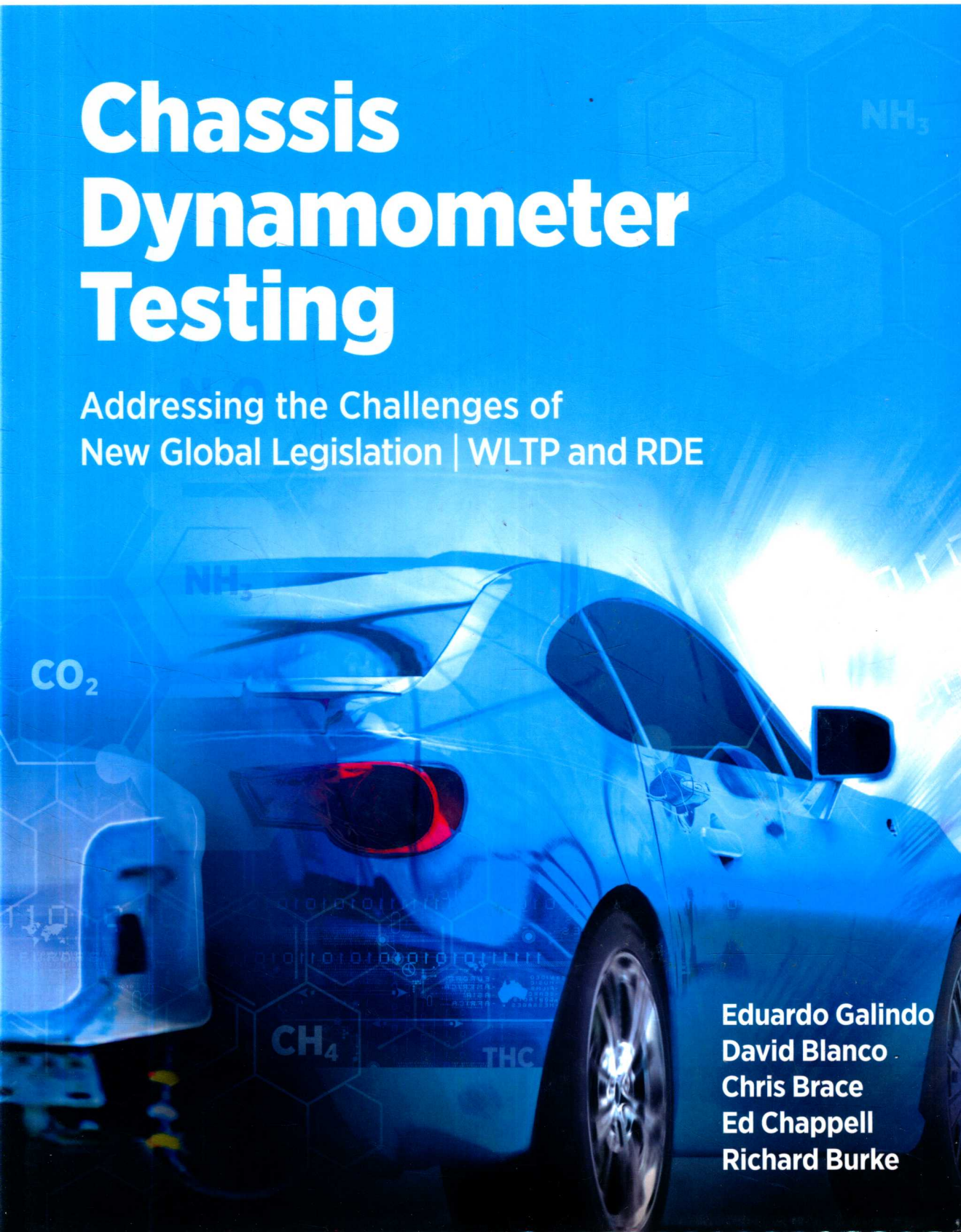
SAE INTERNATIONAL

AUTOMOTIVE

Chassis Dynamometer Testing

Addressing the Challenges of New Global Legislation | WLTP and RDE



Eduardo Galindo
David Blanco
Chris Brace
Ed Chappell
Richard Burke

Chassis Dynamometer Testing

Addressing the Challenges of New Global Legislation (WLTP and RDE)

