INTERNATIONAL STANDARD

ISO 19902

Second edition
2020-11

Petroleum and natural gas industries — Fixed steel offshore structures

Industries du pétrole et du gaz naturel — Structures en mer fixes en acier

Reference number
ISO 19902:2020(E)

© ISO 2020



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword xiv
Introduction xvii
1 Scope 1
2 Normative references 1
3 Terms and definitions 2
4 Symbols 10
5 Abbreviated terms 14
6 Overall considerations 16
6.1 Types of fixed steel offshore structure 16
6.1.1 General 16
6.1.2 Jackets 16
6.1.3 Towers 17
6.1.4 Jack-ups 17
6.2 Planning 18
6.2.1 General 18
6.2.2 Hazards 18
6.2.3 Designing for hazards 19
6.2.4 Design situations and criteria 19
6.2.5 Design for inspection and maintenance 19
6.2.6 Foundations and active geological processes 20
6.2.7 Regulations 20
6.3 Service and operational considerations 20
6.3.1 General considerations 20
6.3.2 Water depth 20
6.3.3 Structural configuration 20
6.3.4 Access and auxiliary systems 21
6.4 Safety considerations 21
6.5 Environmental considerations 21
6.5.1 General 21
6.5.2 Selecting design metocean parameters and action factors 22
6.6 Exposure levels 22
6.7 Assessment of existing structures 23
6.8 Structure reuse 23
7 General design requirements 23
7.1 General 23
7.2 Material properties for steel 24
7.3 Incorporating limit states 24
7.4 Determining design situations 24
7.5 Structural modelling and analysis 25
7.6 Design for pre-service and removal situations 25
7.7 Design for the in-place situation 25
7.8 Determination of component resistances 25
7.8.1 General 25
7.8.2 Physical testing to derive resistances 26
7.8.3 Resistances derived from computer simulations validated by physical testing 26

© ISO 2020 – All rights reserved

7.8.4 Resistances derived from computer simulations validated against design formulae ... 26
7.8.5 Resistances derived from unvalidated computer simulations ... 26
7.9 Strength and stability checks ... 26
7.9.1 Action and resistance factors ... 26
7.9.2 Strength and stability equations ... 26
7.9.3 Unfactored actions ... 27
7.10 Robustness ... 27
7.10.1 General ... 27
7.10.2 Damage tolerance ... 27
7.11 Reserve strength ... 28
7.11.1 New structures ... 28
7.11.2 Existing structures ... 29
7.12 Indirect actions ... 29
7.13 Structural reliability analysis ... 29

8 Actions for pre-service and removal situations ... 30
8.1 General ... 30
8.1.1 Coverage ... 30
8.1.2 Design situations ... 30
8.1.3 Actions ... 30
8.2 General requirements ... 31
8.2.1 Weight control ... 31
8.2.2 Dynamic effects ... 31
8.2.3 Action effects ... 31
8.3 Onshore lifting ... 33
8.3.1 General ... 33
8.3.2 Dynamic effects ... 33
8.3.3 Effect of tolerances ... 34
8.3.4 Multi-crane lift ... 34
8.3.5 Local factor ... 34
8.3.6 Member and joint strengths ... 35
8.3.7 Lifting attachments ... 35
8.3.8 Slings, shackles and fittings ... 36
8.4 Fabrication ... 36
8.5 Loadout ... 36
8.5.1 Direct lift ... 36
8.5.2 Horizontal movement onto vessel ... 36
8.5.3 Self-floating structures ... 37
8.6 Transportation ... 37
8.6.1 General ... 37
8.6.2 Metocean conditions ... 37
8.6.3 Determination of actions ... 37
8.6.4 Other considerations ... 38
8.7 Installation ... 38
8.7.1 Lifted structures ... 38
8.7.2 Launched structures ... 38
8.7.3 Crane assisted uprighting of structures ... 38
8.7.4 Submergence pressures ... 38
8.7.5 Member flooding ... 39
8.7.6 Actions on the foundation during installation ... 39

