

DIN EN ISO 13628-5:2010-05 (E)

Petroleum and natural gas industries - Design and operation of subsea production systems - Part 5: Subsea umbilicals (ISO 13628-5:2009); English version EN ISO 13628-5:2009, only on CD-ROM

Inhalt	Seite
Foreword	8
Introduction.....	9
1 Scope	10
2 Normative references	10
3 Terms, abbreviated terms and definitions	12
3.1 Terms and definitions	12
3.2 Abbreviated terms	18
4 Functional requirements.....	19
4.1 General requirements	19
4.1.1 Umbilical.....	19
4.1.2 End terminations and ancillary equipment.....	19
4.2 Project-specific requirements.....	20
5 Safety, design and testing philosophy.....	20
5.1 Application	20
5.2 Safety objective	20
5.3 Systematic review	20
5.4 Fundamental requirements	20
5.4.1 General	20
5.4.2 Quality assurance.....	21
5.5 Design philosophy	21
5.5.1 Design principles.....	21
5.5.2 Design basis	21
5.5.3 Design methodology	22
5.6 Testing	22
5.6.1 General	22
5.6.2 Qualification testing	23
5.6.3 Verification testing	23
5.6.4 Acceptance testing.....	23
6 Design requirements.....	24
6.1 General	24
6.2 Loads	24
6.2.1 Load classification	24
6.2.2 Functional loads	24
6.2.3 Environmental loads	25
6.2.4 Accidental loads	25
6.2.5 Load combinations and conditions.....	26
6.3 Load effect analysis	28
6.3.1 General	28
6.3.2 Global load-effect analysis.....	30
6.3.3 On bottom stability analysis	30
6.3.4 Pull-out analysis	30
6.3.5 Vortex-induced vibration analysis.....	31
6.3.6 Interference analysis.....	31
6.3.7 Free spanning analysis.....	32
6.3.8 Pull-in analyses	32
6.3.9 Structural analysis	33

6.4	Installation analysis.....	34
6.5	Fatigue life	35
7	Component design, manufacture and test.....	35
7.1	General.....	35
7.1.1	Design verification.....	35
7.1.2	Quality plan	35
7.1.3	Materials selection.....	36
7.2	Electric cables.....	36
7.2.1	General.....	36
7.2.2	Operating voltages	36
7.2.3	Power cables	36
7.2.4	Signal cables	37
7.2.5	Construction.....	37
7.2.6	Performance requirements	39
7.2.7	Structural analysis.....	40
7.2.8	Manufacturing	40
7.2.9	Verification/qualification testing	42
7.2.10	Acceptance testing	44
7.3	Hoses	47
7.3.1	General.....	47
7.3.2	Hose sizing	47
7.3.3	Hose construction	47
7.3.4	Performance requirements	49
7.3.5	Structural analysis.....	50
7.3.6	Manufacturing	50
7.3.7	Verification/qualification testing	51
7.3.8	Component factory acceptance tests.....	56
7.4	Optical-fibre cable.....	58
7.4.1	General.....	58
7.4.2	Fibre type.....	58
7.4.3	Fibre construction	58
7.4.4	Cable construction	58
7.4.5	Termination interface	59
7.4.6	Performance requirements	59
7.4.7	Jointing	60
7.4.8	Structural analysis.....	60
7.4.9	Manufacturing	60
7.4.10	Verification/qualification testing	60
7.4.11	Acceptance testing	61
7.4.12	Delivery testing	62
7.5	Metallic tubes	62
7.5.1	General.....	62
7.5.2	Tube size.....	62
7.5.3	Materials selection.....	66
7.5.4	Corrosion/erosion protection	67
7.5.5	Hydrogen embrittlement	68
7.5.6	Tube manufacture.....	68
7.5.7	Tube welding.....	71
7.5.8	Steel tube testing.....	73
8	Terminations and ancillary equipment design	78
8.1	Design principles	78
8.2	Design process	79
8.3	Armour terminations	79
8.4	Tube and hose terminations.....	79
8.5	Cable terminations.....	80
8.6	Pull-in head.....	80
8.7	Topside hang-off.....	81
8.8	Subsea termination interface	81
8.9	Subsea umbilical termination.....	81
8.10	Bend restrictors	82
8.11	Bend stiffeners.....	82

