

ISO/TR 27923:2022-01 (E)

Carbon dioxide capture, transportation and geological storage - Injection operations, infrastructure and monitoring

| Contents | | Page |
|--------------------|--|-------------|
| Foreword | | vii |
| Introduction | | viii |
| 1 | Scope | 1 |
| 2 | Normative references | 1 |
| 3 | Terms and definitions | 1 |
| 4 | Symbols and abbreviated terms | 15 |
| 5 | Legal framework | 17 |
| 5.1 | General | 17 |
| 5.2 | United States | 17 |
| 5.2.1 | General | 17 |
| 5.2.2 | UIC Class II and Class VI | 18 |
| 5.3 | The European Union | 18 |
| 5.3.1 | General | 18 |
| 5.3.2 | The EU CCS Directive | 18 |
| 5.3.3 | The Environmental Liability Directive | 19 |
| 5.4 | Germany | 19 |
| 5.5 | France | 20 |
| 5.6 | Norway | 20 |
| 5.6.1 | General | 20 |
| 5.6.2 | The permitting regime for CCS activities | 20 |
| 5.6.3 | Financial security | 20 |
| 5.6.4 | Monitoring | 21 |
| 5.7 | Canada | 21 |
| 5.8 | Japan | 22 |
| 5.9 | Australia | 22 |
| 6 | Well design | 23 |
| 6.1 | General | 23 |
| 6.2 | Components | 23 |
| 6.2.1 | Conductor casing | 23 |
| 6.2.2 | Surface casing | 23 |
| 6.2.3 | Main section casing | 24 |
| 6.2.4 | Liner | 25 |
| 6.2.5 | Tubing and completion assemblies | 25 |
| 6.2.6 | Wellhead and Christmas tree | 25 |
| 6.3 | CO ₂ Injection wells | 25 |
| 6.3.1 | Well design and construction | 26 |
| 6.3.2 | Well completion | 26 |
| 6.3.3 | CO ₂ -EOR injection well construction | 26 |
| 6.3.4 | Research injection well construction | 27 |
| 6.3.5 | Commercial-scale injection | 28 |
| 6.4 | Monitoring well construction | 29 |
| 6.4.1 | General | 29 |
| 6.4.2 | Perforated monitoring well | 29 |
| 6.4.3 | Induction logging monitoring well (Plastic casing: Nagaoka, Cranfield) | 30 |

| | | |
|----------------------|--|----|
| 6.5 | Discussion | 31 |
| 7 | Surface infrastructure concepts (non-well) | 33 |
| 7.1 | Design and materials | 33 |
| 7.1.1 | General | 33 |
| 7.1.2 | Material selection | 33 |
| 7.1.3 | Carbon steel | 33 |
| 7.1.4 | Stainless steel | 34 |
| 7.1.5 | Alloys | 34 |
| ISO/TR 27923:2022(E) | ISO/TR 27923:2022(E) 7.2 Equipment | 34 |
| 7.2.1 | Tie-in to CO2 injection well | 34 |
| 7.2.2 | Pressurization to supercritical phase | 34 |
| 7.2.3 | Dehydration | 34 |
| 7.2.4 | Valves | 34 |
| 7.2.5 | Measurement | 35 |
| 7.2.6 | Leak detection | 35 |
| 7.2.7 | Venting | 35 |
| 7.3 | Considerations for storage incidental to CO2-EOR | 35 |
| 7.3.1 | General | 35 |
| 7.3.2 | Liquids | 36 |
| 7.3.3 | CO2 stream production and recycling | 37 |
| 7.3.4 | Operating pressure regime | 37 |
| 7.3.5 | Recycle Compression | 37 |
| 7.3.6 | Interstage cooling & separation | 38 |
| 7.3.7 | Dehydration | 38 |
| 7.3.8 | Booster pumps | 38 |
| 7.3.9 | Impact of CO2 production - asphaltenes | 38 |
| 7.3.10 | Impact of recycle stream composition on metering and operating pressures | 39 |
| 7.4 | Maintenance and remediation | 39 |
| 7.5 | Onshore case studies | 39 |
| 7.6 | Offshore case studies | 40 |
| 8 | CO2 storage site injection operations | 41 |
| 8.1 | General | 41 |
| 8.1.1 | Objectives | 41 |
| 8.1.2 | Scope of operations | 41 |
| 8.2 | Design of CO2 injection operations | 41 |
| 8.2.1 | General components of operations design | 41 |
| 8.2.2 | Storage complex design parameters | 43 |
| 8.2.3 | Storage project modelling | 43 |
| 8.2.4 | Case Study - Aquistore | 44 |
| 8.2.5 | Contractual agreement impacts on injection design parameters | 44 |
| 8.3 | Operations and maintenance plan | 45 |
| 8.3.1 | General - Definition of the main operational conditions | 45 |
| 8.3.2 | Operational protocols and maintenance schedules | 45 |
| 8.3.3 | Recording management of change | 45 |
| 8.3.4 | Communication plan | 46 |
| 8.3.5 | Nomination process for CO2 delivery and receipt | 46 |
| 8.3.6 | Safety plan | 46 |
| 8.4 | Injection operations | 46 |
| 8.4.1 | Initial (start-up) | 47 |
| 8.4.2 | Shutdowns | 47 |
| 8.4.3 | Start-up following shutdowns | 47 |
| 8.5 | Data acquisition, monitoring and testing | 47 |
| 8.5.1 | General | 47 |
| 8.5.2 | Surface equipment and injection line data | 48 |
| 8.5.3 | Wellbore monitoring | 48 |
| 8.5.4 | Well surveillance | 48 |
| 8.6 | Well intervention (workovers) | 50 |
| 8.7 | Considerations for storage using enhanced oil recovery (CO2-EOR) | 50 |

