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Advancing Subsea CCS Design: Update and Early Uptake of IOGP Report 665

David Saul



How Does Subsea CCS Fit Within the IOGP Structure



Safety Work Stream



Environment Work Stream



Engineering Work Stream



Energy Transition Work Stream



Geomatics Committee



Digital Transformation Committee



Standards Committee

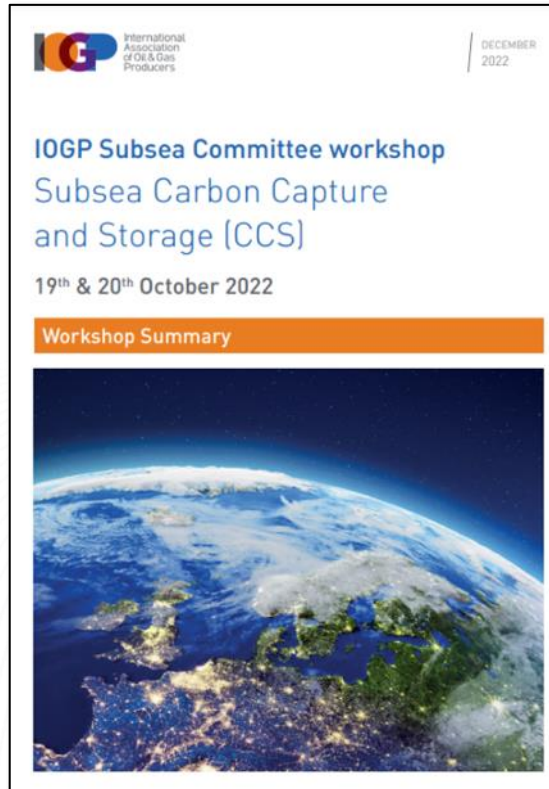


Subsea Subcommittee

CCS Expert Group

The IOGP's Subsea CCS Journey

- **Subsea CCS Workshop** held in October 2022
- Topic:
Roles and requirements for subsea systems in the carbon capture space
- Inputs from Operators and Suppliers to establish an understanding of **key industry issues and needs**



Outcome:

- Set up **Subsea CCS Expert Group** in 2023
- Target, to **develop a Guideline:** An introduction to CCS systems and subsea applications
- Agreed that API will take a monitoring position on CCS and will potentially **incorporate IOGP work in API's future efforts**

IOGP Report 665 Overview

IOGP Report 665 is written as design guidance, not a specification or requirement

- Highlights aspects that are unique vs same between CCS and hydrocarbon system/equipment design
- Provides references to existing industry documents & requirements to avoid duplication and promote standardization
- Provides recommendations for design (e.g., PSL, trim)

Main Content Sections

1. Subsea CCS projects overview
2. Subsea systems design
3. Subsea architecture
4. Equipment functional requirements
5. Appendices
 - A. Reuse of equipment
 - B. Installation, commissioning, and intervention



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REPORT 665
FEBRUARY 2026

Design guidance for subsea carbon capture and storage systems



Subsea CCS design guidance

Key design points of onshore facility:

- Short or long distance subsea "trunk line" from remote onshore suppliers to offshore receiving terminals or transporting to platforms.
- The Subsea Umbilicals Risers and Flowlines (SURF) battery limit typically will be the export site/subsea flowline interface.
- Subsea wells remotely monitored and controlled.

2.1.2 Intermittent injection from ship through subsea system

This option is typically designed to support 'dispatchable' (intermittent) CO₂ emitters.

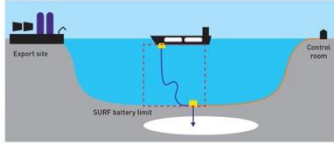


Figure 2 - Typical design of intermittent injection from vessel

Key design points of intermittent injection from ship option:

- Injection from transport vessels may be intermittent, where there may be an interruption in injection ranging from days to weeks.
- Requires a surface connection point typically a buoy to inject CO₂ through a riser to the subsea equipment and into the reservoir.
- May require heating systems to manage offloading temperatures.
- Power generation systems may be vessel mounted or from another source via subsea power cable.
- The SURF battery limit typically will be on the riser and umbilical hang-off.
- During shut-in periods, well condition should be monitored.

2.1.3 Continuous injection from ship through subsea system

Continuous injection via a permanently moored vessel providing buffer storage, allows for widely geographically separated CO₂ sources.

