Voith Turbo SteamTrac Marine

- Company information
- SteamTrac

Voith Group

One of the large family-owned companies in Europe:

- 43,000 employees
- 290 locations
- Euro 5,1 billion in sales

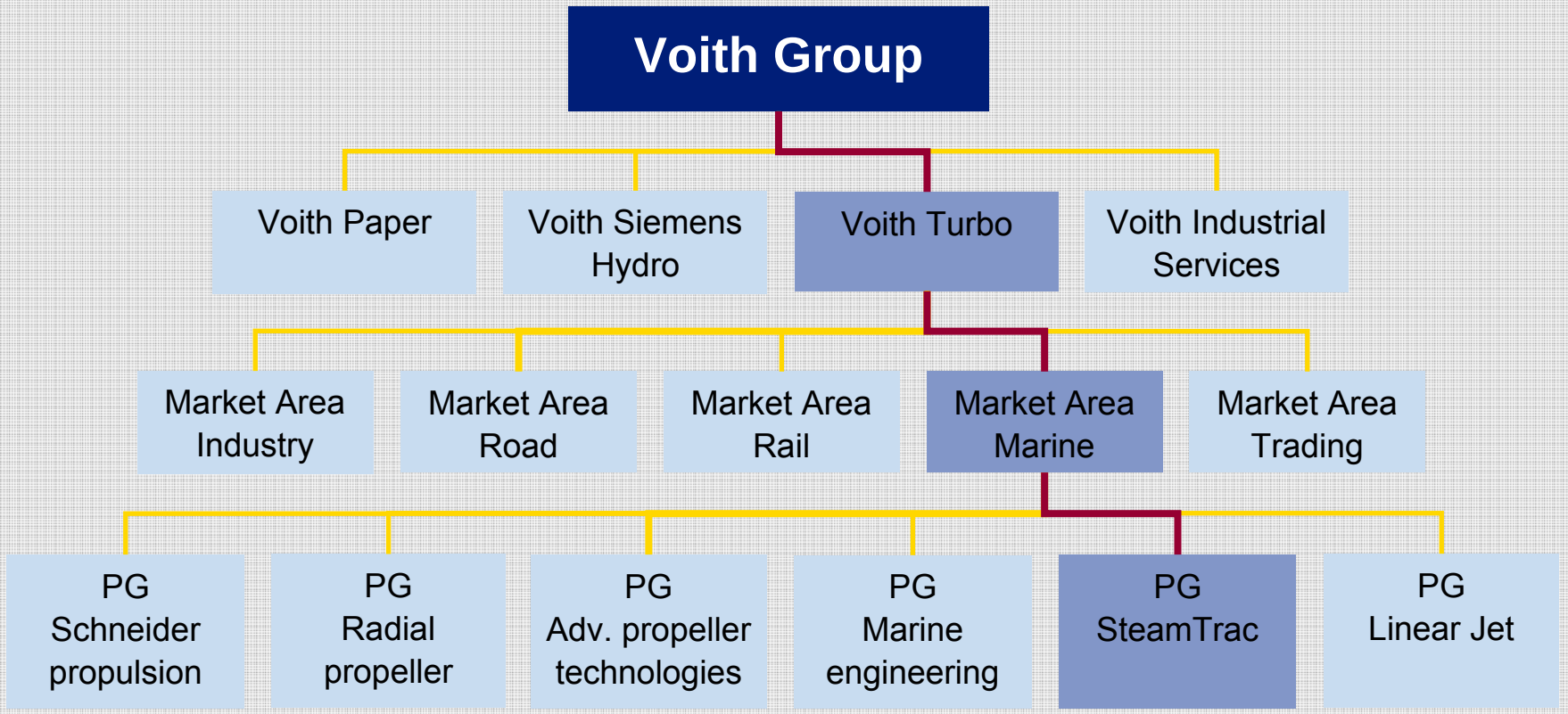
Voith Turbo SteamTrac Marine

Voith Turbo SteamTrac Marine is the company (product group) within the Voith Turbo Marine Division worldwide responsible for the product Voith SteamTrac.

