Havtil Norwegian Ocean Industry Authority

SPE Wells Decomissioning conference

Status update on CO_2 projects on the NCS, and an insight in Norwegian regulatory requirements related to well integrity for legacy wells in the storage complex.

Elin Vargervik
Drilling and Well technolgy

Who are we?

- Government supervisory agency subordinate to the Ministry of Energy
- Regulatory authority for safety, the working environment, emergency preparedness and security
- Our areas of responsibility include petroleum operations, renewable energy production, extraction of seabed minerals and CO_2 transport and storage

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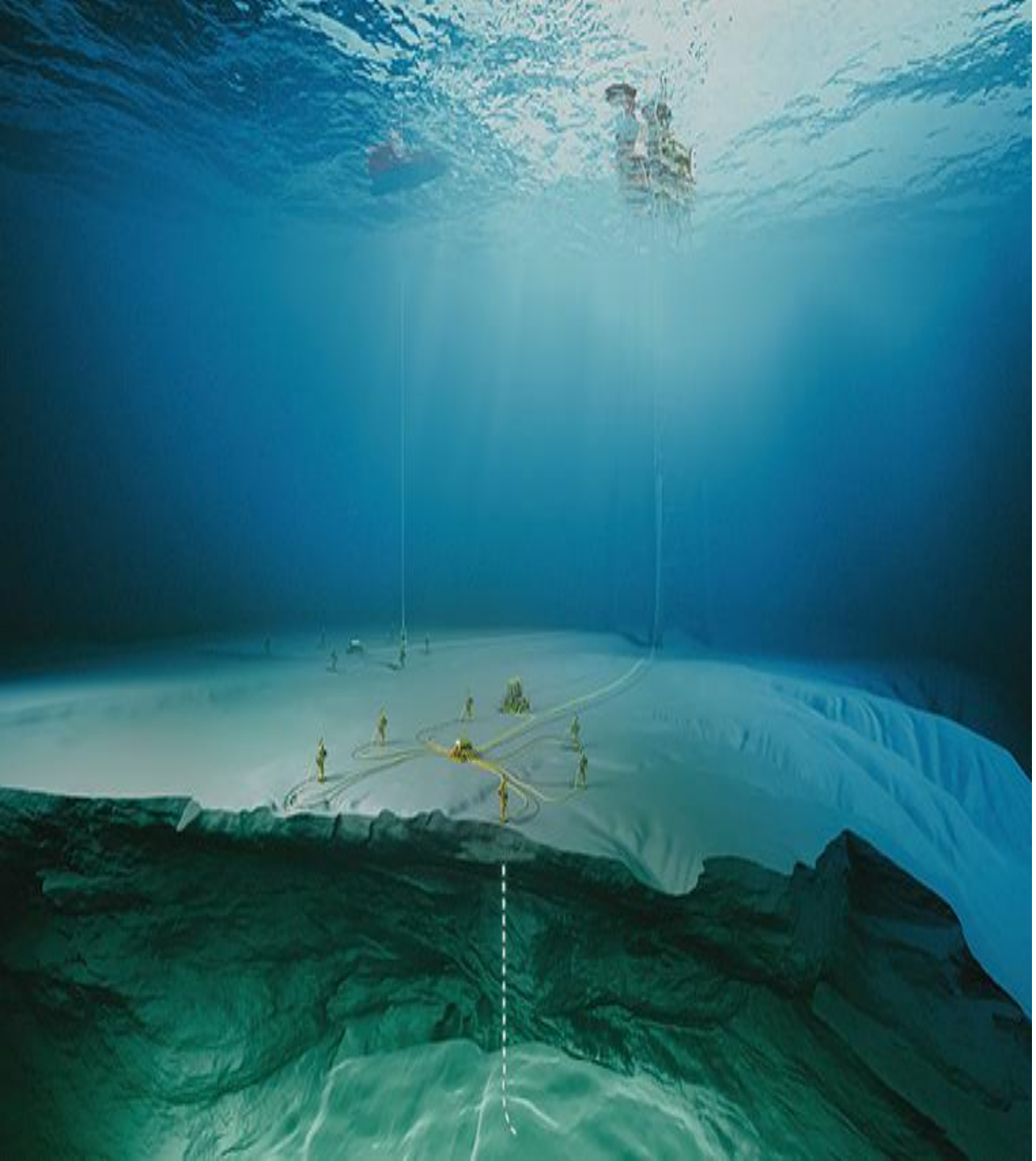

CO2 storage on the NCS

Government strategy: Where is it possible to store CO2 offshore Norway and what is the storage capacity?

