SILVERSTREAM TECHNOLOGIES

The Silverstream® System – Air Lubrication

The smart, verifiable, high impact efficiency technology

Demonstrating the URN Co-Benefits of a Proven Energy Saving Solution

Silverstream Technologies

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Arno Dubois, Lead Hydrodynamicist

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Presentation Overview

- Silverstream Technologies and the Silverstream® System
- Paper by Prof J.S. Carlton: ‘Ship Hull Air Lubrication: Aspects of Cavitation, URN and Propulsion’
- Developing a Pragmatic and Practical Approach to Demonstrate URN Co-Benefits of the Silverstream® System

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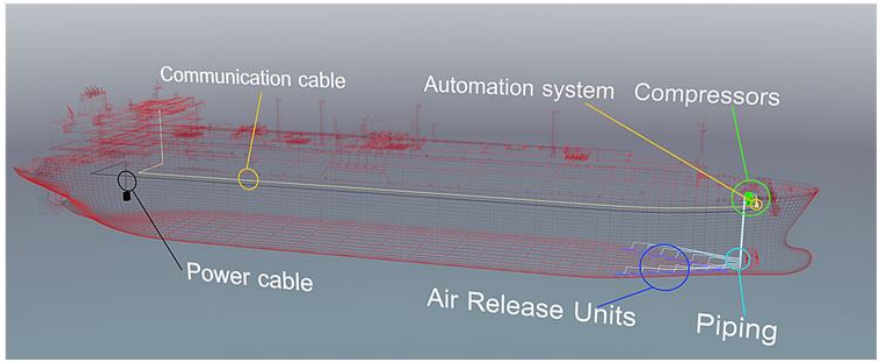
Silverstream Technologies and the Silverstream® System

Air Lubrication – The Silverstream® System

- 5-10% net fuel and emissions savings
- Deployment of uniform carpet of air bubbles
  - Reduce frictional resistance (of flat of bottom)
  - Fluid shearing (unique feature)
  - Reduced shaft power + increased ship speed
- Fuel agnostic solution (energy savings regardless of fuel type)
- Simple installation
  - Newbuild and retrofit in regular dry dock period
  - Robust and elegant (including patented ARUs)
  - Control and automation based on ship speed / draught



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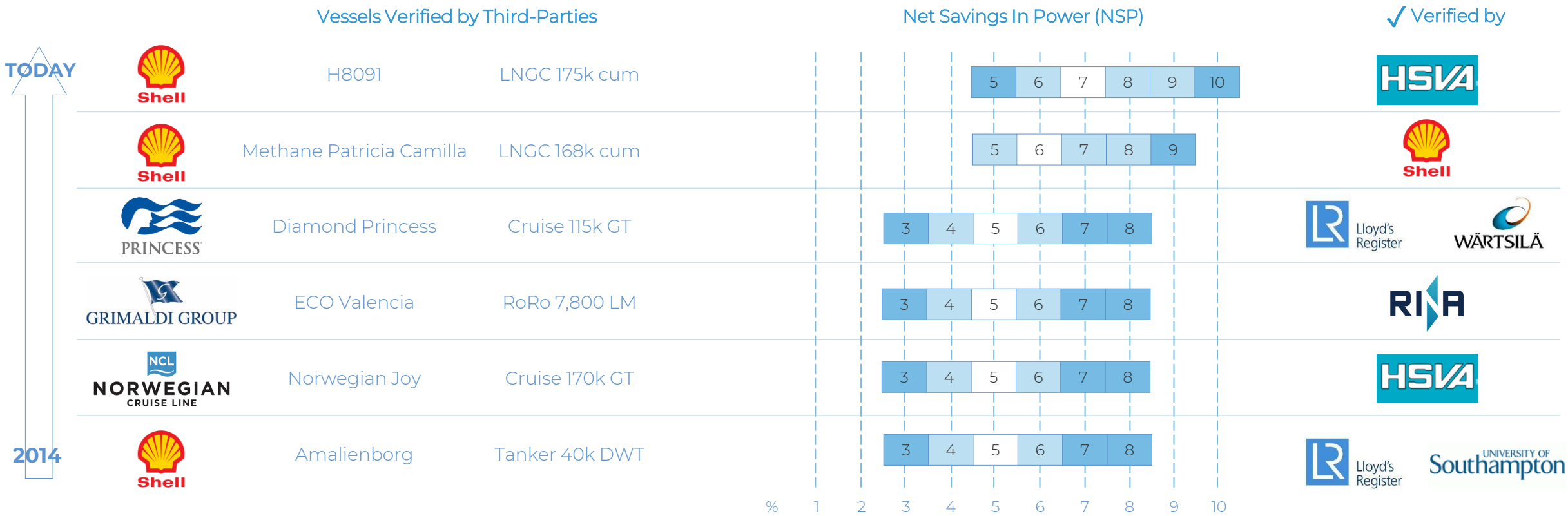
Demonstrated Savings – Verified Performance

'If you can not measure it, you can not improve it.' – Lord Kelvin



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Paper by Prof J.S. Carlton
‘Ship Hull Air Lubrication: Aspects of Cavitation, URN and Propulsion’

