



MANAGING RISK

2nd International Seminar on Ocean Energy



DNV OSS-312 Standardisation in the Renewable Marine Energy Sector

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The Presentation

- About DNV
- Certification definition and importance
- Certification through Qualification DNV OSS-312
- Qualification of new or unproven technology
- The Guidelines for Wave Energy Converters -
Key Aspects
- Conclusions



“To safeguard life, property and the environment”

Independent foundation established 1864

Main industries



Shipping

Oil & Gas

Process

Rail

Automotive

DNV Research

- Formally established in 1954
- Budget 5% of DNV's turnover
 - Strategic Research
 - Development of Services and Tools

DNV in few numbers

6000 employees
(70% staff has a BSc, MSC or PhD)
300 offices in 100 countries

DNV Wind Energy

- Type Certification
- Project Certification

Certification - Definition

- Certification designates the overall scope of work or multiple activities for the issue of a Certificate, whilst Verification is also used for single activities associated with the work. This in essence means that Certification is Verification for which the deliverable includes the issue of a Certificate. Other (related) definitions are:
 - BS 4778 Part 2. Certification: The authoritative act of documenting compliance with requirements.
 - EN 45011. Certification of Conformity: Action by a third party, demonstrating that adequate confidence is provided that a duly identified product, process or service is in conformity with a specific standard or other normative document
 - ISO 8402 1994. Verification: Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled.
- Re-assurance to Stakeholders

- Certification is a convenient process for the developers to obtain an **independent verification** of their work and to provide **evidence** to financiers, partners, utility companies, insurers and the public that the energy converter will **perform adequately** within **acceptable levels** of safety, availability, reliability, asset integrity and environmental impact, **complying** with the Qualification Basis and, where applicable, to relevant standards.
- Certification provides also a good way to obtain access to relevant expertise with a different perspective.

Marine Renewables - The Needs

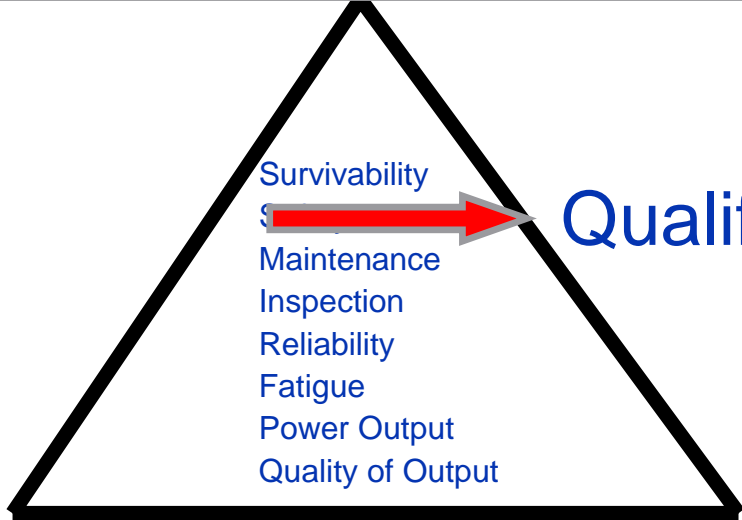
- The success of a wave or tidal device is not based on the safety aspects only. Strength, fatigue and reliability targets are related to **functional requirements** (i.e. based on financial / business model) – with due consideration to:
 - Safety of personnel and third parties
 - Environment impact
 - Asset integrity
 - Continuous operation

- The business model should predict the required operating mode of the device / farm reflecting the required **balance** between construction **costs**, inspection and maintenance costs, unexpected expenditures (de-mobilisation outside maintenance window, loss of revenue, contractual penalties) and maximisation of power generation (**revenue**).

