Design, Construction, Operation, and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)

API RECOMMENDED PRACTICE 1111
FIFTH EDITION, SEPTEMBER 2015

REAFFIRMED, APRIL 2026



Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Classified areas may vary depending on the location, conditions, equipment, and substances involved in any given situation. Users of this Recommended Practice should consult with the appropriate authorities having jurisdiction.

Users of this Recommended Practice should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC, 20001.

Copyright © 2015 American Petroleum Institute

Foreword

This recommended practice (RP) sets out criteria for the design, construction, testing, operation, and maintenance of offshore steel pipelines utilized in the production, production support, or transportation of hydrocarbons, that is, the movement by pipeline of hydrocarbon liquids, gases, and mixtures of these hydrocarbons with water.

The criteria contained in this document are intended to permit the economical transportation of hydrocarbons while providing for the safety of life and property and the protection of the environment. The general adoption of these criteria should assure that offshore hydrocarbon pipelines possess the requisite structural integrity for their safe and efficient operation.

This RP includes a “limit state design” methodology. Safety margins similar to existing levels are obtained for the lower D/t ratio by changing to a limit state design based on the actual burst strength of pipe. The burst pressure formula in the document is based on theoretical considerations and confirmed by more than 250 burst tests of full-size pipe specimens that cover a wide range of pipe grade, diameter, and wall thickness.

Portions of this publication have changed from the previous editions, which have been an RP, but the changes are too numerous to use bar notations in this edition. In some cases, the changes are significant, while in other cases the changes reflect minor editorial adjustments.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC, 20001. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC, 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC, 20001, standards@api.org.

Contents

Page

1 Scope . . . 1
2 Normative References . . . 1
3 Terms, Definitions, Acronyms, Abbreviations, and Symbol . . . 3
3.1 Terms and Definitions . . . 3
3.2 Acronyms, Abbreviations, and Symbols . . . 5
4 Design . . . 7
4.1 Design Conditions . . . 7
4.2 Design Criteria . . . 10
4.3 Pressure Design of Components . . . 11
4.4 Marine Design . . . 17
4.5 Fatigue Analysis . . . 19
4.6 Load Limits . . . 20
4.7 Valves, Supporting Elements, and Piping . . . 21
4.8 Route Selection . . . 21
4.9 Flow Assurance . . . 22
4.10 Thermal Expansion Design . . . 22
5 Materials and Dimensions . . . 23
5.1 Materials . . . 23
5.2 Dimensions . . . 24
6 Safety Systems . . . 24
6.1 General . . . 24
6.2 Liquid and Gas Transportation Systems on Nonproduction Platforms . . . 24
6.3 Liquid and Gas Transportation Systems on Production Platforms . . . 24
6.4 Breakaway Connectors . . . 24
7 Construction and Welding . . . 25
7.1 Construction . . . 25
7.2 Welding . . . 26
7.3 Other Components and Procedures . . . 28
8 Inspection and Testing . . . 29
8.1 General . . . 29
8.2 Testing . . . 30
9 Operation and Maintenance . . . 33
9.1 System Guidelines . . . 33
9.2 Pipeline Operations . . . 33
9.3 Emergency Plan . . . 37
9.4 Records . . . 37
9.5 Qualification of the Pipeline System for Higher Operating Pressure . . . 38
9.6 Change in Pipeline Use . . . 38
9.7 Pipeline Abandonment . . . 38
10 Corrosion Control . . . 38
10.1 General . . . 38
10.2 External Coatings . . . 39

Contents

Page

10.3 Cathodic Protection . . . 39
10.4 Internal Corrosion Control . . . 40
10.5 Maintenance of Cathodic Protection Systems . . . 40
10.6 Records . . . 40

Annex A (normative) **Procedure for Determining Burst Design Criteria for Other Materials** . . . 41

Annex B (normative) **Qualification of Increased Minimum Burst Pressure** . . . 45

Annex C (informative) **Example Calculations for Internal Pressure (Burst) Design and Wall Thickness** . . . 47

Annex D (informative) **External Pressure Design Example** . . . 62

Bibliography . . . 66

Figures

1 Scope of API 1111 . . . 2
2 Pressure Level Relations . . . 10
A.1 Ductile Burst Sample . . . 43
A.2 Brittle Burst Sample . . . 43
C.1 Example Subsea Flowlines and Risers . . . 52

