Low Speed Wind Tunnel Testing

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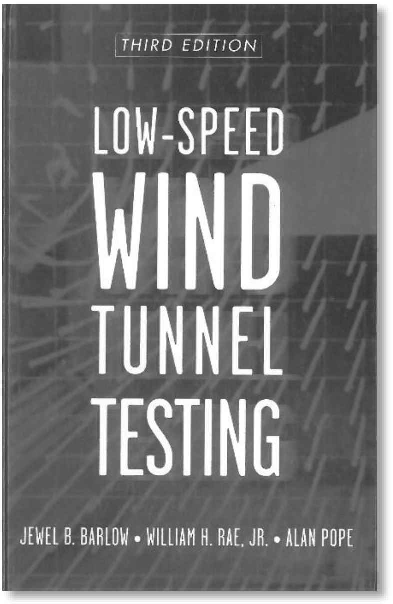

This book is addressed to researchers involved in projects related to Aerospace Sciences, and graduates from Aerospace Engineering, mainly, Mechanical Engineering, Transports Engineering and Civil Engineering as well.

The book represents a synthesis of the authors experience with regard to the aerodynamic testing. Therefore, Jewel B. Barlow is a former chairman of the Subsonic Aerodynamic Testing Association (SATA) and former director of the University of Maryland's Glenn L. Martin Wind Tunnel, William H. Rae was associate director of the F. K. Kirsten Aeronautical Laboratory at the University of Washington and a charter member of the SATA, while Alan Pope was a Professor of Aeronautical Engineering at Georgia Tech, then former manager and director of the Aerodynamics Department at Sandia National Laboratories. Allan Pope has written other two reference books that can be mentioned: High-Speed Wind Tunnel Testing and Wind Tunnel Testing.

The information covered in this book is structured in 18 chapters of a more than 700 A4 pages volume; each chapter is followed by explanatory notes; a useful list of numerical constants and conversion factors is provided in Appendix 2. The topics covered are:

Chapter 1 introduces a part of the basic knowledge of aerodynamics and aeroacoustics (e.g. the properties of air and water, flow similarity, incompressible flow, time dependence of the solutions); the acquirement of such knowledge is considered to be relevant for the further wind tunnel testing. Chapters 2 and 3 provide a large amount of information regarding the wind tunnels and their design. For instance, in **Chapter 2** is given a general presentation of the types of wind tunnels WT (e.g. aeronautical WT, aeroacoustic WT, general-purpose WT, environmental WT, as well as automobile WT, smoke tunnels and water tunnels). **Chapter 3** is highly focused on the design of the wind tunnels; once the overall aerodynamic objectives being set, the design of the WT is customized, in accordance with the power considerations. Significant design details, as input data (e.g. section loss coefficients, energy ratios) and methodology (e.g. return diffuser, drive system, cooling, test section inserts, as well as safety) are also exposed.

Chapter 4 is dedicated to the measurements of pressure, flow and shear stresses; the preparation and specific instrumentation, up to the flow field and surface analysis are detailed. The experiments are completed with the flow visualization methods and techniques presented within **Chapter 5**; path-lines, streak-lines, streamlines and timelines are defined and different visualization methods and techniques (such as direct visualization, surface flow visualization, flow field visualization and data-driven visualization) are presented. Trustworthiness of the acquired experimental data can be obtained after a proper consideration of the calibration of the test section, which is presented in **Chapter 6**. Thorough attention must be given to the test-section calibration, wind tunnel boundary layers and acoustics as well as to wind tunnel data systems.

The determination of forces and moments from balanced measurements is explained in **Chapter 7**; a thorough presentation of the balance requirements and specifications, for both types (i.e. external and internal balances), together with the basics of model installations, is done. **Chapter 8** details the use of wind tunnel data, with the consideration of the scale effects. For such purpose, the influence of the boundary layer and the drag, lift curve, flap characteristics and the pitching moment are required; the management of stability (longitudinal, directional and lateral) and control is important for determining the correlation of wind tunnel with the flight data.