Setting the targets – The balance

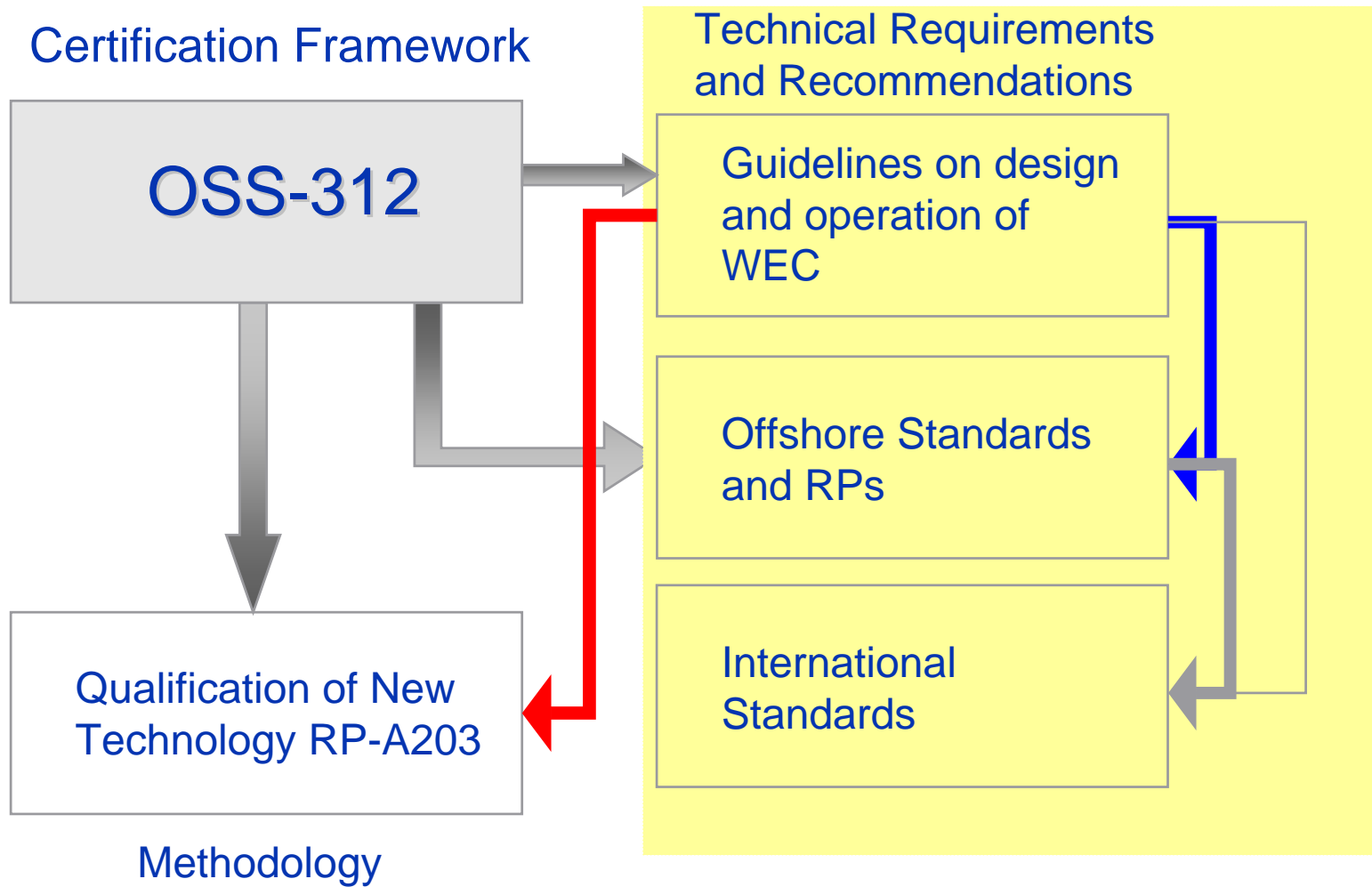
Construction (structure, equipment supply and installation / commissioning)
Installation
Normal intervention (frequency and extent, access, interruption of power generation)
Reduction of unexpected intervention (redundancy, design, commissioning)
Repair (robustness, access, replacement, redundancy)
Insurance Premium
Authorities expectation
Environmental controls
Monitoring of performance and data collection

Maximisation of power output (power capacity)
Continuous power output
Quality of output
Tariffs



Qualification Basis

Certification Basis



Certification through Qualification OSS-312

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The OSS describe the certification process (requirements, scope and deliverables)

Based on the following principles:

- Use of Qualification process
- Technical requirements are given in the MEC Guidelines. In general, most of Sections of the Guideline are also applicable to Tidal Energy Converter devices. However, some guidance and specific interpretations are given for tidal on a case-by-case basis
- Generic and systematic approach to cover wave devices and tidal devices and the different concepts within each group.
- Stepwise process: interaction with developer and directly associated to the normal progress of design.
- Design Approval, Manufacturing Surveillance and In-service Operation
- Feedback and updating on OSS and OS

