Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems

API RECOMMENDED PRACTICE 14E
FIFTH EDITION, OCTOBER 1991

REAFFIRMED, SEPTEMBER 2019

AMERICAN PETROLEUM INSTITUTE

Issued by
AMERICAN PETROLEUM INSTITUTE
Production Department

FOR INFORMATION CONCERNING TECHNICAL CONTENTS OF THIS PUBLICATION CONTACT THE API PRODUCTION DEPARTMENT, 1201 MAIN STREET, SUITE 2535, DALLAS, TX 75202-3994 — (214) 748-3841. SEE BACK COVER FOR INFORMATION CONCERNING HOW TO OBTAIN ADDITIONAL COPIES OF THIS PUBLICATION.

Users of this publication should become completely familiar with its scope and content. This publication is intended to supplement rather than replace individual engineering judgment.

OFFICIAL PUBLICATION

REG. U.S. PATENT OFFICE

API RECOMMENDED PRACTICE FOR DESIGN AND INSTALLATION OF OFFSHORE PRODUCTION PLATFORM PIPING SYSTEMS

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Attention Users of this Publication: Portions of this publication have been changed from the previous edition. The locations of changes have been marked with a bar in the margin, as shown to the left of this paragraph. In some cases the changes are significant, while in other cases the changes reflect minor editorial adjustments. The bar notations in the margins are provided as an aid to users as to those parts of this publication that have been changed from the previous edition, but API makes no warranty as to the accuracy of such bar notations.

NOTE: This is the fifth edition of this Recommended Practice. It includes changes to the fourth edition adopted at the 1990 Standardization Conference.

This standard shall become effective on the date printed on the cover, but may be used voluntarily from the date of distribution.

POLICY STATEMENT

API PUBLICATIONS NECESSARILY ADDRESS PROBLEMS OF A GENERAL NATURE. WITH RESPECT TO PARTICULAR CIRCUMSTANCES, LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS SHOULD BE REVIEWED.

API IS NOT UNDERTAKING TO MEET DUTIES OF EMPLOYERS, MANUFACTURERS, OR SUPPLIERS TO WARN AND PROPERLY TRAIN AND EQUIP THEIR EMPLOYEES, AND OTHERS EXPOSED, CONCERNING HEALTH AND SAFETY RISKS AND PRECAUTIONS, NOR UNDERTAKING THEIR OBLIGATIONS UNDER LOCAL, STATE, OR FEDERAL LAWS.

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 THIS PUBLICATION BE CONSTRUED AS INSURING ANYONE AGAINST LIABILITY FOR INFRINGEMENT OF LETTERS PATENT.

GENERALLY, API STANDARDS ARE REVIEWED AND REVISED, REAFFIRMED, OR WITHDRAWN AT LEAST EVERY FIVE YEARS. SOMETIMES A ONE-TIME EXTENSION OF UP TO TWO YEARS WILL BE ADDED TO THIS REVIEW CYCLE. THIS PUBLICATION WILL NO LONGER BE IN EFFECT FIVE YEARS AFTER ITS PUBLICATION DATE AS AN OPERATIVE API STANDARD OR, WHERE AN EXTENSION HAS BEEN GRANTED, UPON REPUBLICATION. STATUS OF THIS PUBLICATION CAN BE ASCERTAINED FROM THE API AUTHORING DEPARTMENT (TEL. 214-748-3841). A CATALOG OF API PUBLICATIONS AND MATERIALS IS PUBLISHED ANNUALLY AND UPDATED QUARTERLY BY API, 1220 L ST., N.W., WASHINGTON, D.C. 20005.

American Petroleum Institute (API) Recommended Practices are published to facilitate the board availability of proven, sound engineering and operating practices. These Recommended Practices are not intended to obviate the need for applying sound judgment as to when and where these Recommended Practices should be utilized.

The formulation and publication of API Recommended Practices is not intended to, in any way, inhibit anyone from using any other practices.

Any Recommended Practice may be used by anyone desiring to do so, and a diligent effort has been made by API to assure the accuracy and reliability of the data contained herein. However, the Institute makes no representation, warranty or guarantee in connection with the publication of any Recommended Practice and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use, for any violation of any federal, state or municipal regulation with which an API recommendation may conflict, or for the infringement of any patent resulting from the use of this publication.

