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Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines

Industries du pétrole et du gaz naturel — Contrôle et atténuation des feux et des explosions dans les installations en mer — Exigences et lignes directrices

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

This second edition cancels and replaces the first edition (ISO 13702:1999), which has been technically revised.

The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

Introduction

The successful development of the arrangements required to promote safety and environmental protection during the recovery of hydrocarbon resources requires a structured approach to the identification and management of health, safety, and environmental hazards applied during the design, construction, operation, inspection, maintenance, and decommissioning of a facility.

This International Standard has been prepared primarily to assist in the development of new installations through their lifecycle. For existing installations that predate this International Standard, not all requirements are necessarily appropriate. Retrospective application of this International Standard can be undertaken where it is reasonably practicable to do so. During the planning for a major change to an installation, there will be more opportunity to implement the requirements. A careful review of this International Standard will determine those sections which can be utilized in the change.

The technical content of this International Standard is arranged as follows.

— **Objectives**: lists the goals to be achieved by the control and mitigation measures being described.

— **Functional requirements**: represent the minimum criteria to meet the stated objectives. The functional requirements are performance-orientated measures and, as such, are applicable to the variety of offshore installations utilized for the development of hydrocarbon resources throughout the world.

— Annex A **(informative)**: typical fire and explosion hazardous events.

— Annex B **(informative)**: describes recognized practices to be considered in conjunction with statutory requirements, industry standards, and individual operator philosophy to determine that the measures necessary are implemented for the control and mitigation of fires and explosions. The guidelines are limited to principal elements and are intended to provide specific guidance which, due to the wide variety of offshore operating environments, cannot be applicable in some circumstances.

— Annex C **(informative)**: typical examples of design requirements for large integrated offshore installations.

— **Bibliography**: lists documents to which informative reference is made in this International Standard.

Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines

1 Scope

This International Standard describes the objectives and functional requirements for the control and mitigation of fires and explosions on offshore installations used for the development of hydrocarbon resources.

This International Standard is applicable to the following:

— fixed offshore structures;

— floating systems for production, storage, and offloading;

— petroleum and natural gas industries.

Mobile offshore units as defined in this International Standard and subsea installations are excluded, although many of the principles contained in this International Standard can be used as guidance.

This International Standard is based on an approach where the selection of control and mitigation measures for fires and explosions is determined by an evaluation of hazards on the offshore installation. The methodologies employed in this assessment and the resultant recommendations will differ depending on the complexity of the production process and facilities, type of facility (i.e. open or enclosed), manning levels, and environmental conditions associated with the area of operation.

NOTE Statutory requirements, rules, and regulations can, in addition, be applicable for the individual offshore installation concerned.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 73, *Risk management — Vocabulary*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 73 and the following apply.

3.1.1
abandonment
act of personnel onboard leaving an installation in an emergency

3.1.2
accommodation
place where personnel onboard sleep and spend their off-duty time

Note 1 to entry: It can include dining rooms, recreation rooms, lavatories, cabins, offices, sickbay, living quarters, galley, pantries, and similar permanently enclosed spaces.

3.1.3
active fire protection
AFP
equipment, systems, and methods which, following initiation, can be used to control, mitigate, and extinguish fires

3.1.4
area classification
division of an installation into hazardous areas and non-hazardous areas and the sub-division of hazardous areas into zones

Note 1 to entry: This classification is based on the materials which can be present and the probability of a flammable atmosphere developing. Area classification is primarily used in the selection of electrical equipment to minimize the likelihood of ignition if a release occurs.

3.1.5
cellulosic fire
CF
fire involving combustible material such as wood, paper, furniture, etc.

3.1.6
class of fire
type of fire
classification of fires, based on the nature of the fuel

Note 1 to entry: ISO 3941 describes the classes of fires.

3.1.7
control
<of hazards> limiting the extent or duration of a hazardous event

Note 1 to entry: The definition of control is specific in this International Standard and other definitions are used in other standards.

