

# NEXT GENERATION NO<sub>x</sub> REDUCTION DIGITAL AIRLESS MULTIPOINT® SCR SYSTEMS FOR MARINE APPLICATIONS



- ◆ Better than IMO 2016 Requirements
- ◆ Potential for 6-9% Saving in Fuel and CO<sub>2</sub> Emission
- ◆ Highly Corrosion Resistant
- ◆ Technology Tested by Leading Engine Manufacturers
- ◆ Unique Patent Pending Technology. PCT/DK2010/050313
- ◆ Easy and Low Cost Installation
- ◆ Low Weight and Highly Compact System
- ◆ Robust System with Low Maintenance Requirements
- ◆ Remarkable Noise Attenuation
- ◆ Chosen and Implemented by the Royal Danish Navy

# BLUNOX Digital Airless Multipoint® SCR Systems for Marine Applications outperform traditional SCR systems and have several distinct benefits.

## Benefits

### ◆ NOx-Reduction Better than IMO 2016 Requirements

The Digital Airless Multipoint (DAM) SCR System utilises high precision digital dosing of urea to achieve high NOx-reduction without ammonia slip. This guarantees NOx reduction of up to 95% and NOx emissions lower than the strict IMO 2016 requirements.

### ◆ No Extra Fuel Consumption

Unique to the DAM SCR System, it has neither the need for compressed air for urea spray nor the need for an exhaust gas mixer. These facts give a SCR system with very low counter pressure and energy usage resulting in no extra fuel consumption

### ◆ Easy and Low Cost Installation – Low Weight and Highly Compact

The DAM SCR System is designed to be low in weight and highly compact compared to traditional SCR systems. Key to achieving these goals is the use of a low weight honeycomb catalyst rather than a heavy traditional extruded catalyst. Also the system integrates silencer and catalyst so no extra space is needed compared to the existing/traditional silencer, which can be removed/eliminated. Finally, the absence of compressed air and an exhaust gas mixer naturally gives a very compact and low weight system.

### ◆ No Adverse Effects of Running without Urea Dosing

The DAM SCR System will not be damaged nor will it affect engine performance when running without dosing urea. This is important should the urea supply be exhausted or when choosing not to reduce NOx. In either case the vessel can keep operating with no adverse effects.

### ◆ Robust System with Low Maintenance Requirements

The system has been designed with robust components, many tested by leading engine manufacturers and proven to automotive standards. The airless injection nozzles are extremely robust, long-term tested and free from electronics and moving parts. Compared to traditional extruded catalyst elements, which are prone to cracking when exposed to sudden temperature changes, the DAM SCR System's honeycomb catalyst elements have a high tolerance to changes in temperature due to changes in engine load.

Maintenance intervals are longer or the same as for the engine. The catalyst elements are guaranteed for 16,000 operating hours at 100% effectiveness. After this their effectiveness will gradually be reduced by roughly 8% effectiveness for each 10,000 operating hours. Typically, a complete change out of catalyst elements is needed for every 30,000-40,000 operating hours. A complete change out of catalyst elements can be done in less than 6 hours thanks to the easy access design through the top of the catalyst housing.



Royal Danish Navy patrol vessel P522 fitted with BLUNOX DAM SCR System

### ◆ Potential for 6-9% Saving in Fuel and CO<sub>2</sub> Emission

Today's engines compromise on fuel efficiency to keep NO<sub>x</sub> emissions moderate; by tuning the engine and thereby producing more NO<sub>x</sub>, which subsequently can be removed by the DAM SCR System, the fuel savings potential can be achieved.

### ◆ Highly Corrosion Resistant

The DAM SCR System is designed to operate in the toughest marine environments and its construction in AISI 304 and AISI 316 grade stainless steel ensures high corrosion resistance.

### ◆ Broad Exhaust Temperature and Engine Load Operating Range

Thanks to the use of digital dosing, the DAM SCR System has an ultra high, dynamic response to engine load changes and the honeycomb catalyst used has a broad operating temperature range and high resistance to SO<sub>x</sub> in the exhaust gas. This ensures reliable, consistent and high NO<sub>x</sub>-reduction across a broad operating range and enables NO<sub>x</sub> reduction for applications with frequent engine load changes such as tug boats, drilling rigs etc.

### ◆ Remarkable Noise Attenuation Tailored to Your Requirements

The DAM SCR System provides remarkable noise attenuation thanks to the design of the catalyst housing and reactor. On current installations a noise attenuation of 35 dB(A) has been readily achieved through the catalyst housing and reactor alone. Taylor made modular silencing units are available to be integrated into the catalyst housing so that specific noise frequencies can be targeted and eliminated.

