION INTERVALS:

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA:

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: T-37 (Concluded) Mike Smith

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: DTA at SAALC is disappointing. Loads software is available but not checked out. Jerry Ash at SAALC is primary contact.

Manufacturer should be involved.

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS:

METHODS WHICH HAVE WORKED WELL: Scratch gage or fatigue gage would be better. Measured strains would be better.

DEFICIENCIES IN CURRENT METHODS: MXU is good for loads and criteria but over kill for crack growth.

INFORMATION SOURCE:

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: T-38

FLEET INFORMATION

NO. OF AIRCRAFT: 800 ATC 120 LIF : YEAR SERVICE BEGAN: 1960

SYSTEM MANAGEMENT: SAALC

DATE TRANSFERRED TO AFLC:

USING COMMAND: ATC, TAC

PRIMARY BASE: Holoman (LIF) (Lead in Fighters)

PRIMARY MISSION TYPES: LIF, ATC, DACT

REMARKS: Also used by T-Bird Team

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | X | | components only |
| FULL-SCALE CYCLIC TEST: | X | | Wing-Block spectrum |
| FULL-SCALE STATIC TEST: | X | | |
| DAMAGE TOLERANCE TESTS: | 25% | | { 11-12 Loca coupons for hot spots |
| DADTA INITIAL: | N/A | | flt-flt spectrum |
| STRENGTH SUMMARY: | X | | |
| TRACKING SYSTEM DESIGN: | | | none now |
| L/ESS DESIGN: | | X | VGH,MXU,MSR(*) |
| FSM PLAN: | | | In process SAALC |
| BASELINE OPS SPECTRA: | X | | |
| DADTA-FINAL: | | X | Due in Dec. 1978 |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | NOR-60-210 | Northrup |

((*) MSR DATA PROCESSED BY ASD).

IAT PROGRAM

ANALYSIS METHOD: Fatigue Damage

APPLICABLE REPORT: ____

DATA COLLECTION: RECORDER: None FORM: TAC LIF only SAAMA 303 (ATTACH DESCRIPTION)

FREQ. OF RETRIEVAL: ____ :TECH.ORDERS: ____

DATE STARTED: ____ HRS.RECORDED: 10,000 % USABLE DATA: ____

DATA COLLECTION PROBLEMS: Estimate of Nz levels considered unreliable.

DATA REDUCTION: WHO DOES IT? ____

HOW IS IT CHECKED? ____

TECHNIQUE TO RECOVER MISSING DATA: ____

LIST PROCESSING STEPS: ____

OUTPUT CONTENTS (ATTACH SAMPLES): ____

LIST PERMANENT FILES: RAW DATA? ____

PROCESSED DATA? ____

WHO EVALUATES OUTPUT? ____

APPLICATIONS: SCHEDULING? Based on flying hours

ANALYSIS UPDATE? ____

TO DETECT CHANGE IN USAGE? ____

REMARKS: The ATC missions are homogeneous and a tracking program has not been considered necessary. MSR is being considered for future TAC T-38 tracking.

L/ESS PROGRAM

ANALYSIS METHOD: Fatigue damage - similar to F-5
MXU NOR 74-58, VGH NOR 74-227, (User Manuals)
Analysis NOR 76-31

APPLICABLE REPORT: ______

DATA COLLECTION BASE: T-Bird=2MXU, 4VGH

NO. OF AIRCRAFT: LIF:10MXU RECORDING DEVICE: VGH MXU-553 (Attach Description)

PARAMETERS RECORDED: Nz,Ny,p,q,r,A/S,Alt,$\delta A$,$\delta R$,$\sigma$ (Attach List)

L/ESS START/STOP DATES: Start ~1967 HRS. RECORDED: 1200 LIF 12600 ATC

% USABLE DATA: ______ DATA RETRIEVAL FREQ. 200 DACT

DEFINITION OF USABLE DATA: ______

COLLECTION PROBLEMS: No calibration on strain gages

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? ______

LIST STEPS: Similar to F-5 for all processing log form is SAAMA form 27.

TECHNIQUE TO RECOVER MISSING PARAMETERS: ______

OUTPUT CONTENTS (Attach Sample): By mission, base, A/C
Fatigue damage, service life.
Evaluation of data stability

LIST PERMANENT FILES: RAW DATA? ______

PROCESSED DATA? On Tape

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE: Using fatigue damage

TO CHECK IAT DATA? ______

TO DETECT CHANGE IN USAGE? in VGH stability program

REMARKS: ______

A/C TYPE: T-38 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE: No PDM or depot maintenance requirements. Looking at tracking for LIF, DACT and T-Bird.

INSPECTION INTERVALS: TO-6 specifies by hours. DTA is expected to update this. 100 hrs for LIF

RANGE OF CRITICAL CRACK LENGTHS: Order of 0.04-0.05 inch.

SPECIAL COMPONENT INSPECTIONS: Wing changes are in process, originally based on time, then tried on-condition based on NDl, now back to time due to suspected NDI unreliability.

DATA COLLECTION:

DATA EVALUATION: AFM 66-1 is of no value in obtaining FMS information.

APPLICATION OF FEEDBACK DATA: No formal system.

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: T-38 (Concluded)

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: No plan. Manufacturer not currently involved in any on-going ASIP programs.

IAT-FSM INTERFACE:

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE:

COMMONALITY WITH OTHER SYSTEMS:

METHODS WHICH HAVE WORKED WELL:

DEFICIENCIES IN CURRENT METHODS: ACI inspections too broad. Not effective in detecting structural fatigue problems. Need better feedback to system manager. Contract lead time is a problem in solving any maintenance deficiency.

ATTACHMENT TO T-38

# T - 38 MXU - 553 RECORDER PROGRAM - CREW CHIEF FLIGHT LOG

| AIRCRAFT TYPE | AIRCRAFT SERIAL NUMBER | | STATION OR BASE | SERIAL NUMBER CARTRIDGE | | DT INSTALLED DAY | MO | YR | DT REMOVED DAY | MO | YR | TOTAL AIRFRAME HOURS AT MAGAZINE INSTALLATION | REMOVAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T 38 | | | | | | | | | | | | | |

| FLT NO | MISSION CODE | TAKEOFF TIME (Z) HOURS | MIN | WEIGHT IN POUNDS TAKEOFF GROSS | TAKEOFF FUEL | | LANDING FUEL WEIGHT IN POUNDS | BASE TAKEOFF | LANDING | | DATE OF FLIGHT DAY | MO | YR | % OF TAPE REMAINING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | | | | | | | | | | | | | | |
| 02 | | | | | | | | | | | | | | |
| 03 | | | | | | | | | | | | | | |
| 04 | | | | | | | | | | | | | | |
| 05 | | | | | | | | | | | | | | |
| 06 | | | | | | | | | | | | | | |
| 07 | | | | | | | | | | | | | | |
| 08 | | | | | | | | | | | | | | |
| 09 | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | |

REMARKS

**MISSION CODE**

01 Pilot Checkout
02 Pilot Proficiency
03 Air Combat Tactics
04 Basic Flight Tactics
05 Intercept
06 Cross Country
07 Ground Tactics
08 Target Simulation
09 Other

4410

# T-38 AIRCRAFT USAGE

| AIRCRAFT SERIAL NO | | | | | | | | FLIGHT NUMBER | HOME BASE CODE | | | LOCATION CODE | | MISSION CODE | | MISSION TIME | | | TOTAL OCCURRENCES OF G LOADS PER FLIGHT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | SYMMETRICAL | | | | | | 0 Gs | | | | | 3 Gs | | | | | 4 Gs | | | | | 5 Gs | | | | | SYMMETRICAL | | | | |
| | | | | | | | | | | | | | | | | | | | -3 Gs | | -2 Gs | | -1 Gs | | ASYM | | SYM | | | ASYM | | SYM | | | ASYM | | SYM | | | ASYM | | SYM | | | 6 Gs | | | 7 Gs | |
| 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 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| | | — | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 1 | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 2 | 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 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |

REMARKS

(See Instructions & Codes on Reverse Side)

SAAMA FORM 303

468

ATTACHMENT TO T-38

ATTACHMENT TO T-38

INSTRUCTIONS

GENERAL: COMPLETE AS MANY BLANKS AS APPLICABLE AT THE END OF EACH FLIGHT

| ITEM | COLUMN | INSTRUCTIONS |
|---|---|---|
| Aircraft Serial Number (Required for first flight only) | 1 thru 8 | Enter complete serial number |
| Flight Number | 8 & 9 | Preprinted |
| Home Base Code (Required for first flight only) | 10 thru 12 | Enter location identifier for base to which aircraft is assigned. Reference FAA Manual 7350.1. |
| Location Code | 14 | If flight was initiated or terminated at the home base enter a Ø (zero); if not enter a 1. |
| Mission Code | 16 | Enter mission code that best describes the purpose of the flight. |

MISSION CODES

A - Pilot Checkout
B - Pilot Proficiency
C - System Test Training
D - Aircraft Performance Training
E - Stability and Control Training
F - Safety Chase
G - Photo Chase
H - Air Combat Tactics
I - Basic Flight Tactics
J - Intercept
K - Cross Country
L - Ground Attack
M - Target Simulation
N - Student Orientation
O - Other

| ITEM | COLUMN | INSTRUCTIONS |
|---|---|---|
| Mission Time | 18 - 19 | Enter Mission Duration IN MINUTES |
| Occurrences of "G" Loads Per Flight | 20 thru 51 | Total occurrences of all positive "G's" (3.0 and above) and all negative "G's" (less than 0.5) are to be recorded. Enter the occurrences in the "A" column for asymmetrical (rolling pull out) maneuvers and in "S" column for symmetrical maneuvers under the appropriate "G" level heading. Round "G's" up or down to the nearest whole number except in the case of an overstress. Annotate exact overstress value in the remarks column. Leave unused Cols blank. If the number of columns provided for a 'G' level entry is too few, place entry in Remarks Section referencing Flight No, G level, and number of occurrences. |

NOTE: Reporting an exceedance of referenced acceleration limits on this form does not alleviate pilot's responsibility to document overstress conditions on the applicable aircraft maintenance form.

STATE-OF-THE-ART REVIEW
FORCE MANAGEMENT METHODS

A/C TYPE: T-43

FLEET INFORMATION

NO. OF AIRCRAFT: 19 : YEAR SERVICE BEGAN: ______

SYSTEM MANAGEMENT: San Antonio ALC

DATE TRANSFERRED TO AFLC: ______

USING COMMAND: ATC

PRIMARY BASE: Mather

PRIMARY MISSION TYPES: Navigational Training

REMARKS: Structurally similar to commercial 737

| STATUS OF ASIP | COMPLETED | IN WORK | REMARKS |
|---|---|---|---|
| DESIGN ANALYSES: | x | | |
| FULL-SCALE CYCLIC TEST: | | | |
| FULL-SCALE STATIC TEST: | | | |
| DAMAGE TOLERANCE TESTS: | | | |
| DADTA INITIAL: | | | |
| STRENGTH SUMMARY: | | | |
| TRACKING SYSTEM DESIGN: | x | | |
| L/ESS DESIGN: | x | | |
| FSM PLAN: | x | | Commercial |
| BASELINE OPS SPECTRA: | | | |
| DADTA-FINAL: | | | |

| APPLICABLE ASIP DOCUMENTS | REPORT NO. | SOURCE |
|---|---|---|
| ASIP MASTER PLAN | | ASD |
| DAMAGE TOLERANCE ANALYSIS: | | |
| DURABILITY ANALYSIS: | | |
| SERVICE LIFE ANALYSIS: | | |
| Fatigue Tracking Report | D-185-10090-8 | Boeing |
| L/ESS Report | D-185-10089-5 | Boeing |

IAT PROGRAM

ANALYSIS METHOD: (Fatigue Analysis) by mission & data block.

APPLICABLE REPORT: D-185-10090-8

DATA COLLECTION: RECORDER: ______ FORM: Mather TW Form (ATTACH DESCRIPTIC

FREQ. OF RETRIEVAL: ______ :TECH.ORDERS: ______

DATE STARTED: ______ HRS.RECORDED: > 95 % USABLE DATA: ______

DATA COLLECTION PROBLEMS: ______

DATA REDUCTION: WHO DOES IT? ASIMIS

HOW IS IT CHECKED? ______

TECHNIQUE TO RECOVER MISSING DATA: Filled in by using flight Hours, landings, etc. separately obtained from ATC.

LIST PROCESSING STEPS: Accomplished at ASIMIS

OUTPUT CONTENTS (ATTACH SAMPLES): Usage by mission type; usage by data block; fatigue damage for 7 control points

LIST PERMANENT FILES: RAW DATA?

PROCESSED DATA? ______

WHO EVALUATES OUTPUT? SA/ALC

APPLICATIONS: SCHEDULING? No

ANALYSIS UPDATE? Working on SOW to update fatigue & Tracking analysis

TO DETECT CHANGE IN USAGE? ______

REMARKS: "Canned" log forms were developed for each of 3 basic mission types-these gave better results than general logs.

L/ESS PROGRAM

ANALYSIS METHOD: The ΔN data are compressed and peak counted by data block.

