

Qualification of New Technologies

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Deepwater Technologies

Today's Challenges....



...Tomorrow's Opportunities

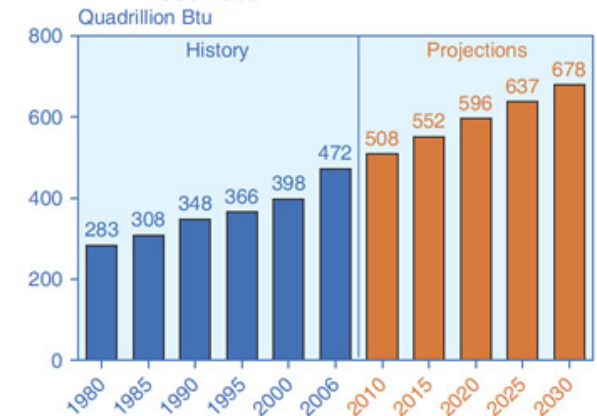
Why Use New Technologies? - Opportunities

- Growth in global energy demand
- “Easy oil” is developed and need to pass technology barriers to access new discoveries. Higher pressure, higher temperature, more corrosive
- Existing assets are ageing → declining production
- Reducing the costs to find, develop, and produce such resources



- Increasing production efficiency and ultimate recovery of such resources
- Improving safety and environmental performance, by minimizing environmental impacts associated with UDW Exploration & Production

Figure 10. World Marketed Energy Consumption, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2009).

Questionnaire

- How do you ensure that your qualified technology will not be used with a combination of design parameters outside past experience?
- Do you feel comfortable that you involved relevant stakeholders when determining your technology's risks?
- When your next client calls (years from now) to ask you to use your existing technology with a new set of design criteria, will you be able to build on your previous qualification?
- When you sell this technology to your client, what is the main argument that will help you instill confidence in your choice of technology solutions?
- Is your qualification process qualified?



Systematic Qualification and TRL



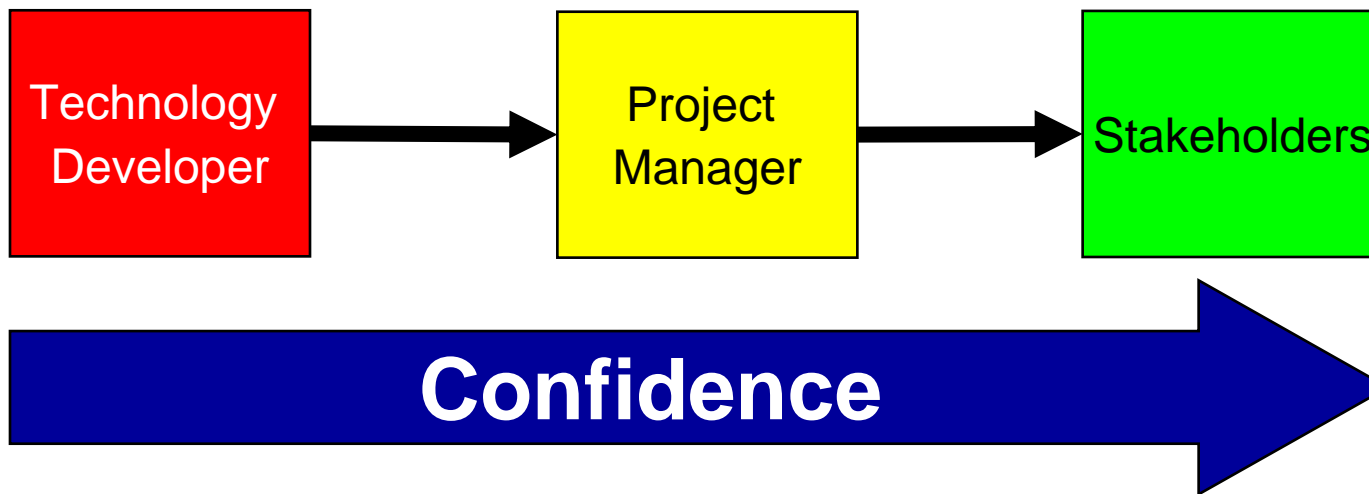
Unveil the Mystery....



