VUB ENGINEERING

Hans Pirlet
Vlaams Instituut voor de Zee (VLIZ)
Jacobsenstraat 1
8400 Oostende

our reference	**contact**	**date**
CLAYTECTONICS-WP4T3	Prof. Christof Devriendt	29-10-2025

Workshop certification criteria DNV

Dear Hans,

In the Claytectonics project, WP4 Task 3 was aimed at linking the project results in terms of fault characterisation, measurement of geotechnical properties and fault modelling to the certification criteria. This can be linked to the Technology Qualification Approach which is being used by certifier Det Norske Veritas (DNV).

To learn more about the Technology Qualification Approach and to check where the project results would fit in to such a process, a workshop was organised with Marcus Klose from DNV. The workshop contents are outlined below and the slide package is attached to this document.

The workshop led to fruitful discussion on the topic of fault characterisation and modelling. The workshop gave insight in the necessary building blocks for starting up a Technology Qualification. The results of Claytectonics align with this process as they outline a framework for assessing whether faults are critical to offshore wind structures and further steps could be taken to make the project approach part of certification.

With kind regards

CHRISTOF DEVRIENDT
Associate Professor

DNV workshop scope

Title: "Certification and Innovation: How to approve what no one has done before"

Abstract: Bringing first-of-a-kind research to market requires more than performance claims—it needs credible, independent evidence. This workshop, delivered by DNV, demystifies certification pathways and shows how risk-based Technology Qualification can unlock adoption for novel solutions. The first half features DNV-led presentations: a high-level overview of certification followed by a deep dive into technology qualification, followed by Q&A. Attendees leave with a shared vocabulary for engaging stakeholders and a practical, first-pass certification pathway they can refine with DNV.

Learning objectives

By the end, participants will be able to:

- Explain the role and business value of certification for innovative technologies (quality, safety, market access, investor confidence).
- Differentiate key actors, conformity routes, typical artefacts, and major schedule/cost drivers in a certification program.
- Apply DNV's Technology Qualification approach to identify critical uncertainties and failure modes for their own technology.
- Draft a clear certification pathway (scope, milestones, gates, responsibilities) using a provided canvas.
- Prepare stakeholder-specific messages and documentation that build confidence with end users, investors.

Certification and Innovation

How to approve what no one has done before

Marcus Klose, Head of Section Offshore Technology and Innovation
Workshop Gent, 25 September 2025

Introduction of presenter
Marcus Klose

- Dipl.Ing. Civil Engineering 2001
  (Technical University of Hamburg)
- Steel and concrete structural design
- 20+ years in DNV
- Verification / 3th party work
- Project Management
- Postgraduate Studies Industrial Engineering
  (Dipl.-Wirtsch.-Ing. (2010))
- Participation in R&D activities as well as standardization committees
- Head of Section Offshore Technology and Innovation, located in Hamburg
- Fully dedicated to offshore wind energy

Content

- Introduction
- Part 1 – Certification basics

Break

- Part 2 -Options to certify innovative solutions – from Concept Review to Technology Qualification
- Questions and discussion

Bad Experience with Certification?

Times are changing…

Introduction

A global assurance and risk management company

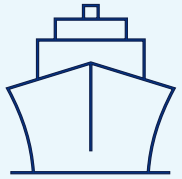
15,000+
employees

100,000+
customers

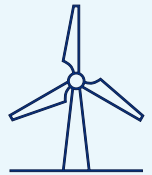
100+
countries

5%+
of revenue to R&D

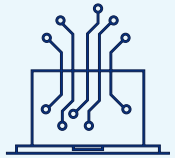
Ship and offshore classification and advisory



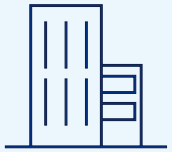
Energy advisory, certification, verification, inspection and monitoring



Software, cyber security, platforms and digital solutions



Management system certification, supply chain and product assurance



DNV

Global Business Unit Renewables Certification

Managing Director

Kim Sandgaard-Mørk

Type & Component Certification

Steffen Haupt

Turbine Engineering, Turbine Integrity, Grid Code Compliance

Project Certification

Mette Redanz

Support Structures, Material & Inspections, Floating, Geotechnical and Concrete

OSS

Markus Kochmann

OSS PM, Safety & Electrical, OSS Structures, Cables, FE Analysis

Loads

Ramakrishna Parasarampuram

Onshore, Offshore Loads

Sales & Product Development

Andreas Kamleitner

Escrow Management, Innovation & Digitalisation, Hydrogen

Service Area

Fabio Pollicino

Service Area, Type, Component, Project Certification, QHSSE, PMO

We are close to our customers by providing a global certification workforce with local presence in emerging markets

300 certification employees working in 14 offices

Accredited by global acknowledge accreditation body DAkkS to provide an extensive range of certification services

DAkkS
Deutsche Akkreditierungsstelle
D-ZE-22290-01-00

Renewables Certification in a nutshell

~ 240 employees working in **10 offices** located in **8 countries**

DAkkS Deutsche Akkreditierungsstelle

Accredited by global acknowledge accreditation body DAkkS to provide certification services

DNV Renewables Certification provide **Certification and Verification** services for:

- Onshore wind
- Offshore wind
- Floating offshore wind
- Energy storage, solar/PV, wave and tidal
- Components and assets related to renewable energies

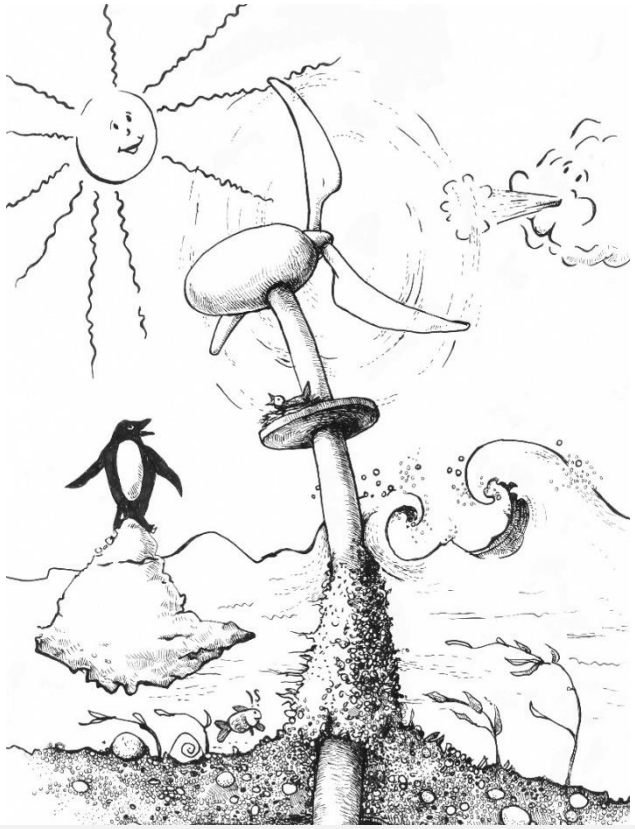
The **main services** are

- Component certification
- Concept certification
- Prototype certification
- Basic design assessment
- Type certification
- Project certification
- Grid code compliance

Active in **developing standards**, **recommended practices** and **specifications** for the wind power plant assets

Certification Basics

What is Certification?



Do they match?

Definition of certification (ISO / IEC 17000)
Certification is a: *Third-party **attestation** related to products, processes, systems or persons*
Attestation means**:** *Issue of a statement, based on a decision following the **review**, that fulfilment of specified requirements has been demonstrated*
Review is done by**:** *Verification of the suitability, adequacy and effectiveness …*

General certification process

- Signed contract
- Customer provides evidence of meeting requirements
  (e.g. submits documentation: calculations, specifications, drawings)
- DNV evaluates the received evidences for compliance
  (reads, checks, performs independent calculations)
- DNV provides feedback and meets customer for clarifications
- Customer adjusts where needed
- DNV finalises the evaluation, reviews and
  makes a certification decision

Renewables Certification – main services

- Accredited certification of equipment (products), services and projects in renewable energy

- Component certification
- Type certification
- Project certification

DAkkS
Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV
Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition

Accreditation

The Deutsche Akkreditierungsstelle GmbH attests that the certification body

Germanischer Lloyd Industrial Services GmbH
DNV Renewables Certification

with the locations

Brooktorkai 18, 20457 Hamburg, Germany
Gostritzer Straße 63, 01217 Dresden, Germany
Tuborg Parkvej 8, 2900 Hellerup, Denmark
30 Stamford Street Vivo Building, 4th floor, SE1 9LQ London, United Kingdom

is competent under the terms of DIN EN ISO/IEC 17065:2013 to carry out certifications of products, processes and services in the following fields:

Wind turbines and their components, wind farm projects, wind power and photovoltaic plants, small wind turbines, ocean energy converters and related services and technologies; Grid connection of power generating units, generating plants and energy storage for wind energy, photovoltaics and other energies; Marking of offshore installations

The accreditation certificate shall only apply in connection with the notice of accreditation of 28.08.2021 with the accreditation number D-ZE-11053-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 18 pages.

