BIBLIOGRAPHY OF ENVIRONMENTAL DATA MEASURED IN FLIGHT

by

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The increased emphasis on product reliability and maintainability has put a premium on knowing what environments, and their intensity, are experienced in flight. A bibliography is being assembled of reports that contain flight test measurements of dynamic data (acoustic, vibration, dynamic loads, flutter, etc.) and thermal data. The purpose of the bibliography is to get a better basis for estimating what the shock, vibration, acoustic and thermal environments are like for today's military aircraft. The bibliography already contains 250 entries consisting of the report number, title, source of the report, type of in-flight measurements made and the systems (A/C and avionics systems or external stores) monitored. A major goal of this project is to determine the potential need for a future systematic flight test program that will fill in gaps in the reported data.

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INTRODUCTION

Increasing attention is being given to maintaining secondary structure and avionics subsystems in today's Air Force. There are several reasons for this increased interest:

- **Increasing costs of**
  - **hardware**
  - **maintenance--regardless of equipment or its age**

- **tactical doctrine that sets as a goal the usage of austere bases with minimal maintenance facilities**

INTRODUCTION

- NEED: A COMPREHENSIVE SURVEY OF ENVIRONMENTAL DATA MEASURED IN-FLIGHT
- WHY: BETTER PREDICTION OF ENVIRONMENTS
- FOR WHOM: DESIGNERS WHO MUST PREDICT SUCH ENVIRONMENTS FOR DESIGN AND ANALYSIS OF NEW COMPONENTS
- HOW: LITERATURE SURVEYS; REPORT EVALUATIONS; IF NECESSARY, FLIGHT TEST PROGRAM
- BY WHOM: LTC RAY HAIN; MAJ ALEX CORONADO; CAPT MIKE DILLARD
- WHERE: WRIGHT LABORATORY, FLIGHT DYNAMICS DIRECTORATE, WRIGHT-PATTERSON AFB, OHIO
- PROJECT SPONSOR: DR. JIM OLSEN, FLIGHT DYNAMICS DIRECTORATE CHIEF SCIENTIST

REASONS

- It seems fairly typical to design to predicted levels only to find out (from the flight testing that is done and field use) that the predictions were too low.
- Fixing broken equipment is expensive.
- A look at reliability data may well corroborate the fact that at least one of the environments was much too low, e.g., the acoustic levels seen by the B-1 Aft Equipment Bay during take-off or the A-10 gunfire acoustic levels in the nose wheel well.
- A flight test program is expensive; finding out what data is available can cut down on such testing.
- No one office is aware of all the testing done; the Navy does testing on the F-16 and AIM-9 but the Air Force may not be aware of it.

REASON FOR EFFORT

- POOR HANDLE ON WHAT ENVIRONMENTS "REALLY" ARE
- INCREASING COSTS
- INCREASING EMPHASIS ON THE "ILITIES"
- EXPENSE INVOLVED IN RUNNING A FLIGHT TEST PROGRAM
- REDUCE DUPLICATION OF EFFORT

ACCOMPLISHMENTS

- Bibliography now contains 250 entries from a wide spectrum of sources. All entries are unclassified but a few are "competition sensitive" or were at time of writing. Presumably this restriction will be (or has been) removed with contract award.
- Several offices at Wright-Patterson are interested in what we are doing: Avionics Integrity Program Office (would like to see extensive surveys); ASD/EN (Engineering) is interested; F-15 SPO could allow us collect data on some of their tests.
- A library at Wright Laboratory, Flight Dynamics Directorate, (Structural Dynamics Branch) has been established for the test reports we collect.

ACCOMPLISHMENTS

- SEVERAL LITERATURE SURVEYS ACCOMPLISHED:
  - 250 REPORTS IDENTIFIED
    - REPORTS COVER APPROXIMATELY 50 YEARS.
- DISCUSSED SURVEY WITH SEVERAL INTERESTED OFFICES AT WRIGHT-PATTERSON AFB:
  - AVIONICS INTEGRITY PROGRAM OFFICE
  - F-15 SPO
  - ASD/EN
- LIBRARY FOR FLIGHT TEST REPORTS ESTABLISHED AT WRIGHT LABORATORY, FLIGHT DYNAMICS DIRECTORATE
- END PRODUCT OF PROJECT: BIBLIOGRAPHY OF REPORTS

DATA BASE STRUCTURE

- DBASE III STRUCTURE
- 19 FIELDS OF DATA
  - THREE FOR A/C TYPES
  - THREE FOR SUBSYSTEMS TYPES
  - THREE FOR AUTHORS AND THEIR ORGANIZATIONS
  - THREE FOR DATA TYPES
  - PLUS FIELDS FOR TITLE, REPORT NUMBER, LOCATION OF COPY, ORGANIZATION OF ORIGINATION, ETC.

BIBLIOGRAPHY STRUCTURE

- USE DBASE I I I
- DATA LISTED:
  - REPORT NO.
  - REPORT TITLE
  - REPORT AUTHOR
  - SYSTEMS MONITORED
    - AIRCRAFT (UP TO THREE IN DATA BASE)
    - SYSTEMS MONITORED (E.G., RADAR, ANTENNAE, GUNFIRE DATA, EXTERNAL STORES) (UP TO THREE LISTED IN DATA BASE)
  - TYPE OF DATA (NOISE, VIBRATION, LOADS, FLUTTER, ETC.)

