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Wind tunnel measurement quality in testing of a standard model

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Abstract

Tests of standard models serve to confirm the overall accuracy and measurement quality in a wind tunnel facility and to confirm confidence in results obtained. The wide-accepted criteria for evaluation of the wind tunnel measurement quality are based on methodology of a few supposedly identical tests of the standard model. Wind tunnel data uncertainty is being considered in the form of test data repeatability. Based on this methodology the overall reliability of the Serbian trisonic wind tunnel is certified and verified. Test data are also correlated with those from other wind tunnel facilities.

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Keywords: wind-tunnel; standard model; repeatabilty of measurement; measurement quality.

1. Introduction

Wind tunnels are experimental installations designed for aerodynamic studies of reduced-scale models, based on achieving geometric, kinematic and dynamic similarity with full-scale objects. A properly calibrated and verified experimental facility is required for timely, effective future-flight-object development.

Testing of standard (calibration) models is considered an important item in the health monitoring of a complete wind tunnel and a testing process, [1-3]. A standard established through the use of identical calibration models for the evaluation of data obtained in the greatest number of aerodynamic test facilities is well recognized.

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Wind tunnel data quality must attain very high standards of repeatability of measurement for all the forms of testing and should be maintained during an exploitation period. Measurement quality in the most used experimental facility of the Military Technical Institute (VTI) in Belgrade is being monitored and assessed based on repeatability of measurement in the wind tunnel testing of the calibration model for three alternative categories with specified accuracy requirements. The repeatability between separate test series, which had started with complete reassembly of the model, is being regarded as a long-term repeatability (between-test variation).

2. Test facility

The T-38 test facility at VTI is a blowdown-type pressurized wind tunnel with a 1.5 m × 1.5 m test section, Fig. 1 (left), [4]. For subsonic and supersonic tests, the test section is equipped with solid walls, while for transonic tests, a section with porous walls is inserted in the tunnel configuration. The porosity of walls can be varied between 1.5% and 8%, depending on Mach number, so as to achieve the best flow quality. Energy for this facility is stored in 2600m^3 air tanks charged up to 20 bar by a five-stage 3.8 MW compressor.

Mach number in the range 0.2 to 4 can be achieved in the test section, with Reynolds numbers up to 110 million per meter. In the subsonic configuration, Mach number is set by sidewall flaps in the tunnel diffuser. In the supersonic configuration, Mach number is set by the flexible nozzle contour, while in transonic configuration, Mach number is both set by sidewall flaps and the flexible nozzle, and actively regulated by blow-off system. Mach number can be set and regulated to within 0.5% of the nominal value.

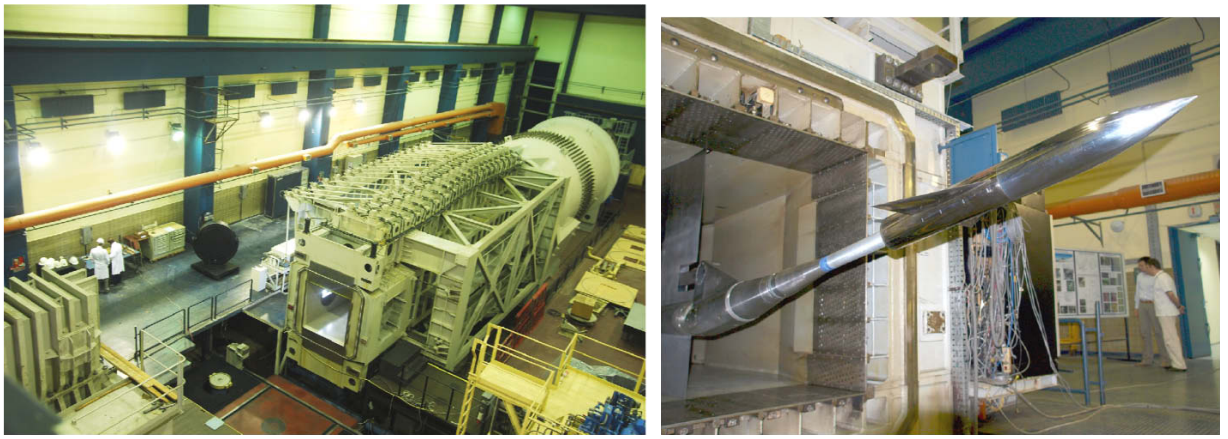

Fig. 1. T-38 wind tunnel facility in VTI, Belgrade (left); AGARD-B 115.8 mm dia. model in the T-38 test section (right).

Stagnation pressure in the test section can be maintained between 1.1 bar and 15 bar, depending on Mach number, and regulated to 0.3% of nominal value. Run times are in the range 6s to 60s, depending on Mach number and stagnation pressure.

Model is supported in the test section by a tail sting mounted on a pitch-and-roll-mechanism. The facility supports both step-by-step and continuous model movements during measurements. Positioning accuracy is 0.05° in both pitch and roll.

3. Standard model

Standard AGARD-B model, a generic supersonic aircraft configuration, is an ogive-cylinder with a delta wing in the form of an equilateral triangle with a span four times body diameter, [1]. Model is used as the standard for force and moment measurements in the T-38 test facility up to Mach number 2, Fig. 1 (right).