

DIN EN ISO 19901-9

ICS 75.180.10

Einsprüche bis 2017-07-26

Entwurf

**Erdöl- und Erdgasindustrie –
 Spezielle Anforderungen für Offshore-Anlagen –
 Teil 9: Integritätsmanagement für Konstruktionen
 (ISO/DIS 19901-9:2017);
 Englische Fassung prEN ISO 19901-9:2017**

Petroleum and natural gas industries –
 Specific requirements for offshore structures –
 Part 9: Structural integrity management (ISO/DIS 19901-9:2017);
 English version prEN ISO 19901-9:2017

Industries du pétrole et du gaz naturel –
 Exigences spécifiques relatives aux structures en mer –
 Partie 9: Gestion de l'intégrité structurelle (ISO/DIS 19901-9:2017);
 Version anglaise prEN ISO 19901-9:2017

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2017-05-26 wird der Öffentlichkeit zur Prüfung und
 Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs
 besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal von DIN unter www.din.de/go/entwuerfe bzw. für Norm-
 Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de,
 sofern dort wiedergegeben;
- oder als Datei per E-Mail an noeg@din.de möglichst in Form einer Tabelle. Die Vorlage dieser Tabelle kann im
 Internet unter www.din.de/go/stellungnahmen-norm-entwuerfe oder für Stellungnahmen zu Norm-
 Entwürfen der DKE unter www.dke.de/stellungnahme abgerufen werden;
- oder in Papierform an den DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG), 10772 Berlin,
 Burggrafenstr. 6, 10787 Berlin.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten
 Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 183 Seiten

DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)

Nationales Vorwort

Dieses Dokument (prEN ISO 19901-9:2017) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ (Sekretariat: NEN, Niederlande) erarbeitet.

Für Deutschland hat hieran der Arbeitsausschuss NA 109-00-01 AA „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie - Spiegelausschuss zu CEN/TC 12 und ISO/TC 67“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Diese Europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO Norm.

Dieses Dokument wird EN ISO 19902:2007 ersetzen.

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Die Benummerung der folgenden Begriffe und Abkürzungen sind identisch mit der Benummerung in der englischen Fassung.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die in ISO 19900, ISO 19901-1, ISO 19901-2, ISO 19901-4, ISO 19901-5, ISO 19902, ISO 19906 angegebenen sowie die folgenden Begriffe.

3.1

Abstand Wasserspiegel

Deckunterseite

Abstand zwischen dem höchsten Wasserspiegel, der unter extremen Bedingungen auf dem offenen Meer eintreten kann, und der Unterseite des Kellerdecks

3.2

Anomalie

Bestandsaufnahmefeststellung während des Betriebs, die außerhalb des akzeptablen Schwellwerts des Entwurfs oder der aktuellsten Betriebstauglichkeitsbewertung liegt

3.3

Beurteilung

detaillierte qualitative oder quantitative Festlegung der Festigkeit von tragenden Bauteilen oder Systemen

3.4

Gewährleistung

Prozess zum Bestätigen, dass das SIM in Übereinstimmung mit den Verfahren durchgeführt wird, die in der SIM-Politik und in der schriftlichen Beschreibung festgelegt sind, und der geltenden Gesetzgebung entspricht

3.5

Zusammenbruch

Tragfähigkeit der Plattform, bei der die Standbeinkonstruktion oder die Decksäulen keine vertikalen Lasten mehr aufnehmen können

3.6

Folge

Auswirkungen eines ungewöhnlichen Ereignisses, das etwa durch das offene Meer, Erdbeben, Eis oder Unfall ausgelöst wird, auf das Personal, die Umwelt oder das Eigentum

3.7

fortlaufende Verbesserung

andauernde Implementierung von Erkenntnissen aus Überprüfungen, um den SIM-Prozess zu verbessern

3.8

fortgesetzter Betrieb

Nachweis der Betriebstüchtigkeit des Bauwerks zum Ende der verlängerten, erwarteten Lebensdauer

3.9

Defekt

Unvollkommenheit, Mangel oder Fehler in einem tragenden Bauteil

3.10

Notfallreaktionsplan

mit einem Unternehmenswert verbundenes schriftliches Dokument, das die Aktionen zum Schützen von Personen, der Umwelt und von Eigentum vor den negativen Auswirkungen von Notsituationen festlegt

3.11

Evaluation

Prüfung des Zustands des Bauwerks im Vergleich zum Zustand, in dem es sich befand, als es zuletzt bewertet wurde, sowie anderer Parameter, welche die Integrität und Risikograde beeinflussen, um gegebenenfalls zu bestätigen, dass die existierenden Beurteilungen des Bauwerks immer noch gelten

3.12

Versagen

unzureichende Festigkeit oder unzulängliche Leistung eines Bauwerks oder Systems, wodurch es am Erfüllen der vorgesehenen Leistungsanforderungen gehindert wird

3.13

Betriebsbereitschaft

Nachweis, dass der fortgesetzte Vor-Ort-Betrieb eines Bauwerks in seinem Ist-Zustand und in seiner vorliegenden oder geplanten Betriebskonfiguration kein unzulässiges Risiko für das Leben, die Umwelt oder das Geschäft darstellt

3.14

Betriebstauglichkeit

technische Bewertungen zum Nachweis der strukturellen Integrität des tragenden Bauteils, das einen Mangel oder einen Defekt enthalten könnte oder das unter besonderen Bedingungen betrieben werden könnte, die ein Versagen hervorrufen könnten

3.15

Informationsmanagement

Prozess, bei dem historische und betriebliche Dokumente, Daten und Informationen gesammelt, mitgeteilt und gespeichert werden

3.16

Inspektion

Besuch der Plattform sowie die zugehörigen Untersuchungsaktivitäten zur Erfassung von Daten, die für die Bewertung seiner strukturellen Integrität für die Fortsetzung des Betriebs erforderlich sind

3.17

Inspektionsprogramm

Arbeitsbeschreibung für die Offshore-Ausführung der Inspektionsaktivitäten, um den Zustand des Bauwerks festzulegen

3.18

Inspektionsstrategie

systematischer Ansatz für die Entwicklung eines Plans zur Inspektion eines Bauwerks während des Betriebs

3.19

Instandhaltung

Aufrechterhaltung des erforderlichen Zustands des Bauwerks durch vorbeugendes Eingreifen auf Grundlage der Ergebnisse der Evaluation des Bauwerks

3.20

Abmilderung

Begrenzung der negativen Folgen oder Verringerung der Wahrscheinlichkeit bestimmter Ereignisse oder Bedingungen

3.21

nicht-redundant

Plattform, deren globale Kapazität erreicht wird, wenn eines ihrer wichtigsten strukturellen Elemente seine maximale Kapazität erreicht

3.22

Eigentümer

Partei, die die physische Infrastruktur besitzt und für die Aufrechterhaltung der strukturellen Integrität verantwortlich ist

3.23

Leistungsstufe

Kriterium, für das eine existierende Plattform die Bestätigung der Betriebstauglichkeit erreichen sollte

3.24

Leistungsstandard

Beschreibung der Leistungsanforderung, die von einem System, einem Betriebsmittel, einer Person oder einem Verfahren verlangt wird und die als Grundlage zur Gefahrenverwaltung während des Lebenszyklus der Plattform verwendet wird

3.25

Politik

Absicht und Richtung des Besitzers in Bezug auf die SIM-bezogenen Prozesse und Aktivitäten

3.26

vorherige Exposition

historische Exposition einer Plattform gegenüber den vorhergesehenen Einwirkungen offenes Meer, Erdbeben und Eis

3.27

Praxis

formales Dokument, das die technischen Kriterien, Verfahren und Prozesse aufstellt

3.28

Verfahren

schriftliche, normalerweise chronisch angeordnete Richtlinie, welche Details oder Schritte zum Ausführen einer bestimmten Aktivität enthält

3.29

Redundanz

Verfügbarkeit alternativer Lastpfade in einem Bauwerk nach dem Versagen eines oder mehrerer tragender Bauteile

3.30

Restfestigkeit

Bruchfestigkeit eines Offshore-Bauwerks in einem beschädigten Zustand

3.31

Tragkraftreserve

Maß der Bruchlast-Tragfähigkeit einer Plattform, definiert als das Verhältnis der Basis-Scherung bei der Kapazitätsgrenze zur Basis-Scherung aus dem 100-Jahr Referenzkriterium

3.32

Prüfung

Prozess zur Ermittlung, wie die SIM-Prozesse auf der Grundlage von internen und externen Erfahrungen sowie bewährten Verfahrensweisen verbessert werden können

3.33

risikobasierte Inspektion

Inspektionsstrategien, die auf Grundlage der Evaluation des Risikos eines Bauwerks entwickelt wurden, mit der Absicht, den Umfang und die Häufigkeit der Inspektion an die Größe und den Ort des Risikos anzupassen

3.34

Widerstandsfähigkeit

Fähigkeit eines Bauwerks, Beschädigungen ohne Versagen zu widerstehen

3.35

Betriebslebensdauer

Zeitraum, der mit dem erwarteten Ende der Feldlebensdauer oder dem Außerbetriebnahmedatum verbunden ist

3.36

Strategie

Prozess zur Lieferung der strukturellen Integrität, die mit der SIM-Politik übereinstimmt

3.37

Konstruktionsanalyse

Berechnung zur Vorhersage des Verhaltens des Bauwerks, normalerweise in Bezug auf besondere Normenanforderungen

3.38

Bauwerksbeurteilung

Interpretation der verfügbaren Informationen einschließlich der verfügbaren Analyseergebnisse, um die Integrität des Bauwerks gegebenenfalls zu bestätigen

3.39

strukturelle Integrität

Fähigkeit eines Bauwerks, seine geforderte Funktion über einen festgelegten Zeitraum auszuführen und dabei Gesundheit, Sicherheit und Umwelt zu schützen

3.40

Management zur Sicherstellung der Integrität des Bauwerks

Mittel zum Nachweis, dass die Personen, Systeme, Prozesse und Ressourcen zur Gewährleistung der Integrität verfügbar sind, eingesetzt werden und ihre Leistungen bei Bedarf während des gesamten Lebenszyklus des Bauwerks erbringen können

3.41

Untersuchung

spezielle Sichtprüfung oder zerstörungsfreie Prüfung eines oder mehrerer Plattformbauteile

3.42

Gewichtsdatenbank

Live-Dokument, welches das dauerhafte und variable Gewicht sowie die Schwerpunkt-Daten der Unterstruktur und der Aufbauten einer Installation, gegliedert in Module und Engineering-Disziplinen enthält

4 Symbole

Nachfolgend eine Zusammenfassung der Hauptsymbole, die in diesem Dokument verwendet werden. Viele weitere Symbole werden dort, wo sie verwendet werden, lokal festgelegt. Lokal werden etwa Hauptsymbole mit einem oder mehreren Indizes verwendet, wenn eine speziellere Verwendung und damit verbundene Definition des Symbols beabsichtigt ist.

