

7-1980

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Recommended Citation

Hutton, P. H. and Skorpik, James R., "Acoustic Emission Monitoring of In-Flight Crack Growth in Air Craft Structures" (1980). *Proceedings of the DARPA/AFML Review of Progress in Quantitative NDE, July 1978–September 1979*. 77.
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Acoustic Emission Monitoring of In-Flight Crack Growth in Air Craft Structures

Abstract

Purpose of the program is to evaluate acoustic emission (AE) for in-flight detection of fatigue crack growth in aircraft structure. A special AE system was developed and installed on a RAAF Macchi jet trainer. It has been effectively measuring AE from a fatigue crack since August, 1978. Work is continuing to investigate correlation of AE data with crack growth.

Keywords

Nondestructive Evaluation

Disciplines

Materials Science and Engineering

ACOUSTIC EMISSION MONITORING OF IN-FLIGHT CRACK GROWTH
IN AIR CRAFT STRUCTURES

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ABSTRACT

Purpose of the program is to evaluate acoustic emission (AE) for in-flight detection of fatigue crack growth in aircraft structure. A special AE system was developed and installed on a RAAF Macchi jet trainer. It has been effectively measuring AE from a fatigue crack since August, 1978. Work is continuing to investigate correlation of AE data with crack growth.

PROGRAM REVIEW

This program was funded by the U.S. Defense Advanced Research Projects Agency for application to a Royal Australian Air Force aircraft. The purpose of the program is to evaluate the use of the acoustic emission (AE) technique to provide a definitive continuous monitor of fatigue crack growth in a critical aircraft structural member.

The program started in September, 1977, with Phase I consisting of defining technical and procedural details and developing and fabricating an AE monitor system. A unique AE monitoring system was fabricated and laboratory tested. (Fig. 1, 2) It utilizes a source isolation feature to distinguish AE signals originating from an identified area of interest. Two parameters of AE information are recorded on one solid state digital memory for later retrieval and analysis. (Fig. 3) Phase I was completed in April, 1978.

Phase 2 was concerned with installing and testing the AE monitoring system in an aircraft. Installation was made in RAAF Macchi 326 aircraft 17-021 during a major maintenance overhaul (Fig. 4, 5) The system is monitoring AE from fatigue cracks in a fastener hole in the tension member of the wing structure center section continuously during flight. (Fig. 6) Installation was completed in August, 1978, with four test flights to evaluate system performance and make necessary adjustments.

Battelle Northwest is providing follow-up support to the Australian Aeronautical Research Laboratory (ARL) on this program under a continuing phase 3. This support includes assistance in data analysis and correction of any AE system problems. Evaluation of data from the first 25 flights shows that background noise and transient signals are not a problem, that the character of the data is stationary and that the AE is influenced by the type of flying--i.e., low level, formation, aerobatics, etc. Sample results from individual flights are shown in Fig. 7, 8, 9. Evaluation of correlation between AE and crack growth will require at least a year of data gathering to assimilate sufficient crack growth data points.

Acknowledgements

The significant contributions made by J. F. Dawson, Battelle, to this program are gratefully acknowledged. Also, Australian ARL and RAAF personnel provided outstanding cooperation and assistance.