3.1.8
control station
place on the installation from which personnel can monitor the status of the installation, initiate appropriate shutdown actions, and undertake any emergency communication

3.1.9
deluge system
system to apply fire-water through an array of open spray nozzles by operation of a valve on the inlet to the system

3.1.10
embarkation area
place from which personnel leave the installation during evacuation

EXAMPLE Helideck and associated waiting area or a lifeboat/liferaft boarding area.

3.1.11
emergency depressurization
EDP
controlled disposal of pressurized fluids to a flare or vent system when required to avoid or minimize a hazardous situation

3.1.12
emergency response
action taken by personnel on or off the installation to control or mitigate a hazardous event or initiate and execute abandonment

3.1.13
emergency response team
group of personnel who have designated duties in an emergency

3.1.14
emergency shutdown
ESD
control actions undertaken to shut down equipment or processes in response to a hazardous situation

3.1.15
escalation
spread of impact from fires, explosions, toxic gas releases to equipment or other areas thereby causing an increase in the consequences of a hazardous event

3.1.16
escape
act of personnel moving away from a hazardous event to a place where its effects are reduced or removed

3.1.17
escape route
route from an area of an installation leading to a muster area, temporary refuge (TR), embarkation area, or means of escape to the sea

3.1.18
critical safety system
any system which has a major role in the control and mitigation of fires and explosions and in any subsequent evacuation, escape, and rescue activities

3.1.19
evacuation
planned method of leaving the installation in an emergency

3.1.20
evacuation, escape, and rescue
EER
range of possible actions including escape, muster, refuge, evacuation, escape to the sea, and rescue/recovery

3.1.21
evacuation route
escape route which leads from the temporary refuge (TR) to the place(s) used for evacuation from the installation

3.1.22
explosion

3.1.22.1
gas explosion
combustion of a flammable gas or mist which generates blast waves due to confinement of the combustion-induced flow or the acceleration of the flame front by obstacles in the flame path

3.1.22.2
physical explosion
explosion arising from the sudden release of stored energy such as from failure of a pressure vessel

3.1.23
fire and explosion strategy
FES
results of the process that uses information from the fire and explosion evaluation to determine the measures required to manage these hazardous events and the role of these measures

3.1.24
functional requirements
minimum criteria which shall be satisfied to meet the stated health, safety, and environmental objectives

3.1.25
hazard
potential source of harm

Note 1 to entry: Hazard can be a risk source for potential for human injury, damage to the environment, damage to property, or a combination of these.

[SOURCE: ISO/IEC Guide 51:2014]

3.1.26
hazardous area
three-dimensional space in which a flammable atmosphere can be expected to be present at such frequencies as to require special precautions for the control of potential ignition sources

3.1.27
hazardous event
event that can cause harm

EXAMPLE The incident which occurs when a hazard is realized such as release of gas, fire, loss of buoyancy.

[SOURCE: ISO/IEC Guide 51:2014]

3.1.28
human factors
environmental, organisational, and job factors which influence behaviour of work in a way that can affect health and safety

3.1.29
ignition sources
any source with sufficient energy to initiate combustion

3.1.30
integrated installation
offshore installation which contains, on the same structure, accommodation, and utilities in addition to process or wellhead facilities

3.1.31
jet fire
JF
turbulent diffusion flame resulting from the combustion of a fuel continuously released with momentum in a particular direction

3.1.32
manned installation
installation on which people are routinely accommodated

3.1.33
mobile offshore unit
mobile platform, including drilling ships, equipped for drilling for subsea hydrocarbon deposits and mobile platform for purposes other than production and storage of hydrocarbon deposits

Note 1 to entry: Includes mobile offshore drilling units, including drillships, accommodation units, construction and pipelay units, and well servicing and well stimulation vessels.

3.1.34
muster area
designated area where personnel report when required to do so

3.1.35
operator
individual, partnership, firm, or corporation having control or management of operations on the leased area or a portion thereof

Note 1 to entry: The operator can be a lessee, designated agent of the lessee(s), or holder of operating rights under an approved operating agreement.