Twello, Netherlands

SteamTrac

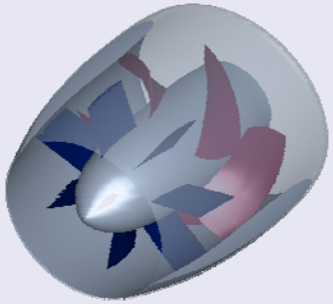
Position in the Voith Group



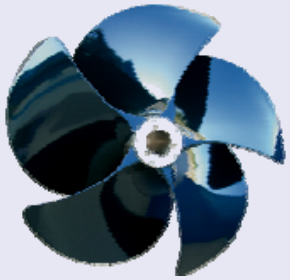
Voith Turbo Marine product range

Voith Schneider Propeller

Voith Turbo Fin

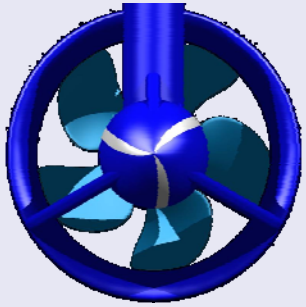


Voith Linear Jet



Voith Contur Propeller

Voith Vector Propeller



Voith Radial Propeller

Voith Inline Thruster

Voith Water Tractor

Voith SteamTrac

Market areas for SteamTrac

Voith SteamTrac Marine

- Waste heat recovery system for combustion engines in marine applications

Further application areas:

- Road
- Rail
- Industry

Marine applications for Voith SteamTrac

Tug boat

Ferries

Navy / Marine

Passenger ships

Special vessels

Offshore supply vessels

Yacht

Inland ships

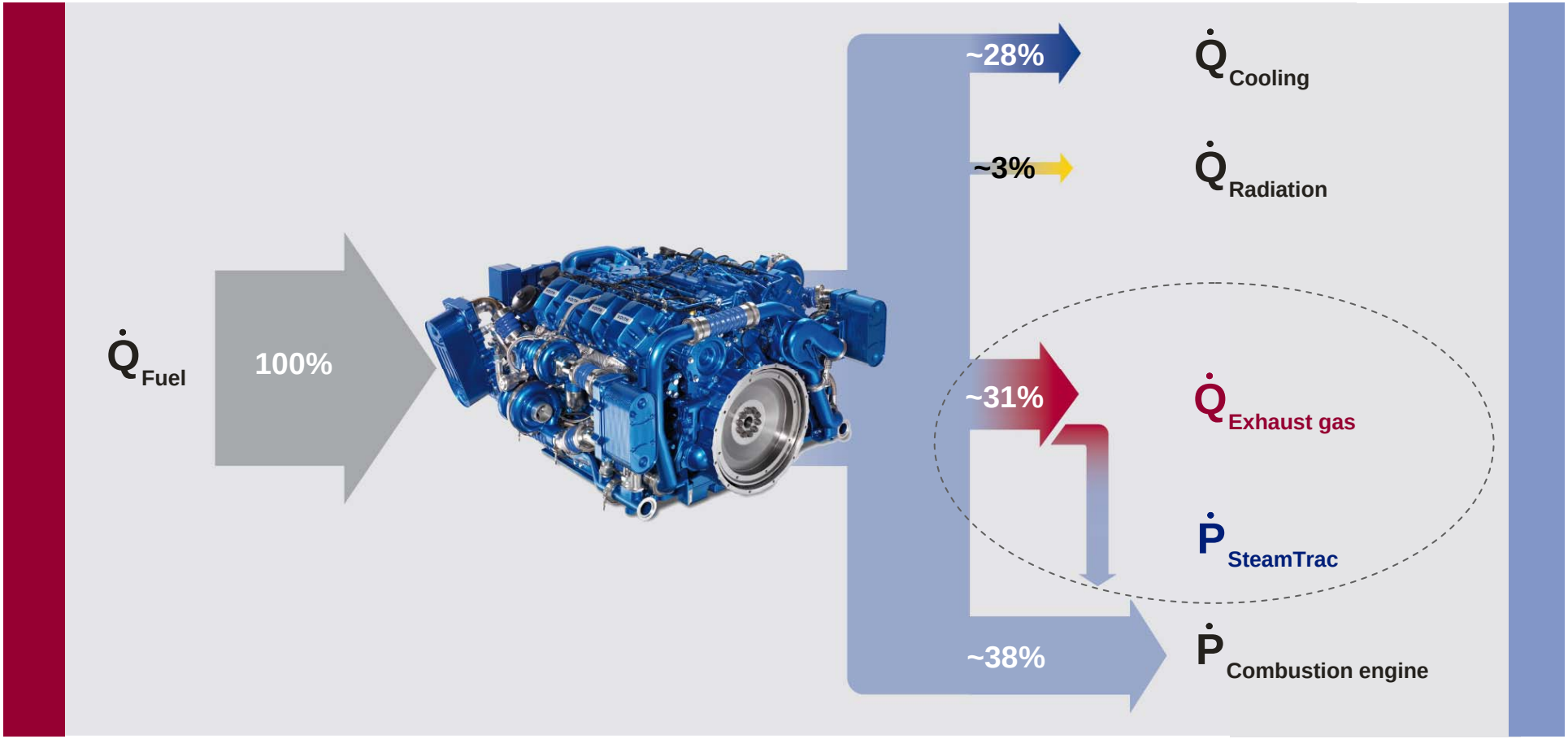
Drilling platforms

FPSO

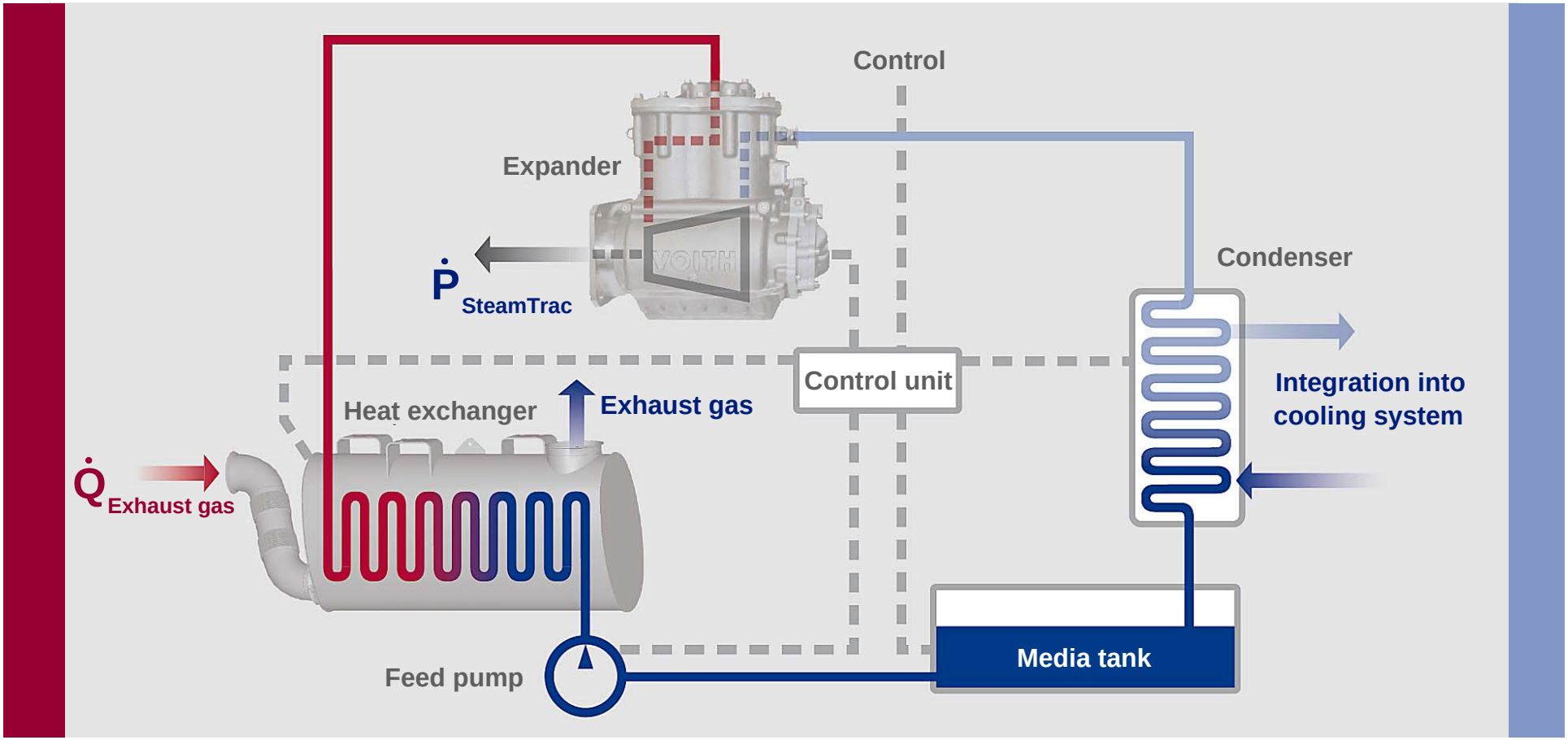
Cruise ships

Drilling vessels

SteamTrac - Balance of a combustion engine

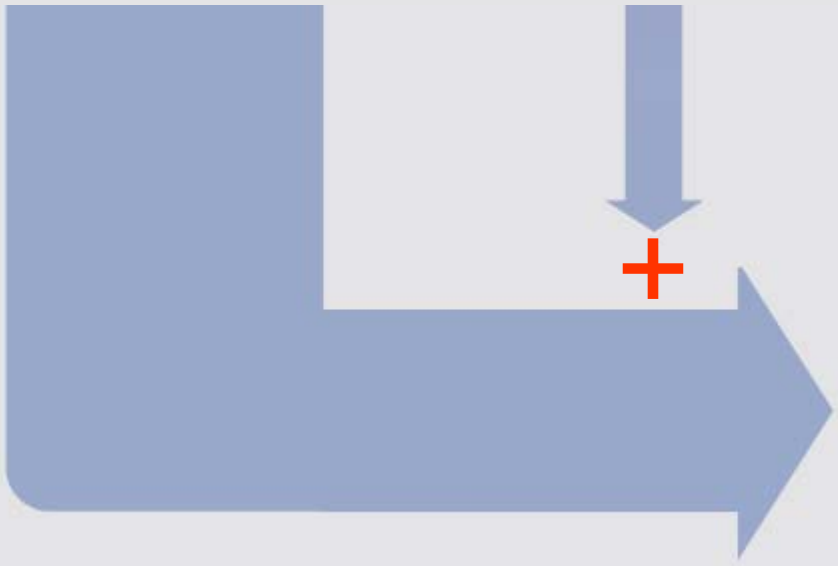


SteamTrac - Working principle



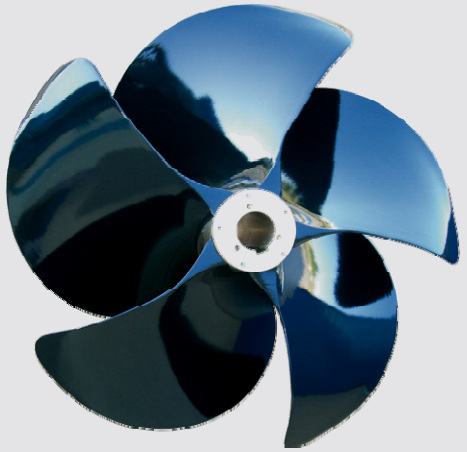
SteamTrac - Working principle

$\dot{P}_{Combustion\ engine}$ + $\dot{P}_{SteamTrac}$



$\dot{P}_{Combustion\ engine}$

- Main propulsion engine
- Auxiliary engines
- PTI Gearbox



SteamTrac - Benefits

- Expected reduction of fuel by SteamTrac up to 12%
- Optimization of working point combustion engine, generating additional fuel savings