APPLICABLE REPORT: D185-10089-5 (Boeing Seattle)

DATA COLLECTION BASE:

NO. OF AIRCRAFT: 5 RECORDING DEVICE: MXU-553/A (Attach Description)

PARAMETERS RECORDED: ($2$ chan of fin root strain on 1 a/c) $n_z$, $n_y$, other data (Attach List)

L/ESS START/STOP DATES: 1973-present HRS. RECORDED: 1590 when prog. ~~left Boeing.~~

% USABLE DATA: 17% DATA RETRIEVAL FREQ. 15 hrs.

DEFINITION OF USABLE DATA:

COLLECTION PROBLEMS:

DATA REDUCTION: WHO DOES IT? ASIMIS & SA/ALC

HOW IS IT CHECKED? Manual scan for easily corrected errors.

LIST STEPS: Cassettes are processed through R/T & data compression program to obtain data blocks.

TECHNIQUE TO RECOVER MISSING PARAMETERS:

OUTPUT CONTENTS (Attach Sample):

ΔN peak counts by data block (Gust & manuever data speareted by on-board analog filter)

LIST PERMANENT FILES: RAW DATA? Reference ASIMIS

PROCESSED DATA?

APPLICATIONS:

METHOD OF UPDATING FLIGHT-BY-FLIGHT SEQUENCE:

Updates have been made to IAT criteria using L/ESS data.

TO CHECK IAT DATA? YES

TO DETECT CHANGE IN USAGE? NO

REMARKS: Counting accelerometers are installed on all 19 aircraft counts are recorded on Mather TW 291 forms every 35 ± days.

A/C TYPE: T-43 (Continued)

FSM PLAN

MAINTENANCE REQUIREMENTS BASE:
Mainly 737 commercial experience - Aloha airlines flies aircraft with greater than 48,000 landings. (15-20 min. average flight duration)

INSPECTION INTERVALS: Maintenance for FAA-certificated T-43 is performed by United Airlines San Francisco.

RANGE OF CRITICAL CRACK LENGTHS:

SPECIAL COMPONENT INSPECTIONS:

DATA COLLECTION:

DATA EVALUATION:

APPLICATION OF FEEDBACK DATA: Commercial experience used to modity FSM plan where applicable.

REMARKS:

APPLICABLE DOCUMENTS:

A/C TYPE: T-43 (Concluded,

COORDINATED FORCE MANAGEMENT

ORGANIZATIONAL INTERFACE PROBLEMS: Lack of contractor involvement since turning programs over to Air Force is mid-1976.

IAT-FSM INTERFACE: IAT not used to schedule FSM operations

L/ESS-IAT INTERFACE:

ORGANIZATIONAL CHANGES PENDING:

AFLC/ALD INTERFACE: NONE

COMMONALITY WITH OTHER SYSTEMS: L/ESS hardware & software similar to E-3; FSM program similar to that of C-9 and proposed for KC-10A.

METHODS WHICH HAVE WORKED WELL: Small force size and single base simplify data collection and maintenance operations. Large 737 usage data base has provided a built-in "Lead-the-Force" program.

DEFICIENCIES IN CURRENT METHODS:

# APPENDIX C

# TO 1F-4C-6ASI-1

# F-4 AIRCRAFT
# STRUCTURAL INTEGRITY PROGRAM

# TECHNICAL MANUAL

# AIRCRAFT STRUCTURAL INTEGRITY PROGRAM

## USAF SERIES
## F-4C, F-4D, F-4E AND RF-4C
## AIRCRAFT

THIS PUBLICATION REPLACES T.O. 1F-4C-6ASI-1 DATED 15 JUNE 1977.

**PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE**

Control Number(s):
50FEDTM2577185R

15 DECEMBER 1977

1. PURPOSE. This technical order identifies those F-4 series aircraft by serial number that requires inspection in accordance with AFR 80-13. The inspection requirements are based on projected damage index values for each aircraft.

2. INSPECTION INSTRUCTIONS. Accomplishment of prescribed inspections, when due, will assure aircraft structural airworthiness. Schedule accomplishment of inspection at quarter/calendar year date indicated. Document compliance and findings on AFTO Form 95. Inform OO-ALC/MMSRH by message of all discrepancies. Level of accomplishment responsibilities are coded either organizational or depot.

3. INSPECTION REQUIREMENTS.

a. Organization Responsibility, due 1/78. WUC 1121U, NDI (ultrasonic) center wing lower torque box skin adjacent to outboard pylon support fitting for cracks at BL 132.50 in accordance with T.O. 1F-4C-36, Section 2. Repair in accordance with T.O. 1F-4C-3-1-2, Section 2.

**NOTE**

Requirement not applicable on aircraft that have had inspection complied with after 15 June 1977 in accordance with AFTO Form 95.

