

# Workshop on Modernisation of Danube Vessels Fleet



Vienna 18/4/2018  
Sebastiaan Creten

**MULTRONIC**  
Emission Systems





## MAKING THE WORLD GREENER

- 35 years of experience in automotive industry
- Located in Belgium close to Brussels
- Design, manufacture and supply diesel engine emission aftertreatment systems
- Flexible approach and customized solutions,
- OEM and retrofit, in a wide range of market sectors



# Milestones



1994 Multronic expands its business on production of retrofit systems for industrial engines

1996 Delivery and installation of catalysts and closed loop systems

1999 Main focus is brought to quickly expanding diesel engines market

2001 DE-Tronic ECU system development started for in-house applications

2005 An industrialization agreement for software development and hardware production was signed with Fuel System Solutions/BRC in Cherasco, Italy

2007 OES agreement signed with Scania Benelux for all DPF SYSTEMS EURO III=> EURO V for PM

2010 Licensing agreement with TU Graz for their SCR dosing technology

2012 OEM agreement signed with ZETOR Tractors for Stage IV and TIER 4F for turn key solution

2013 OEM agreement signed with YAMZ for Euro V turn key solution

2014 OEM agreement signed with LIAZ/MAZ/URALAZ/YAMZ for EURO V turn key solution



# Milestones



2014 Agreement signed with European Commission and TNO/TUV to develop OBD MARINE standard for marine Stage V

2016 Supply to ZETOR Tractors of the Stage IV system begins

2016 Supply to LIAZ, MAZ, URALAZ, KRAZ begins

2017 KUS® exclusive distribution agreement for all of Europe and Turkey.

2017 Development agreement signed with Ashok Leyland for TIER 4F and Bharat Stage 6

2017 Development of specific urea level /temp sensor and suction system for marine applications; flow rates > 200 kg/h

2017 Development of specific multipurpose diesel level sensor and suction system for marine applications flow rates > 250 kg/h

*Multronic continuously enlarges the number of active partners and ongoing projects and looks for new business opportunities and engineering solutions.*



**Marine market**



**MULTRONIC**  
Emission Systems



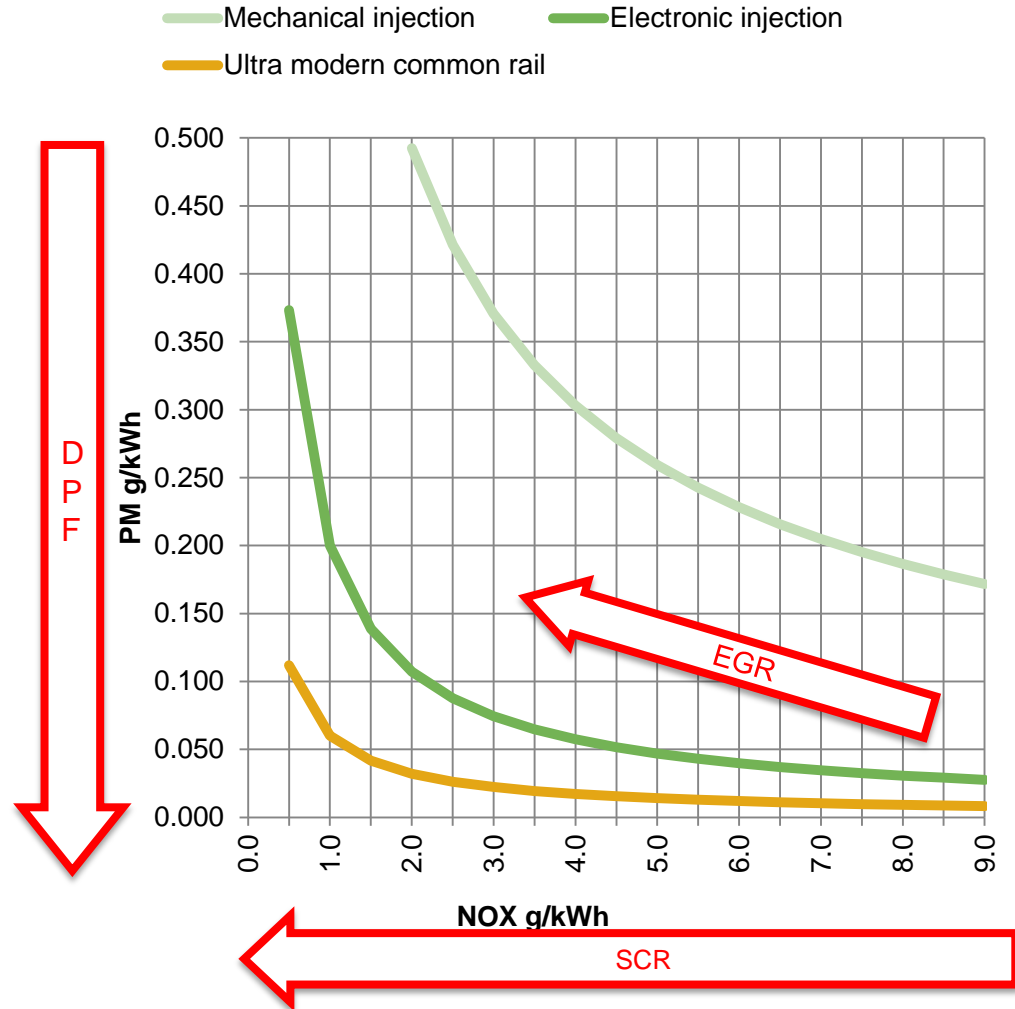
# Marine legislation



The scoped marine legislations are **MARPOL VI [TIER III]** for coasters and sea going vessels, and **Stage V** for inland shipping in Europe and **EPA TIER 4** for the inland vessels in U.S.A..

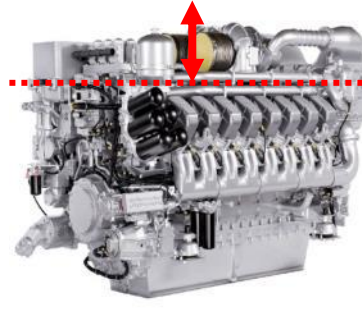
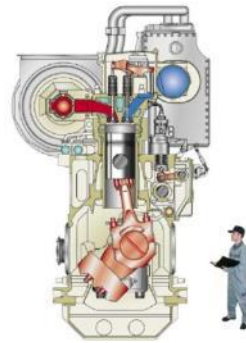
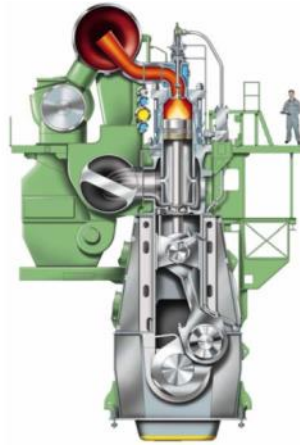
To fulfill **Stage V**,  $\text{NO}_x$  must be reduced between 80 and 95 %.

This can be achieved by the Multronic SCR and SCR + DPF systems.





# Marine Diesel engines



## Multronic scope

Name	Low speed	Medium Speed	High Speed		
Displacement (l/cyl)	200 - 2000	16-120	5 - 16	0,8 - 3	< 0,8
Power range (kW)	4000 – 100000	800 - 40000 kW	Up to 10000 kW	Up to 800 kW	Up to 300 kW
Combustion type	2-stroke & 4 stroke	2-stroke & 4 stroke	2-stroke & 4 stroke	4 stroke	4 stroke
Rotation speed (rpm)	70-300	350 - 850	600 - 2200	600 - 3000	>3000

The marine market is characterized by an enormous variety of engines and power ranges. Each type, application must fulfill different emission requirements.