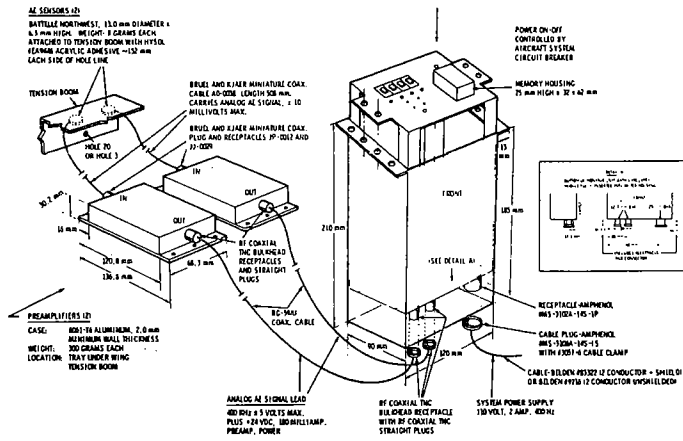


Figure 1. Specifications for Onboard Aircraft AE System

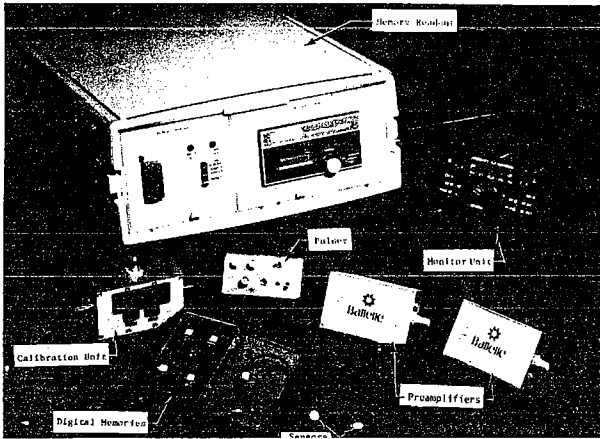


Figure 2. Complete AE Aircraft System

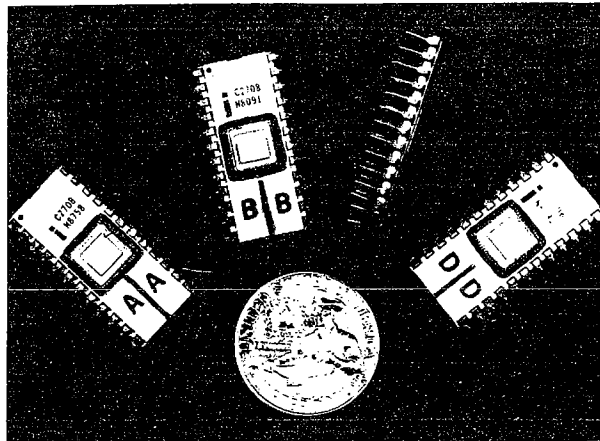


Figure 3. Solid State Digital Memories

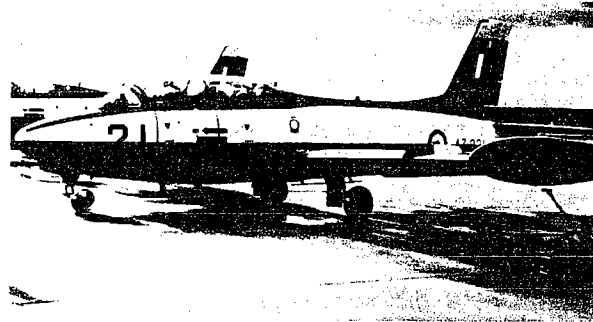


Figure 4. RAAF Macchi 326 Two Place Jet Trainer

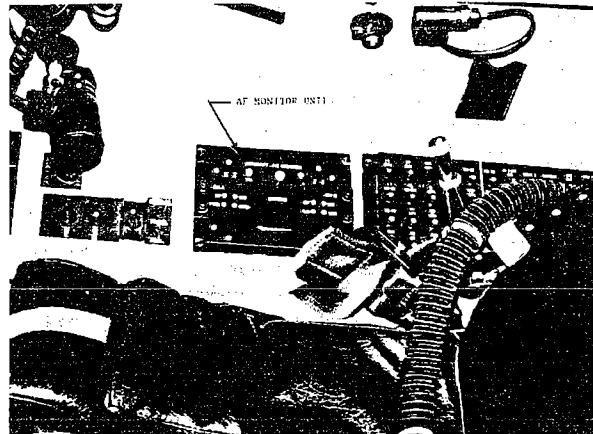


