

Dynamic Risers for Floating Production Systems

API STANDARD 2RD
SECOND EDITION, SEPTEMBER 2013

REAFFIRMED, SEPTEMBER 2020



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.

Users of this Standard 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 © 2013 American Petroleum Institute

Foreword

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.

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.

The verbal forms used to express the provisions in this recommended practice are as follows:

- the term shall denotes a minimum requirement in order to conform to the standard;
- the term should denotes a recommendation or that which is advised but not required in order to conform to the standard;
- the term may is used to express permission or a provision that is optional;
- the term can is used to express possibility or capability.

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, Symbols and Abbreviated Terms	2
3.1	Terms and Definitions	2
3.2	Symbols	13
3.3	Abbreviated Terms	15
4	Design Loads and Conditions	16
4.1	General	16
4.2	Loads	17
4.3	Design Load Cases	17
5	Design Criteria for Rigid Pipe	19
5.1	Objective	19
5.2	Design Format	19
5.3	Capacities of Pipe	19
5.4	Design Criteria	22
6	Components	28
6.1	General	28
6.2	Fatigue	28
6.3	Pressure-containing Components	28
7	Materials	29
7.1	Scope	29
7.2	General Requirements	29
7.3	Steel	32
7.4	Other Materials	33
7.5	Requirements for Elevated Temperature	33
7.6	Requirements for Sour Service	33
7.7	Requirements for Strain-based Design	33
7.8	Prevention of Brittle Fracture	34
7.9	Corrosion Protection	35
7.10	Products	37
7.11	Manufacture, Welding and Fabrication	40
7.12	Examination and Non-destructive Testing (NDT)	44
8	Fabrication and Installation	45
8.1	General	45
8.2	Fabrication	46
8.3	Transportation, Shipping and Marine Operations	47
9	Riser Integrity Management	53
9.1	Introduction	53
9.2	Riser Integrity Management Plan	53
	Annex A (informative) Example TTR Design	55
	Annex B (informative) Example SCR Design	69
	Annex C (informative) Supplemental Design Information	74
	Bibliography	75

Figures

1	Hardness Locations in Seamless and Seam Welded Pipe	36
2	Hardness Locations for Clad Materials	37
A.1	Production Riser Stack-up	58

Tables

1	Representative Intact Strength Load Cases	18
2	Representative Damaged Strength Load Cases	18
3	Representative Fatigue Load Cases	18
4	Applicable Material Specifications	30
5	Test Temperature for Charpy Impact Testing of Steel and Steel Welds	34
6	Carbon and Low-alloy Steel Bolts and Nuts for Pressure-bearing or Main Structural Applications	38
A.1	Production Riser Load Case Matrix	55
A.2	Riser Pipe Sizes and Materials	59
A.3	Internal Overpressure Limits for Outer Riser	60
A.4	Internal Overpressure Limits for Inner Riser	60
A.5	External Overpressure Limits for Outer Riser	62
A.6	External Overpressure Limits for Inner Riser	63
A.7	Riser Keel and Stress Joints	63
A.8	Capacities of the Outer Riser	64
A.9	Riser Loads at Bottom of Keel Joint	65
B.1	A Typical Load Case Matrix for SCR Design	69
B.2	Load Case Matrix for SCR Performance Assessment	70
B.3	100-Year Hurricane Environmental Data	70
B.4	Pipe Properties	70
B.5	Capacity Utilization for ALS and ULS Load Cases	71
B.6	Summary of Pipe Capacity	72
B.7	Riser loads at TDZ for ULS	72

Introduction

Since the first edition of API RP 2RD, *Recommended Practice for Design of Risers for Floating Production Systems (FPSs) and Tensioned-Leg Platforms (TLPs)*, was issued in June 1998, hydrocarbon exploration and production in deep water environments have increased significantly. As a consequence, the need was identified to update that code of practice to address the issues and lessons learned from that experience. The title of the document has been changed to eliminate reference to any one type of floating hull. A broad scope of marine dynamic risers is covered, including various steel catenary risers and top tensioned risers.

Dynamic Risers for Floating Production Systems

1 Scope

This standard addresses riser systems that are part of a floating production system (FPS). Guidelines for design, construction, installation, operation and maintenance of floating production systems (FPSs) are in API 2FPS. A riser is a subsystem in a floating production system.

The provisions of this standard do not apply to the riser systems of mobile offshore drilling units (MODUs).

There is significant interaction among the subsystems in a floating production system. Hull motions affect risers and mooring, and conversely, risers and mooring affect hull motions. Global behavior of the system provides input to assessment of subsystems. Assessment of a subsystem provides feedback (loads) for assessment of the hull and other subsystems.

Determination of the boundaries of a riser system and management of the interactions with other subsystems is the responsibility of the operator.

A riser system is an assembly of components, including pipe and connectors. A riser system can include a riser tensioning system, buoyancy modules, etc. Pipe components can be steel, titanium, or unbonded flexible pipe. Design considerations for unbonded flexible pipe are included primarily by reference to API 17B and API 17J. Design considerations for titanium alloy pipe are included primarily by reference to DNV-RP-F201. Steel and titanium pipe are referred to as rigid pipe and unbonded flexible pipe is referred to as flexible pipe.

All or part of several existing codes, standards, specifications, and recommended practices are included by reference.

Design loads and conditions are described in Section 4. Structural design criteria for rigid pipe are in Section 5. Structural capacity formulae for steel pipe are also in Section 5. Additional requirements for components, including pipe, are in Section 6. Material requirements are in Section 7. Fabrication and installation requirements are in Section 8. Integrity Management is addressed in Section 9.

2 Normative References

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

API Spec 5CT, *Specification for Casing and Tubing*

API RP 5C5, *Recommended Practice on Procedures for Testing Casing and Tubing Connections*

API Spec 5L, *Specification for Line Pipe*

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

API RP 5LW, *Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels*

API RP 17B, *Recommended Practice for Flexible Pipe*

API Spec 17J, *Specification for Unbonded Flexible Pipe*

API Spec 17K, *Specification for Bonded Flexible Pipe*