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Guidance on Practice for Fire Hazard Analysis

GP 24-21

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 24-21.

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Introduction

Value of this Guidance on Practice

An approach for identification of fire hazards and their mitigation methods in the early project development stage, Select and Define, has been developed. Use of this fire hazard analysis process is a key requirement of the plant or facility fire hazard management strategy.

Application

How to use and interpret the wording of this GP is defined in the ETP Introduction document GP 00-01.

Text in italics is Commentary. Commentary provides background information that supports the requirements of the GP, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Feedback and Further Information

Users are invited to feedback any comments and to detail experiences in the application of BP GPs, to assist in the process of their continuous improvement. Please use the ETP Library comment feature or the ETP Shared Learning System to provide feedback regarding issues with this document. You may access both systems through this link <http://etp.bpweb.bp.com/>.



1. Scope

- a. This Guidance on Practice (GP) gives direction and process for fire hazard analysis (FHA) to provide required level of understanding to make informed decisions regarding the most effective combination of fire hazard management strategies.
- b. Guidance contained in this GP shall be applied to all new onshore and offshore installations.
- c. FHA guidance is applicable to the following personnel:
 1. Project managers: to promote understanding of fire hazards as part of hazard management process.
 2. Process, control, and layout engineering disciplines: to optimise their designs to address effects of fire hazards.
 3. Hazard analysts: to identify and quantify fire hazards in form that can be used by discipline engineers and operators.
 4. Loss control/fire protection engineers: to design operable fire protection systems to match consequences of identified fire hazards.
- d. Guidance is intended to be applied to new installations, but application to modifications and existing installations may be considered if further assessment of fire hazards is needed.

FHA provides understanding of the impact of fires and how that impact can be managed.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

GP 24-10	Fire Protection - Onshore.
GP 24-20	Fire and Explosion Hazard Management - Offshore.
GP 24-23	Active Fire Protection - Offshore.
GP 24-24	Passive Fire Protection - Offshore.
	“Smoke and Gas Ingress Assessment Methodology” SPR/G/97/006 Issue 0, April 1997.
	Fire Hazard Training Course, 1999, Graham Dalzell, Simon Webb.

SINTEF Petroleum Research

SINTEF Handbook for Fire Calculations, 1997.

3. Terms and definitions

For the purposes of this GP, the following terms and definitions apply:



Escalation

This occurs when the fire from the original source burns long enough (greater than 1.5 hour) to cause hazardous fire conditions at adjacent fire potential tanks, vessels, piping, or structures. The adjacent equipment then ignites and adds fuel to the original fire, enlarging the fire envelope and putting more adjacent equipment at risk of fire.

Fire hazard management

Process described in GP 24-10 for onshore facilities and in GP 24-20 for offshore installations.

Fire target

Object that may be damaged by fire with serious implications to life, equipment, or structures

Fuel

Flammable hydrocarbon gas or liquid

Hazard zone

Maximum area around a fire source at a given fire effect or radiant heat flux

Radiant Heat Flux

Amount of radiant heat from a heat source, such as a fire, which flows through a unit area of a piece of equipment or structure per unit time

4. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

BLEVE	Boiling Liquid Expanding Vapour Explosion
CFD	Computational Fluid Dynamics
CVP	Capital Value Process
D	Diameter
ESD	Emergency Shut Down
FHA	Fire Hazard Analysis
HAZID	Hazard Identification
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
P&ID	Piping and Instrument Diagram



5. General

5.1. Direction

BP group policy requires fire and explosion hazards to be managed to ensure safety of personnel from fires that could reasonably be anticipated.

The understanding of hazards, their causes and effects is the greatest risk reducer for an operating plant.

5.2. Objectives of FHA

The user of this document shall know that the objectives of conducting a FHA are to:

- a. Provide engineering and management with the understanding of the possible scale and magnitude of uncontrolled fires.
- b. Identify the impact of uncontrolled fires on operating personnel, plant equipment, and facilities.
- c. Analyse the degree of protection of various fire hazard management strategies
- d. Choose the best mitigation strategy to provide a significant reduction of the impact of uncontrolled fires.

5.3. FHA Timing in the Project Cycle

- a. Some basic form of FHA should be part of the Appraise stage of the CVP project cycle.
- b. A preliminary FHA should be conducted in the Select stage to possibly impact the process design of the plants or facilities.
- c. A systematic FHA shall start during the Define stage after the completion of hazard identification (HAZID) studies.
- d. The analysis of fire hazards shall become progressively more detailed through the Execute stage of the project.
- e. A final FHA shall be conducted during the first year of operation of a plant or facility and should be reviewed or conducted on any operating plant or facility on a 3 to 5 year basis.

In many cases, calculation methods will not change, but analysis should become more detailed as additional design information becomes available.

6. FHA process

6.1. Types of Fires addressed

The user of this document shall be aware of the following:

- a. This document describes an analysis method for determining the severity of outdoor hydrocarbon fires.