Eduardo Galindo, David Blanco, Chris Brace,
Ed Chappell, Richard Burke

SAE INTERNATIONAL®

Warrendale, Pennsylvania, USA

400 Commonwealth Drive
Warrendale, PA 15096-0001 USA
E-mail: CustomerService@sae.org
Phone: 877-606-7323 (inside USA and Canada)
724-776-4970 (outside USA)
Fax: 724-776-0790

Library of Congress Catalog Number 2016955855
SAE Order Number R-452
http://dx.doi.org/10.4271/R-452

ISBN-Print 978-0-7680-8278-4
ISBN-PDF 978-0-7680-8412-2
ISBN-epub 978-0-7680-8414-6
ISBN-prc 978-0-7680-8413-9

To purchase bulk quantities, please contact:

SAE Customer Service
E-mail: CustomerService@sae.org
Phone: 877-606-7323 *(inside USA and Canada)*
724-776-4970 *(outside USA)*
Fax: 724-776-0790

Visit the SAE International Bookstore at books.sae.org

Other SAE Books of Interest:

Data Acquisition from HD Vehicles Using J1939 CAN Bus
Richard P. Walter and Eric P. Walter
(Product Code: R-446)

Sensors: Miniaturization and Testing (DVD)
Spotlight on Design
(Product Code: SOD-007)

Fuel Efficiency: Fuel Economy Testing (DVD)
Spotlight on Design
(Product Code: SOD-003/1)

Automotive Fuels Reference Book, Third Edition
Paul Richards
(Product Code: R-297)

For more information or to order a book, contact:
SAE International
400 Commonwealth Drive
Warrendale, PA 15096-0001, USA

Phone: 877-606-7323 (U.S. and Canada only)
or 724-776-4970 (outside U.S. and Canada)
Fax: 724-776-0790
Email: CustomerService@sae.org
Website: http://books.sae.org

1 Introduction

The use of the chassis dynamometer test cell has been an integral part of the vehicle development and validation process for several decades. Developments in global climate science and environmental health monitoring have driven a wide-ranging debate in the fields of CO_2 reduction and air quality improvement. This discourse has focused on road transport and, especially, passenger cars because they are a very visible and tangible sector requiring improvement. Events have moved the type approval testing of passenger cars from being a somewhat niche topic understood by a small group of engineers and regulators into a widespread topic of conversation. The deficiencies in historical testing regimes and the failure of some companies to adequately regulate their own work have focused the attention of regulators, policy makers, and the public on laboratory procedures and instrumentation methods in an unprecedented manner.

For practicing engineers, it is important to understand our wider role in society, as well as in our own organizations. In chassis dynamometer testing, these responsibilities come together and are focused on the delivery of clean efficient vehicles that meet legislative requirements, as well as customer aspiration. These requirements must be met by vehicles that are robust and durable in the real-world. In addition, the vehicles must be economically viable in order for the industry to continue providing the affordable mobility which has driven so much economic, personal, and social progress over the last century. The pervading environmental lobby presents new challenges to our industry, and the precise experimental validation of vehicle performance on modern capable chassis dynamometers under realistic operating conditions will be fundamental in overcoming this challenge.

The chassis dynamometer test cell design involves specialists in many different fields—such as mechanics, ventilation, and refrigeration—who may not be experts in automotive vehicle engineering. In addition, automotive engineers may not have in-depth knowledge in all aspects of testing facilities.