EL 001: Northern Lights JV DA (Aurora/2019)

EXL 002: Equinor AS (Smeaheia / 2022)
EXL 003: Horisont Energi AS, (Polaris/2022)
EXL 004: Harbour Energy, Total Energies (Luna/2022)
EXL 005: Aker BP and OMV (Poseidon/2023),
EXL 006: Harbour Energi and Stella Maris CCS (Havstjerne/2023)
EXL 007: Vår Energi, INPPEX, Storegga (Trudvang/2023)
EXL 008: Equinor LCS AS (Albondigas/2024)
EXL 009: Vår Energi, ØMV, Lime Petroleum (Iroko/2024)
EXL 010: Equinor LCS AS (Kinno/2024)
EXL 011: AkerBP (Atlas/2024)
EXL 012: Harbour Energy / Equinor LCS, (Kaupang/2024)
EXL 013: Equinor LCS / AkerBP (FRIGG/2024)

EL: Exploitation license
EXL: Exploration license

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Application and licensing process

Application from company on acreage

Acreage assessment

Announcement of relevant areas

Submission of applications

Award of exploration license

Implementation of work program

Exploitation license

Finnestad / Oljedirektoratet

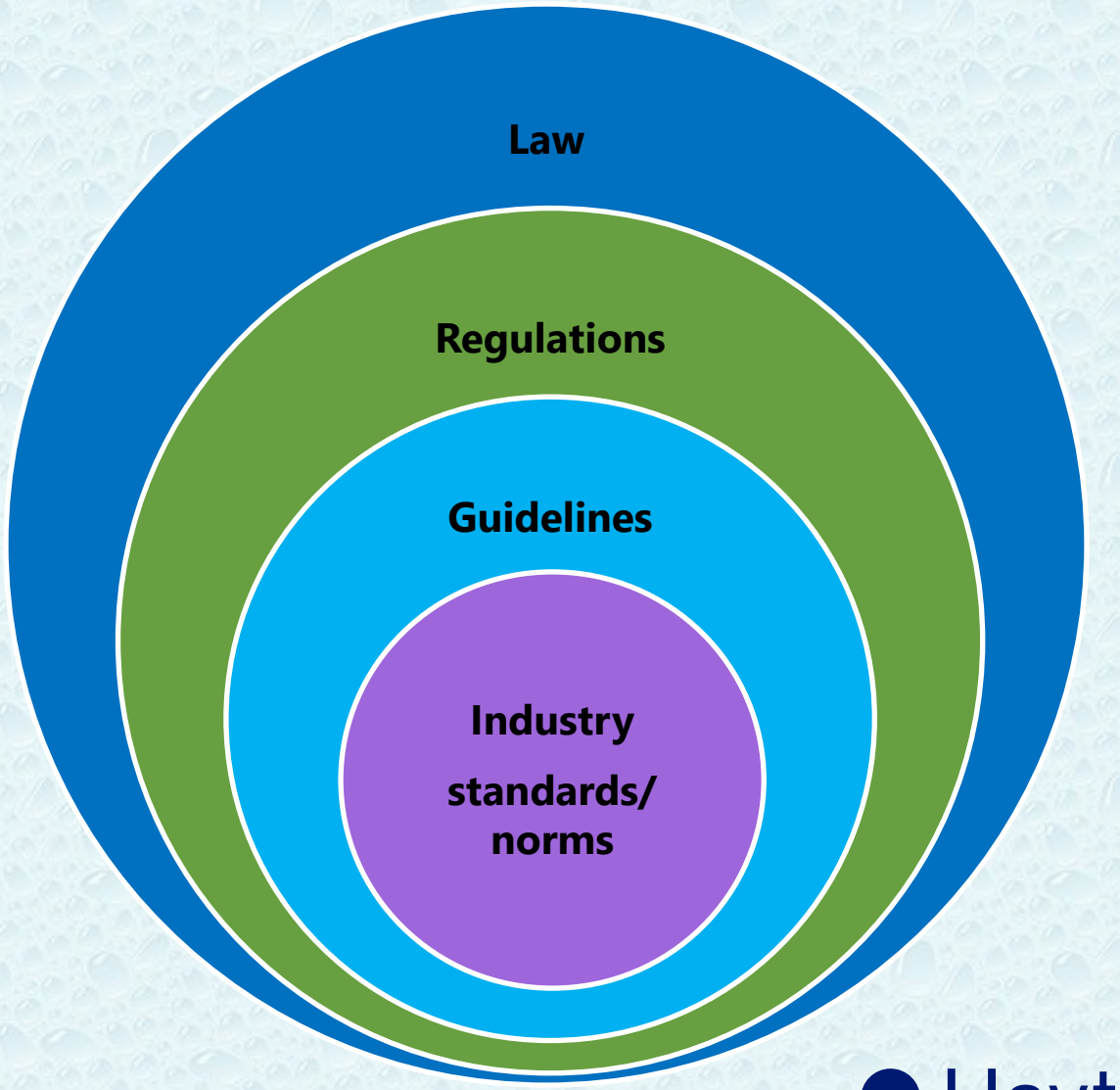
Work programs

Example for last award of exploration licence

Licence	Phase	Duration	Activity
EXL 005	1	2	Acquire and process 3D seismics of storage complex and overburden Geological and geophysical studies incl 3D reservoir modelling Leak and migrations studies DG1 or return of license
	2	2	Drill exploration well and test formation Evaluation and choice of concept DG2 or return of licence
	3	1	Plan for Development and Operations Investment Submission of PDO or return license
		5 years	

The regulations

- Mainly performance-based
- Specifies ***what*** level of safety is to be attained, not ***how***
- Refer to norms and industry standards
- Provide freedom to choose good solutions – and **underline the allocation of responsibility**
- Require the companies to establish HSE targets and manage their business to meet these



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The Norwegian Regulatory landscape

European Union

Directive 2009/31/EC, CCS Directive

Geological storage of carbon dioxide

Ministry of Energy

Act of 21 June 1963 No. 12

Scientific research and exploration for and exploitation of subsea natural resources other than petroleum resources

Ministry of Labour and Social Inclusion

Working Environmental Act

Act relating to the working environment, working hours and employment protection

Norwegian Ocean Industry Authority

CO2 safety regulations

Regulations relating to safety and working environment for transport and injection of co2 on the continental shelf

Norwegian Offshore Directorate

Storage and transportation of CO2

Regulations relating to exploitation of subsea reservoirs o the continental shelf for storage of CO_2 and relating to transportation of CO2 on the continental shelf.

