Flash Fire Risk Assessment for the Upstream Oil and Gas Industry

API RECOMMENDED PRACTICE 99
FIRST EDITION, APRIL 2014
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.

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 recommended practice. At all times users should employ sound business, scientific, engineering, and judgment safety when using this recommended practice.

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.
**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 in order to conform to the specification;

— the term “should” denotes a recommendation or that which is advised but not required in order to conform to the specification;

— 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, 1220 L Street, NW, Washington, DC 20005. 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, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.
## Contents

1 **Scope** ......................................................................................................................... 1  
1.1 **General** ....................................................................................................................... 1  
1.2 **Conditions of Applicability** .......................................................................................... 1  
2 **Terms, Definitions, Acronyms, and Abbreviations** ....................................................... 2  
2.1 **Terms and Definitions** .................................................................................................. 1  
2.2 **Acronyms and Abbreviations** ....................................................................................... 2  
3 **Flash Fire** ....................................................................................................................... 3  
3.1 **General** ....................................................................................................................... 3  
3.2 **Risk of Injury due to Flash Fire** ..................................................................................... 3  
3.3 **Class I Division 1 and Division 2 Locations; Flammable Vapor Illustrations** ............... 3  
4 **Hazard Evaluation** .......................................................................................................... 4  
4.1 **General** ....................................................................................................................... 4  
4.2 **Hazard Identification** .................................................................................................... 4  
4.3 **Simultaneous Operations (SimOps)** .............................................................................. 4  
4.4 **Loss of Containment** .................................................................................................... 4  
5 **Risk Assessment Methods** ............................................................................................. 5  
5.1 **General** ....................................................................................................................... 5  
5.2 **Example Risk Assessment Technique** .......................................................................... 5  
5.3 **Flash Fire Risk Assessment Worksheets and Coversheet** ........................................... 6  
5.4 **Illustrated Risk Assessment for Oil and Gas Operations** ............................................. 6  
6 **Mitigation** ....................................................................................................................... 6  
6.1 **Layers of Protection** ..................................................................................................... 6  
6.2 **Hierarchy of Controls** .................................................................................................. 6  
6.3 **FRC Selection Based on Risk Assessment** ................................................................... 7  
7 **General FRC Guidelines** .............................................................................................. 8  
   
Annex A (informative) **Examples of API 500 Illustrations** ............................................. 10  
Annex B (informative) **Bowtie Model** ................................................................................ 14  
Annex C (informative) **Flash Fire Risk Assessment Coversheet** ....................................... 16  
Annex D (informative) **Flash Fire Risk Assessment Worksheet** ....................................... 19  
Annex E (informative) **Example Flash Fire Risk Assessment Coversheets and Worksheets** 21  
Annex F (informative) **FRC Use Decision Tree** ................................................................. 29  
**Bibliography** ...................................................................................................................... 30  

**Figures**  
1 **Risk of Flash Fire** ........................................................................................................... 3  
2 **Hierarchy of Controls Illustration** .................................................................................. 7  
A.1 **Hydrocarbon Pressure Vessel or Protected Fired Vessel in a Nonenclosed Adequately Ventilated Area** ........................................................................................................ 10  
A.2 **Ball or Pig Launching or Receiving Installation in a Nonenclosed Adequately Ventilated Area** ................................................................. 11
Contents

A.3 Flammable Gas-blanketed and Produced Water-handling Equipment in a Nonenclosed Adequately Vented Area ........................................... 11
A.4 Compressor or Pump in an Adequately Ventilated Nonenclosed Area ........................................... 12
A.5 Drilling Rig Derrick Fully Enclosed (Open Top) ........................................... 12
A.6 Drilling Rig Open Substructure and Semi-enclosed Derrick ........................................... 13
B.1 Example FRC Bowtie Worksheet ........................................... 14
B.2 Flash Fire Bowtie Example ........................................... 15
C.1 Flash Fire Risk Assessment Coversheet ........................................... 18
D.1 Flash Fire Risk Assessment Worksheet ........................................... 20
E.1 Example Drilling Flash Fire Risk Assessment Coversheet ........................................... 22
E.2 Example Drilling Flash Fire Risk Assessment Worksheet ........................................... 23
E.3 Example Gas Processing/Midstream Flash Fire Risk Assessment Coversheet ........................................... 24
E.4 Example Gas Processing/Midstream Flash Fire Risk Assessment Worksheet ........................................... 25
E.5 Example Completions Flash Fire Risk Assessment Worksheet ........................................... 26
E.6 Example Production Operations Flash Fire Risk Assessment Worksheet ........................................... 27
E.7 Example Drilling Flash Fire Risk Assessment Worksheet with Special Conditions ........................................... 28
F.1 FRC Use Decision Tree Flow Chart ........................................... 29

Table
B.1 Flash Fire Engineering and Administrative Controls ........................................... 15
Flash Fire Risk Assessment for the Upstream Oil and Gas Industry

1 Scope

1.1 General

This recommended practice (RP) provides guidance for the upstream oil and gas industry on hazard identification and risk assessment exercises to assess and mitigate the risk of human injury caused by exposure to a flash fire.

The scope of this document is limited to personnel exposed to the risk of hydrocarbon based flash fires in the upstream Exploration and Production sector of the oil and gas industry. In general, this group includes oil and gas production, drilling, well bore (well servicing) operations, and gas processing prior to interstate pipeline transportation.

1.2 Conditions of Applicability

This RP focuses on flash fires that result from the unexpected ignition of hydrocarbon vapors. Emergency preparedness (e.g. firefighting, hazmat response) for exposure to fire event greater than a flash fire is excluded from this RP and is addressed by NFPA and other standards organizations.

Arc flash, as discussed in NFPA 70E and its other related standards, are outside the scope of this document.

Maintenance, care, and limitation of various fire resistant clothing (FRC) materials are outside the scope of this document. These items are addressed by the manufacturer and clothing-related standards.

2 Terms, Definitions, Acronyms, and Abbreviations

2.1 Terms and Definitions

For the purposes of this document, the following definitions apply.

2.1.1 Class I, Division 1 location
A location in which ignitable concentrations of flammable gases or vapors are expected to exist under normal operating conditions or in which faulty operation of equipment or processes might simultaneously release flammable gases or vapors and also cause failure of electrical equipment.

2.1.2 Class I, Division 2 location
A location in which flammable gases or vapors may be present but normally are confined within closed systems; are prevented from accumulating by adequate ventilation; or the location is adjacent to a Division 1 location from which ignitable concentrations might occasionally be communicated.

2.1.3 Class I location
A location in which flammable gases or vapors are, or may be, present in the air in quantities sufficient to produce explosive or ignitable mixtures.

2.1.4 fire
A rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities.