AEROSPACE INFORMATION REPORT

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Design Considerations for Enclosed Turbofan/Turbojet Engine Test Cells

RATIONALE

Revision to incorporate reference to recently published SAE Aerospace Information Report AIR6355.

FOREWORD

One of the strongest motives for documenting the considerations which are judged important in the design of enclosed ground-level testing facilities for turbofan and turbojet engines as described in this work was the generally poor understanding of the aerodynamics associated with the test cell environment. In those instances where the understanding was not so poor, there sometimes remained a lack of appreciation for the fundamental importance of the aerodynamics of the engine testing environment. It is known that such a poor understanding or a lack of appreciation for the importance of the aerodynamics of the testing environment can and does lead to disastrous consequences. Aerodynamic research work has led to a much improved understanding and heightened awareness of the fundamental importance of the aerodynamics of the engine testing environment and has resulted in significantly improved engine test facilities now in use worldwide. This document is intended for individuals associated with the ground-level testing of large and small gas turbine engines and particularly those who might be interested in upgrading their existing or acquiring new test cell facilities.

Turbofan and turbojet engines operating in a ground-level test cell can encounter a number of problems which are directly attributable to the characteristics of the test cell environment. Some of the more important factors which must be considered in the development of test cell designs leading to desired engine operational stability, aerodynamic performance, and acoustic control are described. Test cell performance goals which typically might be used to define "excellent" cell performance are included. When these cell performance goals are achieved, stable and repeatable engine operation can be assured. Research conducted through scale model test studies and numerical analysis, reinforced by results from a number of full-scale operational experiences, has assisted the evolution of engine test cell design and attacked the need for improved engine test facilities.

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1. SCOPE

This SAE Aerospace Information Report (AIR) has been written for individuals associated with the ground-level testing of large and small gas turbine engines and particularly for those who might be interested in upgrading their existing or acquiring new test cell facilities.

1.1 Purpose

There are several purposes served by this document:

a. To provide guidelines for the design of state-of-the-art ground-level enclosed test facilities for turbofan and turbojet engine testing applications.

b. To address the major test cell/engine aerodynamic and acoustic characteristics which can influence the operation of a gas turbine engine and its performance stability in a test cell.

c. To consider acoustic environmental impact and methods to control it.

2. REFERENCES

2.1 Applicable Documents

The following publications for a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of the other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 Karamanlis, A. I., Sokhey, J. S., Dunn, T. C., and Bellomy, D. C.: "Theoretical and Experimental Investigation of Test Cell Aerodynamics for Turbofan Applications," AIAA Paper No. 86-1732, Paper presented to the AIAA/ASME/SAE/ASEE 22nd Joint Propulsion Conference, Huntsville, Alabama, June 16-18, 1986.

2.1.2 Freuler, R. J., and Dickman, R. A.: "Current Techniques for Jet Engine Test Cell Modeling," AIAA Paper No. 82-1272, Paper presented to the AIAA/SAE/ASME 18th Joint Propulsion Conference, Cleveland, Ohio, June 21-23, 1982.

2.1.3 Karamanlis, A. I., Freuler, R. J., Lee, J. D., Hoelmer, W., and Bellomy, D. C.: "A Universal Turboshaft Engine Test Cell - Design Considerations and Model Test Results," AIAA Paper No. 85-0382, Paper presented to the AIAA 23rd Aerospace Sciences Meeting, Reno, Nevada, January 1985.

2.1.4 Grunnet, J. L., and Ference, E.: "Model Test and Full-Scale Checkout of Dry-Cooled Jet Runup Sound Suppressors," AIAA Paper No. 82-1239, AIAA/SAE/ASME 18th Joint Propulsion Conference, Cleveland, Ohio, June 21-23, 1982.

2.1.5 "Gas Turbine Engine Test Cell Correlation," SAE Aerospace Recommended Practice ARP741, Society of Automotive Engineers, Warrendale, Pennsylvania, Issued March 1976, Reaffirmed October 1982. (Note: This ARP was revised and reissued as ARP741 Revision A in September 1993 and Revision B in November 2002; the original March 1976 version is the specific reference here).

2.1.6 Oran, F. M., and Schiff, M. I.: "Design of Air-Cooled Jet Engine Testing Facilities," Industrial Acoustics Company, Bronx, New York, 1979.

2.1.7 Ashwood, P. F., et al.: "Operation and Performance Measurements on Engines in Sea Level Test Facilities," AGARD Lecture Series No. 132 (AGARD-LS-132), Advisory Group for Aerospace Research and Development, North Atlantic Treaty Organization, Neuilly Sur Seine, France, 1984.