Subsea CCS design guidance

API Section Number	Clause title	Commentary
4	Application, service conditions, and production specification levels (PSL)	
4.1	Service conditions	Equipment should be specified as PSL3, however PSL2 may be accepted, depending on project specific operating conditions. PSL2 was considered, but not recommended due to the reduced level of quality control.
4.2	Service Conditions	
4.2.2	Temperature classifications	There is no standard design temperature classification for CCS application due to the industry's relative immaturity. The design temperature range should be based upon flow assurance work, specific to the CCS project. Selecting the temperature rating is the responsibility of the user, based on project specific operating conditions.
4.2.3	Sour service designation and marking	Due to potential CO ₂ flow stream impurities, water ingress, and potential flowback of hydrocarbons or reservoir fluids over the life of field, it is recommended that NACE MR0175/ISO 15156 be specified for line material. Sour service class FF or HH trim is recommended for the injection bore and CE trim is recommended for the annulus bore.
4.3	Product specification levels	Equipment should be specified as PSL3G, however, PSL3 may be accepted depending on project specific operating conditions. PSL2 was considered, but not recommended due to the reduced level of quality control.
9	Common System Requirements	
9.1	Design and Performance Requirements	
9.1.1	General:	
9.1.1.1	Product capability	CO ₂ operating conditions may differ from oil and gas because of fluctuation in supply pressure and/or intermittent supply. Consideration should be given to an increase in operating cycles of valves and chokes, with consequential impact of pressure and temperature cycles for other equipment. Project specific steady state and transient flow assurance models should be used to define pressure and temperature limits. In CO ₂ storage applications, it is anticipated that a post injection monitoring period is required which may affect some elements of the design life.
9.1.1.3	Thermal integrity	Components should be designed for the temperature range based on project specific operating conditions and flow assurance models. This is the responsibility of the user. Lower temperatures than hydrocarbon systems are expected in CO ₂ injection systems which may require additional component validation. Validation should follow methods described in API Spec 17D and ISO 15156-2.



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The Guidance Document in a Little More Detail

Subsea systems design

- Alternative system concepts
- Impacts of reservoir type

Subsea architecture

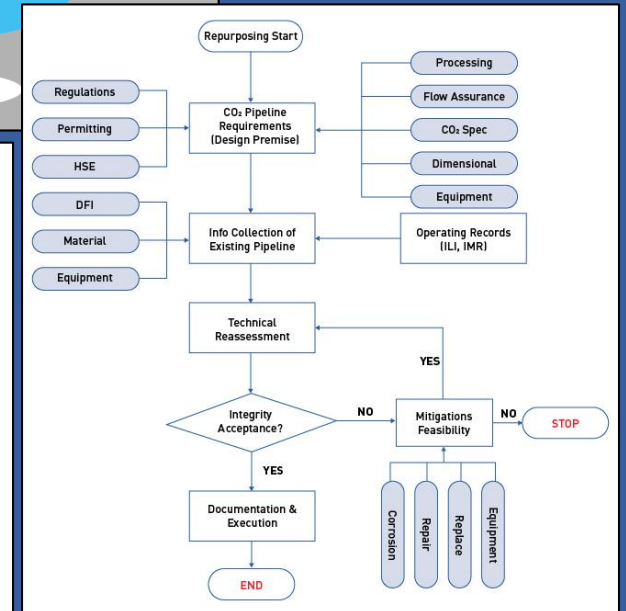
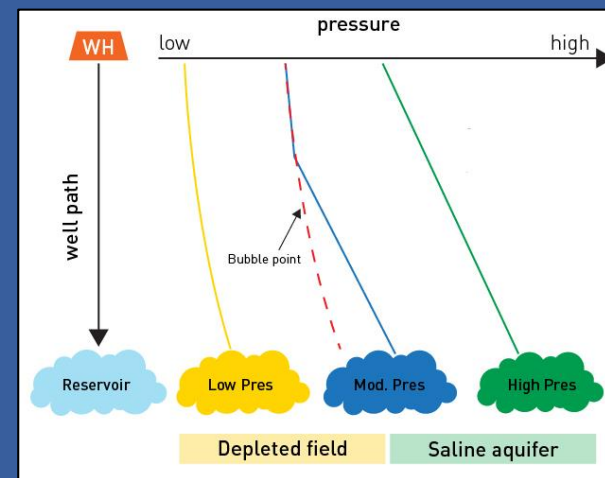
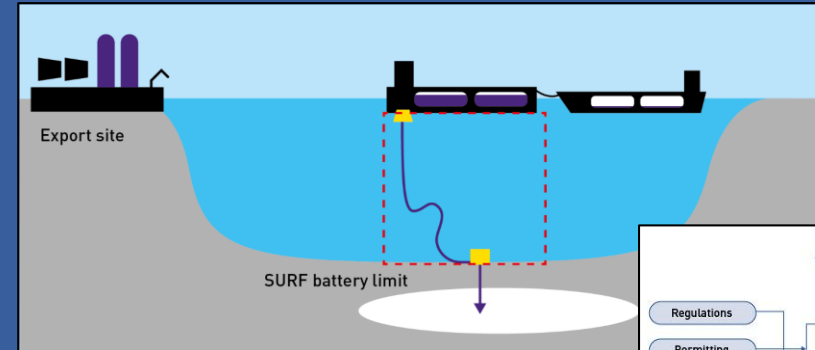
- Layout, sizing & depth considerations
- Qualification, availability
- Barrier philosophy
- Expansion

Equipment functional requirements

- Trees
- Structures
- Pipelines
- Controls & risers

Appendices

- Reuse of equipment
- Installations, commissioning & intervention



The Update

Purpose

- Reviewed stakeholder feedback received since the 2024 publication.
- Improved clarity and usability for designers, operators, suppliers and regulators.
- Reflected early project experience where available.

