

Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities

API PUBLICATION 2510A
SECOND EDITION, DECEMBER 1996

REAFFIRMED, DECEMBER 2015



AMERICAN PETROLEUM INSTITUTE

Currently in preview, click buy full version

Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities

Downstream Segment

API PUBLICATION 2510A
SECOND EDITION, DECEMBER 1996

REAFFIRMED, DECEMBER 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.

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Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years.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 the review cycle. This publication will no longer be in effect five years after its publication, unless as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Authoring Department [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 director of the Authoring Department (shown on the title page of this document), American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. 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 marketing 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 publication covers aspects of the design, operation, and maintenance of liquefied petroleum gas (LPG) storage facilities from the standpoints of prevention and control of releases, fire-protection design, and fire-control measures. The storage facilities covered are LPG installations (storage vessels and associated loading/unloading/transfer systems) at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, and tank farms. This publication provides background, philosophy, methods, and alternatives to achieve good fire protection.

Information on the production or use of liquefied petroleum gas is not included.

This publication is not intended to take precedence over contractual agreements. Existing codes and manuals, wherever practicable, have been used in the preparation of this publication.

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 director of the Health and Environment Department, American Petroleum Institute, 1200 L Street, N.W., Washington, D.C. 20005.

Currently in preview, click buy full version

CONTENTS

	Page
SECTION 1—GENERAL.....	1
1.1 Scope	1
1.2 Retroactions	1
1.3 Introduction	1
1.4 Failure History	1
1.5 Safety Analysis	2
1.6 LPG Properties	2
1.7 Definition of Terms	3
1.8 Referenced Publications	4
SECTION 2—FACILITY DESIGN PHILOSOPHY	5
2.1 Introduction	5
2.2 Site Selection	5
2.3 Layout and Spacing	5
2.4 Drainage and Spill Containment	6
2.5 Ignition Source Control	6
2.6 Vessel Design	8
2.7 Piping	8
2.8 Pumps	10
2.9 Instrumentation	10
2.10 Relief Systems	12
2.11 Vapor Depressurizing System	13
2.12 Loading Trucks and Rail Cars	14
SECTION 3—OPERATING PROCEDURES.....	15
3.1 Introduction	15
3.2 Placing Storage Vessels in Service	15
3.3 Product Transfer	16
3.4 Water Drawing	17
3.5 Sampling	17
3.6 Venting Noncombustibles	18
3.7 Removal of Vessel from Service	18
3.8 Emergency Procedures	18
SECTION 4—MAINTENANCE PROCEDURES.....	19
4.1 Introduction	19
4.2 Vessel Inspection	19
4.3 Vessel Accessories, Including Relief Valves	19
4.4 Vapor Freeing and Isolating Equipment	19
4.5 Work Permits	20
4.6 Repair of LPG Equipment	20
4.7 Fireproofed Surfaces	20
SECTION 5—FIRE-PROTECTION DESIGN CONSIDERATIONS.....	20
5.1 Introduction	20
5.2 Water-Application Rates	20
5.3 Methods of Water Application	22
5.4 Design Considerations for Water Supply	23
5.5 Detection Systems	24

	Page
5.6 Portable Fire Extinguishers	25
5.7 Foam for LPG Fires	25
5.8 Fireproofing	25
 SECTION 6—FIRE CONTROL AND EXTINGUISHMENT	 27
6.1 Prefire Plan	27
6.2 Training	27
6.3 Assessing the Fire	28
6.4 Applying Cooling Water	28
6.5 Isolating Fuel Sources	29
6.6 Firefighting Tactics and Leak Control	29
 Figures	
1—Pool Fire Radiant Heat Flux	7
2—Nonfreeze Drain for LPG Vessels	11
3—Vessel Shell Overheated Above Liquid Level	30
4—Rupture of a Horizontal LPG Vessel	31
5—Concentrate Cooling Water on Flame-Exposed Metal	33
 Tables	
1—Properties of Two Common LPG's	3
2—Tank Pressures for Two Common LPG's	3
3—Vapor Volumes Obtained for Two Common LPG's	4
4—Fire Emergency Situations Requiring Special Consideration	21
5—Water-Application Methods	23

Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities

SECTION 1—GENERAL

1.1 Scope

1.1.1 This publication addresses the design, operation, and maintenance of LPG storage facilities from the standpoints of prevention and control of releases, fire protection design, and fire-control measures. The history of LPG storage facility failure, facility design philosophy, operating and maintenance procedures, and various fire protection and firefighting approaches are presented. This publication, since it supplements API Standard 2510 and provides the basis for many of the requirements stated in that standard, must be used in conjunction with API Standard 2510. In case of conflict, API Standard 2510 shall prevail. Alternate designs are acceptable provided equal safety can be demonstrated.

1.1.2 The storage facilities covered by this publication are LPG installations (storage vessels and associated loading/unloading/transfer systems) at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, and tank farms. The following types of LPG installations are not addressed:

- a. Underground storage, such as buried tanks, storage caverns, salt domes, or wells.
- b. Mounded storage tanks.
- c. Refrigerated storage at pressures below 15 pounds per square inch gauge.
- d. Installations covered by API Standard 2503.
- e. Installations covered by NFPA Standards 5 or 59.
- f. Department of Transportation (DOT) containers.
- g. Those portions of LPG systems covered by NFPA 54 (ASME Z223.1).
- h. Small installations with a single LPG tank of less than 2000-gallon capacity.
- i. Process equipment for LPG manufacture or treatment preceding LPG storage.

1.2 Retractions

The provisions of this publication pertain to new installations but may also be used to review and evaluate existing storage facilities. The applicability of some or all of these provisions to facilities and equipment already in place or in the process of construction or installation before the date of this publication will have to be considered on a case-by-case basis.

1.3 Introduction

1.3.1 In developing fire-protection guidelines for an LPG storage facility, the greatest concern is the massive failure of a

vessel with a full inventory of LPG. The probability of this type of failure can be made virtually negligible with properly engineered and operated facilities. The fire-protection principles of this publication are intended to prevent fire-induced vessel failure.

1.3.2 Most LPG fires originate as small fires that have the potential to become larger and more hazardous. It is important to note that LPG fires usually occur, not as a result of tank failure, but because of pump seal leaks, piping leaks, or failure to follow safe work procedures. Human failure such as overfills and piping leaks from poor drawoff (water and sample) procedures can lead to LPG release and consequent fire. This publication treats the prevention and control of such incidents and provides various fire extinguishment and containment methods.

1.4 Failure History

1.4.1 The most serious LPG release is a massive failure of a storage vessel. Such failures are rare and seldom occur without exacerbating circumstances such as exposure to fire or external explosion.

1.4.2 To project LPG storage vessel failure frequency, fire-protection professionals have reviewed applicable U.S., British, and German failure statistics for pressure vessels.¹ These statistics reveal that the failure rate for pressure vessels from causes other than pre-existing fires or explosions, has been about 1 failure per 100,000 vessel years. To assume this failure rate for hydrocarbon storage vessels is conservative, since most of the data in these studies are for steam boilers and drums operating under more adverse conditions.

1.4.3 A more likely LPG incident, and in the context of this publication a more relevant one, is leakage from piping or other components attached to or near the vessel followed by ignition, a flash fire or vapor cloud explosion, and a continuing pool fire and pressure (torch) fire. The possibility of a pool fire is greater with lower-vapor-pressure LPG or in cold climates. Should flames impinge on a nearby LPG vessel, a boiling liquid-expanding vapor explosion (BLEVE) involving one or more storage vessels may ensue. Injury to facility or neighboring personnel and damage losses of several million dollars can be incurred in these types of LPG incidents.

¹Spencer H. Bush, "Pressure Vessel Reliability," *Transactions of the ASME: Journal of Vessel Technology*, February 1975.