

Management of Hazards Associated with Location of Process Plant Permanent Buildings

API RECOMMENDED PRACTICE 752
FOURTH EDITION, JANUARY 2024



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.

Users of this recommended practice (RP) should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

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 to comply with authorities having jurisdiction.

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 datasheet.

Where applicable, authorities having jurisdiction should be consulted.

Work sites and equipment operations may differ. Users are solely responsible for assessing their specific equipment and premises in determining the appropriateness of applying the RP. At all times users should employ sound business, scientific, engineering, and safety judgement when using this RP.

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 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, 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, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, Suite 1100, Washington, DC 20001, standards@api.org.

Contents

	Page
1	Scope..... 1
1.1	General 1
1.2	Guiding Principles 1
1.3	Relationship with API 753 and API 756 2
2	Normative References 2
3	Terms, Definitions, Acronyms, and Abbreviations 2
3.1	Terms and Definitions 2
3.2	Acronyms and Abbreviations 6
4	Determination of Buildings Requiring Siting Evaluation..... 7
4.1	Buildings Included in the Siting Evaluation 7
4.2	Buildings and Structures Excluded from the Siting Evaluation 8
4.3	Buildings Evaluated for Exclusion..... 9
5	Siting Evaluation Processes 9
5.1	General 9
5.2	Consideration of Applicable Hazards 10
5.3	Assessment Approach and Scenario Selection 11
5.4	Siting Evaluation Criteria 12
5.5	Existing Buildings..... 13
5.6	New Buildings or Modifications to Existing Buildings..... 15
5.7	Personnel Competency Requirements 16
5.8	Application of Guiding Principles 16
5.9	Management of Building Occupancy 16
5.10	Management of Change (MOC) 17
5.11	Revalidation 17
5.12	Documentation..... 17
6	(Reserved)..... 18
7	Siting Evaluation for Explosion 18
7.1	General 18
7.2	Explosions 19
7.3	Determining the VCE Blast Loads on Buildings..... 21
7.4	Building Analysis and Design Tools 22
7.5	Occupant Vulnerability from Explosions 22
7.6	Blast Evaluation of Existing Buildings 23
7.7	Design of New Buildings, Additions, and Structural Modifications to Existing Buildings..... 24
7.8	Additional Considerations 24
8	Siting Evaluation for Fire..... 25
8.1	General 25
8.2	Spacing Table Approach 26
8.3	Factors Influencing Potential and Type of Fires..... 27
8.4	Determining the Fire Effects to Buildings..... 28
8.5	Occupant Vulnerability from Fire..... 28
8.6	Concept Selection for Buildings Exposed to Fire..... 29
8.7	Determining If Existing Buildings Require Mitigation 31
8.8	Siting and Design of New Buildings..... 31

Contents

	Page
8.9 Additional Considerations	31
9 Siting Evaluation for Toxic Material Release.....	32
9.1 General	32
9.2 Determining the Toxic Effects at Buildings.....	33
9.3 Occupant Vulnerability from Toxic Material.....	34
9.4 Concept Selection for Buildings Exposed to Toxic Material Release.....	34
9.5 Determining If Existing Buildings Require Mitigation	36
9.6 Siting and Design of New Buildings.....	36
9.7 Additional Considerations	36
Annex A (informative) Frequently Asked Questions	37
Annex B (informative) Example Coverage for Various Building/Tent Types within the API 752, 753, and 756	41
Annex C (informative) A Siting Evaluation Approach for Toxic Refuges	42
Annex D (informative) Typical Building Protection Features for Buildings Used as Refuges from Flammable/ Toxic Material Exposure.....	48
Annex E (informative) Example Shelter-in-Place Guidance for Occupants.....	49
Annex F (informative) Illustrative Incidents from Industry.....	50
Bibliography.....	57

