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Petroleum and natural gas industries — Specific requirements for offshore structures —

Part 9: Structural integrity management

Industries du pétrole et du gaz naturel — Exigences spécifiques relatives aux structures en mer —

Partie 9: Gestion de l'intégrité structurelle

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 7, *Offshore structures*.

A list of all parts in the ISO 19901 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Structural integrity management (SIM) is the implementation of engineering, inspection, maintenance, monitoring and remediation activities required to demonstrate the fitness-for-service of a structure for its intended application throughout its total service life and prevent/mitigate severe or catastrophic health, safety, environmental, or structural events. The SIM process provides a proactive approach to monitor, evaluate and assess structural condition and establish a procedure to validate the fitness-for-service of an offshore structure.

The purpose of SIM is to provide a process for demonstrating the integrity of the structure throughout its intended total service life. Approaches to dealing with SIM vary depending upon field life, the type of structure and the sophistication of regional infrastructure where the structure is located. In turn, these factors can influence the philosophical approach to the specification of SIM which can vary from one involving emphasis on the use of monitoring equipment to one with a preference for the extensive use of inspections. Additionally, design decisions on safety factors, design margins, corrosion protection, component redundancy and system reliabilities will influence the SIM strategy and program.

SIM process choices are made in the design (e.g. selection of materials, condition monitoring systems, new or proven technology, robustness of design, redundancy, and fabrication/installation methods) that will influence SIM activities during the operations phase. Implementation of a SIM process can benefit significantly from design decisions, such as providing access for inspection and maintenance.

A SIM process is used to develop an inspection scope, program and frequency that, when executed, provides information on the condition of the structure, which can be used to understand present and emerging risk from operating the topsides, and provide information for determining the ongoing strategy for mitigating that risk. A well-implemented SIM process will maintain the structure's fitness-for-service for the operational life of the platform and through the decommissioning process.

Initial SIM development begins early as part of the structure's new design or reuse, ideally during the structure's concept and select stages. Most of the initial SIM data, strategies and program philosophies will be generated during the design by the project team and ultimately handed over to the structure's operating team. Once commissioned, the effective operation of the structure is contingent on the provided SIM philosophy and design documentation from the project team. These deliverables (e.g. design documents, drawings, computer models) are most useful to the operating team when they are complete, up-to-date (i.e. reflect as commissioned installation), organized, in a usable format and readily accessible. To provide sustainable SIM, the project team and operating team work collaboratively during the project in defining the necessary SIM deliverables.

The platform operating team is responsible for validating that the design data are comprehensive and complete. In addition, the operating team is responsible for demonstrating that the SIM strategies conform to the operator's risk criteria, regional regulations and that the SIM strategies are workable based on location infrastructure and capabilities. National and regional regulations can require SIM documentation in a form suitable for verification or for review by a regulator.

ISO 19904-1[5] is applicable to the integrity management (IM) of hull, moorings and marine systems of existing floating offshore structures. However, this document is applicable to the structural integrity management of the topsides structural components of floating facilities.

ISO 19905-1[6] is applicable to the IM of the legs, primary hull structure, spudcans, jacking-systems and marine systems of existing mobile jack-up offshore structures and for setting the limit states. However, this document is applicable to the structural integrity management of permanently located jack-ups.

Petroleum and natural gas industries — Specific requirements for offshore structures —

Part 9: Structural integrity management

1 Scope

This document specifies principles for the structural integrity management (SIM) of offshore structures subjected to known or foreseeable types of actions.

This document specifies requirements and provides recommendations applicable to the following types of fixed steel offshore structures for the petroleum and natural gas industries:

— caissons, free-standing and braced;

— jackets;

— monotowers;

— towers.

This document is applicable to topsides, including but not limited to the main decks, deck legs, topsides modules, crane pedestals, helideck, drilling derrick, skid beams, flare booms, exhaust towers, radio tower, conductor support frames, and lifeboat davits. In addition, it is applicable to compliant bottom founded structures, steel gravity structures, jack-ups, other bottom founded structures and other structures related to offshore structures (e.g. underwater oil storage tanks, bridges and connecting structures), to the extent to which its requirements are relevant.

