

Machinery Protection Systems

API STANDARD 670
FOURTH EDITION, DECEMBER 2000



**Helping You
Get The Job
Done Right.SM**

Machinery Protection Systems

Downstream Segment

API STANDARD 670
FOURTH EDITION, DECEMBER 2000



**Helping You
Get The Job
Done Right.SM**

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.

API is not undertaking to meet the 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.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

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.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years.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 the publication can be ascertained from the API Downstream Segment [telephone (202) 682-8000]. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

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 standard or comments and questions concerning the procedures under which this standard was developed should be directed in writing to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the standardization manager.

API standards are published to facilitate the broad availability of proven, sound engineering and operating practices. These standards are not intended to obviate the need for applying sound engineering judgment regarding when and where these standards should be utilized. The formulation and publication of API standards 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, 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, N.W., Washington, D.C. 20005.

FOREWORD

This standard is based on the accumulated knowledge and experience of manufacturers and users of monitoring systems. The objective of the publication is to provide a purchase specification to facilitate the manufacture, procurement, installation, and testing of vibration, axial position, and bearing temperature monitoring systems for petroleum, chemical, and gas industry services.

The primary purpose of this standard is to establish minimum electromechanical requirements. This limitation in scope is one of charter as opposed to interest and concern. Energy conservation is of concern and has become increasingly important in all aspects of equipment design, application, and operation. Thus, innovative energy-conserving approaches should be aggressively pursued by the manufacturer and the user during these steps. Alternative approaches that may result in improved energy utilization should be thoroughly investigated and brought forth. This is especially true of new equipment proposals, since the evaluation of purchase options will be based increasingly on total life costs as opposed to acquisition cost alone. Equipment manufacturers, in particular, are encouraged to suggest alternatives to those specified when such approaches achieve improved energy effectiveness and reduced total life costs without sacrifice of safety or reliability.

This standard requires the purchaser to specify certain details and features. Although it is recognized that the purchaser may desire to modify, delete, or amplify sections of this standard, it is strongly recommended that such modifications, deletions, and amplifications be made by supplementing this standard, rather than by rewriting or by incorporating sections thereof into another complete standard.

API standards are published as an aid to procurement of standardized equipment and materials. These standards are not intended to inhibit purchasers or producers from purchasing or producing products made to specifications other than those of API.

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 federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

IMPORTANT INFORMATION CONCERNING USE OF ASBESTOS OR ALTERNATIVE MATERIALS

Asbestos is specified or referenced for certain components of the equipment described in some API standards. It has been of extreme usefulness in minimizing fire hazards associated with petroleum processing. It has also been a universal sealing material, compatible with most refining fluid services.

Certain serious adverse health effects are associated with asbestos, among them the serious and often fatal diseases of lung cancer, asbestosis, and mesothelioma (a cancer of the chest and abdominal linings). The degree of exposure to asbestos varies with the product and the work practices involved.

Consult the most recent edition of the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, Occupational Safety and Health Standard for Asbestos, Tremolite, Anthophyllite, and Actinolite, 29 *Code of Federal Regulations* Section 1910.1001; the U.S. Environmental Protection Agency, National Emission Standard for Asbestos, 40 *Code of Federal Regulations* Sections 61.140 through 61.156; and the U.S. Environmental Protection Agency (EPA) rule on labeling requirements and phased banning of asbestos products (Sections 763.160-179).

There are currently in use and under development a number of substitute materials to replace asbestos in certain applications. Manufacturers and users are encouraged to develop and use effective substitute materials that can meet the specifications for, and operating requirements of, the equipment to which they would apply.

SAFETY AND HEALTH INFORMATION WITH RESPECT TO PARTICULAR PRODUCTS OR MATERIALS CAN BE OBTAINED FROM THE EMPLOYER, THE MANUFACTURER OR SUPPLIER OF THAT PRODUCT OR MATERIAL, OR THE MATERIAL SAFETY DATA SHEET.

