Wind Load Design for Petrochemical and Other Industrial Facilities

Second Edition

Task Committee on
Wind-Induced Forces

ASCE

Wind Load Design for Petrochemical and Other Industrial Facilities

Second Edition

Prepared by
Task Committee on Wind-Induced
Forces of the Oil and Gas Committee of the
Energy Division of the American Society of Civil Engineers

Published by the American Society of Civil Engineers

Library of Congress Cataloging-in-Publication Data

Names: American Society of Civil Engineers, author.
Title: Wind load design for petrochemical and other industrial facilities / Task Committee on Wind-Induced Forces of the Oil and Gas Committee of the Energy Division of the American Society of Civil Engineers.
Other titles: Wind loads for petrochemical and other industrial facilities
Description: Second edition. | Reston, Virginia : American Society of Civil Engineers, [2020] | Revised edition of: Wind loads for petrochemical and other industrial facilities / prepared by Task Committee on Wind-Induced Forces of the Petrochemical Committee of the Energy Division of the American Society of Civil Engineers, 2011. | Includes bibliographical references and index. | Summary: "This report represents the state-of-the-practice for wind load design at industrial facilities and is aimed at engineers familia with design of industrial type structures"– Provided by publisher.
Identifiers: LCCN 2020012756 | ISBN 9780784415610 (paperback) | ISBN 9780784483039 (adobe pdf)
Subjects: LCSH: Petroleum refineries–Design and construction. | Industri buildings–Design and construction. | Petroleum refineries–Aerodynamics. | Industrial uildings–Aerodynamics. | Wind-pressure.
Classification: LCC TH4571 .A44 2020 | DDC 624.1/75–dc23
LC record available at https://lccn.loc.gov/2020012756

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191-4382
www.asce.org/bookstore | ascelibrary.org

ISBN 978-0-7844-1561-0 (print)
ISBN 978-0-7844-8303-9 (PDF)

Manufactured in the United States of America.

26 25 24 23 22 21 20 1 2 3 4 5

ASCE Oil and Gas Committee

This publication began as one of five state-of-the-practice engineering reports produced by the former ASCE Petrochemical Energy Committee. These engineering reports were intended to be a summary of current engineering knowledge and design practice, and present guidelines for the design of petrochemical facilities. They represented a consensus opinion of task committee members active in their development. These five ASCE engineering reports were initially published in 1997 in four separate books, with the reports on wind and anchor bolts being printed together in a combined document for publishing convenience, they are:

1. *Design of Anchor Bolts in Petrochemical Facilities*
2. *Design of Blast Resistant Buildings in Petrochemical Facilities*
3. *Design of Secondary Containment in Petrochemical Facilities*
4. *Guidelines for Seismic Evaluation and Design of Petrochemical Facilities*
5. *Wind Loads on Petrochemical Facilities*

Since the initial publication of these five reports, buildings codes and standards have changed significantly, specifically in the calculation of wind and seismic loads and analysis procedures for anchorage design. Additionally, new research in these areas and in blast-resistant design provided opportunities for improvement of the recommended guidelines. ASCE then determined the need to update four of the original reports and publish new editions, based on the latest research and for consistency with current building codes and standards. The ASCE Petrochemical Energy Committee was hence reorganized in 2005 and the following four task committees were formed to update their respective reports:

- Task Committee on Anchorage Design
- Task Committee on Blast-Resistant Design
- Task Committee on Seismic Evaluation and Design for Petrochemical Facilities
- Task Committee on Wind-Induced Forces

In 2011, ASCE published a subsequent version of the renamed *Wind Loads for Petrochemical and Other Industrial Facilities*. However, because the 1997 edition of the book was published in a combined document with *Anchorage Design for Petrochemical Facilities* and the 2011 version of the book was a standalone document, the 2011 version was officially called a first edition (of the standalone document).

Since the publication of that report, notable updates to commonly used design codes and standards cited in the book have been issued. As a result, in 2016 the ASCE Energy Division Executive Committee directed that a task committee be formed to update the book to ensure consistency with current building codes and standards.