Figures

1 Overall Building Siting Evaluation Flowchart	10
2 Siting Evaluation for Explosions	19
3 Siting Evaluation for Fire.....	26
4 Siting Evaluation for Toxic Material Release.....	33
C.1 Toxic Dispersion Example with Potential Hazard Zone	43
F.1 Plan of Area Around 60 Still Base Showing Path of the Jet of Flame.....	52
F.2 Photography of the Still Base	53
F.3 Photograph of Roadway and Buildings Showing Direction of the Flame and Scorch Marks on the Roadway and Main Office Block.....	53
F.4 Intense Blast Regions in the ISOM Unit	55
F.5 Field of View (Yellow) for Operators from Their Vantage Point, Located Just Outside the Control Room and Just Inside the Access Control Fencing, from Which They Assessed the Magnitude of the Incident (Circle)	56

Tables

1 Hierarchy of Mitigation Measures	15
2 Types of Fires from Ignitable Releases	27

Contents

	Page
3 Influential Mitigation Measures on Fire Size and Duration	28
4 Primary Fire Effects on Buildings.....	28
5 Building Consequences Associated with Fire Types.....	29
B.1 Example Coverage for Building/Test Types within API 752, 753, and 756	41
D.1 Typical Protections for Safe Havens and Shelter-in-Place Locations.....	48
F.1 Guiding Principles vs Defining Events	50

Management of Hazards Associated with Location of Process Plant Permanent Buildings

1 Scope

1.1 General

This recommended practice (RP) provides guidance for managing the risks from process-related explosion, fire, and toxic material release hazards to personnel located in on-site buildings. This RP covers:

- new and existing permanent buildings;
- new and existing portable buildings (other than light wood trailers) intended for perpetual use (intended to be used for the life of the building or life of the process plant) in a specific, fixed location.

[Annex B](#) provides examples on the coverage of permanent and portable buildings/tents.

This RP was developed for use at refineries, petrochemical and chemical operations, natural gas liquids extraction plants, natural gas liquefaction plants, and other onshore facilities, such as those covered by the Occupational Safety and Health Administration (OSHA) process safety management regulation, 29 *CFR* 1910.119 ^[1].

Non-process-related hazards exist that could present risks to building occupants including, but not limited to, fires originating from within the building, structural collapse due to extreme weather/seismic events, and objects falling on or striking the building. These non-process-related hazards are addressed by building design standards and applicable building codes/regulations, and are not within the scope of this RP.

1.2 Guiding Principles

API has established guiding principles for building/tent siting, which are used in API 752, API 753, and API 756. These guiding principles apply to all buildings and tents intended for occupancy:

- 1) locate personnel away from process areas consistent with safe and effective operations;
- 2) minimize the use of buildings/tents in close proximity to process areas;
- 3) manage the occupancy of buildings/tents in close proximity to process areas, especially during periods of planned abnormal operation with increased risk including, but not limited to, unit start-up, testing, or planned shutdown operations;
- 4) design, construct, install, modify, and maintain buildings/tents to protect occupants from the hazards created by explosion, fire, and toxic material release;
- 5) manage the use of buildings/tents as an integral part of the design, construction, maintenance, operation, and emergency response of a facility.

These guiding principles reflect the concept of the hierarchy of controls. With respect to building hazards, mitigations arranged in a hierarchy, beginning with the most effective, involve:

- eliminating either the occupancy or the hazards;
- reducing occupancy or the severity of the hazards;
- increasing the distance between the occupants and the hazards;
- increasing the resistance of the building to the hazards;

— administratively managing the occupancy.

[Annex F](#) is provided to summarize a few select events that clarify, illustrate, and emphasize the lessons learned that led to the development of these guiding principles.

1.3 Relationship with API 753 and API 756

All portable buildings intended to be movable and all light wood trailers are covered by API 753 ^[2].

New and existing tents are covered by API 756 ^[3].

[Table B.1](#) provides examples on the coverage of permanent and portable buildings/tents.

All references in this RP to API 753 and API 756 are to the 2nd Edition of both, which published concurrently with API 752.

2 Normative References

There are no normative references for this document.

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

The following terms and definitions apply to this document, as well as API 753 and API 756.