Technology Qualification

- DNV's Definition of Qualification:

- *Qualification is the process of providing the evidence that the technology will function within specific limits with an acceptable level of confidence.*



Technology Readiness – A Common Language

- Technology Readiness Level – TRL

- A common language for communicating technology maturity ("ready for use")
- Initial TRL is the qualification status when equipment is introduced in a project
- Required TRL is the qualification status for the equipment to be "project ready"
- The gap between the initial TRL and the required TRL determines the qualification effort required in a project
- Technology readiness may be defined according to API 17N



Ensuring Subsea Processing Technology Meets Customer Needs

DNV Workshop

Chris Shaw
FMC Technologies

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And keep you ahead.

Define Functional Requirements

- Define Functional Specifications
- Define Functional Requirements
- Define Technology Readiness
 - Component level Failure Modes Effects and Criticality
- Develop Qualification/Mitigation Plan

Product Qualification Sheet

- Contains references to the following by product family:
 - Standard Part Numbers
 - Product Data Sheets
 - Product specifications, capabilities, limitations, descriptions
 - Product Qualification Basis
 - Product test protocols
 - Product Design Documentation
 - Product Reliability Documentation

Casing Hangers									
ASSEMBLY DESCRIPTION	COMPONENT DESCRIPTION	WATER DEPTH	PRESSURE RATING	TEMPERATURE RATING	TRL - API RP 17N *	INDUSTRY SPECIFICATION	TEST REPORT NUMBER	QUALIFICATION TEST DETAIL	PRODUCT DESIGN DOCUMENTATION
10.75" Casing Hanger							1991-15 1991-79 DNV15-03217-63-1	Load tested: 9 5/8" to 5.1 million #, 1million # casing string weight	
13.375" Casing Hanger							DNV15-03217-63-2 1991-79	Load tested: 13 3/8" to 6.1 million #, 1million # casing string weight	
14" Casing Hanger							DNV15-03217-63-2	Load tested: 13 3/8" to 6.1 million #, 1million # casing string weight	
									ADE200005022



Project Specific TRA&MP

- Manage / document product design qualifications to meet project requirements
- Contains references to the following:
 - Standard Product Qualification Documents (from standard catalog)
 - Project specific assessment (qualification risk screen) of Technology Readiness Level (TRL) for each product type required in MEL
 - Identifies areas for next level assessment (TRA&MP) and the formulation of the R&D Plan for bringing low TRL products to required level for delivery
 - All products that are below TRL 6 are taken to the TRA&MP for review and mitigation planning
 - All products below TRL 2 require Failure Modes and Criticality Assessment to provide systematic focus on critical items.



Focus on Least Mature Technology

Table 1 Technology Classification

Operating Condition	Technology Maturity			
	Proven	Limited Field History or use and No Events	New or Experience	Unknown
Proven Experience	1	2	3	4
No Experience or Events	2	3	4	5
No Industry Experience	3	4	5	6

These classification ratings for criticality are defined as:
 1. No new technical uncertainties
 2. New technical uncertainties
 3. New technical challenges
 4. Demanding new technical challenges

Technology Classification					
Snapshot Taken on 01 September 2009					
Technology	Application	Technology Maturity			Comments
		Proven	Qualified	New	
Subsea barrier fluid control	known		2		250 bar hyperbaric, 345 bar internal
Mechanical seals	known	2			250 bar hyperbaric, 345 bar internal, supplier and application well known
Thrust bearing	known	2			thrust loads well below rated capacity, supplier and application well known
Journal bearings	known	2			loads well below rated capacity, supplier and application well known
Coupling	known	2			loads well below rated capacity, supplier and application well known
Balance drum	known	1			standard offering, loads well below rated capacity, supplier and application well known
Motor	unknown			4	motor supplier has limited experience in application and technology
Pump Pressure Housing	known	2			pump supplier has good experience up to 10K burst pressure, limited experience with hyperbaric issues (except Neutalus)
Motor Pressure Housing	known		2		pump supplier has limited experience in application (good Neutalus experience), 2000m w.d. limit
Single phase hydraulics	known	1			up to 10% free gas and designs capable of >9000 psid
Hybrid hydraulics	known		1		hybrid pump hydraulics qualified through Shell led JIP
Multiphase hydraulics	known	1			multiple applications on surface (dry)