The Norwegian Environment Agency

Pollutions Regulations

Part 7A / chapter 35 in existing Pollutions Regulations

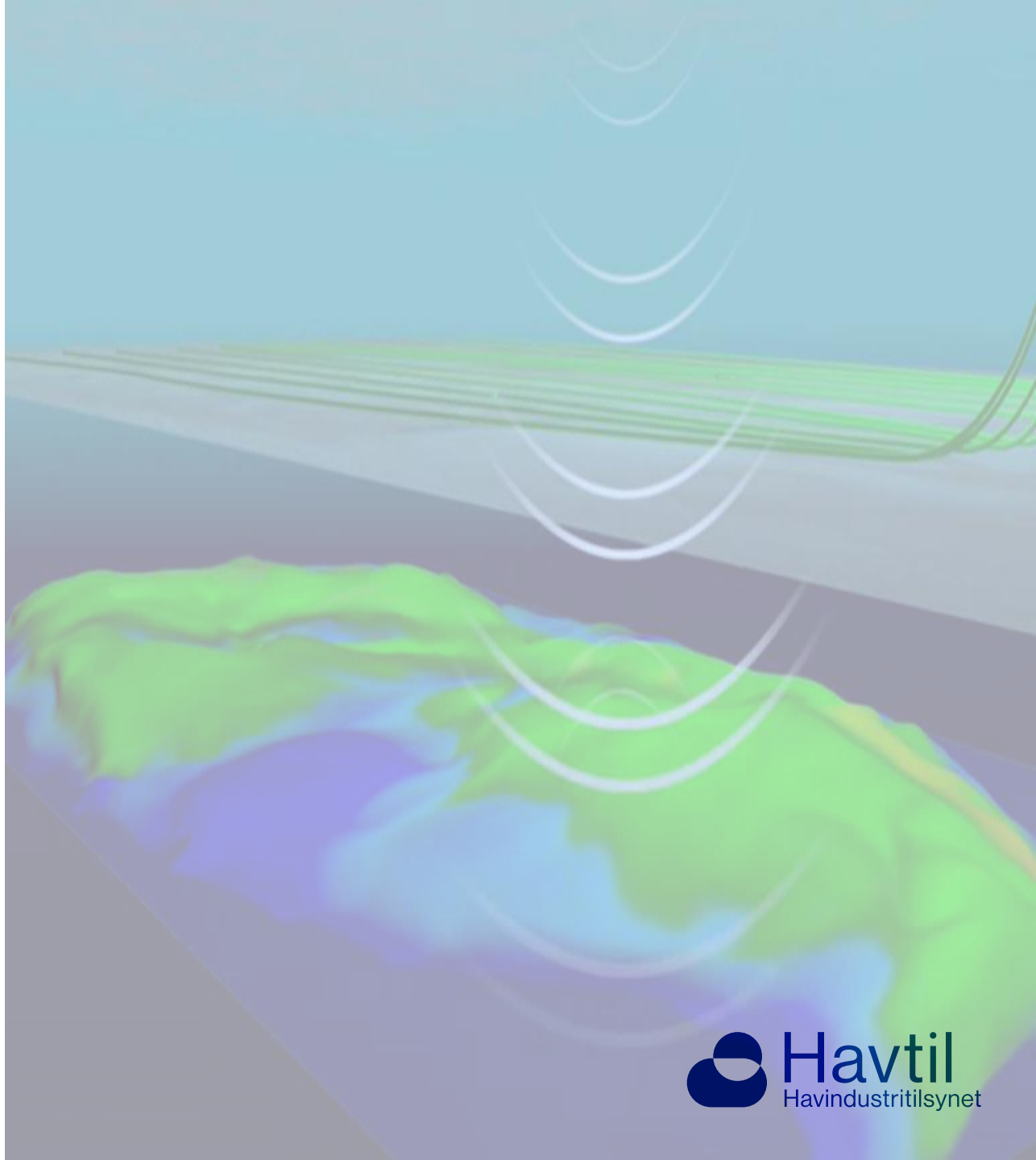
NORWEGIAN OFFSHORE DIRECTORATE

NOD regulation on storage and transportation of CO2

§ 5-2 MONITORING

The operator must monitor the injection facilities and the storage complex, including the CO2 distribution in order to:

- Compare the actual and modeled behavior of CO2 and the formation water in the storage location,
- Identify significant irregularities,
- Follow the migration of CO2,
- Detect leakage of CO2 from the storage complex



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CO2 safety regulations

CO2 safety regulations

Regulations relating to safety and working environment for transport and injection of CO_2 on the continental shelf