# Emission systems



Inland vessels, coaster and luxury yachts	Large cargo vessels
Medium and high speed diesel engines	Low & medium speed diesel engines
4 stroke	2 and 4 stroke
Good quality fuels	Heavy fuel oil , high sulphur levels, phosphor and ash.
Good engine load profile	Good engine load profile
High efficient aftertreatment technology similar to on-road EURO VI heavy duty emission systems	Requires specific EAT solution



**MULTRONIC**  
Emission Systems



Smaller, Smarter, Sustainable





# Validation of DPF + SCR on ships

(Build in 2011 and 12000 engine hours performed on 1/7/2017)



## Barge

This is considered as a normal application

Engine: Scania V8 16 liter 450 kW



## Police Patrol ship

Considered as a worst case scenario

Engine : 2 x MTU V2000-01 600 kW



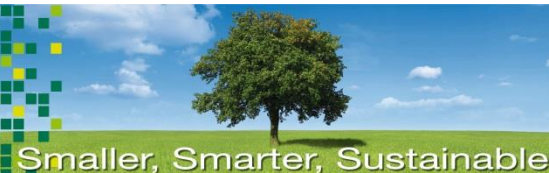
1 x Caterpillar 3516  
1590 kW  
SCR and DPF



1 x Caterpillar 3512  
1250 kW  
SCR and DPF



**MULTRONIC**  
Emission Systems

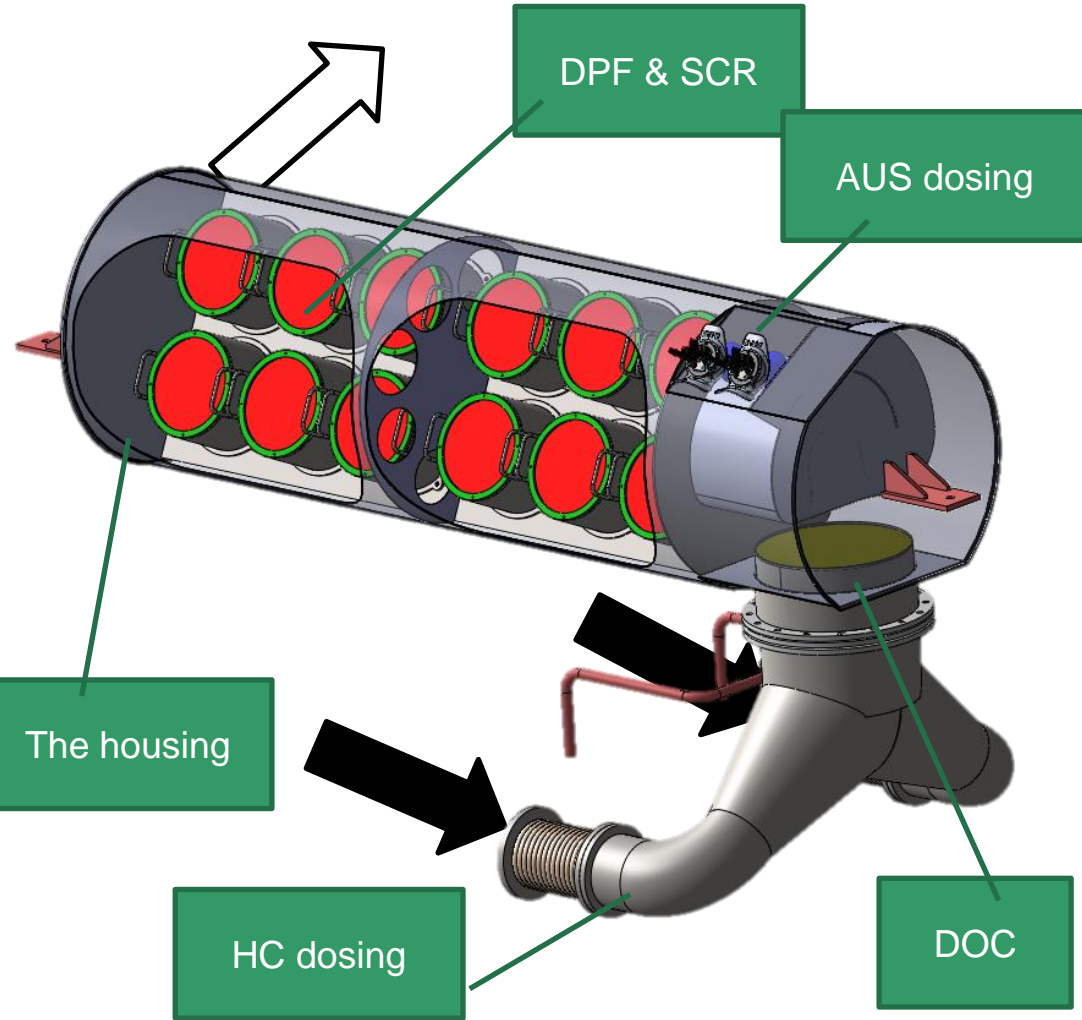
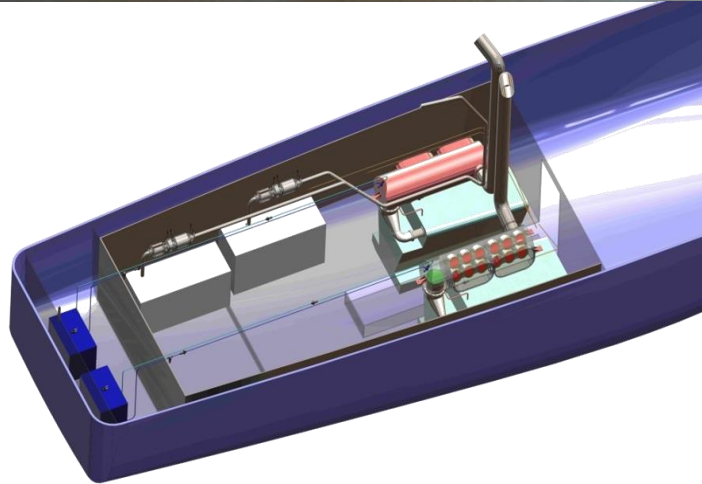