Technical Risk Categories and Operating Condition

Risk factor	Reliability	Technology	Configuration	Environment	Organization
Key Words	Reliability requirements, maintainability, system availability, risk, uncertainty	Materials, design life, stress limits, temperature limits, corrosion, duty	Layout, interfaces, installation, orientation, intervention, tooling	Water depth, seabed conditions, process conditions, transport, storage	Company, contractor, vendors, sub-contractors, manufacture location, operate, maintain
TRL 0-2	Significant reliability improvement demanding a change to the technology	Novel design or new design concepts	New architecture or configuration	New environment, first application subsea	New supplier of technology, new sub-suppliers
TRL 3	Some reliability improvements required	Known technology modified for use subsea	Significant change in architecture or configuration	Major changes versus prior projects	New sub-suppliers
TRL 4-5	Minor reliability improvements required	Minor modification to existing designs	Minor changes in architecture or configuration	Approximately the same as previous	Known suppliers/sub-suppliers
TRL 6-7	Standard equipment	Standard equipment	Standard equipment	Approximately the same as previous	Well Known suppliers/sub-suppliers

Technical Risk Assessment & Mitigation Plan

Reference	System Breakdown		Initial Technology Readiness Level	Current Technology Readiness Level	Overall Risk Rating Before Mitigation	Risk Mitigation Plan	Overall Risk Rating After Mitigation	Overall TRL Rating After Mitigation
Item Number	Subsystem	Component						
1.0	Pump	Motor	3	4	Medium	Complete string/system operation test to power pumps in parallel	Medium	5
1.1		Seals Section	3	4	Medium	Use existing pump stage design. Complete performance test to confirm hydraulic performance, vibration characteristics, efficiency, wear and bearing capacity. Strip down and inspect components after testing is completed.	Medium	5
1.2		Pump Section	3	4	Medium	Use existing pump stage design. Complete performance test to confirm hydraulic performance, vibration characteristics, efficiency, thrust, wear and bearing capacity. Strip down and inspect components after testing is completed.	Medium	5

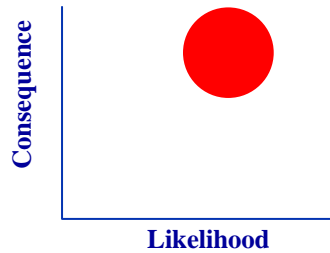
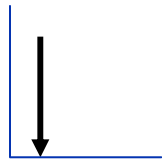
0 - Concept - Unproven	Low	New concept
1 - Concept - Proven	Low	Significantly more severe service
2 - Concept - Validated		
3 - Prototype - Tested	Medium	Derivative
4 - Prototype - Environment Tested	Medium	Moderately more service
5 - Prototype - System Tested		
6 - Field Qualified - System Installed	Low	Close copy
7 - Field Qualified - Field Proven		Same as or less service

Technology Qualification Process – DNV RP A203

- Defines the work process to go from initial TRL to the target/ required TRL
- Improves end user's confidence – especially when codes/ standards are lacking
- Ensures more efficient use of resources – reduce development cost
- Systematically identify failure modes and mechanisms
 - Identifies design changes at an early stage – opportunity to improve system design
 - Optimize qualification testing and analysis
 - Uncovers interface issues between manufacturer and sub-vendors
- Increases the likelihood of on-time delivery – reduces the time to market
- Reduces the risk exposure by reducing uncertainties and increasing reliability – maximize opportunities
- Traceability of qualification efforts
- Allows quicker re-qualification for new operating conditions

From Concept to "Project Ready"

Initial TRL



Money / Budget

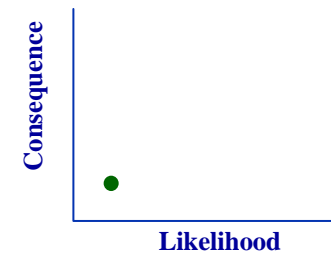
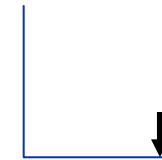
Time / Deadlines

