



Exploration & Production

GENERAL SPECIFICATION

Design of Field Facilities

GS EP SAF 253

Impacted area, restricted area and fire zones

Main Instructor for Derogation: ECI (Design of Field Facilities)

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1. Scope

1.1 Purpose of the specification

The purpose of this general specification is to define the safety requirements for the partition of an oil and gas production installation and the zone surrounding it into an **Impacted Area**, a **Restricted Area** and **Fire Zones**. This approach is aimed at fulfilling a two-fold objective:

- In accordance with **API RP 14J** hazard tree for production installations, and based upon unit layout, nature of equipment and risks (nature and level) associated to equipment, provide means or take dispositions that shall ensure:
 - o **Prevention of ignition:** Separate, as far as practicable, ignition sources from fuel sources
 - o **Mitigation:** Minimise the consequences of fires, explosions and other hazard; prevent escalation of fire to other areas; minimise hydrocarbon inventory in areas where fire initiated (isolation and depressurisation); focus active fire-fighting to one single zone and improve the emergency response; contain the risk within the boundaries of the installation and avoid exposure of public to hazards
 - o **Escape, Evacuation and Rescue:** Protect personnel from fire and explosion in the escape routes to a safe area
- Provide tools that will ensure the safety of public that may be present, either permanently or just passing by, in the vicinity of production facilities.

1.2 Applicability

This specification is not retroactive; it applies to new installations and to major modifications or extensions of existing installations, both onshore and offshore. This specification is limited to the highlighting of functional requirements and safety related considerations; it does not cover, in particular:

- Equipment layout considerations, minimum distances and/or protection between equipment (refer to **GS EP SAF 021**)
- Hazardous areas definition (refer to **GS EP SAF 216**)
- Emergency shutdown and depressurisation systems (refer to **GS EP SAF 261**)
- Emergency Response (refer to **GS EP SAF 371**) and in particular Active Fire-Fighting (refer to **GS EP SAF 311**, **GS EP SAF 321**, **GS EP SAF 322**, **GS EP SAF 331**, **GS EP SAF 334**)
- Detailed design of the Passive Fire Protection systems (refer to **GS EP SAF 337**)
- Escape, Evacuation and Rescue procedures (refer to **GS EP SAF 351**)
- Underground pipelines.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

**Standards**

Reference	Title
Not applicable	

Professional Documents

Reference	Title
API RP 14J	Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities

Regulations

Reference	Title
Circulaire du 23 Juillet 2007	Circulaire DPPR/SEI2/AL-07-0257 du 23/07/07 relative à l'évaluation des risques et des distances d'effets autour des dépôts de liquides inflammables et des dépôts de gaz inflammables liquéfiés. Annexe I Boil over note technique

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
	Statement of Requirements Safety Concept Operating Philosophy Site meteorological data

Total General Specifications

Reference	Title
GS EP SAF 021	Lay-out
GS EP SAF 222	Safety rules for machinery and equipment handling hydrocarbon in enclosed areas
GS EP SAF 261	Emergency Shut-Down and Emergency De-Pressurisation (ESD & EDP)
GS EP SAF 262	Pressure protection relief and hydrocarbon disposal systems
GS EP SAF 321	Fire pump stations and fire water mains
GS EP SAF 334	Foam fire control systems
GS EP SAF 322	Fixed fire water systems
GS EP ECP 103	Process sizing criteria

3. Terminology and definitions

There are three types of statements in this specification, the “shall”, “should” and “may” statements. They are to be understood as follows:

Shall	Is to be understood as mandatory. Deviating from a “shall” statement requires derogation approved by the COMPANY
Should	Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide a similar level of protection and this shall be documented
May	Is used where alternatives are equally acceptable.

For the purpose of this specification, the following definitions shall apply (the terms defined in this section are often in bold characters in the text of the specification):

Active Fire-Fighting (AFF)	Any fire protection system or component which requires the manual or automatic detection of fire and which initiates a consequential response (API)
Credible event	Incident likely to occur within a concerned area. Used for the definition of fire zones. Consequences corresponding to a credible event of a given fire zone shall not impact other fire zones (COMPANY)
Dose (toxic)	A person exposed to a concentration C of a toxic gas during a period of time t inhales a toxic dose $D = C^n \times t$ where n is a constant specific to the substance considered. The value of D determines the level of harm the person will experience: lethality, intoxication, etc.

Emergency De-Pressurisation (EDP)	Control actions undertaken to depressurise equipment or process down to a pre-defined threshold (generally 7 barg or 50% of design pressure) in a given period of time (generally 15 minutes) in response to a hazardous situation (ISO + COMPANY)
Emergency Response (ER)	Action taken by personnel on or off the installation to control and/or mitigate a hazardous event (ISO)
Emergency Shutdown (ESD)	Control actions undertaken to Shutdown equipment or process in response to a hazardous situation (ISO)
Emergency Shutdown System (ESS)	System of manual stations and/or automatic devices which, when activated, initiate platform or facility shutdown (COMPANY)
Emergency Shutdown Valve (ESDV)	High integrity shutdown valve, handling a hazardous fluid or a fluid having an essential function, and located at the limit of a fire zone or within a fire zone to limit hydrocarbon inventory (COMPANY)
Fire and Gas (F&G) system	Safety system which monitors the temperature or the energy flux (fire), the concentration of flammable or toxic gases (gas), and initiates relevant actions (alarm, ESD, EDP active fire-fighting, electrical isolation, etc.) at pre-determined levels (COMPANY)
Fire zone	Area within the installation where equipment is grouped by nature and/or homogeneous level of risk attached to them. The partition of an installation into fire zones results in a significant reduction of the level of risk. This implies that consequences of a fire, flammable gas leak or an explosion corresponding to the credible event likely to occur in the concerned fire zone, shall not impact other fire zones to an extent where their integrity could be put at risk (COMPANY)
Flammable atmosphere	Mixture of flammable gas or vapour in air which will burn when ignited (ISO)
IDLH	Immediately Dangerous to Life and Health: maximum concentration of a toxic substance to which an individual can be exposed during 30 minutes without experiencing irreversible effect to health (NIOSH and OSHA)
Impacted area	Area that extends beyond the boundaries of the installation but which is nevertheless affected either permanently by normal operation of the facility (e.g. noise or radiation) or exceptionally by the consequences of an emergency situation caused by a major failure (COMPANY)
Ignition source	Source of temperature and energy sufficient to initiate combustion (API)
Lethal Concentration (LCx%_(y))	Atmospheric concentration which for a specified duration of exposure will cause the death of x% of an exposed population. The associated exposure is normally given e.g. LC1% ₍₃₀₎ means 1% fatality after a 30-minute exposure (all applicable regulation)

Lower Flammable Limit (LFL)	Lower concentration of gas (by volume and expressed in percentage) in a gas-air mixture that will form an ignitable mixture (API, NFPA)
Major failure	A conceivable incident that can possibly occur on the facility. Used for the definition of the facility restricted area and impacted area (COMPANY)
Mitigation	Reduction of the effects of a hazardous event (ISO)
NIOSH	National (US) Institute for Occupational Safety and Health
Normal operation	Steady-state or transient, nominal or down-graded but staying within the facility initial design intention (COMPANY)
OSHA	Occupational Safety and Health (US) Administration
Passive Fire Protection (PFP)	Coating, cladding arrangements or a free standing system which in the event of fire will provide thermal protection to the substrate to which it is attached or to the protected area (ISO)
Process Control System (PCS)	Controls the process and associated alarms. It does not fulfil a safety function and shall always be separated from other instrument systems fulfilling a safety function
Process Safety System (PSS)	Controls all causes/actions pertaining to SD-3 shutdowns (i.e. individual equipment), including fire and gas at local (equipment/package) level
Restricted area	Area within the boundaries of the installation and hence under the control of COMPANY, affected permanently by normal operation of the facility or exceptionally by the consequences of an emergency situation caused by a major failure (COMPANY)
Shutdown Valve (SDV)	Automatically operated, (generally fail to close) valve used for isolating a process station (API). SDV's are often referred to as Process Shutdown Valves (PSDV). The acronyms SDV and PSDV are equivalent but SDV shall be used in the present specification because SDV's are not always attached to a process system (COMPANY)
Source of release	Point from which flammable gas, liquid or a combination of both can be released into the atmosphere (ISO)
Threshold Limit Value (TLV)	• Short Time Exposure Limit (STEL): used to quantify short term exposure of personnel to toxic gas (maximum of 4 exposures per day of less than 15 min each) • Time Weighted Average (TWA): used to quantify continuous exposure of personnel to toxic gas (8 hours a day or 40 hours per week)
Units	Division of the installation in a reasonable number of geographic and functional groups of equipment having the same type (hydrocarbon, pressure, inventory, ignition, etc.) and levels (high, medium, low) of risks (COMPANY).