A	Deckbereich
C_C	Korrekturfaktor, um Unsicherheiten zu berücksichtigen, die nicht in einer Gefahrenkurve für das offene Meer oder Erdbeben erfasst werden
C_d	Luftwiderstandsbeiwert
C_G	Korrekturfaktor, um Unsicherheiten zu berücksichtigen, die nicht in einer Schwerkrafts-Gefahrenkurve erfasst werden
C_m	Moment-Reduktionsfaktor
C_r	seismischer Reservekapazitätsfaktor
CoV_R	Widerstandsbeiwert der Varianz
CoV_L	Belastungsbeiwert der Varianz
D	Durchmesser
E	Umwelteinwirkung
E_{RP}	Einwirkung im offenen Meer
E_{CP}	Einwirkung im offenen Meer bei Zusammenbruch
E_{100}	100-Jr Einwirkung im offenen Meer
E_{10000}	10 000-Jr Einwirkung im offenen Meer
E_e	extreme Umwelteinwirkung
F	kumulative Wahrscheinlichkeit von Todesfällen
F_{int}	unannehmbare Anzahl Todesfälle
F_d	Bemessungsaktion
F_{dk}	Wellen-/Stromstärke an Deck
F_y	charakteristische Fließspannung
$F-N$	Häufigkeitszahl
G	dauerhafte Einwirkung
H_s	signifikante Wellenhöhe
L	Spanne oder Länge
L_{calc}	berechnete Ermüdungslebensdauer

N	Anzahl Todesfälle
P_f	Wahrscheinlichkeit des Versagens
$p\text{-}y$	seitlicher Bodenwiderstand gegen lokale Pfahlverschiebung
Q	variable Einwirkung
$q\text{-}z$	Pfahlspitzen-Druckwiderstand gegen Pfahlkopfverschiebung
r	auflösender Vektor
r_H	Verhältnis der Einwirkung mit einer 10 000 Jahre Wiederkehrperiode zur Einwirkung mit einer 100 Jahre Wiederkehrperiode
RP	Wiederkehrperiode
RP_C	Wiederkehrperiode bei Zusammenbruch
RP_L	Last der Wiederkehrperiode
S	interne Kraft
$t\text{-}z$	Boden Pfahl Scherübertragung gegen lokale Pfahlverschiebung
T	grundlegende Schwingungsdauer
T	Stärke eines strukturellen Elementes oder einer Platte
T_{dom}	dominierende natürliche Periode
U	aktuelle Geschwindigkeit
WiDA	Welle-in-Deck Einwirkung
WiJA	Welle-in-Standbein Einwirkung
Z_{dk}	Welle-in-Deck Krafterhöhung
θ_w	Wellenrichtung
Γ	Partizipationsfaktor
Φ	modale Verschiebung
γ	Teilsicherheitsbeiwert
γ_f	Teileinwirkungsbeiwert
γ_{FD}	Teilbeschädigung-Designfaktor
γ_R	Teilwiderstandsbeiwert
Δ	Ablenkung mit Indizes für verschiedene Bauteilwirkungen
φ	dynamischer Koeffizient
λp	Plattenparameter

5 Abkürzungen

ACFM	Wechselstrom-Feldmessung (en: alternating current field measurement)
ADS	Panzertauchanzug (en: atmospheric diving suit)
ALE	Erdbeben ungewöhnlicher Stärke (en: abnormal level earthquake)
ALS	unfallbedingter oder ungewöhnlicher Grenzzustand (en: accidental or abnormal limit state)
CFD	Numerische Strömungsdynamik (en: computational fluid dynamics)
CoG	Schwerpunkt (en: centre of gravity)
CoV	Beiwert der Varianz (en: coefficient of variance)
CP	Kathodenschutz (en: cathodic protection)
CS	kritisches Bauwerk (en: critical structure)
CVI	genaue Sichtprüfung (en: close visual inspection)
DAF	dynamischer Verstärkerfaktor (en: dynamic amplification factor)
DLM	Konstruktionsebenenverfahren (en: design level method)
ECI	Wirbelstrominspektion (en: eddy current inspection)
EER	Evakuierung, Flucht und Rettung (en: evacuation, escape and rescue)
ELE	Erdbeben extremer Stärke (en: extreme level earthquake)
ER	Notfallreaktion (en: emergency response)
ESDV	Notabschaltungsventil (en: emergency shutdown valve)
FMD	geflutetes Bauelement Erkennung (en: flooded member detection)
GVI	allgemeine Sichtprüfung (en: general visual inspection)
HLV	Schwergutschiff (en: heavy lift vessel)
HSE	Gesundheit, Sicherheit und Umwelt (en: health, safety and environmental)
ICP	Imperial College Pile (en: Imperial College Pile)
IRPA	Einzelrisiko pro Jahr (en: individual risk per annum)
LJF	lokale Gelenkbeweglichkeit (en: local joint flexibility)
LQ	Mannschaftsräume (en: living quarters)
MOC	Management von Veränderungen (en: management of change)
MPI	Magnetpulverprüfung (en: magnetic particle inspection)
MWL	Mittelwasserstand (en: mean water level)
NDE	zerstörungsfreie Untersuchung (en: non-destructive examination)

NTE	nicht zu überschreiten (en: not-to-exceed)
PA	endgültig verlassen (en: permanently abandon)
PCPT	Piezocone Eindringprüfung (en: piezocone penetration test)
POB	Personal an Bord (en: personnel on-board)
PSHA	probabilistische seismische Gefährdungsanalyse (en: probabilistic seismic hazard analysis)
RSA	Antwortspektren-Analyse (en: response spectra analysis)
RBI	Risikobasierte Inspektion (en: risk-based inspection)
ROV	ferngelenktes Fahrzeug (en: remotely operated vehicle)
RP	Wiederkehrperiode (en: return period)
RT	Durchstrahlungsprüfung (en: radiographic testing)
SDOF	Ein-Massen-Schwinger (en: single degree of freedom)
SECE	sicherheits- oder umweltkritisches Element (en: safety or environmental critical element)
SIM	Managementsystem zur Sicherstellung der Integrität des Bauwerks (en: structural integrity management)
SMR	Verstärkung, Änderung und/oder Reparatur (en: strengthening, modification and/or repair)
SRA	Tragwerks-Zuverlässigkeitsanalyse (en: structural reliability analysis)
SSSV	Sicherheitsventil unter der Oberfläche (en: sub-surface safety valve)
TA	vorübergehend verlassen (en: temporarily abandon)
TDA	Zeitbereichsanalyse (en: time-domain analysis)
THA	Zeitverlaufsanalyse (en: time-history analysis)
TR	Not-Zufluchtsort (en: temporary refuge)
TRIF	Not-Zufluchtsort Beeinträchtigungsfrequenz (en: temporary refuge impairment frequency)
UAV	unbemanntes Luftfahrzeug (en: unmanned aerial vehicle)
ULS	Grenzzustand der Tragfähigkeit (en: ultimate limit state)
UR	Nutzungsgrad (en: utilisation ratio)
USM	Bruchfestigkeitsverfahren (en: ultimate strength method)
UT	Ultraschallprüfung (en: ultrasonic testing)

Contents

Foreword	vii
Introduction	ix
1 Scope	10
2 Normative references	10
3 Terms and definitions	11
4 Symbols	14
5 Abbreviated terms	16
6 SIM fundamentals	18
6.1 General	18
6.2 Fitness-for-service assessment	19
6.3 Management framework	19
6.4 Performance level	20
6.5 Design	20
6.6 Topsides	21
6.7 Continued service	21
6.8 Structural integrity interfaces	21
7 SIM process	22
8 Data	22
8.1 General	22
8.2 Design data	23
8.3 Fabrication and installation data	23
8.4 Condition data	23
8.5 Operational data	23
8.6 Engineering data	23
8.7 Missing data	24
8.8 Data management	24
9 Evaluation	25
9.1 General	25
9.2 Factors	25
9.3 Hazards	26
9.4 Critical structure (CS)	26
9.5 Risk	27
9.5.1 General	27
9.5.2 Consequence of failure	27
9.5.3 Likelihood of failure	29
9.5.4 Risk presentation	30
9.6 Performance level	31
9.6.1 General	31
9.6.2 Life-safety	32
9.6.3 Pollution of the environment	32
9.6.4 Financial loss	32

ISO/DIS 19901-9:2017(E)

9.7	Fatigue	32
9.8	Assessment.....	33
9.8.1	General	33
9.8.2	Assessment motive.....	33
9.8.3	Assessment initiators	34
9.9	Mitigation measures	36
9.9.1	General	36
9.9.2	Consequence reduction.....	36
9.9.3	Likelihood reduction	37
10	Strategy.....	39
10.1	General.....	39
10.2	Inspection strategy	40
10.2.1	General	40
10.2.2	Inspection motives	40
10.2.3	Inspection type	41
10.2.4	Inspection method.....	42
10.2.5	Inspection interval.....	44
10.2.6	Inspection scope	48
10.2.7	Pre-selected inspection areas.....	51
10.3	Maintenance strategy	51
10.4	Monitoring strategy	51
10.4.1	General	51
10.4.2	Weight monitoring.....	52
10.4.3	Deck elevation monitoring.....	52
10.4.4	Natural frequency monitoring	52
10.4.5	Corrosion protection monitoring.....	53
10.4.6	Metoccean monitoring	53
10.5	Evacuation strategy.....	53
10.6	Geotechnical investigation	53
11	Program	54
11.1	General.....	54
11.2	Inspection program	54
11.2.1	General	54
11.2.2	Specifications	54
11.2.3	Inspection method.....	55
11.3	Maintenance program.....	57
11.4	Monitoring program.....	57
12	Assessment requirements	57
12.1	General.....	57
12.2	Assessment information	58
12.2.1	General	58
12.2.2	Information requirements	58
12.2.3	Limited or missing information.....	58
12.2.4	Above water information	59
12.2.5	Underwater information	59
12.2.6	Geotechnical information	59
12.3	Assessment method.....	59
12.3.1	General	59