Manning

Uncertainties and risks

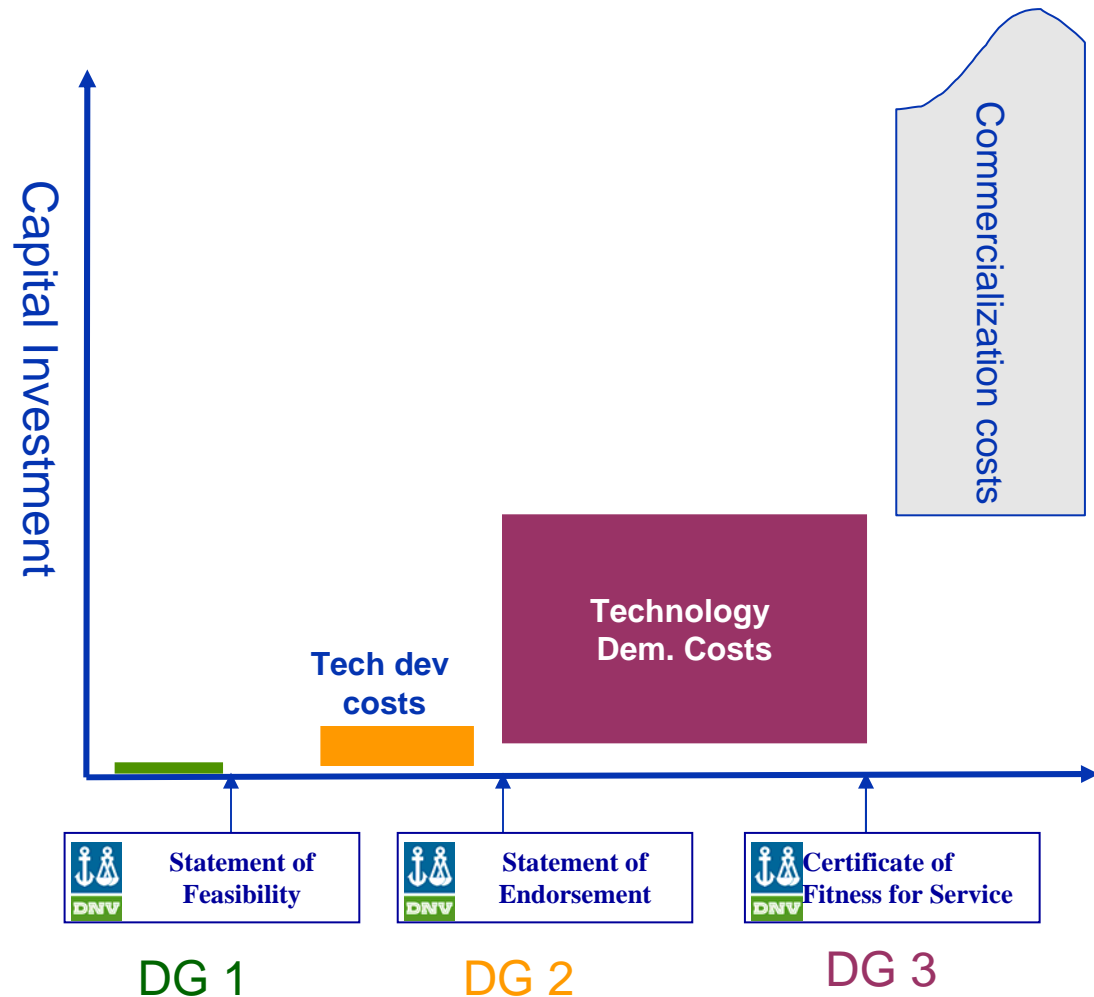
Confidence

Target TRL

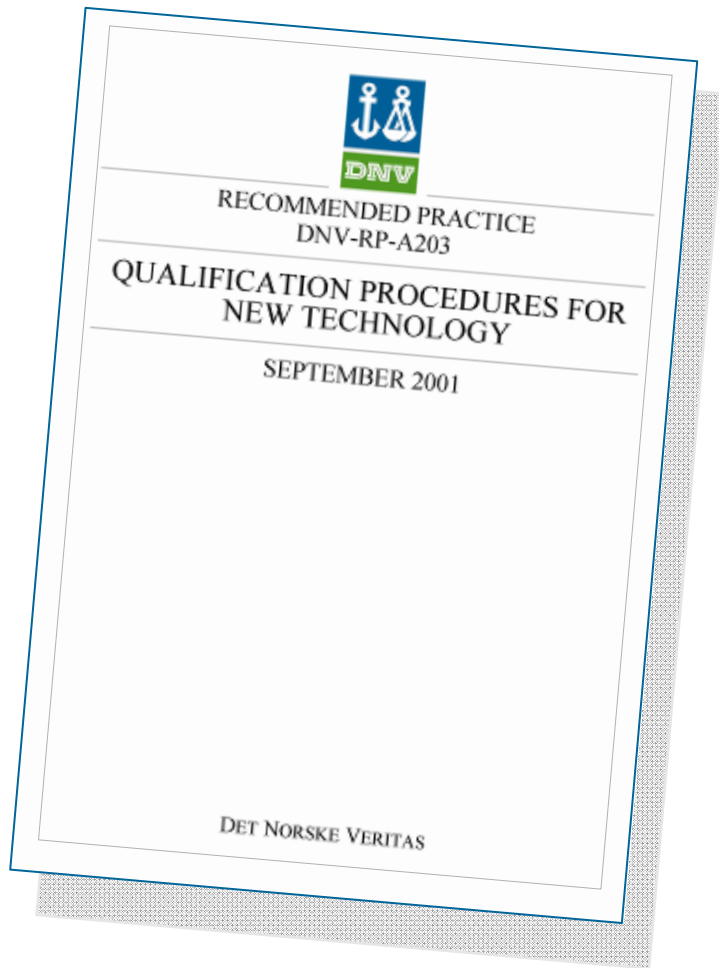


Investment in New Technology - Three Decision Gates

- **DG1: Feasibility Statement - “No show stoppers”**
 - Investor: Should I follow-up further?
- **DG 2: Endorsement Statement - “Technically executable”**
 - Investor: Is it worth an investment?