FOREWORD

a. This recommended practice (RP) is under the jurisdiction of the American Petroleum Institute (API) Committee on Standardization of Offshore Safety and Anti-Pollution Equipment. It has been prepared with the overall advisory guidance of the API, Offshore Operators Committee (OOC), and the Western Oil and Gas Association (WOGA). Corrosion related sections were prepared with the assistance of the National Association of Corrosion Engineers (NACE).

b. This RP contains information for use primarily by design engineers with a working knowledge of production platform operations. Some of the information may be useful to experienced operating personnel. Nothing in this RP is to be construed as a fixed rule without regard to sound engineering judgement nor is it intended to supercede or override any federal, state, or local regulation where applicable.

c. Conversion of English units to International System (SI) metric units has been omitted to add clarity to graphs and empirical formulas. Factors that may be used for conversion of English units to SI units were taken from API Publication 2564, and are listed below:

LENGTH

1 inch (in.)	= 25.4 millimetres (mm) exactly

PRESSURE

1 pound per square inch (psi)	= 0.06894757 Bar

NOTE: 1 Bar = 100 kilopascals (kPa)

STRENGTH OR STRESS

1 pound per square inch (psi)	= 0.006894757 Megapascals (MPa)

IMPACT ENERGY

1 foot-pound (ft-lb)	= 1.355818 Joules (J)

TORQUE

1 foot-pound (ft-lb)	= 1.355818 newton-metres (N·m)

TEMPERATURE

The following formula was used to convert degrees Fahrenheit (F) to degrees Celsius (C):

$C = 5/9 (F-32)$

VOLUME

1 Cubic Foot (cu ft)	= 0.02831685 Cubic Metre (m^3)
1 Gallon (gal)	= 0.003785412 Cubic Metre (m^3)
1 Barrel (bbl)	= 0.1589873 Cubic Metre (m^3)

WEIGHT

1 pound (lb)	= 0.4535924 Kilograms (kg)

FORCE

1 pound (lb)	= 4.448222 Newtons (N)

FLOW RATE

1 Barrel per day (BPD)	= 0.1589873 Cubic Metres per day (m^3/d)
1 Cubic foot per min (CFM)	= 40.77626 Cubic Metres per day (m^3/d)

DEFINITIONS

The following definitions apply specifically to the equipment and systems described in this RP.

CHLORIDE STRESS CRACKING SERVICE —Process streams which contain water and chlorides under conditions of concentration and temperature high enough to induce stress cracking of ferrous base alloy materials. Other constituents present, such as oxygen (O_2), may contribute to such chloride stress cracking.

CHOKE —A device specifically intended to restrict the flow rate of fluids.

CORROSION-EROSION —The phenomenon of a protective film of corrosion product being eroded away by the erosive action of the process stream, exposing fresh metal which then corrodes. Extremely high metal weight loss may occur under these conditions.

CORROSIVE GAS —A gas which when dissolved in water or other liquid causes metal attack. Usually included are hydrogen sulfide (H_2S), carbon dioxide (CO_2) and oxygen (O_2).

CORROSIVE HYDROCARBON SERVICE —Process streams which contain water or brine and carbon dioxide (CO_2), hydrogen sulfide (H_2S), oxygen (O_2) or other corrosive agents under conditions which cause metal weight loss.

DESIGN PRESSURE —Maximum allowable working pressure at the design temperature.

EXPANSION BELLOWS —A corrugated piping device designed for absorbing expansion and contraction.

EXPANSION BEND —A piping configuration designed to absorb expansion and contraction.

FIRE WATCH —One or more trained persons with operable fire fighting equipment standing on alert during welding or burning operations.

FLOWLINE —Piping which carries well fluid from wellhead to manifold or first process vessel.

FLOW REGIME —The flow condition of a multiphase process stream such as slug, mist, or stratified flow.

FLUID —A generic term meaning a gas, vapor, liquid or combinations thereof.

HEADER —That part of a manifold which directs fluid to a specific process system. (See Figure 6.1A)

HYDROCARBON WETABILITY —The ability of the process stream to form a protective hydrocarbon film on metal surfaces.

MANIFOLD —An assembly of pipe, valves, and fittings by which fluid from one or more sources is selectively directed to various process systems.

NIPPLE —A section of threaded or socket welded pipe used as an appurtenance that is less than 12 inches in length.

NON-CORROSIVE HYDROCARBON SERVICE —Process streams under conditions which do not cause significant metal weight loss, selective attack, or stress corrosion cracking.