4. Main Principles and Requirements

4.1 General risk reduction philosophy

An underlying concept applied in the present General Specification is that distance is considered as the most efficient protection measure against the outcomes of hazardous scenarios.

4.2 Hazardous scenarios

The list of applicable hazardous scenarios shall comprise events whose probability to occur and/or magnitude of outcomes have been deemed sufficiently high by COMPANY and/or Authorities having jurisdiction.

A typical list of applicable scenarios outcomes with their definitions is included in Section 5.3.2.

4.3 Principle of application

The safety distances shall be calculated using the consequence based prescriptive approach developed further in this document.

Whenever specific project constraints make it impossible to apply the results of this approach, a risk assessment study is performed to check the acceptability of the design.

4.4 Criteria and thresholds

For each retained hazardous scenario, based on established assumptions, calculations are carried out to determine safety distances related to given criteria such as:

- Level of flammability
- Radiation or thermal dose level (including solar radiation contribution)
- Overpressure
- Concentration of toxic compounds (toxic dose).

5. General Approach

5.1 Partition of an installation

The layout and the partitioning (refer to Figure 1 - Typical layout - Fire zoning, restricted and impacted areas boundaries) of an oil and gas processing installation shall:

- Comply with the requirements imposed by consideration of safety within the installation itself
- Take into consideration risks resulting from industrial activity, either routine operation or abnormal event, to areas surrounding the facilities and population living there, if any.

The control of activities taking place within the installation is the responsibility of COMPANY. An area is determined in which only personnel authorized by COMPANY can be present. This area is called the **restricted area**.

The restricted area is further divided into **fire zones**.

The operation of the installation might however affect an area extending beyond the restricted area. This area is called the **impacted area**.

The discrimination between restricted and impacted areas also corresponds to the maximum prejudice that COMPANY's activities, either resulting from normal operation or from an incident, can cause to people:

- **Outside the impacted area:** People are not subject to any increased hazards than those inherent to any other human activities
- **Inside the impacted area (but outside the restricted area):** People might be subject to irreversible effects caused by a major failure of the installation. However, during normal plant operations, permanent prejudice to human beings is not expected
- **Inside the restricted area:** The consequences of an incident or from normal operation can be severe enough to cause permanent prejudice to human beings and shall therefore be off-limit to public.

