High-pressure High-temperature Design Guidelines

API TECHNICAL REPORT 17TR8
FIRST EDITION, FEBRUARY 2015

AMERICAN PETROLEUM INSTITUTE

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 Technical Report 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, 1220 L Street, NW, Washington, DC 20005.

Copyright © 2015 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.

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.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

Contents

Introduction

This technical report is the first of several editions to serve as a design guidelines for high-pressure high-temperature (HPHT) equipment, specifically for subsea applications. This first edition is offered in hopes of bringing relevant state-of-the-art practices to address emerging projects while the task group continues to work on specific problems requiring additional time to research and resolve issues such as welding, CRA cladding, QA, sensors, etc.

This document is not intended to be a standalone specification or standard. Rather it is presented as a technical guidance document so that specifications, standards, and recommended practices may reference this document, in part or in total, to augment their operating scope greater than 15,000 psi (103.43 MPa) and/or greater than 350 °F (177 °C) wellbore conditions as proffered by API 1PER15K-1.

It is necessary that users of this technical report be aware that additional or different requirements which can better suit the demands of a particular service environment, the regulations of a jurisdictional authority or other scenarios not specifically addressed in this technical report, may be applied as required. This document is a technical report and it is not intended to replace sound engineering judgment.

In the development of this technical report, the items below are recognized as on-going work for resolution. Many will require additional discussion and debate, between governing API and ASME standards and their associated design/manufacturing processes. Rather than wait and hold up the publication of the first edition of this technical report, until everything is resolved, the task group elected to release the work it has accomplished so far, and alert the reader to the work still to be resolved; highlighting that there could be changes to the technical report in subsequent editions.

1) Materials QA/QC differences between API, and ASME standards: The task group acknowledges that the QA/QC requirements found in ASME and API standards are not aligned, and additionally, may not be aligned between API sub-committees. It is beyond the scope of this technical report to close this gap. As further work is conducted and information comes to light, it is envisioned that the gaps will progress to convergence. It is recommended that these gaps be documented in a FMECA as input to the verification process, and included in the development of a documented design validation program to address the gap.

2) Inclusion of external loading: The task group has authored this technical report to provide specific guidance to utilize design codes which are applicable for the inclusion of external loading.

3) Where the design codes (e.g. ASME *BPVC* Section VIII, Div. 2 and Section VIII, Div. 3) are referenced in this technical report for subsea applications, these design codes and this technical report provide guidance for applicable loads, static, dynamic, and cyclic.

4) Hydrostatic body test pressures: API Specifications typically require a hydrostatic body test on single-equipment units and this technical report recommends different minimum hydrostatic test pressures depending on the design verification method chosen. This could result in two or more components being assembled where ASME Section VIII, Div. 2 component(s), tested to 1.5xRWP, combined with ASME Section VIII, Div. 3 component(s), tested to 1.25xRWP, into an assembly/system. However, system integration testing (SIT) of an assembly/system is not in the scope of this technical report.

5) Application of “Extreme” and “Survival” loading conditions: The task group acknowledges differences between API and ASME *BPVC* loading conditions and allowable limits for these loading conditions. Currently, it is the task group’s opinion that there is insufficient correlation to provide specific recommendations of the treatment and acceptance criteria of these load cases. It is recommended that, if these loading conditions are present during HPHT applications they should be documented in the FMECA process, inputted to the design verification process, and included in the design validation program, as needed to address this gap.

As a cautionary note: It should be understood that some of the text on design methodology, material performance data, and qualification/validation requirements published in this first edition may be modified (i.e. changed, added, deleted, etc.) as continuing topics are resolved and as new information and technology become available in subsequent editions.

High-pressure High-temperature Design Guidelines

1 Scope

1.1 Scope of Technical Report

The scope of this technical report is to provide design guidelines for oil and gas subsea equipment utilized in high-pressure high-temperature (HPHT) environments (refer to 3.1.16). For the purpose of the technical report, HPHT environments are intended to be one or a combination of the following well conditions:

1) the completion of the well requires completion equipment or well control equipment assigned a pressure rating greater than 15,000 psia [15 ksi, 103.43 MPa] or a temperature rating greater than 350 °F (177 °C);

2) the maximum anticipated surface pressure including shut-in tubing pressure is greater than 15,000 psia [15 ksi, 103.43 MPa] on the seafloor for a well with a subsea wellhead or tied back to the surface and terminated with surface operated equipment; or

3) the flowing temperature is greater than 350 °F (177 °C) on the seafloor for a well with a subsea wellhead or tied back to the surface and terminated with surface operated equipment.

Service temperature ratings above 550 °F (288 °C) are outside the scope of this technical report.

This technical report is intended to serve as a general design guideline for HPHT application. Other subsea task groups and subcommittees may elect to adopt a portion or all of the presented guidelines for HPHT application, subject to their component hardware and application-related design constraints.

1.2 Application

The scope of this technical report is limited to equipment and components identified in API documents that focus on subsea production equipment while addressing one or a combination of the following loading conditions:

— internal and external pressure;

— ambient and elevated operating temperatures;

— static and dynamic mechanical loads;

— other pressure/temperature induced loadings.

This technical report is intended to provide design guidelines for pressure-containing components, seals and fastener components that come in contact with or are immediately adjacent to wellbore fluids operating at HPHT conditions. Intra-field piping systems (e.g. steel flowline and pipeline jumpers, manifold piping, valving and connectors, intervention riser equipment) are within the scope of this technical report.

The design methodology referenced in this technical report may also be applied to pressure-controlling components if the design methodology can appropriately assess the applicable failure mode(s).

This technical report does not cover:

— flexible pipes (bonded and unbonded);

— oil-country tubular goods (OCTG) for drilling or completing wells;