3.1.1

assigned work location

Designated work location for personnel to fulfill their specific job function or provide personnel support function.

3.1.2

blast load

The load applied to a structure or object from a blast wave, which is described by the combination of overpressure and either impulse or duration.

3.1.3

building

Any structure that is designed or intended for support, enclosure, shelter, or protection of person or property having a rigid roof that is supported by columns or rigid walls.

3.1.4

confinement

A physical surface that inhibits the expansion of a flame front of a burning vapor cloud and its combustion products in at least one direction.

3.1.5

congested volume

The volume of congestion that is calculated by considering the size (see example methods of calculation in Annex D of API 753, 2nd Edition) of the congestion (usually a process area but can be other sources of congestion), regardless of the presence of ignitable materials.

3.1.6

congestion

A collection of closely spaced objects in the path of the flame front that has the potential to increase flame speed to an extent that it can generate a damaging blast wave.

3.1.7

consequence

The potential effects of an explosion, fire, or toxic material release. Consequence descriptions may be qualitative or quantitative.

3.1.8

consequence-based approach

The methodology used for siting evaluation that is based on the impact of explosion, fire, and toxic material release and that does not consider the frequency of these events.

3.1.9

essential personnel

Personnel with specific work activities that require them to be located in or near a process area for logistical and response purposes. The identification of essential personnel will vary with operation and work activities including normal operation and periods of planned abnormal operation with increased risk.

3.1.10

fire refuge

A designated place to provide limited protection to personnel from a fire. A fire refuge can be an entire building or designated rooms or portions of a building.

3.1.11

free-field overpressure

The pressure experienced by an object as a blast wave passes by.

3.1.12

hazard

An inherent physical or chemical characteristic (e.g., flammability, toxicity, corrosivity, stored chemical energy, or mechanical energy) that has the potential for causing harm to people, property, or the environment.

3.1.13

ignitable material

Any material or mixture that is handled above its closed-cup flash point or that has a flash point below ambient temperature.

3.1.14

internal environment quality

The suitability of the air and physical environment for occupancy.

3.1.15

light wood trailer

A portable building with a wall design consisting of "2 x 4" studs with a thin outer skin. Metal trailers, wood trailers with wider studs, or other wall construction are not considered light wood trailers.

NOTE "2 x 4" studs refers to timber framing members that actually have cross-sectional measurements of 1.5 in. by 3.5 in. (38 mm by 89 mm).

3.1.16

maximum credible event

MCE

A hypothetical explosion, fire, or toxic material release event that has the potential maximum consequence to the occupants of the building/tent under consideration from among the major scenarios evaluated. The major scenarios have a reasonable probability of occurrence considering the chemicals, inventories, equipment and piping design, operating conditions, fuel reactivity, process unit geometry, industry incident history, and other factors.

Each building/tent location may have its own set of MCEs for potential explosion, fire, or toxic material release impacts.

3.1.17

nonessential personnel

Personnel who do not meet the definition of “essential personnel.”

3.1.18

occupant vulnerability

Proportion of occupants that could potentially experience a life-threatening injury or fatality if a potential event were to occur.

3.1.19

permanent building

Any building that is not designed to be movable and is designed for use in a specific, fixed location. See [Annex B](#) for additional guidance.

3.1.20

personnel

Employees, contractors, visitors, service providers, and others present at the facility.

3.1.21

portable building

Any building that is designed to be movable, regardless of the length of time it is kept at a specific location. See [Annex B](#) for additional guidance.

3.1.22

process area

An area containing equipment intended to process, handle, or store materials having the potential for explosion, fire, or toxic material release.

3.1.23

risk

A measure of potential injury, environmental damage, or economic loss in terms of both the incident likelihood and the severity of the loss or injury.

3.1.24

risk-based approach

The systematic development of numerical estimates of the frequency and consequence of potential process safety accidents based on engineering evaluation and mathematical techniques. The numerical estimates can vary from simple estimates/values of probability/frequency of an event occurring based on relevant historical industry or other available data, to very detailed frequency and/or consequence-modeling techniques.

