SURFACE VEHICLE RECOMMENDED PRACTICE

J2971™ MAR2026

Issued 2013-04
Revised 2026-03

Superseding J2971 AUG2019

Truck and Bus Aerodynamic Device and Concept Terminology

RATIONALE

This document has been revised to update a couple of definition names and Appendix A.

FOREWORD

The extensive growth of state and federal regulations governing truck and trailer aerodynamic performance and the expansion of commercialization of aerodynamic devices provides the opportunity for SAE to facilitate industry and government through standardization of truck and trailer aerodynamic terminology. This standard recognizes that the descriptions of truck and trailer aerodynamic devices and functions are unique from automotive ones detailed in SAE J1594. Government, industry, and academia's uncontrolled attempts at adapting the historical automotive and aircraft-based aerodynamic terminology to describe truck and trailer applications have resulted in a variety of inconsistent commercial and legal descriptions for the same features or functions. Trademark, patent, and copyright of terminology have also contributed to an expansion of inconsistent descriptors for components. The SAE Truck and Bus Aerodynamic and Fuel Economy Committee sponsored the SAE Truck and Bus J2971 Task Force to develop a recommended practice related to Truck and Bus Aerodynamic Terminology. This document will support the use of SAE J1321, SAE J1526, SAE J1252, and SAE J2966, as well as future truck and bus aerodynamic documents.

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1. SCOPE

This SAE J2971 Recommended Practice describes a standard naming convention of aerodynamic devices and technologies used to control aerodynamic forces on trucks and buses weighing more than 10000 pounds (including trailers).

1.1 Purpose

This recommended practice provides a detailed list and definition of truck and bus aerodynamic device terminology that may provide a common nomenclature for use in publishing data, reports, and SAE Recommended Practices.

1.2 Document Use

This document is structured to service both the novice and the expert user.

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: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

SAE J670	Vehicle Dynamics Terminology
SAE J1252	SAE Wind Tunnel Test Procedure for Trucks and Buses
SAE J1321	Fuel Consumption Test Procedure - Type II
SAE J1526	SAE Fuel Consumption Test Procedure (Engineering Method)
SAE J1594	Vehicle Aerodynamics Terminology
SAE J2084	Aerodynamic Testing of Road Vehicles - Testing Methods and Procedures
SAE J2966	Guidelines for Aerodynamic Assessment of Medium and Heavy Commercial Ground Vehicles Using Computational Fluid Dynamics

Hucho, W.-H. (1998). *Aerodynamics of road vehicles*. SAE International. ISBN 978-0-7680-0029-0.

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2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Recommended Practice.

2.2.1 SAE Publications

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

SAE J1263	Road Load Measurement and Dynamometer Simulation Using Coastdown Techniques
SAE J1264	Joint RCCC/SAE Fuel Consumption Test Procedure (Short Term In-Service Vehicle) Type 1
SAE J2263	Road Load Measurement Using Onboard Anemometry and Coastdown Techniques
SAE J2711	Recommended Practice for Measuring Fuel Economy and Emissions of Hybrid-Electric and Conventional Heavy-Duty Vehicles
SAE J2881	Measurement of Aerodynamic Performance for Mass-Produced Cars and Light-Duty Trucks
TSB003	Rules for SAE Use of SI (Metric) Units

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.

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.

2.2.2 TMC Publications

Available from the Technology and Maintenance Council, American Trucking Associations, 80 M Street, Suite 800, Washington, DC 20003, Tel: 703-838-1763, https://tmc.trucking.org.

TMC Report, “Report of Frederick, Maryland, Truck and Bus Fuel Economy Demonstration, Conducted October 22-November 1, 1979, by the Joint TMC/SAE Task Force for In-Service Test Procedures of The American Trucking Industry,” November 1980.

TMC RP 1102	TMC Fuel Consumption Test Procedure - Type II
TMC RP 1103	TMC Fuel Consumption Test Procedure - Type III
TMC RP 1109	Type IV Fuel Economy Test Procedure
TMC RP 1110	Aerodynamic Devices: Inspection and Maintenance Procedures
TMC RP 1111	Relationships Between Truck Components and Fuel Economy
TMC RP 1115	Guidelines for Qualifying Products Claiming a Fuel Economy Benefit

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2.2.3 U.S. Government Publications

2.2.3.1 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at www.ecfr.gov.