Reduction of Fuel

- Reduction Carbon dioxide (CO2)
- Nitrogen oxides (NOx)
- Sulphur oxides (SOx)
- Particulate Matter (PM)
- Hydrocarbons (HC)

Reduction of Emissions

- LCC Combustion engine
- Downsizing combustion engine

Reduction of other Cost

Voith SteamTrac - fuel & emissions saving example

Basic calculation information

Fuel type	ISO-DMX
Bunker fuel price	650,00 Euro per metric ton
Reference:	Bunker world Prices - Latest Prices
Time vessel operational	3.500 hours per year
Engine type	Cummins QSK60M
Applied SteamTrac model	R6/3000

Voith SteamTrac - fuel & emissions saving example

Operation profile

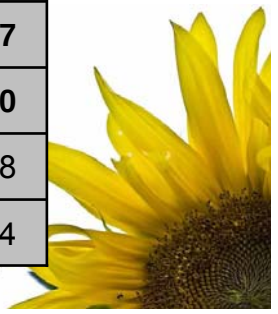
	y % MCR	10,0%	25,0%	50,0%	75,0%	85,0%	100,0%
	(x % of T)						
Power set point 1	10,0%	1,0%					
Power set point 2	10,0%					8,5%	
Power set point 3	30,0%						30,0%
Power set point 4	50,0%			25,0%			
Σ(X % of T)	100,0%						
*Σ (X% of T) *(y % MCR)*		1,0%	0,0%	25,0%	0,0%	8,5%	30,0%
Average MCR power set point in 100 % T					**64,50%**		
(MCR=Maximum Continuous Rating)							

Voith SteamTrac - fuel & emissions saving example

Engine type	Cummins QSK60M	
Engine information	**Unit**	**Amount**
MCR	kW	1.491
rated speed	rev/min	1800
φ exhaust gas	l/sec	5474
Exhaust gas temp (turbine out)	deg C	373
Fuel consumption@rated speed	l/hr	376,9
Spec fuel gravity	gr/liter	0,8389
Spec fuel consumption	gr/kWh	212,1
NOx (Oxide of Nitrogen) emission (ISO 8178 E3 test cycle)	gr/kWh	6,25
PM (Particulate Matter) emission (ISO 8178 E3 test cycle	gr/kWh	0,08
Annual fuel cost per engine	**Euro**	**463.957**

Voith SteamTrac - fuel & emissions saving example

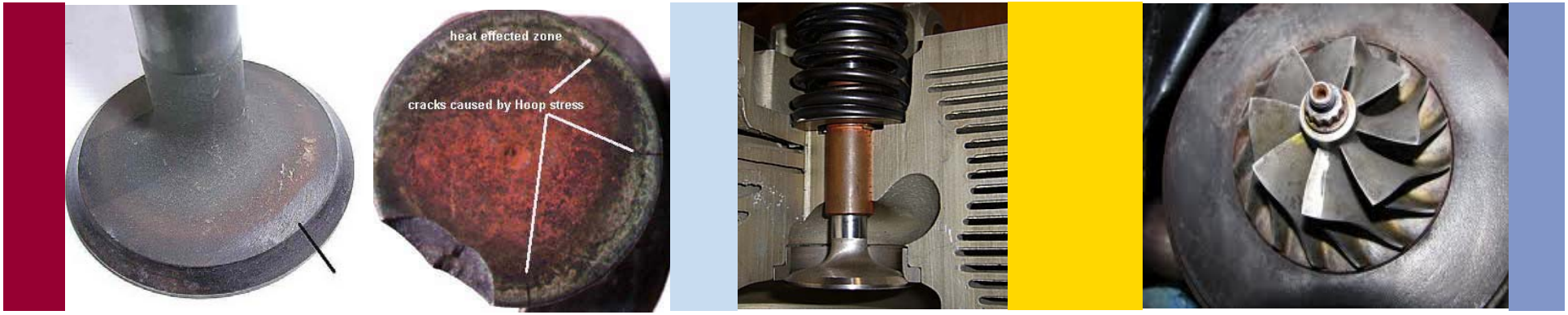
Engine type	Cummins QSK60M	
Applied Voith SteamTrac model	R6/3000	
	Unit	Amount
Annual generated energy engine @ flywheel	MWh	3.366
Annual CO2 emission engine	kg/year	2.246.249
Annual NOx emission engine	kg/year	21.037
Annual PM (Particulate Matter) emission engine	kg/year	269,3
Effective energy feedback@flywheel SteamTrac Expander	kWh	269.275
Annual fuel savings by Voith SteamTrac	€/year	**37.117**
Annual savings CO2 emission	kg/year	**179.700**
Annual savings NOx emission	kg/year	168
Annual savings PM (Particulate Matter) emission engine	kg/year	21,54