3.1.25

safe haven

A fire or toxic refuge that has a specific engineered design level of protection.

3.1.26

shelter-in-place location

A fire or toxic refuge that gets additional isolation by the occupant actions including closing doors, closing windows, and shutting off HVAC systems to reduce the exposure to hazards but is not designed for prolonged shelter.

3.1.27

siting evaluation

The procedures described in this RP that are used to site buildings/tents given their performance characteristics and the hazards at the specific location.

3.1.28

spacing tables approach

The “spacing tables” approach uses established tables to determine minimum separation distances between equipment and buildings/tents intended for occupancy. Industry groups, insurance associations, regulators, and owner/operator companies may have experience-based spacing tables that are useful for establishing minimum building/tent spacing for fire.

3.1.29

tent

A tent is a structure composed of a covering made of pliable materials or combination of pliable and rigid materials that is supported by mechanical means such as poles, metal frames, beams, air, columns, arches, ropes, and/or cables. Some of the tent types are defined below.

- **Air-inflated structure:** a structure in which the shape is maintained by air pressurization of cells or tubes to form a barrel vault over the usable area. The pressurized areas used to support the structure are not occupied.
- **Air-supported structure:** a structure in which the shape is attained by air pressure, and occupants of this structure are within the pressurized area.
- **Engineered tent:** a tent that has been designed to meet a specific design code.
- **Scaffolding tent:** a self-supported structure built with scaffolding components with a pliable covering.
- **Pole tent:** a fabric-covered structure that achieves its support by use of columns/poles and is stabilized along the perimeter with ropes/cables. Pole tents are available in wind-rated and non-wind-rated designs.
- **Frame tent:** a fabric-covered structure that uses a frame to maintain its shape and is stabilized along the perimeter with ropes/cables. Unlike pole tents, the frame tents have no center poles. Structural members are located around the perimeter and the upright members are rigidly secured to the roof frame members. Frame tents are available in wind-rated and non-wind-rated designs.
- **90-mph tent:** a tent that is rated and certified to resist the pressure from a 90-mph (145-km/hr) service level basic wind speed or equivalent (i.e., 70-mph [113-km/hr] fastest-mile wind speed service level or 115-mph [185-km/hr] [3-second gust] strength level wind speed).
- **Blast-resistant tent:** a tent that has been demonstrated to meet the siting evaluation criteria for blast using a detailed structural analysis ([7.4.3](#)) and/or by explosion testing ([7.4.4](#)).
- **Small lightweight tent:** a tent that has a footprint of less than 150 ft² (14 m²) structural support system. The structural support system components may consist of arches, columns, beams, and bracing cables. The stresses developed in the tensioned membrane interact with those in the structural support so that the entire assembly acts together to resist the applied load. A tension membrane tent differs from a light frame tent in that:
 - a tension membrane tent has a much more robust frame;
 - the frame is directly anchored to the ground (no staked ropes/cables along the perimeter); and
 - the fabric is taut.
- **Improvised tent:** a makeshift non-manufactured tent, not covered by the tent types described above.

3.1.30

toxic material

An airborne agent that could result in acute adverse human health effects.

3.1.31

toxic refuge

A designated place to provide limited protection to personnel from a toxic material release. A toxic refuge can be an entire building/tent or designated rooms or portions of a building/tent.

3.1.32

turnaround

A work activity in which an entire process unit or a major section of a unit is shut down for a period of time for the purpose of inspection, maintenance, or modification.

3.1.33

vapor cloud explosion

The explosion resulting from the ignition of a cloud of flammable vapor, gas, or mist in which the flame speed accelerates to sufficiently high velocities to produce a damaging blast load.

3.2 Acronyms and Abbreviations

The following acronyms and abbreviations apply to this document, as well as API 753 and API 756.