Certification through Qualification OSS-312

Certification Scope :

- Load and response analyses (the control system may/will have significant effect on the global behaviour)
- Structures
- Mooring system
- Electrical system
- Mechanical system
- Hydraulic system
- Control system
- Safety systems incl. emergency shutdown system
- Marine systems including bilge system
- Other systems such as: turbines, lubrication, dehumidification, cooling systems, etc
- Power Measurement
- Maintenance procedures

Certification through Qualification OSS-312

Deliverables

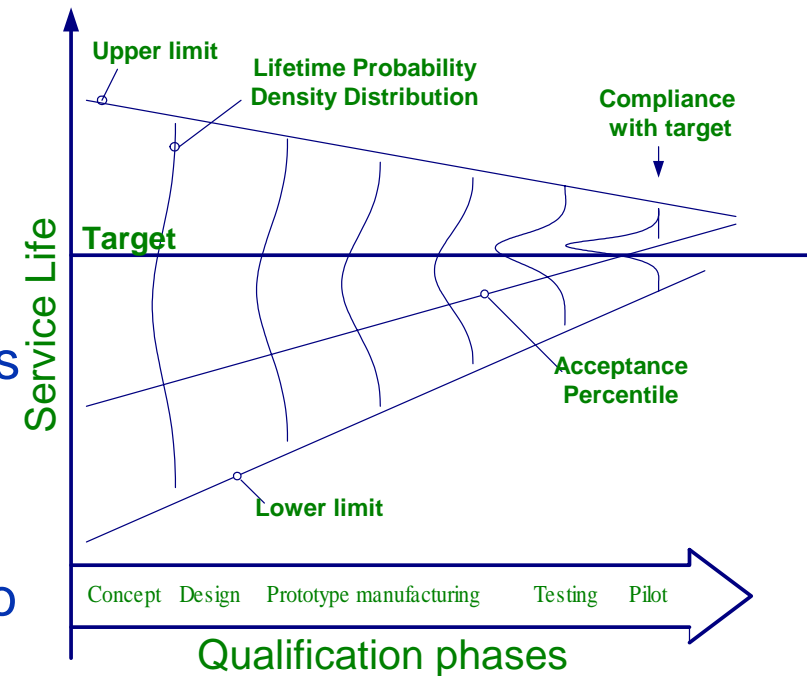
- Approval in Principle or Statement of Feasibility
- Statement of Endorsement
- Design Approval
- Product Certificates for Components and Assemblies
- Survey Reports
- Certificates:
 - DNV Type Certificate

In order to account for the different stages in the development of the device DNV may in addition to the Type Certificate issue the following certificates:

 - DNV Prototype Certificate, class C
 - DNV Type Certificate, class B
 - DNV Project Certificate

Extent and process

- **Fabrication and manufacturing surveillance** should be defined / confirmed based on the qualification process.
- Review of **commissioning** procedures and handling of uncertainties.
- **Data from prototype** to further address remaining uncertainties and to consolidate confidence on the device prior start production model (Qualification Method).



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Organisation of this Offshore Service Specification
Objects covered
DNV Document hierarchy
International Standards

SECTION 2 CERTIFICATION SERVICES

PRINCIPLES OF CERTIFICATION

Definition of services
Deliverables

SECTION 3 CERTIFICATION OF TIDAL AND WAVE ENERGY CONVERTERS

PRINCIPLES OF CERTIFICATION OF TIDAL AND WAVE ENERGY CONVERTERS

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Certification Approach
Scope of Certification

QUALIFICATION OF NEW TECHNOLOGY

General
Basis for the qualification of new technology
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STRUCTURAL DESIGN