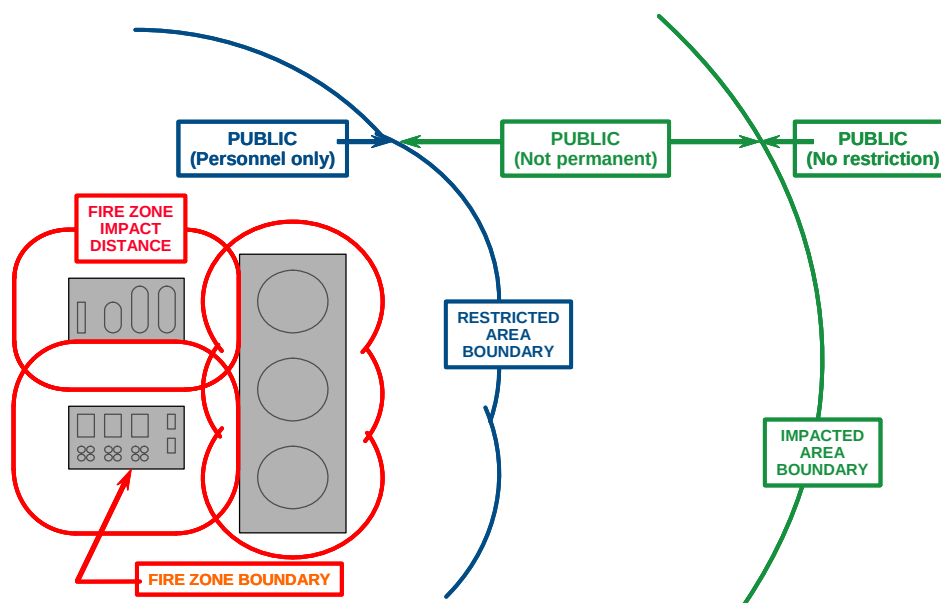


Figure 1 - Typical layout - Fire zoning, restricted and impacted areas boundaries

5.2 Definition of Fire Zone, Restricted and Impacted Areas

5.2.1 Fire zone

Fire Zones are the areas within the installation where equipment are grouped by nature and/or homogeneous level of risk attached to them.

The partition of an installation into fire zones results in a significant reduction of the level of risk. This implies that consequences of a fire, flammable gas leak or an explosion corresponding to the **credible event** likely to occur in the concerned fire zone, shall not impact other fire zones to an extent where their integrity could be put at risk.

5.2.2 Restricted Area

The **Restricted Area** is the area within the boundaries of the installation and hence under the control of COMPANY. The restricted area is affected:

- Permanently by **normal operation** of the facility
- Exceptionally by the consequences of an emergency situation caused by a **major failure**.

Within the restricted area, COMPANY shall have control of all possible sources of ignition, including vehicles (onshore) and vessels (offshore).

Onshore, a security fence shall include at least the restricted area. Offshore, the limits of the restricted area are to be shown on marine maps and may be materialised by buoys.

5.2.3 Impacted Area

The **Impacted Area** is the area that extends beyond the boundaries of the installation but which is nevertheless affected either permanently by **normal operation** of the facility (e.g. noise or radiation) or exceptionally by the consequences of an emergency situation caused by a **major failure**.

The impacted area is not under the control of COMPANY but agreement shall be formalised with LOCAL AUTHORITIES to minimise presence of public (e.g. to limit construction of buildings, in particular permanent settlements, or operation of transportation means open to public).

The Emergency Response Plan and a Site Contingency Plan are set up by the COMPANY in collaboration with LOCAL AUTHORITIES to manage incidents and accidents within the impacted area. The Emergency Response Plan and the Site Contingency Plan may also cover areas extending beyond the impacted area but it is not the purpose of the present document to elaborate upon it.

5.3 General Methodology

5.3.1 Principle

A deterministic approach is used to delimit fire zones, restricted and impacted areas.

A list of hazardous scenarios shall be established by performing a hazard identification (HAZID) study and selecting the appropriate scenarios outcomes from the Section 5.3.2 reference table. If necessary, relevant scenarios not contemplated in the reference table may be added.

The magnitude of the outcome resulting from the retained scenarios shall be established using models of consequence analysis validated by experience and/or by local regulation if more stringent.

A set of criteria (flammability limit, concentration of toxic compounds, radiation or thermal dose, overpressure) for maximum tolerable effects applicable to people and/or equipment shall be imposed.

The outcome of consequence analysis calculations provides distance envelopes defining for each case (onshore/offshore - fire zone/restricted area/impacted area), the corresponding safety distance or contour limit.

A calculation note shall be issued presenting selected scenarios outcomes, criteria used, assumptions taken and safety distance calculation results.

This calculation note shall be updated at each phase of the design of the installation (e.g. pre-project studies, project basic and detailed engineering). It shall also be updated during the operational phase if major change occurs (e.g. appearance of H₂S, new neighbouring third party installations).

5.3.2 Scenarios outcomes definition

The table below gives the definition of the main typical scenarios outcomes applicable to oil and gas production and processing installations.