9 Actions for in-place situations ... 39
9.1 General ... 39
9.2 Permanent actions (G) and variable actions (Q) ... 40

 © ISO 2020 – All rights reserved

9.2.1 Permanent action 1, G_1 40
9.2.2 Permanent action 2, G_2 40
9.2.3 Variable action 1, Q_1 40
9.2.4 Variable action 2, Q_2 41
9.2.5 Unintentional flooding 41
9.2.6 Position and range of permanent and variable actions 41
9.2.7 Carry down factors 41
9.2.8 Representation of actions from topsides 41
9.2.9 Weight control 41
9.3 Extreme metocean actions 42
9.3.1 General 42
9.3.2 Notation 42
9.4 Extreme quasi-static action due to wind, waves and current (E_e) 42
9.4.1 Procedure for determining E_e 42
9.4.2 Direction of extreme wind, waves and current 43
9.4.3 Extreme global actions 44
9.4.4 Extreme local actions and action effects 44
9.4.5 Vortex induced vibrations (VIV) 45
9.5 Extreme quasi-static action caused by waves only (E_{we}) or by waves and currents (E_{wce}) 45
9.5.1 Procedure for determining E_{we} and E_{wce} 45
9.5.2 Models for hydrodynamic actions 46
9.5.3 Hydrodynamic models for appurtenances 50
9.6 Actions caused by current 50
9.7 Actions caused by wind 51
9.7.1 General 51
9.7.2 Determining actions caused by wind 51
9.7.3 Wind actions determined from models 52
9.8 Equivalent quasi-static action representing dynamic response caused by extreme wave conditions 52
9.8.1 General 52
9.8.2 Equivalent quasi-static action (D_e) representing the dynamic response 53
9.8.3 Global dynamic analysis in waves 53
9.9 Factored actions 55
9.9.1 General 55
9.9.2 Factored permanent and variable actions 55
9.9.3 Factored extreme metocean action 55
9.10 Design situations 56
9.10.1 General considerations on the ultimate limit state 56
9.10.2 Demonstrating sufficient RSR under metocean actions 56
9.10.3 Partial factor design format 57
9.11 Local hydrodynamic actions 58

10 Accidental and abnormal situations 59
10.1 General 59
10.1.1 Treatment of ALS events 59
10.1.2 Accidental events 60
10.1.3 Abnormal environmental events 60
10.2 Vessel collisions 60
10.2.1 General 60
10.2.2 Collision events 61
10.2.3 Collision process 61

© ISO 2020 – All rights reserved

10.3 Dropped objects 61
10.4 Fires and explosions 62
10.5 Abnormal environmental actions 62
10.6 Assessment of structures following damage 63

11 Seismic design considerations 63
11.1 General 63
11.2 Seismic design procedure 63
11.3 Seismic reserve capacity factor 64
11.4 Recommendations for ductile design 64
11.5 ELE requirements 66
11.5.1 Partial action factors 66
11.5.2 ELE structural and foundation modelling 66
11.6 ALE requirements 67
11.6.1 General 67
11.6.2 ALE structural and foundation modelling 68
11.6.3 Non-linear static pushover analysis 68
11.6.4 Time-history analysis 70