Smaller, Smarter, Sustainable

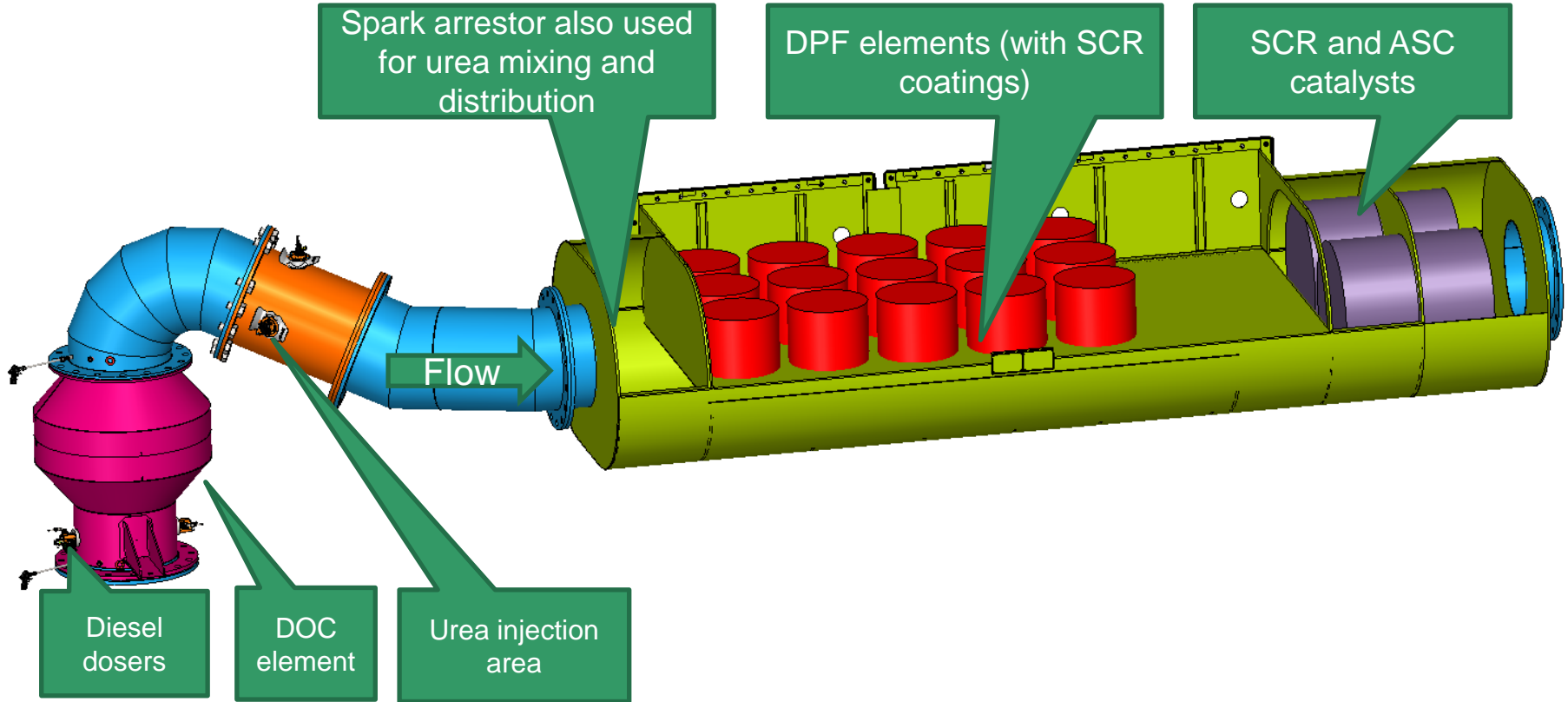




# Patrol ship: DPF & SCR



# Tanker vessel: DPF & SCR





# Tanker vessel: installation work



**MULTRONIC**  
Emission Systems



Smaller, Smarter, Sustainable

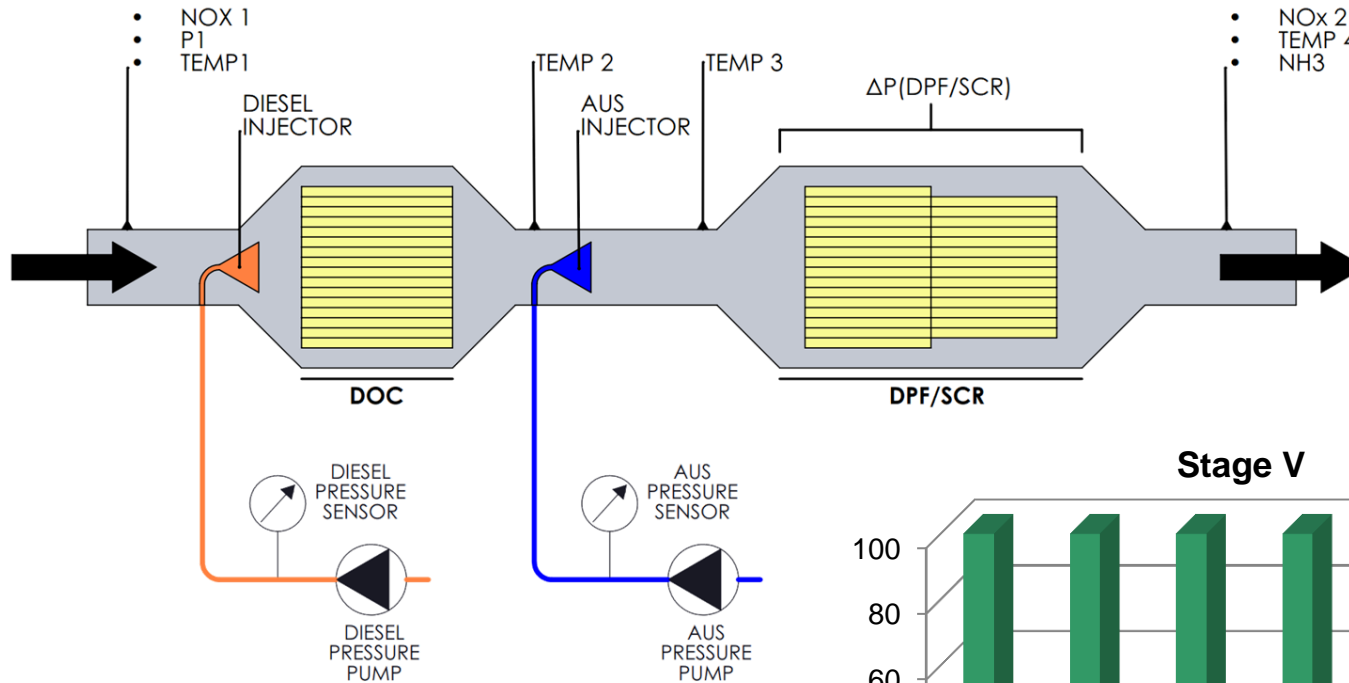




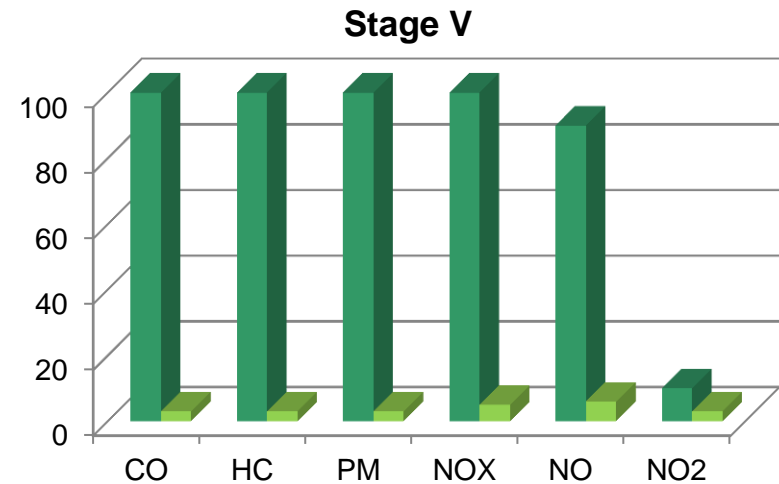
# Stage V: DPF and SCR

Developed within PROMINENT

# Modular Stage V systems



To achieve **Stage V** both NO<sub>x</sub> and PM must be reduced between 60 and 90%. This can be achieved with the Multronic modular Stage V marine packages.