AIRCRAFT IDENTIFICATION IN NUMERICAL SEQUENCE

| | | | | | |
|---|---|---|---|---|---|
| 637412C | 637688C | 640904C | 650738D | 667459D | 667629D |
| 637418C | 637689C | 640905C | 650739D | 667463D | 667633D |
| 637420C | 637696C | 640908C | 650742D | 667465D | 667634D |
| 637421C | 637703C | 640910C | 650743D | 667466D | 667638D |
| 637428C | 637704C | 640911C | 650746D | 667468D | 667640D |
| 637433C | 637705C | 640912C | 650747D | 667477D | 667641D |
| 637434C | 637750RF | 640917C | 650749D | 667480D | 667648D |
| 637436C | 640655C | 640919C | 650754D | 667486D | 667649D |
| 637443C | 640661C | 640926C | 650764D | 667489D | 667650D |
| 637446C | 640673C | 640956D | 650767D | 667491D | 667652D |
| 637460C | 640677C | 640968D | 650772D | 667496D | 667657D |
| 637470C | 640707C | 640970D | 650774D | 667497D | 667658D |
| 637475C | 640725C | 640976D | 650778D | 667500D | 667661D |
| 637491C | 640745C | 640977D | 650781D | 667502D | 667666D |
| 637492C | 640748C | 640979D | 650790D | 667511D | 667667D |
| 637510C | 640754C | 640980D | 650791D | 667515D | 667668D |
| 637512C | 640759C | 650583D | 650792D | 667520D | 667669D |
| 637514C | 640765C | 650586D | 650793D | 667527D | 667673D |
| 637532C | 640766C | 650590D | 650797D | 667539D | 667674D |
| 637540C | 640772C | 650595D | 650801D | 667542D | 667676D |
| 637545C | 640775C | 650598D | 650828RF | 667544D | 667685D |
| 637550C | 640781C | 650601D | 650849RF | 667547D | 667689D |
| 637553C | 640783C | 650603D | 650853RF | 667549D | 667690D |
| 637555C | 640785C | 650615D | 650870RF | 667551D | 667692D |
| 637556C | 640789C | 650617D | 650900RF | 667555D | 667693D |
| 637557C | 640790C | 650638D | 660226D | 667556D | 667694D |
| 637564C | 640794C | 650643D | 660229D | 667560D | 667696D |
| 637568C | 640796C | 650644D | 660242D | 667561D | 667699D |
| 637569C | 640802C | 650647D | 660243D | 667566D | 667708D |
| 637570C | 640804C | 650648D | 660249D | 667570D | 667710D |
| 637576C | 640806C | 650661D | 660256D | 667575D | 667711D |
| 637578C | 640820C | 650662D | 660270D | 667578D | 667712D |
| 637583C | 640822C | 650665D | 660274D | 667579D | 667714D |
| 637589C | 640823C | 650681D | 660282D | 667580D | 667715D |
| 637601C | 640827C | 650688D | 660283D | 667582D | 667720D |
| 637605C | 640828C | 650690D | 660286E | 667585D | 667721D |
| 637610C | 640838C | 650695D | 660291E | 667594D | 667723D |
| 637622C | 640840C | 650697D | 660315E | 667595D | 667724D |
| 637631C | 640841C | 650701D | 660329E | 667604D | 667733D |
| 637632C | 640844C | 650702D | 660377E | 667605D | 667734D |
| 637647C | 640851C | 650712D | 660384RF | 667608D | 667735D |
| 637657C | 640865C | 650717D | 660407RF | 667610D | 667746D |
| 637662C | 640879C | 650719D | 660428RF | 667614D | 667749D |
| 637667C | 640882C | 650721D | 660444RF | 667617D | 667751D |
| 637685C | 640902C | 650735D | 660470RF | 667623D | 667754D |

| | | | | | |
|---|---|---|---|---|---|
| 667755D | 668727D | 668804D | 670453RF | 680595RF | 690236E |
| 667758D | 668730D | 668806D | 680310E | 680596RF | 690245E |
| 667762D | 668737D | 668819D | 680378E | 680599RF | 690255E |
| 667772D | 668755D | 668821D | 680509E | 680602RF | 690277E |
| 668701D | 668756D | 668823D | 680517E | 680603RF | 690349RF |
| 668711D | 668759D | 670371E | 680581RF | 680605RF | 690350RF |
| 668714D | 668783D | 670429RF | 680588RF | 680606RF | 690352RF |
| 668723D | 668793D | 670448RF | 680593RF | 680607RF | 690368RF |

b. Organization Responsibility, due 1/78. WUC 1121N, NDI (eddy-current) holes on inboard wing fold rib, part No. 32-11040, for cracks as shown in figure 1 in accordance with T.O. 1F-4C-36, Section 1. Reseal per T.O. 1F-4C-3-1-6, Section 2.

**WARNING**

Fasteners are located in wet wing area. Drain fuel in accordance with T.O. 1F-4( )-2-10 prior to fastener removal.

**NOTE**

If crack indications are found, a complete inspection per T.O. 1F-4C-36, Section 2 is required. Wing fold rib removal is depot level maintenance.

**NOTE**

Requirement not applicable on aircraft that have had inspection previously complied with in accordance with AFTO Form 95.

AIRCRAFT IDENTIFICATION IN NUMERICAL SEQUENCE

| | | | | | |
|---|---|---|---|---|---|
| 637411C | 637471C | 637598C | 637686C | 640775C | 640892C |
| 637412C | 637482C | 637601C | 637689C | 640777C | 640896C |
| 637414C | 637490C | 637602C | 637693C | 640780C | 640899C |
| 637415C | 637495C | 637610C | 637699C | 640789C | 640912C |
| 637418C | 637500C | 637611C | 637702C | 640792C | 640913C |
| 637420C | 637501C | 637617C | 637711C | 640806C | 640937D |
| 637422C | 637510C | 637622C | 640665C | 640815C | 640942D |
| 637433C | 637511C | 637623C | 640666C | 640816C | 640945D |
| 637434C | 637512C | 637624C | 640673C | 640822C | 640956D |
| 637437C | 637516C | 637626C | 640677C | 640825C | 650707D |
| 637439C | 637519C | 637628C | 640679C | 640828C | 650740D |
| 637442C | 637520C | 637630C | 640682C | 640829C | 650747D |
| 637446C | 637532C | 637637C | 640691C | 640831C | 650754D |
| 637448C | 637555C | 637646C | 640699C | 640836C | 650791D |
| 637453C | 637556C | 637649C | 640713C | 640838C | 650792D |
| 637454C | 637559C | 637655C | 640724C | 640840C | 650794D |
| 637455C | 637562C | 637657C | 640726C | 640841C | 650797D |
| 637457C | 637566C | 637662C | 640747C | 640847C | 650828RF |
| 637463C | 637589C | 637670C | 640754C | 640851C | 660227D |
| 637465C | 637591C | 637672C | 640759C | 640865C | |
| 637468C | 637595C | 637685C | 640763C | 640882C | |

AIRCRAFT IDENTIFICATION IN NUMERICAL SEQUENCE (Cont)

| | | | | | |
|---|---|---|---|---|---|
| 660242D | 667457D | 667515D | 667663D | 667771D | 668794D |
| 660244D | 667460D | 667527D | 667665D | 668693D | 668802D |
| 660261D | 667466D | 667550D | 667675D | 668719D | 668805D |
| 660271D | 667468D | 667577D | 667701D | 668722D | 668815D |
| 660279D | 667472D | 667593D | 667704D | 668733D | 668823D |
| 660416RF | 667480D | 667640D | 667730D | 668739D | 670453RF |
| 660428RF | 667491D | 667652D | 667738D | 668789D | 690349RF |
| 667456D | 667500D | 667659D | 667742D | | |

c. Organization Responsibility, due 1/78. WUC 1123N, NDI (eddy-current and fluorescent-penetrant) holes on outboard wing lower skin for cracks as shown in figure 2 in accordance with T.O. 1F-4C-36, Section 2. Repair in accordance with T.O. 1F-4C-3-1-4, Section 2.

**NOTE**

Requirement not applicable on aircraft that have had inspection previously complied with in accordance with AFTO Form 95.

AIRCRAFT IDENTIFICATION IN NUMERICAL SEQUENCE

| | | | | | |
|---|---|---|---|---|---|
| 637631C | 637702C | 640804C | 640882C | 667577D | 667674D |
| 637632C | 640766C | 640838C | | | |

d. Organization Responsibility, due 1/78. WUC 1121U, NDI (Ultrasonic) center wing lower torque box skin adjacent to outboard pylon support fitting for cracks at BL 132.50 in accordance with T.O. 1F-4C-36, Section 2. Repair in accordance with T.O. 1F-4C-3-1-2, Section 2.

