

ISO 29400:2020-05 (E)

Ships and marine technology - Offshore wind energy - Port and marine operations

Contents	Page
Foreword	xi
Introduction	xii
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Symbols and abbreviated terms	25
4.1 Symbols.....	25
4.2 Abbreviated terms.....	29
5 General considerations	32
5.1 Introduction.....	32
5.1.1 General.....	32
5.1.2 Safety requirements.....	33
5.2 Jurisdiction.....	34
5.2.1 Introduction.....	34
5.2.2 Safety of life at sea.....	34
5.2.3 Environment.....	35
5.3 HSSE plan.....	35
5.4 Risk management.....	35
5.4.1 Introduction.....	35
5.4.2 Techniques to evaluate risks.....	36
5.5 Job safety analysis.....	36
5.6 Environmental impact study.....	37
5.7 Manning, qualifications, job and safety training.....	37
5.8 Daily progress and incident reporting.....	37
5.9 Personnel tracking.....	38
5.10 Approval by national authorities.....	38
6 Organization, documentation and planning	38
6.1 Introduction.....	38
6.2 Organization and communication.....	39
6.2.1 Project organization.....	39
6.2.2 Operational organization.....	39
6.3 Quality assurance and administrative procedures.....	40
6.4 Technical procedures.....	40
6.5 Technical documentation.....	41
6.5.1 Document numbering system.....	41
6.5.2 RAMS for port and marine operations.....	41
6.5.3 Operational schedule/programme.....	42
6.5.4 Contingency philosophy.....	43
6.5.5 Contingency planning and emergency procedures.....	43
6.5.6 Emergency response coordination plan.....	44
6.5.7 As-built documentation/Post construction file.....	45
6.5.8 Standards for data transfer to CAD systems.....	46
6.6 Certification and documentation.....	48
6.6.1 Introduction.....	48
6.6.2 Required or recommended documentation.....	49
6.7 Marine warranty survey.....	49
6.7.1 Introduction.....	49
6.7.2 Role of the marine warranty surveyor.....	49

6.7.3	MWS scope of work	50
6.7.4	Certificate of approval	50
6.8	Systems and equipment	51
6.8.1	Introduction	51
6.8.2	Marine vessels	51
6.8.3	Major equipment	51
7	Metocean requirements	51
7.1	Introduction	51
7.2	Weather-restricted/weather-unrestricted operations	52
7.2.1	Weather-restricted operations	52
7.2.2	Weather-unrestricted operations	52
7.3	Metocean conditions	52
7.3.1	Wind	52
7.3.2	Wave, wave period and swell conditions	53
7.3.3	Current	53
7.3.4	Other metocean factors	53
7.3.5	Temperature	54
7.3.6	Marine growth	54
7.4	Metocean criteria	54
7.4.1	Design criteria and operational limits	54
7.4.2	Return periods	55
7.4.3	Vessel response-based analysis	55
7.4.4	Probability distributions of sea state parameters	55
7.5	Operational duration, contingency and weather window	55
7.5.1	Planned operational duration	55
7.5.2	Weather window and contingency	56
7.5.3	Point of no return	56
7.5.4	Forecasted and monitored operational limits, metocean reduction factor	57
7.6	Weather forecasts	58
7.6.1	Introduction	58
7.6.2	Forecast parameters	58
7.7	On-site monitoring	58
8	Onshore transport and nearshore transport	59
8.1	Introduction	59
8.2	Structural integrity calculations	59
8.3	Transport by road	59
8.4	Transport via inland waterways	59
8.5	Transport via nearshore waterways	60
8.6	Transport via railways	60
8.7	Transport frames and equipment	60
9	Intermediate storage areas	60
9.1	Introduction	60
9.2	Infrastructure requirements	61
9.2.1	Load bearing	61
9.2.2	Surface	61
9.3	Storage frames and equipment	61
9.4	Requirements of components for storage	62
9.5	Protection of components against environmental conditions	62
9.6	Structural integrity calculations	62
9.6.1	Introduction	62
9.6.2	Vortex shedding	62
9.7	Security measures	63
10	Pre-assembly	63
10.1	Introduction	63
10.2	Pre-assembly area requirements	63
10.3	Pre-assembly activities	63
10.4	Pre-assembly equipment	64
10.5	Structural integrity calculations	64
10.6	Vortex shedding	64
10.7	Security measures	64

11	Port activities	64
11.1	Introduction	64
11.2	Accessibility of harbour areas	64
11.2.1	Water access	64
11.2.2	Inland access	65
11.3	Storage areas of quayside	65
11.4	Security measures	65
11.5	Quayside requirements	65
11.6	Port subsea soil requirements for jacking activities	65
12	Weight control	66
12.1	Introduction	66
12.2	Weight control classes	67
12.3	Weight and CoG constraints	67
12.4	Weight control monitoring	67
12.5	Dimensional control	68
12.6	Serial items	68
12.7	Weight determinations	68
13	Stability	68
13.1	Introduction	68
13.2	General requirements	69
13.3	Stability calculations	69
13.4	Intact stability	70
13.4.1	Introduction	70
13.4.2	Intact stability criteria	71
13.5	Damage stability	72
13.5.1	Introduction	72
13.5.2	Damage stability criteria	74
13.6	Single-barge transports	75
13.7	Multi-barge transports	75
13.8	Classed vessels	76
13.9	Self-floating structures	76
13.9.1	Introduction	76
13.9.2	Intact and damage stability	76
13.9.3	Upending and installation of self-floating and launched structures	77
13.10	Loadout operations	78
13.11	Watertight integrity and temporary closures	79
13.12	Inclining tests	79
14	Ballasting operations	80
14.1	Introduction	80
14.2	Ballast calculations for different stages	81
14.3	In ballast system	81
14.3.1	Operational aspects	81
14.3.2	Other operational considerations	82
14.4	Protection against damage and deterioration	82
14.4.1	Introduction	82
14.4.2	Freezing	83
14.5	Prevention of progressive flooding in damage condition	83
14.6	Control and indicating systems	83
14.7	Pumps	84
14.7.1	Introduction	84
14.7.2	Specification and layout	84
14.7.3	Pump performance curves and functional limitations	84
14.8	Valve arrangements	84
14.9	Vent systems	85
14.10	Air cushion system capacity	85
14.11	System testing	85

15	Loadout	85
15.1	Introduction	85
15.2	Categories of loadout.....	86
15.2.1	Introduction.....	86
15.2.2	Design: structural analysis during all loadout phases.....	87
15.2.3	Loadout planning.....	87
15.2.4	Cargo weight details and CoG information	87
15.2.5	Deck loading plan.....	88
15.3	Structure being loaded.....	88
15.4	Site and quay.....	88
15.5	Barge.....	89
15.6	Link beams, skidways and skidshoes	89
15.7	Moorings.....	89
15.7.1	Weather-restricted operation.....	89
15.7.2	Temporary mooring system	90
15.8	Grounded loadouts.....	90
15.9	Pumping and ballasting.....	91
15.9.1	Pump capacity.....	91
15.9.2	Recommended pump capacity.....	91
15.10	Loadouts by trailers, SPMTs or hydraulic skidshoes.....	92
15.10.1	Introduction.....	92
15.10.2	Structural capacity	92
15.10.3	Load equalization and stability.....	93
15.10.4	Vertical alignment.....	93
15.10.5	Skidshoes.....	93
15.11	Propulsion system design, redundancy and back-up	93
15.11.1	Propulsion system.....	93
15.11.2	Redundancy and recommendations	94
15.12	Float-on onto submersible barges or vessels	95
15.13	Lifted loadouts.....	96
15.14	Horizontal loadouts	97
15.15	Barge reinstatement and sea fastenings	97
15.16	Tugs.....	98
15.17	Management and organization	98
15.18	Loadout manual	98
15.19	Operating manual.....	98
16	Transportation	100
16.1	Introduction	100
16.2	General considerations.....	100
16.2.1	Manned tows.....	100
16.2.2	Unmanned tows.....	101
16.2.3	Navigation lights, signals and day shapes	101
16.2.4	Contingency.....	101
16.2.5	Motion responses.....	101
16.2.6	Verification of the transported object.....	101
16.2.7	Structural analysis during all transport phases.....	101
16.2.8	Transport planning.....	102
16.3	Weather routeing and forecasting.....	102
16.4	Ports of shelter, shelter areas, holding areas	102
16.5	Inspections during the towage or voyage.....	103
16.6	Responsibility	103
16.7	Hazardous materials.....	103
16.8	Ballast water	104
16.9	Restricted depths, heights and manoeuvrability.....	104
16.10	Under-keel clearances	104
16.11	Air draught	105
16.12	Channel width.....	105
16.13	Survey requirements	105