Registration number of the certificate: **D-ZE-11053-01-00**

Berlin, 28.08.2021

Dr. Heike Manke
Head of Division

The certificate together with the annex reflects the status as indicated by the date of issue.
The current status of the given scope of accreditation may be found, inter alia, in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH: https://www.dakks.de/en/content/accredited-bodies-search

- Onshore wind
- Offshore wind incl. floating
- Energy storage, solar/PV, wave and tidal

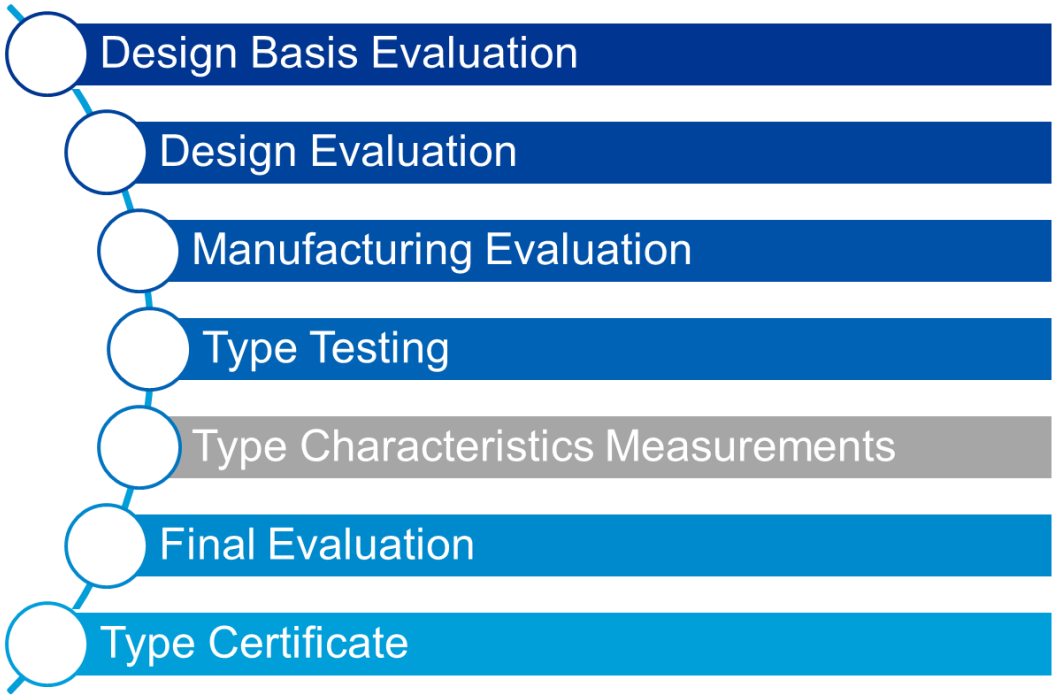
- Certification is based upon:
  - Internationally accepted standards
  - Various national standards
  - DNV service documents

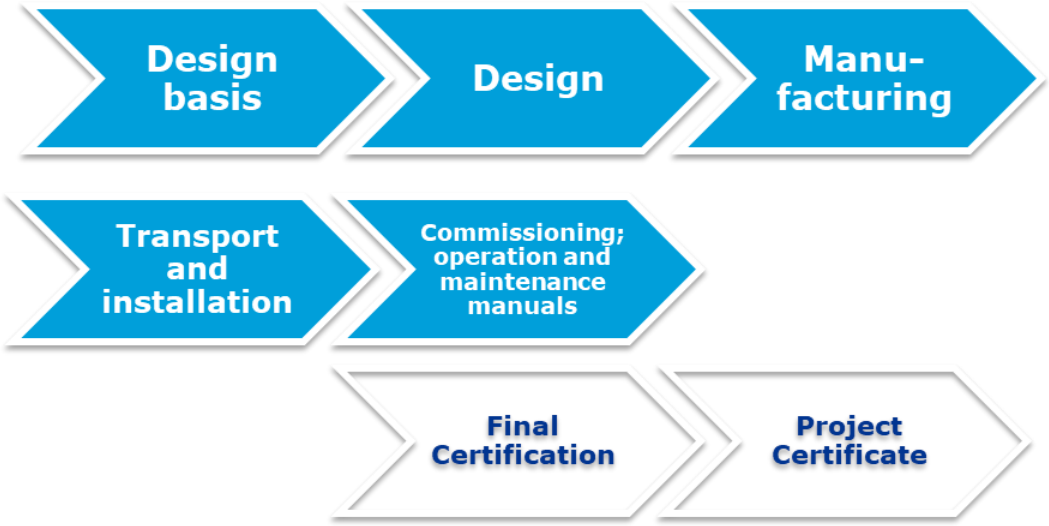
Type Certification vs. Project Certification

- A wind turbine **type**
  - Evaluated for compliance with applicable regulations and assumed conditions (e.g. wind turbine class)
- Selected design parameters and conditions
- Manufacturing process and type testing on a sample

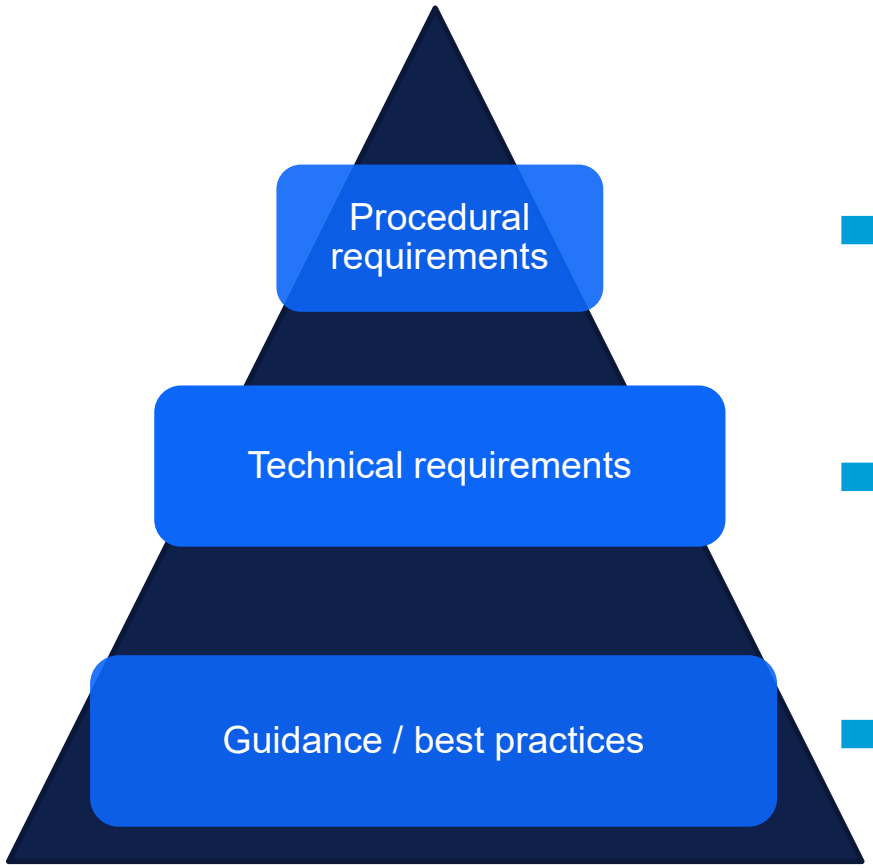
- **Power plant** including wind turbines
  - Evaluated for compliance with applicable regulations and **site-specific** conditions
- Designed for a specific location
- Manufactured for a specific project
- Installed and commissioned under site-specific circumstances

Type Certification and Project Certification



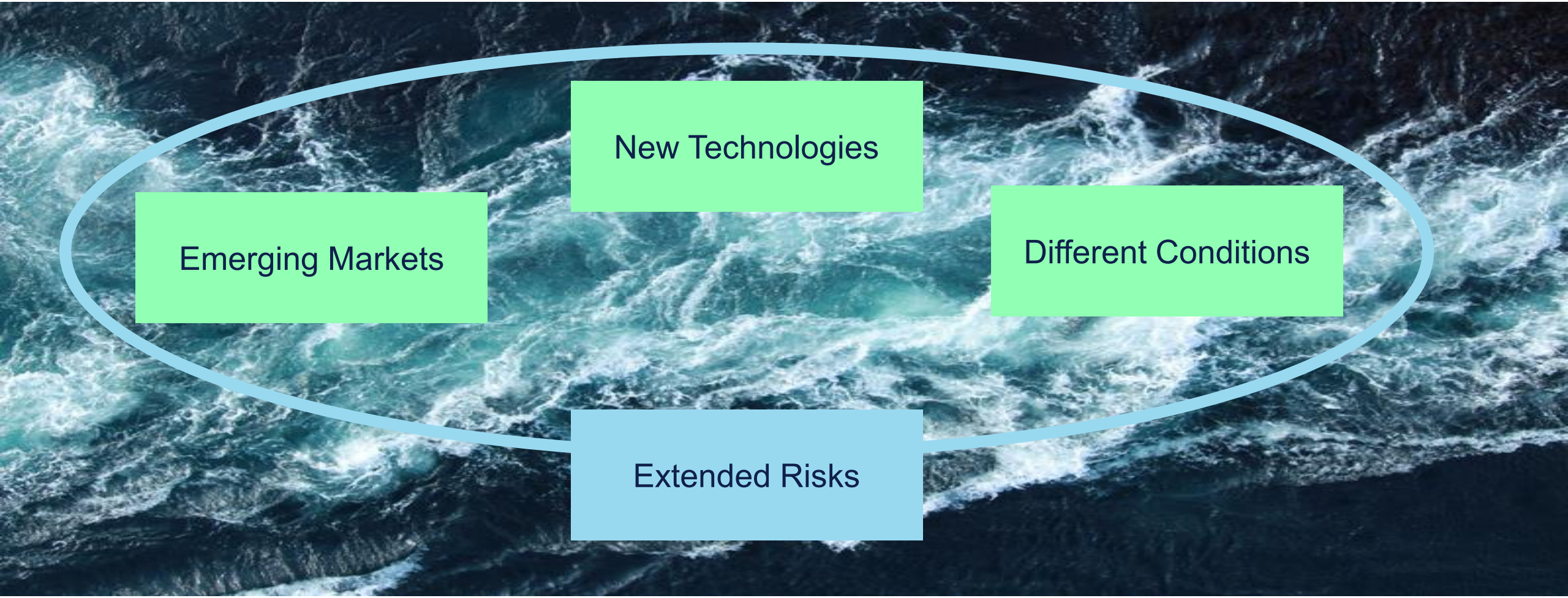


DNV service documents and comparison to IECRE documents



	DNV document types (abbreviation)	IECRE document types (abbreviation)
Procedural requirements	Service Specifications (SE)	Rules and Operational Document (OD)
Technical requirements	Standards (ST)	Standards (IEC 61400 series)
Guidance / best practices	Recommended Practices (RP)	Technical Specification and informative appendices (TS, Appendix)
	DNV rules and standards	IECRE Rules, Operational Documents & Guides

The industry is working hard to reduce costs by adopting new technologies and business models



Certification as a key tool to manage risks

Certification delivers the foundation for trust in any major renewables project. It delivers confidence to all stakeholders about the soundness of the underlying technology and its implementation.