12 Structural modelling and analysis 70
12.1 Purpose of analysis 70
12.2 Analysis principles 71
12.2.1 Extent of analysis 71
12.2.2 Calculation methods 71
12.3 Modelling 71
12.3.1 General 71
12.3.2 Level of accuracy 71
12.3.3 Geometrical definition for framed structures 72
12.3.4 Modelling of material properties 75
12.3.5 Topsides structure modelling 75
12.3.6 Appurtenances 75
12.3.7 Soil-structure interaction 76
12.3.8 Other support conditions 77
12.3.9 Local analysis structural models 77
12.3.10 Actions 78
12.3.11 Mass simulation 78
12.3.12 Damping 79
12.4 Analysis requirements 79
12.4.1 General 79
12.4.2 Fabrication 81
12.4.3 Other pre-service and removal situations 81
12.4.4 In-place situations 84
12.5 Types of analysis 86
12.5.1 Natural frequency analysis 86
12.5.2 Dynamically responding structures 86
12.5.3 Static and quasi-static linear analysis 86
12.5.4 Static ultimate strength analysis 87
12.5.5 Dynamic linear analysis 87
12.5.6 Dynamic ultimate strength analysis 87
12.6 Non-linear analysis 88
12.6.1 General 88
12.6.2 Geometry modelling 88
12.6.3 Component strength 89
12.6.4 Models for member strength 89
12.6.5 Models for joint strength 89

 © ISO 2020 – All rights reserved

12.6.6 Ductility limits 89
12.6.7 Yield strength of structural steel 90
12.6.8 Models for foundation strength 90
12.6.9 Investigating non-linear behaviour 90

13 Strength of tubular members 91
13.1 General 91
13.2 Tubular members subjected to tension, compression, bending, shear, torsion or hydrostatic pressure 93
13.2.1 General 93
13.2.2 Axial tension 93
13.2.3 Axial compression 94
13.2.4 Bending 95
13.2.5 Shear 97
13.2.6 Hydrostatic pressure 98
13.3 Tubular members subjected to combined forces without hydrostatic pressure 101
13.3.1 General 101
13.3.2 Axial tension and bending 101
13.3.3 Axial compression and bending 102
13.3.4 Axial tension or compression, bending, shear and torsion 103
13.3.5 Piles 105
13.4 Tubular members subjected to combined forces with hydrostatic pressure 105
13.4.1 General 105
13.4.2 Axial tension, bending and hydrostatic pressure 106
13.4.3 Axial compression, bending and hydrostatic pressure 107
13.4.4 Axial tension or compression, bending, hydrostatic pressure, shear and torsion 108
13.5 Effective lengths and moment reduction factors 108
13.6 Conical transitions 110
13.6.1 General 110
13.6.2 Design stresses 110
13.6.3 Strength requirements without external hydrostatic pressure 113
13.6.4 Strength requirements with external hydrostatic pressure 118
13.6.5 Ring design 118
13.7 Dented tubular members 121
13.7.1 General 121
13.7.2 Dented tubular members subjected to tension, compression, bending or shear 121
13.7.3 Dented tubular members subjected to combined forces 126
13.8 Corroded tubular members 129
13.9 Grouted tubular members 129
13.9.1 General 129
13.9.2 Grouted tubular members subjected to tension, compression or bending 129
13.9.3 Grouted tubular members subjected to combined forces 133

14 Strength of tubular joints 134
14.1 General 134
14.2 Design considerations 135
14.2.1 Materials 135
14.2.2 Design forces and joint flexibility 136
14.2.3 Minimum joint strength 136
14.2.4 Weld strength 136
14.2.5 Joint classification 136
14.2.6 Detailing practice 139

