



SURFACE VEHICLE RECOMMENDED PRACTICE

J1594™

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(R) Vehicle Aerodynamics Terminology

RATIONALE

This revision of the document includes the addition of an appendix to provide a suggested naming convention for typical components used on passenger cars and light trucks for aerodynamic purposes. Multiple naming conventions are in use, and this is meant to provide a recommended terminology for related literature and for use in the community of vehicle aerodynamicists. The contributions of the United States Council for Automotive Research Aerodynamics Working Group and the SAE Truck and Bus Aerodynamics and Fuel Economy Committee are gratefully acknowledged.

The reader's attention is also drawn to the previous revision to the axis system used so that x-positive is rearward and z-positive is upward. This change did not affect the positive sense of aerodynamic forces and moments.

FOREWORD

The original SAE Road Vehicle Aerodynamics Terminology included in SAE J670 (ca. 1974) was found inadequate for use by vehicle aerodynamics engineers. The originating Vehicle Dynamics Committee therefore initiated a new Vehicle Aerodynamics Subcommittee. This subcommittee first met in October 1975 to begin work on a new Aerodynamics Terminology. A comprehensive survey of terminology used in North America, Europe, and Japan showed that there was no standard set of nomenclature in use. The subcommittee in association with a number of non-member contributors used this survey, along with traditional (aircraft) aerodynamics and vehicle dynamics nomenclature, as inputs to a first draft document completed in 1977.

The ever-increasing activity in ground vehicle aerodynamics led to the formation of a full committee, the Road Vehicle Aerodynamics (Forum) Committee (RVAC), in 1983, and RVAC has been custodian of this document since that time.

1. SCOPE

This terminology document is intended to provide a common nomenclature for use in publishing road vehicle aerodynamics data and reports.

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

2.1.1.1 SAE J670, Vehicle Dynamics Terminology

2.1.1.2 SAE J1252, SAE Wind Tunnel Test Procedure for Trucks and Buses

2.1.1.3 Buckley, F., and Sekscienski, W., "Comparisons of Effectiveness of Commercially Available Devices for the Reduction of Aerodynamic Drag on Tractor-Trailers," SAE Technical Paper 750704, 1975, <https://doi.org/10.4271/750704>.

2.1.1.4 Sovran, G., "The Effect of Ambient Wind on a Road Vehicle's Aerodynamic Work Requirement and Fuel Consumption," SAE Technical Paper 840298, 1984, <https://doi.org/10.4271/840298>.

2.1.1.5 Hucho, W.-H. (Ed.). (1998). *Aerodynamics of road vehicles* (4th ed.). SAE International.

2.1.1.6 Walter, J., Canacci, V., Rout, R., Koester, W. et al., "Uncertainty Analysis of Aerodynamic Coefficients in an Automotive Wind Tunnel," SAE Technical Paper 2005-01-0870, 2005, <https://doi.org/10.4271/2005-01-0870>.

2.1.1.7 TSB003, Rules for SAE Use of SI (Metric) Units

2.1.1.8 Santer, R., and Gleason, M., "The Aerodynamic Development of the Probe IV Advanced Concept Vehicle," SAE Technical Paper 831000, 1983, <https://doi.org/10.4271/831000>.

2.1.2 NACA Publications

Copies of these documents are available online at <https://www.nasa.gov>.

2.1.2.1 Report 1135 – Equations, Tables, and Charts for Compressible Flow, 1953. <https://www.nasa.gov/wp-content/uploads/2023/03/equations-tables-charts-compressibleflow-report-1135.pdf>.

2.1.3 NOAA Publications

Copies of these documents are available online at <https://www.ngdc.noaa.gov>.

2.1.3.1 NOAA-S/T 76/1562—U.S. Standard Atmosphere, 1976. Product Code ADA035728. https://www.ngdc.noaa.gov/stp/space-weather/online-publications/miscellaneous/us-standard-atmosphere-1976/us-standard-atmosphere_st76-1562_noaa.pdf.

2.1.4 John Wiley & Sons, Inc., Publications

Available from John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030-5774, Tel: 1-800-567-4797, www.support.wiley.com.

