



SURFACE VEHICLE RECOMMENDED PRACTICE

J2881™

OCT2019

Issued 2010-06
Revised 2019-10

Superseding J2881 JUN2010

Measurement of Aerodynamic Performance for Mass-Produced Cars and Light-Duty Trucks

RATIONALE

This Recommended Practice defines the method for documenting road vehicle aerodynamic performance along with the associated vehicle set-up and full-scale wind tunnel conditions employed for the measurement. This is one of the key elements of achieving an overall aerodynamic certification standard for passenger vehicles.

TABLE OF CONTENTS

1.	SCOPE	3
2.	REFERENCES	3
2.1	Applicable Documents	3
2.1.1	SAE Publications	3
3.	VEHICLE LOADING, ATTITUDE, AND CONTENT	4
3.1	Vehicle Loading and Attitude	4
3.2	Vehicle Content	5
4.	INSTALLATION AND TESTING CONFIGURATION	5
4.1	Yaw Angle	5
4.2	Tires and Tire Pressure	5
4.3	Fluid Levels	5
4.4	Fuel Level	5
4.5	License Plates	5
4.6	Cooling Fans	5
4.7	HVAC Controls, Cooling Inlets, Windows, and Vents	5
4.8	Windshield Wipers	5
4.9	Antennas	5
4.10	Outside Mirrors	6
4.11	Vehicle-Specific Configurations	6
4.12	Active Devices	6
4.13	Test Speed	6
4.14	Photographic Requirements	6

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2019 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: SAE J2881_201910

SAE values your input. To provide feedback on this
Technical Report, please visit
http://standards.sae.org/J2881_201910

Documents
Document Sharing Hub

5.	WIND TUNNEL TESTING AND DATA PROCESSING	6
5.1	General.....	6
5.2	Wind Tunnel Information	6
5.3	Data Processing	8
5.3.1	Data Corrections	8
5.3.2	Other Data Corrections	8
6.	REPORTING	9
7.	SUBMITTAL PROCEDURE	9
8.	NOTES	9
8.1	Revision Indicator.....	9
APPENDIX A	ACKNOWLEDGEMENTS	10
APPENDIX B	VEHICLE INFORMATION SHEET WITH ATTACHMENTS	11
APPENDIX C	WIND TUNNEL INFORMATION SHEET	14
APPENDIX D	SAMPLE SUBMITTAL	15
Table 1	Key performance results	9

1. SCOPE

This Recommended Practice provides a procedure for measuring and documenting the aerodynamic performance in a full-scale wind tunnel of passenger vehicles, i.e., mass-produced cars and light-duty trucks intended primarily for individual consumers. Testing or numerical modeling of pre-production and/or reduced-scale models is outside the scope of this document. Aerodynamic *development* procedures, i.e., methods to improve or optimize aerodynamic performance, are also excluded.

It is well-known that aerodynamic performance results depend significantly on vehicle content and loading, as well as the wind tunnel itself (type, scale, and simulation qualities of the wind tunnel). Publication of non-standard test results causes unnecessary additional development work and incorrect perception of a vehicle's anticipated aerodynamic performance by government, academia, and the general public.

The intent of this document is to promote uniformity and traceability of published aerodynamic performance data acquired in a wind tunnel, thereby enhancing the public reputation and credibility of the aerodynamics discipline in the total vehicle development process.

Measurement of the aerodynamic performance according to this Recommended Practice requires a full-scale wind tunnel test on a production-ready, full-scale vehicle according to specifications for vehicle loading, content, and wind tunnel conditions.

The measurement and resulting documentation for a particular vehicle shall be reported only by the company that intends to produce the vehicle. Whenever there is an opportunity for interpretation of the document, a good faith effort shall be made to obtain the vehicle's typical in-service performance and avoid finding the best possible performance under the best possible circumstances.