Type of installation

Environmental data

Floating Tidal and Wave Energy Converters

Fixed Tidal and Wave energy converters

POSITION KEEPING

MACHINERY AND MARINE SYSTEMS

Floating Installations

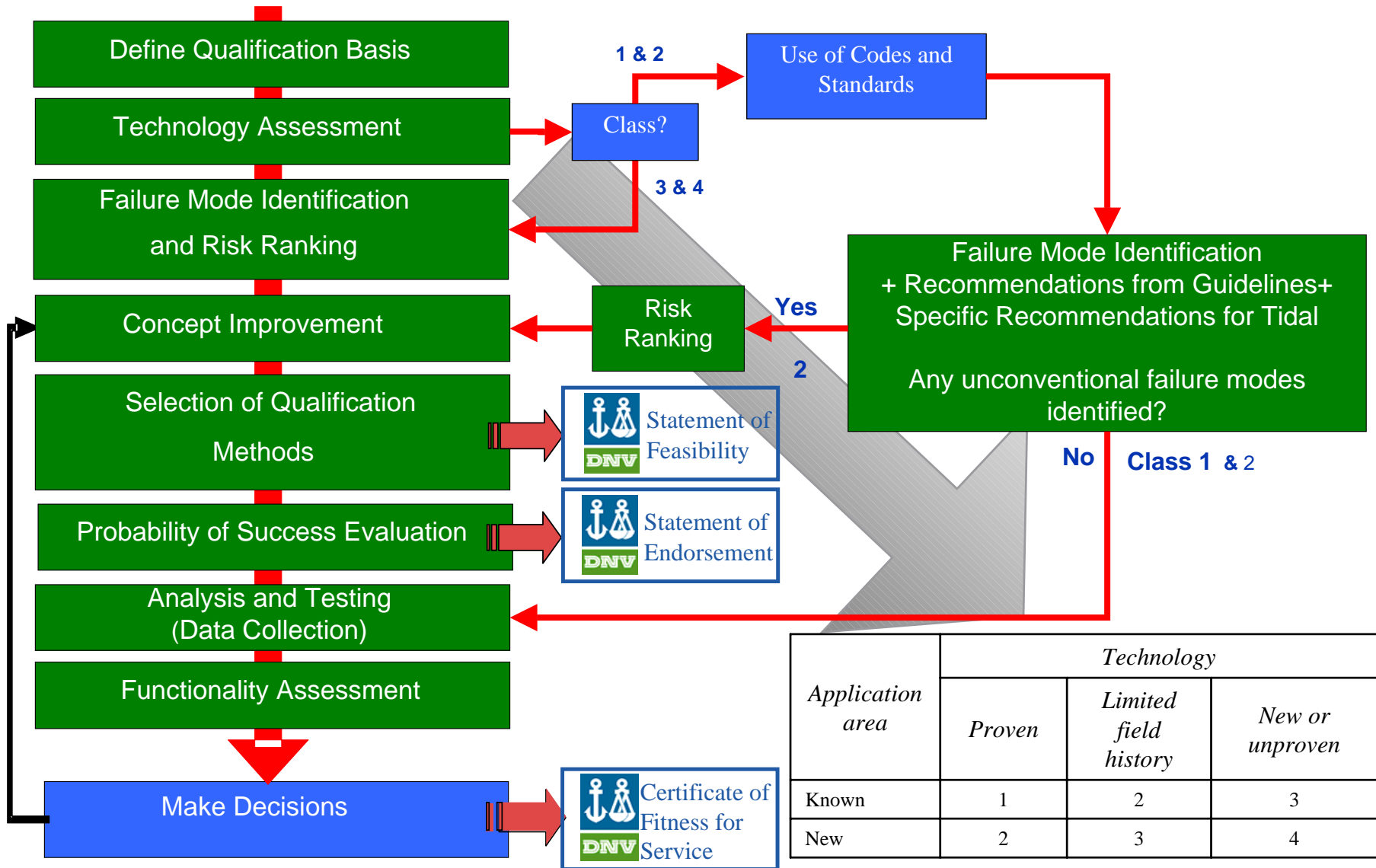
Fixed Installations

ELECTRICAL SYSTEMS

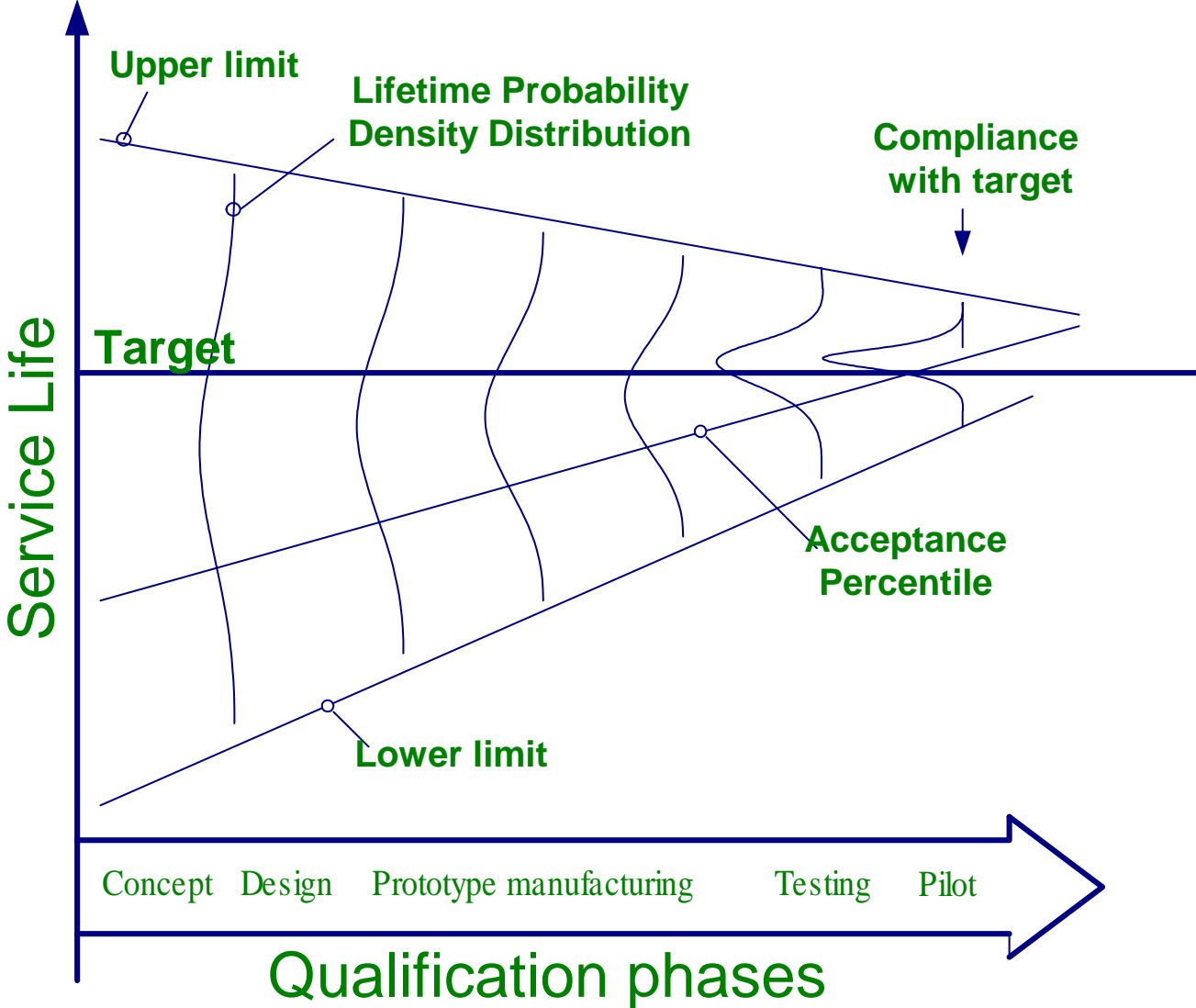
INSTRUMENTATION AND CONTROL SYSTEMS

FIRE PROTECTION AND SAFETY SYSTEMS

The Qualification Process - Renewables



The Qualification Process



Failure Mode Identification

The system / technology is broken down to a level of detail that each failure mechanism is understood

Handling of uncertainties

Workshop format (multi-discipline, all phases during life time of device / technology)

The description of failure and its risk ranking will be used to define the qualification method (i.e. what needs to be done to deal with uncertainty)

Components and functions										
ID	Component	Function	Failure mode	Failure mechanism or cause	Detection	Consequence	Risk Ranking			Comments
							Cons.	Prob.	Risk	

Phases and activities										
ID	Activity	Component	Failure mode	Failure mechanism or cause	Detection	Consequence	Risk Ranking			Comments
							Cons.	Prob.	Risk	
1	Mobilisation									
1.1	<Activity 1>	<Component X>								
		<Component Y>								

