

Specification for Pumping Units

API SPECIFICATION 11E
NINETEENTH EDITION, NOVEMBER 2013

EFFECTIVE DATE: MAY 1, 2014

ERRATA, AUGUST 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.

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 © 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.

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

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

Contents

	Page
1	Scope 1
2	Normative References 1
3	Terms, Definitions, Abbreviations, and Symbols 2
3.1	Terms and Definitions 2
3.2	Abbreviations and Symbols 4
4	Product Requirements 7
4.1	Functional Requirements 7
4.2	Technical Requirements 8
5	Beam Pump Structure Requirements 9
5.1	General 9
5.2	Design Loads for All Structural Members Except Walking Beams 9
5.3	Design Stresses for All Structural Members Except Walking Beams, Bearing Shafts, and Cranks 10
5.4	Design Loads for Walking Beam 10
5.5	Maximum Allowable Stress for Walking Beams 11
5.6	Other Structural Components 12
5.7	Structural Bearing Design 13
5.8	Brakes 13
6	Speed Reducer Requirements 14
6.1	General 14
6.2	Gear Reducers 14
6.3	Chain Reducers 36
6.4	Components 37
7	Product Identification 41
7.1	Beam Pump Structure Nameplate 41
7.2	Speed Reducer Nameplate 41
7.3	Installation Markings 41
7.4	Supplier/Manufacturing Requirements 42
8	Storage and Maintenance 42
8.1	Shipping and Handling 42
8.2	Lubrication 42
	Annex A (informative) API Monogram 43
	Annex B (normative) Beam Pumping Unit Designations 47
	Annex C (informative) Recommended Data Forms 50
	Annex D (informative) Torque Factor on Beam Pumping Units with Rear Mounted Geometry Class I Lever Systems with Crank Counterbalance 55
	Annex E (informative) Torque Factor on Beam Pumping Units with Front Mounted Geometry Class III Lever Systems with Crank Counterbalance 67
	Annex F (informative) Torque Factor on Beam Pumping Units with Front Mounted Geometry Class III Lever System with Air Counterbalance 76

Contents

	Page
Annex G (informative) Torque Factor on Beam Pumping Units with Rear Mounted Geometry Class I Lever Systems with Phased Crank Counterbalance	83
Annex H (informative) Examples for Calculating Torque Ratings for Pumping Unit Reducers	93
Annex I (informative) System Analysis	101
Annex J (informative) Product Nomenclature	102
Bibliography	103

Figures

1 Walking Beam Elements	11
2 Helical Gear Load Distribution Factor, C_m, for Helical and Herringbone Gears and Well-controlled Heat-treating Processes	18
3 Allowable Contact Fatigue Stress for Through Hardened and Tempered Steel Gears S_{ac} for Helical and Herringbone Gears	20
4 Allowable Bending Fatigue Stress for Through Hardened and Tempered Steel Gears S_{at}	21
5 Helical Gear Load Distribution Factor, K_m, for Helical and Herringbone Gears	26
6 Allowable Yield Strength Number for Steel and Nodular Iron, S_{ay}	30
7 Minimum Effective Case Depth for Flame or Induction Hardened Gears, h_e	32
8 Acceptable Flame and Induction Hardening Patterns	33
9 Effective Case Depth for Carburized Gears, h_e	34
10 Minimum Total Case Depth for Nitrided Gears, h_c	35
11 Allowable Stress—Shafting	38
12 Beam Pump Structure Nameplate	41
13 Pumping Unit Reducer Nameplate	41
C.1 Rating Form for Crank Counterbalances	51
C.2 Pumping Unit Stroke and Torque Factor Form	52
C.3 Manufacturer's Gear Reducer Datasheet	53
D.1 Pumping Unit Geometry	56
D.2 Division of Dynamometer Card by Crank Angle Using Polished Rod Position Data	61
D.3 Torque Curves Using Torque Factors	64
D.4 Calculation Sheet—Clockwise Rotation	65
D.5 Calculation Sheet—Counterclockwise Rotation	66
E.1 Front Mounted Geometry, Class III Lever System	68
E.2 Division of Dynamometer Card by Crank Angle Using Polished Rod Position Data	72
E.3 Torque Curves Using Torque Factors	75
F.1 Pumping Unit Geometry	77
F.2 Division of Dynamometer Card by Crank Angle Using Polished Rod Position Data	81
F.3 Torque Curves Using Torque Factors	82
G.1 Rear Mounted Geometry, Class I Lever System with Phased Crank Counterbalance	84
G.2 Division of Dynamometer Card by Crank Angle Using Polished Rod Position Data	88
G.3 Torque Curves Using Torque Factors	91
G.4 Net Reducer Torque Calculation Sheet	92
J.1 Beam Pumping Unit Nomenclature	102