**NOTE**

Requirement not applicable on aircraft that have had inspection complied with after 15 June 1977 in accordance with AFTO Form 95.

AIRCRAFT IDENTIFICATION IN NUMERICAL SEQUENCE

| | | | | | |
|---|---|---|---|---|---|
| 637411C | 637534C | 640659C | 640862C | 650674D | 660269D |
| 637413C | 637536C | 640660C | 640864C | 650677D | 660273D |
| 637419C | 637537C | 640666C | 640866C | 650680D | 660276D |
| 637422C | 637541C | 640672C | 640867C | 650683D | 660277D |
| 637423C | 637542C | 640675C | 640868C | 650704D | 660279D |
| 637426C | 637543C | 640682C | 640871C | 650705D | 660280D |
| 637431C | 637549C | 640686C | 640872C | 650707D | 660286E |
| 637432C | 637552C | 640699C | 640877C | 650716D | 660289E |
| 637437C | 637559C | 640705C | 640881C | 650718D | 660292E |
| 637439C | 637566C | 640706C | 640884C | 650720D | 660294E |
| 637440C | 637574C | 640711C | 640886C | 650729D | 660295E |
| 637442C | 637575C | 640712C | 640887C | 650730D | 660297E |
| 637447C | 637582C | 640715C | 640888C | 650734D | 660302E |
| 637449C | 637584C | 640724C | 640889C | 650737D | 660309E |
| 637452C | 637585C | 640741C | 640890C | 650740D | 660312E |
| 637455C | 637591C | 640749C | 640891C | 650744D | 660317E |
| 637459C | 637592C | 640750C | 640892C | 650752D | 660319E |
| 637465C | 637594C | 640757C | 640893C | 650753D | 660328E |
| 637467C | 637602C | 640761C | 640895C | 650755D | 660330E |
| 637473C | 637607C | 640763C | 640896C | 650760D | 660333E |
| 637474C | 637611C | 640784C | 640899C | 650768D | 660351E |
| 637477C | 637615C | 640791C | 640903C | 650773D | 660353E |
| 637478C | 637618C | 640793C | 640907C | 650775D | 660355E |
| 637479C | 637620C | 640812C | 640913C | 650782D | 660357E |
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| 637515C | 637670C | 640856C | 650613D | 660254D | 667478D |
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AIRCRAFT IDENTIFICATION IN NUMERICAL SEQUENCE (Cont)

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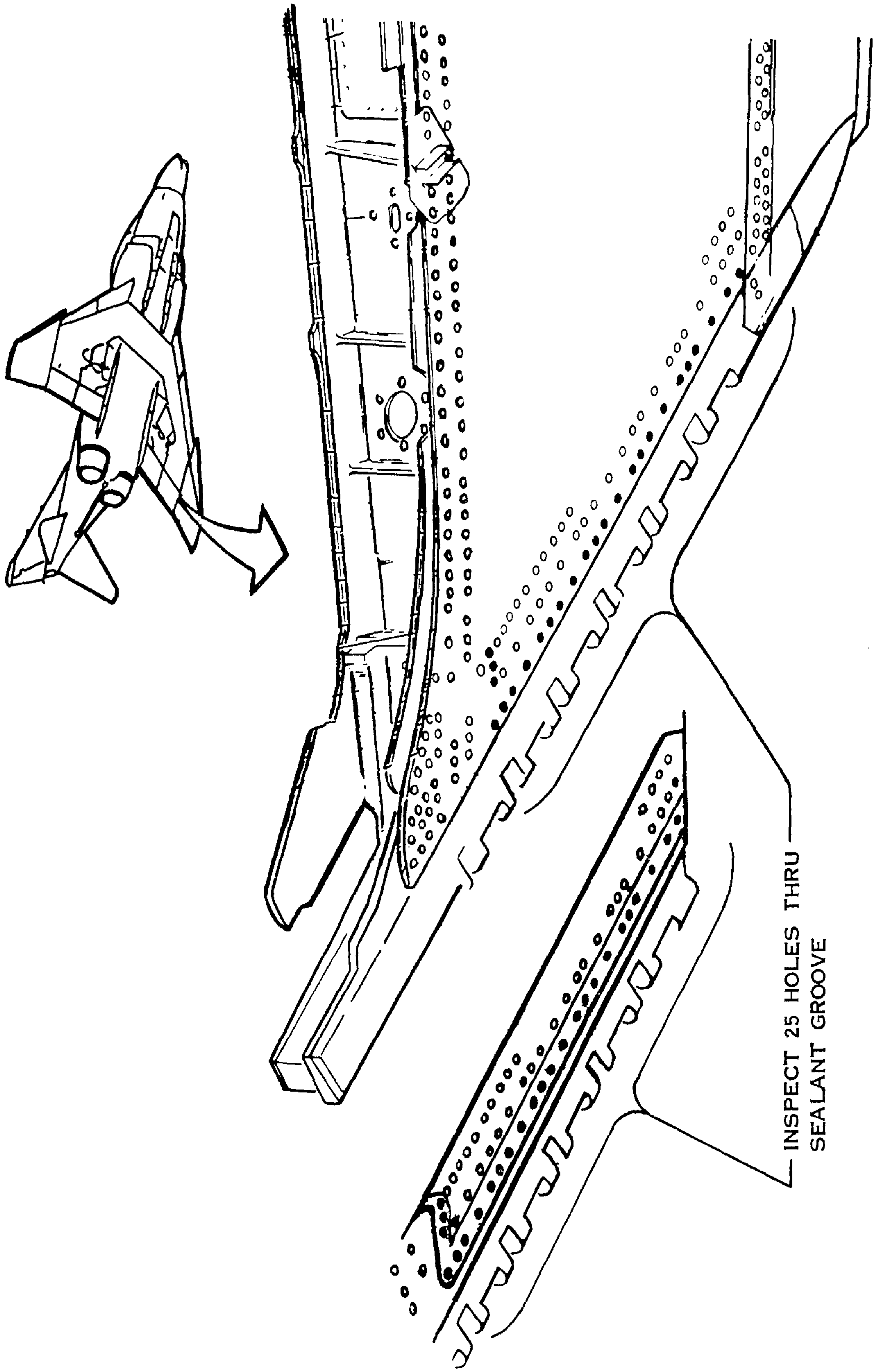


Figure 1. Inner Wing Fold Rib Holes (Lower Surface)