Figure 5. AE Monitor Unit Installed in Macchi Aircraft A7-021

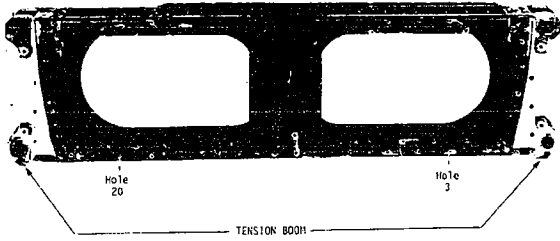


Figure 6. Center Wing Section - Macchi 326 Aircraft

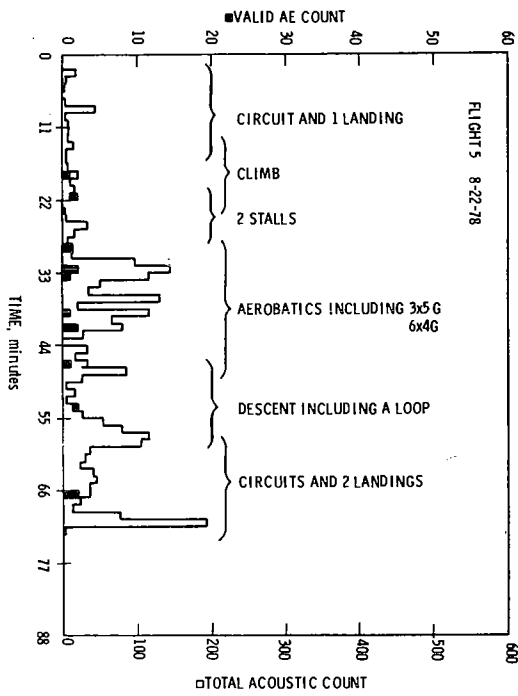


Figure 7. Sample Data - Flight 5

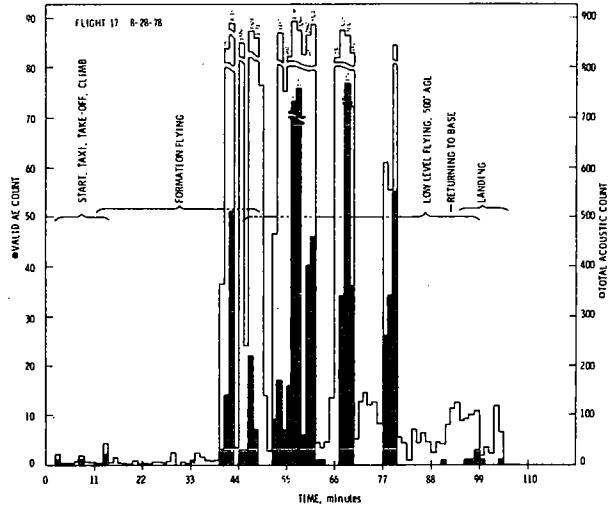


Figure 8. Sample Data - Flight 17

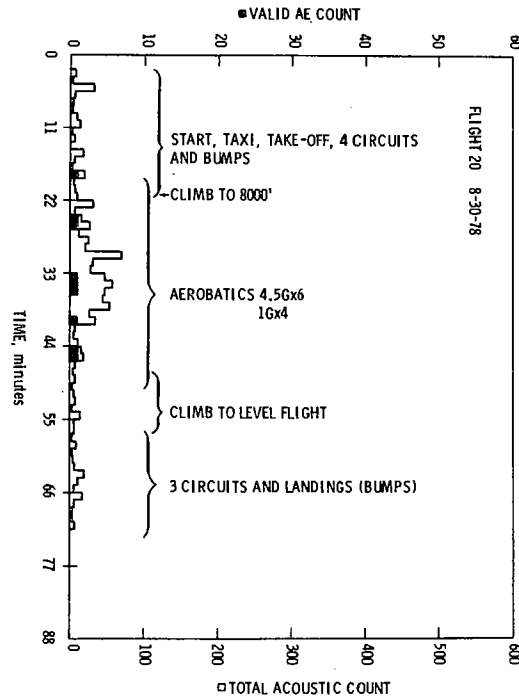


Figure 9. Sample Data - Flight 20