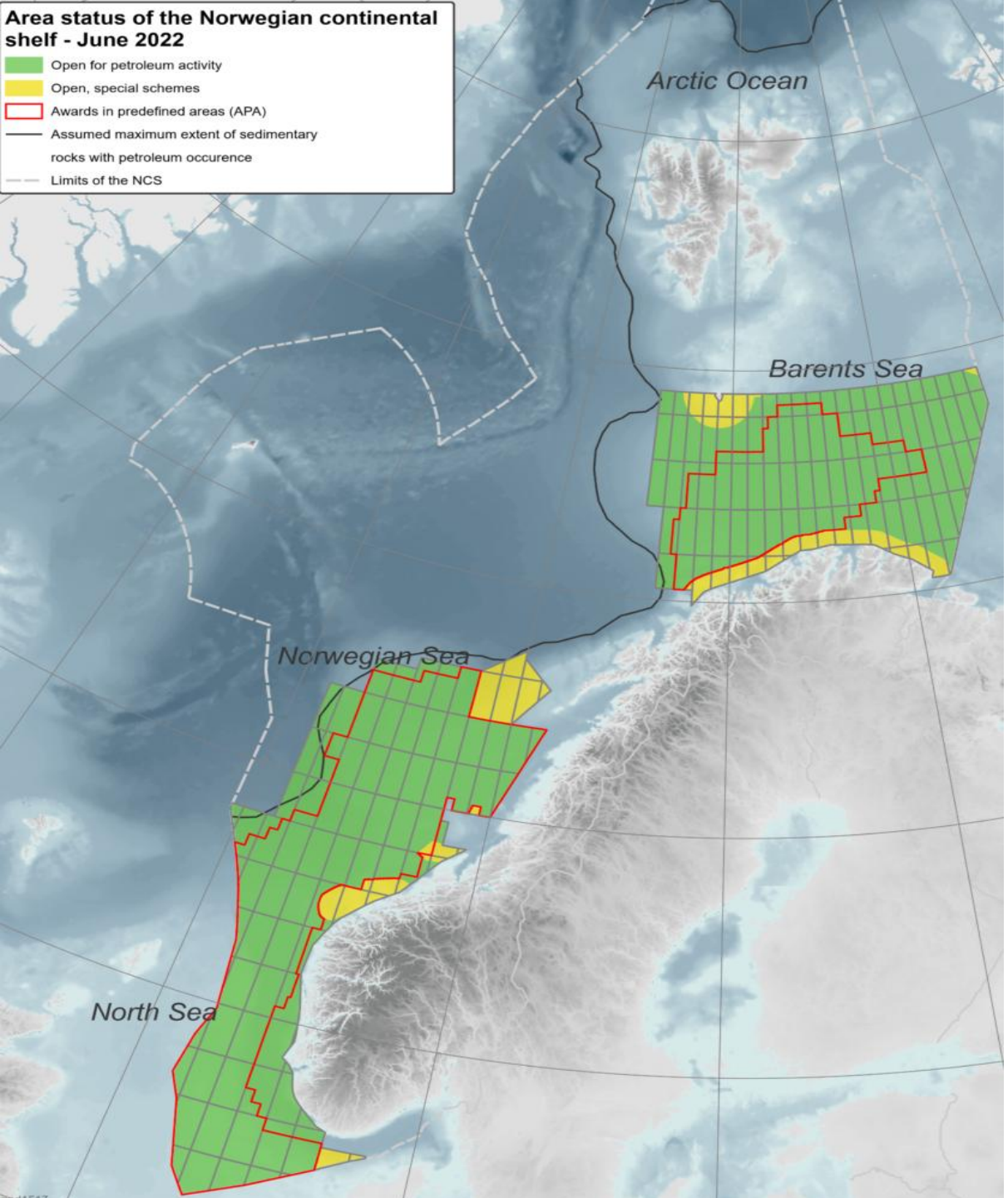
§ 17 Drilling and well systems and drilling and well activities

Share link

The requirements that apply to drilling and well systems in **Chapter VIII of the Facilities Regulations** and to drilling and well activities in **Chapter XV of the Activities Regulations**, apply correspondingly to the scope of these regulations.