12.3.2	Semi-quantitative methods	60
12.3.3	Quantitative methods.....	61
12.3.4	Fatigue analysis	63
12.4	Assessment model.....	63
12.4.1	General	63
12.4.2	Tubular members	63
12.4.3	Connections.....	64
12.4.4	Conductors	64
12.4.5	Damage	64
12.4.6	Repaired and strengthened elements	65
12.4.7	Foundation model	65
12.4.8	Material strength	66
12.5	Assessment for gravity hazard	66
12.5.1	General	66
12.5.2	Design level method (DLM)	66
12.5.3	Ultimate strength method (USM)	67
12.6	Assessment for metocean hazard	67
12.6.1	General	67
12.6.2	Metocean criteria.....	67
12.6.3	Crest elevation.....	67
12.6.4	Metocean action vector - jacket.....	68
12.6.5	Metocean action vector - deck.....	68
12.6.6	Directionality of metocean hazards.....	69
12.6.7	Design level method (DLM)	69
12.6.8	Linear-elastic redundancy method.....	69
12.6.9	Ultimate strength method (USM)	69
12.7	Assessment for seismic hazard.....	70
12.7.1	General	70
12.7.2	Seismic criteria.....	70
12.7.3	Seismic action vector	70
12.7.4	Directionality of seismic hazards	71
12.7.5	Design level method (DLM)	71
12.7.6	Ultimate strength method (USM)	71
12.8	Assessment for collision hazard	72
12.8.1	General	72
12.8.2	Collision zone	73
12.8.3	Collision criteria	73
12.8.4	Directionality of collision hazards.....	73
12.8.5	Collision assessment method	74
12.9	Assessment for ice hazard	74
12.10	Assessment for explosion hazard	74
12.11	Assessment for fire hazard	74
13	Reuse	74
13.1	General	74
13.2	Fatigue in reused structures	74
13.3	Steel in reused structures	75
13.4	Inspection of reused structures.....	75
13.4.1	General	75

ISO/DIS 19901-9:2017(E)

13.4.2	Initial condition assessment of structural members and connections	75
13.4.3	Extent of weld inspection	76
13.4.4	Corrosion protection systems	76
13.5	Removal and reinstallation	76
14	Decommissioning	76
14.1	General	76
14.2	Decommissioning process	76
14.3	Pre-decommissioning data gathering	77
14.4	Planning and engineering	77
14.5	Well decommissioning	77
14.6	Facilities decommissioning	77
14.7	Pipeline decommissioning	77
14.8	Conductor removal	77
14.9	Structure decommissioning	78
14.10	Site clearance	78
Annex A	(informative) Additional information and guidance	79
A.1	Scope	79
A.2	Normative references	80
A.3	Terms and definitions	80
A.4	Symbols	80
A.5	Abbreviated terms	80
A.6	SIM fundamentals	80
A.7	SIM process	90
A.8	Data	91
A.9	Evaluation	95
A.10	Strategy	119
A.11	Program	137
A.12	Assessment requirements	140
A.13	Reuse	164
A.14	Decommissioning	167

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 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 19901-9 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*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO 19901 consists of the following parts, under the general title *Petroleum and natural gas industries — Specific requirements for offshore structures*:

- *Part 9: Structural integrity management*
- *Part [n]:*
- *Part [n+1]:*

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

ISO/DIS 19901-9:2017(E)

The committee responsible for this document is Technical Committee ISO/TC 67, Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries, Subcommittee SC 7, Offshore structures.

This first edition of ISO 19901-9 cancels and replaces ISO 19902:2007, Clauses 23, 24 and 25, which have been withdrawn.

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

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 service life and prevent/mitigate severe or catastrophic health, safety, environmental, or structural incidents. The SIM process provides a proactive measure to monitor, evaluate and assess structural condition and establish a process to validate the structural integrity of an offshore platform.

Purpose of SIM is to provide a process for demonstrating the structural integrity of the platform throughout its intended design service life on a fit-for-service basis. Approaches to dealing with SIM vary depending upon field life, type of structure and 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. Regardless, the resulting SIM aims to maintain the structural integrity of the platform throughout its service life.

SIM 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 can benefit significantly from design decision, such as providing access for inspection and maintenance.

SIM process is used to develop an inspection program, scope and frequency that, when executed, can provide 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.

Project and operating teams have important roles in the initial specification and development of the SIM process, including the identification of how the structure is expected to respond and the limitations inherent in the design, whether in the form of loading limitations or environmental restrictions that could apply to weather-sensitive operations. The project team in charge of the design is generally responsible for developing the SIM data, initial strategies and program philosophy that will be handed over to the operations team.

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 owner 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.

Platform operating team is responsible for maintaining the structure in such a way that it can safely fulfil its intended future use according to the provisions of this document and of the relevant structure-specific standard in the series of documents applicable to offshore structures.

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 covers all topsides and structures above sea level, 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.

ISO 19904-1 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 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 structural integrity performance level. However, this document is applicable to the structural integrity management of permanently located jack-ups.

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 19900:2013, *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, ISO 19906 and the following apply.

3.1

air gap

clearance between the highest water surface that occurs during the extreme metocean conditions and the underside of the cellar deck

3.2

anomaly

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

3.3

assessment

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

3.4

assurance

process to confirm that SIM is performed in conformity with the procedures set out in the SIM policy and written description, and complies with applicable legislation

3.5

collapse

load bearing capacity of the platform, at which the jacket structure or deck columns are no longer able to support vertical loads

3.6

consequence

effects of an abnormal event, such as metocean, seismic, ice or accidental, on personnel, the environment, or property

3.7

continual improvement

ongoing implementation of findings of reviews to improve the SIM process

ISO/DIS 19901-9:2017(E)

3.8

continued service

demonstration of fitness-for-service of the structure to the end of the extended anticipated operating service life

3.9

defect

imperfection, fault, or flaw in a structural component

3.10

emergency response plan

written document associated with a company asset, which defines the actions intended to protect people, the environment, and property from adverse consequences associated with emergency situations

3.11

evaluation

review of condition of the structure compared to that when it was last assessed and other parameters that affect the integrity and risk levels to confirm or otherwise that the existing structural assessments still apply

3.12

failure

insufficient strength or inadequate performance of a structure or system, preventing it from fulfilling its intended performance requirements

3.13

fit-for-service

demonstration that the continued in-situ operation of a structure in its as-is condition and present or planned operating configuration does not cause unacceptable risk to life-safety, the environment or the business

3.14

fitness-for-service

engineering evaluations performed to demonstrate the structural integrity of structural component that could contain a flaw or damage or that could be operating under specific conditions that could produce a failure

3.15

information management

process by which historical and operational documents, data and information are collected, communicated and stored

3.16

inspection

visit to the platform and the associated survey activities for purposes of collecting data required in evaluating its structural integrity for continued operation

3.17

inspection program

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

3.18

inspection strategy

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

3.19

maintenance

upkeep of the required condition of the structure by proactive intervention based on output from the structural evaluation

3.20

mitigation

limitation of negative consequence or reduction in likelihood of particular event or condition

3.21

non-redundant

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

3.22

owner

party who owns the physical infrastructure and is responsible for maintaining structural integrity

3.23

performance level

criteria for which an existing platform should achieve to confirm fitness-for-service

3.24

performance standard

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

3.25

policy

intention and direction of the owner with respect to the SIM related processes and activities

3.26

prior exposure

historical exposure of a platform to the design metocean, seismic or ice events

3.27

practice

formal document that establishes the technical criteria, methods and processes

3.28

procedure

written directive, usually arranged chronologically, which provides details or steps required to perform a given activity

3.29

redundancy

availability of alternate load paths in a structure following the failure of one or more structural components

3.30

residual strength

ultimate strength of an offshore structure in a damaged condition

3.31

reserve strength ratio

measure of the ultimate load carrying capacity of a platform, defined as the ratio of the base shear at ultimate capacity to the base shear from the 100-year reference criteria

ISO/DIS 19901-9:2017(E)

3.32

review

process used to determine how the SIM processes can be improved on the basis of in house and external experience and industry best practice

3.33

risk-based inspection

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

3.34

robustness

ability of a structure to tolerate damage without failure

3.35

service life

time period associated with the structure's anticipated end of field life or decommissioning date

3.36

strategy

process for delivering the structural integrity consistent with the SIM policy

3.37

structural analysis

calculation to predict the behaviour of the structure usually relative to specified code requirements

3.38

structural assessment

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

3.39

structural integrity

ability of a structure to perform its required function over a defined time period whilst protecting health, safety and the environment

3.40

structural integrity management

means of demonstrating that the people, systems, processes and resources that deliver integrity are in place, in use and will perform when required of the whole lifecycle of the structure

3.41

survey

specific visual or non-destructive examination of one or more platform components

3.42

weight database

live document containing the permanent and variable 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	correction factor applied to account for uncertainties not captured in a metocean or seismic hazard curve
C_d	drag coefficient
C_G	correction factor applied to account for uncertainties not captured in a gravitational hazard curve
C_m	moment reduction factor
C_r	seismic reserve capacity factor
CoV_R	resistance coefficient of variance
CoV_L	loading coefficient of variance
D	diameter
E	environmental action
E_{RP}	metocean action
E_{CP}	metocean action at collapse
E_{100}	metocean 100-yr action
E_{10000}	metocean 10 000-yr action
E_e	extreme environmental action
F	cumulative probability of fatalities
F_{int}	intolerable number of fatalities
F_d	design action
F_{dk}	wave/current force on deck
F_y	characteristic yield stress
$F-N$	frequency-number
G	permanent action
H_s	significant wave height
L	span or length
L_{calc}	calculated fatigue life
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

ISO/DIS 19901-9:2017(E)

r resolving vector

r_H ratio of the action having a 10 000 years return period to the action having a 100 years return period

RP return period

RP_C return period at collapse

RP_L return period load

S internal force

$t-z$ soil pile shear transfer versus local pile displacement

T fundamental period of vibration

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

Z_{dk} wave-in-deck force elevation

Θ_w wave direction

Γ participation factor

Φ modal displacement

γ partial safety factor

γ_f partial action factor

γ_{FD} partial damage design factor

γ_R partial resistance factor

Δ deflection with subscripts for various component effects

φ dynamic coefficient

λ_p plate parameter

5 Abbreviated terms

ACFM alternating current field measurement

ADS atmospheric diving suit

ALE abnormal level earthquake

ALS	accidental or abnormal limit state
CFD	computational fluid dynamics
CoG	centre of gravity
CoV	coefficient of variance
CP	cathodic protection
CS	critical structure
CVI	close visual inspection
DAF	dynamic amplification factor
DLM	design level method
ECI	eddy current inspection
EER	evacuation, escape and rescue
ELE	extreme level earthquake
ER	emergency response
ESDV	emergency shutdown valve
FMD	flooded member detection
GVI	general visual inspection
HLV	heavy lift vessel
HSE	health, safety and environmental
ICP	Imperial college pile
IRPA	individual risk per annum
LJF	local joint flexibility
LQ	living quarters
MOC	management of change
MPI	magnetic particle inspection
MWL	mean water level
NDE	non-destructive examination
NTE	not-to-exceed
PA	permanently abandon
PCPT	Piezocone penetration test

ISO/DIS 19901-9:2017(E)

POB personnel on-board

PSHA probabilistic seismic hazard analysis

RSA response spectra analysis

RBI risk-based inspection

ROV remotely operated vehicle

RP return period

RT radiographic testing

SDOF single degree of freedom

SECE safety or environmental critical element

SIM structural integrity management

SMR strengthening, modification and/or repair

SRA structural reliability analysis

SSSV sub-surface safety valve

TA temporarily abandon

TDA time-domain analysis

THA time-history analysis

TR temporary refuge

TRIF temporary refuge impairment frequency

UAV unmanned aerial vehicle

ULS ultimate limit state

UR utilisation ratio

USM ultimate strength method

UT ultrasonic testing

6 SIM fundamentals

6.1 General

Structural integrity management (SIM) shall use a continuous process for demonstrating that an offshore structure is fit-for-service from installation through to decommissioning. SIM shall be used to manage the effects of deterioration, damage, changes in loading and accidental overloading. In addition, SIM shall be used to establish the framework for inspection planning, maintenance, and repair of a platform or group of platforms.