8.11.1	General	82
8.11.2	Dynamic bend stiffeners.....	82
8.11.3	Static bend stiffeners	83
8.12	Ancillary equipment	83
8.12.1	Joint box.....	83
8.12.2	Weak link	83
8.12.3	Buoyancy attachments	84
8.12.4	Centralizers	84
8.12.5	Vortex-induced vibration strakes	84
8.12.6	Riser-tube seals.....	84
8.12.7	Tie-back clamps.....	85
8.12.8	Temporary hold-back clamps	85
8.12.9	Bellmouth	85
8.12.10	Riser clamps	85
9	Umbilical design	85
9.1	Temperature range	85
9.2	Maximum tensile load	86
9.3	Ultimate tensile load.....	86
9.4	Minimum bend radius	86
9.5	Cross-sectional arrangement.....	86
9.6	Lay-up.....	86
9.7	Sub-bundles	86
9.8	Inner sheath	87
9.9	Armouring	87
9.10	Outer sheath	88
9.11	Length marking.....	88
10	Umbilical manufacture and test	88
10.1	Umbilical manufacture	88
10.1.1	General	88
10.1.2	Lay-up.....	88
10.1.3	Inner sheath	89
10.1.4	Armouring	90
10.1.5	Outer sheath	90
10.2	Qualification and verification tests.....	90
10.2.1	General	90
10.2.2	Monitoring during full scale umbilical tests	91
11	Factory acceptance tests	91
11.1	General	91
11.2	Visual and dimensional inspection	92
11.3	Electrical continuity at the termination	92
11.4	Trial termination fit-up	92
11.5	Electric cable	92
11.6	Optical fibre cables	92
11.7	Hoses	92
11.8	Tubes	93
11.9	Terminations	93
11.10	Continuity check.....	93
12	Storage	93
12.1	General	93
12.2	Protection of unterminated umbilical components	94
12.2.1	Electrical cables	94
12.2.2	Optical-fibre cables	94
12.2.3	Hydraulic hoses or tubes	94
12.3	Spare length	94
12.4	Repair kits	94
12.5	Handling for integration tests	94
13	Pre-installation activity	95
13.1	Umbilical information.....	95
13.2	Route information.....	96

13.3	Terminations and ancillary equipment information	96
13.4	Host facility information.....	96
13.5	Subsea structure information.....	97
13.6	Host facility visit	97
14	Load-out.....	97
14.1	General.....	97
14.2	Technical audit of load-out facilities.....	97
14.3	Load-out procedure	98
14.4	Pre-load-out meetings	98
14.5	Pre-load-out tests	99
14.5.1	General.....	99
14.5.2	Electric cables.....	99
14.5.3	Optical fibre cables.....	99
14.5.4	Hoses/tubes.....	100
14.6	Load-out operation	100
14.7	Stopping and starting the load-out.....	100
14.8	Handling of the umbilical	100
14.8.1	General.....	100
14.8.2	Twist.....	100
14.8.3	Bending.....	101
14.8.4	Lifting the umbilical	101
14.8.5	Transfer across spans	101
14.8.6	Terminations	101
14.8.7	Weak link	101
14.9	Load-out monitoring.....	101
14.9.1	General.....	101
14.9.2	Electric cables.....	101
14.9.3	Optical fibre cables.....	102
14.9.4	Hoses/tubes.....	102
14.9.5	Visual examination	102
14.9.6	Umbilical length	102
14.10	Load-out on a reel or carousel	102
14.11	Post-load-out tests	102
15	Installation operations	103
15.1	General.....	103
15.2	Requirements for installation vessel and equipment.....	103
15.3	Pre-installation survey	104
15.3.1	General.....	104
15.3.2	Requirements of survey.....	104
15.3.3	Reporting	105
15.4	I-tube or J-tube pull-in operations	105
15.4.1	General.....	105
15.4.2	Preparatory work	105
15.4.3	Weather window for pull-in.....	105
15.4.4	Initiation of pull-in operations	105
15.4.5	Visual survey.....	106
15.4.6	Recovery of the messenger wire.....	106
15.4.7	First end pull-in	106
15.4.8	Securing the umbilical on the host facility	107
15.4.9	I- or J-tube sealing and chemical protection	107
15.4.10	Second end pull-in.....	107
15.4.11	Movement of vessel away from the host facility	107
15.5	Lay-down of subsea termination (first end).....	107
15.6	Lay route.....	108
15.7	Handling requirements for the main lay	108
15.8	Vessel positioning to achieve required touch-down	108
15.9	Control and monitoring of length laid	109
15.10	Integrity monitoring during lay.....	110
15.10.1	General.....	110
15.10.2	Electric cables.....	110
15.10.3	Optical fibre cables.....	110