AEGL	acute exposure guideline level
AIChE	American Institute of Chemical Engineers
API	American Petroleum Institute
BDL	building damage level
BLEVE	boiling liquid expanding vapor explosion
BRM	blast-resistant module
BST	Baker-Strehlow-Tang
CAM	congestion assessment method
CCPS	Center for Chemical Process Safety
CFD	computational fluid dynamics
CFR	Code of Federal Regulation
CV	congested volume
EN	European standard (European Norm)
ERPG	Emergency Response Planning Guideline
GP	guiding principle
HVAC	heating, ventilation, and air conditioning
LWT	light wood trailer
MCE	maximum credible event
MOC	management of change
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
PSM	process safety management
RP	recommended practice
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (English: Netherlands Organization for Applied Scientific Research)
VCE	vapor cloud explosion

4 Determination of Buildings Requiring Siting Evaluation

4.1 Buildings Included in the Siting Evaluation

Buildings intended for occupancy (unless listed as an exception in [4.2](#)) shall be included in the siting evaluation.

A building is intended for occupancy if it has personnel assigned to it or if it is used for a recurring group (i.e., more than one person) personnel function.

Examples of buildings that have personnel assigned include, but are not limited to:

- buildings that may become occupied during emergencies (e.g., buildings/rooms designated as fire refuges and/or toxic refuges or emergency command centers);
- control rooms;
- field operator buildings (i.e., buildings where operators are routinely located, sometimes referred to as “operator shelters”). See [A.3.7](#) and [A.3.8](#);
- guardhouses;
- laboratories with assigned personnel (see [A.3.2](#));
- maintenance shops with assigned personnel;
- shop buildings for fabrication, welding, or equipment assembly;
- offices;
- warehouse buildings with assigned personnel (see [A.3.3](#));
- “buildings within buildings” (i.e., buildings intended for occupancy located within other buildings or tents; see [A.3.5](#));
- rooms intended for occupancy (e.g., office, shop, control room) within an enclosed process area (see [A.3.10](#)).

Examples of buildings used for a recurring group personnel function include, but are not limited to:

- rooms used for breaks or meals;
- lunchrooms;
- change houses;
- orientation rooms;
- training rooms,
- conference/meeting rooms;
- weather shelters (e.g., cooldown and warm-up buildings) unless addressed in [4.3](#).

4.2 Buildings and Structures Excluded from the Siting Evaluation

4.2.1 Buildings Not Intended for Occupancy

Buildings not intended for occupancy may be excluded from siting evaluation.

Controls shall be implemented to ensure that the use of these buildings does not change to “buildings intended for occupancy.” Personnel, however, may periodically be present in these buildings to perform their duties.

The following examples are buildings and structures that do not have personnel assigned and that require at most only intermittent access:

- tool trailers or storage sheds without attendant stationed inside;
- decontamination facilities;
- instrument/control equipment enclosures;
- equipment enclosure buildings (such as for noise reduction or equipment weather protection);
- abandoned buildings (i.e., removed from service, unused for any function, and no longer intended for occupancy);
- analyzer sheds;
- field sampling/testing stations;
- electrical substations and motor control centers (MCCs);
- electric generators;
- buildings that primarily house materials;
- enclosed safety showers.

4.2.2 Excluded Occupied Structures

This section addresses a group of structures that are occupied but excluded from the siting evaluation.

- a) Structures with both flat roofs (e.g., with slopes 10 degrees or less from horizontal) and no walls (sometimes referred to as canopies or pavilions) whose primary function is to provide limited protection to personnel from weather. These include, but are not limited to:
 - loading/unloading canopies
 - covered walkways,
 - smoking canopies.

NOTE Horizontal roofs without walls allow the blast wave to load the top and bottom of the roof at the same time limiting the blast wave's effect on the structure.

- b) Enclosed process areas where only essential personnel are assigned to perform activities similar to those performed at an outdoor process area.

For buildings that are excluded from the siting evaluation, the owner/operator should consider the factors listed in [7.8](#), [8.9](#), and [9.7](#).