# Modular Stage V systems

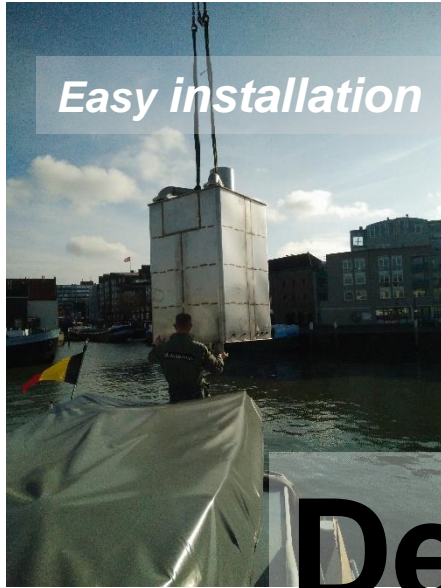


## Validation of the Multronic modular Stage V package

- Start of feasibility 01/01/2010
- First ships fitted with proof of concept 01/05/2012
- DPF modules: fitting and removal for maintenance validated
- Electronics, pumps, urea injectors, sensors fully tested
- Main validation for Stage V within PROMINENT



# Modular Stage V systems



*Easy installation*

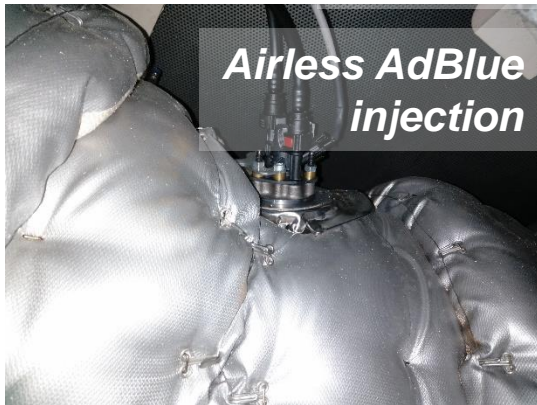


*Scalable solution for large engine range*



*Stainless steel housing*

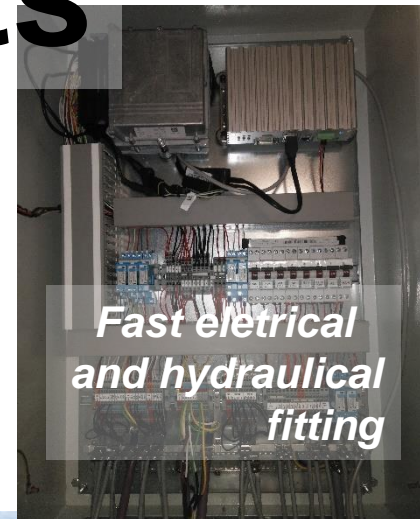
## Design targets



*Airless AdBlue injection*



*Compact setup*



*Fast electrical and hydraulic fitting*







# Industrialization of the Modular Stage V systems

## Cost improvement on catalyst substrates & DPF substrates

### Substrates

- Available in high number of diameters & lengths and materials and specifications
- Options to reduce cost here is to limit variety

### DOC

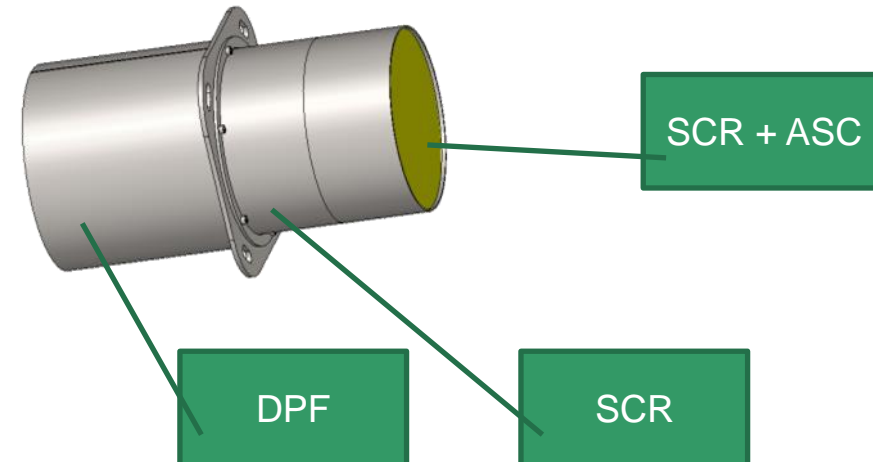
- 6 models
- 1 coating type / washcoat and PGM loading covering full range of ships

### SCR and SCR/ASC

- 1 substrate model and type package for 50 kW

### DPF substrate

- Component with the highest constraint
- Largest cost driver over life time (maintenance & service item)
- Drives design complexity (access to substrates for service)
- High volume required to improve cost
- 1 DPF element and package type for 50 kW





