DIN EN ISO 16530-1:2017-11 (E)

Petroleum and natural gas industries - Well integrity - Part 1: Life cycle governance (ISO 16530-1:2017)

Contents

Page

European foreword 6

Foreword 7

Introduction 8

1 Scope 9

2 Normative references 10

3 Terms and definitions 10

4 Abbreviated terms 18

5 Common elements of the well integrity life cycle 19

5.1 General 19
5.2 Well integrity 19
5.3 Well integrity policy 20
5.4 Well integrity management system 20
5.5 Risk assessment 20
5.5.1 General 20
5.5.2 Risk register 21
5.5.3 Well type risk profile 22
5.6 Organizational structure and tasks 22
5.7 Barriers 22
5.7.1 General 22
5.7.2 Barrier philosophy 23
5.7.3 Well barriers 23
5.7.4 Operational barriers 25
5.7.5 Human barriers 25
5.7.6 Administrative controls 25
5.7.7 Impact barriers 26
5.8 Performance standards for equipment 26
5.8.1 General 26
5.8.2 Well operating limits 26
5.9 Well barrier verification 27
5.9.1 General 27
5.9.2 Function testing 27
5.9.3 Barrier verification testing 27
5.9.4 Direction of flow 28
5.9.5 Effects of temperature 29
5.9.6 Modelling verification 29
5.10 Reporting and documentation 29
5.10.1 General 29
5.10.2 Well integrity status reporting 29
5.10.3 Well life cycle phase deliverables 30
5.10.4 Well handover process 31
5.11 Management of change 31
5.11.1 General 31
5.11.2 MOC process 31
5.11.3 Dispensation from the WIMS 32

5.12 Continuous improvement 32
5.12.1 General 32
5.12.2 Key performance indicator monitoring 32
5.12.3 Lessons learned 33
5.13 Auditing 33
5.13.1 General 33
5.13.2 Audit process 33
6 Basis of design phase 33
6.1 Basis of design phase objectives 34
6.2 Organizational structure and tasks 34
6.3 Well barriers 35
6.4 Hazard identification and assessment 35
6.5 Well integrity considerations for the basis of design 36
6.5.1 General information to be provided 36
6.5.2 Well objectives and life cycle 36
6.5.3 Inflow requirements 36
6.5.4 Outflow requirements 37
6.5.5 Well location and targets 37
6.5.6 Prognoses regarding geological formations, pore pressure, formation strength and temperature 37
6.5.7 Data acquisition requirements 37
6.5.8 Other considerations for well integrity 38
6.5.9 Production and injection characteristics affecting well integrity through the life cycle 38
6.6 Quality assurance and approval process 38
6.7 Deliverables 38
7 Well design phase 39
7.1 Well design phase objectives 39
7.2 Organizational structure and tasks 39
7.3 Risk controls in well design 40
7.3.1 Risk register 40
7.3.2 Lessons learned 41
7.3.3 Well life cycle risk considerations 41
7.3.4 Additional considerations during well design 42
7.4 Well barriers 44
7.4.1 General 44
7.4.2 Well barrier plan 44
7.4.3 WBE design performance standards 45
7.4.4 Verification of the final well barrier 46
7.4.5 Emergency shutdown related safety systems 46
7.5 Well operating limits 47
7.6 Contingency planning for well construction 47
7.7 Surveillance and monitoring requirements 47
7.8 Well design deliverables, reporting and documentation 48
8 Well construction phase 48
8.1 Well construction phase objectives 48
8.2 Organizational structure and tasks 49
8.3 Well programme 50
8.4 Well barrier schematic 50
8.5 Barrier verification 50
8.5.1 General 50
8.5.2 Wellhead movement and fatigue 50
8.5.3 Cement 50
8.5.4 Casing shoe testing 51
8.5.5 Wellhead seal profile 52
8.5.6 Tubular connections 52
8.5.7 Casing wear 52

8.6 Risk identification and assessment ... 52
8.7 Management of change ... 52
8.7.1 Potential changes to the well plan ... 52
8.7.2 Suspended well considerations ... 53
8.8 Deliverables (reporting and documentation) ... 53
8.8.1 Well handover information ... 53
8.8.2 Risk register ... 54
8.9 Continuous improvement ... 54