4.3 Buildings Evaluated for Exclusion

Buildings with no personnel assigned but occupied by individuals for a short duration may be excluded from a siting evaluation. The basis for the building's exclusion should consider the number and frequency of visiting personnel and the cumulative level of occupancy among all occupants. These buildings include, but are not limited to:

- smoking shelters,
- bus stops,
- storm shelters,
- dock attendant stations,
- loading rack personnel stations,
- restroom buildings,
- decontamination facilities,
- buildings used for regulatory compliance and intended to meet owner/operator industrial hygiene requirements for extreme environmental conditions (e.g., where people can work in a hot environment for a limited time but need time inside the building for thermal recovery).

For buildings that are excluded from the siting evaluation, the owner/operator should consider the factors listed in [7.8](#), [8.9](#), and [9.7](#).

5 Siting Evaluation Processes

5.1 General

A systematic process for siting evaluation for new and existing buildings is shown in [Figure 1](#).

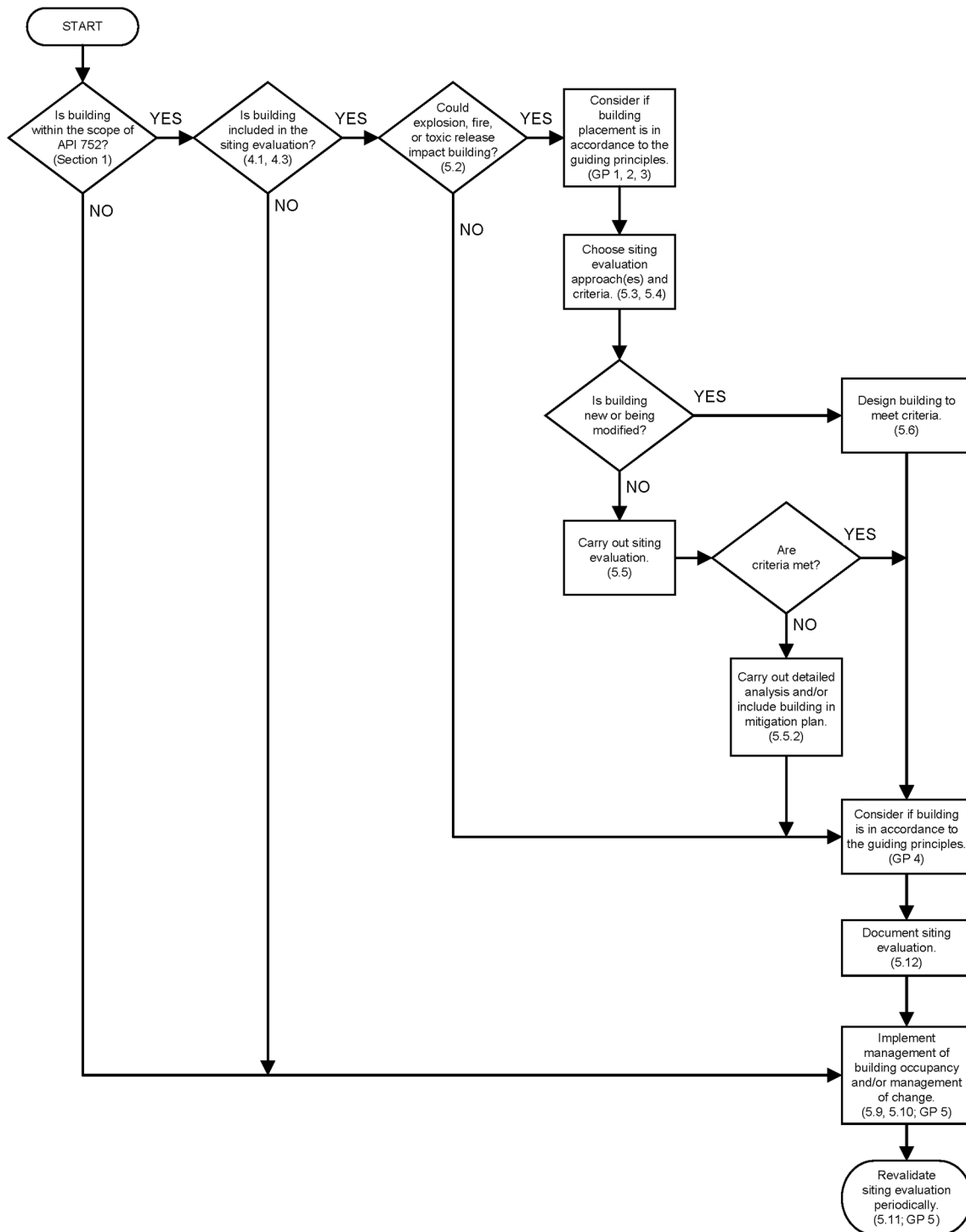


Figure 1—Overall Building Siting Evaluation Flowchart

5.2 Consideration of Applicable Hazards

Owner/operators shall determine if the building intended for occupancy under consideration could be impacted by a credible explosion, flammable vapor release, thermal radiation, or toxic material release. For each hazard type that could impact the building, a siting evaluation of the hazard shall be conducted (per [Sections 7, 8, and 9](#)) and documented. For each hazard type, where no potential scenario is identified that could adversely impact the building under consideration (per siting evaluation criteria), a siting evaluation for that hazard type is not required, and the exemption should be documented (see [5.12](#)).

5.3 Assessment Approach and Scenario Selection

5.3.1 Assessment Approach

Owner/operators may choose one or more of the following three approaches as a siting evaluation method for new and existing buildings for explosion, fire, and toxic material release scenarios.

- a) The “consequence-based” approach involves performing a consequence analysis that takes into consideration the impact of explosion, fire, and toxic material release scenarios. This approach shall be based on maximum credible events (MCEs) for each building and type of hazard considered.
- b) The “risk-based” approach is quantitative and takes into consideration numerical values for both the consequences and the frequencies of explosion, fire, and toxic material release scenarios.
