WIND TUNNEL WALL INTERFERENCE CORRECTIONS
- LIST OF IMPORTANT REFERENCES -

BY

N. Ulbrich
Jacobs Technology Inc., Moffett Field, California 94025

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The following commented list of references was prepared for wind tunnel test engineers. It is intended to give the reader an idea (a) where information about the assessment and calculation of wind tunnel wall interference effects can be found and (b) what types of correction techniques are used in the industry today.

[1] Ewald, B. F. R., et al., "Wind Tunnel Wall Correction," AGARDograph 336, published by the North Atlantic Treaty Organization, October 1998. - This is the most complete publication about wind tunnel wall interference correction assessment. Experts in the field discuss correction assessment techniques for closed wall, open jet, perforated wall, and slotted wall test sections (state-of-the-art, late 1990s).

[2] Garner, H.C., Rogers, E.W., Acum, W.E.A., and Maskell, E.C., "Subsonic Wind Tunnel Wall Correction," AGARDograph 109, published by the North Atlantic Treaty Organization, October 1966. - This report contains the most detailed discussion of "classical" wall interference correction techniques. It is the predecessor of Ref. [1].

[3] Baldwin, B. S., Turner, J. B., Knechtel, E. D., "Wall Interference in Wind Tunnels with Slotted and Porous Boundaries at Subsonic Speeds," NACA TN 3176, Ames Aeronautical Laboratory, Moffett Field, California, May 1954. - This NACA report contains information on how to assess blockage corrections in tunnels with slotted or porous wall boundary conditions. Corrections are assessed using analytical equations that were derived from Fourier transform solutions of the wall interference flow field. It is the "classical" reference for assessing blockage in test sections with ventilated walls.

[4] Pindzola, M. and Lo, C. F., "Boundary Interference at Subsonic Speeds in Wind Tunnels with Ventilated Walls," AEDC-TR-69-47, Arnold Engineering Development Center, Arnold Air Force Station, Tennessee, May 1969. - This AEDC report is the "classical reference" for estimating blockage & lift interference in ventilated wall test sections. The solutions were found using the Fourier transform technique.

[5] Sivells, J. C. and Salmi, R. M., "Jet-Boundary Corrections for Complete and Semispan Swept Wings in Closed Circular Wind Tunnels," NACA TN 2454, 1951. - Classic reference for the assessment of wall interference in tunnels with circular cross-section. Report contains formulas that may be used to assess higher-order wall interference corrections for swept wings. These corrections take the span- and chordwise variation of the wall interference induced angle of attack correction into account.

[6] Heyson, H. H., "Jet-Boundary Corrections for Lifting Rotors Centered in Rectangular Wind Tunnels, " NASA Technical Report R-71, Langley Research Center, Langley Field, VA, 1960. - Heyson's "classical" NASA Report that discusses wall interference corrections for lifting rotors in rectangular wind tunnels.

[7] Maskell, E. C., "A Theory of the Blockage Effects on Bluff Bodies and Stalled Wings in a Closed Wind Tunnel, " R.A.E. Report No. 3400, November 1963. - "Classical" reference for the assessment of blockage corrections in highly-separated flows. Method tends to overpredict blockage corrections. It has essentially been replaced by techniques that are based on wall boundary measurements of the test section flow.

[8] Hackett, J. E., Wilsden, D. J., and Lilley, D. E., "Estimation of Tunnel Blockage from Wall Pressure Signatures: a Review and Data Correlation, " NASA CR-152241, Lockheed-Georgia Company, Marietta, Georgia, March 1979. - Reference that describes key ideas related to the assessment of wall interference corrections using wall boundary measurements. These types of measurements are needed whenever blockage corrections have to be assessed in highly-separated flows (e.g. high angle of attack testing). Hackett's wall signature method requires a singularity representation of the test article. Ashill's method (see Ref.[10] and [11] below), on the other hand, does not require a singularity representation of the model. Both approaches, however, need information about the location of the test article's reference points in the tunnel (e.g., ¾ chord line of the wing) as corrections need to be obtained at those points.