© ISO 2020 – All rights reserved

14.3 Simple tubular joints 142
14.3.1 General 142
14.3.2 Basic joint strength 143
14.3.3 Strength factor, Q_u 144
14.3.4 Chord force factor, Q_f 145
14.3.5 Effect of chord can length on joint strength 146
14.3.6 Strength check 147
14.4 Overlapping joints 148
14.5 Grouted joints 148
14.6 Ring stiffened joints 149
14.7 Other joint types 149
14.8 Damaged joints 149
14.9 Non-circular joints 150
14.10 Cast joints 150
15 Strength and fatigue resistance of other structural components 150
15.1 Grouted connections 150
15.1.1 General 150
15.1.2 Detailing requirements 152
15.1.3 Axial force 152
15.1.4 Reaction force from horizontal shear force and bending moment in piles 152
15.1.5 Interface transfer stress 153
15.1.6 Interface transfer strength 154
15.1.7 Strength check 157
15.1.8 Fatigue assessment 157
15.2 Mechanical connections 158
15.2.1 Types of mechanical connectors 158
15.2.2 Design requirements 158
15.2.3 Actions and forces on the connector 159
15.2.4 Resistance of the connector 159
15.2.5 Strength criteria 159
15.2.6 Fatigue criteria 160
15.2.7 Stress analysis validation 160
15.2.8 Threaded fasteners 161
15.2.9 Swaged connections 162
15.3 Clamps for strengthening and repair 163
15.3.1 General 163
15.3.2 Split sleeve clamps 163
15.3.3 Prestressed clamps 163
15.3.4 Forces on clamps 164
15.3.5 Clamp design 164
15.3.6 General requirements for bolted clamps 166
15.3.7 Bolting considerations 167
16 Fatigue 167
16.1 General 167
16.1.1 Applicability 167
16.1.2 The fatigue process 167
16.1.3 Fatigue assessment by analysis using *S–N* data 167
16.1.4 Fatigue assessment by analysis using fracture mechanics methods 168
16.1.5 Fatigue assessment by other methods 168
16.2 General requirements 168
16.2.1 Applicability 168
16.2.2 Fatigue crack initiation and crack propagation 169

 © ISO 2020 – All rights reserved

16.2.3 Sources of variable stresses causing fatigue 169
16.2.4 Service life and fatigue life 169
16.2.5 The nature of fatigue damage 170
16.2.6 Characterization of the stress range data governing fatigue 170
16.2.7 The long-term stress range history 170
16.2.8 Partial action and resistance factors 171
16.2.9 Fatigue resistance 171
16.2.10 Fatigue damage calculation 171
16.2.11 Weld improvement techniques 171
16.3 Description of the long-term wave environment 172
16.3.1 General 172
16.3.2 Wave scatter diagram 172
16.3.3 Mean wave directions 172
16.3.4 Wave frequency spectra 173
16.3.5 Wave directional spreading function 173
16.3.6 Periodic waves 173
16.3.7 Long-term distribution of individual wave heights 173
16.3.8 Current 173
16.3.9 Wind 173
16.3.10 Water depth 174
16.3.11 Marine growth 174
16.4 Performing the global stress analyses 174
16.4.1 General 174
16.4.2 Actions caused by waves 175
16.4.3 Quasi-static analyses 176
16.4.4 Dynamic analyses 176
16.5 Characterization of the stress range data governing fatigue 177
16.6 The long-term local stress range history 178
16.6.1 General 178
16.6.2 Probabilistic determination using spectral analysis methods 179
16.6.3 Deterministic determination using individual periodic waves 179
16.6.4 Approximate determination using simplified methods 180
16.7 Determining the long-term stress range distribution by spectral analysis 180
16.7.1 General 180
16.7.2 Stress transfer functions 181
16.7.3 Short-term stress range statistics 182
16.7.4 Long-term stress range statistics 182
16.8 Determining the long-term stress range distribution by deterministic analysis 184
16.8.1 General 184
16.8.2 Wave height selection 184
16.8.3 Wave period selection 184
16.8.4 Long-term stress range distribution 184
16.9 Determining the long-term stress range distribution by approximate methods 184
16.10 Geometric stress ranges 185
16.10.1 General 185
16.10.2 Stress concentration factors for tubular joints 185
16.10.3 Geometric stress ranges for other fatigue sensitive locations 186
16.11 Fatigue resistance of the material 187
16.11.1 Basic S–N curves 187
16.11.2 High strength steel 188
16.11.3 Cast joints 188
16.11.4 Thickness effect 188
16.12 Fatigue assessment 189
16.12.1 Cumulative damage and fatigue life 189