Performing certification to internationally accepted standards gives stakeholder the confidence that all risks have been minimized in a safe and sustainable way.

National requirements

Rules & standards development

Areas where typically certification for offshore wind is required

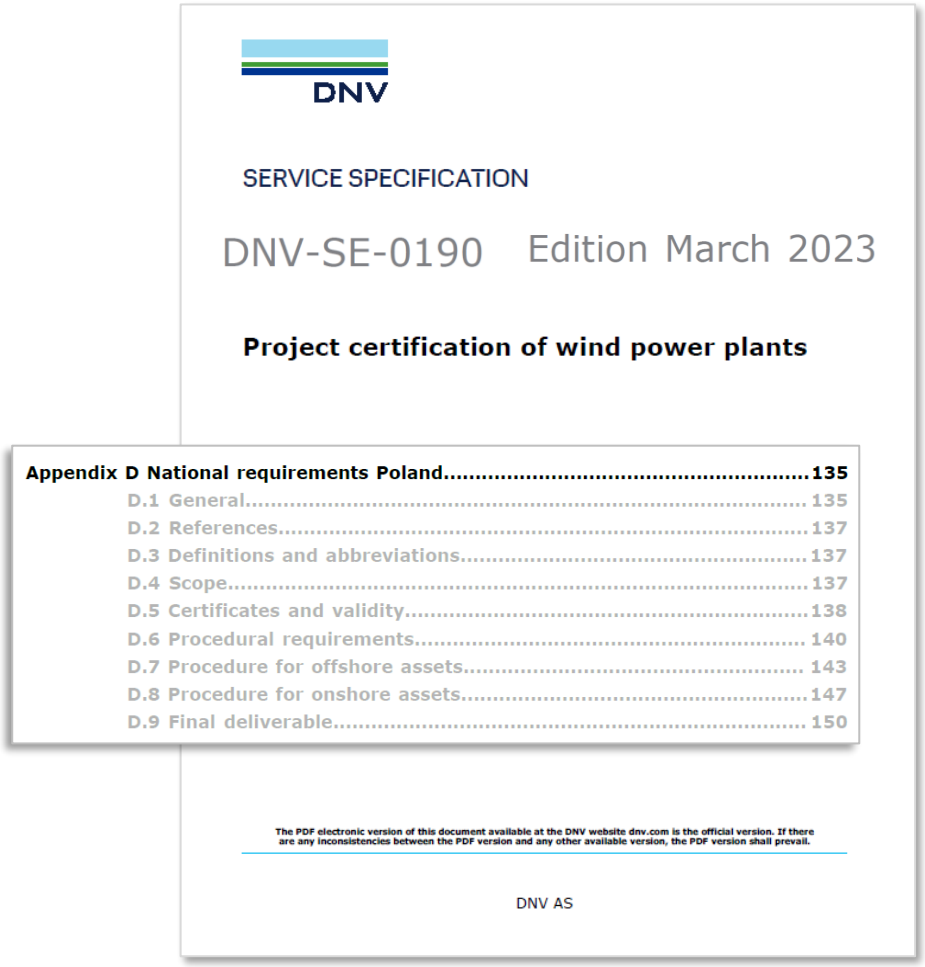
Required

Partly required

Background source: 4COffshore

6. Building Permit & Maritime Safety Act

DNV Poland-dedicated OWF certification solution:



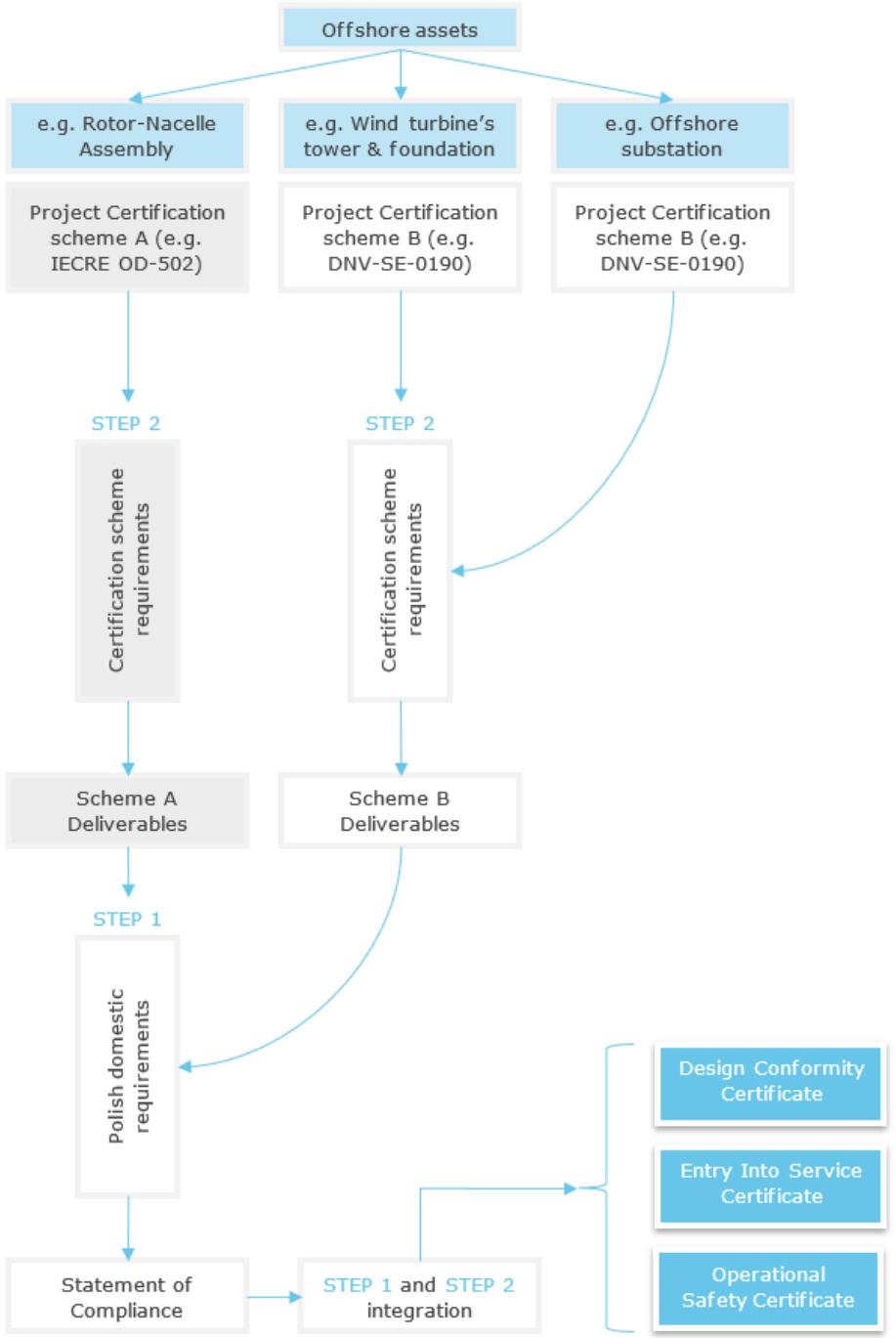
DNV

SERVICE SPECIFICATION

DNV-SE-0190 Edition March 2023

Project certification of wind power plants

DNV AS



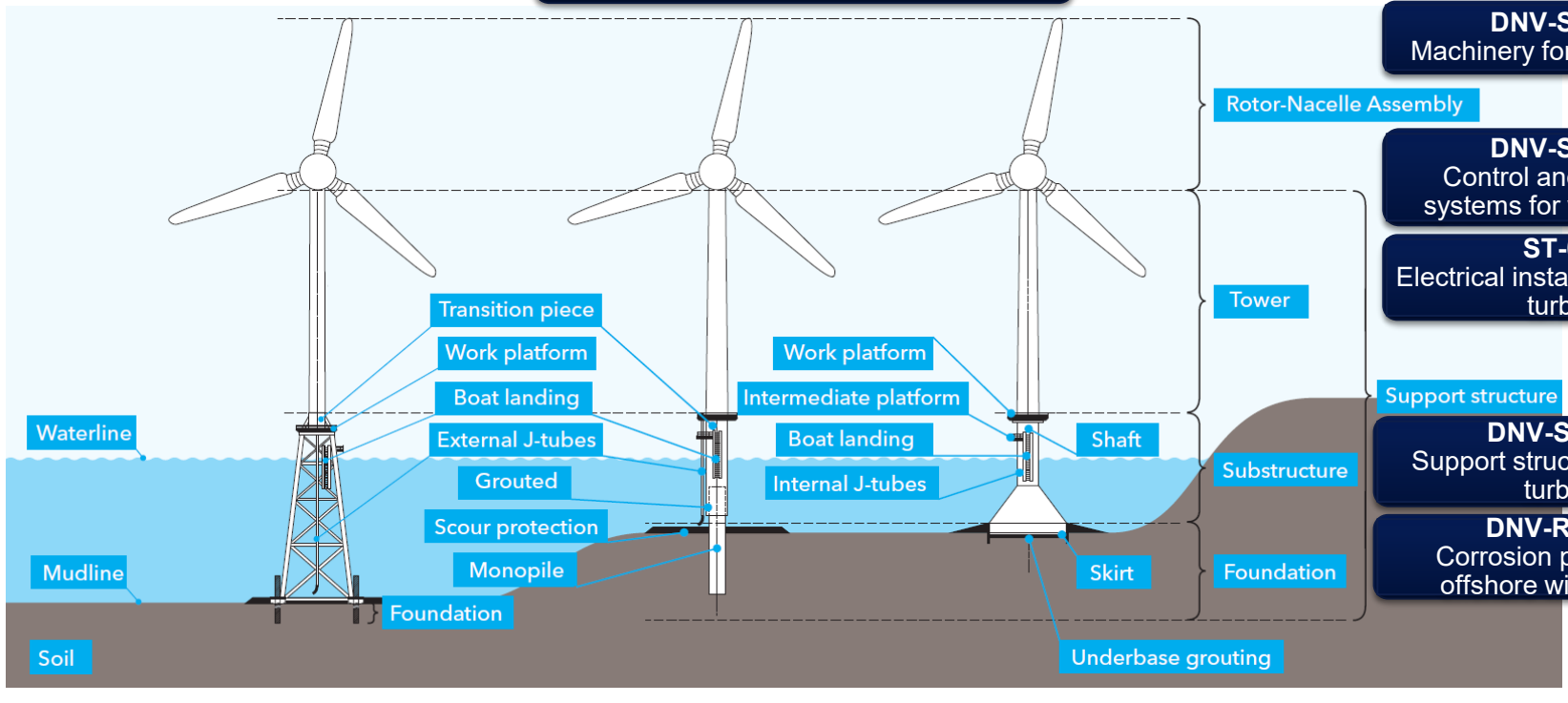
Standards and recommended practices for bottom fixed power plants

DNV-ST-0437
Loads and site conditions wind for turbines

DNV-ST-0376
Rotor blades for wind turbines

DNV-ST-0361
Machinery for wind turbines

DNV-ST-0145
Offshore substation

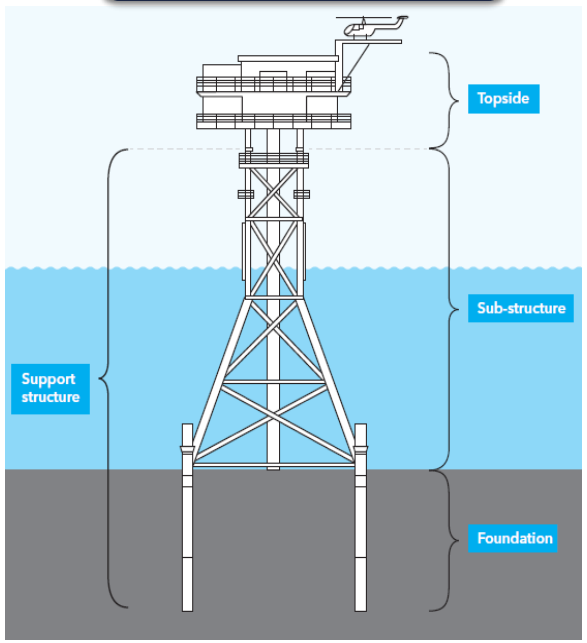


DNV-ST-0438
Control and protection systems for wind turbines

ST-0076
Electrical installations for wind turbines

DNV-ST-0126
Support structures for wind turbines

DNV-RP-0416
Corrosion protection of offshore wind turbines



DNV-ST-0054
Transport and installation of offshore wind turbines

DNV-RP-0419
Analysis of grouted connections

DNV-ST-0359
Subsea power cables

DNV-ST-0125
Grid code compliance

DNV-RP-0423
Manufacturing and commissioning of offshore substations

- IEC and other standards considered in the DNV standards
- DNV Energy Systems documents listed are public available: https://rules.dnv.com/

Hot topics of research – some insights into ongoing JIPs

a Joint Industry Project…

- …is a project where a number of companies choose to collaborate and share the costs in order to solve an industry challenge
- Together with our partners, DNV works to find solutions to complex technical challenges in the energy industry
  - DNV performs the majority of the work and is managing the project
  - Others can support for free (or payment)
  - Every partner pays a ticket
- JIP documents are confidential and accessible only to the partners
- Our joint industry projects result in openly-accessible standards and recommended practices
- More than 40 JIP's are now under way…

No standstill, ever developing - some of our JIPs

Floating Wind Reliability JIP

Laying grounds for tomorrow's rules

Floating offshore wind substations

Joint Industry Project

Initiated and run by RC

01 MAY 2022

Alleviating Challenges from Earthquakes for wind farms

ACE 2: Evolution

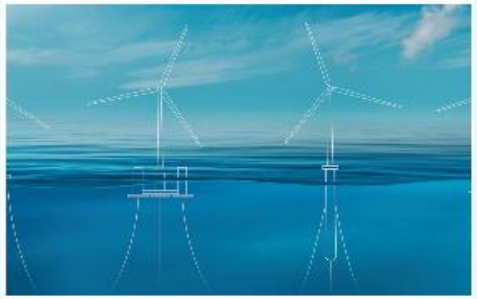
Power and renewables

23 JUNE 2022

Concrete for Floating Offshore Wind (FLOW)

DNV has secured sufficient interest from industry partners to launch a new joint industry project to…

Power and renewables



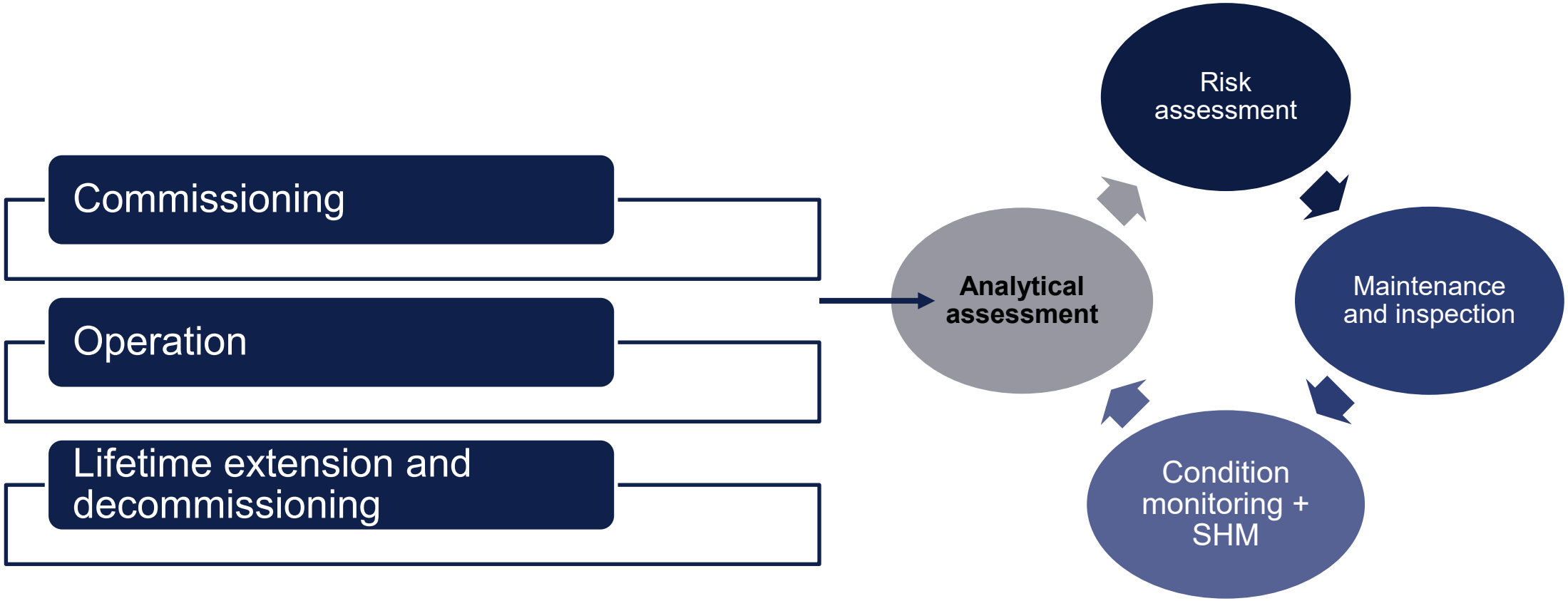
17 MAY 2023

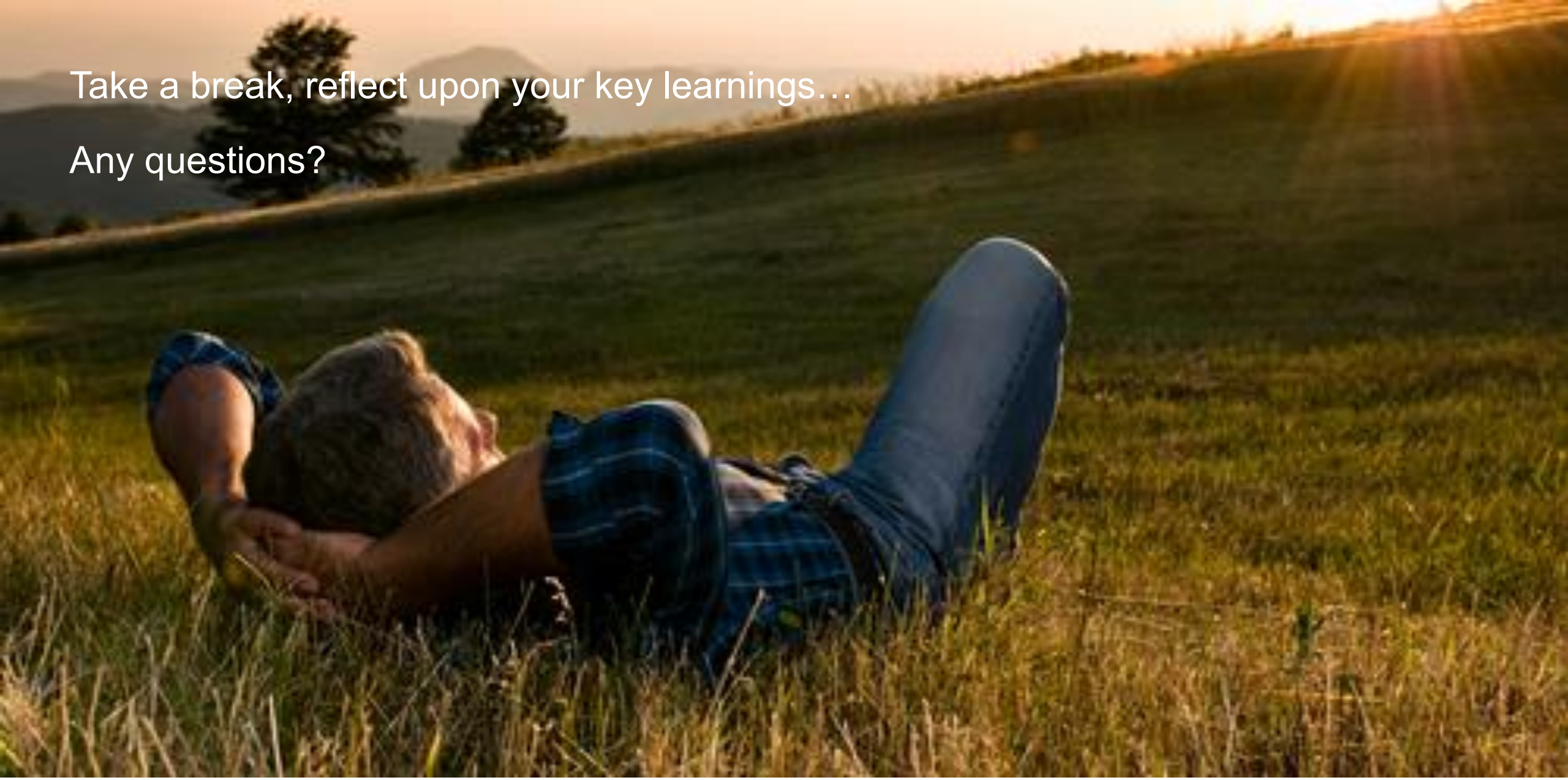
Ground investigation for floating wind turbines