6.2 Fitness-for-service assessment

This document shall be used for performing fitness-for-service assessment against minimum performance levels for the major offshore structural hazards. The fitness-for-service assessment approaches lead to an approximate probability of failure for surviving a given event, which combined with a consequence model gives an estimate of risk. This allows for the setting of risk-based inspection plans that could vary in time interval and in scope of work.

Fit-for-service assessment approach is structured so that the damage to or collapse of a platform will not increase life-safety or environmental risk. However, the approach can create an economic burden to the owner in terms of facility and production losses. The determination of an acceptable level of financial risk is left to the owners' discretion. It can be beneficial for an owner to perform explicit cost-benefit risk analyses in addition to using the fitness-for-service performance levels recommended in this document.

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

Fitness-for-service assessment requirements shall be performed in conformance to the assessment requirements (see Clause 12).

6.3 Management framework

The owner shall establish and maintain a management framework that provides evidence to the corporate and regulatory stakeholders that the owner has a commitment to a sustainable lifecycle approach to demonstrate structural fitness-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:

- company policy, which sets out the intention and direction of the owner with respect to SIM;
- written description, which documents the processes and procedures adopted by the owner 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;
- procedures, which are followed for implementation of the required activities;
- MOC, which is used to identify and monitor changes;
- validation, which is used to measure and verify performance against a set of defined metrics;
- continual improvement, which reviews the process periodically and implement 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.

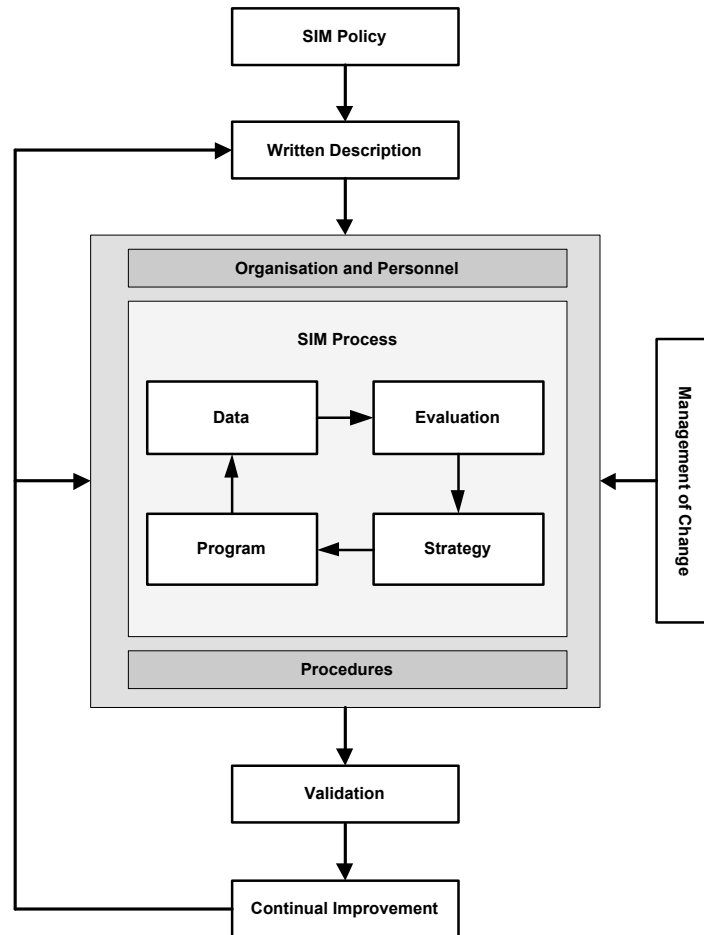


Figure 1 — Management framework

6.4 Performance level

Prior to implementing the SIM process, the owner shall establish fit-for-service performance levels for the platform or group of platforms for each of the operational hazards. The performance level shall provide a statement in quantitative terms of the structural performance required from the platform structural system and critical structure. The fit-for-service performance level shall:

- a) be used as a reference for defining the structural integrity implementation strategies;
- b) address the possible consequences after an event;
- c) address all hazards.

6.5 Design

SIM should be established during the project phase, and should include a systematic and iterative review of risks. Links between design, operation, inspection and maintenance should be addressed during the platform design.

The owner should identify the main threats to the platform and their associated risks, and subsequently develop strategies to manage these risks. This should include identifying the inspection, maintenance and monitoring requirements and adjusting the platform structural aspects to accommodate.

Before the start of operations of a new or newly acquired facility, the SIM data generated during the project or available from the previous owner should be made available to the operations team responsible for structural integrity of the facility. Handover to operation main activities should include:

- transfer of design, fabrication and installation data;
- documenting critical structure for the substructure and topsides;
- performing an initial risk assessment;
- initial long term plans for inspection, maintenance and monitoring.

Platform designs should incorporate SIM operational learnings and experience into new designs or brownfield modifications. This should include:

- site specific criteria;
- damage to existing structures and the causes;
- vessel activity in the region;
- local regulatory requirements;
- decommissioning requirements and regulations;
- general operational experience relating to structural performance, including appurtenances.

6.6 Topsides

SIM shall include topsides structures with focus on structural components that provide safety to personnel in the event of an incident. In addition, the topsides SIM shall address the interfaces with other discipline-specific integrity programs and the SIM of third-party packages included on the topsides.

For offshore structures, the SIM of a topsides structure shall be consistent with the SIM process principles used for the supporting structure. The differences between the two are how they change over time, and what activities are performed to maintain the various components for the life of the platform. The topsides are more likely affected by corrosion due to coating failure, increase in member loads due to additions to the topsides and wear and tear / damage caused by daily operations.

6.7 Continued service

As the structural components age and the platform approaches the end of its original design service life, or the presently agreed service life, the owner shall demonstrate that the structure is fit-for-service (i.e. operating within tolerable risk levels) during the extended service life. The owner shall demonstrate that risks are at tolerable levels and the platform condition is understood and can be maintained in a fit-for-service condition through the revised target service life.

For continued service, the assessment initiator occurs at the time the owner proposes to extend the operational service beyond the original or presently approved service life. The initiator is not triggered by the age of the structure, but rather when the decision is made to extend the operational service life. This can occur at any time during the structure's service life.

6.8 Structural integrity interfaces

Offshore platforms have inspection interfaces, which should be understood and managed within the SIM process. Structural integrity interfaces include:

- topsides / support structure connection;

ISO/DIS 19901-9:2017(E)

- boundary between above and below water inspection;
- activities performed by other disciplines (e.g. caisson internal inspection) or equipment vendors.

Inspection interfaces between topsides and support structures for SIM can vary by platform type.

In addition to the inspection structural integrity interfaces, the SIM process can require interfacing with:

- geotechnical engineers;
- metocean engineers;
- earthquake engineers;
- risk engineers;
- document controllers.

7 SIM process

The SIM process shall involve the periodic evaluation of the platform data to define mitigation strategies and programs, and shall consist of four primary elements, as illustrated in Figure 2:

- a) data;
- b) evaluation;
- c) strategy;
- d) program.

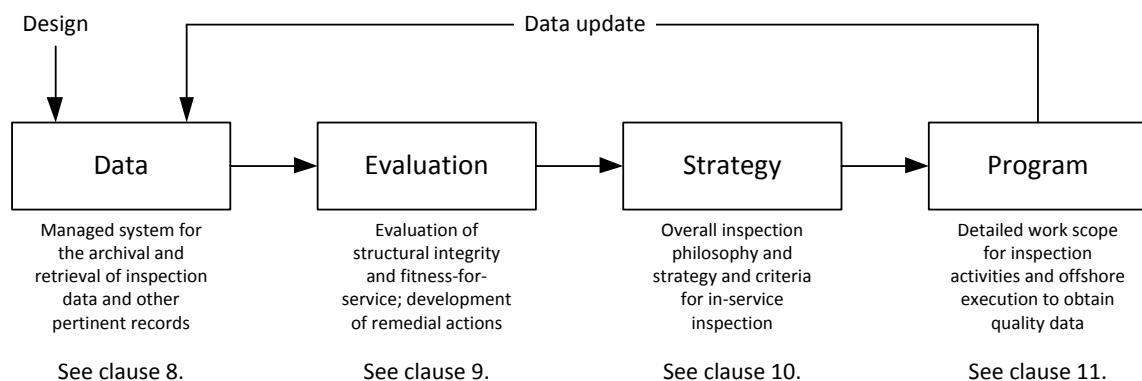


Figure 2 — SIM process

8 Data

8.1 General

An in-service data management system containing SIM data shall be established and maintained for the service life of the platform. Data shall include information from the original design of the structure, fabrication and installation data, inspection findings, effects of damage and deterioration, structural analyses, overloading, and changes in loading and/or use. In addition, data should include technology development projects or in-service experience of similar structures within industry.

Data should be collated into a data management system at the completion of the platform design, fabrication and installation phases of a project. However, it is recognized that for many old platforms data is often collated well into the operational phase of the platform.

