

Risk-Based Inspection Methodology

API RECOMMENDED PRACTICE 581
FOURTH EDITION, JANUARY 2025



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. 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 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, 200 Massachusetts Avenue NW, Suite 1100, Washington, DC 20001.

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 in order to conform to the standard.

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

Currently in preview, click buy full version

Part I—Introduction to Risk-based Inspection Methodology

1	Scope	1
1.1	Purpose	1
1.2	General	1
1.3	Risk Management.....	1
1.4	Organization and Use	2
2	Normative References	2
3	Terms, Definitions, Acronyms, and Abbreviations	3
3.1	Terms and Definitions.....	3
3.2	Acronyms and Abbreviations.....	10
4	Basic Concepts	16
4.1	Probability of Failure (POF).....	16
4.1.1	Overview	16
4.1.2	GFF Method	16
4.1.3	Two-parameter Weibull Distribution Method	17
4.2	Consequence of Failure (COF).....	17
4.2.1	Overview	17
4.2.2	Level 1 COF	18
4.2.3	Level 2 COF	19
4.3	Risk Analysis.....	20
4.3.1	Determination of Risk	20
4.3.2	Risk Plotting	21
4.3.3	General Comments Concerning Risk Plotting	22
4.4	Inspection Planning Based on Risk Analysis	22
4.4.1	Overview	22
4.4.2	Targets	23
4.4.3	Inspection Effectiveness—The Value of Inspection	23
4.4.4	Inspection Planning	24
5	Nomenclature.....	24
6	Tables.....	25
7	Figures.....	28

Risk-based Inspection Methodology

Part 1—Introduction to Risk-based Inspection Methodology

1 Scope

1.1 Purpose

This recommended practice, API 581, provides semiquantitative analysis procedures to establish an inspection program using risk-based methods for pressurized fixed equipment including pressure vessels, piping, tankage, pressure-relief devices (PRDs), and heat exchanger tube bundles. API 580 provides guidance for developing Risk-Based Inspection (RBI) programs on fixed equipment in refining, petrochemical, chemical process plants, and oil and gas production facilities. The intent is for API 580 to introduce the principles and present minimum general guidelines for RBI, while this recommended practice provides examples of semiquantitative calculation methods to determine risk and associated inspection plans.

1.2 General

The calculation of risk outlined in API 581 involves the determination of a probability of failure (POF) combined with the consequence of failure (COF). Failure is defined as a loss of containment from the pressure boundary resulting in leakage to the atmosphere or rupture of a pressurized component. Risk increases as damage accumulates during in-service operation as the risk tolerance or risk target is approached and an inspection is recommended of sufficient effectiveness to better quantify the damage state of the component. The inspection action itself does not reduce the risk; however, it does reduce uncertainty and therefore allows more accurate quantification of the damage present in the component.

1.3 Risk Management

In most situations, once risks have been identified, alternate opportunities are available to reduce them. However, nearly all major commercial losses are the result of a failure to understand or manage risk. In the past, the focus of a risk assessment has been on site safety-related issues. Presently, there is an increased awareness of the need to assess risk resulting from:

- a) on-site risk to employees,
- b) off-site risk to the community,
- c) business interruption risks, and
- d) risk of damage to the environment.

Any combination of these types of risks may be factored into decisions concerning when, where, and how to inspect equipment.

The overall risk of a plant may be managed by focusing inspection efforts on the process equipment with higher risk. API 581 provides a basis for managing risk by making an informed decision on inspection frequency, level of detail, and types of nondestructive examination (NDE). It is a consensus document containing methodology that will be applicable to their RBI programs. In most plants, a large percent of the total unit risk will be concentrated in a relatively small percent of the equipment items. These potential higher risk components may require greater attention, perhaps through a revised inspection plan. The cost of the increased inspection effort can sometimes be offset by reducing excessive inspection efforts in the areas identified as having lower risk. Inspection will continue to be conducted as defined in existing working documents, but priorities, scope, and frequencies can be guided by the methodology contained in API 581.

This approach can be made cost-effective by integration with industry initiatives and government regulations, such as *Process Safety Management of Highly Hazardous Chemicals* (OSHA 29 CFR 1910.119), or the EPA risk management programs for chemical accident release prevention [Section 112(r) of the Clean Air Act amendments], or *Oil and Gas and Sulphur Operations in the Outer Continental Shelf* (30 CFR Part 250).