INTERNATIONAL STANDARD

**ISO 13702**

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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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## Contents







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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 13702 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

Annexes A, B and C of this International Standard are for information only.

## 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 and as such it may not be appropriate to apply some of the requirements to existing installations. Retrospective application of this International Standard should only be undertaken where it is reasonably practicable to do so. During the planning for a major change to an installation there may be more opportunity to implement the requirements and a careful review of this International Standard should be undertaken to determine those sections which can be utilised 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 which shall be satisfied to meet the stated objectives. The functional requirements are performance-orientated measures and, as such, should be applicable to the variety of offshore installations utilized for the development of hydrocarbon resources throughout the world.



— **Guidelines** (annex B) - describe recognized practices which should 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, may in some circumstances not be applicable.



— **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, functional requirements and guidelines 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:

— fixed offshore structures;

— floating production, storage and off-take systems;

for the 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 may 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 the environmental conditions associated with the area of operation.

Users of this International Standard should note that while observing its requirements, they should, at the same time, ensure compliance with such statutory requirements, rules and regulations as may be applicable to the individual offshore installation concerned.

## 2 Terms, definitions and abbreviated terms

### 2.1 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

**2.1.1**
**abandonment**
act of personnel onboard leaving an installation in an emergency

**2.1.2**
**accommodation**
place where personnel onboard sleep and spend their off-duty time

NOTE It may include dining rooms, recreation rooms, lavatories, cabins, offices, sickbay, living quarters, galley, pantries and similar permanently enclosed spaces.

**2.1.3**
**active fire protection**
**AFP**
equipment, systems and methods which, following initiation, may be used to control, mitigate and extinguish fires

**2.1.4**
**area classification**
division of an installation into hazardous areas and nonhazardous areas and the sub-division of hazardous areas into zones

NOTE This classification is based on the materials which may 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.

**2.1.5**
**cellulosic fire**
**CF**
fire involving combustible material such as wood, paper, furniture, etc.

**2.1.6**
**class of fire**
**type of fire**
classification used to facilitate the selection of extinguishers

**2.1.7**
**control**
<of hazards> limiting the extent and/or duration of a hazardous event to prevent escalation

**2.1.8**
**control station**
**CS**
place on the installation from which personnel can monitor the status of the installation, initiate appropriate shutdown actions and undertake any emergency communication



**2.1.9**
**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



**2.1.10**
**embarkation area**
place from which personnel leave the installation during evacuation

EXAMPLES A helideck and associated waiting area or a lifeboat/liferaft boarding area.

**2.1.11**
**emergency depressurization**
**EDP**
controlled disposal of pressurized fluids to a flare or vent system when required to avoid or minimize a hazardous situation

**2.1.12**
**emergency response**
action taken by personnel on or off the installation to control or mitigate a hazardous event or initiate and execute abandonment

**2.1.13**
**emergency response team**
group of personnel who have designated duties in an emergency

**2.1.14**
**emergency shutdown**
**ESD**
control actions undertaken to shut down equipment or processes in response to a hazardous situation

**2.1.15**
**emergency station**
place where emergency response personnel go to undertake their emergency duties

**2.1.16**
**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

**2.1.17**
**escape**
act of personnel moving away from a hazardous event to a place where its effects are reduced or removed

**2.1.18**
**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

**2.1.19**
**essential safety system**
any system which has a major role in the control and mitigation of fires and explosions and in any subsequent EER activities

**2.1.20**
**evacuation**
the planned method of leaving the installation in an emergency

**2.1.21**
**evacuation, escape and rescue**
**EER**
general term used to describe the range of possible actions including escape, muster, refuge, evacuation, escape to the sea and rescue/recovery



**2.1.22**
**evacuation, escape and rescue strategy**
**EERS**
results of the process that uses information from an evaluation of events which may require EER to determine the measures required and the role of these measures



**2.1.23**
**evacuation route**
escape route which leads from the temporary refuge (TR) to the place(s) used for primary or secondary evacuation from the installation