### ◆ Proven Technology Tested by Leading Engine Manufacturers

The SCR DAM technology was originally developed by DANSK TEKNOLOGI for truck and bus applications and has been extensively tested in cooperation with leading engine manufacturers. From 2011 the SCR DAM technology will be fitted on next generation busses and trucks from leading manufacturers.

### ◆ Chosen by the Royal Danish Navy

Following successful results with the first prototypes of the DAM SCR Systems for Marine Applications, the Royal Danish Navy has chosen to equip their entire DIANA-class of vessels with DAM SCR systems.

# The Digital Airless Multipoint® SCR System is so compact that it will fit into the space of the vessel's existing silencer.

The system's main components are:  
Stainless steel catalyst housing, modular catalyst elements, airless TwinJet urea injection nozzles, a digital dosing system and a control unit.  
An optional soot blowing system is also offered.

## DAM SCR System Overview

### 1 Digital Dosing System Ensures Precise, Dynamic Response to Engine Load Variations

Long-term stable, high precision digital dosing of urea ensures high NO<sub>x</sub>-reduction without ammonia slip and optimised urea consumption. The digital dosing system has an ultra high, dynamic response to engine load changes which enables NO<sub>x</sub> reduction for applications such as tug boats, drilling rigs etc.



### 2 Airless TwinJet Nozzles Eliminate Need for Compressed Air and Mixer

The patented multipoint airless nozzle design ensures effective NO<sub>x</sub> reduction without compressed air and exhaust gas mixer required by traditional SCR Systems. The airless nozzles are extremely robust, long-term tested and free from electronics and moving parts.



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### 3 Ultra Compact Catalyst Will Fit into Existing Silencer Space

The DAM SCR System's compact catalyst elements enables a light weight installation that does not exceed the volume of the existing silencer, which can be removed. The structure of the catalyst elements make them highly resistant to temperature changes and ensures very low counter pressure.



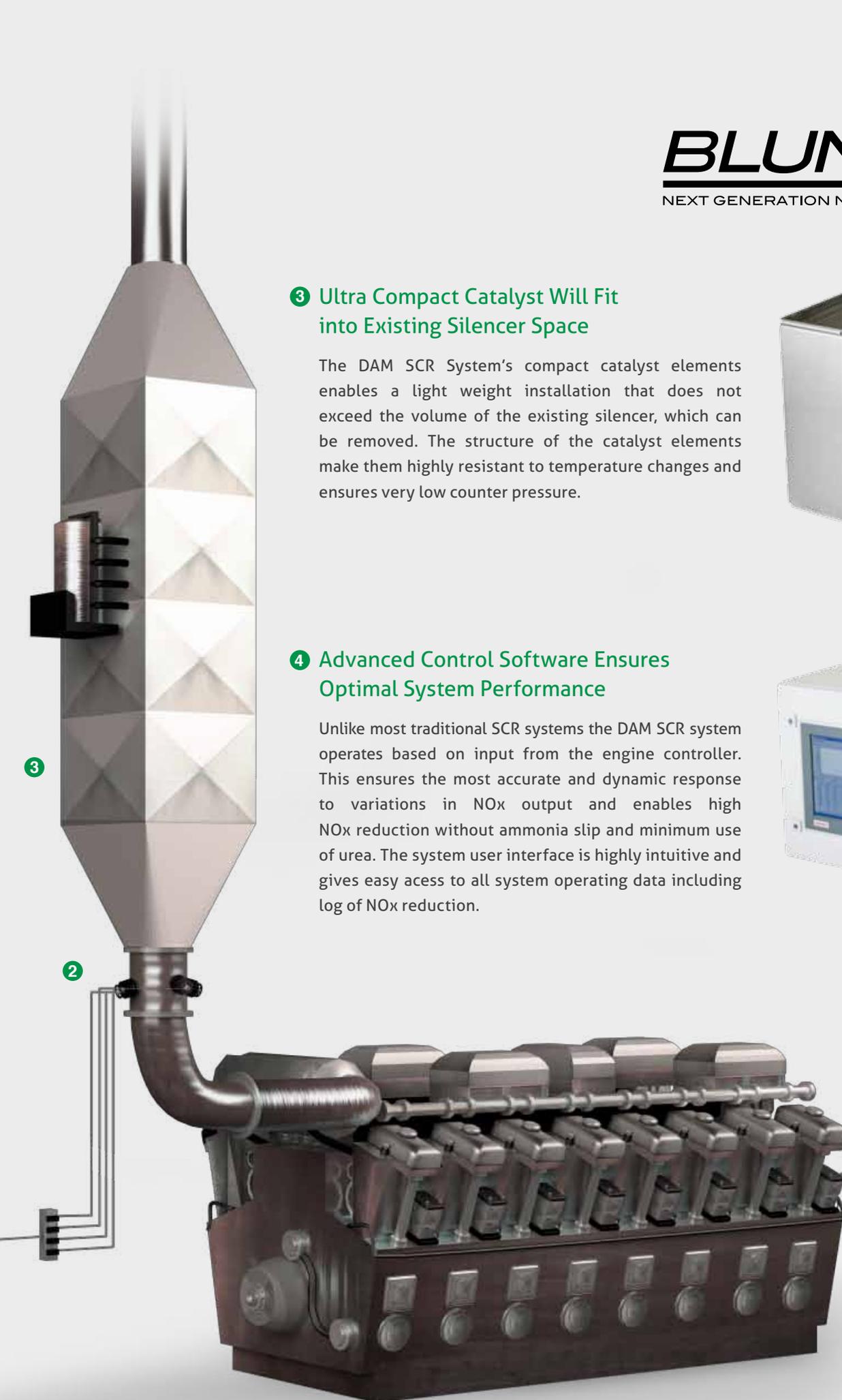
### 4 Advanced Control Software Ensures Optimal System Performance