15.10.4 Hoses/tubes	110
15.10.5 Visual inspection	110
15.10.6 In-line termination	110
15.11 Burial operations	111
15.11.1 General	111
15.11.2 Monitoring during the burial operation	111
15.11.3 Interaction with umbilical	111
15.12 Approach to subsea termination position (second end).....	112
15.13 Lay-down of subsea termination	112
15.14 Pull-in of subsea termination	112
15.15 Pipeline crossings	113
15.16 Buoyancy attachments	113
15.17 Arming of the weak link	113
15.18 Post-lay survey	114
15.19 Post-burial survey	114
15.20 Post-pull-in test	114
15.21 Post-hook-up test	115
15.22 Retrieval of installation aids.....	115
15.23 Contingencies.....	115
15.24 Repairs	115
15.25 Post-installation survey	116
Annex A (informative) Information that should be provided in a purchaser's functional specification.....	117
A.1 General	117
A.2 Information that should be provided.....	117
A.2.1 Scope of development	117
A.2.2 Scope of supply	117
A.2.3 Applicable codes, standards and regulations.....	118
A.2.4 Operating environment.....	118
A.2.5 Specific purchaser requirements	118
A.2.6 One-off functional requirements.....	120
A.2.7 Interfaces.....	121
A.2.8 Installation requirements.....	121
A.2.9 Responsibilities	121
A.3 Design basis document	122
Annex B (informative) Umbilical testing	124
B.1 Schedule of tests performed as part of the manufacturer's quality assurance programme....	124
B.2 Schedule of tests performed as part of the installer's load-out and installation program	126
Annex C (informative) Hose and tube preferred sizes	128
Annex D (normative) Characterization tests for hoses and umbilicals	129
D.1 Hose	129
D.1.1 Volumetric expansion test.....	129
D.1.2 Dynamic hose response test.....	130
D.2 Umbilical bend stiffness test.....	132
Annex E (informative) Fatigue testing	133
Annex F (informative) Load-effect analysis.....	135
F.1 Structural analysis	135
F.1.1 General	135
F.1.2 Overview of structural analysis methods	135
F.1.3 Calibration of structural analysis methods	137
F.2 Comparison of umbilical designs.....	138
F.3 Fatigue analysis strategies	138
F.4 Global load effect analysis methodology	140
F.4.1 General	140
F.4.2 Cross-sectional modelling in global analyses	142
F.4.3 Global modelling considerations.....	144
F.5 Installation analysis	145
Annex G (informative) Umbilical full-scale tests	147

G.1	Umbilical full scale tests	147
G.2	Example procedure detail: Umbilical squeeze/crush test	151
G.2.1	Purpose	151
G.2.2	Test procedure	151
G.2.3	Acceptance criteria	152
G.2.4	Reporting	152
Annex H	(informative) Tube material matrix	153
H.1	General	153
Annex I	(informative) Tube-wall thickness example calculation	165
I.1	General	165
I.2	SI units	165
I.2.1	Input details	165
I.2.2	Design calculation	166
I.2.3	Design check	167
I.3	Calculations in USC units	168
I.3.1	Input details	168
I.3.2	Design calculation	169
I.3.3	Design check	170
Annex J	(informative) Buckling of metallic tubes	172
J.1	Displacement controlled bending	172
J.2	Collapse	172
J.3	Propagating buckling	174
Bibliography	175