EPA 40 CFR § 86.012-2 Part 86 - Control of Emissions from New and In-Use Highway Vehicles and Engines - Subpart A - General Provisions for Heavy-Duty Engines and Heavy-Duty Vehicles - Section 86.012-2 - Definitions

EPA 40 CFR § 1036.801 Part 1036 - Control of Emissions from New and In-Use Heavy-Duty Engines - Subpart I - Definitions and Other Reference Information - Section 1036.801 - Definitions

EPA 40 CFR § 1037.801 Part 1037 - Control of Emissions from Heavy-Duty Motor Vehicles - Subpart I - Definitions and Other Reference Information - Section 1037.801 - Definitions

EPA 40 CFR § 1065.1001 Part 1065 - Engine-Testing Procedures - Subpart K - Definitions and Other Reference Information - Section 1065.1001 - Definitions

EPA 40 CFR § 1066.1001 Part 1066 - Vehicle-Testing Procedures - Subpart K - Definitions and Other Reference Material - Section 1066.1001 - Definitions

NHTSA 49 CFR § 523.2 Part 523 - Vehicle Classification - Section 523.2 - Definitions

NHTSA 49 CFR § 535.4 Part 535 - Medium- and Heavy-Duty Vehicle Fuel Efficiency Program - Section 535.4 - Definitions

NHTSA 49 CFR § 571.3 Part 571 - Federal Motor Vehicle Safety Standards - Subpart A - General - Section 571.3 - Definitions

2.2.3.2 EPA Publications

Available from Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Washington, DC 20460, Tel: 202-564-4700, www.epa.gov.

SmartWay Designated Tractors:
https://www.epa.gov/verified-diesel-tech/smartway-designated-tractors

U.S. EPA SmartWay Trailer and Aerodynamic Program Policy Manual:
https://www.epa.gov/sites/production/files/2016-03/documents/420b15021.pdf

California EPA Title 17. Public Health, Division 3. Air Resources, Chapter 1. Air Resources Board Subchapter 10. Climate Change, Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions, Sub-Article 1. Heavy-Duty Vehicle Greenhouse Gas Emission Reduction Regulation (Refs), § 95302. Definitions.

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3. DEFINITIONS

AERODYNAMICS: A branch of dynamics that deals with the motion of air and other gaseous fluids and with the forces acting on bodies in motion relative to such fluids.

AERODYNAMIC DEVICE: A structure or system added to the exterior of the vehicle for altering the aerodynamic forces acting on the vehicle.

ATTACHED FLOW: Fluid flow along a surface and parallel to the surface tangent.

BASE: The rearmost aft-facing surface of the cab, sleeper, tractor, trailer, truck, or bus.

BOUNDARY LAYER: The layer of fluid in the immediate vicinity of a surface where the effects of viscosity are significant.

COANDA EFFECT: The tendency of a fluid jet to be attracted to a nearby surface.

CROSS FLOW: Wind velocity that is at an angle to the vehicle longitudinal centerline.

DEVICE, AERODYNAMIC: A contrivance, invention, technique, or means serving a particular purpose used to modify the aerodynamics of the vehicle.

DRAG FORCE: The aerodynamic force that opposes the forward motion of the vehicle.

FAIRING: An aerodynamically shaped structure that covers a poorly shaped structure that is typically used to reduce aerodynamic drag.

FLOW ANGLE: The angle between the body's reference line and the oncoming flow.

FLOW CONTROL: A system that modifies the mass, momentum, or energy of the flow to modify the aerodynamics of the vehicle. Control may be passive or active including control schemes, sensors, and feedback loops. The adjectives "passive" or "active" may be used in concert with the device type terminology specified in Section 4. Examples of passive flow control devices include static geometric shaping, vortex generators, grooves, riblets, surface roughness, vents, diverters, etc. Examples of active methods include dynamic boundary layer separation control, vortex control, morphing, oscillating, rotating, flapping, jetting, etc.

FLOW SEPARATION: A condition in which fluid flow becomes detached from the surface of the object and takes the forms of eddies and vortices.

GAP, TRACTOR TO TRAILER: Longitudinal distance between the vertical flat surface of the back of the cab/sleeper to the vertical flat surface on the front of the trailer.

LIFT FORCE: The aerodynamic force that acts perpendicular in a vertical direction to the forward motion of the vehicle.

LAMINAR FLOW: Fluid flows in parallel layers, with no disruption between the layers of viscous fluid near a boundary.

LAMINAR SEPARATION BUBBLE: A separation of the laminar boundary layer that is constrained by the downstream reattachment of a turbulent boundary layer.

REVERSE FLOW: The portion of the boundary layer or freestream flow that reverses in flow direction.

REYNOLDS NUMBER: A dimensionless number that gives a measure of the ratio of inertial forces to viscous forces and consequently quantifies the relative importance of these two types of forces for given flow conditions.