9 Well operational phase ... 54
9.1 Well operational phase objectives ... 54
9.2 Organizational structure and tasks ... 55
9.3 Well barriers ... 55
9.3.1 General ... 55
9.3.2 Performance standards ... 55
9.3.3 Leak rates ... 56
9.4 Well monitoring and surveillance ... 59
9.4.1 General ... 59
9.4.2 Monitoring and surveillance frequency ... 59
9.4.3 Well operating limits ... 60
9.4.4 Suspended and shut-in wells ... 61
9.4.5 Visual inspection ... 61
9.4.6 Well logging ... 61
9.4.7 Corrosion monitoring ... 61
9.4.8 Corrosion monitoring and prevention – external ... 62
9.4.9 Erosion monitoring ... 62
9.4.10 Structural integrity monitoring ... 62
9.4.11 Well elevation monitoring ... 63
9.4.12 Reservoir subsidence ... 64
9.5 Annulus pressure management ... 64
9.5.1 Management considerations ... 64
9.5.2 Sources of annulus pressure ... 64
9.5.3 Annulus pressure monitoring and testing ... 65
9.5.4 Frequency of monitoring tubing and annulus casing pressures ... 66
9.5.5 Investigation of annulus pressure ... 66
9.5.6 Maximum allowable annulus surface pressure ... 67
9.5.7 Maintaining annulus pressure within the thresholds ... 69
9.5.8 Review and change of MAASP and thresholds ... 69
9.6 Well maintenance ... 70
9.6.1 General ... 70
9.6.2 Replacement parts ... 70
9.6.3 Frequency of maintenance ... 71
9.6.4 Component testing methods ... 72
9.7 Risk assessment of well integrity failure and its management ... 72
9.7.1 General ... 72
9.7.2 Integrity failure ranking and prioritization ... 72
9.7.3 Well failure model ... 72
9.8 Reporting and documentation ... 73
9.9 Periodic well review ... 74
9.9.1 Well use review ... 74
9.9.2 End of well life review ... 74
9.10 Change of well use ... 75
9.11 Well stock performance review ... 75
9.12 Continuous improvement ... 77

10 Well intervention phase **77**
10.1 Well intervention phase objectives 77
10.2 Organizational structure and tasks 78
10.3 Well handover 79
10.4 Well intervention programme 79
10.5 Well barriers 79
10.5.1 General 79
10.5.2 Well barrier plans 80
10.5.3 Well barrier qualification 80
10.5.4 Well barrier verification 80
10.5.5 Well operating limits 80
10.6 Risk management 80
10.7 Management of change 81
10.8 Deliverables (documentation and reports) 81

11 Well abandonment phase **81**
11.1 Well abandonment phase objectives 81
11.2 Organizational structure and tasks 82
11.3 Well abandonment programme 83
11.4 Well barriers for abandonment 83
11.4.1 General 83
11.4.2 Well barrier material selection and qualification 84
11.4.3 Well barrier placement, configuration and redundancy 84
11.4.4 Well barrier verification 84
11.4.5 Reference documents for well abandonment barriers 84
11.5 Risk management 85
11.6 Management of change 85
11.7 Deliverables (documentation and reports) 85

Annex A (informative) **Risk assessment techniques** **87**

Annex B (informative) **Risk register** **90**

Annex C (informative) **Example of well integrity roles and responsibilities chart** **93**

Annex D (informative) **Example of a well integrity competence matrix** **94**

Annex E (informative) **Examples of well barrier elements, functions and failure characteristics** **96**

Annex F (informative) **Examples of well barriers during the well life cycle and a well barrier schematic** **99**

Annex G (informative) **Example of performance standard for well barrier elements** **104**

Annex H (informative) **Function testing by analysing hydraulic signature** **106**

Annex I (informative) **Determination of leak rate** **108**

Annex J (informative) **Well handover** **112**

Annex K (informative) **Examples of key performance indicators** **114**

Annex L (informative) **Example of hazard identification checklist** **115**

Annex M (informative) **Example plot of pore pressure versus formation strength** **116**

Annex N (informative) **Well barrier element performance requirements** **117**

Annex O (informative) **Example of leak testing of gas-lift valves** **118**

Annex P (informative) **Example of well operating limits** **120**

Annex Q (informative) **Example of possible well leak paths** **122**

Annex R (informative) **MAASP calculations** **123**

Annex S (informative) **Example of a change in MAASP calculations** **129**

Bibliography **131**