2.1.4.1 Barlow, J.B, Rae, W.H., and Pope, A. (1999). *Low-speed wind tunnel testing* (3rd ed.). John Wiley & Sons, Inc.

3. AXES SYSTEM AND VEHICLE ANGLES

3.1 Orientation

The stability axes system yaws with the vehicle or model (see Figure 1). Axes form an orthogonal system, which is, as seen by the driver:

- x direction: positive rearward
- y direction: positive right
- z direction: positive up

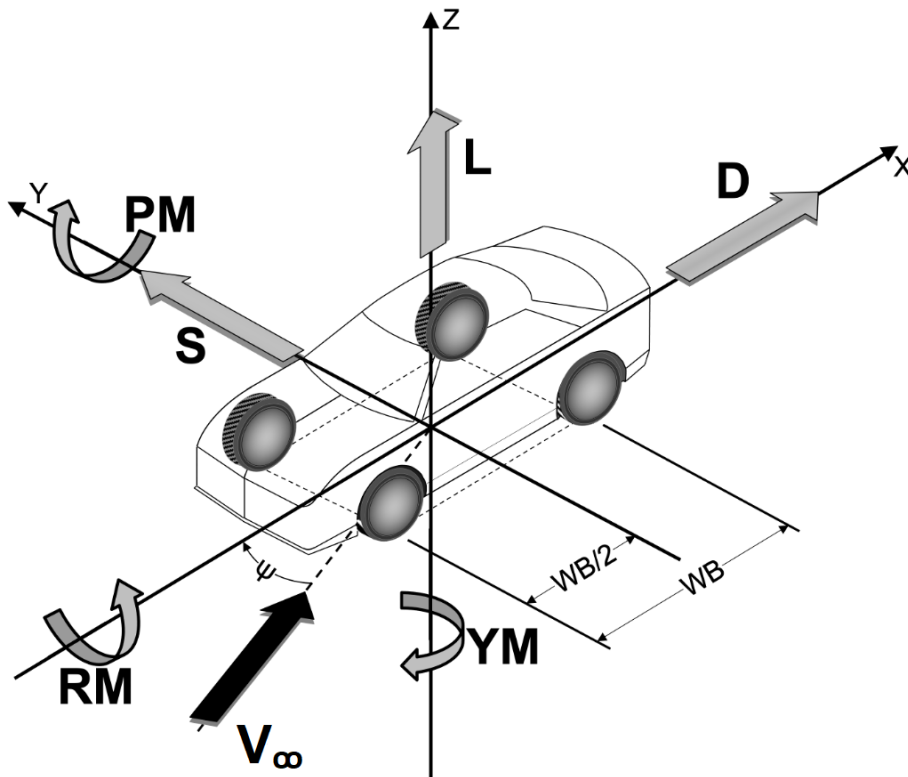


Figure 1 - Coordinate system and sign conventions

3.2 Resolving Center

The origin of the axes system is located in the plane of the ground surface at mid-wheelbase and mid-track.

3.3 Vehicle Angles

- Pitch Angle (α): Angle between the vehicle body longitudinal axis (x-direction) and the ground surface, positive nose-up
- Yaw Angle (ψ): Angle between the x-axis and the free-stream velocity vector ($\vec{V}_\infty$), positive nose-right (see Figure 2)
- Roll Angle (ϕ): Angle between the vehicle body lateral axis (y-direction) and the ground surface, positive right side down

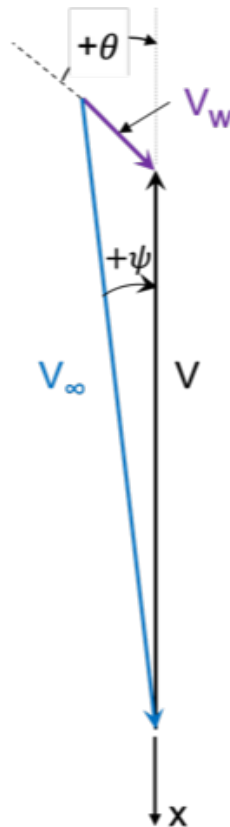


Figure 2 - Free-stream speed: $V_{\infty} = \left| \vec{V}_W - \vec{V} \right|$

4. TERMINOLOGY

4.1 Vehicle Parameters

- Wheelbase (WB): Distance (in the x-direction) between the front and rear axle centers
- Frontal Area (A): Vehicle area projection in the x-direction
- Scale Factor (σ): Model dimensional fraction of full scale vehicle
- Vehicle Velocity ($\vec{V}$): Vehicle velocity vector with magnitude V in the -x direction (see Figure 2)

4.2 Flow Parameters

- Wind Velocity ($\vec{V}_W$): Ambient wind velocity vector, assumed to lie in the x-y plane, with magnitude V_W with direction θ relative to the x-axis (see Figure 2)
- Wind Angle (θ): Angle of the wind velocity vector relative to the x-axis (see Figure 2), positive when the wind approaches from the left
- Free-stream Speed (V_{∞}): Magnitude of the wind velocity vector relative to the vehicle velocity vector: $V_{\infty} = \left| \vec{V}_W - \vec{V} \right|$