In January 2017, James R. (Bob) Bailey, chair of the Oil and Gas Committee acting on behalf of the Energy Division Executive Committee, reformed the Task Committee on Wind-Induced Forces to update the book, resulting in the issuance of this present book, *Wind Load Design for Petrochemical and Other Industrial Facilities*, Second Edition. Although titled a second edition (of the standalone document), it is the third time that the book has been issued (1997, 2011, and now 2020).

ASCE Task Committee on Wind-Induced Forces

This book is intended to be a state-of-the-practice set of guidelines. It is based on reviews of current practice, internal company standards, published documents, and the work of related organizations. The book includes references that provide additional information, commercial publications, and government reports.

This book was prepared to provide guidance for determination of wind-induced forces on structures found in petrochemical and other industrial facilities. It should be of interest to engineers familiar with the design of industrial-type structures and the application of ASCE 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, to these types of structures.

In helping create a consensus set of guidelines, a number of individuals provided valuable assistance and review. Reviewers of the entire manuscript include John Geigel, P.E. (retired, formerly ExxonMobil) and Clay Willis, P.E., S.E. (Wood Group USA, Inc.). Reviewers of the section titled "Wind Loads for LNG Facilities," also include Joseph Sieve [Pipeline and Hazardous Materials Safety Administration (PHMSA), US Department of Transportation] and Robert Bachman, P.E., S.E. (R.E. Bachman, Consulting Structural Engineer). The committee is extremely appreciative of the efforts of these reviewers.

The committee is also very appreciative of the efforts of its representative on the main Oil and Gas Committee, Bob Bailey, Ph.D., P.E., F.ASCE, who contributed knowledge and guidance to the committee and attended committee meetings.

Finally, the committee would also like to acknowledge Jay Snyder and Donna Dickert of ASCE, who provided logistical facilitation along the way.

Paul B. Summers, P.E., S.E., F.ASCE, Simpson Gumpertz & Heger, *Chair*
Samuel D. Amoroso, Ph.D., P.E., S.E., Exponent, Inc., *Co-Chair*
Matthew J. Brightman, P.E., S.E., ExxonMobil, *Secretary*

Guzhao Li, Ph.D., P.E., S.E.	Simpson Gumpertz & Heger
Eddy Mulia, P.E., S.E.	Chevron Energy Technology Company
Carlos A. Ortega, Ph.D., P.E., S.E.	Simpson Gumpertz & Heger
Rajendra Prasad, P.E.	Wood Group USA, Inc
Nicholas Truong, P.E.	Cheniere Energy, Inc.
Silky S. K. Wong, Ph.D., P.E., S.E.	Dow (formerly with Fluor Corp.)
Randall L. Wright, P.E., S.E.	Wood Group USA, Inc.
Xiping Steven Wu, Ph.D.	Shell Projects & Technology

This page intentionally left blank

Contents

CHAPTER 1
Introduction

The focus of this book is on the procedures for determining the design wind loads for non-building structures in petrochemical and other industrial facilities. The book is structured around the following generic types of structures usually found in these facilities. Examples are also provided for some of these structures:

- Pipe support structures (pipe racks, pipe bridges),
- Open and partially clad frame structures,
- Vessels (vertical, horizontal, and spherical),
- Cooling towers,
- Air coolers (air-cooled heat exchangers, also known as fin-fans),
- Tanks, and
- Steel stacks.

1.1 BACKGROUND

The basis and procedures for determining design wind loads for enclosed structures and other conventional structures are well documented in the engineering literature. These design bases and procedures have been adopted by ASCE and prescribed in ASCE 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (hereafter referred to as ASCE 7) and its predecessor documents. Other organizations have incorporated the major provisions of ASCE 7 into building codes. The International Building Code (IBC) states that wind loads should be calculated in accordance with the latest version of ASCE 7, and the IBC is adopted throughout the United States. ASCE 7 provides several methods for calculating design wind loads on the main wind force resisting system (MWFRS) and on components and cladding:

- Directional procedure for building MWFRS;
- Envelope procedure for building MWFRS;
- Directional procedure for MWFRS of building appurtenances and other structures;