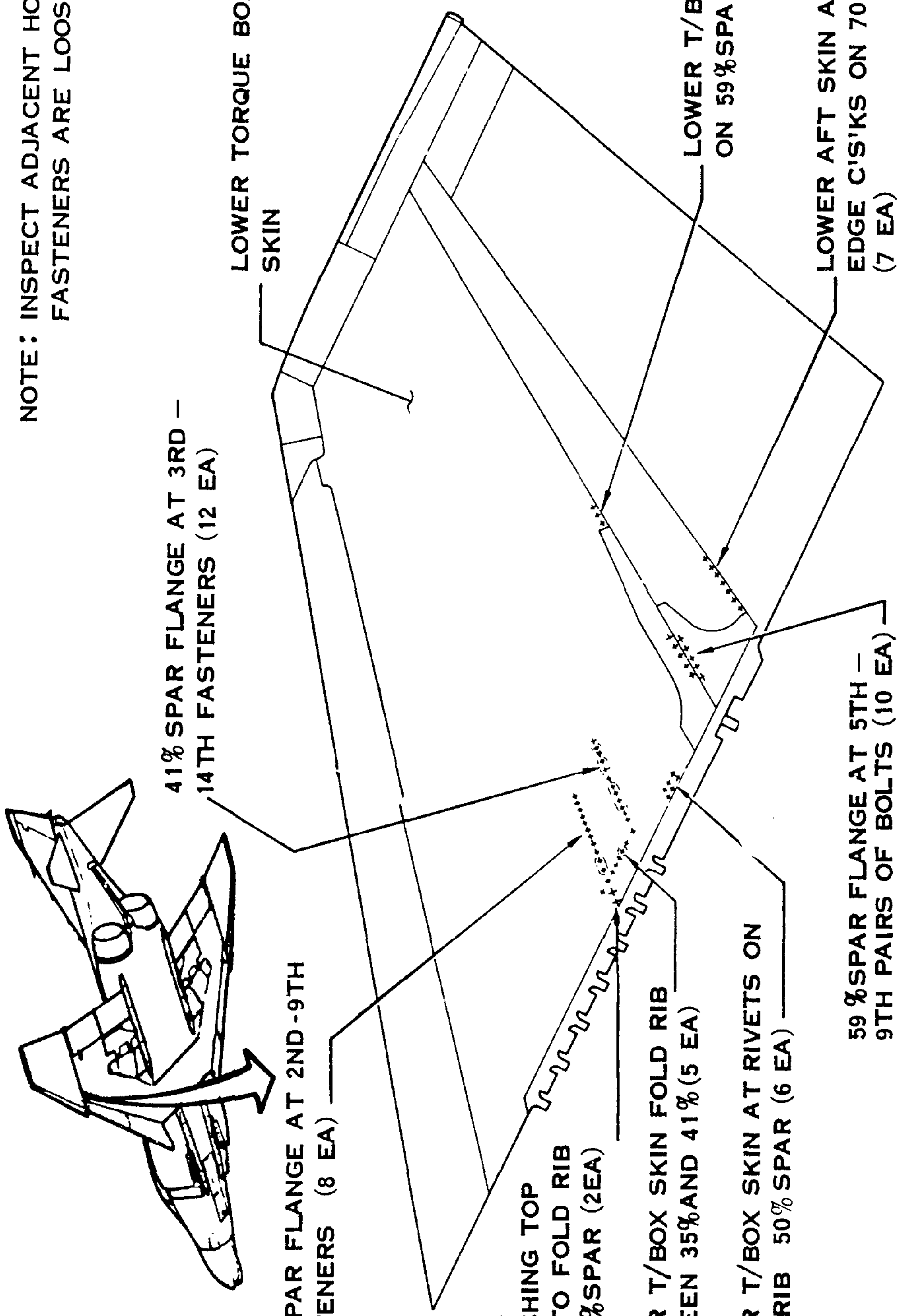


Figure 2. Outer Wing Lower Torque Box Skin (Lower Surface)

THE END

## REFERENCES


1. Morcock, D.S., Brown, K.E., Johnson, R.L., and Davis, J.C., "Force Management Methods - Transport/Bomber Aircraft State-of-the-Art Task I Final Report", Report No. LG78 ER0189-1, Lockheed-Georgia Company, Marietta, GA, 7 July 1978.

2. Sandlin, N.H., "Force Management Methods - Attack/Fighter/ Trainer Aircraft State-of-the-Art Task I Final Report", Report No. 2-30400/8R-3505, Vought Corporation, Dallas, Texas, 21 July 1978.

3. "Aircraft Structural Integrity Program, Service Life Monitoring Program - USAF Series T-39A Aircraft", T.O. IT-39A-38, 15 July 1976.

4. "Military Specification-Recorder, Signal Data MXU-553/A", MIL-R-83165A (USAF) 26 July 1969.

5. "Military Specification-Converter-Multiplexer, Signal Data, General Specification For", MIL-C-83166A (USAF) 3 September 1969.

6. "Data Acquisition System" CONRAC Brochure.

7. "Mechanical Strain Recorder System" Leigh Instruments Limited Presentation, June 1978.

8. "The Influence of Fleet Variability on Crack Growth Tracking Procedures for Transport/Bomber Aircraft" Seventh Oral Report, Contract AF 33615-76-C-3130, Boeing-Withita, 14 June 1978.

## BIBLIOGRAPHY


1. Parker, G.S., "Generalized Procedures for Tracking Crack Growth in Fighter Aircraft", AFFDL-TR-76-133, January 1977.

2. Dill, H.D., and Saff, C.R., "Effect of Fighter Attack Spectrum on Crack Growth", AFFDL-TR-76-112, March 1977.

3. "A Method of Deriving Fighter Loads Spectra Using Multiple Airspeed/ Altitude Combinations", Oral Presentation, McDonnell Douglas Corporation.

4. Brougham, H.E., Littlefield, J.E., and White, D.J., "A-7D ASIP Part I - Damage Tolerance and Fatigue Assessment Program", Vought Corporation Report 2-53440/7R-5928 - Vol. I, January 1977.

5. Brougham, H.E., White D.J., and Lauridia, R.R., "A-7D ASIP Part II - Flight Recorder Program", Vought Corporation Report 2-53470/7R-5929, January 1977.

6. Sandlin, N.H., Lauridia, R.R., White, D.J., "Summary of Flight Spectra Development for Fighter Aircraft", ASTM Symposium on Service Fatigue Loads Monitoring, Simulation and Analysis, Nov. 1977.

7. NOR 72-28, "F-5E Structural Fatigue Loads", July 1972, Northrop Corporation.

8. NOR 76-69, "F-5E Parametric Fatigue and Loads Analysis Computer Program User's Manual, Volume I", Sept. 1976, Northrop Corporation.

