DNV GL Additive Manufacturing Services

Pathways to Qualification

Christopher D. Taylor and Joanna Ye February 2nd, 2022 WHEN TRUST MATTERS

A global assurance and risk management company





Our purpose

To safeguard life, property, and the environment **Our vision**

A trusted voice to tackle global transformations



The world's leading resource of independent energy experts and technical advisors

4000 experts provide local access to global best practice delivering safe and effective energy systems	90+ years serving the energy industry, including the oil and gas, wind and solar sectors	24 laboratories and test centres including facilities for full-scale testing	170 industry standards, guidelines and recommended practices, and approx. 30 joint industry projects per year
65% of offshore pipelines designed and installed to DNV standards	42 GW of real-time operational data from solar PV, wind and storage assets under management	>100 Iarge power utility companies trust us as their technical advisor	World 1 st hydrogen full-scale testing facility supporting safety, infrastructure and policy



DNV and Additive Manufacturing





AM: A World of Opportunities

- Re-invent Supply Chain
- Digital Inventories
- Novel Designs/Functionalities
- Smart Manufacturing
- Lightweighting
- Superior Materials Control



Confidence and Trust in AM



General applications

Assurance around fitness for service Quality, reliability, traceability Digital security, repeatability



Safety critical applications

Compliance with regulations, standards, codes (DNV, ASTM / ISO, API, ASME etc.)

Processes and parts must meet necessary requirements



Technical Standards - Compliance Verification



DNV Rules and Guidelines for AM

Rules

- Path to Manufacturer Qualification
- Documenting
 Manufacturing Processes
- Product Testing and Inspection

Guidelines

- Preparing test samples
- Mechanical Testing for Verification
- NDT and Acceptance Criteria



DNV GL AM related service documents:

Rules, Class Guideline, Type approval, Manufacturer Approval, Certification of Products

DNV·GL		DNV·GL	DNV·GL
CLASS GUIDELINE	CLASS PROGRAMME	RULES FOR CLASSIFICATION	OFFSHORE STANDARDS
DNVGL-CG-0197 Edition November 2017	Type approval	Edition January 2017 Amended January 2018	Divide-US-B101 Edition January 2018
Additive manufacturing - qualification and certification process for materials and components	Additive Manufacturing - Feedstock	Part 2 Materials and welding Chapter 1 General requirements for materials and fabrication	Metallic materials
	DNV·GL		
DNV·GL			
CLASS GUIDELINE	Approval of manufacturers DNVGL-CP-0267 Edition July 2018	accepts that it is prohibited by anyone eite but DWV GL and/or this forenests to differ and/or parform classification, critication and/or controllation services, critication and or controllations and/or particulation theorem of the and/or particulation and/or controllation services, critication and or controllation and or control a	The electronic pelf version of bhis document, available free of charge from http://www.dngit.com, is the officially binding version,
DNVGL-CG-0162 Edition August-2019		DNV GL AS	DNV GL AS
Robotic welding	Additive manufacturing	Included AM as a manufacturing process in Ship Rule	Included AM as a manufacturing process in Offshore Standard

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Various Certification options offered by DNV GL in AM

Certification Scheme for AM Materials Certification Scheme for AM Products Competence Certification Scheme for Personnel

Manufacturers Product Quality Assessment, Facility Certification, Manufacturing Process Qualification Approval of Manufacturer

> Management Systems, Safety Certification

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DNV ST-B203

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STANDARD		• Thre • AN
DNVGL-ST-B203	Edition May 2020	■ Mar ● F ● B ● P
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- Requirements and guidance for:
 - Qualification of parts made by AM
 - Quality management for manufacturers
- Three part categories based on criticality
 - AMC 1, 2 & 3
- Manufacturers can 'prequalify'
 - Facility level qualification
 - Build process qualification (BPQ) per material

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Part qualification for part families

AMC 1-3 Definitions

Additive manufacturing category	Requirements
AMC 1 The part shall be built using a qualified build process.	
AMC 2	The part shall be built using a qualified build process. Production testing shall be performed. Part qualification testing may be required.
AMC 3	The part shall be built using a qualified build process. Production testing shall be performed. Part qualification testing shall be performed.

Guidance note:

When deciding on the relevant AMC, the following should be considered:

- consequences of failure for safety
- consequences of failure for the economy of, e.g. the end user
- consequences of failure for the environment
- consequences of failure for the reputation of, e.g. the purchaser
- third party or governmental requirements.

A part's designated criticality level may be affected by other measures, e.g. tests or control steps added outside of the scope of this document. Such measures could be full scale testing or a design safety factor. This should be assessed by the purchaser.

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Qualification Levels







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Qualification services



Developing Experience and Competencies in AM





Service Specification SE- 0568	Materials testing (Columbus, Ohio Lab)	Mixed metals AM	Partnerships	AM Operator Training
 Procedures for obtaining qualification 	• 17-4 PH, Inconel 718 under corrosive environments and stresses	HIP+HT hybrid materials resistant to creep oxidation	 Ohio State: in situ monitoring based qualification DOE HeroX: AM for geothermal logging 	 Section 6 AWS D20.1 Training course supervision, examination and witness builds



Summary



Actively developing qualification processes with input of manufacturers and users



Adaptive criticality-based qualification process has been developed and used in the oil and gas and maritime industries



Laboratory services and technology qualification can support market confidence and adoption



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Thank you for your attention

Joanna Ye Joanna.Ye@dnv.com Christopher Taylor Christopher.Taylor@dnv.com

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