Focussing on pragmatic approaches to site investigation and ground modelling.

Power and renewables

Lifetime Extension of Offshore Windfarms
Would you like to see a JIP?




Take a break, reflect upon your key learnings…
Any questions?

Options to certify innovative solutions

Innovative Solutions – Need of Certification & Benefits

Need of Certification

In order to use the innovative solutions and to survive and thrive in the market,

- There is an increasing need to demonstrate product quality,
- Convince stakeholders that risks are identified and mitigated, and
- To stand out between a multitude of competitors with apparently similar products.

Benefits of Certification

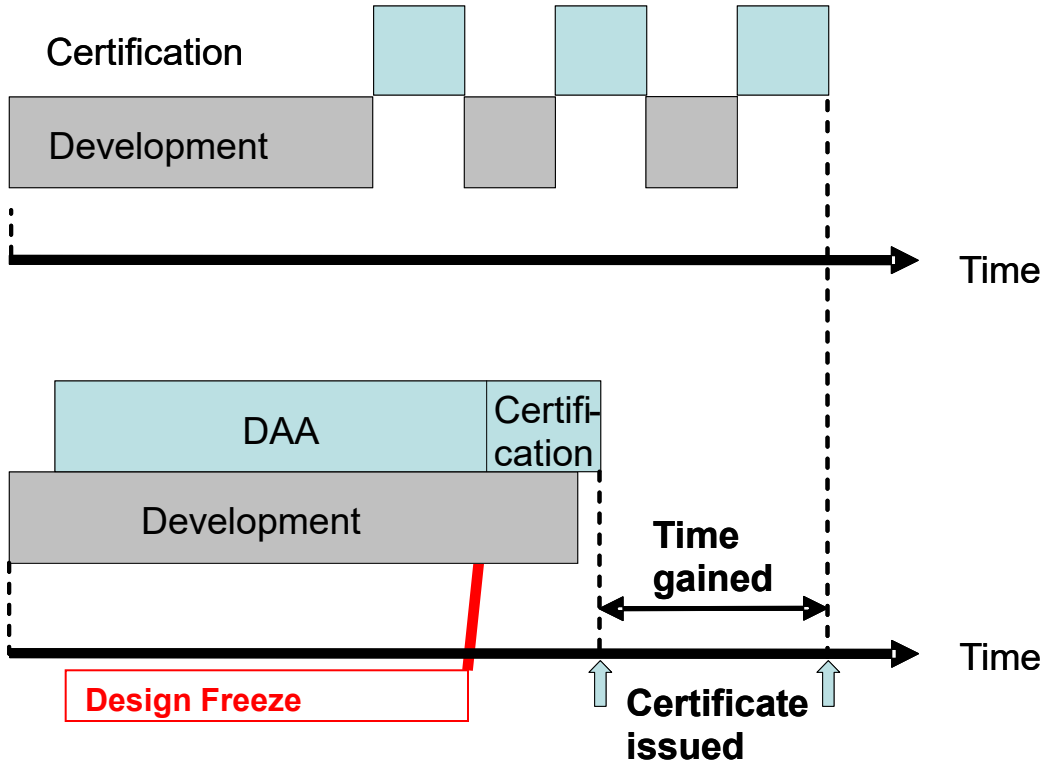
- Distinguish the new technology from the competition.
- Provide confidence to new technologies' end users and investors.
- Prove and increase quality, including safety.

Certification Concepts for Innovative Foundation Designs

DAA – Development-Accompanying Assessment

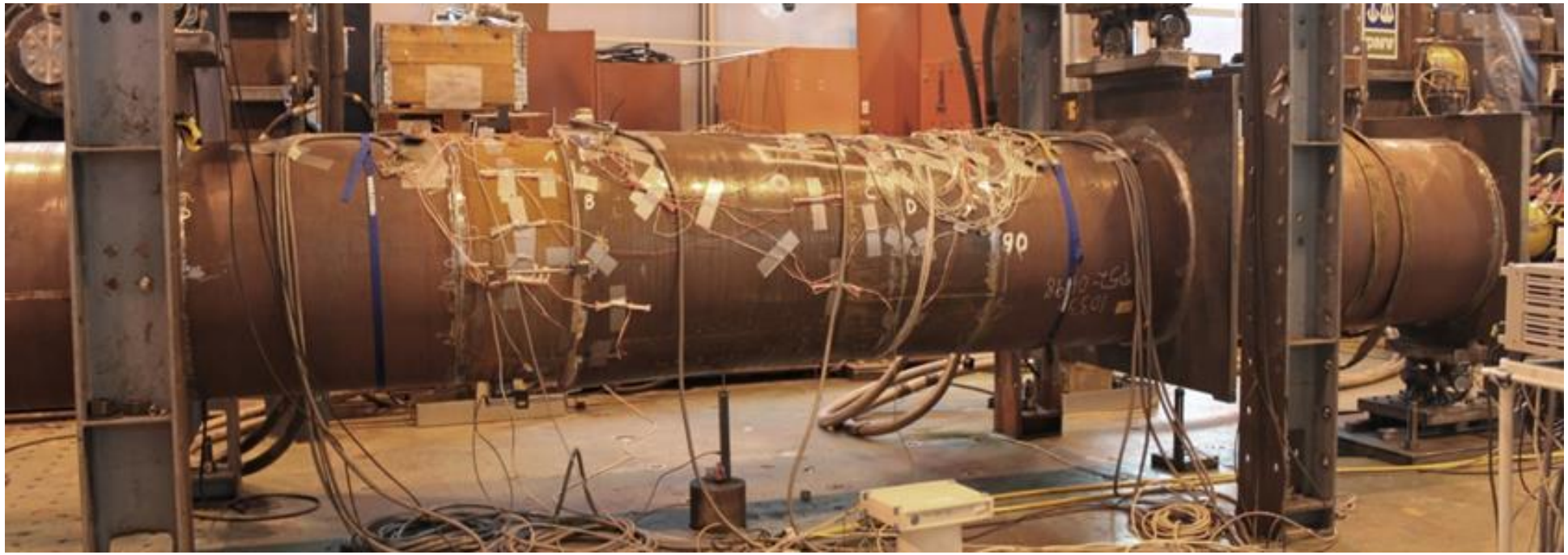
Without DAA
(classic 'serial' certification approach)

With DAA
('parallel' approach)



Elements of DAA

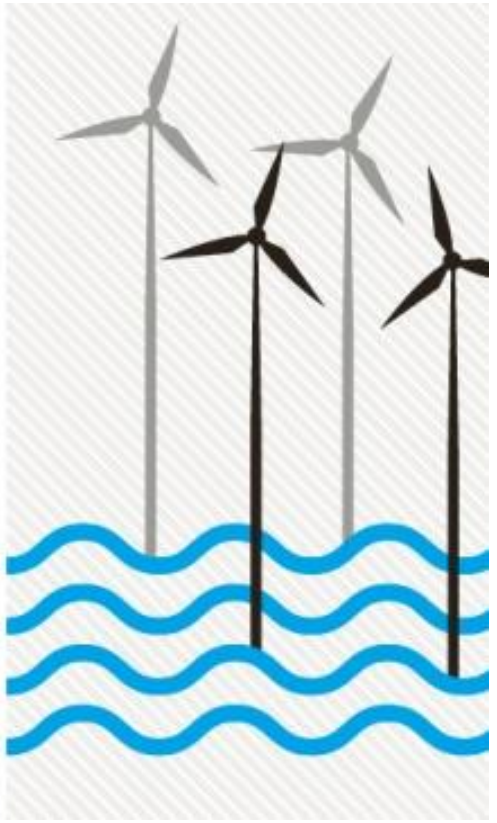
- Design Basis development, applicable standards
- Regulatory requirements
- Definition of test scope
- Witness prototype tests in lab or on site or tests at Høvik Lab
- Prototype Approval
- Independent Analysis