# Modular Stage V systems



Standard shapes / volumes and module # in function of exhaust flow rate

Standard shape

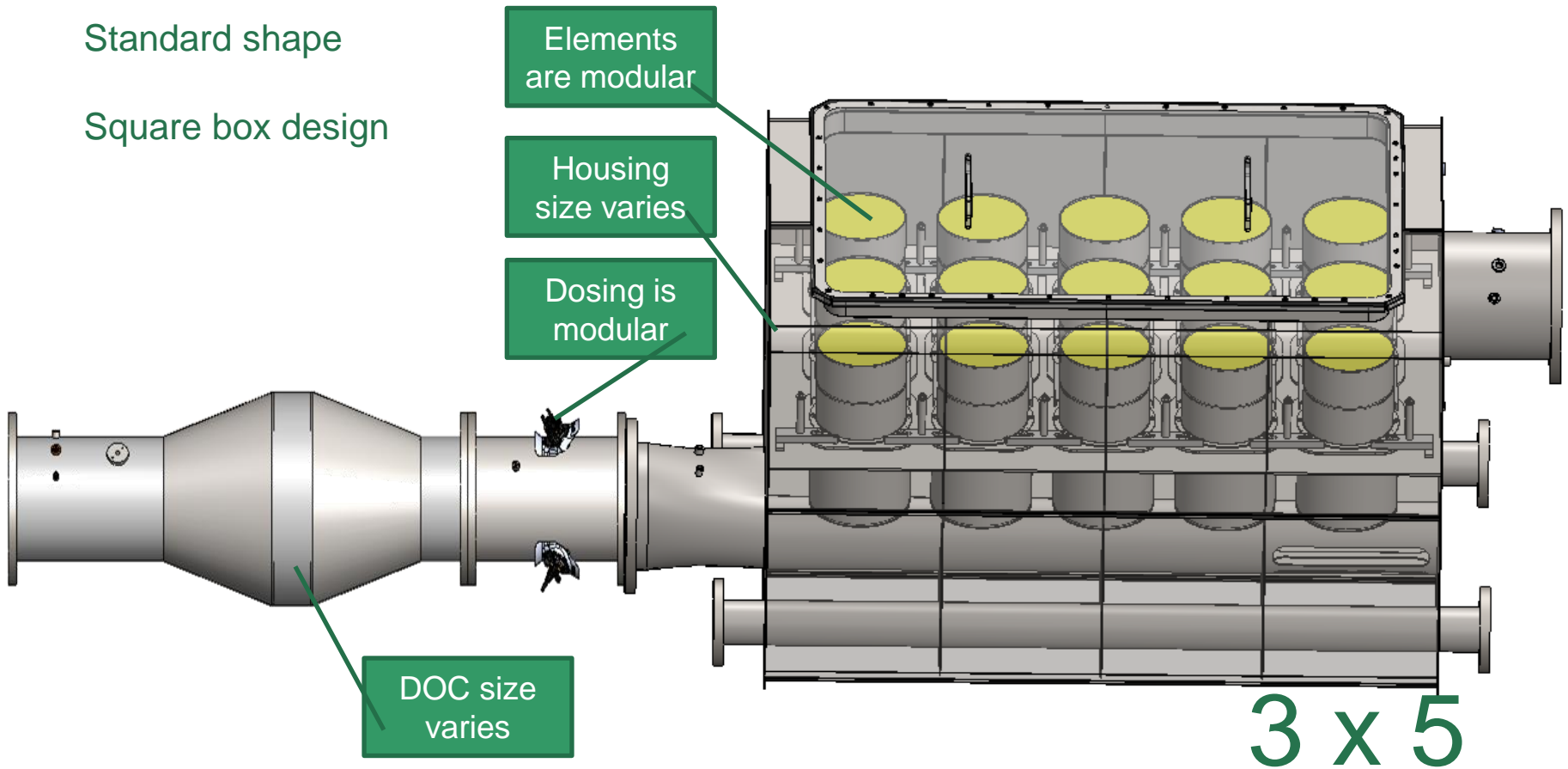
Square box design

Elements are modular

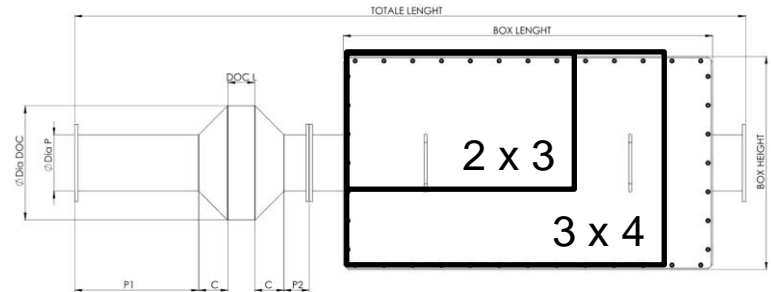
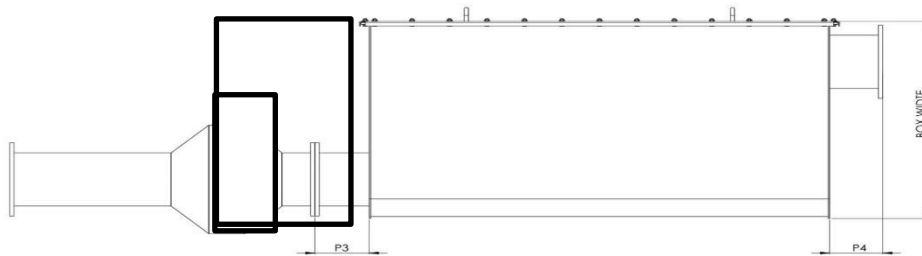
Housing size varies

Dosing is modular

DOC size varies



# Modular Stage V systems



## Stage V box design integrated mixing pipe / DOC delivered seperately with cones

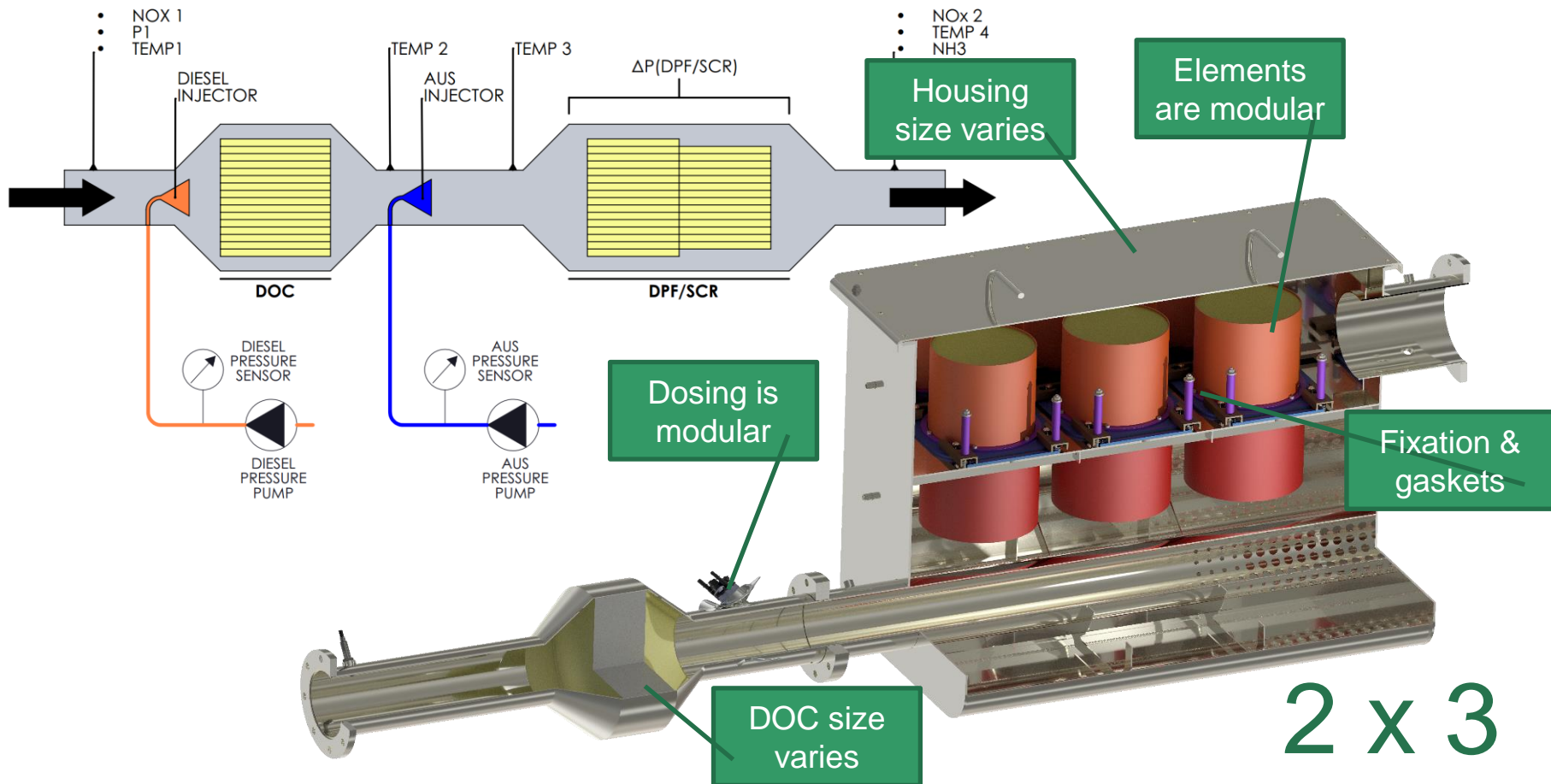
LAYOUT	DPF & SCR LAYOUT			Flange DIN 2573- PN6	DOC SECTION						DPF & SCR BOX SIZE					Sales price ex works	
	row	column	#		Dia p	Dia DOC	DOC L	P1	C	P2	T	Lenght	width	Height	P3	P4	silencer
	mm	mm	mm	mm	mantel mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		
TWIN ROW SYSTEMS	3	2	6	150	374	130	500	110	120	970	1100	900	650	300	200	€	37.800
	4	2	8	200	404	130	520	100	120	970	1410	950	650	300	200	€	48.600
	5	2	10	200	444	130	520	120	120	1010	1720	950	650	300	200	€	58.800
	6	2	12	200	494	130	550	145	120	1090	2030	950	650	300	200	€	64.150
	9	2	18	300	574	130	650	135	120	1170	3100	950	650	300	200	€	89.050