8.2 Design data

Platform design data should be collected and retained by the owner over the service life of the structure. Design data forms the benchmark configuration of the platform that should be collected during the project design phase. The platform's design data is the baseline data that represents the structure at installation and includes a broad spectrum of information.

Other design data the owner should obtain from the project and maintaining over the service life are design computer models. Models can be used to assess future changes over the service life or be incorporated into an emergency response program to assess major damage resulting from accidents, storms, or deterioration.

8.3 Fabrication and installation data

Fabrication processes produce a vast quantity of information regarding the construction of an offshore platform and its predicted response to loading. Fabrication and installation inspection data provides information about the initial structure condition and have a direct bearing on the in-service inspection strategy.

8.4 Condition data

Platform condition data should include the changes to the characteristic data that can occur during the service life of the platform and represent the present as-is and possible future condition of the structure.

Condition data should be divided into two categories:

- historical condition data, relating to changes made to the platform;
- present condition data, relating to the surveyed condition of the platform.

8.5 Operational data

Platform operational data should include knowledge on the installations actual structural performance and provide a benchmark for understanding some of the assumptions and uncertainties used in the platform design.

Operational data should include information on:

- changes in topsides and deck loads;
- platform exposure to storms, earthquakes and other environmental events;
- platform exposure to accidental events;
- envelopes used in operating platform equipment.

8.6 Engineering data

Engineering data should include information on the methods, decisions and data used to demonstrate that the platform structural aspects are fit-for-service. In addition, engineering data should include documentation on work performed to confirm fitness-for-service and can include hazard studies, risk assessments, calculations, analysis, structural analysis and/or structural models.

ISO/DIS 19901-9:2017(E)

8.7 Missing data

If platform data is missing or is inaccurate, this can force using conservative assumptions during inspection planning or an engineering assessment. This can lead to unnecessary inspections being performed or prevent upgrades being made and hence unjustly prevent potential development.

If the original design data or as-built drawings are not available, assessment data may be obtained by field measurements of dimensions and sizes of structural members and appurtenances.

For platforms, where there is little or no weight monitoring and control, a weight audit should be performed to monitor and validate loading, equipment layout and other structures.

8.8 Data management

Topside weight database should be maintained and kept up-to-date with weight, CoG changes and modifications (i.e. additions, relocations and removals). Proposed weight and CoG changes should be captured and communicated to the structural integrity engineer. Structural models and topside weight database should be kept synchronized.

Data management should be integrated across the stakeholders with differing overlapping structural integrity objectives, including:

- field concept development;
- front end engineering design;
- detail engineering design;
- fabrication;
- installation and hook-up;
- verification / classification;
- periodic inspection and monitoring;
- interventions to mitigate inspection findings that may compromise the structural integrity;
- periodic review of SIM – identifying trends and updating the inspection strategy;
- brownfield development from concept through to commissioning;
- decommissioning.

In addition, the data management should be integrated across disciplines, including:

- process equipment, tiebacks – weight control;
- pipeline/riser integrity – structural integrity of appurtenance supports and global loading;
- drilling and work-over campaigns.

9 Evaluation

9.1 General

An evaluation of the platform integrity data shall be performed as new information/data is collected. Evaluation shall review the new information/data to identify anomalous conditions and determine whether a detailed assessment (i.e. assessment initiator observed) or risk reduction is required to demonstrate fitness-for-service.

Evaluation shall be performed throughout the platform service life and shall be used to confirm that the platform structural integrity, mitigation strategies and established risk levels are still valid to achieve the performance level. The evaluation may address the overall platform structure or parts thereof where damage or adverse conditions have arisen or occurred.

Findings from the evaluation shall be used as a basis for supporting or adjusting the integrity strategy (see Clause 10) and integrity program (see Clause 11), and shall conclude either

- that the platform or critical structure is fit-for-service between inspections and requires on-going scheduled maintenance/ monitoring/ inspection (with a specified scope), or
- that remedial measures (immediate or longer term) are required.

Evaluation may incorporate engineering judgement, operational experience, research data, qualitative screening analysis and predictive techniques to assess the effect that new data has on the SIM strategy. Evaluation should be based on a qualitative analysis of the platform and may include a review of results from a previous design or assessment structural analysis of the platform, without performing a detailed assessment.

9.2 Factors

Evaluation should account for the following information/data:

- a) original design criteria;
- b) characteristic data (e.g. platform age, framing, number of legs and deck elevation);
- c) design data (e.g. platform reserve strength and residual strength);
- d) condition data reported from in-service inspection findings (e.g. performance of corrosion protection system, component degradation and/or deterioration);
- e) condition data reported from on-line monitoring;
- f) operational data (e.g. weight control data);
- g) fabrication data (e.g., fabrication welding quality and occurrence of rework);
- h) transportation/installation data (e.g. pile driving records, reported damage);
- i) SMR data (e.g. platform structural modifications and/or structural repairs/strengthening);
- j) analytical data (e.g., analysis results and assumptions on condition and criteria used in the original design or previous assessments);
- k) capacity data (e.g. updated knowledge for soil capacity and published capacity of tubular members or joints from laboratory tests);
- l) updated knowledge on geotechnical methods for determining soil capacity;

ISO/DIS 19901-9:2017(E)

- m) criteria data (e.g. updated knowledge for metocean, seismic, ice and/or collision assessment actions);
- n) incident/accident data (e.g. fire, blast, collision, dropped object event or metocean, seismic, ice extreme or abnormal event);
- o) learning from similar platforms.

In instances where the information/data recommended for inclusion as part of the evaluation is not available, an evaluation may be performed, recognizing the inherent uncertainties and assumptions from the missing information. However, missing information/data can affect the evaluation and SIM strategy/program for the platform. Where characteristic data is not available, or the condition information/data is out-of-date, evaluation may provide a recommendation to survey the structure and facilities to collect the required information.

9.3 Hazards

Evaluation shall address possible hazards that can result in total collapse of the platform, partial collapse of the platform or rupture of hydrocarbon containing risers, pipework or conductors. The partial collapse scenario should be used to categorize which structural components of the platform are critical to limiting the risk to life-safety, risk to the environment or risk to financial viability.

Identification of the hazards should be based on professional judgment, expertise and experience for the platform in question. Hazards are either natural occurrences or accidental occurrences and for offshore platforms they typically include:

- gravity action;
- metocean;
- seismic;
- ice;
- collision (e.g. passing vessels, supply vessels, floating jack-ups, toppling of adjacent elevated jack-ups or platforms);
- fire and/or blast;
- dropped and/or swinging objects;
- seabed instability (e.g. mudslides, seabed volcanoes).

Corrosion, fatigue, seabed scour and liquefaction are degradation mechanisms rather than hazards. Hazards apply actions to the platform, while degradation mechanisms reduce the capacity of the platform to resist those actions.

9.4 Critical structure (CS)

A CS is a part of the platform structure, failure of which will cause specific life-safety, environmental pollution or financial consequences. A CS is typically a structural barrier that is used to prevent an event from causing a major incident or is a structural barrier used to provide mitigation and de-escalation in the event of an incident.

CS identification and categorization should be used by the owner to understand the consequences of CS failure and should form the basis for risk-based SIM strategies recommended in this document.

9.5 Risk

9.5.1 General

The owner should adopt risk-based approaches to manage the platform structural integrity. The platform or CS risk should be established and used to optimise the inspection, monitoring or maintenance activities required to confirm fitness-for-service. To adopt a risk-based approach, the owner shall establish the tolerable risk, either qualitatively or quantitatively, for life-safety risk, environmental pollution risk and financial risk.

Platform risks shall be evaluated based on the product of the potential consequence of failure (see 9.5.2) and the likelihood of failure (see 9.5.3), and should account for the actions from hazards being applied to the platform and degradation mechanisms causing reduction in capacity to resist these actions.

9.5.2 Consequence of failure

9.5.2.1 General

Platform risk should account for health and safety, environmental pollution, financial and reputation consequence that can result from failure of the platform or failure of a CS during a hazard event.

Structural failure is determined from an assessment of the capacity of the CS against the required performance level (see 9.6). Structural failure can take the form of failure of an individual structural component that makes the CS lose its capacity without collapse or can take the form of overall system failure resulting in collapse of the CS.

9.5.2.2 Life-safety consequence

9.5.2.2.1 General

Platform life-safety consequence shall be categorized as either manned or unmanned and should account for the events that can result in one or more fatalities from a global or local structural failure. This categorization includes risk of loss of life for people other than the platform's normal complement and personnel on adjacent structures that can be affected by failure of the platform.

Local failure of the structure includes collapse of the structural components directly supporting the TR (or LQ) that can result in the TR (or LQ) sliding or toppling from the platform. In addition, the life-safety categorization should account for escalation from an oil or gas release to a fire and blast hazard due to:

- local collapse of the platform structure causing rupture of risers supported from the jacket, risers supported from the underdeck, ESDV platforms supported from the underdeck and conductors;
- rupture of the risers or conductors due to directly applied actions;
- rupture of the risers, pipework or conductors due to loss of mechanical integrity.

Life safety consequence in this document is not a function of the number of potential fatalities. The owner or regional regulator can require an F-N approach where life safety consequence is a function of the number of potential fatalities.

9.5.2.2.2 Manned categorization

Manned life-safety consequence category refers to a platform (or an adjacent structure that can be affected by the collapse of the platform) that is continuously (or nearly continuously) occupied by persons accommodated and living thereon, and from which personnel evacuation prior to a predetermined magnitude of metocean hazard is not intended. Hazards, for which evacuation is not practical prior to the event, include winter storms, sudden hurricanes and earthquakes.

ISO/DIS 19901-9:2017(E)

9.5.2.2.3 Manned-evacuated categorization

This document does not use “manned-evacuated” as a life-safety consequence of failure category.

9.5.2.2.4 Unmanned categorization

Unmanned life-safety consequence category refers to a platform that is only manned for occasional inspection, maintenance and modification visits.

A platform may be categorized as unmanned if:

- visits to the platform are undertaken only for specific planned inspection, maintenance or modification operations on the platform itself;
- visits are not expected to last more than 24 hr duration during seasons when pre-determined metocean hazards can potentially occur;
- platform does not have permanent quarters;
- platform has emergency shelters.

9.5.2.3 Environmental pollution consequence

9.5.2.3.1 General

Environmental pollution consequence should be categorized as either high environmental pollution or low environmental pollution and should account for the consequence from global or local structural failures that could result in oil or sour gas pollution.