As the demands on chassis dynamometer testing become more exacting and at the same time more diverse, the challenge of delivering effective installations and operating

procedures becomes ever greater. This book sets out to gather knowledge from both groups of specialists to achieve a better understanding on the testing uncertainties associated with the vehicle chassis dynamometer test cell, and to enable informed design and the use of these facilities.

I.1 General Objective

The intention of this book is to analyze the main factors affecting a vehicle in order to reproduce them as close as possible in a testing facility specifically designed for this purpose.

The first objective is to give guidance and recommendations on how vehicle tests should be performed.

The second objective is to obtain a deeper knowledge on the requirements of chassis dynamometer testing facilities so that they can be optimized, reducing unnecessary cost because of overdimensioning or underperformance.

The last objective is to give the reader an overview of the current emissions legislation, its limitations, and its evolution.

I.2 Book Structure

This book has been divided into three parts:

- ***Part I: The Vehicle:*** The objective of this section is to analyze the main parameters of influence on a vehicle when it is running on the road and look at how to consider these parameters when designing a chassis dynamometer test cell. The key aspects affecting the vehicle system performance and powertrain operating principles must be considered at all stages when designing the facility and test procedures if a realistic validation environment is to be achieved.
- ***Part II: The Test Cell:*** The objective of this section is to study the different components of a chassis dynamometer test cell, the characteristics, and the design criteria of the test cell, which are relevant to the execution of effective vehicle tests. The chassis dynamometer system is a large and complex installation with many interdependencies. The designer or test engineer must understand enough of the essential behavior of each part of the facility to form an effective overview.
- ***Part III: Vehicle Homologation Process and Tests:*** This section is largely governed by legislative requirements for today and the foreseeable future.

  The main objective of this section is to give the reader an understanding on the main legislation worldwide. It explains briefly the enforcement programs in the EU and the U.S., analyzing in more detail how effective it has been in Europe until 2017.

  It introduces the reasons for the revision of the EU legislation and the new testing procedures known as Worldwide Harmonized Light-Duty Vehicle Test Procedure and real-driving emissions.

Acknowledgments

This work is the result of the effort to fully understand a complex topic: chassis dynamometer testing. The investment to pursue this project was provided by AVL Spain, a company led by two entrepreneurs, Alberto Zumeta (Managing Director) and Jesus Sinde (Engineering Manager). AVL Spain is a place where people are not only allowed, but encouraged to bring their ideas to work and to develop them beyond the current state of the art. It is the result of implementing a philosophy that questions current beliefs to the ultimate consequences, never giving up until everything is understood and justified. It is the outcome of a long-term strategy that proves that committing new ideas and good technical knowledge can definitely make a company successful.

I would like to thank Alberto and Jesus for creating and sharing these unique values.

All the data and knowledge gathered in this book are the result of team work. It would have not been possible without the help of many colleagues from AVL Spain, especially David Blanco, who believed in the project from the first day and has been a great contributor.

I am also grateful for the opportunity to work for AVL UK. I had the chance to learn from great engineers such as David Moore, Neil Avery, and Colin Hussell and, through them, meet Dr. Chris Brace, Dr. Richard Burke, and Dr. Edward Chappell from the University of Bath. They have been instrumental in complementing our knowledge and working on the material now presented.

We have also had the privilege of having very experienced reviewers such as Ken Barnes, Tim Beatty, Fernando Moreno, and Rodolph Belleux, to whom I want to express special gratitude. The readers will gain immensely from their input.

I also want to thank Carmen Muñoz for the work she has done in integrating the various chapters of the book and Enrique Fradejas for the excellent job with the images we needed.

Finally, I want to thank my parents, Julio Galindo and Carmiña Ferreiro, for teaching me the enormous value of perseverance, and my wife, Sara, for her support and patience during all the hours I have dedicated to writing this book.

Eduardo Galindo

Chassis Dynamometer Testing

Addressing the Challenges of New Global Legislation (WLTP and RDE)

Contents

Part I

The Vehicle