The Qualification Process - Risk Ranking

Class	Estimate of frequency of occurrence	Consequence					
		Freq	1	2	3	4	5
1	Very infrequent, e.g. once in a lifetime	5	Low	Med	High	High	High
2	Infrequent, several times in a lifetime	4	Low	Med	Med	High	High
3	Typical occurrence once in 5 years	3	Low	Low	Med	Med	High
4	Occasional occurrences e.g. once per annum	2	Low	Low	Low	Med	Med
5	Several occurrences per annum	1	Low	Low	Low	Low	Low

Risk Ranking

- Effectiveness: different priorities for different failure modes. Focus attention and resources on the issues that will have large impact on the success of the device to achieve the established targets.

Risk Matrix definition

- The tolerance levels should be in line with Qualification Basis, Corporate policies and financial / business model

Class	Description of consequences (impact on)				
	Function	Safety	Environment	Operation	Assets
1	Minimal effect, easily repairable or redundant system	No injury, effect on health	No pollution	Minimal effect on production	Negligible
2	Loss of redundant function, reduced capacity	Minor injuries, health effects	Minor pollution	Some small loss of production	Significant, but repairable
3	Loss of parts of main function, with significant repairs required	Significant injuries and/or health effects	Limited levels of pollution, manageable	Light intervention required to replace equipment	Localised damage, repairable
4	Shutdown of system	A fatality, moderate injuries	Moderate pollution, with some clean-up costs	Significant loss of production, major repair needed	Loss of main function, major repair needed
5	Complete failure	Several fatalities, serious injuries	Major pollution event, with significant clean-up costs	Total loss of production, major repairs / replacement required	Loss of device (or major component), with potential consequences

The Guidelines for Wave Energy Converters

MANAGING RISK



Key aspects:

- **Qualification** at the core of the Guideline
- **Building blocks** approach
- **Safety and Reliability**
- **Fatigue**
- **Transference of technology** from other sectors

Guidelines on design and operation of wave energy converters

A guide to assessment and application of engineering standards and recommended practices for wave energy conversion devices

Commissioned by the Carbon Trust
and carried out by Det Norske Veritas
May 2005



- Adoption and adaptation of **relevant technology** from offshore, maritime or other relevant industries as a way to accelerate development
- Consideration of **methods for dealing with novel aspects** of marine devices and handling of uncertainties
- Provision of a **common “language”**. Common understanding of the problems to be solved and requirements. Contractual Basis.
- Handling of **Safety level** tailored to needs regarding personnel safety (manned v. unmanned), damage or loss of asset and production interruptions
- **Reliability and confidence levels** in achieving production with minimal operation interrupts– (influencing cost/kWh)
- To provide a way to **demonstrate** handling of uncertainties and risk management. **Assurance**