Fires are started when an appropriate combination of fuel and oxygen reaches its flammability limits and the fuel and oxygen mixture reaches an ignition source. The type of fire depends on:

- *Type of fuel contributing to fire.*
- *Shape and size of hole in loss of containment scenario.*



- *Pressure and temperature of material being released.*
 - *Degree of congestion and confinement around release point.*
- b. Fires within the scope of this GP are typically classified as follows:
1. Jet fire - combustion of high pressure gas
 2. Spray fire - combustion of pressurised liquid release
 3. Pool fire - combustion of flammable vapours from liquid hydrocarbon pool
 4. Blowout - well head spray or jet fire
 5. Flash fire - combustion of flammable gas cloud without developing explosion overpressures
 6. BLEVE - rapid ignited release of pressurised contents of heated vessel resulting in blast overpressure and large fireball
 7. Boilover - sudden steam generation in atmospheric storage tanks throwing tank contents high in the air
- c. Fires and explosions not within the scope of this GP are:
1. Fires resulting from cellulose, electrical, metal fires, etc.
 2. Fires inside buildings
 3. Explosions
- d. Annex A of this GP presents some simple calculations that may be used to analyse fire hazards. Computer codes may be used in place of calculations (e.g., BP model CIRRU or equivalent). Choice of either approach should be based on preference of user.

The method presented in this GP should produce results that are equivalent to the use of these simple computer models.

6.2. Analysis process steps

The FHA process used to determine the fire hazard management strategy shall include the following steps below. The overall FHA process is described in Figure 1.

1. Identify areas where hazardous flammable inventories are present (e.g., from HAZID).
2. Determine inventory of fire hazards:
 - a) Identify size of each flammable inventory.
 - b) Identify fire type.
3. Screen out flammable inventories with no significant potential for damage (e.g., based on mass).
4. Identify personnel, equipment, and structures that may be affected by fire.
5. Determine size of uncontrolled hazard zones.
6. Apply selected fire hazard management strategies (e.g., automatic isolation and blow down) and identify size and duration of hazard zones:
 - a) Identify size and duration of hazard zones for flame envelope and radiant heat fluxes that correspond to impairment criteria.



- b) Review location of personnel and muster locations and embarkation areas against hazard zones for relevant impairment criteria.
- c) Identify which structures and equipment can be exposed to flames for periods longer than typical failure times.
- 7. List paths to escalation
- 8. Review impact of fire against acceptance criteria

6.3. Inventory of fire hazards

- a. Distinct hydrocarbon inventories shall be identified by FHA.

In many cases, the HAZID will not provide an inventory of fire hazards but will simply list areas where significant fire hazards are present. The HAZID will typically list "Fire resulting from hydrocarbon release in processing area A1".

- b. Facility shall be split into areas and, if necessary, sub areas.

- c. FHA shall establish:

- 1. Hydrocarbon inventories based on location of major equipment
- 2. Arrangement of isolation and blow down valves or other breaks in process

- d. Individual inventories within these areas should be identified using the following steps:

- 1. Divide plant into isolatable inventories, that is, those sections segregated by ESD valves or by unit boundaries where few or no ESD valves are present.
- 2. Divide inventories into elements, such as vessels, lengths of piping, heat exchangers, and pumps. Isolatable inventory should consider individual elements or group of elements as flammable inventories.

Typically, liquid inventories will be the liquid in major vessels, and the gas inventories will be the gas volume between these major vessels. In many cases, the liquid will act as a seal or break point between gas inventories. The location of pumps in liquid systems may also be used as a break point. If there is significant pressure change, gas volumes may be split or settle out conditions defined.

- 3. Identify contents, fuel components, operating pressure, and temperature.
- 4. For elements with multiple contents (hydrocarbon liquid, gas, and water), determine volume of each component.
- 5. Calculate mass of stable hydrocarbon liquid, liquefied gas, or gas in each element.
- 6. Calculate total mass of gas in system by adding mass of gas in each element and any dissolved gas in liquid.
- 7. Calculate mass of stable hydrocarbon liquid in each element by subtracting water that may be mixed with it and dissolved or liquefied gas.

Liquid stored at a temperature below which the LPG content liquefies should be considered a liquid and not a liquefied gas.

- 8. Calculate mass of liquefied gas, i.e., which would flash off if plant was depressurised to atmospheric pressure.

