

Liquid Ring Compressors and Vacuum Pumps in Petroleum, Chemical, and Gas Industry Services

API STANDARD 681
SECOND EDITION, JULY 2021



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. The use of API publications is voluntary. In some cases, third parties or authorities having jurisdiction may choose to incorporate API standards by reference and may mandate compliance.

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 ensure 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 used. 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, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

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.

The verbal forms used to express the provisions in this document are as follows.

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

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

May: As used in a standard, “may” denotes a course of action permissible within the limits of a standard.

Can: As used in a standard, “can” denotes a statement of possibility or capability.

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, and Abbreviations	4
3.1 Terms and Definitions	4
3.2 Acronyms and Abbreviations	11
4 General	11
4.1 Unit Responsibility	11
4.2 Nomenclature	11
5 Requirements	11
5.1 Units of Measure.....	11
5.2 Statutory Requirements	11
5.3 Conflicting Requirements.....	11
6 Basic Design	12
6.1 General	12
6.2 Pressure Casings	15
6.3 Casing Connections.....	17
6.4 Flanges	19
6.5 External Forces and Moments.....	20
6.6 Rotating Elements	22
6.7 Mechanical Shaft Seals	23
6.8 Dynamics	25
6.9 Bearings, Bearing Housings, and Lubrication.....	27
6.10 Materials	31
6.11 Sealless Design	36
6.12 Nameplates and Rotation Arrows	37
7 Accessories	38
7.1 Drivers	38
7.2 Couplings.....	40
7.3 Guards	41
7.4 Belt Drives	42
7.5 Baseplates	43
7.6 Controls and Instrumentation.....	46
7.7 Ring Liquid System and Auxiliaries.....	55
7.8 Piping.....	58
8 Inspection, Testing, and Preparation for Shipment	60
8.1 General	60
8.2 Inspection	61
8.3 Testing	63
8.4 Preparation for Shipment.....	68
9 Vendor's Data	71
Annex A (informative) Data Sheets.....	72

Contents

	Page
Annex B (informative) Contract Documents and Engineering Design Data	98
Annex C (informative) Liquid Ring Compressor and Vacuum Pump Nomenclature	114
Annex D (normative) Materials and Material Specifications	119
Annex E (informative) Ring Liquid System Schematics	128
Annex F (informative) System Considerations, Operating Variables, and Test Performance Conversion	133
Annex G (informative) Packaging.....	136
Bibliography.....	139

Figures

1	Typical Gusset Design	18
2	Coordinate System for the Forces and Moments in Table 4, Top Suction/Top Discharge LRC/VP Design 21	
3	Coordinate System for the Forces and Moments in Table 4—Top Suction/Side Discharge LRC/VP Design.....	22
4	Coordinate System for the Forces and Moments in Table 4—Side Suction/Side Discharge LRC/VP Design.....	22
5	Indicative Locations for Taking Vibration on Overhung and Between Bearing LRC/VP	27
C.1	LRC/VP—Two Stage, Between Bearing, Plate Design	114
C.2	LRC/VP—Single Stage, Between Bearing, Conical Design, Single Suction	115
C.3	LRC/VP—Single Stage, Between Bearing, Conical Design, Single Suction	115
C.4	LRC/VP—Single Stage, Overhung, Plate Design.....	115
C.5	Magnetic Drive LRC/VP—Single Stage, Between Bearing, Plate Design, Double Suction.....	116
C.6	LRC/VP Typical Flow Paths	117
E.1	LRC/VP Once-through System	128
E.2	LRC/VP Partial Recirculation System (NOTE 5).....	129
E.3	LRC/VP Total Recirculation System (Vertical Separator).....	130
E.4	LRC/VP Total Recirculation System (Horizontal Separator)	131
E.5	Typical Three-phase Separator.....	132

Tables

1	SI and U.S. Standard Conditions	9
2	Conditions for Cooling Water System Design Parameters	13
3	Material Casting Factors	16
4	Nozzle Loadings	20
5	Power Ratings for Motor Drives	39
6	Minimum Thickness for Control Panels	48
7	Minimum Alarm, Shutdown, and Trip Recommendations	51
8	Minimum Tubing Wall Thickness	59
9	Materials Inspection Standards	62

Contents

	Page
10 Maximum Allowable Free Air Gauss Levels.....	63
11 Performance Tolerances.....	67
D.1 Material Classes for LRC/VP Parts.....	119
D.2 Material Specifications for LRC/VP Parts	120
D.3 Non-metallic Wear Part Materials	125
D.4 Piping Materials	126

Introduction

Users of this standard should be aware that further or differing requirements may be needed for individual applications. This standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this standard and provide details.

- Annex A contains data sheets which purchasers are encouraged to use.
- Annex B contains guidelines for submittal of contract documents and engineering design data including typical forms which may be used to indicate vendor drawing and data requirements.
- Annex C contains nomenclature for the various equipment components.
- Annex D specifies requirements and gives guidance on materials selection.
- Annex E contains schematic drawings of ring liquid systems.
- Annex F contains system considerations, operating variables, and test performance guidance.
- Annex G contains guidance on packaging.

This standard requires the purchaser to specify certain details and features. A bullet [•] in the margin indicates that either a decision by, or further information from, the purchaser is required. Further information should be shown on the data sheets (see example in Annex A) or stated in the quotation request and purchase order.

In this standard, U.S. customary units are included in brackets for information.

Liquid Ring Compressors and Vacuum Pumps in Petroleum, Chemical, and Gas Industry Services

1 Scope

1.1 This standard covers the minimum requirements for liquid ring compressor and vacuum pump (LRC/VP) systems for service in the petroleum, chemical, and gas industries. The requirements include basic equipment design, materials, fabrication, inspection, testing, and preparation for shipment.

1.2 This standard requires the purchaser to specify certain details and features. A bullet [•] in the margin indicates that a decision by, or further information from, the purchaser is required. Further information should be stated in the quotation request and purchase order.

1.3 The purchaser and the vendor shall mutually determine the measure that shall be taken to comply with governmental codes, regulations, ordinances, or rules that are applicable to the equipment.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Recommended Practice 500, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*

API Recommended Practice 686, *Machinery Installation, and Installation Design*

API Recommended Practice 691, *Risk-based Machinery Management*

API Standard 520, *Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries; Part I— Sizing and Selection*

API Standard 520, *Sizing, Selection, and Installation of Pressure- relieving Devices in Refineries; Part II— Installation*

API Standard 526, *Flanged Steel Pressure Relief Valves*

API Standard 541, *Form-wound Squirrel- cage Induction Motors—500 Horsepower and Larger*

API Standard 547, *General-purpose Form- wound Squirrel-cage Induction Motors—250 Horsepower and Larger*

API Standard 614, *Lubrication, Shaft-sealing, and Control-oil Systems and Auxiliaries*

API Standard 670: *Machinery Protection Systems*

API Standard 677, *General-Purpose Gear Units for Petroleum, Chemical and Gas Industry Services*

API Standard 682, *Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps*

ABMA Standard 7, ¹ *Shaft, Housing Fits for Metric Radial Ball and Roller Bearings (Except Tapered Roller Bearings) Conforming to Basic Boundary Plans*

ABMA 19.1, *Tapered Roller Bearings—Radial Metric Design*

¹ American Bearing Manufacturers Association, 2025 M Street, NW, Suite 800, Washington, DC 20036, www.abma-dc.org.