Scenario outcome	Definition
Un-ignited gas/spray cloud (flammable gas cloud or flammable atmosphere)	Mixture of flammable gas or vapour in air which will burn when ignited (ISO).
Un-ignited gas/spray cloud (toxic gas cloud)	Mixture of toxic gas or vapour in air (COMPANY).
Vapour Cloud Explosion in unit (VCE)	The explosion resulting from an ignition of a premixed cloud of flammable vapour, gas or spray with air, in which flames accelerate to sufficiently high velocities to produce significant overpressure (Yellow Book, TNO, 1997). This type of explosion can occur in a confined enclosed unit or in a congested open unit (COMPANY).
Pool fire	Combustion of flammable or combustible liquid spilled and retained on a surface (ISO). Combustion of material evaporating from a layer of liquid at the base of the fire (UKOOA).
Jet fire	The combustion of material emerging from an orifice with a significant momentum (UKOOA). Ignited release of pressurised flammable fluids (ISO).
Boiling Liquid Expanding Vapour Explosion (BLEVE) & boil over	BLEVE: sudden rupture due to fire impingement of a vessel and/or system containing liquefied flammable gas under pressure; the pressure burst and the flashing of the liquid to vapour creates a blast wave and potential missile damage, and immediate ignition of the expanding fuel-air mixture leads to intense combustion creating a fireball (UKOOA) ¹ . Boil over: expulsion of crude oil (or certain other liquids) from a burning tank. The light fractions of the crude oil burn off producing a heat wave in the residue, which on reaching a water stratum may result in the expulsion of a portion of the contents of the tank in the form of froth (OSHA).
Blowout	When well pressure exceeds the ability of the wellhead valves to control it. Oil and gas "blow wild" at the surface (UKOOA).

¹ It is caused by the reduction of the vessel metal strength due to heat competing with the increasing pressure of the liquefied gases inside the vessel.

Scenario outcome	Definition
Fixed roof tank explosion	Confined explosion of a fuel-oxidant mixture inside a closed system such as vessel, module, etc. (UKOOA).
Flare normal operation	Maximum Continuous Flaring (MCF): flaring the largest allowable steady flow of combustible gas in normal operating conditions (COMPANY). Emergency Flaring (EF): flaring a peak flow of combustible gas in upset or emergency operating conditions (COMPANY).
Flare flame out: flammable and/or toxic	Unignited flare gas release.
Cold vents	Vent handling significant flow rates generally from pressurised equipment. The word "cold" meaning without flame (COMPANY) ² .
Degassing vents	Vent handling low flowrates, generally from atmospheric equipment. A degassing vent is a non ignited vent (COMPANY) ² .
LPG pool vaporisation	Vaporisation of liquid LPG spilled and retained on a surface

² The difference between "cold vent" and "degassing" vent are spelled out in details in [GS EP SAF 262](#).

5.3.3 Application of scenarios outcomes

The table below gives the different scenarios outcomes used to define distances between fire zones and to establish the contour limits of restricted and impacted areas of onshore and offshore installations.

Fire zone	Restricted area	Impacted area
Un-ignited leak gas/spray/liquid (LFL)		
	Un-ignited leak gas/spray/liquid (Toxic)	
	Jet fire gas/spray/liquid (Radiation)	
	Pool fire (Radiation)	
	VCE (Overpressure)	
	BLEVE and Boil over (Radiation)	
	Blow-out: un-ignited (LFL - Toxic),	Blow-out: un-ignited (Toxic),
	Blow-out: ignited (Radiation)	
	Fixed roof tank explosion (Overpressure)	
	Flare flame out: continuous and emergency (LFL - Toxic)	Flare flame out: continuous and emergency (Toxic)
	Flaring normal operation: continuous and emergency (Radiation - Toxic)	Flaring normal operation: continuous and emergency (Radiation)
	Cold vents un-ignited: emergency (LFL - Toxic)	
	Cold vents ignited: emergency (Radiation - Toxic)	
	Degassing vents un-ignited (LFL - Toxic)	
	Degassing vents ignited (Radiation)	
LPG pool vaporisation (LFL)		
Any other relevant scenario outcomes resulting from the HAZID study or imposed by local regulations		