9. Joyce, R.E., "Development of the F-5E Fatigue Spectrum", NB-74-329, Northrop Corporation, Sept. 1974.

10. Dellosso, Francis J., "Development of Flight-by-Flight Spectrum for Repeated Load Test", Fairchild-Republic Company.

11. Denyer, A.G., "Flight-by-Flight Spectrum Development", ASTM Symposium on Service Fatigue Loads, Monitoring, Simulation, and Analysis, November 1977.

12. 16 PR 356, "F-16 Durability and Damage Tolerance Loads Spectra Analysis", 28 March 1977, General Dynamics.

13. 16 PR 308, "F-16 Airframe Preliminary Durability Analysis", April 1977, General Dynamics.

14. 16 PR 378, "F-16 Wing and Center Fuselage Preliminary Damage Tolerance Analysis", March 1977, General Dynamics.

15. 16 PR 379, "F-16 Horizontal Stabilizer Preliminary Durability and Damage Tolerance Analysis," March 1977, General Dynamics.

16. "A37B Crack Growth Analysis Results", Report No. 318E-7516-074, February 1976, Cessna Aircraft Company.

17. "A37B Damage Rate Update", Report No. 318E-7716-038, 1 March 1977.

18. "A37B Control Document for Mission Code Store Load Damage Rates", Report No. 318E-7405-006, Cessna Aircraft Co., 8 February 1974.

19. "Parametric Fatigue Cost Comparison Study A37B", Report No. 318E-7505-083, Cessna Aircraft Co., 8 December 1975.

20. Pickens, Stephen W., "A37B Parametric Fatigue Study Sensitivity Analysis", Cessna Aircraft Co., Presented at Structural Loads Work-Shop, September 23-24, 1974, WPAFB.

21. D185-10074-1, "T-43A Service Missions Fatigue Analysis", The Boeing Company, 6 July 1973.

22. D185-10073-1, "T-43A Parametric Fatigue Analysis", The Boeing Company, 6 July 1973.

23. SA160R9403, Rev. A, "Development of Flight by Flight Spectrum for A-10A PDV Tests", Fairchild Republic Company, 21 February 1975.

24. SR160R0003, "A-10A Aircraft Fatigue Load Spectra", Fairchild Republic Company, 18 February 1975.

25. SA160R9401, Rev-J, "Aircraft Structural Integrity Program Plan", A-10 Airplane, 15 December 1977.

26. MDC A0833 Vol. III, "F-15 Loads Analysis Fatigue Loads Report",

27. MDC A0928, "F-15 Fatigue Design Analysis Report",

28. MDC A1456, "F-15 Service Life Analysis",

29. MDC A0913, "F-15 Fracture Mechanics Report",

30. MDC A2883 Vol I, "F-4 Fatigue and Damage Tolerance Assessment Program"

31. MDC A2883, Vol. II, "F-4 Fatigue and Damage Tolerance Assessment Program",

32. NOR-60-210 "T-38 Airframe Fatigue Analysis and Service Life Estimate".

33. LG1US667-2-2 "C-5A Parametric and Service Missions Fatigue Analysis, Volume II, Loads and Criteria", 1 May 1973.

34. SRD 71-13-03 "C-5A Flight By Flight Fatigue Loads Computer Program System", 2 May 1975.

35. LG77ER0098 "Preliminary Damage Tolerance Analysis C-5A Wing Modification" 12 Sept 1977.

36. White, D.J., et al, "Flight Spectra Development for Fighter Aircraft", Technical Report NADC-76132-30, July 1977.

37. Stauffer, W.A., John G. Lewolt, Frederic M. Hoblit, "Application of Advanced Methods to the Determination of Design Loads of the Lockheed L-1011 Tristar", AIAA Paper No. 72-775, Aug 1972.

38. LG1US48-2-8, "C-5A ALDCS Structural Fatigue Evaluation", Lockheed-Georgia Co., May 1975.

39. "Analysis of Mechanically Fastened Joints Utilizing PSD Loads", Lockheed-Georgia Co., Presentation, Oct. 1975.

40. "PSD Loads/Load Transfer Stress Analysis Technique Development" Lockheed-Georgia Co., May 1975 (Unpublished Notes).

41. Shah, Bharat M., J.L. Russ, "Fatigue Analysis of Mechanically Fastened Joints Utilizing PSD Loads", Journal of Aircraft, Vol. 14, No. 11, Nov 1977, pp. 1064-1069.

42. Ekvall, J.C., L. Young, "Converting Fatigue Loading Spectra for Flight-By-Flight Testing of Aircraft and Helicopter Components", Journal of Testing and Evaluation, JTEVA, Vol. 4, No. 4, July 1976, pp. 231-247.

43. LG1US44-1-1 "C-5A Wing Loads" Lockheed-Georgia Co., (Selected Items).

44. F-111 A/E Airframe Initial Unit Damage Data for Service Life Monitoring (ECP0315), FZS-12-343-1, Vol I, 28 July 1972.

45. A-37B Individual Aircraft Service Life Monitoring (Seventh Quarterly Report), Rep. No. 318E-7616-068, 31 Jan. 1977.

46. A-37B Lower Carry-Thru Crack Growth Analysis (Original Carry-Thru), Rep. No. 318E-7616-051@, 13 Aug 1976.

47. T-43A Methodology Report for Operational Usage Program (OUP), D185-10061-1, 24 Nov 71.

48. T-43A Life History Recording Program Report, D185-10089-5, 1 June 1976.

49. A-10A Aircraft Methodology for the Life History Recorder Program, SR 160 R0005, 12 Mar 1976.

50. ASIP Master Plan for C-5A System 410A, 1 July 1973, Rev Dec. 1974, C-5A SPO/ASD/YAP.

51. TF-15 Service Usage Recorder Program Data Collecting and Reporting, Maintenance Instructions, TO IF-15A-2-2-4, 1 Oct 1976.