This document contains requirements for planning and engineering of the following tasks:

a) integrity management data requirements;

b) in-service inspection and integrity management of both new and existing structures;

c) assessment of existing structures;

d) evaluation of structures for reuse at different locations;

e) evaluation of structures for their future removal.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19900, *Petroleum and natural gas industries — General requirements for offshore structures*

ISO 19901-1, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations*

ISO 19901-2, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 2: Seismic design procedures and criteria*

ISO 19901-4, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations*

ISO 19901-5, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 5: Weight control during engineering and construction*

ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures*

ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19900, ISO 19901-1, ISO 19901-2, ISO 19901-4, ISO 19901-5, ISO 19902 and ISO 19906 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
anomaly
in-service survey measurement, which is outside the threshold acceptable from the design or most recent fitness-for-service assessment

3.2
assessment
detailed qualitative or quantitative determination of the structural component or system strength

3.3
assurance
process to confirm that *SIM* (3.21) is performed in conformity with the procedures set out in the SIM policy and written description

3.4
collapse
loss of the load-bearing capacity of the platform through failure of one or more structural components

3.5
continual improvement
ongoing implementation of findings of reviews to improve the SIM process

3.6
defect
imperfection, fault, or flaw in a structural component

3.7
emergency response plan
written document associated with an asset, which defines the actions intended to protect people, the environment, and property from adverse consequences associated with emergency situations

3.8
inspection program
scope of work for the offshore execution of the inspection activities to determine the condition of the structure

3.9
inspection strategy
systematic approach to the development of a plan for the in-service inspection of a structure

3.10
mitigation
limitation of negative consequence or reduction in likelihood of a hazardous event or condition

3.11
non-conformance
insufficient strength or inadequate performance of a structure or structural component relative to a limit state or *performance level* (3.13)

3.12
non-redundant
platform for which its global capacity is reached when one of its primary structural elements reaches its maximum capacity

3.13
performance level
required functionality of the structure during and after a hazardous event

3.14
performance standard
statement of the performance required of a system, item of equipment, person or procedure, which is used as the basis for managing the hazard through the lifecycle of the platform

3.15
prior exposure
historical exposure of a structure to significant metocean, seismic or ice events

3.16
redundancy
availability of alternate load paths in a structure following the loss of connection of one or more structural components

3.17
residual strength
maximum strength of a structure in a damaged condition

3.18
risk-based inspection
RBI
inspection strategies developed from an evaluation of the risk associated with a structure with the intention of tailoring inspection scope and frequency to risk magnitude and location

3.19
structural analysis
determination of the effects of actions on structures and their components

3.20
structural assessment
interpretation of available information including available analysis results used to confirm or otherwise the integrity of the structure

3.21
structural integrity management
SIM
systematic multi-step cyclic process intended to assure structural integrity and functionality of a structure throughout its total service life

[SOURCE: ISO 19900:2019, 3.51]

3.22
tolerable risk
level of risk deemed acceptable by society in order that some benefit or functionality can be obtained, but in the knowledge that the risk has been evaluated and is being managed

3.23
weight database
live document containing the present base and factored, dry and operating weight and CoG data for an installation's substructure and topside, broken down by module and by engineering discipline

4 Symbols

The following is a summary of the main symbols that are used throughout this document. Many other symbols are locally defined where they are used. Local use includes main symbols with one or more subscripts when a more specific use and associated definition of the symbol is intended.