Last changed: 25 February 2020

Guidelines and audit reports with nonconformities related to the section →



CO2 Safety Regulation Section § 11

§ 11 Matters relating to safety and working environment in the plan for development and operation of a subsea reservoir for injection and storage of CO2 and specific licence for the installation and operation of facilities for transport

Share link

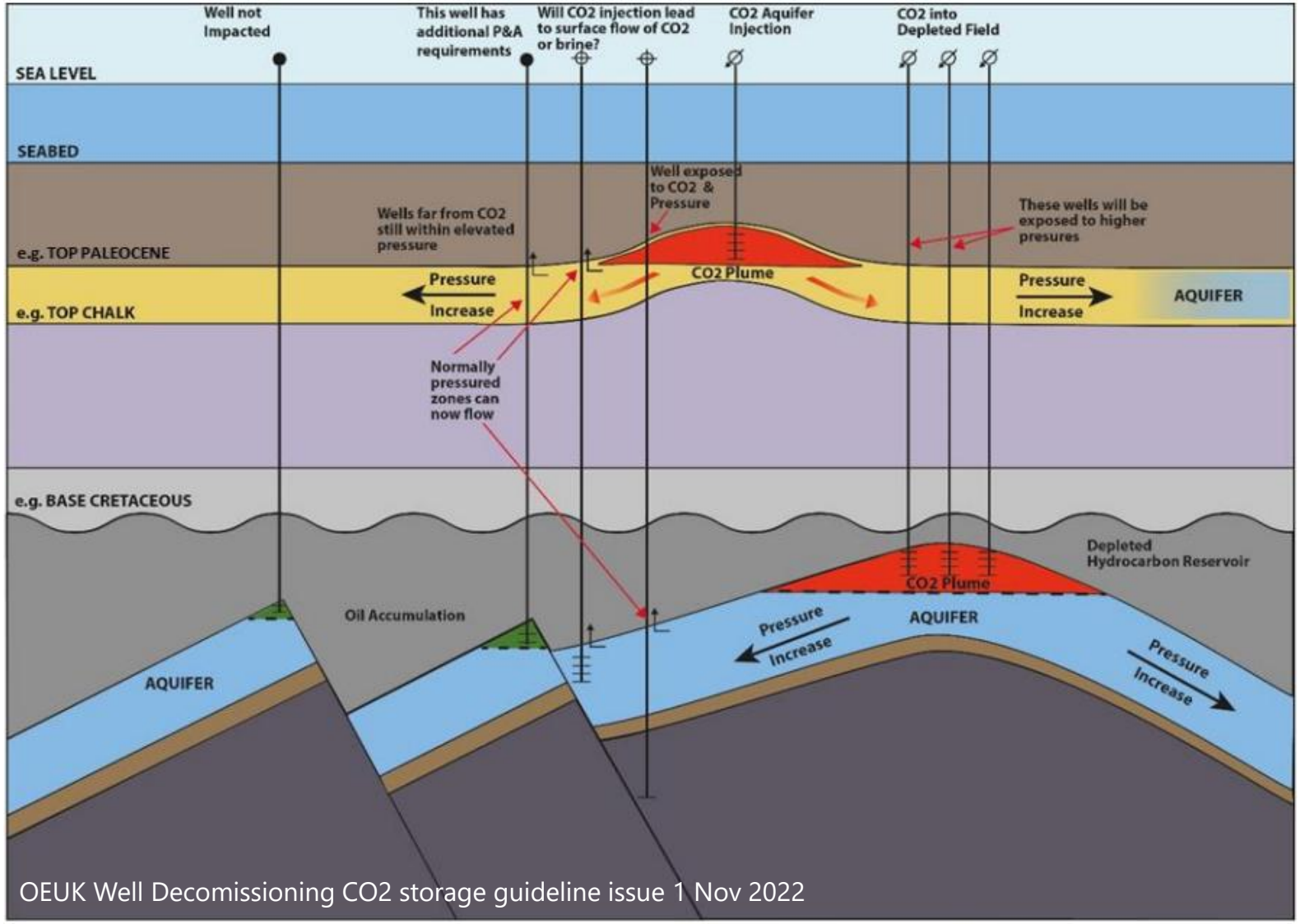
In addition to the account required by **Sections 4-6 and 6-2 of the Regulations relating to storage and transport of CO2 on the shelf**, the plan for the development and operation of subsea reservoirs for the injection and storage of CO_2 and specific licence for installation and operation of facilities for transport include an account of matters that are important for safety and the working environment as mentioned in **Section 27 of the Framework Regulations**.