What Changed

- A targeted maintenance revision rather than a major rewrite.
- Continued emphasis on supporting safe and reliable subsea CCS system design as standards and regulations continue to evolve.

Key Technical Enhancements

- Refined guidance on subsea architecture considerations.
- Expanded discussion on venting to sea, allowable leakage rates, self-sealing potential and regulatory considerations.
- Updated references to technology readiness and relevant ISO reliability standards.



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Design guidance for subsea carbon capture and storage systems



Testimonials



Andrew Fitton
Principal Subsea Hardware Engineer & TA2





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ Shell is currently using IOGP Reports 665 and 665-1 in the concept select phase of one of our UK projects and is widely promoting the new documents on our internal global platforms. The current guidelines assist in identifying key risks for CCS subsea developments which differ from conventional O&G developments. The new guidelines will assist in de-risking new CCS subsea fields, improving reliability and availability, whilst also providing alignment of requirements across the supply chain. ”



Dan Pedersen
Chief Engineer Subsea Technology and Operation





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ The IOGP 665 and 665-1 are being used as a reference for an update of our governing documentation regarding the development of subsea CCS facilities and as guidelines for our ongoing CCS projects. They also form the basis for joint technology development projects with other operators, and I am sure they will help the industry gain quality and efficiency in the development of international standards. ”



Michael Blowers
Senior Principal, SP&S Front-End System Engineering





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ As an equipment supplier to the industry, these reports clarify the traditional Oil & Gas principles that should be retained and where changes can be tolerated considering the new CCS process to better address the requirements. The insight gathered helps us shape concept designs specifically for the CCS market and focus on the aspects that are important to this new process. With an increasing amount of knowledge across the Subsea industry, the guidelines provide alternate areas of consideration during the design process that may not be typical of legacy subsea developments. ”



Ryan Gola
Principal Engineer – Subsea Systems & Hardware





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ By aligning with these IOGP guidance documents, we expect the industry will see benefits that are generally associated with the use of common design philosophies, such as improved safety by maintaining common minimum requirements and reliability enhancement through continuous improvement because at a core level designs will be similar. ”



Awaluddin Berwanto
Custodian (Subsea System)





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ Petronas is using IOGP Reports 665 and 665-1 to help assess the practicality, design, and risks of deploying CCS in underwater assets, whether in shallow or deepwater. These guidelines serve as key references in evaluating well integrity and barrier philosophies tailored for CO₂-rich environments. The guidelines are foundational in establishing consistent, globally applicable practices for subsea CCS, promoting safer and more efficient deployments. ”





Daniel Dawes
Senior Subsea System Engineer





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ TotalEnergies' Subsea Technologies and CO₂ teams are using guidelines 665 and 665-1 to support ongoing CCS projects. These guidelines also serve as a foundation for our CCS development studies - both for standalone CCS projects and those where CCS is integrated into oil and gas projects. The guideline introduces and explains the specific technical and operational challenges that come with CO₂ injection in subsea environments and offers mitigations and design solutions. ”





Lars Timberlid Lundheim
Subsea Shallow Water Tree Product Champion





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ These guidelines are key as they give Operators and Suppliers a common and well thought through starting point in CCS developments that the existing standards and guidelines do not really address. Ongoing CCS projects and future prospects will provide valuable insights that will allow us to further develop and strengthen the framework. ”





Øyvind Koldal
Principal Facility & Project Engineer





Industry Outlook:
Subsea Carbon Capture and Storage (CCS) Systems

“ IOGP Report 665 has been instrumental for us, and we have utilized its content extensively and plan to continue leveraging it in future CCS projects. It provides a high-level system overview of the subsea scope by elaborating on the interdisciplinary impacts of the various subsea CCS concepts, which again support decision makers on a strategic level. As the subsea CCS business develops, the 665 report is a candidate for continuing to be an overarching guideline for presenting a “helicopter view” of the high-level features of subsea CCS concepts. ”



Next Steps

Discussions with Standards Bodies

Monitoring Uptake

Design guidance for subsea carbon capture and storage systems



Subsea Barrier and Isolation Philosophy for CCS Systems



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IOGP Report 665

Design guidance for subsea carbon capture and storage systems



IOGP Report 665-1

Subsea Barrier and Isolation Philosophy for CCS Systems



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