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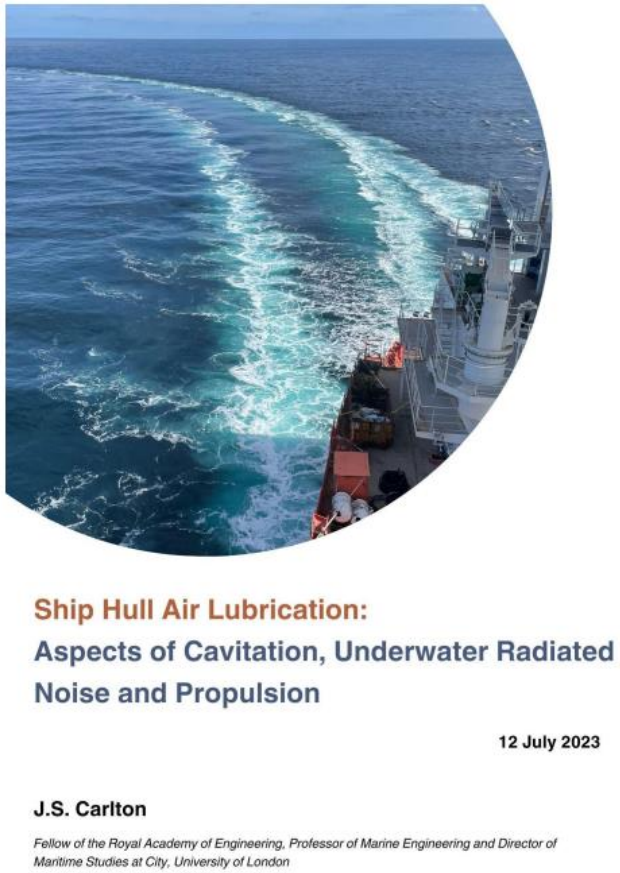
Introduction to the Paper

- Authored by Prof J.S. Carlton (funded through EU Horizon 2020, project CHEK)
- Based on literature, experimental studies, and available sea trial data
- Formulates conclusions on the effect of air injection on
  - URN
  - Propeller radiated pressures
  - Propeller erosion
  - Propulsion
- ‘Translating’ of paper conclusions to ALS



‘Translating’ Paper to Silverstream® System

- Silverstream® System
  - Effective and efficient air delivery through fluid shearing
  - Presence of bubble carpet and air introduced into propeller
- URN reduction capabilities identified
  - Masking of shipborne noise emitted through the flat of bottom
  - Reduce noise levels generated by the propeller through the cushioning effect of emitted pressure pulses
- Develop a pragmatic and practical approach to conclusively demonstrate co-benefits

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Developing a Pragmatic and Practical Approach to Demonstrate the URN Co-Benefits of the Silverstream® System

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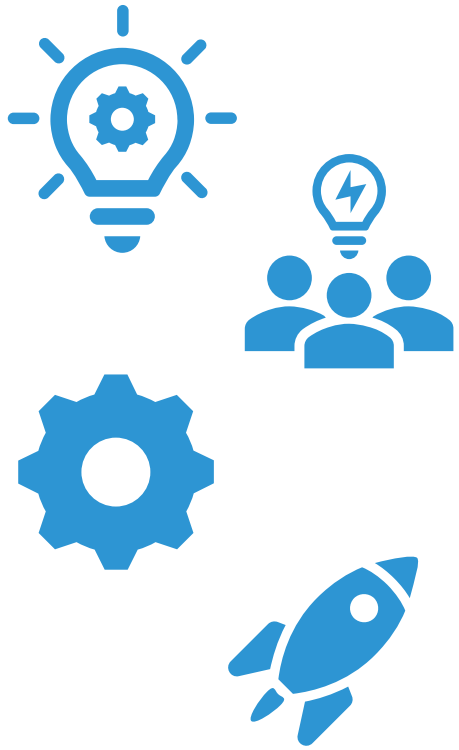
Research Methodology Development

- Currently, anecdotal evidence only

- Research approaches considered
  - First principles (including literature)
  - Experimental (lab)
  - Numerical modelling
  - Full-scale trials → focus area

- Other considerations
  - Quantify performance of EET / ALS (trade-off vs co-benefit)
  - Relative vs absolute effects
  - Importance of regulations / class (notation) requirements

- Engage stakeholders (academic, industry, customers)



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Initial Focus Area and Scope

- Need for pragmatic approach
  - Existing standards as basis (ISO17208-1/2 and ANSI/ASA S12.64)
  - Identified by stakeholder engagement
  - Can ‘proxy’ methodology be developed (on-board measurements)?
- Dedicated vs opportunistic measurements
- What’s next?
  - Intention declaration
    - Engage stakeholders (collaboration agreements)
    - Identify opportunities
  - Continued review and scope evaluation
    - System identification (ALS focused)
    - URN characterisation (noise sources, frequency ranges, acoustic characteristics, etc.)
    - Measurement tools (options, uncertainty, etc.)
  - Define scope of work for first project early 2024

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