- **DG3 :Fitness for Service Certificate - “Ticket to trade”**
 - Investor: Invest further, emission, sell?
- Deployment new technology



Succeeding with Technology Qualification



Fact
or
Myth?



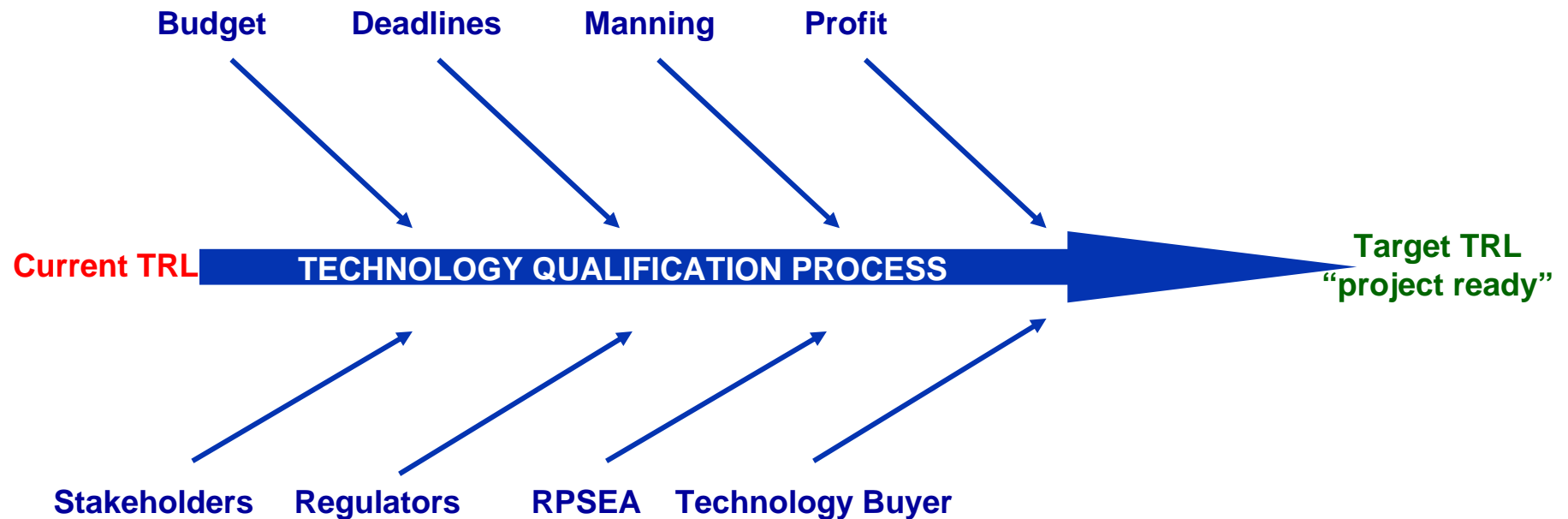
Technology Qualification Roadmap

“Everyone wants to be first to be second”

Million dollar project on the line....