Concept Certification within Project Certification

- Plausibility check of the wind power plant concept

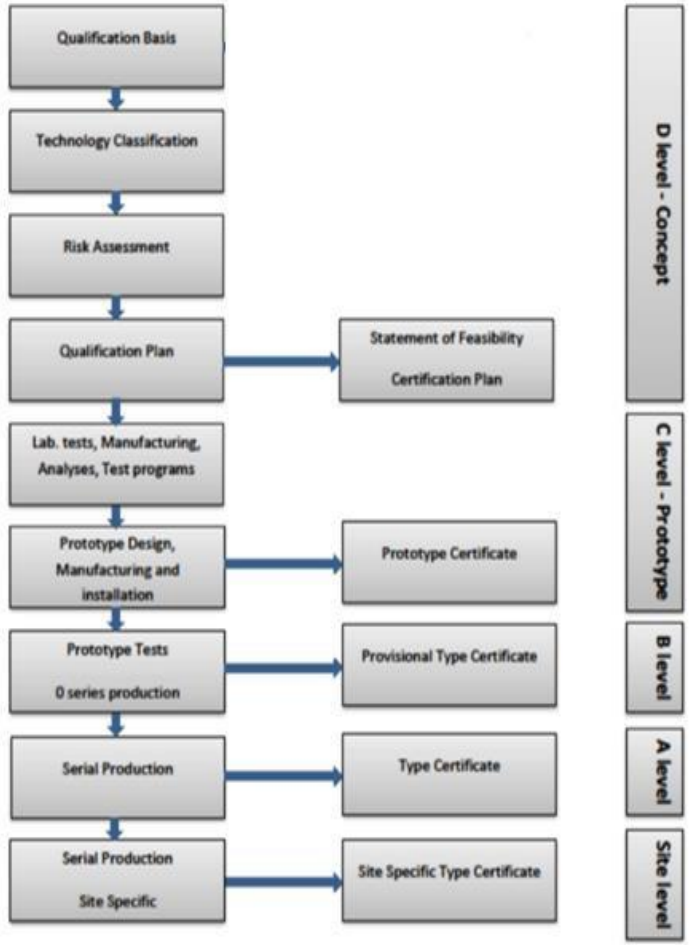
- Demonstrating a feasible concept of the wind power project



DNV Certification Approach (DNV-SE-0441)

- DNV´s suggested approach for innovative components, will be a technology qualification process (categorized as a D-level certification process), followed by further certification levels ending with a component certificate.

Level	Module Design	Module Test	Module Manufacturing	Final Deliverable
D	**SoF D** Statement of Feasibility Certification plan considering new technology	-	-	**SoF D** **Statement of Feasibility**
C	**SoC C-Design** Structural integrity Limited scope of evaluation of fatigue life	**SoC C-Test** Test of turbine behaviour Static blade test	**SoC C-Manufacturing** Blade manufacturing + QM certificate (blade manufacturing)	**PT C** **Prototype Certificate**
B	**SoC B-Design** *C-Design +* QM certificate - Design Outstanding issues with no safety implication during validity period allowed. *Options see "Site"-level*	**SoC B-Test** *C-Test +* Gearbox test at the test bench Other component tests e.g. from SoF D certification plan Type inspection *Options see "Site"-level*	**SoC B-Manufacturing** *C-Manufacturing +* QM certificate Gearbox manuf. + QM cert. Other critical components and processes e.g. new installation methods + QM certificate(s) *Options see "Site"-level*	**TC B** **Provisional Type Certificate**
A	**SoC A-Design** *B-Design +* Closing of all outstanding issues *Options see "Site"-level*	**SoC A-Test** *B-Test +* Blade fatigue test Load measurements Gearbox test at the wind turbine *Options see "Site"-level*	**SoC A-Manufacturing** *B-Manufacturing +* Hub and Nacelle Assembly, Tower *Option: Tailor inspection program for TC Site (prepare for PC/Site); see "Site"-level*	**TC A** **Type Certificate**
Site	**SoC Site-Design** *A-Design* + Site specific loads Grid connection equipment design *Options (also applicable to A and B levels):* *Foundation and/or substructure,* *Tower structure may be omitted*	**SoC Site-Test** *A-Test* *Options (also applicable to A, B and C levels):* *Noise emission* *Power performance* *Electrical characteristics Electromagnetic Compatibility*	**SoC Site-Manufacturing** *A-Manufacturing +* Inspections/audits according to inspection program. *Options (also applicable to A and B levels):* *Foundation and/or substructure,* *Tower structure may be omitted*	**TC Site** **Site Specific Type Certificate**



D-Level Certification

- D-level certification is applicable for the conceptual design stage.
- The purpose of this phase is to identify and process key elements for system certification, such as system components and structure, risks and mitigation measures, (partially) applicable standards.

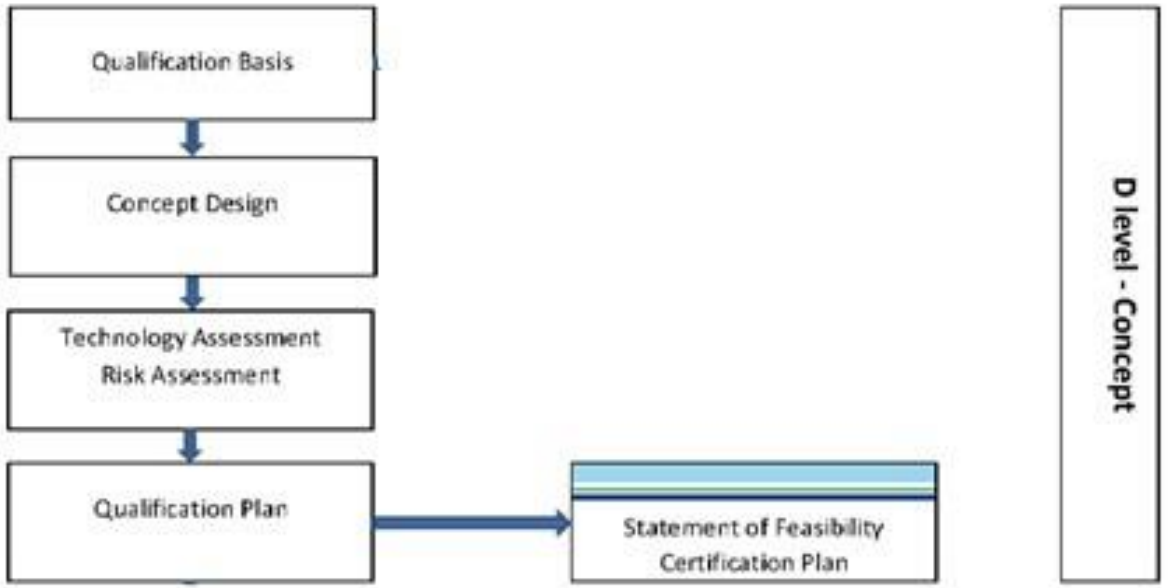
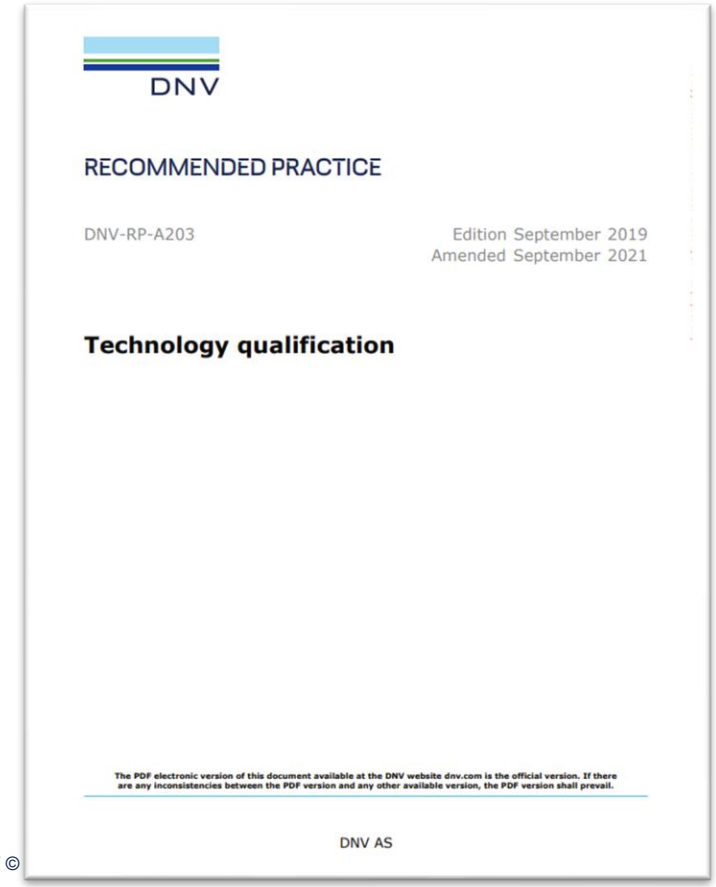


Figure 1 Overview of the D level certification

- Following a successful completion, DNV shall issue a Statement of Feasibility and Certification Plan.

Basis for D-Level Certification DNV-SE-0441, by applying DNV-RP-A203

- DNV GL has a dedicated and industry accepted process for this very purpose, supported by its Recommended Practice “Technology Qualification” (DNV-RP-A203).
- But being a recommended practice rather than a standard, it can only be used as a basis for verification and not by itself for certification.