© ISO 2020 – All rights reserved

16.12.2 Fatigue damage design factors 190
16.12.3 Local experience factor 190
16.13 Other causes of fatigue damage than wave action 190
16.13.1 General 190
16.13.2 Vortex induced vibrations 191
16.13.3 Wind induced vibrations 191
16.13.4 Transportation 191
16.13.5 Installation 191
16.13.6 Risers 191
16.14 Further design considerations 192
16.14.1 General 192
16.14.2 Conductors, caissons and risers 192
16.14.3 Miscellaneous non-load carrying attachments 192
16.14.4 Miscellaneous load carrying attachments 192
16.14.5 Conical transitions 192
16.14.6 Members in the splash zone 192
16.14.7 Topsides structure 193
16.14.8 Inspection strategy 193
16.15 Fracture mechanics methods 193
16.15.1 General 193
16.15.2 Fracture assessment 194
16.15.3 Fatigue crack growth law 194
16.15.4 Stress intensity factors 195
16.15.5 Fatigue stress ranges 195
16.15.6 Castings 195
16.16 Fatigue performance improvement of existing components 195

17 Foundation design 195
17.1 General 195
17.2 Design of pile foundations 196
17.3 Pile wall thickness 198
17.3.1 General 198
17.3.2 Pile stresses 198
17.3.3 Pile design checks 198
17.3.4 Check for design situation due to weight of hammer during hammer placement 198
17.3.5 Stresses during driving 199
17.3.6 Minimum wall thickness 200
17.3.7 Allowance for underdrive and overdrive 200
17.3.8 Driving shoe 200
17.3.9 Driving head 200
17.4 Length of pile sections 200
17.5 Shallow foundations 201
17.5.1 General 201
17.5.2 Stability of shallow foundations 202

18 Corrosion control 202
18.1 General 202
18.2 Corrosion zones and environmental parameters affecting corrosivity 202
18.3 Forms of corrosion, associated corrosion rates and corrosion damage 203
18.4 Design of corrosion control 204
18.4.1 General 204
18.4.2 Considerations in design of corrosion control 204
18.4.3 Coatings, linings and wrappings 204
18.4.4 Cathodic protection 205

 © ISO 2020 – All rights reserved

18.4.5 Corrosion resistant materials ... 208
18.4.6 Corrosion allowance ... 208
18.5 Fabrication and installation of corrosion control ... 209
18.5.1 General ... 209
18.5.2 Coatings and linings ... 209
18.5.3 Cathodic protection ... 209
18.5.4 Corrosion resistant materials ... 209
18.6 In-service inspection, monitoring and maintenance of corrosion control ... 209
18.6.1 General ... 209
18.6.2 Coatings and linings ... 210
18.6.3 Cathodic protection ... 210
18.6.4 Corrosion resistant materials ... 211

19 Materials ... 211
19.1 General ... 211
19.2 Lowest anticipated service temperature ... 212
19.3 Chemical composition ... 212
19.3.1 General ... 212
19.3.2 Carbon equivalent ... 212
19.3.3 Modified carbon equivalent ... 213
19.4 Strength, toughness and other considerations ... 213
19.4.1 Yield strength ... 213
19.4.2 Toughness ... 213
19.4.3 Other considerations ... 214
19.5 Material category approach ... 214
19.5.1 Steel selection philosophy ... 214
19.5.2 Material characterization ... 214
19.5.3 Material selection criteria ... 214
19.5.4 Selection process ... 215
19.5.5 Steel strength groups ... 216
19.5.6 Toughness class ... 216
19.5.7 Applicable steels ... 217
19.6 Design class approach ... 217
19.6.1 General ... 217
19.6.2 DC component classification ... 218
19.6.3 Materials ... 218
19.6.4 Applicable steels ... 221
19.7 Cement grout ... 221
19.7.1 Grout materials ... 221
19.7.2 Onshore grout trial ... 221
19.7.3 Offshore grout trial ... 222
19.7.4 Offshore quality control ... 222