Use of and compliance with this Recommended Practice is voluntary; however, it is mandatory for those advertising or otherwise publishing aerodynamic performance as "measured according to SAE J2881." Conversely, any advertised or otherwise published result carrying this or a substantially similar designation must have the necessary documentation accepted by and on file with the SAE in accordance with the procedures defined in this Recommended Practice.

Appendices B and C contain the necessary submittal documents for compliance with this Recommended Practice. When a submittal is made, the chairman of the Road Vehicle Aerodynamics Forum Committee (RVAC) or his/her designee shall review the submittal for proper completion according to the requirements herein, but without consideration of the technical merit of the claimed performance. After the chairman's review, SAE will maintain an electronic database of all submittals.

The database shall be available only to members and liaison members of the RVAC. Any RVAC member who retrieves information from the database shall do so with the understanding that the information is to be considered confidential within his or her company.

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.

SAE J1263 Road Load Measurement and Dynamometer Simulation Using Coastdown Techniques

SAE J1594 Vehicle Aerodynamics Terminology

SAE J2084 Aerodynamic Testing of Road Vehicles - Testing Methods and Procedures

SAE J2263 Road Load Measurement Using Onboard Anemometry and Coastdown Techniques



Eaker, G., "Wind Tunnel-to-Road Aerodynamic Drag Correlation," SAE Technical Paper 880250, 1988, <https://doi.org/10.4271/880250>.

Iwase, H., Yamada, S., and Koga, H., "A New Approach to Measuring Road Load by Chassis Dynamometer and Wind Tunnel Tests," SAE Technical Paper 820377, 1982, <https://doi.org/10.4271/820377>.

Le Good, G., Howell, J., Passmore, M., and Cogotti, A., "A Comparison of On-Road Aerodynamic Drag Measurements with Wind Tunnel Data from Pininfarina and MIRA," SAE Technical Paper 980394, 1998, <https://doi.org/10.4271/980394>.

Mercker, E. and Cooper, K., "A Two-Measurement Correction for the Effects of a Pressure Gradient on Automotive, Open-Jet, Wind Tunnel Measurements," SAE Technical Paper 2006-01-0568, 2006, <https://doi.org/10.4271/2006-01-0568>.

Mercker, E. and Wiedemann, J., "On the Correction of Interference Effects in Open Jet Wind Tunnels," SAE Technical Paper 960671, 1996, <https://doi.org/10.4271/960671>.

Mercker, E., Cooper, K., Fischer, O., and Wiedemann, J., "The Influence of a Horizontal Pressure Distribution on Aerodynamic Drag in Open and Closed Wind Tunnels," SAE Technical Paper 2005-01-0867, 2005, <https://doi.org/10.4271/2005-01-0867>.

Mercker, E., Wickern, G., and Weidemann, J., "Contemplation of Nozzle Blockage in Open Jet Wind-Tunnels in View of Different 'Q' Determination Techniques," SAE Technical Paper 970136, 1997, <https://doi.org/10.4271/970136>.

Nijhof, B. and Wickern, G., "Reference Static and Dynamic Pressures in Automotive Wind Tunnels," SAE Technical Paper 2003-01-0428, 2003, <https://doi.org/10.4271/2003-01-0428>.

Walter, J., Pruess, D., and Romberg, G., "Coastdown/Wind Tunnel Drag Correlation and Uncertainty Analysis," SAE Technical Paper 2001-01-0630, 2001, <https://doi.org/10.4271/2001-01-0630>.

Wickern, G. and Schwartekopp, B., "Correction of Nozzle Gradient Effects in Open Jet Wind Tunnels," SAE Technical Paper 2004-01-0669, 2004, <https://doi.org/10.4271/2004-01-0669>.

Wickern, G., "On the Application of Classical Wind Tunnel Corrections for Automotive Bodies," SAE Technical Paper 2001-01-0633, 2001, <https://doi.org/10.4271/2001-01-0633>.