[9] Hackett, J. E., Wilsden, D. J., and Stevens, W. A., "A Review of the Wall Pressure Signature and other Tunnel Constraint Correction Methods for High Angle-of-Attack Tests," AGARD-R-692, Munich, May 1980. - This publication compares different methods that use wall boundary measurements for the assessment of wall interference corrections for high angle-of-attack tests.

[10] Ashill, P. R., Keating, R. F. A., "Calculation of Tunnel Wall Interference from Wall Pressure Measurements, " The Aeronautical Journal, Vol. 92, No. 911, January 1988, p.36 to p.53. - This journal article describes Ashill's two variable method. The technique, similar to Hackett's wall signature method (see Ref. [8]), uses wall boundary measurements for the assessment of wall interference. Ashill's correction method, however, does not require a singularity representation of the test article.

[11] Ashill, P. R., "Boundary-Flow Measurement Methods for Wall Interference Assessment and Correction; Classification and Review," proceedings, 73rd AGARD Fluid Dynamics Panel Meeting and Symposium on Wall Interference, Support Interference and Flowfield Measurements, Oct. 4-7, 1993, p.12-1 to p.12-21. - Symposium paper that compares advantages & disadvantages of methods that use wall boundary measurements for the assessment of wall interference in wind tunnel testing.

[12] Mokry, M., "Subsonic Wall Interference Corrections for Half-Model Tests using Sparse Wall Pressure Data," Aeronautical Report LR-616, NRC No. 25132,

National Research Council Canada, Ottawa (Ontario), 1985. - This NRC report describes Mokry's method for the assessment of wall interference in semispan model testing. Mokry's method also uses wall boundary flow measurements. Report contains some information about the wall pressure measurement system that was used to obtain wall boundary flow measurements in the tunnel's test section.

[13] Ulbrich, N., "The Real-Time Wall Interference Correction System of the NASA Ames 12-Foot Pressure Wind Tunnel," NASA/CR-1998-208537, Ames Research Center, Moffett Field, California, July 1998. - This NASA report describes key elements of Ulbrich's modified version of Hackett's wall signature method. The modified wall signature method was originally developed for Ames' 12ft Pressure Wind Tunnel. It was also implemented in the Ames 11ft Transonic Wind Tunnel.

[14] Ulbrich, N., "Description of Panel Method Code ANTARES," NASA/CR-2000-209592, NASA Ames Research Center, Moffett Field, California, May 2000. - This NASA report describes a panel method code that was specifically developed for the calculation of wall interference corrections in 3D wind tunnel flow fields. The panel code solves the subsonic potential equation numerically in order to obtain the wall interference flow field. The report contains rigorous derivations of compressibility corrections for the different types of wall boundary conditions and singularities that may be used for the assessment of wall interference effects at high subsonic speeds. Method of images equations for closed wall and open jet boundary conditions are also given.

[15] Boone, A. R. and Ulbrich, N., "The Development of a Wall Pressure Measurement System for Two NASA Ames Wind Tunnels," AIAA 2002-3250, paper presented at the 22nd AIAA Aerodynamic Measurement Technology and Ground Testing Conference, St. Louis, Missouri, June 24-27, 2002. - This paper discusses two wall pressure measurement systems that provide wall boundary measurements for the assessment of wind tunnel wall interference corrections. The systems were implemented in the Ames 12ft Pressure Wind Tunnel and the Ames 11ft Transonic Wind Tunnel.

[16] Ulbrich, N. and Boone, A. R., "Direct Validation of the Wall Interference Correction System of the Ames 11-Foot Transonic Wind Tunnel," NASA/TM-2003-212268. NASA Ames Research Center, Moffett Field, California, May 2003. - This NASA report describes results of tests that were performed at the Ames 11ft Transonic Wind Tunnel in order to validate wall interference correction estimates. The report discusses advantages and disadvantages of different approaches that may be selected for the validation of wall interference corrections in wind tunnel testing.

[17] Iyer, V. and Everhart, J. L., "Application of Pressure-Based Wall Correction Methods to Two NASA Langley Wind Tunnels," AIAA 2001-2472, paper presented at the 19th AIAA Applied Aerodynamics Conference, Anaheim, California, June 11-14, 2001. - Conference paper that discusses some recent work at NASA Langley Research Center in the area of wall pressure based wall interference correction methods.