DNV

RECOMMENDED PRACTICE

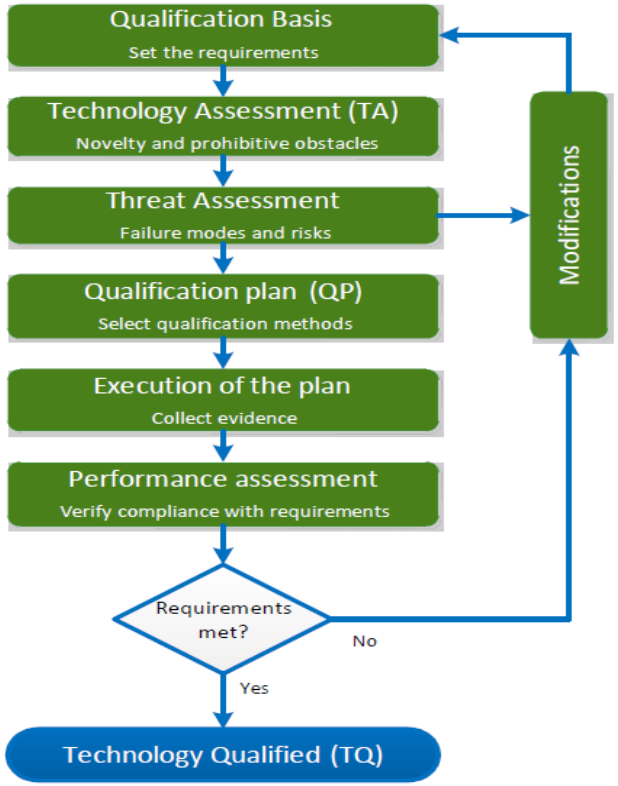
DNV-RP-A203

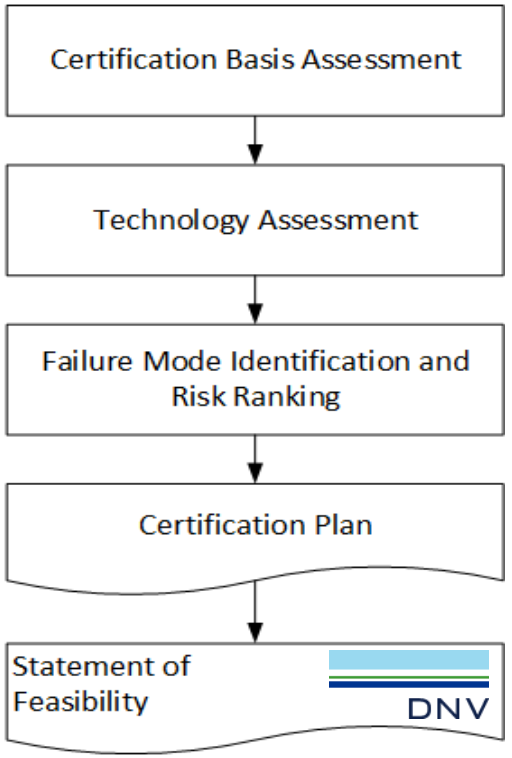
Edition September 2019
Amended September 2021

Technology qualification

The PDF electronic version of this document available at the DNV website dnv.com is the official version. If there are any inconsistencies between the PDF version and any other available version, the PDF version shall prevail.

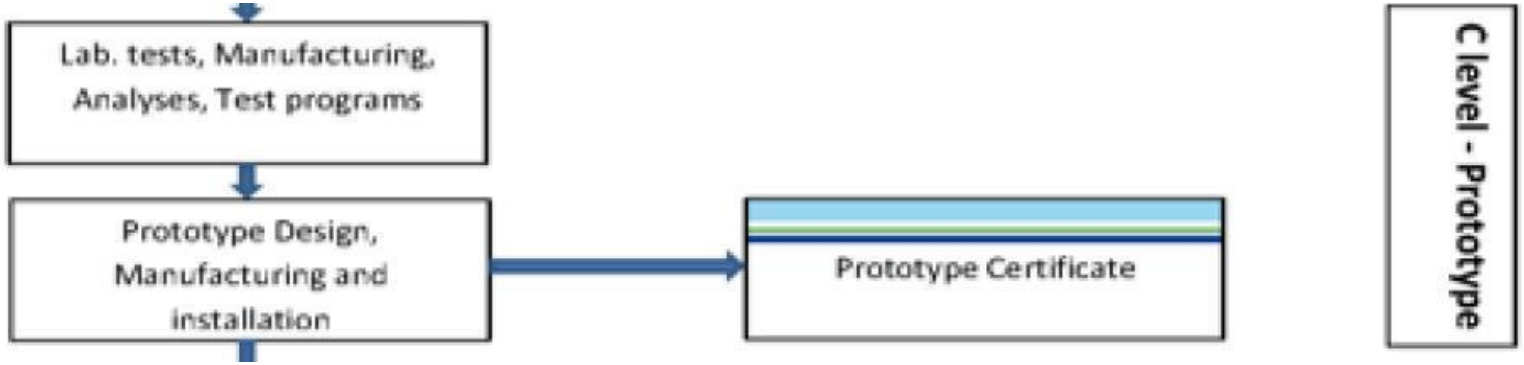
DNV AS





C-Level Certification (Prototype Certificate) DNV-SE-0441 by applying DNV-ST-0126

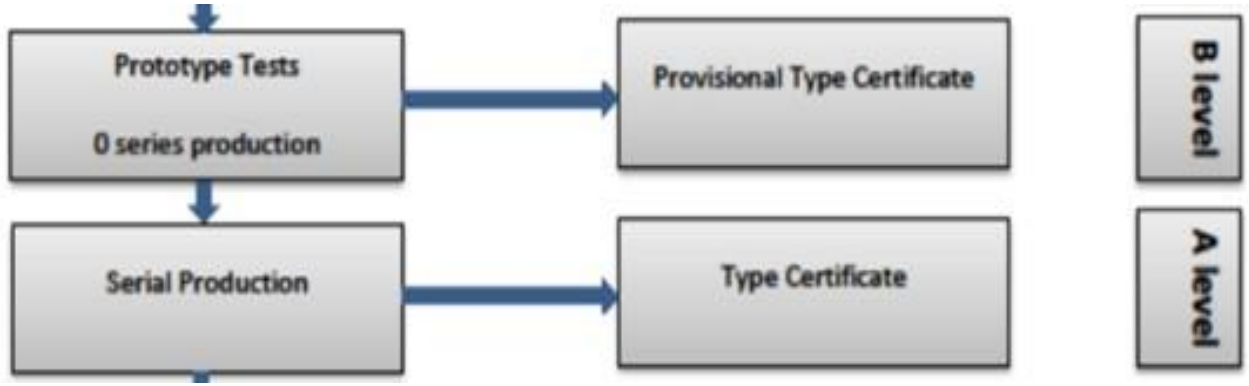
- After having successfully finished the Technology Qualification a Certification Plan has been defined which shall be used for the certification of the new technology.
- The intention of the C-level certification is to demonstrate that the new technology is sufficiently designed and documented for the prototype stage during the development.
- DNV will carry out checks on the design documentation (basic design, test programs, manufacturing and installation etc.) for the prototype.



- Prototype certificate (PT): The prototype certificate shall allow the customer to manufacture, install and operate a prototype wind turbine during the period of validity of the certificate.

A/B-Level Certification (Final/Provisional Component Certificate) DNV-SE-0441 by applying DNV-ST-0126

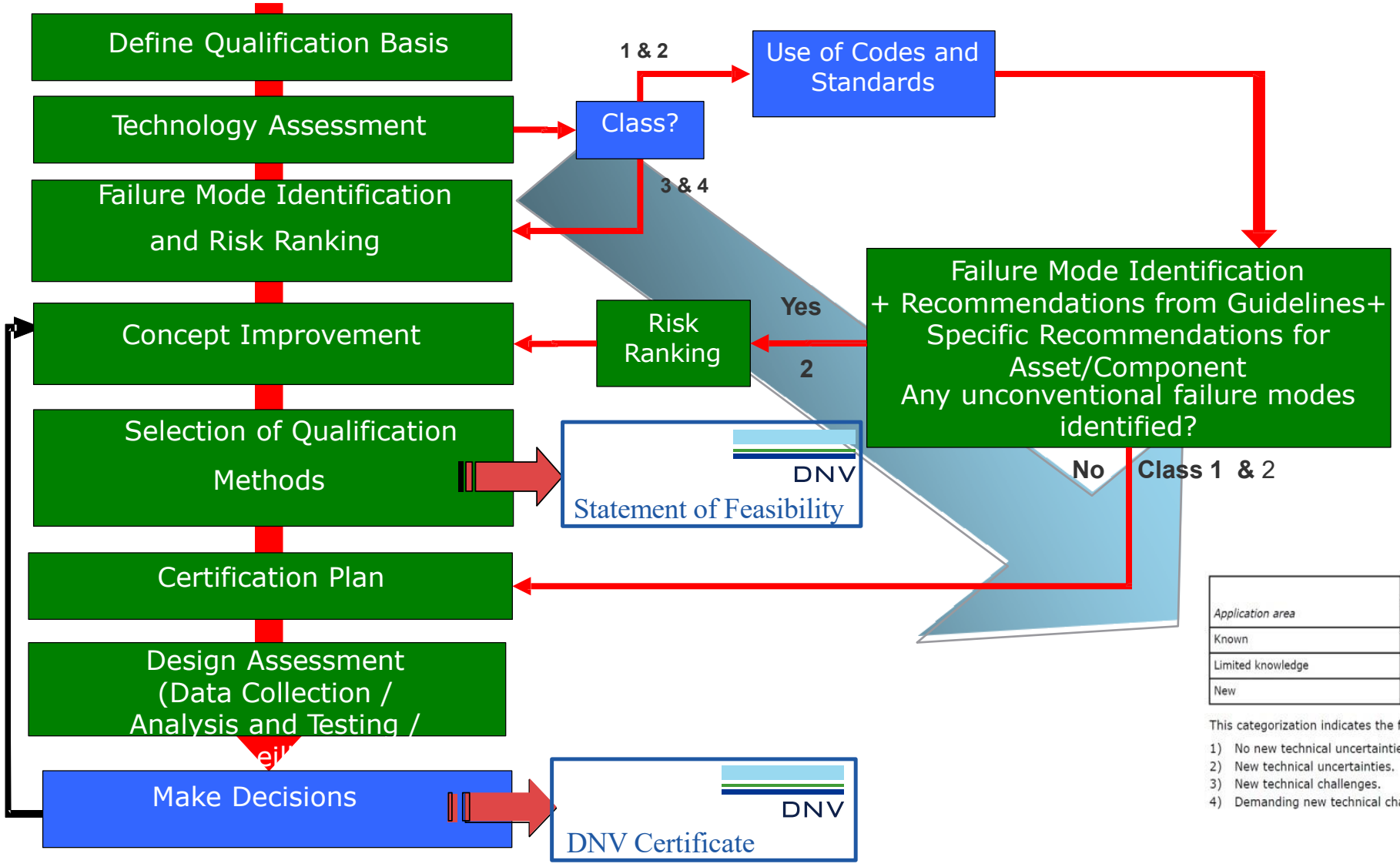
- Performance of prototype tests and results validation.
- The statement of compliance for B-design for the specific design of the new technology may be issued if items are still outstanding, providing these are not directly safety-relevant.