Wickern, G., "Recent Literature on Wind Tunnel Test Section Interference Related to Ground Vehicle Testing," SAE Technical Paper 2007-01-1050, 2007, <https://doi.org/10.4271/2007-01-1050>.

Wiedemann, J., Fischer, O., and Jiabin, P., "Further Investigations on Gradient Effects," SAE Technical Paper 2004-01-0670, 2004, <https://doi.org/10.4271/2004-01-0670>.

Cooper, K. (ed.), "Closed-Test-Section Wind Tunnel Blockage Corrections for Road Vehicles," SAE SP 1176, 1996.

Lindener, N. (ed.), "Aerodynamic Testing of Road Vehicles in Open Jet Wind Tunnels, SAE SP 1465, 1999. [N.B. contains useful technical information, but specific correction methods are superseded by the references that follow.]

3. VEHICLE LOADING, ATTITUDE, AND CONTENT

3.1 Vehicle Loading and Attitude

The vehicle shall be tested at the manufacturer's intended nominal attitude with full fluids and fuel, and with passenger loading according to the chart provided in Appendix B, Attachment 1, or with 70 kg in each of the two front seats, or corresponding to loading according to the appropriate Environmental Protection Agency (EPA) Engineering Test Weight (ETW). The loading used shall be documented on the Vehicle Information Sheet. The vehicle shall not be tested at a lower attitude resulting from the inclusion of build tolerances, etc. If the intended nominal attitude is not known, the vehicle may be loaded as above and tested at the resulting attitude. The vehicle's test attitude shall be documented by measuring the height from the wind tunnel floor to the edge of the wheel opening arch above each wheel centerline. It will also be recorded whether the vehicle attitude is fixed by the tunnel apparatus during the test or whether the vehicle chassis is able to float vertically under aerodynamic loading.

3.2 Vehicle Content

The intent of this Recommended Practice is to promote uniformity and traceability of published aerodynamic performance data. To that end, the vehicle being tested shall in general represent a nominal variation of the model rather than extremes which will not be produced or which may be produced in small numbers.

Special optional content packages (e.g., "sport package") may be submitted, provided that the nature and detail of the content are specified on the form. Absent such a specific disclosure, however, the vehicle tested shall contain the optional content nominally corresponding to the highest sales volume anticipated for that model. Prior to the test, a good faith effort shall be made to determine optional content corresponding to the highest sales volume.

The Vehicle Information Sheet (Appendix B) contains entries to indicate the presence of some common options that influence aerodynamic performance. In addition to these items, indicate in the space provided all other optional content on the vehicle that may influence aerodynamic performance.

4. INSTALLATION AND TESTING CONFIGURATION

This section defines configuration requirements for the vehicle installation and testing in the wind tunnel.

4.1 Yaw Angle

The vehicle shall be set at 0 degree $\pm$ 0.1 degree yaw angle with the front wheels centered (zero steer angle), with adjustment applied as required to account for empty-tunnel yaw of the oncoming flow.

4.2 Tires and Tire Pressure

Set tire pressures to manufacturer's specification(s) consistent with the vehicle loading. Tires should have at least legal tread depth.

4.3 Fluid Levels

Set fluid levels (engine oil, coolant, transmission fluid, etc.) at nominal fill.

4.4 Fuel Level

The fuel tank shall be full as defined by the manufacturer's specifications.

4.5 License Plates

Note whether the vehicle was equipped with a front number/license plate during the test.

4.6 Cooling Fans

Electric fans shall have no power applied so that they are allowed to rotate freely. Lock the clutch on engine-driven fans.

4.7 HVAC Controls, Cooling Inlets, Windows, and Vents

Turn HVAC control off and (if possible) to re-circulation mode. Open all cooling inlets and grilles. Fully close all windows and vents.

4.8 Windshield Wipers

Set windshield wipers to the parked position.

4.9 Antennas

Fully retract the antenna if possible. Fixed antennas shall remain installed on the vehicle.