- c) The “spacing tables” approach uses established tables to determine minimum separation distances between equipment and buildings intended for occupancy. The applicability of this approach to the siting study is addressed in [8.2](#). Industry groups, insurance associations, regulators, and owner/operator companies have developed experience-based spacing tables for minimum building spacing (typically to address pool fires); however, these fire-specific tables are not appropriate for siting evaluation for explosion and toxic material release and shall not be used for hazards other than the specifically applicable fire type. Scenario selection is not required for experience-based fire spacing tables. Spacing tables may be found in various references including *Guidelines for Siting and Layout of Facilities* ^[4]. The spacing tables approach also includes index methods (e.g., *Dow’s Fire & Explosion Index* ^[5], Mond Index ^[6]).

Owner/operators may develop spacing distances for each building type considered, to cover explosions, fires, or toxic material release. These distances shall be based on approach a) or b) above. This is considered an application of a consequence-based or risk-based approach and not the spacing tables approach as discussed above.

Owner/operators may select the level of detail used in risk-based and consequence-based approaches. Approaches that use a lower level of detail should use conservative assumptions to account for details not included in the approach. Additional guidance may be found in [Sections 7, 8, and 9](#).

5.3.1.1 Consequence-based Approach

A consequence-based approach is a technical assessment of potential consequences from explosion, fire, and toxic release hazards. Consequence-based approaches should be based on major release scenarios, considering incidents and their outcomes that have or could have occurred in similar process units within industry (i.e., scenarios with the more severe consequences).

The suitability of a particular type of building shall be determined based on the the building response or impact on occupants from these hazards.

5.3.1.2 Risk-based Approach

The risk-based approach is quantitative and takes into consideration numerical values for both the consequences and the frequencies of explosion, fire, and toxic material release scenarios.

5.3.2 Scenario Selection for Consequence-based and Risk-based Approaches

The scenario selection process includes, where applicable, hazards associated with operations including loss of containment, releases from flares, process vent stacks, and atmospheric relief devices.