# Modular Stage V systems



Standard shapes / volumes and module # in function of exhaust flow rate



# Modular Stage V systems

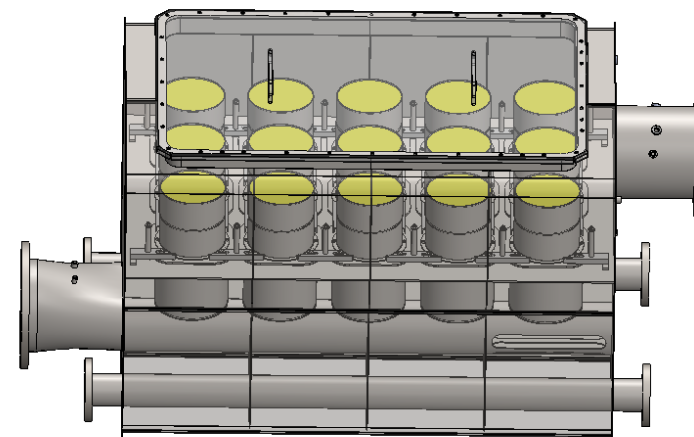
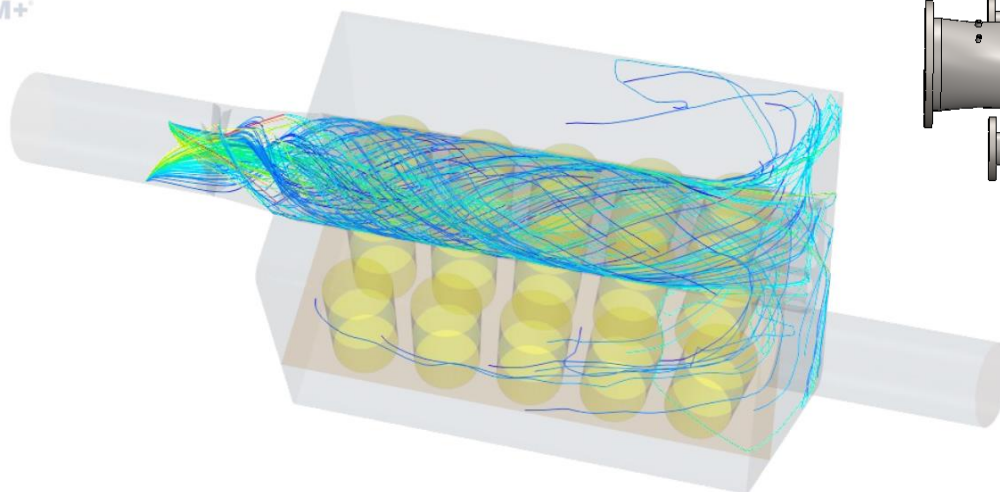


## CFD study of the different layouts

Targets:

- Standard injection configuration
- Guaranteed performance
- Back pressure estimation

STAR-CCM+



**MULTRONIC**  
Emission Systems

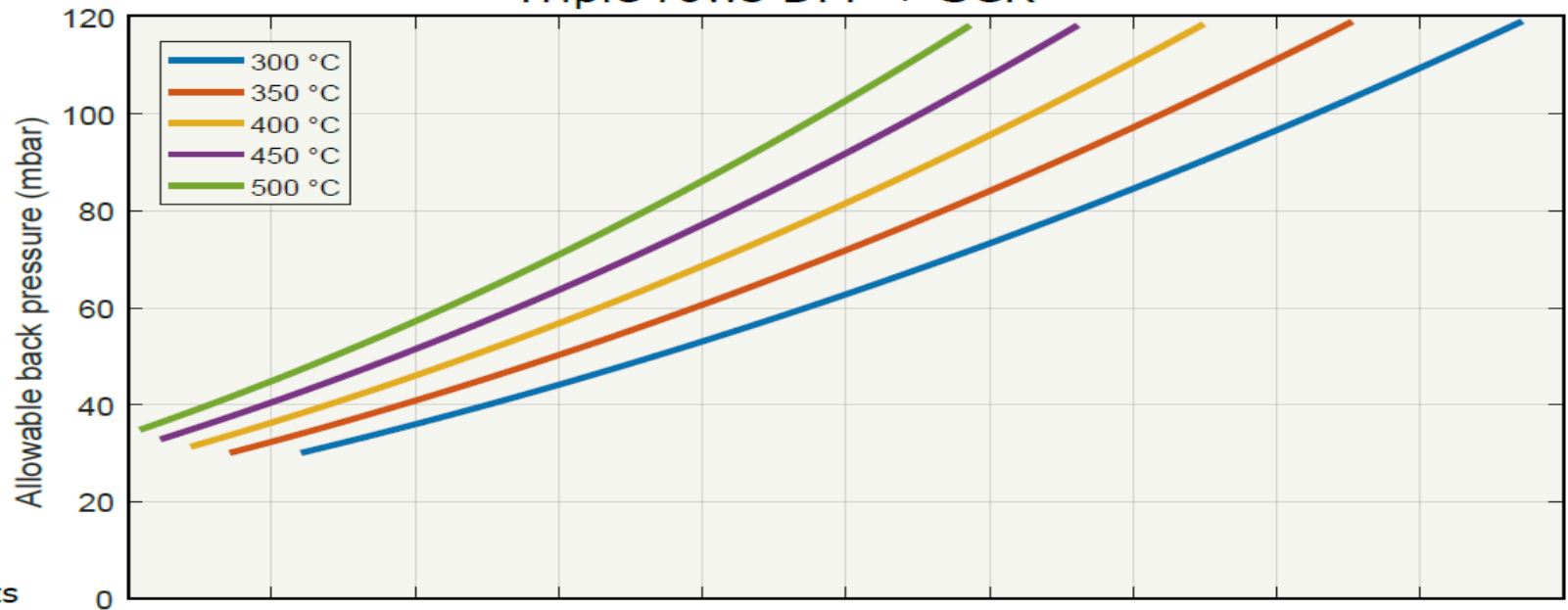


Smaller, Smarter, Sustainable

# Modular Stage V systems



Multronic EAT system sizing chart  
Triple rows DPF + SCR

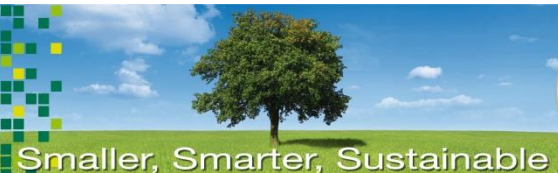


# elements

9	2250	2700	3150	3600	4050	4500	4950	5400	5850	6300	6750
12	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000
15	3750	4500	5250	6000	6750	7500	8250	9000	9750	10500	11250
18	4500	5400	6300	7200	8100	9000	9900	10800	11700	12600	13500
21	5250	6300	7350	8400	9450	10500	11550	12600	13650	14700	15750
24	6000	7200	8400	9600	10800	12000	13200	14400	15600	16800	18000
27	6750	8100	9450	10800	12150	13500	14850	16200	17550	18900	20250