CONTENTS

	Page
1 GENERAL.....	1
1.1 Scope	1
1.2 Alternative Designs	1
1.3 Conflicting Requirements	1
2 REFERENCES	1
3 DEFINITIONS.....	2
4 GENERAL DESIGN SPECIFICATIONS	6
4.1 Component Temperature Ranges	6
4.2 Humidity	6
4.3 Shock	7
4.4 Chemical Resistance	7
4.5 Accuracy	7
4.6 Interchangeability	9
4.7 Scope of Supply and Responsibility	9
5 CONVENTIONAL HARDWARE.....	9
5.1 Radial Shaft Vibration, Axial Position, Phase Reference, Speed Sensing, and Piston Rod Drop Transducers	9
5.2 Accelerometer-Based Casing Transducers	14
5.3 Temperature Sensors	14
5.4 Monitor Systems	15
5.5 Wiring and Conduits	23
5.6 Grounding	26
5.7 Field-Installed Instruments	26
6 TRANSDUCER AND SENSOR ARRANGEMENTS	28
6.1 Location and Orientation	28
6.2 Mounting	34
6.3 Identification of Transducers and Temperature Sensors	36
7 INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT	36
7.1 General	36
7.2 Inspection	37
7.3 Testing	37
7.4 Preparation for Shipment	37
7.5 Mechanical Running Test	37
7.6 Field Testing	38
8 VENDOR'S DATA.....	38
8.1 General	38
8.2 Proposals	42
8.3 Contract Data	43

APPENDIX A	MACHINERY PROTECTION SYSTEM DATA SHEETS	45
APPENDIX B	TYPICAL RESPONSIBILITY MATRIX WORKSHEET	53
APPENDIX C	ACCELEROMETER APPLICATION CONSIDERATIONS	55
APPENDIX D	SIGNAL CABLE	59
APPENDIX E	GEARBOX CASING VIBRATION CONSIDERATIONS	61
APPENDIX F	FIELD TESTING AND DOCUMENTATION REQUIREMENTS	63
APPENDIX G	CONTRACT DRAWING AND DATA REQUIREMENTS	67
APPENDIX H	TYPICAL SYSTEM ARRANGEMENT PLANS	71
APPENDIX I	SETPPOINT MULTIPLIER CONSIDERATIONS	79
APPENDIX J	ELECTRONIC OVERSPEED DETECTION SYSTEM CONSIDERATIONS	83

Tables

1	Machinery Protection System Accuracy Requirements	8
2	Minimum Separation Between Installed Signal and Power Cables	24
3A	Accelerometer Test Points (SI)	42
3B	Accelerometer Test Points (Customary Units)	42
D-1	Color Coding for Single-Circuit Thermocouple Signal Cable	60
F-1	Tools and Instruments Needed to Calibrate and Test Machinery Protection Systems	63
F-2	Data, Drawing, and Test Worksheet	64
G-1	Typical Milestone Timeline	67
G-2	Sample Distribution Record (Schedule)	68
J-1	Recommended Dimensions for Speed Sensing Surface When Magnetic Speed Sensors are Used	85
J-2	Recommended Dimensions for Non-Precision Speed Sensing Surface When Proximity Probe Speed Sensors are Used	85
J-3	Recommended Dimensions for Precision-Machined Speed Sensing Surface When Proximity Probe Speed Sensors are Used	85

Figures

1	Machinery Protection System	4
2	Standard Monitor System Nomenclature	5
3	Transducer System Nomenclature	7
4	Typical Curves Showing Accuracy of Proximity Probe Channels	10
5	Standard Probe and Extension Cable	11
6	Standard Options for Proximity Probes and Extension Cables	12
7	Standard Magnetic Speed Sensor With Removable (Non-Integral) Cable and Connector	13
8	Piston Rod Drop Calculations	19
9	Piston Rod Drop Measurement Using Phase Reference Transducer For Triggered Mode	20
10	Typical Standard Conduit Arrangement	24
11	Typical Standard Armored Cable Arrangement	25
12	Inverted Gooseneck Trap Conduit Arrangement	26
13	System Grounding (Typical)	27
14	Standard Axial Position Probe Arrangement	29
15	Typical Piston Rod Drop Probe Arrangement	31
16	Typical Installations of Radial Bearing Temperature Sensors	33
17	Typical Installations of Radial Bearing Temperature Sensors	34
18	Typical Installation of Thrust Bearing Temperature Sensors	35
19	Calibration of Radial Monitor and Setpoints for Alarm and Shutdown	39