A deck area

C_C metocean or seismic hazard curve correction factor

C_d drag coefficient

C_m moment reduction factor

C_r seismic reserve capacity factor

CoV_R resistance coefficient of variance

D diameter

$D1$ existing fatigue damage

$D2$ future fatigue damage

E environmental action

E_{RP} metocean action with return period of RP

E_{100} metocean 100-yr action

F cumulative probability of fatalities

F_{int} intolerable number of fatalities

F-N frequency-number

G permanent action

Hs significant wave height

L span or length

N number of fatalities

P_f probability of failure

p-y lateral soil resistance versus local pile displacement

Q variable action

Q-z	pile end bearing resistance versus pile tip displacement
r	resolving vector
RP	return period
S	internal force
t-z	axial soil-pile shear transfer versus local axial pile displacement”
T	thickness of a structural element or plate
T_{dom}	dominant natural period
U	current speed
WiDA	wave-in-deck action
WiJA	wave-in-jacket action
Γ	participation factor
Φ	modal displacement
γ	partial safety factor
Δ	deflection with subscripts for various component effects
φ	dynamic coefficient

5 Abbreviated terms

ACFM	alternating current field measurement
ADS	atmospheric diving suit
ALE	abnormal level earthquake
ALS	accidental or abnormal limit state
CoG	centre of gravity
CoV	coefficient of variance
CP	cathodic protection
CPT	cone penetration test
CS	critical structure
CVI	close visual inspection
DLM	design level method
ELE	extreme level earthquake
FMD	flooded member detection
GVI	general visual inspection

HSE health, safety and environmental

LQ living quarters

MOC management of change

MPI magnetic particle inspection

NDE non-destructive examination

ROV remotely operated vehicle

SMR strengthening, modification and/or repair

SRA structural reliability analysis

TR temporary refuge

ULS ultimate limit state

UR utilization ratio

USM ultimate strength method

WiD wave in deck

6 SIM fundamentals

6.1 General

SIM is used to manage the effects of deterioration, damage, changes in actions and accidental overloading. In addition, SIM is used to establish the framework for inspection planning, maintenance, and repair of a structure or group of structures.

6.2 Limit states and performance levels

In the design phase, exposure levels and limit states are specified for the structure and/or structural components.

The most severe consequences are categorized through defining exposure levels appropriate for the structure (ISO 19900). ISO 19900 further details the process for specifying appropriate limit states and for verifying that such limits are not exceeded. For fixed steel structures, ISO 19902 details the design/assessment criteria for the highest exposure level, L1, which covers manned and high environmental pollution exposed structures. These criteria are supplemented in ISO 19901-3[2] for topsides and 19906 for structures in arctic and cold climate regions.

Other limit states can be specified by stakeholders, such as those on L1 and L2 structures that cover potential financial and reputational events.

Where several limit states are associated with the same hazardous event, these can be termed performance levels.

6.3 Fitness-for-service assessment

Fitness-for-service assessment leads to an approximate likelihood of exceeding the limit state for a given hazardous event, which combined with a consequence model gives an estimate of risk. This allows the operator to specify risk-based inspection plans.

Motives for performing fitness-for-service assessments should be established prior to selecting the assessment method. Motives can be driven by desire to optimize an inspection program and/or the desire to understand the cost-benefit in determining the effectiveness of a mitigation strategy.

Fitness-for-service evaluation is detailed in Clause 9 while the assessment procedure is detailed in Clause 12.

6.4 Management framework

The operator shall establish and maintain a management framework that provides evidence to the corporate and regulatory stakeholders that the operator has a commitment to a sustainable lifecycle approach to demonstrate the structure is fit-for-service.

The management framework refers to the integrated systems, work processes and documentation, which are used together with the SIM process to deliver structural integrity.

The SIM framework should align with the HSE and business objectives and should have the following interrelated elements:

— policy, which sets out the intention and direction of the operator with respect to SIM;

— written description, which documents the processes and procedures adopted by the operator for the management of the structural integrity;

— organization and personnel, which provides the reporting lines, accountabilities, roles and responsibilities, and competencies required for the personnel;

— SIM process, which is used for demonstrating fit-for-service assets based on asset information/data asset from inception to decommissioning;

— procedures, which are followed for the implementation of the required activities;

— MOC, which is used to identify and monitor changes;

— validation, which is used to measure and verify the implementation against a set of defined metrics;

— continual improvement, which reviews the process periodically and implements required changes.

Core of the management framework is the SIM process (see Clause 7) as illustrated in Figure 1. The other elements mainly support this core process.