Voith SteamTrac - additional savings / benefits

- Due to lower average engine load:
  - reduced brake mean effective pressure – increased bearing life
  - lower combustion chamber temperature (thermal load) - increased exhaust valve/piston/turbo life

→ the combustion engine repair cost will improve !



Voith SteamTrac - additional savings / benefits

- Engine working point optimization:
  - Cummins QSK 60@ 1800 rpm → engine load from 100 % to 80%

→ Specific fuel consumption improves with ~ 3 % !

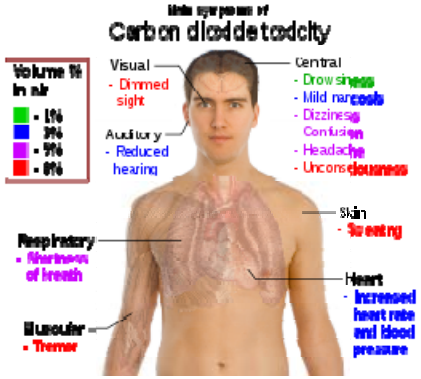
OUTPUT POWER			FUEL CONSUMPTION			
%	kWm	BHP	Kg/ kW-h	Lb/ BHP–h	Liter/ hour	U.S. Gal/ hour
100%	1900	2547	0.215	0.353	486.3	128.5
75%	1425	1910	0.209	0.344	355.1	93.8
50%	950	1273	0.217	0.357	246.1	65.0
25%	475	637	0.261	0.430	148.0	39.1
10%	190	255	0.380	0.626	86.2	22.8
CONTINUOUS POWER						
80%	1520	2038	0.211	0.348	383.4	101.3

SteamTrac - additional savings / benefits

- Engine exhaust emissions reduction **improves** :
  - Carbon dioxide CO_2 → favourable environmental tax regime

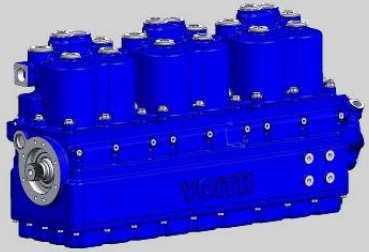
→ less toxicity

→ climate change



  - Sulfur dioxide and nitrogen oxides → acid rain
  - Particulate matter (PM) → asthma, lung cancer, cardiovascular issues

Voith SteamTrac - Expander portfolio

				
Type	**R2/800**	**R4/2000**	**R6/3000**	**R4/8000**
Cylinders	2	4	6	4
Volume	800 ccm	2000 ccm	3000 ccm	8000 ccm
Power output	40 kW	95 kW	145 kW	360 kW
RPM-Range	600 – 3500	600 – 2300	600 – 2300	300 - 1900
Max. Pressure	60 bar	60 bar	60 bar	60 bar
Max. Temp.	400 °C	400 °C	400 °C	380 °C
Suitable for engine	300 – 500 kW	400 – 1200 kW	800 – 2000 kW	1800 – 3600 kW