20 Welding, weld inspection and fabrication ... 222
20.1 General ... 222
20.2 Welding ... 223
20.2.1 Selected generic welding and fabrication standards ... 223
20.2.2 Weld metal and HAZ properties ... 225
20.2.3 Tubular T-, Y- and K-joints ... 229
20.3 Inspection ... 229
20.4 Fabrication ... 229
20.4.1 General ... 229
20.4.2 Weld requirements ... 230
20.4.3 Forming ... 232
20.4.4 Fabrication tolerances ... 232

© ISO 2020 – All rights reserved

20.4.5 Grouted connections 233
21 Quality control, quality assurance and documentation 233
21.1 General 233
21.2 Quality management system 234
21.3 Quality control plan 235
21.3.1 General 235
21.3.2 Inspector qualifications 235
21.3.3 NDT personnel qualifications 235
21.3.4 Inspection of materials 235
21.3.5 Inspection of fabrication 236
21.3.6 Inspection of welding 236
21.4 Documentation 236
21.4.1 General 236
21.4.2 Calculations 237
21.4.3 Weight and centre of gravity reports 237
21.4.4 Fabrication inspection documentation 237
21.5 Drawings and specifications 237
22 Loadout, transportation and installation 238
22.1 General 238
22.1.1 Planning 238
22.1.2 Records and documentation 239
22.1.3 Actions and required resistance 239
22.1.4 Temporary bracing and rigging 239
22.2 Loadout and transportation 239
22.2.1 General 239
22.2.2 Loadout 239
22.2.3 Cargo and launch vessels 240
22.2.4 Towing vessels 240
22.2.5 Actions on the platform components 241
22.2.6 Buoyancy and flooding systems 241
22.3 Transfer of the structure from the transport vessel into the water 241
22.3.1 General 241
22.3.2 Lifting operations 241
22.3.3 Launching 242
22.4 Placement on the sea floor and assembly of the structure 242
22.4.1 General 242
22.4.2 Safety of navigation 243
22.4.3 Stationkeeping 243
22.4.4 Positioning of the structure 243
22.5 Pile installation 244
22.5.1 General 244
22.5.2 Stabbing guides 244
22.5.3 Lifting methods 244
22.5.4 Field welds 245
22.5.5 Driveability studies 245
22.5.6 Drilled and grouted piles 245
22.5.7 Grouting pile-to-sleeve connections and grouted repairs 245
22.5.8 Pile installation records 245
22.6 Installation of conductors 245
22.7 Topsides installation 245
22.7.1 General 245
22.7.2 Alignment and tolerances 246
22.7.3 Securing topsides 246

 © ISO 2020 – All rights reserved

22.8 Grounding of installation welding equipment 246
22.8.1 General 246
22.8.2 Welding equipment 246
22.8.3 Monitoring remote ground efficiency 246
Annex A (informative) Additional information and guidance 247
Annex B (normative) Weld CTOD testing procedures 497
Annex C (informative) Material category approach 502
Annex D (informative) Design class approach 508
Annex E (informative) Welding and weld inspection requirements — Material category approach 512
Annex F (informative) Welding and weld inspection requirements – Design class approach 516
Annex G (normative) Fabrication tolerances 523
Annex H (informative) Regional information 538
Bibliography 544

© ISO 2020 – All rights reserved

Foreword

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

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

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

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

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

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 7, *Offshore structures*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

This second edition cancels and replaces the first edition (ISO 19902:2007), which has been technically revised. It also incorporates the Amendment ISO 19902:2007/Amd.1:2013. The main changes compared to the previous edition are as follows:

— duplication of symbols has largely been eliminated (see Clause 4);

— use of metocean versus environmental has been rationalized. Metocean now refers to wind, wave and current actions only while environmental encompasses metocean, ice and seismic;