SEMI-TRAILER: Trailer supported at the rear by its own wheels and at the front by a fifth wheel mounted to a tractor or dolly.

SEPARATION POINT: A point where the boundary layer flow becomes detached from the surface.

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SLOT (AERODYNAMIC GAP): Longitudinal distance between the aft most point of the cab external surface, including aerodynamic side fairings, and the forward most point of the cargo carrying portion of the vehicle.

STAGNATION LINE: A location on the surface where the fluid is brought to rest (zero velocity).

TRACTOR: A vehicle designed primarily to pull a semi-trailer by the use of the fifth wheel that is mounted over its drive axle(s). May be called a truck/highway tractor to differentiate it from a farm tractor.

TRAILER: A freight carrying unpowered unit pulled by a powered unit.

TRUCK: A vehicle which carries cargo in a body (van, tank, etc.) which is mounted to a chassis, possibly in addition to a trailer which is towed by the powered vehicle.

TRUCK-TRAILER: A truck-trailer combination consists of a truck that holds cargo in its body which is connected to its chassis, and which tows a trailer.

TURBULENT FLOW: A flow regime characterized by chaotic and stochastic property changes.

VORTEX: A spinning, often turbulent, flow of fluid. Any spiral motion with closed streamlines.

YAW ANGLE: The effective wind angle experienced by the vehicle based upon vehicle ground velocity, wind velocity, and wind angle, relative to the vehicle heading. Vehicle drag changes with increasing yaw angle.

4. AERODYNAMIC DEVICES AND CONCEPTS

A description of the aerodynamic devices and concepts used within the truck and bus community is provided below and within Table A1 located in Appendix A.

The following information makes use of the coordinate system shown in Figure 1.

4.1 Bus/Truck/Tractor Mounted Devices

4.1.1 Aerodynamic Bumper

Three-dimensional smoothly contoured solid-surface bumper mounted at the front of the vehicle. See Figure 2.

4.1.2 Aerodynamic Mirror

A mirror with a fairing covering the upstream forward-facing portion of the mirror. See Figure 2.

4.1.3 Aerodynamic Visor/Slat

Three-dimensional smoothly contoured solid-surface airfoil shaped structure attached to the leading edge of the vehicle cab roof. See Figure 4.

4.1.4 Air Dam (Front Spoiler/Front Lip/Lip Spoiler/Valence)

Vertically orientated solid-surface structure that attaches below the front bumper. See Figure 2.

4.1.5 Cab Edge Radius

Curved section joining the cab forward facing surface to the cab side and top surfaces. See Figure 6.

4.1.6 Cab Roof Fairing

Three-dimensional, smoothly contoured and solid-surface structure that attaches to the roof of a truck cab and extends upward and rearward. (Note: The fairing may be integral to the cab, permanently attached, or removable.) See Figure 3.

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4.1.7 Cab Roof Deflector

Flat solid-surface structure that attaches to the roof of a truck cab and extends upward and inclined rearward. See Figure 3.

4.1.8 Side Edge Turning Vane

Three-dimensional smoothly contoured solid-surface airfoil shaped structure that attaches to the forward side edges of the vehicle. See Figure 6.

4.1.9 Cab Side Extender (Fairing)

Vertically aligned planar (XZ plane) solid-surface structures that attach to the side trailing edges of the cab and extend rearward. See Figure 4.

4.1.10 Cab Side Flex Extender

Vertically aligned planar (XZ plane) flexible surface structures that attach to the side extender edges of the cab or sleeper and extend rearward. See Figure 4.

4.1.11 Chassis Fairings

Three-dimensional smoothly contoured solid-surface panels that attach to each lower side of the truck between the truck steer and drive wheels. See Figure 4.

4.1.12 Chassis Fairings Ground Seal

A flexible sacrificial panel extending downward from the lower edge of the chassis skirt. See Figure 4.

4.1.13 Tractor/Truck Undercarriage Axle Fairing

An aerodynamic shaped structure that shields an axle. See Figure 5.

4.1.14 Tractor/Truck Undercarriage Fairing

Flat solid-surface structure that attaches to the lower chassis structure under the cab/bus. See Figure 5.

4.1.15 Tractor/Truck Undercarriage Bogie Fairing

An aerodynamic shaped structure that shields the bogie axles. See Figure 5.

4.1.16 Fender Lips

An aerodynamic shape that attaches to the exposed wheel opening edges of the fenders. See Figure 2.

4.1.17 Radiator Grille or Shutter

Air intake systems for vehicle cooling modules may have structural pieces partially obstructing air flow. These pieces may be optimized for aerodynamic performance as passive or active aerodynamic devices.

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