PLATFORM PIPING —A general term referring to any piping, on a platform, intended to contain or transport fluid.

PRESSURE SENSOR —A device designed to detect a predetermined pressure.

PROCESS COMPONENT —A single functional piece of production equipment and associated piping such as a pressure vessel, heater, pump, etc.

RISER —The vertical portion of a pipeline (including the bottom bend) arriving on or departing from a platform.

SHUTDOWN VALVE —An automatically operated valve used for isolating a process component or process system.

SULFIDE STRESS CRACKING SERVICE —Process streams which contain water or brine and hydrogen sulfide (H_2S) in concentrations high enough to induce stress corrosion cracking of susceptible materials.

WELLHEAD PRESSURE —The maximum shut-in surface pressure that may exist in a well.

SYMBOLS

The following symbols apply specifically to the equations contained in this RP.

A	=	minimum pipe cross-sectional flow area required, inches²/1000 barrels fluid/day
B	=	mean coefficient of thermal expansion at operating temperatures normally encountered, inches/inch/°F
C	=	empirical pump constant
c	=	empirical constant
C_v	=	valve coefficient (GPM water flow at 60°F across valve with a pressure drop of 1 psi)
d_f	=	pipe inside diameter, feet
d_i	=	pipe inside diameter, inches
D	=	nominal pipe diameter, inches
D_o	=	pipe outside diameter, inches
E	=	longitudinal weld joint factor, dimensionless
E_m	=	modulus of elasticity of piping material in the cold condition, psi
f	=	Moody friction factor, dimensionless
g	=	gravitational constant, feet/second²
GPM	=	liquid flow rate, gallons/minute
h_a	=	acceleration head, feet of liquid
h_f	=	friction head, feet of liquid
h_p	=	absolute pressure head, feet of liquid
h_{st}	=	static head, feet of liquid
h_{vh}	=	velocity head, feet of liquid
h_{vpa}	=	absolute vapor pressure, feet of liquid
Δhw	=	differential static pressure head, inches of water
K	=	acceleration factor, dimensionless
L	=	pipe length, feet
Δ_l	=	expansion to be absorbed by pipe, inches
$NPSH_a$	=	available net positive suction head, feet of liquid
P	=	operating pressure, psia (See Note (1))
P_i	=	internal design pressure, psig
Δp	=	pressure drop, psi
ΔP	=	pressure drop, psi/100 ft
Q_g	=	gas flow rate, million cubic feet/day (14.7 psia and 60°F)
Q_l	=	liquid flow rate, barrels/day
q'h	=	gas flow rate, cubic feet/hour (14.7 psia and 60°F)
R	=	gas/liquid ratio, standard cubic feet/barrel
R_e	=	Reynolds number, dimensionless
R_p	=	pump speed, revolutions/minute
ρ_g	=	gas density at operating pressure and temperature, lbs/ft³
ρ_l	=	liquid density at operating temperature, lbs/ft³
ρ_m	=	gas/liquid mixture density at operating pressure and temperature, lbs/ft³
S	=	allowable stress, psi
S_g	=	gas specific gravity (air = 1)
S_l	=	liquid specific gravity (water = 1)
T	=	operating temperature, °R (See Note (2))
t	=	pressure design thickness, inches
ΔT	=	temperature change, °F
U	=	anchor distance, feet (straight line distance between anchors)
μ_g	=	gas viscosity at flowing pressure and temperature, centipoise
μ_l	=	liquid viscosity, lbs/ft-sec
V_e	=	fluid erosional velocity, feet/second
V_g	=	average gas velocity, feet/second (See Note (3))
V_l	=	average liquid velocity, feet/second
W	=	total liquid plus vapor rate, lbs/hr
Y	=	temperature factor, dimensionless
Z	=	gas compressibility factor, dimensionless

NOTES:
(1) Also denoted in text as "flowing pressure, psia."
(2) Also denoted in text as "flowing temperature, °R."
(3) Also denoted in text as "gas velocity, feet/second."