Challenges and uncertainties - Risks need to be managed

Confidence needs to be installed



Overall Technology Qualification Program– The Roadmap

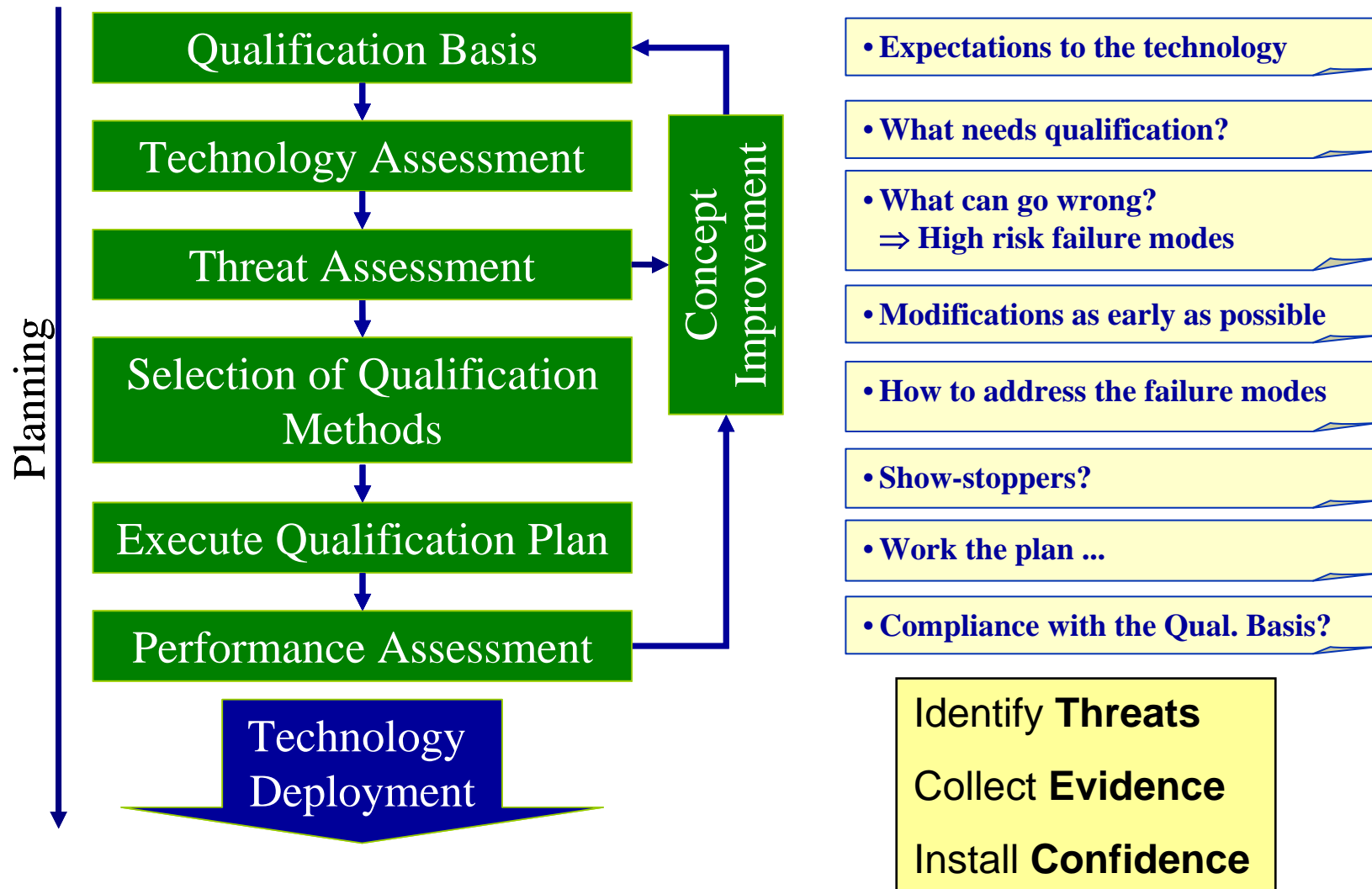
- How will the qualification project be accomplished?
 - Resources needed (people, software/hardware etc.)
 - Roles and responsibilities (specify requirements, completion of work, verification)
 - Stakeholder involvement (partners, client, sub-contractors, authorities, 3rd party)
 - Budget constraints
 - Schedule and milestones
 - QA/QC and SHE requirements
 - Address supply chain risks