16.14	Towline pull required, fleet composition and towing arrangement.....	106
16.14.1	Towline pull required.....	106
16.14.2	Towing fleet.....	107
16.14.3	Towing arrangement.....	107
16.14.4	Towline length.....	108
16.15	Tow out from dry dock.....	108
16.15.1	Introduction.....	108
16.15.2	Under-keel clearance.....	108
16.15.3	Side clearances.....	108
16.15.4	Air cushion/air pressure.....	108
16.15.5	Capacity of winching and towing arrangements.....	109
16.15.6	Positioning systems.....	109
16.15.7	Survey requirements.....	109
16.16	Inshore tow.....	109
16.16.1	Tow route and towing clearances.....	109
16.16.2	Positioning systems.....	110
16.17	Transport onboard a vessel/Offshore tow.....	110
16.17.1	Vessel selection.....	110
16.17.2	Stability.....	110
16.17.3	Sea fastening.....	110
16.17.4	Vortex shedding.....	112
16.17.5	Navigation systems.....	112
16.18	Transport manual.....	112
17	Temporary mooring and stationkeeping for marine operations.....	113
17.1	Introduction.....	113
17.2	Environmental criteria.....	113
17.3	Determination of mooring response.....	114
17.3.1	Analysis methods.....	114
17.3.2	General considerations on the mooring design.....	114
17.4	Sizing of mooring lines.....	115
17.4.1	General considerations.....	115
17.4.2	Line tension limits and design safety factors.....	115
17.4.3	Particular mooring conditions.....	116
17.5	Sizing of anchors.....	116
17.6	Sizing of attachments.....	117
17.7	Sizing of mooring line components.....	117
17.8	Clearances under extreme conditions.....	117
17.9	Clearances during positioning.....	118
17.10	Tensioning of moorings.....	118
17.11	Other stationkeeping means.....	118
17.11.1	Introduction.....	118
17.11.2	DP systems.....	119
17.11.3	Purpose-built mooring arrangements.....	119
17.11.4	Use of tugs.....	119
17.12	System for common reference stations.....	119
18	Offshore installation operations.....	120
18.1	Introduction.....	120
18.1.1	Foundation.....	120
18.1.2	Transition piece.....	120
18.1.3	Wind turbine generator.....	120
18.1.4	Offshore substation/Offshore accommodation platforms.....	120
18.1.5	Installation plan.....	120
18.1.6	Cargo weight details and CoG information.....	123
18.2	Installation site.....	123
18.2.1	Sea floor survey.....	123
18.2.2	Soil survey.....	124
18.2.3	Soil preparation.....	124