DATA

- Vibration data is presented in several ways:
  - Acceleration PSDs
  - RPM vs Amplitude
  - Double Amplitude displacement vs. frequency
- Acoustic data is generally presented as dB per octave band with some at smaller band widths.
  - Very little aeroacoustic noise is reported. Need more of it.
- Thermal data is at a premium. Very little of it appears in the open literature.
- Dynamic Loads data and flutter data are reported. Need more of both.

TYPES OF DATA

- VIBRATION
- ACOUSTIC
- THERMAL
- DYNAMIC LOADS
- FLUTTER

SYSTEMS

- Various combinations of aircraft systems have been monitored. Almost all systems are represented in some test or other. Generally, only one or two (occasionally three) aircraft systems are monitored. Some systems are monitored on more than one airplane.

- Extensive data for very FEW aircraft are available; the two in our data base are the F-111 and F-15.

SYSTEMS MONITORED

- AIRCRAFT
  - FIGHTERS
  - CARGO A/C
  - BOMBERS
  - HELICOPTERS
- EXTERNAL STORES
  - BOMBS AND FUSES
  - AIR-TO-AIR MISSILES
  - FUEL TANKS
- INTERNAL EQUIPMENT
  - RADAR SETS
  - VARIOUS RECEIVERS AND ANTENNAS
  - GUN DATA (VIBRATION AND ACOUSTIC)

TESTING

- Of the data collected, very little is actually reduced. There are several reasons for this: (1) only as much of the collected data as is thought necessary to solve problem is reduced; (2) lack of resources (money, manpower, or equipment); (3) lack of vision for future needs; (4) inability to read tapes because tape parameters are no longer known.

- Many different agencies run a flight test program of some type. Each is often unaware that any other test has been accomplished. Duplication of effort results.

TEST PROGRAMS

- GENERALLY USED TO SOLVE A VERY LIMITED PROBLEM
- LIMITED AMOUNT OF THE DATA COLLECTED IS ACTUALLY REDUCED
- VERY FEW SURVEYS OF ENTIRE A/C
- RUN BY MANY DIFFERENT AGENCIES

TEST ORGANIZATIONS

- Each of the services run their own tests "in-house". Some of the tests are run by several agencies within the home service.
- Other tests are run by the contractors who expect to be paid for their effort. They provide what is paid for only.
- Particular test organizations:
  - Air Force Flight Test Center • Air Force Flight Dynamics Lab
  - Air Force Special Weapons Center • Armament Division (AFSC)
  - 4950th Test Wing (WPAFB) • Federal Aviation Administration
  - NASA • Naval Air Test Center • Naval Weapons Center
  - Army's ECOM • Army Missile Command • AGARD
  - Plus many more military and civilian organizations.

TEST ORGANIZATIONS

- HOME "SERVICE" OF TEST ORGANIZATIONS REPRESENTED IN DATA BASE
  - AIR FORCE
  - NAVY
  - ARMY
  - NASA
- CONTRACTORS
  - McDONNEL DOUGLAS CORPORATION
  - GENERAL DYNAMICS
  - BOLT, BERANEK, AND NEWMAN
  - BOEING
  - PLUS ANY ONE ELSE PRODUCING MILITARY HARDWARE

FURTHER EFFORTS

- A Continuing effort is being made to collect as much additional data as possible. We are trying to add as many titles as possible to our bibliography.
- A systematic flight test program will be designed to fill as many of the gaps as possible--but only if necessary.
- Several avenues of data collection are being followed:
  - Additional literature surveys/searches
  - Letters to test organizations asking for inputs
  - Searching filing cabinets of reports
  - "Piggybacking" instrumentation on other tests (F-15 SPO may allow this)
  - "Piggybacking" instrumentation packages on training missions if MAJCOM will allow it.

CONTINUING EFFORT

- COLLECT COPIES OF AS MANY REPORTS AS POSSIBLE TO BE ADDED TO LIBRARY
- CONTINUING LITERATURE SURVEYS/SEARCHES
- LETTERS TO TEST ORGANIZATIONS ASKING FOR INPUTS
- COLLECT DATA BY:
- DESIGNING A FLIGHT TEST PROGRAM TO FILL IN GAPS IN DATA (IF NEEDED)
- PIGGYBACK ON OTHER TEST PROGRAMS
  - F-15 IS POSSIBLE
- PIGGYBACK ON TRAINING MISSIONS
  - WHEN MAJCOM WILL ALLOW IT

ADDITIONAL DATA

- Additional data and bibliographic entries are our current aim.
- Information requested includes:
  - Report number
  - Report title
  - Report authors
  - Type of data in report (i.e., vibration, noise, flutter, loads, etc.)
  - Systems monitored (i.e., A/C type, avionics components, structure)
  - Point of contact to obtain copy of report or to review report
  - Location of copy of test report
  - Source of report, i.e., the test organization

COLLECTION OF DATA

- TYPE OF DATA WANTED:
  - DYNAMIC
    - VIBRATION
    - ACOUSTIC
      - REGARDLESS OF SOURCE
    - FLUTTER
  - THERMAL
- COPY OF TEST REPORT FOR LIBRARY AT WRIGHT LABORATORY, FLIGHT DYNAMICS DIRECTORATE
- HELP FROM OTHER TEST ORGANIZATIONS:
  - SEND INFORMATION TO:

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