— high strength steel: applicable specified minimum yield strength increased to 800 MPa but only with respect to non-material requirements;

— hazards and designing for hazards moved from 10.1.1 and 10.1.2, respectively, to 6.2.2 and 6.2.3, respectively;

— deck elevation (6.3.3.2) expanded to include air gap plus need to consider crest levels 15 % higher than calculated values;

— exposure levels (6.6) are addressed in ISO 19900 so text modified accordingly;

 © ISO 2020 – All rights reserved

— damage tolerance now more appropriately addressed in 7.10.2 rather than 10.1.6.1;

— reserve strength ratio (7.11.1): detailed procedure introduced because of general lack of adequate, appropriate documentation;

— structural reliability analysis (7.13): text reordered and supplemented by text from completely rewritten A.9.9.3.3;

— onshore lifting (8.3): because offshore lifting is now addressed in ISO 19901-6, the text and tabulated information on DAFs have been modified accordingly;

— multi-crane lifts (8.3.4): for consistency with ISO 19901-6, now considered in place of dual lifts;

— gravity load partial action factors for extreme conditions reduced from 1.1 to 1.0 (Table 9.10-1 and Table 8.2-1);

— clarified that for abnormal design situations, verification is required even if wave-in-deck events do not occur to ensure that the appropriate robustness requirement is realized;

— ELE structural and foundation modelling: new first paragraph added in response to questions to Seismic Panel (responsible for ISO 19901-2) regarding the appropriate weight of personnel to consider during an event;

— tubular member diameter to thickness ratio non-dimensionalized (13.1);

— shear and torsion now included in all tubular member strength formulae including those addressing hydrostatic pressure;

— tubular member strength formulae for combined axial and bending loading now of cosine interaction form instead of previously adopted linear interaction;

— formulae (13.6-2) and (13.6-3) relating to conical transitions corrected;

— tubular joint strength formulae nearly all changed through adoption of the API RP 2A-WSD 21st Edition Supplement 2 (October 2005) tubular joint formulae supplemented by some limited non-linear FEA;

— grouted connections: pile outer diameter limited (15.1.5.2);

— use of HSS in fatigue applications: warning re possible hydrogen embrittlement when yield strength exceeds 700 MPa (16.11.2);

— fatigue damage design factors: effect of considering life cycle (16.12.2);

— Clause 17: detailed pile design requirements moved to ISO 19901-4 so no longer addressed;

— Clause 19: expanded to include more detailed requirements for Design class approach;

— Clause 20: expanded to include more detailed requirements for Design class approach;

— Clause 21: some requirements for Design class approach added to Tables 21.2-1 and 21.4-1 (previously 21.7-1);

— particular standards identified for NDT personnel qualification (21.3.3);

— Clause 21: existing 21.4 to 21.6 moved to ISO 19901-6;

© ISO 2020 – All rights reserved

— Clause 22: reference to ISO 19901-6 added where appropriate. Requirements for flotation (22.3.2.4) and crane barges (22.3.2.5) combined (22.3.3.4);

— Clauses 23 to 25 (and A.23 to A.25) deleted because ISO 19901-9 *Structural integrity management* approved;

— Annex A modified to accommodate above changes to normative text as appropriate;

— Table C.1: extra strength groups for chord cans and padeyes;

— Table C.4 enlarged considerably;

— Annex D completely rewritten;

— E.3: 100 % CVI now required for all welding;

— Annex F: substantially rewritten and expanded. Now important to consider whether LAST is $\geq -10°C$ or $< -10°C$;

— new Table F.5 and Figure F.1 similar to existing requirements in Table D.3 and Figure D.1, now deleted from Annex D;

— new Table F.6 addressing subsea structures whereas Table F.5 only concerns jacket structures;

— minimum RSR requirement added for North West Europe (H.2.3.1);

— H.3.3.2 Canadian welding references revised;

— US Customary units have been deleted;

— a number of figures have been corrected.