9.5.2.3.2 High environmental pollution consequence

High environmental pollution consequence refers to platforms with large topsides or hubs and/or those platforms that have the potential for well flow of either oil or sour gas in the event of platform failure. In addition, it includes platforms where the shut-in of the oil or sour gas production is not planned or not practical prior to the occurrence of the hazard (e.g. seismic hazard). Platforms that support oil transport lines and/or storage facilities for intermittent oil shipment are recognized as having a high consequence of failure.

9.5.2.3.3 Low environmental pollution consequence

Low environmental pollution consequence refers to platforms where production will be shut in during the design event. Wells that can flow on their own in the event of platform failure shall contain subsurface safety valves (SSSVs), which are manufactured and tested in accordance with applicable specifications. Oil storage is limited to process inventory and “surge” tanks for pipeline transfer. These platforms can support production departing from the platform and low volume infield pipelines. Oil storage is limited to process inventory.

9.5.2.4 Financial consequence

9.5.2.4.1 General

Financial consequence should be categorized as either high financial consequence or low financial consequence and should account for the anticipated losses to the owner, other owners, and industry. The financial consequence should include possible repair costs, lost production revenues, and clean-up costs. A driver for the financial categorization can be the possible damage to society (e.g. the situation where a community/state/country will suffer significant financial losses as a consequence of the interruption of production).

Financial consequence categorization is based on the assumption that the owner determines the financial loss category to suit its tolerance of risk, with the agreement of the regulator where applicable.

9.5.2.4.2 High financial consequence

Examples of platforms that should be categorized as high financial consequence include:

- platforms with high production rates and/or large storage/processing capability;
- hub platforms that support trunk oil transport lines and/or storage facilities for intermittent oil shipment;
- platforms that on failure could damage an adjacent high consequence platform or infrastructure.

9.5.2.4.3 Low financial consequence

Examples of platforms that should be categorized as low financial consequence include:

- platforms with low production rates and/or limited storage/processing capability;
- platforms that on failure are assessed as unlikely to cause damage to a high consequence platform it is operating over or to which it is adjacent.

9.5.3 Likelihood of failure

9.5.3.1 General

SIM data should be evaluated to determine the likelihood of platform failure or local failure of a CS. The likelihood that a platform will fail as a result of actions from an abnormal or accidental hazard event (metocean, ice, seismic, collision or some other foreseeable hazard) is a function of the robustness of the structure.

Each platform has a likelihood of failure based on structural characteristics (e.g. deck elevation, the robustness provided by the number of legs and bracing configuration, and the ductility of the critical members). Damage or deterioration can indicate that the strength of a platform has reduced, which increases the likelihood of failure.

Platform likelihood of failure should be determined by quantitative methods, although qualitative or semi-quantitative methods may be used for fleets of platforms.

9.5.3.2 Qualitative method

Platform likelihood of failure may be established using a qualitative method that uses judgment, experience and knowledge on the platform structural aspects to categorize the platform or CS.

9.5.3.3 Semi-quantitative method

Platform likelihood of failure may be established using a semi-quantitative method that categorizes a platform based on a set of rules relative to other platforms in a fleet. The ranking system should determine a likelihood score based upon key platform information that account for the platform strength, and the extreme action.

Likelihood categorization system should identify the platform characteristics that affect the platform strength and loads (e.g. platform type (drilling, production, wellhead), year designed, number of legs, bracing scheme, water depth). Factors that indicate the strength of the platform has deteriorated or is not up to present standards increase the likelihood. In addition, factors that indicate that extreme platform loads can increase in frequency or severity increase the likelihood.

ISO/DIS 19901-9:2017(E)

9.5.3.4 Quantitative method

Platform likelihood of failure may be established using a quantitative method that uses explicit probabilities of collapse, or implied probabilities of collapse, based on code based DLM to categorize the platform or CS.

9.5.4 Risk presentation

Risk may be presented in a variety of ways to communicate the results of the analysis to decision-makers and inspection planners. One goal of the risk determination is to communicate the results in a common format that each stakeholder can understand. This can be achieved by presenting the risk in the form of a matrix. The risk presentation should differentiate between the type of hazard and the type of consequence.

Typical matrices for the life-safety consequence and environmental/financial consequence are provided in Figure 3 and Figure 4, respectively. In these figures, the consequence category and likelihood categories are arranged such that the highest risk ranking is toward the upper right-hand corner. The owner may adopt more detailed risk assessment techniques or more complex matrices to further subdivide the platform consequence category and/or likelihood. Risk categories are typically assigned to the boxes on the risk matrix as illustrated in Figure 3 and Figure 4.

Risk matrices and consequence levels illustrated in Figure 3 and Figure 4 provide a useful basis for presenting risk. However, the risk determination should be supplemented with additional assessment, if the risk level is too coarse or general to address specific concerns, aspects of performance or individual components. Risk matrices can be presented as symmetrical or asymmetrical (i.e. the consequence of platform or CS failure is given a higher weighting than the likelihood category).

Consequence of failure	Manned	Risk level 3	Risk level 2	Risk level 1
	Unmanned	N/A	N/A	N/A
		Low $\leq 10^{-4}$	Medium $> 10^{-4}$ and $\leq 4 \times 10^{-4}$	High $> 4 \times 10^{-4}$
		Likelihood of failure / annum		

Figure 3 — Example life-safety risk matrix

Consequence of failure	High	Risk level 3	Risk level 2	Risk level 1
	Low	Risk level 4	Risk level 3	Risk level 2
		Low $\leq 10^{-3}$	Medium $> 10^{-3}$ and $\leq 10^{-2}$	High $> 10^{-2}$
		Likelihood of failure / annum		

Figure 4 — Example environmental pollution risk matrix

9.6 Performance level

9.6.1 General

Minimum performance levels provided in this document shall be used to define acceptable probabilities of CS failure to life-safety and environmental pollution consequence. Performance levels to limit life-safety risk and environmental pollution risk are independent of remaining service life (i.e. these risks are measured as risk per annum).

Performance levels shall be set at a level equivalent or more onerous than the minimum requirements in Table 1 and shall address:

- a) statutory requirements;
- b) owners' corporate policy;
- c) industry standards/practices.

ISO 19900 states that the requirements of that document provide minimum requirements. The owner can choose more stringent criteria. Different levels of reliability, in conjunction with different platform consequence of failure levels and the specific limit state, can be achieved by selection of different values of partial action factors.

Conformance to the performance level does not remove the recommendation to evaluate prevention and mitigation risk reduction measures.

Table 1 — Minimum fitness-for-service performance level

Life safety			Environmental pollution ^c		
Consequence	RP ^a	Comments	Consequence	RP ^a	Comments
Manned	2 500 ^b	Possible fatalities	High	1 000	Possible environmental pollution
Unmanned	N/A	No fatalities	Low	100 ^d	Limited environmental pollution consequences

^a RP used to set the fitness-for-service performance level is the RP of the event.

^b If life-safety mitigation procedures are in-place to unman the platform prior to the forecast of a pre-determined metocean event (e.g. hurricane or typhoon) the minimum performance level may be based on a reduced population storm (e.g. sudden hurricane for U.S. Gulf of Mexico).
If life-safety mitigation procedures are in-place to unman prior to the forecast of a pre-determined sea state (Hs) the minimum performance level may be based on the pre-determined Hs.
If life-safety mitigation procedures are not in-place then the metocean hazard performance level shall be based on the full population storm.

^c Financial loss performance level should be established by the owner in conjunction with possible requirements from the national regulator.

^d Performance level is set in relation to mitigating the possible effects on life-safety and the environment in the event of platform collapse. Use of the low environmental consequence performance level can result in placing an economic burden on the owner.

ISO/DIS 19901-9:2017(E)

9.6.2 Life-safety

Life-safety performance level should account for the individual risk and group, or societal, risk. Individual risk per annum (IRPA) should include hazards that offshore personnel can be exposed to, and should include a summation of the operational risks (e.g. helicopter transfers and hydrocarbon blast and fire risks) along with the structural failure risks in determining the tolerable performance level. Group risk per annum may be measured by TRIF and includes hazards that personnel can be exposed to in the TR (or LQ), including smoke and gas ingress, heat stress and submergence of the TR (or LQ) by global or local collapse of the platform.

If a platform is planned to be manned during an event, either from a natural hazard or an accidental hazard, the owner shall demonstrate that the critical structure achieves the following life-safety performance level as a minimum:

- a) platform does not collapse during a hazard event;
- b) TR (or LQ) does not slide off or topple from the platform during a hazard event.

In some regions, owners and regulators have a SIM strategy to unman specific platforms on forecast of the sea state exceeding a predetermined magnitude. In these situations the owner shall demonstrate that the annual probability of failing to achieve the minimum tolerable life-safety performance levels while the platform is manned is smaller than the performance level recommended in Table 1.

9.6.3 Pollution of the environment

When a platform is known to have storage for oil that can be released during an event, the owner shall demonstrate that the oil containing pipes and vessels do not rupture during a hazard event. Rupture of oil containing pipes can be caused by the action from the hazard being applied directly to the pipe or can be due to large deformations of their supports or due to platform collapse.

9.6.4 Financial loss

Financial loss performance level should be established by the owner in conjunction with possible requirements from the regional regulator. Financial risk may be measured per annum or over the remaining service life.

9.7 Fatigue

Offshore structures, regardless of location, are subject to fatigue degradation. In many areas, fatigue is a major design factor due to relatively high ratios of operational sea states to maximum design metocean events.

As part of the evaluation process for future service life, accumulated fatigue degradation effects should be accounted for. Where CVI and/or NDE underwater inspections are made and known damage is assessed and/or repaired, fatigue analyses may not be required before the next inspection interval. Alternatively, fatigue life may be demonstrated by means of an analytical procedure in accordance with ISO 19902.

In some cases, underwater non-destructive inspection of the joint can be used to “reset” accumulated fatigue degradation if there is no evidence of surface cracking. This information can be used to establish an acceptable RBI interval that accounts for the inspection method and length of in-service exposure of the weld to fatigue. Monitoring fatigue-sensitive joints, and/or reported crack-like indications, is an acceptable alternative to analytical verification.

9.8 Assessment

9.8.1 General

If the engineering evaluation determines that the platform operational risk has significantly changed, some level of engineering assessment analyses should be performed to determine whether the platform achieves the structural strength performance level or whether risk reduction or mitigation measures are required. The assessment is part of evaluation as illustrated in Figure 5. Recommended methods of assessment and analyses are provided in the assessment requirements (see Clause 12).