The consequences for the well barriers of existing wells in the CO_2 storage complex shall be accounted for.

GUIDANCE

- Wells that are in use and temporarily or permanently abandoned wells.
- By storage complex is meant storage location and the geological environment that may have an impact on the safety of storage.
- To assess the well barriers to existing wells when storing CO_2, DNVGL-RP-J203 Section 7 and ISO 27914 Chapter 7.6 should be used.

Assessment of wells in storage complex



OEUK Well Decomissioning CO2 storage guideline issue 1 Nov 2022

- Long term pressure increase, above initial formation fluid pressure
- Pressure wave in front of plume
- CO2 phase behaviour
- CO2 interaction with in-situ fluids and materials
- Cyclic pressure and temperature effects

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Facility regulations §48 Well Barrieres

Well barriers shall be designed such that well integrity is ensured, and the barrier functions are safeguarded during the *well's lifetime*.

Well barriers shall be designed such that unintended well influx and outflow to the external environment is prevented…

When a well is temporarily or permanently abandoned, the barriers shall be designed such that they consider well integrity for the longest period of time the well is expected to be abandoned.

The well barrier envelopes shall be defined prior to commencement of an activity by identifying all required well barrier elements to be in place.

The identified WBE s shall comply with their specific acceptance criteria.

Table C.22 — EAC Table 22 – Annulus cement

Features	Acceptance criteria	See
A. Description	This element consists of cement in solid state located in the annulus between concentric casing strings, or the casing/liner and the formation.	
B. Function	The purpose of the element is to provide a continuous, permanent seal along hole in the casing annulus or between casing strings, to prevent flow of formation fluids and/or injection fluids, resist pressures from above or below, and support casing or liner strings structurally.	
C. Design, construction, and selection	1) A cement programme shall be issued for each cement job, minimum covering the following: a) casing/liner centralization giving sufficient stand-off to achieve pressure and sealing integrity across the natural sealing formation for source of inflow or entire qualified WBE length, whichever is less; b) use of fluid spacers; c) effects of hydrostatic pressure differentials inside and outside casing and ECD during pumping and loss of hydrostatic pressure prior to cement setting up; d) the risk of lost returns and mitigating measures during cementing. 2) Hydraulic and displacement simulations shall be performed during planning. 3) For HPHT conditions and complex/foam slurry designs the cement programme shall be verified by independent (internal or external), qualified personnel. 4) The cement recipe shall be lab tested with dry samples and additives from the rigsite under representative well conditions. The tests shall provide thickening time and compressive strength development. 5) The properties of the set cement shall provide lasting zonal isolation, structural support, and withstand expected temperature exposure. 6) Cement slurries used for isolating sources of inflow containing hydrocarbons shall be designed to prevent gas migration, including CO_2 and H_2S, if present. 7) Planned annulus cement length: a) Should be designed to allow for future use of the well (sidetracks, recompletions, and abandonment). b) **General**: Should be minimum 100 m MD above a casing shoe/window for kick tolerance purposes and minimum 200 m MD if next section will penetrate a source of inflow. c) **Conductor**: Should be defined based on structural integrity requirements.	API RP 10B (entire series) NS-EN ISO 10426-1 [9]

NORSOK D-010:2021 provided by Standard Online AS for Petroleumstilsynet (PTIL) 2021-01-20

Well design, CO2 injection wells

- Continuous or discontinuous injection
- Understand and capture CO^2 supercritical phase behaviour
- Blow-out & kill studies
- Facilities
- Materials
- Permanent plugging of wells for eternity

Standards and recommended practices

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