	Page
20 Calibration of Axial Position (Thrust) Monitor	40
21 Typical Field Calibration Graph for Radial Vibration and Axial Position.	41
C-1 Typical Flush Mounted Accelerometer Details	56
C-2 Typical Non-Flush Mounted Arrangement Details for Integral-Stud Accelerometer	57
C-3 Typical Non-Flush Mounting Arrangement for Integral-Stud Accelerometer and Armored Extension Cable	57
H-1 Typical System Arrangement for a Turbine With Hydrodynamic Bearings	72
H-2 Typical System Arrangement for a Double-Helical Gear	73
H-3 Typical System Arrangement for a Centrifugal Compressor or a Pump With Hydrodynamic Bearings.	74
H-4 Typical System Arrangement for an Electric Motor With Sleeve Bearings.	75
H-5 Typical System Arrangement for a Pump or Motor With Rolling Element Bearings	76
H-6 Typical System Arrangement for a Reciprocating Compressor.	77
I-1 Setpoint Multiplication Example	80
J-1 Overspeed Protection System	83
J-2 Relevant Dimensions for Overspeed Sensor and Multi-Tooth Speed Sensing Surface Application Considerations	84
J-4 Precision-Machined Overspeed Sensing Surface.	86

Machinery Protection Systems

1 General

1.1 SCOPE

This standard covers the minimum requirements for a machinery protection system measuring radial shaft vibration, casing vibration, shaft axial position, shaft rotational speed, piston rod drop, phase reference, overspeed, and critical machinery temperatures (such as bearing metal and motor windings). It covers requirements for hardware (transducer and monitor systems), installation, documentation, and testing.

Note: A bullet (●) at the beginning of a paragraph indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the datasheets (see Appendix A); otherwise, it should be stated in the quotation request or in the order.

1.2 ALTERNATIVE DESIGNS

The machinery protection system vendor may offer alternative designs. Equivalent metric dimensions and fasteners may be substituted as mutually agreed upon by the purchaser and the vendor.

1.3 CONFLICTING REQUIREMENTS

In case of conflict between this standard and the inquiry or order, the information included in the order shall govern.

2 References

2.1 The editions of the following standards, codes, and specifications that are in effect at the time of publication of this standard shall, to the extent specified herein, form a part of this standard. The applicability of changes in standards, codes, and specifications that occur after the inquiry shall be mutually agreed upon by the purchaser and the machinery protection system vendor.

API

RP 552	<i>Signal Transmission Systems</i>
RP 554	<i>Process Instrumentation and Control, Section 3, Alarm and Protective Devices</i>
Std 610	<i>Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services</i>
Std 612	<i>Special Purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services</i>

ANSI¹

MC96.1	<i>Temperature Measurement Thermocouples</i>
--------	--

¹American National Standards Institute, 11 West 42nd Street, New York, New York 10036.

ASME²

Y14.2M	<i>Line Conventions and Lettering</i>
PTC 20.2-1965	<i>Overspeed Trip Systems for Steam Turbine-Generator Units</i>

CENELEC³

EN50082-2	<i>Electromagnetic Compatibility Generic Immunity Standard. Part 2: Industrial Environment</i>
-----------	--

DIN⁴

EN 50022	<i>Low voltage switchgear and controlgear for industrial use; mounting rails, top hat rails, 35 mm wide for snap-on mounting of equipment.</i>
----------	--

IEC⁵

584-1	<i>Thermocouples, Part I: Reference Tables</i>
-------	--

IPCEA⁶

S-61-402	<i>Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy</i>
----------	--

ISA⁷

S12.1	<i>Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations</i>
S12.4	<i>Instrument Purging for Reduction of Hazardous Area Classification</i>
S84.01	<i>Application of Safety Instrumented Systems for the Process Industries</i>

Military Specifications⁸

MIL-C-39012-C	<i>Connectors, Coaxial, Radio Frequency, General Specification for</i>
MIL-C-39012/5F	<i>Connectors, Plug, Electrical, Coaxial, Radio Frequency, [Series N (Cabled) Right Angle, Pin Contact, Class 2]</i>

²American Society of Mechanical Engineers, 22 Law Drive, Box 2300, Fairfield, New Jersey 07007-2300.

³European Committee for Electrotechnical Standardization, Rue de Stassart, 35, B - 1050 Brussels.

⁴Deutsches Institut fuer Normung e.V., Burggrafenstrasse 6, Postfach 11 07, 10787 Berlin, Germany.

⁵International Electrotechnical Commission, 1 Rue de Varembe, Geneva, Switzerland.

⁶Insulated Power Cable Engineers Association, 283 Valley Road, Montclair, New Jersey 07042.

⁷Instrument Society of America, P.O. Box 12277, Research Triangle Park, North Carolina 27709.

⁸Available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.