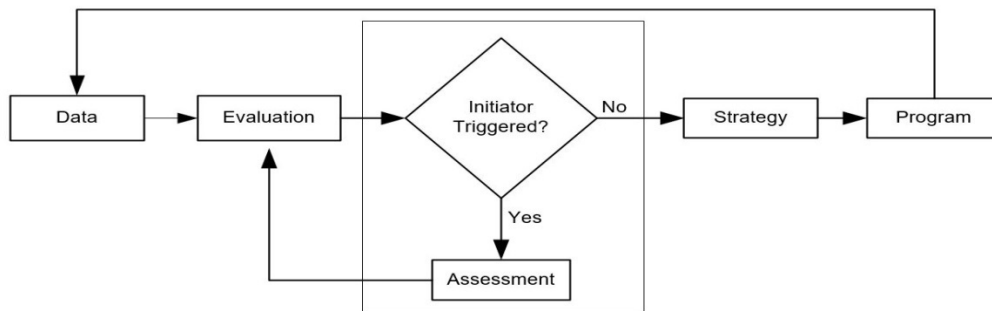


Figure 5 — Assessment within the SIM process

Assessment should use quantitative techniques to demonstrate that, for every hazard to which the structure is exposed, the performance of CSs or the platform structural system achieves the required performance level. Assessment is typically step-wise with increasing complexity and is typically accomplished by performing a structural analysis of the system or component.

A platform fitness-for-service assessment determines the capacity of a structure and compares this against the required performance levels. An assessment may consist of comparing an actual proof or extreme/abnormal action against the performance level.

If the evaluation indicates that the platform operational risk has increased, an assessment should be performed to determine whether the platform achieves the performance level (see 9.6) or whether risk reduction or mitigation measures are required.

9.8.2 Assessment motive

Motives for performing a structural assessment vary and should be established prior to performing the assessment. The selection of the assessment method is influenced by the assessment motive, which can include:

- Supporting an evaluation - for platforms where the evaluation has determined that an assessment of the structural strength is required, an assessment should be performed to demonstrate that the platform achieves the performance level required by the SIM strategy.
- Categorizing the platform structural likelihood of failure - for risk-based SIM strategies an assessment should be performed to determine the platform likelihood of failure and provide input into categorizing the platform's structural risk.
- Supporting an inspection program - an assessment should be performed to determine the structural locations required for inspection and for setting inspection anomaly threshold reporting requirements.

ISO/DIS 19901-9:2017(E)

- d) Supporting a monitoring program - platforms that have included monitoring as part of their SIM strategies should be assessed to provide information on the threshold that would indicate a change in the structural condition. In situations where monitoring provides a life safety mitigation measure the actions and triggering thresholds should be determined such that life safety risk is maintained to the required performance level.
- e) Supporting a mitigation strategy - for platforms that have included planned mitigation as part of their SIM strategies an assessment should be performed to provide information on the platform operating limits, which can include:
 - platform evacuation ahead of predictable events;
 - re-manning platforms after an event;
 - hurricane preparedness;
 - triggering of monitoring action thresholds.
- f) Determining the platform probability of collapse - if the owner requires quantifying the probability of platform collapse in support of a performance standard required by a stakeholder, an assessment should be performed to determine the probability of platform collapse.

9.8.3 Assessment initiators

9.8.3.1 General

Evaluation should provide recommendations for performing an assessment for changes that can increase the platform operational risk, including:

- changes in condition (see 9.8.3.2);
- changes in action (see 9.8.3.3);
- changes in criteria (see 9.8.3.4);
- changes in consequence (see 9.8.3.5);
- changes in use (see 9.8.3.6).

Structural assessment shall be performed in conformance to Clause 12.

9.8.3.2 Changes in condition

Evaluation should periodically review the condition of the platform structural components to determine if the platform structural capacity has reduced below that used to demonstrate that the structure achieves the performance level. The evaluation should review the condition used in the platform design or most recent assessment against the new condition.

Evaluation should account for credible degradation and deterioration mechanisms. The mechanisms should be divided into the following categories:

- time dependent where the deterioration can be observed and measured through inspection (e.g. corrosion);
- non-time dependent where deterioration develops quickly after an unknown incubation period and inspection is ineffective (e.g. mechanical damage).

An assessment of the platform system or component structural strength against the SIM performance level should be performed if the evaluation indicates that the condition of the platform has resulted in a reduction of the platform structural capacity. The assessment should be made for the present degraded condition and the anticipated additional degradation at the planned end of service life.

9.8.3.3 Changes in action

Evaluation should periodically review the actions used to demonstrate that the structure achieves the performance level. The evaluation should review the actions used in the platform design or most recent assessment against the estimated new actions.

An assessment of the platform system or component structural strength against the SIM performance level should be performed if the evaluation indicates that the actions on the platform has increased.

9.8.3.4 Changes in criteria

Evaluation should periodically review the hazard criteria or soil data criteria used to demonstrate that the structure achieves the performance level. Hazard criteria can change as industry knowledge and capability to improve the accuracy of hazard curves increases. The evaluation should review the following criteria used in the platform design or most recent assessment against the new criteria, as a minimum:

- metocean;
- seismic;
- ice;
- collision;
- geotechnical.

An assessment of the platform system or component structural strength against the SIM performance level should be performed if the evaluation indicates that the new criterion is more onerous.

9.8.3.5 Changes in consequence

Evaluation should periodically review the platform consequence of failure. If the evaluation indicates that the platform consequence of failure is more restrictive than that used to set the performance level in the design or most recent assessment, an assessment of the platform system or component structural strength should be performed.

Evaluation should, as a minimum, review the following consequence:

- addition of accommodation facilities;
- addition of facilities (e.g. additional pipelines, additional wells, or an increase in topside hydrocarbon inventory capacity).

9.8.3.6 Change-in-use

An assessment of the platform system or component structural strength against the performance level should be performed if the evaluation indicates that the platform plans to change its use. Use of the low environmental pollution performance level (i.e. 100-yr RP) should not be used for making decisions on the suitability of changing the use of a platform. For platforms that are unmanned and that have a low environmental consequence, the change-of-use suitability should be based on an evaluation of the financial risk.

ISO/DIS 19901-9:2017(E)

Examples of platform change-in-use include the addition of a pipeline crossing to an existing platform, the use of an existing platform as a tie-back for a deepwater facility, and the conversion of an existing platform into a receiving terminal for liquid natural gas or other non-exploration and production activity. In these cases, the use of the offshore structure has changed since the platform can now have a different function, expected life and consequence of failure. For example, fatigue should be re-evaluated since the structure now has a longer-term use under perhaps different loading conditions compared to its original design.

9.9 Mitigation measures

9.9.1 General

If a structure does not achieve the fitness-for-service performance level (see 9.6), risk reduction measures shall be implemented. Risk reduction should be addressed at each stage of an assessment and may be used in lieu of more complex assessment.

Mitigation measures may include structural modifications or changes in operational procedures that reduce loads, increase capacities or reduce the consequence of failure. Modifications to inspection and monitoring programs may be implemented as a means to identify further deterioration.

Mitigation measures that reduce the risk of structural failure can be implemented in isolation or in conjunction with each other. The choice of measures and their extent will depend on the source of risks to structural integrity and their magnitude.

9.9.2 Consequence reduction

9.9.2.1 Life-safety

Life-safety mitigation measures should involve permanently de-manning the platform, or temporarily un-manning the platform during a forecasted extreme event.

9.9.2.2 Environmental

Consequence of failure mitigation measures should include one or more of the following:

- installation of SSSVs;
- removal or reduction of hydrocarbon storage or inventory volume;
- removal or re-routing of major oil lines;
- removal or re-routing large volume gas flow lines;
- PA or TA of non-producing wells;
- isolation of the pipeline to reduce the potential volume of hydrocarbon release.

9.9.2.3 Abnormal storm preparedness

Advanced planning should be used to reduce abnormal storm risks as well as improve post storm response. Abnormal storm preparedness plans should be developed covering general storm preparedness activities and structure-specific response activities. Checklists and platform-specific guides can assist during the evacuation process.

9.9.3 Likelihood reduction

9.9.3.1 General

Likelihood of failure reduction methods may include:

- increased inspection and/or monitoring;
- removal of a known damaged component;
- load reduction;
- localized strengthening and/or repair;
- global strengthening and/or repair.

Strengthening of the jacket structure can be an effective means of reducing the likelihood of failure of the platform. Strengthening scheme should be designed to increase the system capacity of the platform to the level required to achieve the performance level, for the consequence category of the platform in conformance to 9.5.2. Alternatively, it is possible to modify the structure to reduce the loading.

Platform fitness-for-service shall be demonstrated for the selected likelihood of failure reduction method.

9.9.3.2 Increased inspection and/or monitoring

Revisions or additions to the inspection and monitoring plan to detect anomalies may be used to reduce the risk. More frequent inspection of an area known to have damage or where damage is more likely to occur will identify damage, enabling mitigation to be implemented before failure has occurred. Similarly, an increased level of inspection may be used (e.g. CVI instead of GVI or NDE instead of CVI) to provide a better level of clarity on the true condition of a CS and detection of anomalies.

Monitoring efforts may be used to help maintain a level of understanding about the condition of a CS between inspections. Monitoring can identify anomalous conditions that could increase the likelihood of failure such that a response (e.g. additional inspection, repair) can be implemented to prevent failure.

9.9.3.3 Strengthening, modification and/or repair (SMR) techniques

Design practices for platform SMR are usually outside the scope of recognized codes of practice, standards and regulations. Assessment engineering should determine the requirements for and the selection of load reduction and/or strengthening options. Strengthening and repair of existing platforms requires engineers to provide economical solutions that can be efficiently and safely installed.

A selection of SMR techniques available for likelihood reduction is provided in Figure 6.