The scenarios should be based primarily on the process area specific factors such as equipment failure rate data, design of the equipment in the process area, process stream composition, and operating conditions. Consideration should be given to relevant company and industry loss of containment data on similar types of processes and equipment when selecting scenarios. Examples that illustrate the credible

determination may be found in *Guidelines for Evaluating Process Plant Buildings for External Explosions, Fires and Toxic Releases* ^[7] Section 3.3.1.

Scenario selection may consider mechanical, system, and human factor-initiating events for both consequence and risk-based analysis. Relevant near-miss and incident histories should be reviewed when selecting scenarios.

Many events have originated from releases from piping systems and equipment of various hole sizes, and use of a single hole size may not describe the range of possible consequences. In risk-based assessments, a range of leak sizes are commonly analyzed. In consequence-based assessments, considering multiple leak sizes may help characterize the range of potential consequences.

In particular, for fire and toxic material release hazards, it may be necessary to analyze a range of various hole sizes to establish whether smaller releases of longer duration (from smaller hole sizes) or larger releases of shorter duration (from larger hole sizes) produce the more significant consequences.

5.4 Siting Evaluation Criteria

5.4.1 General

Owner/operators shall establish siting evaluation criteria for new and existing buildings consistent with the selected assessment approach(es). Prior to starting a siting evaluation, owner/operators should select the siting evaluation criteria. Further guidance on siting evaluation criteria may be found in *Guidelines for Evaluating Process Plant Buildings for External Explosions, Fires and Toxic Releases* ^[7] Chapter 4.

5.4.2 Siting Evaluation Criteria for the Consequence-based Approach

Siting evaluation criteria for the consequence-based approach can be expressed as building exposure or consequence criteria. These criteria are specific to the characteristics of the building under consideration (such as materials of construction and building design) and hazard type (explosion, fire, toxic material release).

Building exposure criteria are typically expressed as:

- blast load,
- thermal flux and exposure time,
- flammable gas concentration,
- toxic concentration and exposure time.

Consequence criteria are typically expressed as:

- occupant vulnerability,
- occupant exposure,
- building damage,
- internal environment quality. Factors may include, but are not limited to:
 - oxygen, carbon dioxide, and carbon monoxide levels;
 - air temperature;
 - humidity;

- smoke and other products of combustion, due to ingress of external effects, or degradation from building components;
- temperature of interior building surfaces.

5.4.3 Siting Evaluation Criteria for the Risk-based Approach

Siting evaluation criteria for the risk-based approach shall address the risk to the building occupants as a group (aggregate risk) and the risk to an individual. An owner/operator may choose to establish a single risk criterion that addresses both individual and aggregate risk. Siting evaluation criteria may be expressed as the following:

- numerical values, which include:
 - individual risk,
 - aggregate risk,
 - exceedance frequency value for a defined level of building performance; use of this approach does not require occupant vulnerability calculations.
- graphical formats, which include:
 - cumulative frequency vs consequence (F/N) curves,
 - matrices with numerical axes.

Refer to [8] for additional information.

5.4.4 Siting Evaluation Criteria for the Spacing Tables Approach

When a spacing tables approach is used, the siting evaluation criteria are the appropriate values in the spacing table. The criterion is satisfied when the separation distance in the spacing table is met or exceeded (see [5.3.1](#)).

5.4.5 Protection Features

If specific protection features (e.g., heating, ventilation and air conditioning [HVAC], building blast resistance, gas detection system, fire protection systems, PPE, safety instrumented systems) are used to meet the siting evaluation criteria, the performance and/or design requirements shall be documented. The protection features shall be monitored and maintained over the life cycle of the building.

If procedures are used to meet the siting evaluation criteria (e.g., emergency response plan, building access control), owner/operators should verify that the procedures are:

- implemented,
- effective, and
- in continuous use over the life cycle of the building.

5.5 Existing Buildings

5.5.1 Siting Evaluation for Existing Buildings

Owner/operators shall carry out siting evaluations for existing buildings intended for occupancy in accordance with [Sections 7](#), [8](#), and [9](#).