3.1.36
passive fire protection
PFP
coating or cladding arrangement or free-standing system which, in the event of fire, will provide thermal protection to restrict the rate at which heat is transmitted to the object or area being protected

3.1.37
pool fire
turbulent diffusion fire burning above a horizontal pool of vaporizing hydrocarbon fuel under conditions where the fuel has zero or very low initial momentum

3.1.38
risk
combination of the probability of occurrence of harm and the severity of that harm

[SOURCE: ISO/IEC Guide 51:2014]

3.1.39
running liquid fire
fire involving a flammable liquid flowing over a surface

3.1.40
temporary refuge
TR
place provided where personnel can take refuge for a predetermined period while investigations, emergency response, and evacuation preplanning are undertaken

3.1.41
zone
part of a hazardous area based upon the frequency of the occurrence and duration of an explosive gas atmosphere

3.2 Abbreviated terms

AB accommodation block

AFP active fire protection

API American Petroleum Institute

BA	breathing apparatus
BOP	blowout preventer
CCR	central control room
CF	cellulosic fire
CS	control station
EDP	emergency depressurization
EER	evacuation, escape, and rescue
ESD	emergency shutdown
FES	fire and explosion strategy
F&G	fire and gas
GOR	gas oil ratio
HC	hydrocarbon
HMI	human machine interface
HVAC	heating, ventilation, and air conditioning
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
JF	jet fire
PA	public address
PFP	passive fire protection
PLC	programmable logic controllers
SSIV	sub-sea isolation valve
SSSV	sub-surface safety valve
TEMPSC	totally enclosed motor-propelled survival craft
TR	temporary refuge
UA	utility area
UPS	uninterruptable power supply
WH	wellhead area

4 Objectives

The following are the principal objectives of this International Standard, in order of priority:

— safety of personnel;

— protection of the environment;

— protection of assets;

— minimization of financial and consequential losses of fires and explosions.

5 Fire and explosion evaluation and risk management

5.1 Management system

All companies associated with the offshore recovery of hydrocarbons shall have, or conduct their activities in accordance with, an effective management system which addresses environmental issues such as described in ISO 14001 or similar (for example, operators should have an effective management, contractors should have either their own management system or conduct their activities consistently with the operators management system) and additionally addresses issues relating to health and safety. One key element of such management systems shall be a process of evaluation and risk management which shall take place in a framework which provides the policies, procedures, and organizational arrangements that will embed risk management throughout the organization.

5.2 Risk assessment and the risk management framework

This International Standard assumes that the risk assessment is performed within the principles and guidelines for risk management described in ISO 31000.

In particular, those carrying out risk assessments shall be clear about the following:

a) organization's risk management policy, its objectives, and the context in which the organization operates;

b) extent and type of risks that are tolerable and how to treat any risks that are deemed not to be tolerable;

c) how risk assessment integrates into organizational processes;

d) methods and techniques to be used for risk assessment and their contribution to the risk management process;

e) accountability, both for performing risk assessment and for making decisions taking account of the results;

f) resources required to carry out risk assessment;

g) how the risk assessment will be reported and reviewed.

5.3 Risk assessment process

Risk assessment provides decision-makers and responsible parties with an improved understanding of risks that could affect achievement of objectives and the adequacy and effectiveness of controls already in place. This provides a basis for decisions about the most appropriate approach to be used to treat the risks. The output of risk assessment is an input to the decision-making processes of the organization.

Risk assessment is the overall process of risk identification, risk analysis, and risk evaluation. The manner in which this process is applied is dependent not only on the context of the risk management process but also on the methods and techniques used to carry out the risk assessment.

5.4 Risk identification

The starting point for risk management is the systematic identification of the sources of risk and their potential consequences which can be dependent on the location, activities, and materials which are used or encountered in them.

The risk identification process shall be applied to all stages in the life cycle of an installation and to all types of hazards encountered as a consequence of the development of hydrocarbon resources.

