

Fire Protection in Refineries

API RECOMMENDED PRACTICE 2001
TENTH EDITION, JULY 2019



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 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 specification are as follows:

- the term “shall” denotes a minimum requirement to conform to the standard;
- the term “should” denotes a recommendation or that which is advised but not required to conform to the standard;
- the term “may” is used to express permission or a provision that is optional;
- the term “can” is used to express 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.

For API Monogram Program licensees and APIQR Program registrants, this standard shall become effective on the program date printed on the cover but may be used voluntarily from the date of publication.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every 5 years. A one-time extension of up to 2 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 Purpose and Scope	1
1.1 Purpose	1
1.2 Scope	1
1.3 Concept of Hazard vs Risk.....	1
2 Normative References.....	1
3 Terms, Definitions, Abbreviations, and Acronyms	2
3.1 Terms and Definitions.....	2
3.2 Acronyms and Abbreviations.....	3
4 Chemistry and Physics of Fire—Special Considerations	4
4.1 Chemistry and Physics of Fire.....	4
4.2 Special Situations, Considerations, and Hazards	5
5 Fire Considerations in Refinery Design.....	5
5.1 General.....	5
5.2 Hazard Analysis.....	5
5.3 Process Design	6
5.4 Equipment Design	6
5.5 Location.....	14
5.6 Layout and Spacing.....	14
5.7 Fireproofing	23
5.8 Pressure Relief and Flare Systems.....	23
5.9 Drainage, Containment, and Waste Disposal.....	26
5.10 Power and Utilities.....	27
6 Fire Control and Extinguishing Equipment	29
6.1 General.....	29
6.2 Water for Fire Suppression.....	29
6.3 Foam	37
6.4 Dry Chemicals	38
6.5 Combined (Dual) Agents	39
6.6 Clean Agent Fire Extinguishing	39
7 Operating Practices	41
7.1 General.....	41
7.2 Normal Operations	42
7.3 Emergency Operations.....	43
7.4 Loss of Containment	44
8 Maintenance Procedures	45
8.1 General.....	45
8.2 Hot Work.....	45
8.3 Planned Maintenance Activities.....	46
8.4 Winterizing and Freeze Protection	46
9 Emergency Response Organization.....	47
9.1 General.....	47
9.2 Incident Command System (ICS).....	47
9.3 Duties of Fire Protection Staff.....	48

Contents

	Page
9.4 Notification Procedures	48
9.5 Firefighter Selection and Training	49
9.6 Incident Commander	49
9.7 Firefighter Personal Protective Clothing and Equipment.....	50
10 Training for Firefighting.....	50
10.1 General.....	50
10.2 Drill Ground Training	50
10.3 Classroom Instruction.....	52
10.4 Overcoming Personal Concerns	52
10.5 Documentation	52
11 Pre-fire Incident Planning	52
11.1 General.....	52
11.2 Pre-fire Incident Planning	53
Annex A (informative) Chemistry and Physics of Fire.....	54
Annex B (informative) Cold Weather Hazards, Winterizing, and Freeze Protection	61
Annex C (informative) Conversion Factors.....	70
Annex D (Informative) Marine Firefighting.....	72
Bibliography.....	74

Figures

1 Risk Assessment Work Process Example.....	20
2 Water-foam Solution Flow Requirement for Full Surface Fire, gallons per minute at Varied gpm/ft ² Application Rates (Figure 5 from API 2021, Fourth Edition)	34
A.1 Fire Tetrahedron Diagram.....	54

Tables

1 Example Water Flow Rates for Manual Firefighting a	32
2 Suggested Residual Pressures	33
B.1 Historical Freezing Weather Incident Examples.....	63
B.2 Winterization Audit Checklist	65
B.3 Winterization “Discovery” Dead-leg Surveillance—Sample Checklist for Evaluating Dead-legs	66
B.4 Sample—Winterization Checklist—Example of One Approach.....	68
C.1 U.S. Customary (USC) to Metric (SI) Units of Measure	71

Introduction

API's *Fire Protection in Refineries*, First Edition, appeared in 1933 as the beginning of fire safety guidance series for the "downstream" segment. This 10th Edition recommended practice builds on experience gained over seven decades.

The term fire protection used in this publication includes measures taken to prevent fires, as well as those to minimize, control, or extinguish fires already burning. A thorough approach to fire protection starts with an understanding of the ignition and combustion processes, including control of potential fuel sources with an emphasis on containment. This publication gives some basic information on these subjects and identifies sources of more detailed information. While sections of this document discuss general design principles, it is not intended as a design manual. Rather, it presents guidance for those providing fire protection services to refineries and gives reference to sources of more detailed design related information.

The information presented is based primarily upon experience in many refineries. It is not intended to exclude or limit the use of other approaches of comparable merit.

Fire protection references comprise a very large body of literature. API 2001 highlights many of these references relevant to refineries while seeking not to duplicate them. Most of these references are not incorporated as "normative," and the user is advised to determine their relevance for specific applications.

Fire Protection in Refineries

1 Purpose and Scope

1.1 Purpose

The purpose of this recommended practice is to provide a better understanding of refinery fire protection and the steps needed to promote the safe storage, handling, and processing of petroleum and petroleum products in refineries. A basic premise of this standard is that fire prevention provides the fundamental foundation for fire protection.

1.2 Scope

This document covers basic concepts of refinery fire prevention and protection. It reviews the chemistry and physics of refinery fires; discusses how the design of refinery systems and infrastructure impact the probability and consequences of potential fires; describes fire control and extinguishing systems typically used in refineries; examines fire protection concepts that should be covered in operating and maintenance practices and procedures; and provides information on organization of and training for refinery emergency responders. Many of the concepts, systems, and equipment discussed in this document are covered in detail in referenced publications, standards, or governmental requirements.

1.3 Concept of Hazard vs Risk

Hazards are situations or properties of materials with the inherent ability to cause harm. Flammability, toxicity, corrosivity, and stored electrical, chemical, or mechanical energy all are hazards associated with various industrial materials or situations.

Risk requires exposure. A hot surface or material can cause thermal skin burns or a corrosive acid can cause chemical skin burns, but these can occur only if there is contact exposure to skin.

A person working at an elevated height has “stored energy” and a fall from a height can cause injury—but there is no risk unless a person is indeed working at heights and thus exposed to the hazard. There is no risk when there is no potential for exposure.

Determining the level of risk for any activity involves understanding and recognizing hazards, then estimating the probability and severity of exposure events that could lead to harm or damage, and the resulting consequences. Principles relating hazards to the risk for people are valid for evaluating property or environmental risk. For instance, hydrocarbon vapors in a flammable mixture with air can ignite if exposed to a source of ignition resulting in a fire that could cause property damage as well as injure people. Hydrocarbons that will burn are hazardous materials—but one element of risk includes a flammable fuel-air mixture being exposed to an ignition source.

2 Normative References

The following referenced documents are indispensable for the application of this document and are normative in those geographic areas under U.S. Federal OSHA jurisdiction. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. The bibliography organizes other references and sources of additional information by primary subject area. Additional information may be available from the Internet sites cited therein.

NFPA 30¹, *Flammable and Combustible Liquids Code*

¹ National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169, www.nfpa.org.