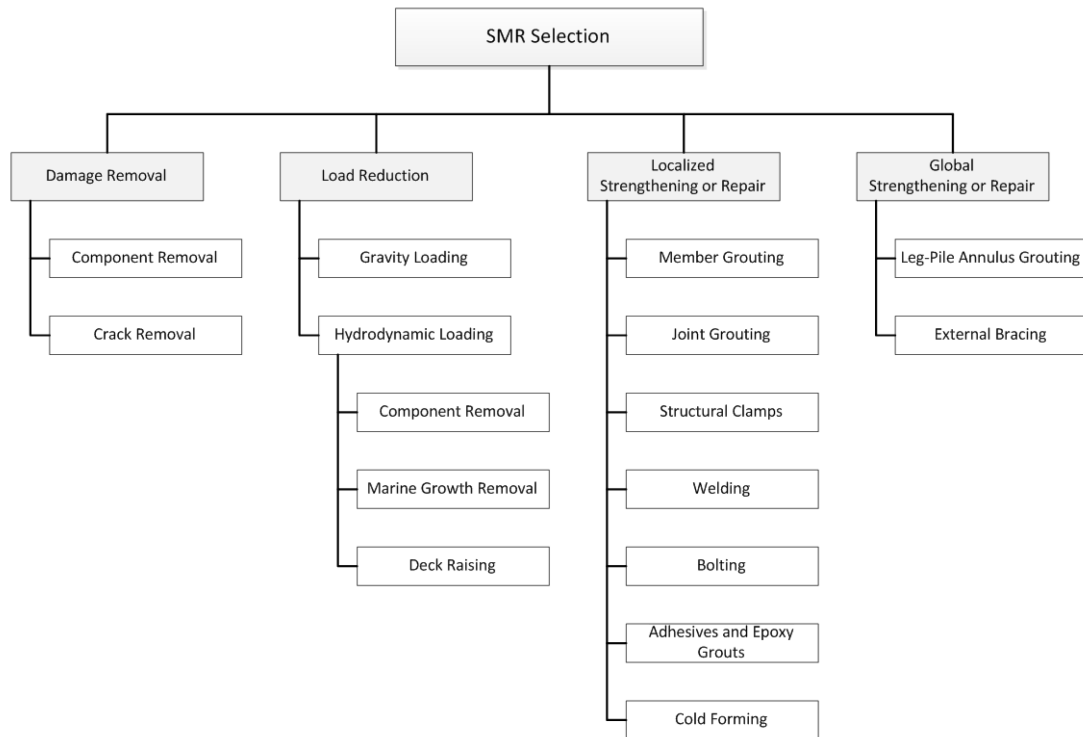


Figure 6 — SMR techniques

9.9.3.4 Factors

There are a large number of SMR techniques available that may be used, as illustrated in Figure 6. The platform assessment (see Clause 12) should determine whether platform strengthening or repair is required to achieve the platform performance level. If the platform requires strengthening and/or repair, the assessment model should be used to develop strengthening options. Once a decision has been made in favour of SMR, an appraisal should be performed of available SMR techniques.

Selecting and designing an SMR technique include accounting for:

- a) safety of diving, diving support, construction and operations personnel;
- b) potential for use of diverless techniques;
- c) difficulty of fabrication, handling, and installation;
- d) rigging complexity and layout;
- e) list support vessel type, availability, and access;
- f) fit-up tolerance (clamps and members);
- g) interference with conductors, jacket members, and appurtenances (e.g. sumps, caissons, anodes);
- h) potential for collision with existing risers and control bundles;
- i) requirements for pre-design inspection, field measurements, and materials samples;
- j) outfitting with well-designed installation aids;
- k) required weather windows.

Load reduction may be achieved by removing items that contribute to the gravitational loading. Alternatively, or in conjunction, load reduction may be achieved by removing items that attract metocean loading. This will be most beneficial in the upper water column where wave kinematics is highest.

Localized strengthening or repair can be used to directly strengthen or repair a component without altering load paths within the structure. For damaged structures, the damage will normally be left in-place. The designer should recognize that additional load can be attracted to the component by virtue of its increased stiffness following SMR or due to increased hydrodynamic loads.

Localized strengthening or repair options include:

- grout filling – members and joints;
- clamps – unstressed grouted, stress grouted, mechanical and elastomer-lined;
- welding, one atmosphere, wet welding and hyperbaric techniques;
- weld improvement, grinding, shot peening, and toe dressing;
- member removal as a standalone repair technique;
- mechanical repair system (e.g. bolting or swaging);
- composite materials.

Design of a global strengthening or repair scheme should confirm that load is diverted away from the damaged or under-strength component. To achieve this, the strengthening or repair scheme should be designed to attract a portion of the load which would otherwise have been applied to the defective part of the structure.

10 Strategy

10.1 General

The owner shall develop a SIM strategy, which sets out the process for delivering the integrity management of its assets in line with the SIM policy and required performance level. The SIM strategy shall identify the mitigation, monitoring and inspections that shall be included in the continuous risk reduction requirements for the integrity-critical structural components and the structural system.

SIM strategy should be compiled into a living document that is periodically reviewed and updated, including the evolving risks in the operation. The strategy should detail the program objectives and the targets that should be met to demonstrate fitness-for-service and continuous risk reduction. The strategy should identify the single points of accountability and responsibility for delivering the steps in the program.

Plans should reflect the overall SIM philosophy, which varies depending upon the design margins, field life, type of structure and sophistication of local infrastructure. These factors can influence the philosophical approach, affecting the extent of future maintenance activities as well as varying the degree of reliance between inspections and monitoring activities to demonstrate fitness-for-service.

For a new platform or platform reuse the overall SIM strategies should be developed during the early concept, select and feed stages of the design. Inspection, monitoring and maintenance plans should be developed during the later detailed design stages of a platform reuse, ideally performed early enough that potential plan implementation and execution issues can be addressed within the design. Additionally, development of the plans should include full participation of the operating team to confirm that the design, SIM strategy and SIM program are aligned.

ISO/DIS 19901-9:2017(E)

SIM strategy should identify the frequency and type of activities required for the platform structural components. These activities should be based on maintaining the structural integrity of the structural components identified as critical during the data evaluation and should include developing:

- inspection strategies (see 10.2);
- maintenance strategies (see 10.3);
- monitoring strategies (see 10.4);
- evacuation strategies (see 10.5);
- geotechnical investigations (see 10.6).

10.2 Inspection strategy

10.2.1 General

An inspection strategy shall be developed for the structures included in the structural integrity process and cover the service life of the platform. The inspection strategy shall provide the framework for the surveys and should account for the interdependence of between the SIM process phases (see Figure 2).

Inspection strategy shall be a dynamic or a “living” document, meaning that inspection requirements can change as required due to inspection results or changes to the structure (e.g. changes in topsides weight, discovery of damage and/or addition of new risers).

Inspection strategy should be periodically reviewed, and as required updated, throughout the service life based on receipt and evaluation of new data/information (usually through amendments following the receipt of additional inspection reports, results of structure reanalysis or assessments, and other data or information pertinent to structural integrity).

Inspection strategy should be developed from the engineering evaluation (see Clause 9) that, when implemented, can determine within a reasonable level of confidence the existence and extent of deterioration, defects and damage.

Inspection strategy shall address:

- inspection motives (see 10.2.2);
- inspection type (see 10.2.3);
- inspection method (see 10.2.4);
- inspection frequency (see 10.2.5);
- inspection scope (see 10.2.6).

10.2.2 Inspection motives

Inspection strategy should serve as proactive measures to detect damage and deterioration as well as provide information on the condition of the structure that should be used to confirm that the structural components remain fit-for-service.

General motives of the inspection plan(s) include:

- identifying mechanical damage;
- identifying degradation or deterioration of the structure;

- identifying design uncertainties or errors;
- identifying areas of potential environmental or weight overload;
- identifying accidental events damage;
- monitoring of known defects or repair effectiveness;
- performing due diligence prior to change of ownership;
- addressing statutory requirements;
- confirming platform condition prior to reuse;
- confirming platform condition prior to decommissioning;
- statutory requirements;
- owner's corporate policy;
- other industry or national standards and practices.

10.2.3 Inspection type

10.2.3.1 General

SIM inspection strategy should account for scheduled inspections and unscheduled inspections.

10.2.3.2 Scheduled inspections

10.2.3.2.1 General

Scheduled inspections should include baseline inspections, periodic inspections and special inspections.

10.2.3.2.2 Baseline inspection

Baseline inspections should be performed to determine the initial condition of the structure for use as a benchmark for items not included in fabrication and installation inspections, and to detect transportation or installation damage and early appearance of defects or deterioration.

10.2.3.2.3 Periodic inspection

Periodic inspections should be performed to provide information/data on the present condition of the platform by executing surveys with the objective of detecting deterioration, defects and degradation to the platform structural components. The inspection strategy should define the inspection interval and the inspection scope of work for periodic inspections, which can vary depending on the results of periodic evaluations.

Periodic underwater platform inspections should be performed to detect, measure and record platform defects, deterioration or anomalies that affect the structural integrity. Platform deterioration can include corrosion to welds and members, weld/joint damage (including deformation due to overload and cracking due to fatigue damage) and mechanical damage in the form of dents, holes, bows and gouges. Anomalies can include non-operating or ineffective corrosion protection system, scour, seafloor instability, hazardous or detrimental debris, and marine growth.

10.2.3.2.4 Special inspections

Special inspections may include performing the following:

ISO/DIS 19901-9:2017(E)

- Anomaly or damage monitoring inspections to verify the condition of known anomalies of damage (e.g. monitor growth of known cracks at primary or safety-critical secondary member end connections or confirming that damage that has been evaluated through the assessment process as not requiring a repair has not become more extensive through fatigue, corrosion, or another mechanism).
- SMR monitoring inspections to verify the condition of repairs to structural components and appurtenances (e.g. NDE of underwater wet welds, confirming the tightness of bolts in stressed ungrouted clamps, or inspection of swaging or mechanical connectors).
- Pre-engineering assessment inspections to provide condition/configuration information of the structure or critical structure prior to performing an engineering assessment.
- Pre-decommissioning inspections to provide condition/configuration information of the structure or critical structure prior to the structure decommissioning and assist in demonstrating that the structure is robust enough to sustain the loads imposed during removal.
- Pre-reuse inspections to provide condition/configuration information of the structure or critical structure prior to the structure reuse and assist in demonstrating that the structure is robust enough to sustain the loads imposed during removal and reinstallation.

10.2.3.3 Unscheduled inspections

Unscheduled inspections should be performed to provide information on the platform's structural condition following a potential overload event or incident.

Well intervention or maintenance campaigns can increase the likelihood of accidental damage for the topsides. Therefore, these events should be treated as a potential overload case and a post-event inspection can be planned in advance. Unscheduled post-event inspections should be developed based on an evaluation of the available data, including event/incident reports.

10.2.4 Inspection method

10.2.4.1 General

Inspection scope of work may include one or more of the following inspection methods to understand the condition of the structure:

- a general visual inspection (see 10.2.4.2);
- a close visual inspection (see 10.2.4.3);
- a non-destructive examination (see 10.2.4.4).

Selection of appropriate inspection method(s) for a given task shall be determined by qualified personnel based on the goals/objectives of the inspection and the sensitivity, effectiveness, reliability, cost, and availability of the various tools and techniques.

10.2.4.2 General visual inspection (GVI)

A GVI should be specified to detect the following:

- deterioration due to corrosion on structural members or plating;
- areas of generalized pitting or local pits;
- rust staining from welds (can indicate weld failure on coated surfaces)
- deformation or fracture due to accidental or abnormal events;