ADDITIVE MANUFACTURING EUROPEAN CONFERENCE

3D printing and digital supply chain

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Agenda

- ❑ Shell AM Vision
- ❑ Additive Manufacturing in Shell
- ❑ Accelerating Additive Manufacturing adoption in energy sector

Lloyd's Register

Working together for a safer world

Additive Manufacturing Facility Qualification

In accordance with the requirements of the LR-TWI Guidance Notes for the Certification of Metallic Parts made by Additive Manufacturing 2017

This is to certify that:

Shell Technology Centre Amsterdam (STCA)
Grasweg 31, 1031 HW Amsterdam, The Netherlands

has been assessed against the requirements for additive manufacturing facilities and conforms to the requirements for the equipment and processes described below:

Reception, handling and storage of feedstock
Additive manufacturing process & build control incorporating the equipment below:

Concept Laser M2 Dual Laser Machine (Powder Bed Fusion) utilising CL100NB feedstock in accordance with ASTM F3055-14 (Inconel UNS N07718)

"This Qualification relates only to the facility stated above; it is not valid for equipment, feedstock materials or operators which have been varied from those included within the qualification scope (see Facility Audit Report RET0296481 rev.0 for full details). Approval is subject to the continued maintenance of the quality system in accordance with the requirements of the Guidance Notes referred to above and associated inspection procedures.

Lloyd's Register shall be notified of any modification or changes to the equipment in order to obtain a valid qualification. Furthermore, any materials or components produced at this facility shall be subject to the appropriate certification activities."

Certificate No: **RET0296481**
Original Approval: **12 June 2019**
Current Certificate: **12 June 2019**
Certificate Expiry: **11 June 2020**

***David Hardacre** on behalf of Lloyd's Register Nederland BV*
a subsidiary of Lloyd's Register Group

Lloyd's Register Nederland BV
a member of the Lloyd's Register Group

3D Printing Vision for our Supply Chain

Thrive in the energy transition

World-class investment case

Strong licence to operate

To radically simplify our spare parts supply chain

Shift from 'Buy just in case to Buy just in time'; Source locally; Repair vs Replace

1. **Lowering total cost of ownership**
2. **Increased production uptime and availability**
3. **Lowering carbon footprint**

Zeroing In On Inventory

Safe & Efficient Physical Supply Chain

Digital Supply Chain

Shell 3D Printing Focus

SPARE PART PRINTING

Focus on suppliers and assets:

Value generated by;

- Increased uptime
- Reduced Cost to Carry
- No (physical) warehousing costs
- Reduced lead time
- Solution for obsoleted parts
- Increase local content & improve sustainability

NOVEL DESIGN

Creating "impossible" parts.

Multiple benefits;

- Higher efficiency
- Less materials, less weight
- Lower maintenance costs
- Reduced installation time
- Function integrated parts

VISUALISATIONS

Visualising a 3D model.

- Rapid prototyping
- Scale model of plants
- Turnarounds
- Design validation
- Conversation facilitator

3D printing examples

Pump Bearing Housing

Implemented in Gas to Liquids plant

Impellers

Implemented in refinery

Forked Pipe

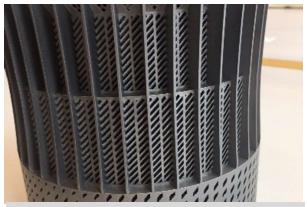
Implemented in FLNG

Water barrage seal

Reverse engineered and printed for FPSO

Valve

Printed and being tested for upstream asset

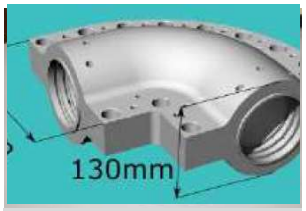


Valve 12” trim

Being printed for upstream asset

Valve trims

Printed and delivered to upstream asset



Low pressure clamp

In production for gas to liquids plant

Impeller

Printed for refinery

Impellers

Implemented for chemicals plant

Pressure vessel

Printed for R&D, testing underway

Impeller

In production for LNG plant

Accelerating Additive Manufacturing Technology in Energy Sector

- Collaboration across Operators and Vendors
  - Common Goals & Trust
  - Standardization
  - Data and knowledge sharing

- Technical Assurance & Development