**2.1.24 explosion**

**2.1.24.1**
**chemical explosion**
violent combustion of a flammable gas or mist which generates pressure effects due to confinement of the combustion-induced flow and/or the acceleration of the flame front by obstacles in the flame path

**2.1.24.2**
**physical explosion**
explosion arising from the sudden release of stored energy such as from failure of a pressure vessel, or high voltage electrical discharge to earth

**2.1.25**
**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

**2.1.26**
**flammable atmosphere**
mixture of flammable gas or vapour in air which will burn when ignited

**2.1.27**
**functional requirements**
minimum criteria which must be satisfied to meet the stated health, safety and environmental objectives

**2.1.28**
**grade of release**
<area classification> measure of the likely frequency and duration of a release

NOTE It is independent of the rate of release, the quantity of material released, the degree of ventilation and the characteristics of the fluid.

**2.1.29**
**hazard**
potential for human injury, damage to the environment, damage to property, or a combination of these

**2.1.30**
**hazard assessment**
process whereby the results of an analysis of a hazard or hazardous event are considered against either judgement, standards or criteria which have been developed as a basis for decision-making

**2.1.31**
**hazardous area**
three-dimensional space in which a flammable atmosphere may be expected to be present at such frequencies as to require special precautions for the control of potential ignition sources

**2.1.32**
**hazardous event**
incident which occurs when a hazard is realized



EXAMPLES Release of gas, fire, loss of buoyancy.



**2.1.33**
**ignition sources**
any source with sufficient energy to initiate combustion

**2.1.34**
**integrated installation**
offshore installation which contains, on the same structure, accommodation and utilities in addition to process and/or wellhead facilities

**2.1.35**
**jet fire**
**JF**
ignited release of pressurized, flammable fluids

**2.1.36**
**life jacket**
device worn by personnel which has sufficient buoyancy and stability to turn the body of an unconscious person and keep the person's mouth clear of the water

**2.1.37**
**mitigation**
<of hazardous event> reduction of the effects of a hazardous event

**2.1.38**
**manned installation**
installation on which people are routinely accommodated

**2.1.39**
**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

**2.1.40**
**muster area**
designated area where personnel report when required to do so

**2.1.41**
**operator**
individual, partnership, firm or corporation having control or management of operations on the leased area or a portion thereof

NOTE The operator may be a lessee, designated agent of the lessee(s), or holder of operating rights under an approved operating agreement.

**2.1.42**
**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

**2.1.43**
**pool fire**
combustion of flammable or combustible liquid spilled and retained on a surface

**2.1.44**
**prevention**
<of hazardous event> reduction of the likelihood of a hazardous event



**2.1.45**
**primary method**
<for evacuation> preferred method of leaving the installation in an emergency



**2.1.46**
**rescue**
process by which those who have entered the sea directly or in TEMPSC/liferafts are retrieved to a place where medical assistance is available

**2.1.47**
**risk**
combination of the chance that a specified undesired event will occur and the severity of the consequences of that event

**2.1.48**
**running liquid fire**
fire involving a flammable liquid flowing over a surface

**2.1.49**
**secondary method**
<for evacuation> method of leaving the installation which can be carried out in a fully controlled manner under the direction of the person in charge, independent of external support

**2.1.50**
**source of release**
point from which flammable gas, liquid or a combination of both can be released into the atmosphere

**2.1.51**
**survival suit**
protective suit made of waterproof materials which reduces the body heat-loss of a person wearing it in cold water

**2.1.52**
**temporary refuge**
**TR**
place provided where personnel can take refuge for a predetermined period whilst investigations, emergency response and evacuation preplanning are undertaken

**2.1.53**
**tertiary method**
<for escape to the sea> method of leaving the instsllation which relies considerably on the individual's own action

**2.1.54**
**totally enclosed motor-propelled survival craft**
**TEMPSC**
craft capable of sustaining the lives of persons in distress from the time of abandoning the installation

**2.1.55**
**zone**
<area classification> distance in any direction from the source of release to the point where the flammable atmosphere has been diluted by air to a sufficiently low level

NOTE Different zone ratings are possible depending on the frequency that flammable mixtures are expected to be present.