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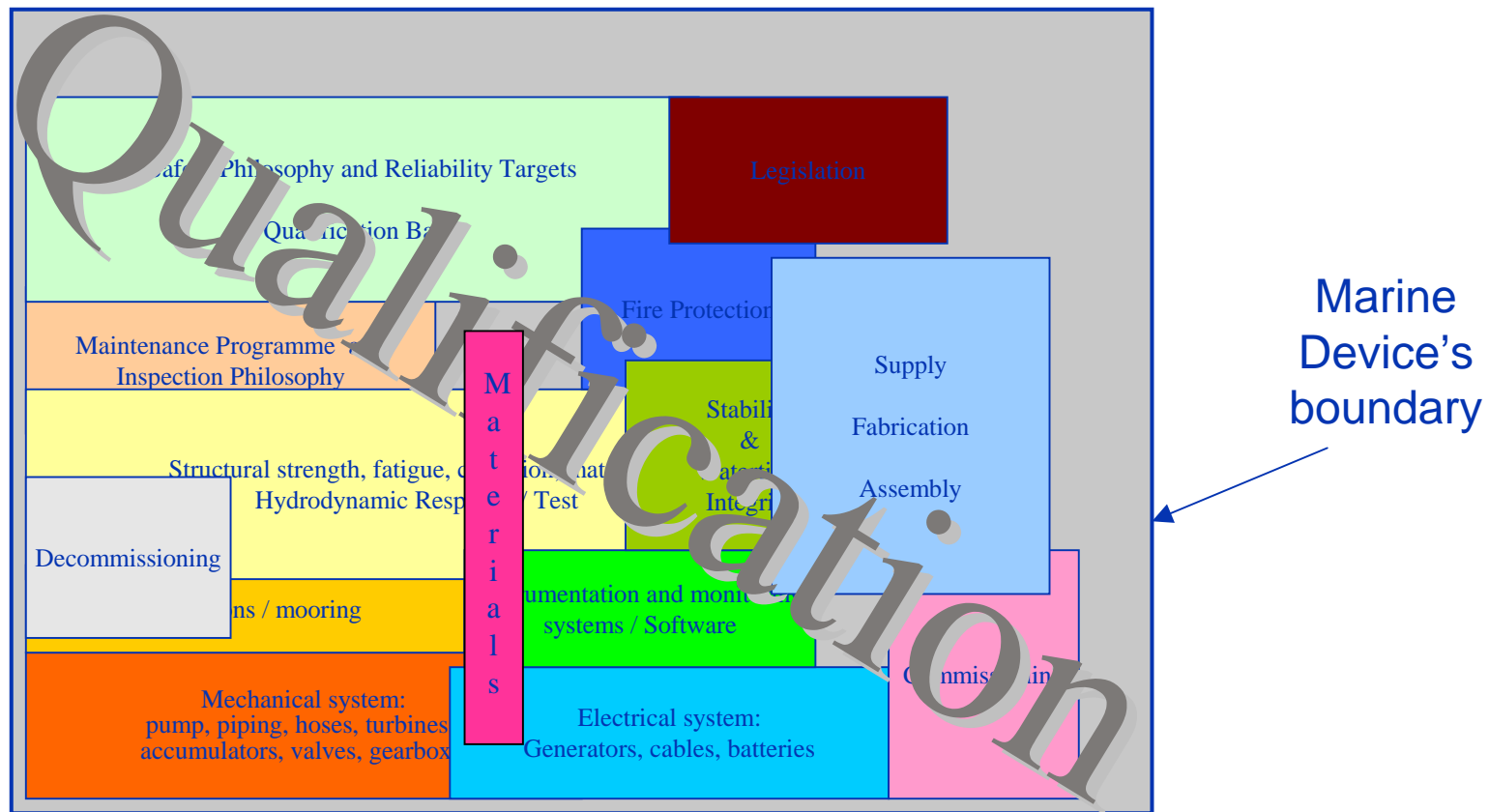
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Guidelines – The Building Blocks

Addressing of systems and components that are generic and can be combined in different solutions (building blocks)

Qualification process covers the new technology aspects



Guidelines – Safety and Reliability

Safety Philosophy

- Risk to life
- Environmental impact (fluid releases, anti-fouling coatings, bilge water)
- Loss of production
- Inspection and maintenance cost, risks during removal of equipment for inspection and maintenance
- Reputation of developer, industry, concept
- Underwriter perception of risks and definition of premium value
- Financial or venture capital communities' perception of risk to the return on investment
- Expected safety level by Authorities

Safety Level Low

Safety Level Normal

Safety Level High

Separate target levels for **Personnel, Asset, Production** and **Environmental Safety**.

Guidelines – Safety and Reliability

Safety Philosophy – Steel Structure

Table D1 Load factors γ_f for ULS (OS-C101 Ch.1 Sec.2)				
<i>Combination of design loads</i>	<i>Load categories</i>			
	G	Q	E	D
a)	1.3 / 1.2 ¹⁾	1.3/ 1.2 ¹⁾	0.7	1.0
b)	1.0	1.0	1.3 / 1.15 ²⁾	1.0
Load categories are:				
G	- permanent load	E	- environmental load	
Q	- variable load	D	- Deformation load	
<p>1) When permanent loads (G) and variable functional loads (Q) are well defined, e.g. hydrostatic pressure, a load factor of 1.2 may be used in combination a) for these load categories. If a load factor $\gamma_f = 1.0$ on G and Q loads in combination a) results in higher design load effect, the load factor of 1.0 shall be used.</p> <p>2) Based on a safety assessment (see Section 8 Safety Philosophy for Structure, Equipment and System Design) considering the risk for both human life and the environment, the load factor for environmental loads may be reduced to 1.15 in combination b) if the structure is unmanned during extreme environmental conditions.</p>				

Guidelines – Safety and Reliability

Reliability Target

Balance between Costs (Construction, Operation and due to unplanned events and business interruptions) and revenue.