- The A-level certification is intended to cover wind turbines for serial production.
- The final delivery is a type certificate for the A-level certification or a provisional type certificate for the B-level certification.

Technology Qualification Details

Handling Novelty and Uncertainties (Qualification Process)



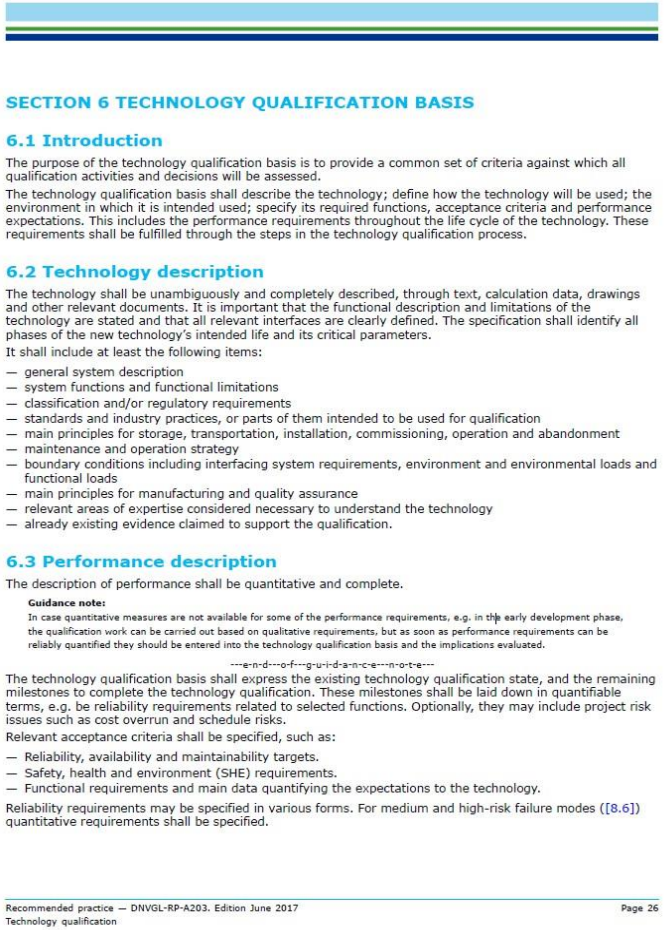
Application area	Degree of novelty of technology		
	Proven	Limited field history	New or unproven
Known	1	2	3
Limited knowledge	2	3	4
New	3	4	4

This categorization indicates the following:

1) No new technical uncertainties (proven technology).
2) New technical uncertainties.
3) New technical challenges.
4) Demanding new technical challenges.

Qualification Basis

- The purpose of the Qualification Basis is to provide a common set of criteria against which all qualification activities and decisions will be assessed.
  - Technology description
  - Performance description



SECTION 6 TECHNOLOGY QUALIFICATION BASIS

6.1 Introduction

The purpose of the technology qualification basis is to provide a common set of criteria against which all qualification activities and decisions will be assessed.

The technology qualification basis shall describe the technology; define how the technology will be used; the environment in which it is intended used; specify its required functions, acceptance criteria and performance expectations. This includes the performance requirements throughout the life cycle of the technology. These requirements shall be fulfilled through the steps in the technology qualification process.

6.2 Technology description

The technology shall be unambiguously and completely described, through text, calculation data, drawings and other relevant documents. It is important that the functional description and limitations of the technology are stated and that all relevant interfaces are clearly defined. The specification shall identify all phases of the new technology's intended life and its critical parameters.

It shall include at least the following items:

— general system description
— system functions and functional limitations
— classification and/or regulatory requirements
— standards and industry practices, or parts of them intended to be used for qualification
— main principles for storage, transportation, installation, commissioning, operation and abandonment
— maintenance and operation strategy
— boundary conditions including interfacing system requirements, environment and environmental loads and functional loads
— main principles for manufacturing and quality assurance
— relevant areas of expertise considered necessary to understand the technology
— already existing evidence claimed to support the qualification.

6.3 Performance description

The description of performance shall be quantitative and complete.

Guidance note:
In case quantitative measures are not available for some of the performance requirements, e.g. in the early development phase, the qualification work can be carried out based on qualitative requirements, but as soon as performance requirements can be reliably quantified they should be entered into the technology qualification basis and the implications evaluated.

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The technology qualification basis shall express the existing technology qualification state, and the remaining milestones to complete the technology qualification. These milestones shall be laid down in quantifiable terms, e.g. be reliability requirements related to selected functions. Optionally, they may include project risk issues such as cost overrun and schedule risks.

Relevant acceptance criteria shall be specified, such as:

— Reliability, availability and maintainability targets.
— Safety, health and environment (SHE) requirements.
— Functional requirements and main data quantifying the expectations to the technology.

Reliability requirements may be specified in various forms. For medium and high-risk failure modes ([8.6]) quantitative requirements shall be specified.

Technology Assessment/Concept Design

- The purpose of Technology Assessment is to determine which elements require technology qualification, and identify their key challenges and uncertainties. The input to the Technology Assessment shall be the Qualification Basis.

  - Technology composition analysis (phases of life cycle of the system)
  - Assessing the technology elements with respect to novelty (technology categorization)
  - Identification of the main challenges and uncertainties

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Failure Mode Identification and Risk Assessment

- The objective of this step is to identify relevant failure modes with underlying failure mechanisms for the novel technology elements, and assess the associated risks.

Table 8-4 Example of probability classes

No.	*Description*
1	Failure is not expected ($p_f < 10^{-4}$)
2	An incident has occurred in industry or related industry ($10^{-4} < p_f < 10^{-3}$)
3	Has been experienced by most operators ($10^{-3} < p_f < 10^{-2}$)
4	Occurs several times per year per operator ($10^{-2} < p_f < 10^{-1}$)
5	Occurs several times per year per facility ($10^{-1} < p_f$)

Consequence Classes

Class	Description of consequences (impact on)				
	Safety	Environment	Operation	Assets	GBP
1	Negligible injury, effect on health	Negligible pollution or no effect on environment	Negligible effect on production (hours)	Negligible	1k
2	Minor injuries, health effects	Minor pollution / slight effect on environment (minimum disruption on marine life)	Partial loss of performance (retrieval not required outside maintenance interval)	Repairable within maintenance interval	10k
3	Moderate injuries and/or health effects	Limited levels of pollution, manageable / moderate effect on environment	Loss of performance requiring retrieval outside maintenance interval	Repairable outside maintenance interval	100k
4	Significant injuries	Moderate pollution, with some clean-up costs / Serious effect on environment	Total loss of production up to 1 month	Significant but repairable outside maintenance interval	1m
5	A fatality	Major pollution event, with significant clean-up costs / disastrous effects on the environment	Total loss of production greater than 1 month	Loss of device, major repair needed by removal of device and exchange of major components	10m

Table A-6 Risk categories

	Consequence				
Probability	**1**	**2**	**3**	**4**	**5**
5	Low	Med	High	High	High
4	Low	Med	Med	High	High
3	Low	Low	Med	Med	High
2	Low	Low	Low	Med	Med
1	Low	Low	Low	Low	Med
Notes:					
Low	Tolerable, no action required				
Medium	Mitigation and improvement required to reduce risk to Low				
High	Not acceptable: mitigation and improvement required to reduce risk to Low (ALARP)				

Qualification Plan

- The purpose of the technology qualification plan is to describe what evidence is required to consider the new technology qualified.
- This shall include a description of the qualification basis, and identification of suitable qualification methods.
- The technology qualification plan shall also address the mitigation of the failure modes in the risk register.

D-Level Certification

- Following a successful completion, DNV shall issue a Statement of Feasibility and Certification Plan.

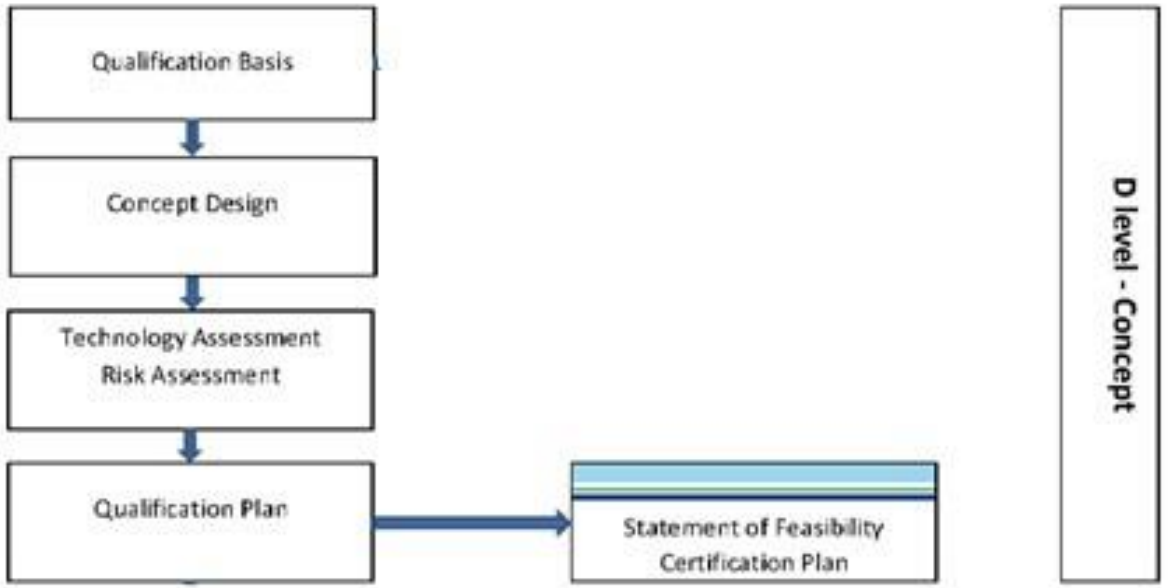

Figure 1 Overview of the D level certification

Thank you for your attention!

Questions?

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