MAF (kg/h)

**MULTRONIC**  
Emission Systems



Smaller, Smarter, Sustainable





# Modular Stage V systems

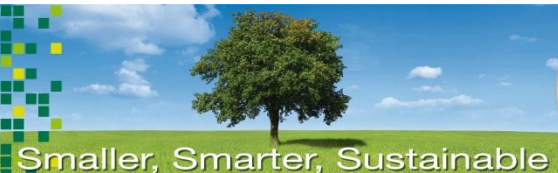


## Advantages

- Standardized modular package for marine
- Over 90% of all components are modular
- Flexible standard solutions for in and outlet position of the systems
- Compliance with marine lifetime expectations
- Long maintenance intervals
- Scope from 300 to 1600 kW
- Mass flow from 1500 up to 18000 kg/h
- Software incorporates all necessary OBD and diagnostic functions
- EPM (environmental performance monitor) integrated
- Low cost system calibration / SW package
- Ready for diesel electrical power trains & gensets



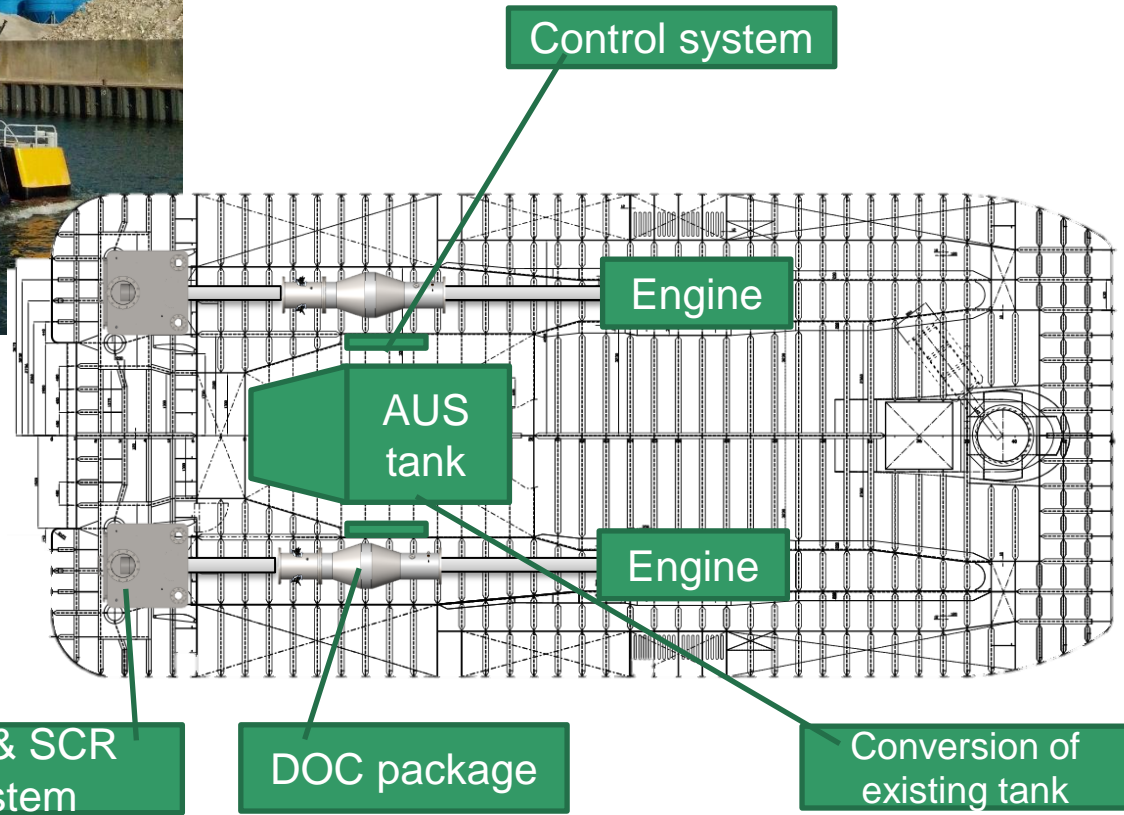
# PROMINENT Stage V field validation



# PROMINENT field validation



Motorization:  
CAT 3508  
750 kW  
CCR 2



# PROMINENT field validation



## Visual inspection of DPF performance



SCR at installation

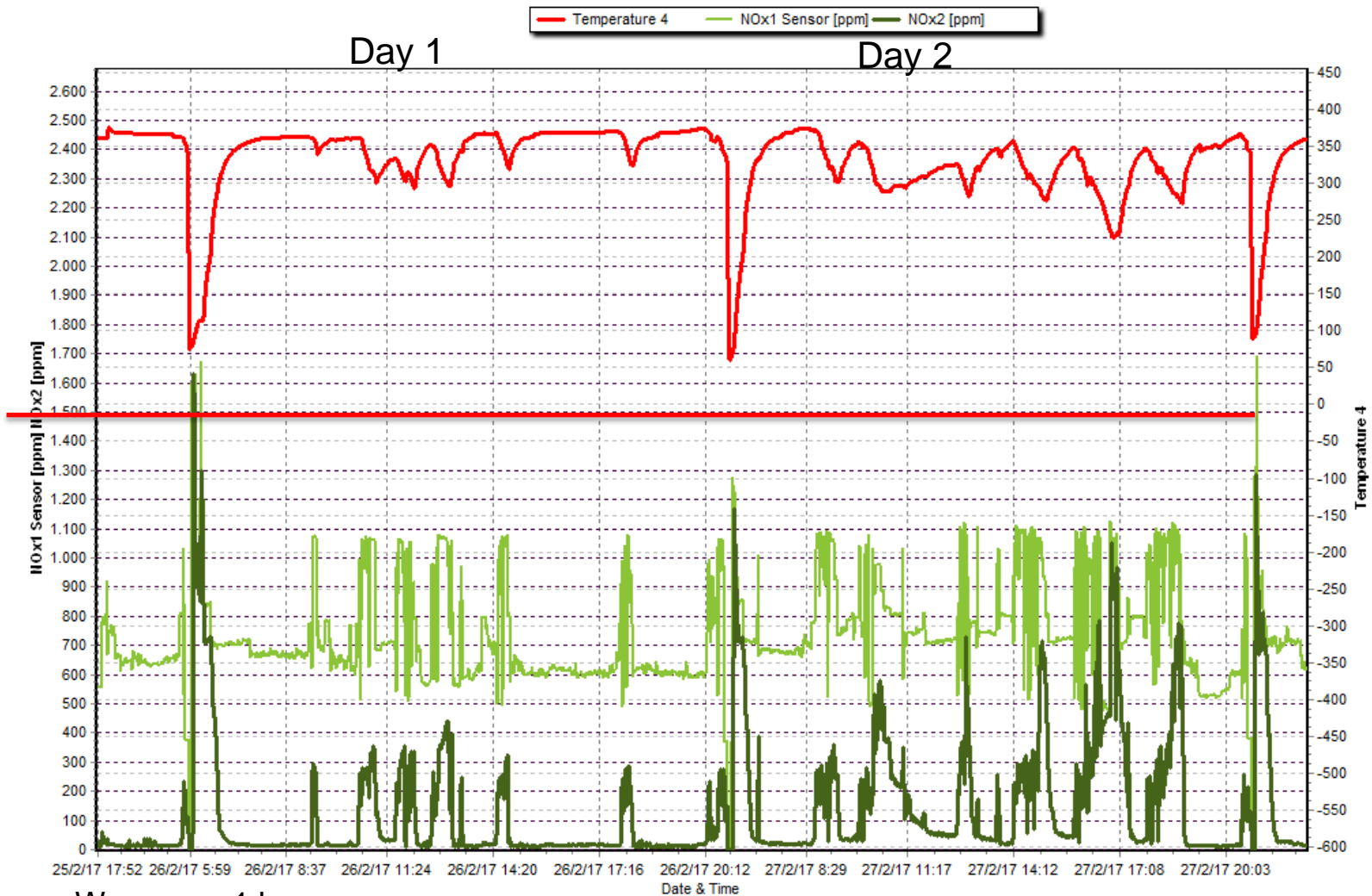


SCR after 10 months of use





# PROMINENT field validation

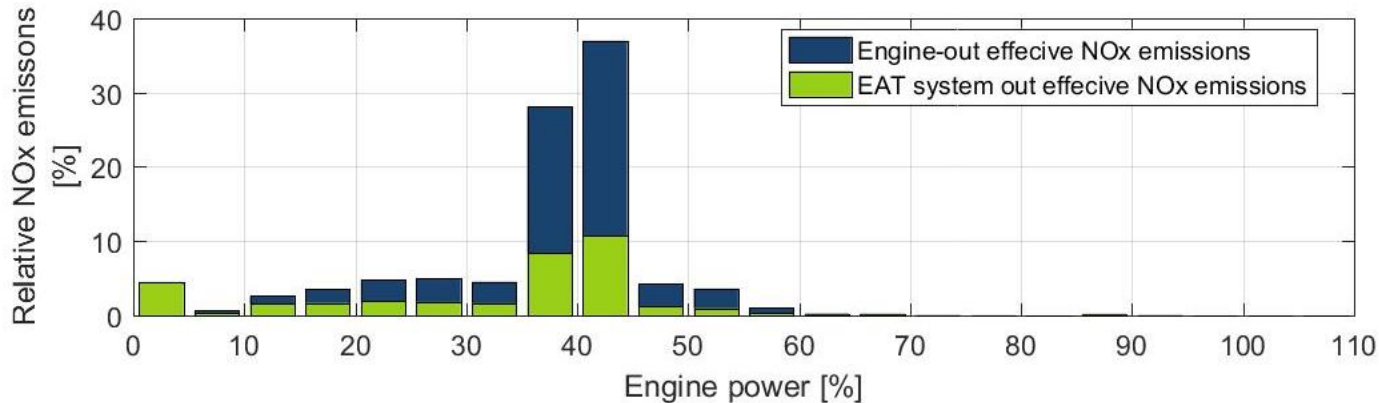
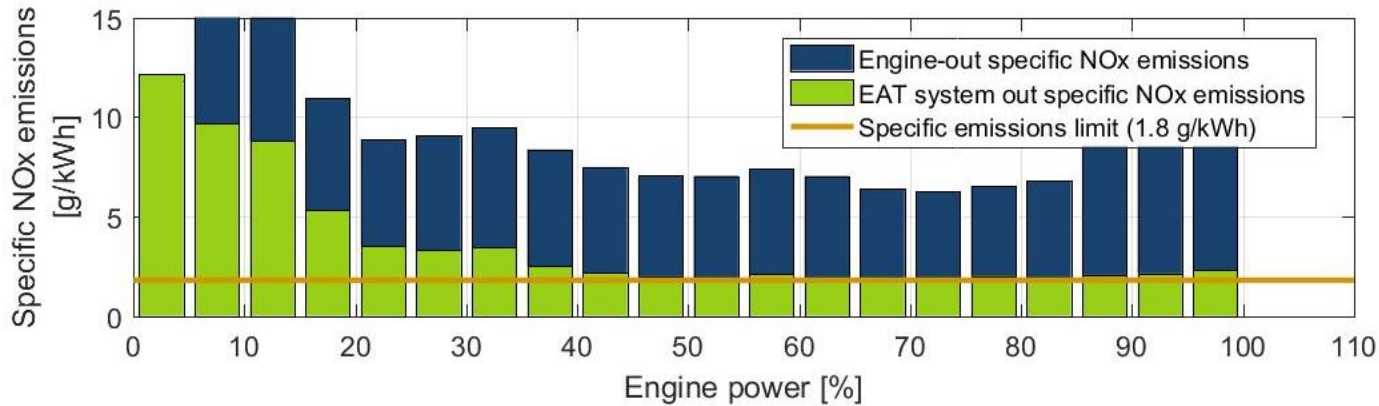


Warm up ~1 h





# PROMINENT field validation



# Costs and advantages

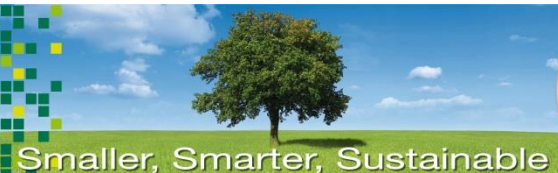


# Purchase cost



## Budget example

- Engine:
  - Caterpillar 3512
  - CCNR 2
  - 746 kW
- Setup:
  - DOC: 30 liter
  - SCR / DPF: 15 modules
- System cost:
  - 100 000 euro / system
    - 25 000 euro baseline
    - 100 euro / kW
- Installation:
  - 1 week at shipyard (for 2 systems incl. tank)
  - 20 000 euro / system (incl. tank)



# System cost



## Budget example

- Engine:
  - Caterpillar 3512
  - CCNR 2
  - 746 kW
- Purchase cost:
  - System: 100 000 euro
  - Installation: 20 000 euro