- May form the basis for performing project risk management

- Document needs to be kept up to date
 - Typically it will become more detailed as the project progresses



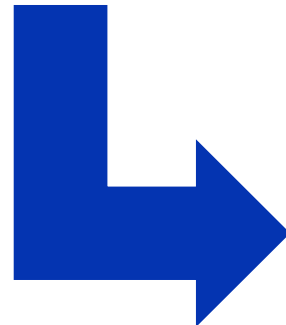
Technology Qualification Process



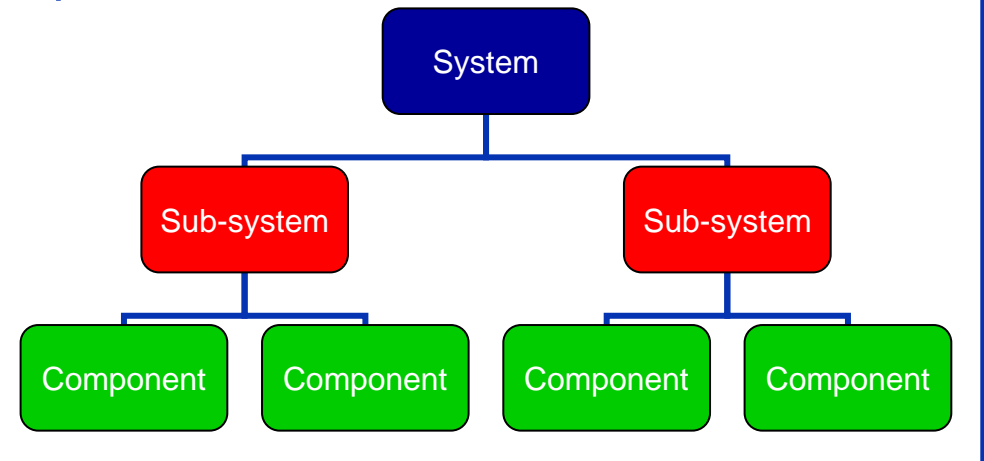
Qualification Basis - Expectations

Qualification Basis

- Functional requirements
- Design parameters
- Interfaces
- Codes and Standards
- HSE requirements
- Operating philosophy
- Maintenance strategy
- RAM requirements

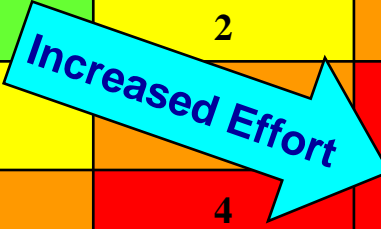


Specifications



Technology Assessment – Determining Focus Areas

Application Area	Technology Maturity		
	Proven	Limited field history	New or unproven
Known	1	2	3
Limited Knowledge	2	3	4
New	3	4	4



1. No new technical uncertainties
2. New technical uncertainties
3. New technical challenges
4. Demanding new technical challenges

- Assess degree of novelty – unproven elements
- Identify and focus on the elements of uncertainty in the technology
- Determine the appropriate level of activities in the qualification process
- Not the same as TRL but has a link with regards to uncertainty
- Does not consider criticality
- Reliability, criticality, system architecture/ configuration, complexity, environment, organization

Build Confidence

How to be sure the technology will perform as expected in a safe and reliable way?

- Threat assessment
 - Properly facilitated
 - Failure mechanisms linked to qualification activities
- Assess all failure modes of concern with a validated qualification method
- Obtain third party verification
 - Verification of overall process
 - Facilitation of Threat Assessment
 - Review and verification of documented evidence
 - Independent calculations
 - Review of test procedures
 - Witnessing of tests



Summary

- Use of new technologies represents opportunities in a market for growing energy demand, but also significant risks and uncertainties
- These risks need to be managed through a systematic process
- The technology qualification process should identify threats, gather evidence, and install confidence
- TRL classification can be used to specify a product's state of readiness for use in a specific project
- Confidence is built throughout the qualification process by
 - Involving the right people (experts, stakeholders)
 - Identify all threats to the technology and use validated qualification methods to address the risks
 - Creating a transparent document trail throughout the project
 - Third party verification



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Thank you for your attention!

Questions?



MANAGING RISK

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