## 2.2 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 |
| EERS | EER Strategy |
| ESD | Emergency Shutdown |
| FES | Fire and Explosion Strategy |
| SDV | Shutdown valve |
| F&G | Fire and Gas System |
| HC | Hydrocarbon |
| HVAC | Heating, Ventilation and Air Conditioning |
| OCS | Outer Continental Shelf |
| IEC | International Electrotechnical Commission |
| IMO | International Maritime Organization |
| JF | Jet Fire |
| PA | Process Area |
| 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 |
| UPS | Uninterruptable Power Supply |
| UKOOA | United Kingdom Offshore Operators Association |
| UA | Utility Area |
| WH | Wellhead Area |



## 3 Objectives

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

— safety of personnel;

— protection of the environment;

— protection of assets;

— minimization of financial consequences of fires and explosions.

## 4 Fire and explosion evaluation and risk management

All companies associated with the offfshore 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[1)], 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. The starting point for evaluation and risk management is the systematic identification of the hazards and effects which may arise from offshore recovery locations and activities and from the materials which are used or encountered in them. The identification process should 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.

The results of the identification process should be used both to evaluate the consequences of hazardous events and to determine appropriate risk reduction. The process of selecting risk-reduction measures will predominantly entail the use of sound engineering judgement, but this may need to be supplemented by a recognition of the particular circumstances which may require deviation from past practices and previously applied codes and standards. In certain circumstances, risk assessment may be able to provide useful input to the decision-making process, providing that the operator has established criteria for this purpose. Risk-reduction measures should include those to prevent incidents (i.e. reduction of the probability of occurrence), to control incidents (i.e. limiting the extent and duration of a hazardous event) and to mitigate the effects (i.e. reduction of the consequences). Preventative measures, such as using inherently safer designs and ensuring asset integrity, should be emphasized wherever practicable. Emergency response measures to recover from incidents should be provided based on the evaluation and should be developed taking into account possible failures of the control and mitigation measures. Based on the results of the evaluation, detailed health, safety and environmental objectives and functional requirements should be set at appropriate levels.

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.



The results of the evaluation process and the decisions taken with respect to the need for, and role of, any risk reduction measures should be recorded so that they are available for those who operate the installation and for those involved in any subsequent change to the installation. For convenience in the remainder of this International Standard, the term 'strategy' has been adopted for this record. Two such strategies are introduced, namely a Fire and Explosion Strategy (FES) and an Evacuation, Escape and Rescue Strategy (EERS). These strategies do not have to be separately documented and the relevant information may be included with other health, safety and environmental information as part of the management of all hazardous events on an installation. The EERS may, for example be included in an overall installation Emergency Response Strategy. For many existing installations, the FES and EERS may be contained in previous risk assessments, or may be restricted to a simple statement of the standards and/or procedures, which are applied to deal with fire and explosion and escape and evacuation aspects of the installation.



The strategies should be updated whenever there is a change to the installation which may affect the management of the fire and explosion hazardous events.

The level of detail in a strategy will vary depending on the scale of the installation and the stage in the installation life cycle when the risk management process is undertaken. For example:

— complex installations, e.g. a large production platform incorporating complex facilities, drilling modules and large accommodation modules, are likely to require detailed studies to address the fire and explosion hazardous events. Typical examples of some of the issues that may need to be addressed for such installations are given in annex C;

— for simpler installations, e.g. a wellhead platform or other small platforms with limited process facilities, it may be possible to rely on application of recognized codes and standards as a suitable base which reflects industry experience for this type of facility;

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1) For example, operators should have an effective management system. Contractors should have either their own management system or conduct their activities consistently with the operators management system.