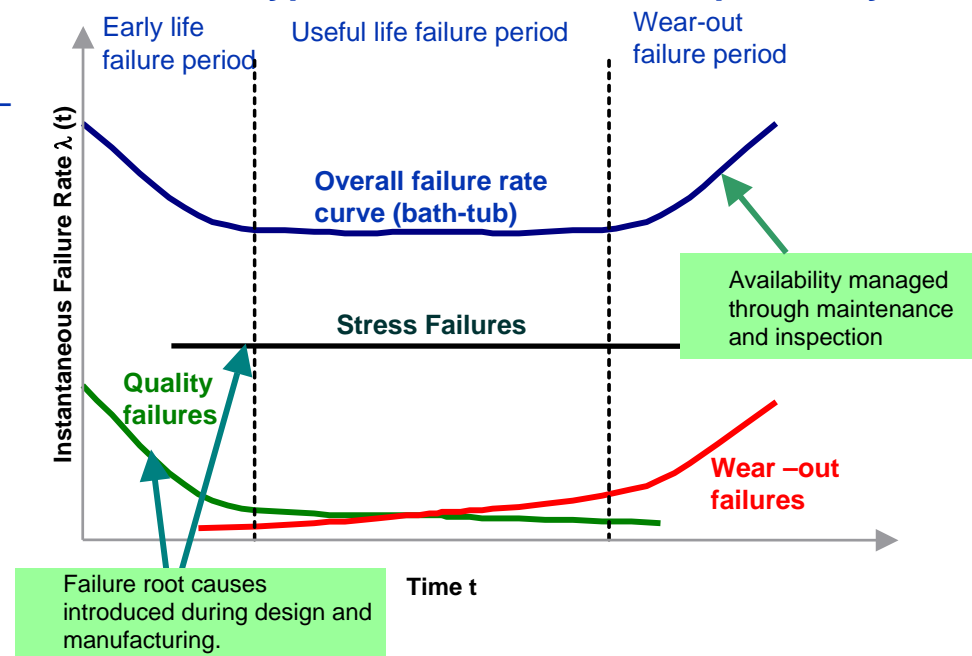
Selection of reliability target will impact on: construction costs, extent and frequency of inspections and maintenance regime, likelihood of unexpected intervention and repairs, financial penalties due to lack of production.

Strategies towards reliability:

- **Low utilisation** of mechanical strength – a higher resulting reserve (or safety factor)
- **Redundancy** of essential or important equipment – to maximise up-time
- Use of well-proven components
- Environmental simulation testing of components subject to various environmental loads
- Thorough FMEA study
- Rigorous manufacturing testing and evaluation of fatigue parts subject to cyclic loads

Reliability Centred **Maintenance** (RCM): optimisation of preventive maintenance based on evaluation of failure modes and their effects.

Common types failure rates time dependency



Guidelines – Technology Transfer

- Guidelines provide a consistent set of standards across different disciplines and subjects (no “standard hopping”)
- DNV Offshore Standards, Recommended Practices, Rules, Classification and Certification Notes, Approval Schemes plus International Standards referred to in the Standards are the basis for the Guideline
- For areas not covered by them, other standards were considered
- Other International Standards (~220) are referred to as possible alternative standards covering similar subjects
- Recommendations given are not the only way to achieve safety and reliability targets, but they are considered the best approach (**Principle of Equivalence**)

Conclusions

- OSS-312 provides a suitable framework for certification activities of marine renewable energy converters.
 - Based on Qualification process (generic, systematic, demonstrable, risk based and traceability)
 - **Gradual** process linked to natural flow of development
 - Based on targets related to safety, environmental and **functional** requirements
 - Use of **existent knowledge** (codes and standards) addressing most of the likely design requirements
 - Handling of uncertainties, different concepts
 - Lifecycle approach
- Guidelines available for downloading from the DNV website (<http://www.dnv.com/energy/windenergy/>) and the Carbon Trust website
- OSS-312 is likely to be released on April 2007 and it will be available for downloading from DNV website.



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