SECTION 1

GENERAL

1.1 Scope. This document recommends minimum requirements and guidelines for the design and installation of new piping systems on production platforms located offshore. The maximum design pressure within the scope of this document is 10,000 psig and the temperature range is -20°F to 650°F. For applications outside these pressures and temperatures, special consideration should be given to material properties (ductility, carbon migration, etc.). The recommended practices presented are based on years of experience in developing oil and gas leases. Practically all of the offshore experience has been in hydrocarbon service free of hydrogen sulfide. However, recommendations based on extensive experience onshore are included for some aspects of hydrocarbon service containing hydrogen sulfide.

a. This document contains both general and specific information on surface facility piping systems not specified in API Specification 6A. Sections 2, 3 and 4 contain general information concerning the design and application of pipe, valves, and fittings for typical processes. Sections 6 and 7 contain general information concerning installation, quality control, and items related to piping systems, e.g., insulation, etc. for typical processes. Section 5 contains specific information concerning the design of particular piping systems including any deviations from the recommendations covered in the general sections.

b. Carbon steel materials are suitable for the majority of the piping systems on production platforms. At least one carbon steel material recommendation is included for most applications. Other materials that may be suitable for platform piping systems have not been included because they are not generally used. The following should be considered when selecting materials other than those detailed in this RP.
   (1) Type of service.
   (2) Compatibility with other materials.
   (3) Ductility.
   (4) Need for special welding procedures.
   (5) Need for special inspection, tests, or quality control.
   (6) Possible misapplication in the field.
   (7) Corrosion/erosion caused by internal fluids and/or marine environments.

1.2 Code for Pressure Piping. The design and installation of platform piping should conform to ANSI B31.3, as modified herein. Risers for which B31.3 is not applicable, should be designed and installed is accordance with the following practices:

a. Design, construction, inspection and testing should be in accordance with ANSI B31.4, ANSI B31.8, CFR Title 49, Part 192, and/or CFR Title 49, Part 195, as appropriate to the application, using a design stress no greater than 0.6 times SMYS (Specified Minimum Yield Strength).

b. One hundred percent radiography should be required for welding in accordance with API Std 1104.

c. Impact tests should be required at the lowest expected operating temperatures for pipe grades higher than X-52.

d. Valves, fittings and flanges may be manufactured in conformance with MSS (Manufacturers Standardization Society of the Valve and Fittings Industry) standards. Pressure/temperature ratings and material compatibility should be verified.

e. In determining the transition between risers and platform piping to which these practices apply, the first incoming and last outgoing valve which blocks pipeline flow shall be the limit of this document's application. Recommended Practices included in this document may be utilized for riser design when factors such as water depth, batter of platform legs, potential bubbling area, etc., are considered.

1.3 Policy. American Petroleum Institute (API) Recommended Practices are published to facilitate the broad availability of proven, sound, engineering and operating practices. These Recommended Practices are not intended to obviate the need for applying sound judgment as to when and where these Recommended Practices should be utilized.

The formulation and publication of API Recommended Practices is not intended to, in any way, inhibit anyone from using any other practices.

Nothing contained in any API Recommended Practice is to be construed as granting any right, by implication or otherwise, for the manufacture, sale or use in connection with any method, apparatus, or product covered by letters patent, nor as insuring anyone against liability for infringement of letters patent.

This Recommended Practice may be used by anyone desiring to do so, and a diligent effort has been made by API to assure the accuracy and reliability of the data contained herein. However, the Institute makes no representation, warranty or guarantee in connection with the publication of this Recommended Practice and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use, for any violation of any federal, state or municipal regulation with which an API recommendation may conflict, or for the infringement of any patent resulting from the use of this publication.

1.4 Industry Codes, Guides and Standards. Various organizations have developed numerous codes, guides and standards which have substantial acceptance by industry and governmental bodies. Listed below are the codes, guides and standards referenced herein.

Included-by-reference standards shall be the latest published edition unless otherwise stated.

a. **American Iron and Steel Institute.**
   AISI Steel Products Manual, *Stainless and Heat Resisting Steels.*

b. **American National Standards Institute (Formerly "ASA" and "USAS").**
   (1) ANSI B2.1, *Pipe Threads.*
   (2) ANSI B16.5, *Steel Pipe Flanges, Flanged Valves, and Fittings.*
   (3) ANSI B16.9, *Factory-Made Wrought Steel Buttwelding Fittings.*
   (4) ANSI B16.10, *Face-to-Face and End-to-End Dimensions of Ferrous Valves.*
   (5) ANSI B16.11, *Forged Steel Fittings, Socket-Welding and Threaded.*
   (6) ANSI B16.28, *Wrought Steel Buttwelding Short Radius Elbows and Returns.*
   (7) ANSI B31.3, *Petroleum Refinery Piping.*
   (8) ANSI B31.4, *Oil Transportation Piping.*