Unlike most traditional SCR systems the DAM SCR system operates based on input from the engine controller. This ensures the most accurate and dynamic response to variations in NOx output and enables high NOx reduction without ammonia slip and minimum use of urea. The system user interface is highly intuitive and gives easy access to all system operating data including log of NOx reduction.



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# Selective Catalytic Reduction (SCR) Technology is the most effective method of eliminating NOx.

The SCR technology was substantially rationalised and improved when DANSK TEKNOLOGI developed and introduced the Digital Airless Multipoint® SCR Technology which will set the standard for next generation SCR systems.

## SCR Technology



### SCR – How it works

SCR works by injecting a cheap harmless substance, urea, into the exhaust gas and passing the mixture through a catalyst. This process transforms the toxic NOx gasses into harmless nitrogen (79% of our natural atmosphere is nitrogen). Thanks to the Airless Technology there is no need for compressed air.

### DAM SCR Process From Toxic NOx to Harmless Nitrogen

- 1 Airless injection of urea solution
- 2 Conversion of urea to ammonia,  $\text{NH}_3$
- 3 Reduction of NOx with ammonia through SCR catalyst
- 4 Output of harmless nitrogen,  $\text{N}_2$



The Digital Airless Multipoint SCR process from toxic NOx to harmless nitrogen



## Why NOx Reduction?

Sandfrakt's bulk-carrier M/V Norholm fitted with BLUNOX DAM SCR System

### NOx Causes Health Problems

NOx damages lung tissue and causes respiratory problems such as asthma, emphysema and bronchitis. NOx is a suspected carcinogenic and it is known to aggravate existing heart disease.

### Avoid NOx Taxes and Ensure Access to All Waters

NOx reduction complying with the strict IMO 2016 requirements ensures access to all waters with NOx laws in effect and avoidance of associated environmental NOx taxes/fees.

### NOx Damages our Environment

NOx is a component in ground-level ozone and smog, and it contributes to acid rain. NOx is also an indirect greenhouse gas that contributes to global warming and climate change. Furthermore it leads to oxygen depletion in bodies of water, upsets chemical balance to aquatic wildlife, and creates acidic lakes and streams.

## IMO Worldmap for ECA's (Emission Control Areas)



# Digital Airless Multipoint® SCR Systems

for Marine Applications by DANSK TEKNOLOGI

## Outstanding Innovation and Delivery Track Record

Since 1982 DANSK TEKNOLOGI has worked as a product development contractor to many of the world's leading companies such as A.P. Møller-Maersk, Airbus, Grundfos and Novo Nordisk to name a few. More than 850 projects have been successfully completed. DANSK TEKNOLOGI is also highly experienced within manufacturing and assembly of industrial products.

## Chosen by the Royal Danish Navy

The Digital Airless Multipoint® (DAM) SCR technology was originally developed by DANSK TEKNOLOGI for truck and bus applications and has been extensively tested in cooperation with leading engine manufacturers. The DAM SCR is now available for marine applications and has been chosen, field-tested and implemented by the Royal Danish Navy.

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