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

© ISO 2020 – All rights reserved

Introduction

The International Standards on offshore structures prepared by TC 67/SC 7 (i.e. ISO 19900, the ISO 19901 series, ISO 19902, ISO 19903, ISO 19904-1, the ISO 19905 series, ISO 19906) constitute a common basis covering those aspects that address design requirements and assessments of all offshore structures used by the petroleum and natural gas industries worldwide. Through their application, the intention is to achieve reliability levels appropriate for manned and unmanned offshore structures, whatever the type of structure and the nature or combination of the materials used.

It is important to recognize that structural integrity is an overall concept comprising models for describing actions, structural analyses, design rules, safety elements, workmanship, quality control procedures and national requirements, all of which are mutually dependent. The modification of one aspect of design in isolation can disturb the balance of reliability inherent in the overall concept or structural system. The implications involved in modifications, therefore, need to be considered in relation to the overall reliability of all offshore structural systems.

These documents applicable to the various types of offshore structure are intended to provide wide latitude in the choice of structural configurations, materials and techniques without hindering innovation. Sound engineering judgment is therefore crucial in the use of these documents.

Annex A provides background to and guidance on the use of this document and should be read in conjunction with the main body of this document. The clause numbering in Annex A is the same as in the normative text to facilitate cross-referencing.

Materials, welding and weld inspection requirements can be based either on a “material category” or on a “design class” approach, as discussed in Clauses 19 and 20. If the material category approach is used, see the corresponding provisions of Annexes C and E; if the design class approach is used, see the corresponding provisions of Annexes D and F.

Annex G gives requirements on fabrication tolerances.

Regional information on the application of the document to certain specific offshore areas is provided in Annex H.

To meet certain needs of industry for linking software to specific elements in this document, a special numbering system has been permitted for figures, tables, formulae and bibliographic references.

© ISO 2020 – All rights reserved

Petroleum and natural gas industries — Fixed steel offshore structures

1 Scope

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.

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 (such as underwater oil storage tanks, bridges and connecting structures).

This document contains requirements for planning and engineering of the design, fabrication, transportation and installation of new structures as well as, if relevant, their future removal.

NOTE 1 Specific requirements for the design of fixed steel offshore structures in arctic environments are presented in ISO 19906.

NOTE 2 Requirements for topsides structures are presented in ISO 19901-3; for marine operations in, ISO 19901-6; for structural integrity management, in ISO 19901-9 and for the site-specific assessment of jack-ups, in ISO 19905-1.

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 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10414-1, *Petroleum and natural gas industries — Field testing of drilling fluids — Part 1: Water-based fluids*

ISO 12135, *Metallic materials — Unified method of test for the determination of quasistatic fracture toughness*

ISO 15653, *Metallic materials — Method of test for the determination of quasistatic fracture toughness of welds*

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

© ISO 2020 – All rights reserved

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 19901-3, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 3: Topsides structure*

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

ISO 19901-6, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 6: Marine operations*

ISO 19901-8, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 8: Marine soil investigations*

ISO 19901-9, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 9: Structural integrity management*

ISO 19905-1, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups*

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 19901-1, ISO 19901-2, ISO 19901-4, ISO 19901-9 and the following apply.

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

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

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

3.1
abnormal environmental event
environmental hazardous event having a probability of occurrence typically between 10^{-3} and 10^{-4} per annum (i.e. return periods between 1 000 years and 10 000 years)

[SOURCE: ISO 19900:2019, 3.1, modified]

3.2
accidental event
non-environmental hazardous event having a probability of occurrence typically of 10^{-4} per annum (i.e. return period of 10 000 years)

EXAMPLE Impact, fire, explosion, local structural failure, loss of intended differential pressure (e.g. buoyancy).

[SOURCE: ISO 19900:2019, 3.2, modified]

© ISO 2020 – All rights reserved