Chapters 9, 10 and 11 deal with a thorough presentation of the boundary correction. Thus, the basics of the 2 D cases are explained in **Chapter 9** (mathematical models and bodies spanning the tunnel), while in **Chapter 10** are detailed the 3D cases (due to the consideration of flow features that require a 3D approach, such as: solid blockage, wake blockage, streamline curvature, downwash corrections, flow behind the wing, open jet, etc.). Additional applications that require boundary corrections are analyzed in **Chapter 11** (non-uniform lift in case of swept wings, reflection plane models, control surface hinge moments, ground proximity effects for aircraft, downwash corrections in case of powered models, boundary corrections for propellers and boundary effects for carrying V/STOL experiments).

Additional considerations regarding wind tunnel experiments, such as the design of aerodynamic experiments, model design and construction, planning the experiment, the use of facilities are exposed in **Chapter 12**. Aircraft and aircraft components are detailed in **Chapter 13**, where the power effects of propeller aircraft and of jet aircraft are highlighted, as well as details regarding the V/STOL vehicles and reentry landing craft. **Chapter 14** deals with the ground vehicles (i.e. automobiles, racing vehicles, trucks, motorcycles and other vehicles), while in **Chapter 15** are studied the marine vehicles, divided in surface vessels and underwater vessels. In **Chapter 16** are presented elements of wind engineering, such as modeling the atmospheric surface wind, local pressure, panel loads and loads on complete structures, as well as structures exhibiting elastic motion. **Chapter 17** is oriented towards small wind tunnels and experiments carried on at low Reynolds numbers. **Chapter 18** which is the last one, but not the least of importance, deals with the dynamic tests; topics like the spin characteristics and spin recovery, dynamic aeroelastic experiments, Jettison experiments, parabrake evaluations and cavity resonance are covered.

The **References list** attached to each chapter contains significant books from the relevant domains. The book itself represents a useful, well documented guide for carrying on wind tunnel experiments with accurate significant results.

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“**Low Speed Wind Tunnel Testing**” is one of the basic books used by the romanian researchers. This “Book Review” is also a tribute to one of the authors, **Alan Pope**, who died on March 25th 2003.

The full message from October 2003 published by ***AIAA Albuquerque Section*** https://info.aiaa.org/Regions/SC/Albuquerque/Newsletters/2003-10.pdf, page 7 is presented below:

Alan Pope

Alan Pope, one of the founding fathers of the AIAA Albuquerque Section (formerly, American Rocket Society) passed away March 25, 2003. He had been a resident of Florida for the past several years. Alan was the Chairman of the AIAA Albuquerque Section during the 1950s. Here are a few excerpts from “Aerodynamics History at Sandia National Laboratories” by Randy Maydew, dated January 6, 1986, regarding Alan Pope’s career:

> “Alan Pope was a Professor of Aeronautical Engineering at Georgia Tech for many years before he came to Sandia in 1951. He worked for the National Advisory Committee for Aeronautics at Langley Field, VA, prior to teaching at Georgia Tech. He also supervised the operation of a large, low speed wind tunnel at Georgia Tech for several years. As manager of the Experimental Aerodynamics Division, Alan Pope decided in 1954 that we should build the “backyard facilities” at Sandia National Laboratories. (Some people have termed small wind tunnels as “backyard facilities”.) The SNL 12-inch transonic wind tunnel was placed into operation in 1956. Alan is the author of a number of textbooks on low and high speed wind tunnel testing and supersonic aerodynamics. He was president of the Supersonic Tunnel Association in 1960. During the period from 1957 to 1965, Alan was the Aerodynamics Department Manager. In 1965, Alan Pope was promoted to Director of Aerodynamics or Aerospace Engineering at Sandia Laboratories. He held that position until 1977, at which time he retired. Alan started the terradynamics R&D at Sandia in 1962 and personally directed the earth penetration studies (including flight tests at many locations such as TTR, Panama, Alaska, Greenland, etc.) until 1974 when the work was transferred to an Exploratory Systems Department. From 1965 to 1968, Alan was also responsible for Aerospace Nuclear Safety. Alan is an excellent speaker and gave many lectures to AIAA and other organizations on rockets or terradynamics work at Sandia National Laboratories.”