— for installations which are a repeat of earlier designs, evaluations undertaken for the original design may be deemed sufficient to determine the measures needed to manage the fire and explosion hazardous events, but new knowledge and technology should be considered;

— for installations in the early design phases, the evaluations will necessarily be less detailed than those undertaken during later design phases.

The strategies should describe the role and any functional requirements for each of the systems required to manage possible hazardous events on the installation. In developing functional requirements, the following should be considered:

a) the functional parameters of the particular system. This should be a statement of the purpose and essential duties that the system is expected to perform;

b) the integrity, reliability and availability of the system;

c) the survivability of the system under the emergency conditions which may be present when it is required to operate;

d) the dependency on other systems which may not be available in an emergency.

The identified essential elements should form the basis for the specification for each of the systems to be provided, and should be verified for the life of the installation in order to ensure that the strategies remain valid and to identify the need for any remedial action.

In developing the strategies, there are a wide range of issues which should be considered to ensure that the measures selected are capable of performing their function when required to do so. For the FES, these issues include:



— the nature of the fires and explosions which may occur (see annex A);

— the risks of fires and explosions;

— the marine environment;

— the nature of the fluids to be handled;

— the anticipated ambient conditions;

— the temperature and pressure of fluids to be handled;

— the quantities of flammable materials to be processed and stored;

— the amount, complexity and layout of equipment on the installation;

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

— the EERS;

— the production and manning philosophy;

— human factors.

For the EERS, issues to be considered include:

— normal means of access to the installation;

— means available for evacuation, escape and rescue and their likely availability in the identified accident scenarios;

— fire and explosion scenarios which might lead to the need for escape or evacuation (including the effects of smoke and radiant heat);

— number and distribution of personnel;

— emergency command and communication;

— emergency monitoring and control;

— layout of the installation and arrangement of equipment;

— environment in which the installation is located;

— level of assistance available from external sources;

— any regulations and guidance which are applicable to the installation;

— human factors.

The following clauses of this International Standard identify requirements and provide guidance on a range of measures which may have a role in either the control and mitigation of the potential fire and explosion hazardous events on an installation or in the EER activities which may be required as a result of a fire or explosion.

## 5 Installation layout

### 5.1 Objectives

- To minimize the possibility of hazardous accumulations of both liquids and gaseous hydrocarbon, and to provide for the rapid removal of any accumulations which do occur;
- To minimize the probability of ignition;
- To minimize the spread of flammable liquids and gases which may result in a hazardous event;
- To separate areas required to be nonhazardous from those designated as being hazardous;
- To minimize the consequences of fire and explosions;
- To provide for adequate arrangements for escape and evacuation;
- To facilitate effective emergency response.



### 5.2 Functional requirements

The layout of an installation may have a major effect on the consequences of fires and explosions and on the arrangements required for EER. Consequently, for a new installation or the modification of an existing installation the impact of layout options on the FES and EERS shall be fully evaluated as a basis for the selection of the design which, so far as is reasonably practicable, minimizes the risks of fire and explosion.

In developing the layout of the installation, consideration shall be given to maximizing so far as is reasonable the separation by distance of the temporary refuge (TR), accommodation and evacuation, escape and rescue (EER) facilities from areas containing equipment handling hydrocarbons.

Either separation by distance or the use of barriers can prevent the escalation of fire to another area. Where such barriers are required to avoid escalation, they shall be adequate to resist fire and, as far as is reasonable the effects of explosions. The provision of such barriers will influence ventilation, access/escape routes, ESD/EDP system design, explosion resistance and firewater demands. The interdependency of safety systems shall be considered during the design of the installation. Any penetration of a barrier provided to prevent escalation of a fire or explosion shall not jeopardize the integrity of the barrier.

Essential safety systems (such as control stations, temporary refuge, muster areas, fire pumps) shall be located where they are least likely to be affected by fires and explosions. In some situations such systems will need to be designed to withstand fire and explosions, at least until people on board have been safely evacuated or the situation has been brought under control.