18.2.4	Site charts.....	124
18.2.5	Unexploded ordnance (UXO).....	125
18.3	Systems and equipment.....	127
18.3.1	Introduction.....	127
18.3.2	Vessels.....	127
18.3.3	Equipment.....	127
18.3.4	Position reference system.....	128
18.3.5	Ballast systems.....	128
18.3.6	Transport vessel interface with marine equipment.....	128
18.4	Positioning of vessels.....	128
18.5	Site reference system.....	129
18.6	Geotechnical site-specific assessment for jack-up operations.....	129
18.6.1	Introduction.....	129
18.6.2	Required soil investigations.....	129
18.6.3	Penetration analysis, punch-through and horizontal-vertical-interaction.....	130
18.7	Vessel operation manual.....	132
18.8	Jack-up preloading procedure.....	133
18.9	Ballasting.....	133
18.10	Lifted installations.....	133
18.10.1	Introduction.....	133
18.10.2	Installation of liftable jackets.....	133
18.10.3	Installation of templates for piles.....	134
18.10.4	Installation of piles.....	134
18.10.5	Installation of transition pieces.....	134
18.10.6	Installation of GBS.....	134
18.10.7	Transfer of items from a barge to the deck of a crane vessel/jack-up vessel.....	135
18.10.8	Installation of towers.....	135
18.10.9	Installation of WTG including nacelle, hub and blades.....	135
18.10.10	
	Installation of topsides of offshore substations/accommodation platforms.....	135
18.10.11	
	Operational aspects.....	135
18.10.12	
	Operational control parameters.....	136
18.11	Lowering by ballasting.....	136
18.11.1	Introduction.....	136
18.11.2	Operational aspects.....	136
18.11.3	Operational control parameters.....	136
18.12	Precise positioning on the sea floor by active and passive means.....	137
18.12.1	Introduction.....	137
18.12.2	Operational design aspects.....	137
18.12.3	Operational control parameters.....	137
18.13	Skirt penetration.....	138
18.13.1	Introduction.....	138
18.13.2	Gravity penetration.....	138
18.13.3	Suction penetration.....	138
18.13.4	Operational design aspects.....	138
18.13.5	Operational control parameters.....	138
18.14	Pile installation.....	139
18.14.1	Introduction.....	139
18.14.2	Operational design aspects.....	139
18.14.3	Operational control parameters.....	140
18.15	Grouting.....	140
18.15.1	Introduction.....	140
18.15.2	Grouting of pile/transition piece structure.....	140
18.15.3	Underbase grouting of pile/jacket structure.....	141
18.15.4	Operational design aspects.....	141
18.15.5	Preparations.....	141