5.5 Risk analysis

Risk analysis involves developing an understanding of the risks. Risk analysis provides an input to risk evaluation and to decisions on whether risks need to be treated, and on the most appropriate risk treatment strategies and methods. Risk analysis can also provide an input into making decisions where choices are made and the options involve different types and levels of risk.

Risk analysis involves consideration of the causes and sources of risk, their positive and negative consequences, and the likelihood that those consequences can occur. Factors that affect consequences and likelihood shall be identified. An event can have multiple consequences and can affect multiple objectives. Existing controls and their effectiveness and efficiency shall also be taken into account.

5.6 Risk evaluation

The purpose of risk evaluation is to assist decision-making and shall be based on the outcomes of risk analysis.

Risk evaluation involves comparing the level of risk found during the analysis process with qualitative or quantitative criteria established when the context was considered. Based on this comparison, the need for treatment shall be considered.

Decisions shall take account of the wider context of the risk and include consideration of the tolerance of the risks borne by parties other than the organization that get benefits from the risk. Decisions shall be made in accordance with legal, regulatory, and other requirements.

In some circumstances, the risk evaluation can lead to a decision to undertake further analysis. The risk evaluation can also lead to a decision not to treat the risk in any way other than maintaining existing controls. This decision will be influenced by the organization's risk attitude and the criteria that have been established.

5.7 Risk treatment

5.7.1 General

Risk treatment involves selecting one or more options for modifying risks and implementing those options. Once implemented, treatments provide or modify the controls.

Risk treatment involves a cyclical process of

— assessing a risk treatment,

— deciding whether residual risk levels are tolerable,

— generating a new risk treatment, if risk levels are not tolerable, and

— assessing the effectiveness of that treatment.

Risk treatment options are not necessarily mutually exclusive or appropriate in all circumstances. The options can include the following:

a) avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk;

b) taking or increasing the risk in order to pursue an opportunity;

c) removing the risk source;

d) changing the likelihood;

e) changing the consequences;

f) retaining the risk by informed decision.

The process of selecting risk treatment measures predominantly entails the use of sound engineering judgement, but it can be necessary to supplement this by recognition of the particular circumstances which can require deviation from past practices and previously applied codes and standards.

5.7.2 Prioritization of risk treatment measures

Preventative measures, such as using inherently safer designs and ensuring asset integrity, shall be emphasized wherever practicable. Based on the results of the evaluation, detailed health, safety and environmental objectives, and functional requirements shall be set at appropriate levels.

5.8 Risk treatment in the context of offshore oil and gas operations

5.8.1 General

The above is general and applies to all hazards and potentially hazardous events. In the context of fires and explosions, the evaluation of these events may be part of an overall installation evaluation or may be treated as a separate process which provides information to the overall evaluation. For further requirements and guidelines related to hazard identification and risk assessment, reference is made to ISO 17776.

In developing the risk treatment measures, there are a wide range of issues which shall be considered to ensure that the measures selected are capable of performing their function when required to do so. These issues include the following:

a) nature of the fires and explosions which might occur (see Annex A);

b) risks of fires and explosions;

c) marine environment;

d) nature of the fluids to be handled;

e) anticipated ambient conditions;

f) temperature and pressure of fluids to be handled;

g) quantities of flammable materials to be processed and stored;

h) flammability and toxicity of materials in non-hazardous areas including accommodation and control station;

i) amount, complexity, and layout of equipment on the installation;

j) location of the installation with respect to external assistance/support;

k) emergency response strategy;

l) production and manning philosophy;

m) human factors;

n) interaction with adjacent facilities and vessels, e.g. jack-up, flotel, offtake tankers.

Clause 6 to Clause 16 identify requirements and provide guidance on a range of measures which can have a role in either the control and mitigation of the potential fire or explosion hazardous events on an installation.

5.8.2 Design loads

The evaluation of the fire and explosion hazards on the installation shall define the fire and explosion loads. The loads shall be summarized into a form to provide suitable input to the design process and thereby constitute the minimum loads that the installation shall be designed to withstand, unless