The installation layout may result in equipment being at risk from impact of dropped objects or collisions. The need to protect critical items of process equipment, especially where failure could result in a major loss of inventory, shall be considered to determine whether impact protection is required.

## 6 Emergency shutdown systems and blowdown

### 6.1 Objective

- To initiate appropriate shutdown, isolation and blowdown actions to prevent escalation of abnormal conditions into a major hazardous event and to limit the extent and duration of any such events which do occur.

### 6.2 Functional requirements

An emergency shutdown (ESD) system shall be provided, in accordance with the requirements of the FES, in order to:

— isolate the installation from the major hydrocarbon inventories within pipelines and reservoirs which, if released on failure, would pose an intolerable risk to personnel, environment and the equipment;

— where appropriate, sectionalize topside inventory to limit the quantity of material released on loss of containment;

— control potential ignition sources such as fired units, engines and non-essential electrical equipment;

— control subsurface safety valve(s);

— where appropriate, depressurize hydrocarbon inventory and vent it to a safe place.



An ESD system shall be designed such that it is capable of fulfilling its function under the conditions which may be experienced when the system is required to operate.

An ESD system shall provide adequate information at a control station so that personnel involved in managing an emergency have the information they need. The information presented to the operator and the controls provided shall be such that the operator can effectively execute the required actions in an emergency.

If plant is in operation, the essential shutdown functions shall be available during maintenance activities which affect the operation of the ESD system.

Emergency depressurization (EDP) systems shall be considered for pressurized hydrocarbon systems to dispose of the gaseous inventory under emergency conditions in order to reduce the duration of an event, the quantity of material released or the likelihood of a pressure vessel failure in a fire.

The design of an ESD system may be for manual or automatic initiation or both. When manual initiation is required, the systems shall be simple to operate and shall not require operators to make complex or non-routine decisions.

Once initiated, all control actions required by the ESD system shall occur automatically.

Manual stations for initiation of ESD shall be located in strategic positions, be readily accessible, well marked and protected against unintentional activation.

The ESD system shall contain facilities for testing of both input/output devices and internal functions.

# 7 Control of ignition

## 7.1 Objective

- To minimize the likelihood of ignition of flammable liquids and gases following a loss of containment.

## 7.2 Functional requirements

Arrangements to minimize the likelihood of ignition shall be provided in accordance with the requirements of the FES. This should include minimization of the number of potential ignition sources as far as reasonably practicable.

Ignition of flammable liquid and gas leaks shall be minimized by identifying those areas where such leaks are likely to occur and by providing in these areas equipment which is designed to reduce the likelihood of ignition of flammable liquids and gases.

The installation shall be classified into hazardous and nonhazardous areas in accordance with a recognized standard or code.

The need for the ESD system to incorporate isolation of electrical equipment which is not suitable for use in hazardous areas during major gas emergencies shall be considered in the design of the ESD system.

Procedures to control the use of temporary equipment which may present ignition sources shall be established.

Direct-fired equipment shall be located or protected to prevent ignition following loss of containment.



# 8 Control of spills

## 8.1 Objective



- To provide measures for containment and proper disposal of flammable liquid spills.

## 8.2 Functional requirements

Arrangements for control of spills shall be provided in accordance with the requirements of the FES.

Measures shall be provided for dealing with spills in all areas which have a source of liquid hydrocarbons so as to minimize the risk of fires and to avoid damage to the environment.

Hazardous and nonhazardous open drains shall be physically separate.

Hazardous closed drains shall be separate from all open drainage systems.

The design of the drainage system shall limit the maximum spread of a spill and attempt to minimize any escalation arising from the spill.

# 9 Emergency power systems

## 9.1 Objective

- To provide a reliable source of emergency power.

## 9.2 Functional requirements

Emergency power shall be provided in accordance with the requirements of the FES.

Systems requiring electrical power to fulfil their functions and to allow the installation to be safely shut down and evacuated shall have a secure power supply of sufficient capacity and duration for a period sufficient for effective management of the installation while main power generation is unavailable.