| | | |
|---|--|----|
| 9 | Storing CO2 in petroleum reservoirs | 51 |
| 9.1 | General | 51 |
| 9.2 | Reservoir screening | 53 |
| 9.2.1 | Storage complex integrity | 53 |
| 9.2.2 | Project transition type | 53 |
| 9.2.3 | Geological data | 53 |
| 9.2.4 | Historical production and reservoir performance | 54 |
| ISO/TR 27923:2022(E) 9.2.5 Hydrocarbon compositional analysis (PVT) | | 54 |
| 9.2.6 | CO2 storage capacity | 54 |
| 9.2.7 | Reservoir pressure history | 55 |
| 9.2.8 | Aquifer considerations | 56 |
| 9.2.9 | Water extraction | 56 |
| 9.3 | Surface production and injection facilities | 56 |
| 9.3.1 | CO2 distribution system | 56 |
| 9.3.2 | Production facilities | 57 |
| 9.4 | Production and injection wellbores (subsurface infrastructure) | 58 |
| 9.5 | Operating considerations | 58 |
| 9.5.1 | Operations management plan | 58 |
| 9.5.2 | Measurement calibration | 58 |
| 9.5.3 | Well interventions | 59 |
| 9.6 | Monitoring | 59 |
| 9.7 | Transition to storage | 59 |
| 9.7.1 | Reservoir considerations | 60 |
| 9.7.2 | Legal/regulatory considerations | 60 |
| 9.7.3 | Financial considerations | 60 |
| 9.8 | Closure | 61 |
| 10 | Monitoring | 61 |
| 10.1 | General | 61 |
| 10.2 | Monitoring objectives | 61 |
| 10.3 | Monitoring plan design | 61 |
| 10.3.1 | Geological Storage vs. CO2-EOR storage projects | 62 |
| 10.3.2 | Land vs. marine storage project | 62 |
| 10.3.3 | Monitoring vs. project stage | 62 |
| 10.4 | Monitoring methods | 63 |
| 10.4.1 | Wellbore monitoring | 63 |
| 10.4.2 | Surface-based monitoring | 64 |
| 10.5 | Case studies | 69 |
| 10.5.1 | CCS pilot projects (<100 kt) | 69 |
| 10.5.2 | Industrial-scale CCS projects | 70 |
| 10.5.3 | CO2-EOR projects with monitoring | 74 |
| 11 | Decommissioning | 74 |
| 11.1 | General | 74 |
| 11.2 | Activities | 74 |
| 11.3 | Closure or termination plan | 75 |
| 11.4 | Identification of jurisdictions and relevant framework | 75 |
| 11.5 | United States | 76 |
| 11.5.1 | EPA regulations for closure and post-injection site care | 76 |
| 11.5.2 | Class II well plugging regulations | 76 |
| 11.5.3 | Class VI well plugging regulations | 76 |
| 11.5.4 | Class VI PISC | 76 |
| 11.6 | The European Union | 77 |
| 11.6.1 | Closure | 77 |
| 11.6.2 | Post closure | 77 |
| 11.6.3 | Transfer of liability | 77 |
| 11.7 | Germany | 77 |
| 11.8 | France | 78 |
| 11.9 | Norway | 78 |
| 11.10 | Canada | 78 |
| 11.11 | Japan | 79 |

| | | |
|--|---|------------|
| 11.12 | Discussion of closure at selected projects | 79 |
| 11.12.1 | | |
| Illinois Basin Decatur Project | | 79 |
| 11.12.2 | | |
| Ketzin | | 81 |
| ISO/TR 27923:2022(E) 11.12.3 | | |
| Sleipner | 84 | |
| 11.12.4 | | |
| Snøhvit | | 84 |
| Annex A (informative) Case studies project overview | | 85 |
| Bibliography | | 110 |