Tables

1 Minimum Radius of Field Cold Bends . . . 20
C.1 Pipe Data . . . 47
C.2 PIP, Gas/Oil Production Flowline and Riser . . . 53
C.3 Single-pipe, Gas/Oil Production Flowline and Riser . . . 54
C.4 PIP, Gas/Oil Production Flowline and Riser Limiting Riser to Within a Horizontal Distance of 300 ft from the Surface Facility . . . 55
C.5 Single-pipe, Gas/Oil Production Flowline and Riser Limiting Riser to Within a Horizontal Distance of 300 ft from the Surface Facility . . . 56
C.6 PIP, Gas/Oil Production Flowline and Riser Increased Burst Pressure Due to Improved Mechanical Properties and Dimensions Control . . . 57
C.7 Single-pipe, Gas/Oil Production Flowline and Riser Increased Burst Pressure Due to Improved Mechanical Properties and Dimensions Control . . . 58
C.8 PIP, Gas/Oil Production Flowline and Riser Limiting Riser to Within a Horizontal Distance of 300 ft from the Surface Facility Increased Burst Pressure Due to Improved Mechanical Properties and Dimensions Control . . . 59
C.9 Single-pipe, Gas/Oil Production Flowline and Riser Limiting Riser to Within a Horizontal Distance of 300 ft from the Surface Facility Increased Burst Pressure Due to Improved Mechanical Properties and Dimensions Control . . . 60
C.10 Comparison of Results . . . 61
D.1 Net External Pressure Loading . . . 63
D.2 Collapse Pressure . . . 63
D.3 External Pressure Collapse Resistance . . . 63
D.4 Buckling Limit State Bending Strains . . . 64
D.5 Combined Bending and External Buckle Resistance . . . 65

Introduction

Limit state design has been incorporated in this recommended practice (RP) to provide a uniform factor of safety with respect to rupture or burst failure as the primary design condition independent of the pipe diameter, wall thickness, and grade. Background on theory and practice of limit states for pressure-containing cylinders may be found in Hill [2] and in Crossland and Jones [1], as listed in the Bibliography at the end of the RP. Burst design criteria within this practice are presently defined for carbon steel line pipe. Application of the proposed design criteria to other materials requires determination by the user of the minimum burst criteria using the procedure set forth in Annex A.

Design and construction practices other than those set forth in Section 4 and Section 7 may be employed when supported by adequate technical justification, including model or proof testing of involved components or procedures as appropriate. Nothing in this RP should be considered as a fixed rule for application without regard to sound engineering judgment.

NOTE Certain governmental requirements or company specifications may differ from the criteria set forth in this RP, and this RP does not supersede or override those differing requirements or specifications.

This publication has incorporated by reference all or parts of several existing codes, standards, and RPs that have been found acceptable for application to offshore hydrocarbon pipelines.

Caution—Users shall use the most recent editions of all reference documents in this RP. For ASME B31.4 and ASME B31.8 specifically, the 2006 edition and the 2007 edition, respectively, of the documents were used as the basis for determining the requirements. However, the reference is meant to be to the corresponding part in the latest revision or edition of the publication.

Design, Construction, Operation, and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)

1 Scope

This recommended practice (RP) sets criteria for the design, construction, testing, operation, and maintenance of offshore steel pipelines utilized in the production, production support, or transportation of hydrocarbons; that is, the movement by pipeline of hydrocarbon liquids, gases, and mixtures of these hydrocarbons with water. This RP may also be utilized for water injection pipelines offshore.

The RP also applies to any transportation piping facilities located on a production platform downstream of separation and treatment facilities, including meter facilities, gas compression facilities, liquid pumps, associated piping, and appurtenances.

The design, construction, inspection, and testing provisions of this RP may not apply to offshore hydrocarbon pipelines designed or installed before this latest revision of the RP was issued. The operation and maintenance provisions of this RP are suitable for application to existing facilities.

For a graphic representation of the scope of this RP, see Figure 1.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Recommended Practice 2A-WSD, *Planning, Designing, and Constructing Fixed Offshore Platforms—Working Stress Design*

API Standard 2RD, *Dynamic Risers for Floating Production Systems*

API Specification 5L, *Specification for Line Pipe*

API Recommended Practice 5L1, *Recommended Practice for Railroad Transportation of Line Pipe*

API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*

API Specification 6D, *Specification for Pipeline and Piping Valves*

API Recommended Practice 14C, *Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms*

API Standard 1104, *Welding of Pipelines and Related Facilities*

ASME B31G [1], *Manual for Determining the Remaining Strength of Corroded Pipelines*

ASME B31.4, *Pipeline Transportation Systems for Liquids and Slurries*

ASME B31.8, *Gas Transmission and Distribution Piping Systems*

ASME *Boiler and Pressure Vessel Code* (*BPVC*), *Section IX: Welding, Brazing, and Fusing Qualifications*

[1] ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.