52. F-5E Aircraft Structural Integrity Program Annual Status Report, 30 June 1976.

53. NOR 74-226 F-5E/F Counting Accelerometer Fatigue Damage Computer Program, Users Manual, Nov. 1974.

54. NOR 20-59 "F-5E/F Aircraft Structural Integrity Program Master Plan", Northrop Corporation, April 1970.

55. NOR 74-225 F-5E/F Usage Card Edit Program User's Manual, Sept 1974.

56. TO 1F-5E-6, F-5E/F Aircraft Scheduled Inspection and Maintenance Requirements 1 July 1976, Chg 3, 1 April 1977.

57. TO IF-5E-36 Nondestructive Inspection, F-5E and F-5F, 1 Mar 77, Chg 1, 1 July 1977.

58. Allen, A. Phil, "F-4 Aircraft Structural Integrity Presentation", Presented at ASIP meeting, OCALC, Oct. 1977.

59. F/RF-4 Aircraft Structural Integrity Program Master Plan, 1 May 1977 Revision, OO-ALC/MMSRA.

60. Lunde, T., "Fatigue and Stress Corrosion Guidelines," Lockheed-California Company, 1976.

61. MMSRB 77-1, "F-100 Service Life Capability Initial Report", SM-ALC, 31 Dec. 76.

62. MMS 73-514, "Aircraft Structural Integrity Program, F-100 Master Plan," SM-ALC, 15 January 1973, Amendments 1 and 2 included.

63. NA-75-182-4 "F-100 Tail Surveillance Damage Data, Interim Report IV", K.K. Karlstan, D.Y. Konishi, Rockwell International, 15 March 1977.

64. MMS 73-508, "Aircraft Structural Integrity Program, T-39 Master Plan," SM-ALC, 2 January 1973. Incorporates changes through 30 June 1977.

65. MMS 77-516 "Aircraft Structural Integrity Program, F-105 Master Plan", SM-ALC, 1 November 1977.

66. MME 76-607, "Fatigue Life Capability Analysis F/FB-111 Airframe Structure", Report Number 1, SM-ALC, 24 Dec 1975.

67. FZS-12-8008-6 Vol. II, "F-111 Airframe Structure Service Life Monitoring Report", General Dynamics, 1 April 1976.

68. FZM-12-13928-1, "F-111 Tactical Fighter Wings A/E/D/F Service Life Monitoring Base Usage Report, Thru First Quarter 1976", General Dynamics, 1 October 1976.

69. FZM-12-6516-1, "FB-111A Service Life Monitoring Base Usage Report, Pease Air Force Base (509th Bomb Wing), Plattsburg Air Force Base (380th Bomb Wing), Thru First Quarter 1976," General Dynamics, 1 December 1976.

70. FZS-12-343-7, Volume I, Book 2 of 2, "F-111A Airframe Unit Damage Data for Service Life Monitoring, Unit Damage Data No. 7," General Dynamics, 20 March 1977.

71. FZS-12-6066-8, Volume III, "FB-111A Operational Usage and Vertical Load Factor Information for Service Life Monitoring", General Dynamics, 7 June 1977.

72. FZS-12-8007-7, Volume I, Book 1 of 2, Appendix A, "F-111 Airframe Unit Damage Data for Service Life Monitoring, Appendix A, Loads Spectra Summary", General Dynamics, 15 June 1977.

73. FZS-12-399-7, "NZ Counter and Damage Adjustment Factor Data for Service Life Monitoring, F-111A", General Dynamics, 27 June 1977.

74. FZM-12-6531 "Overview, F/FB-111 Service Life Monitoring Program" General Dynamics, 25 Jan, 1978.

75. "F-16 Aircraft Structural Integrity Program", Feb. 1977.

76. FZS-12-343-7, Vol. I, "F-111 A/E Airframe Initial Unit Damage Data for Service Life Monitoring" (ECP 0315) General Dynamics, 28 July, 1972.

77. "T-37B Development of Structural Fatigue Damage Rate of AFTO 781 Form Mission Code for Wing and Carry-Thru Structure", Report No. 318B-7319-006 (A), Cessna Aircraft Co., 17 May, 1973.

78. "Lanoy, Michael A., et. al., "Derivative and Analysis of Loading Spectra for USAF Aircraft", Report ASD-TR-76-1, January 1976.

79. "General Description of the Collection and Processing of Aircraft Structural Integrity Data", ASIMIS-TR-73-01, April 1973.

80. Eichenbaum, Frederick D., "Response of Aircraft to Three Dimensional Random Turbulence", AFFDL-TR-72-28, October 1972.

81. Eichenbaum, Frederick D., "Evaluation of 3-D Turbulence Techniques for Designing Aircraft", AFFDL-TR-74-151, January 1975.

82. Parker, G.S., and Pinckert, R.E., "Generalized Procedures for Tracking Crack Growth in Fighter Aircraft", MCAIR 77-015, McDonnell Aircraft Co., Nov. 1977.

83. Pinckert, R.E., "Damage Tolerance Assessment of F-4 Aircraft", MCAIR 76-015 Rev. A. McDonnell Aircraft Company, September 1976.

84. Pinckert, Richard E., and Melliere, Ronald A., "ASIP and the Eagle, F-15 Fatigue Tracking Program", Product Support Digest, McDonnell Aircraft Company.

85. "Aircraft Structural Integrity Program Master Plan for A-37B",October 1970, Revised June 1977, San Antonio Air Logistics Center.

86. "Revised F-16 ASIP", Exhibit A, ECD-16-76-36, Revision A, 15 August,1977.

87. "Fleet Management Program", 16PPO294, 7 July 1975, (Current F-16 ASIP, 4-24-78).



☆U.S.Government Printing Office: 1979 — 657-002/453

78. "Lanoy, Michael A., et. al., "Derivative and Analysis of Loading Spectra for USAF Aircraft", Report ASD-TR-76-1, January 1976.

79. "General Description of the Collection and Processing of Aircraft Structural Integrity Data", ASIMIS-TR-73-01, April 1973.

80. Eichenbaum, Frederick D., "Response of Aircraft to Three Dimensional Random Turbulence", AFFDL-TR-72-28, October 1972.

81. Eichenbaum, Frederick D., "Evaluation of 3-D Turbulence Techniques for Designing Aircraft", AFFDL-TR-74-151, January 1975.

82. Parker, G.S., and Pinckert, R.E., "Generalized Procedures for Tracking Crack Growth in Fighter Aircraft", MCAIR 77-015, McDonnell Aircraft Co., Nov. 1977.

83. Pinckert, R.E., "Damage Tolerance Assessment of F-4 Aircraft", MCAIR 76-015 Rev. A. McDonnell Aircraft Company, September 1976.

84. Pinckert, Richard E., and Melliere, Ronald A., "ASIP and the Eagle, F-15 Fatigue Tracking Program", Product Support Digest, McDonnell Aircraft Company.

85. "Aircraft Structural Integrity Program Master Plan for A-37B",October 1970, Revised June 1977, San Antonio Air Logistics Center.

86. "Revised F-16 ASIP", Exhibit A, ECD-16-76-36, Revision A, 15 August,1977.

87. "Fleet Management Program", 16PPO294, 7 July 1975, (Current F-16 ASIP, 4-24-78).



☆U.S.Government Printing Office: 1979 — 657-002/453