  - 1 week out of service
- Operational cost
  - 10 000 l AdBlue on 1 year (~2500 euro)
  - Maintenance: 6000 – 10000 euro



# Advantages and drawbacks



## Advantages

- Retrofit solution which guaranty to comply to Stage V
  - Emission reductions >90%
  - Mature technique
- Durability and performance of the DPF+SCR system demonstrated on large scale on HD road applications (EURO VI, China VI, BSIV, US 2010 Stage IV and Stage V)
- Limited volume and modifications to ship required
  - Volume of the existing muffler is normally sufficient
  - Possibility to adapt the geometry to the actual situation
  - AdBlue tank volume is limited
- Free choice of engine
- No requirement for new distribution network
  - AdBlue is available on bunker ships
- Commercial value of a green ship
- Several ports give reductions to green ships





# Advantages and drawbacks



## Advantages

- Guaranty to comply to Stage V
- Limited vessel adaptation required
- Mature technology: durability and performance demonstrated on large scale on HD road applications
- Free choice of engine
- Available distribution network

## Drawbacks

- Operational costs
- Small numbers still result in high installation and system cost compared to HD road applications
- CO2 emissions are not affected
  - Fuel consumption can be tuned in parallel



# Contact details



Please come and visit our stand on the

**MARITIME INDUSTRY EXHIBITION,**

**EVENEMENTENHAL, GORINCHEM,**

**THE NETHERLANDS**

**29-31 MAY, 2018**

**HALL 2 STAND L122**

Or visit our website:

[www.multronic.be](http://www.multronic.be)

**Leeuwerikweg 8**

**3300 Tienen**

**Belgium**

**Tel: + 32 (0)16 78 19 00**

**Info@multronic.be**

**MULTRONIC**  
Emission Systems