18.15.6	Operational control parameters.....	142
18.16	Bolted connections of foundation.....	142
18.17	Welding of piles/foundation to topsides.....	142
18.18	Noise mitigation measures.....	142
18.19	Crew transfer to and from installation units.....	143
18.20	Offshore completion.....	143
18.20.1	Introduction.....	143
18.20.2	ROV inspection.....	143
18.20.3	Removal of temporary equipment.....	144
18.20.4	Scour protection.....	144
18.20.5	Final inspection.....	144
18.21	Project execution manual.....	144
19	Design and operation of lifting equipment.....	145
19.1	Introduction.....	145
19.2	Rigging geometry.....	147
19.3	Actions and action effects.....	147
19.4	Weight contingency factors.....	149
19.5	Dynamic amplification factors (DAFs).....	150
19.5.1	Introduction.....	150
19.5.2	Lifts by a crane.....	150
19.5.3	Offshore lifts by cranes on two or more vessels.....	152
19.6	Representative hook load.....	152
19.6.1	One-hook lifts by a single crane.....	152
19.6.2	Two-hook lifts by two cranes.....	152
19.7	Representative lift weight per lift point.....	153
19.7.1	One-hook lifts.....	153
19.7.2	Two-hook lifts.....	153
19.8	Representative forces on a lift point.....	154
19.8.1	Representative vertical force.....	154
19.8.2	Representative force in line with the sling direction.....	155
19.8.3	Representative lateral force.....	155
19.9	Representative force for slings and grommets.....	156
19.10	Design values of actions and action effects.....	156
19.11	Strengths of slings, grommets and shackles.....	158
19.11.1	Steel cable slings.....	158
19.11.2	Fibre rope slings and fibre rope grommets.....	158
19.11.3	Working load limits and design strengths of fibre slings and grommets.....	159
19.11.4	Working load limit and design strength of shackles.....	160
19.12	Design verifications.....	160
19.12.1	Allowable hook load.....	160
19.12.2	Slings and grommets.....	161
19.12.3	Lift points and their attachment to the structure and supporting members.....	163
19.13	Lift point design.....	164
19.13.1	Introduction.....	164
19.13.2	Sling ovalization.....	164
19.13.3	Plate rolling direction and direction of loading.....	164
19.13.4	Pinholes.....	164
19.13.5	Cast padears and welded trunnions.....	165
19.13.6	Cheek plates.....	165
19.13.7	Padeyes.....	165
19.14	Clearances.....	165
19.14.1	Introduction.....	165
19.14.2	Clearances around lifted objects.....	166
19.14.3	Clearances around crane vessel.....	166
19.14.4	Clearances around jack-up crane vessel.....	167
19.14.5	Clearances around mooring lines and anchors of crane vessels.....	167
19.14.6	Clearances around array cable zones.....	168
19.14.7	Clearances around spud-can positions of jack-up vessels.....	168

19.15	Bumpers and guides.....	168
19.15.1	Introduction.....	168
19.15.2	Object movements.....	168
19.15.3	Position of bumpers and guides.....	168
19.15.4	Bumper and guide loads.....	169
19.15.5	Design considerations.....	169
19.16	Heave compensated lifts.....	170
19.17	Lifts using DP.....	170
19.18	Practical considerations.....	170
19.18.1	Access.....	170
19.18.2	Design of seafastening.....	170
19.18.3	Equipment.....	170
19.18.4	Slings.....	171
19.19	Certification requirements for lifting equipment.....	171
19.19.1	Standard lifting equipment.....	171
19.19.2	Custom-made lifting equipment.....	171
19.19.3	Recertification of lifting equipment.....	172
20	Laying, burial, jointing, and repair of sub-sea cables.....	172
20.1	Introduction.....	172
20.2	Planning and design.....	172
20.2.1	Cable dimensions and handling parameters.....	172
20.2.2	Seafloor survey — Specifically cable route corridors between turbines and substation(s).....	173
20.2.3	Vessel suitability.....	175
20.2.4	Cable storage and cable handling equipment.....	177
20.2.5	Navigation equipment — Positioning and control of vessel/cable interface.....	177
20.3	Cable loadout and offshore transfer.....	178
20.3.1	Introduction.....	178
20.3.2	Handling and lifting.....	178
20.3.3	Loadout by reeling, spooling, winding and coiling.....	178
20.3.4	Lifted loadout and offshore transfer.....	180
20.4	Cable laying.....	180
20.4.1	Introduction.....	180
20.4.2	Cable pull-in procedures.....	181
20.4.3	Laying.....	182
20.5	Cable protection.....	182
20.5.1	Introduction.....	182
20.5.2	Cable burial.....	182
20.5.3	Non-burial cable protection.....	183
20.6	Cable crossings.....	185
20.7	Landfalls.....	185
20.8	Cable jointing and repair.....	185
20.9	As-built survey.....	186
20.10	Cable integrity check.....	186
20.11	Cable installation manual.....	186
21	Construction management.....	186
21.1	Introduction.....	186
21.2	Marine coordination.....	187
21.3	Harbour coordination.....	188
21.4	Guard vessel.....	188
21.5	Reporting.....	188
21.6	Personnel tracking.....	188
	Annex A (informative) Additional information and guidance.....	189
	Bibliography.....	203