Contents

Page

Tables

1	Maximum Allowable Stresses in Pumping Unit Walking Beams of Structural Steel	12
2	Pumping Unit Reducer Sizes and Ratings	15
3	Speeds for Peak Torque Rating for Gear Reducers	15
4	Maximum Allowable Contact Stress Number S_{ac} for Other Than Through Hardened and Tempered Steel Gears	19
5	Elastic Coefficient C_p for Gear/Pinion Material Combinations	19
6	Minimum Gear and Pinion Brinell Hardness Combinations for Through Hardened and Tempered Steel Gears	20
7	Allowable Bending Fatigue Stress, S_{at} (for Other Than Through Hardened and Tempered Steel Gears)	24
8	Yield Strength Factor, K_y	29
9	Allowable Key Stresses	39
10	Maximum Allowable Tensile Stress, Fasteners	40
B.1	Pumping Unit Designation	48

Introduction

This specification under the jurisdiction of the API Executive Committee on Standardization and was developed with oversight from API Subcommittee 11 on Field Operating Equipment. This specification is intended to give requirements and information to both parties in the design, selection, and manufacture of beam pumping units. Furthermore, this specification addresses the minimum requirements with which the manufacturer is to comply so as to claim conformity with this specification.

Users of this specification should be aware that requirements above those outlined in this specification may be needed for individual applications. This specification is not intended to inhibit a manufacturer from offering, or the user/purchaser from accepting, alternative equipment or engineering solutions. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the manufacturer should identify any variations from this specification and provide details.

Annex A contains information on the application of the API Monogram for those organizations licensed to API Specification 11E. Forms are provided in Annex C for rating of crank counterbalances (Figure C.1) and for recording pumping unit stroke and torque factors (Figure C.2). Recommendations and examples for the calculation and application of torque factors are contained in Annex D to Annex G, and examples for calculating torque ratings for pumping unit reducers are contained in Annex H. Recommendations and considerations for conducting a system analysis are contained in Annex I. Annex J contains an illustration of a typical beam pumping unit and the nomenclature associated with it.

Specification for Pumping Units

1 Scope

This specification provides the requirements and guidelines for the design and rating of beam pumping units for use in the petroleum and natural gas industry. Included are all components between the carrier bar and the speed reducer input shaft. This includes the following:

- a) beam pump structures,
- b) pumping unit gear reducer, and
- c) pumping unit chain reducer.

Only loads imposed on the structure and/or gear reducer by the polished rod load are considered in this specification.

Also included are the requirements for the design and rating of enclosed speed reducers wherein the involute gear tooth designs include helical and herringbone gearing. The rating methods and influences identified in this specification are limited to single and multiple stage designs applied to beam pumping units in which the pitch-line velocity of any stage does not exceed 5000 ft/min and the speed of any shaft does not exceed 3600 rpm.

This standard does not cover chemical properties of materials, installation and maintenance of the equipment, beam type counterbalance units, prime movers and power transmission devices outside the gear reducer, or control systems.

See Annex A for product is supplied bearing the API Monogram and manufactured at a facility licensed by API.

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 Specification 11B, *Specification for Sucker Rods*

AGMA 908-B89¹, *Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth*

AGMA 2001-D04, *Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth*

ANSI²/AGMA 1012-G05, *Gear Nomenclature, Definitions of Terms with Symbols*

ASME B29.100³, *Precision Power Transmission, Double-Pitch Power Transmission, and Double-Pitch Conveyor Roller Chains, Attachments, and Sprockets*—Incorporating ASME B29.1, ASME B29.3, and ASME B29.4

¹ American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314, www.agma.org.

² American National Standards Institute, 25 West 43rd Street, 4th floor, New York, New York 10036, www.ansi.org.