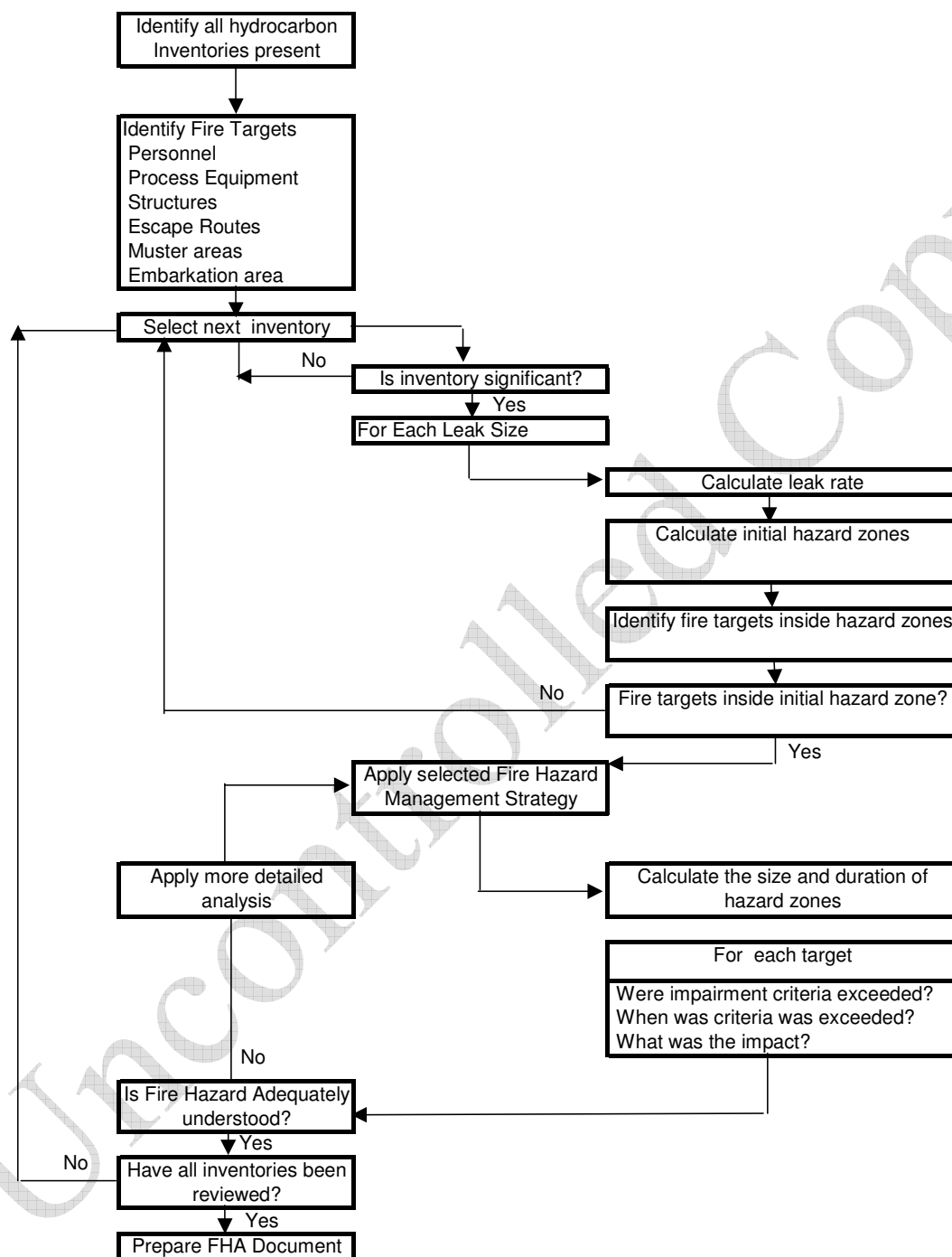


Gas releases are based on the combined inventory of free gas, dissolved gas, and liquefied gas. Liquid releases are based on the mass of stable hydrocarbon liquid plus the gas that is still liquid at the release pressure.

- e. For each inventory, mass of hydrocarbon, phase, composition, pressure, and fire hazard types present shall be identified by FHA. This information may be presented in tabular form as shown in Table 1.
- f. Assumptions used in determining inventories shall be documented in FHA.



Figure 1 - Overview of FHA process



6.4. Damage potential

- a. Assessment of significance (damage potential) of inventories shall be based on normal operating conditions with liquid levels at normal liquid level.

The damage potential of a hydrocarbon inventory depends on the mass available for release.

- b. All gas inventories shall be considered.
- c. The following describes circumstances regarding liquid hydrocarbons in FHA:
1. Liquid inventories of less than 500 kg (1000 lb) should be excluded from FHA.
 2. Liquid inventories in 500 kg (1000 lb) to 2500 kg (5000 lb) range shall be considered in FHA but may be excluded from detailed consideration if they present no special hazards.
 3. Liquid inventories above 2500 kg (5000 lb) shall be considered in FHA.
 4. Liquid inventories of more than 2500 kg (5000 lb) may be excluded from FHA if:
 - a) Flash point of the liquid is greater than 37°C (100°F).
 - b) Material is normally at ambient temperature or stored temperature is significantly below flash point.

6.5. Selection of fire cases for analysis

6.5.1. Uncontrolled fires

- a. Consequences of unprotected, uncontrolled fire are determined by:
1. Type of material released.
 2. Pressure and temperature of the material being released
 3. Throughput and available inventory
 4. Degree of congestion and confinement
 5. Ambient conditions including temperature, wind speed, wind direction, atmospheric stability, atmospheric pressure and humidity
 6. Ventilation of area (e.g., enclosed or open)
 7. Proximity of personnel and critical equipment and structures
- b. For each flammable inventory, initial hazard zones for the following leak sizes shall be determined by FHA:
1. Small - 12 mm (1/2 in) leak.
 2. Medium - 25 mm (1 in) leak.
 3. Large - 50 mm (2 in) leak.
- c. For some large systems with large throughputs, use of larger leak sizes for small, medium, and large may be appropriate.