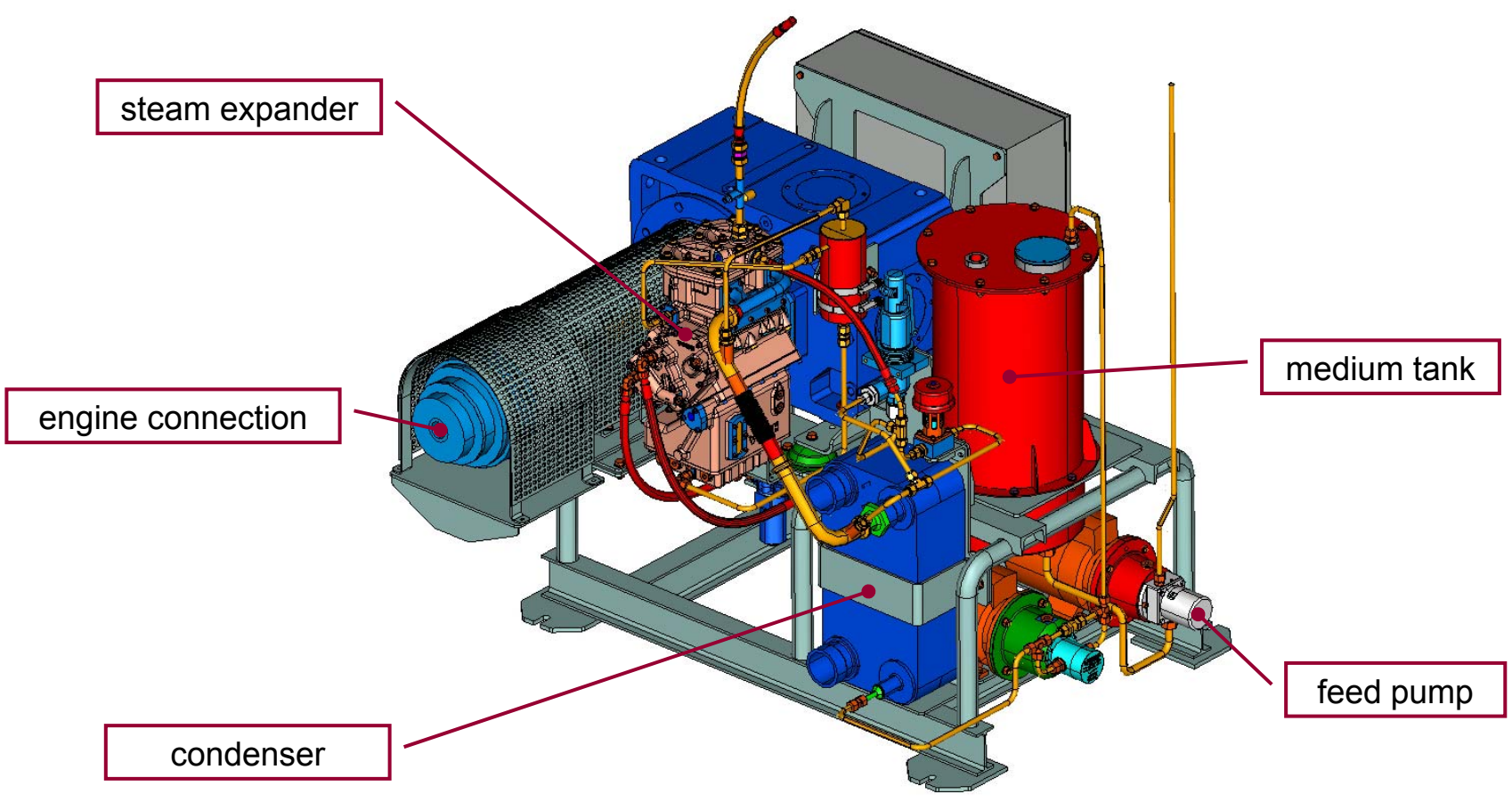
SteamTrac - Project ThyssenKrupp Veerhaven X

Testing SteamTrac on inland ship for 6 months.

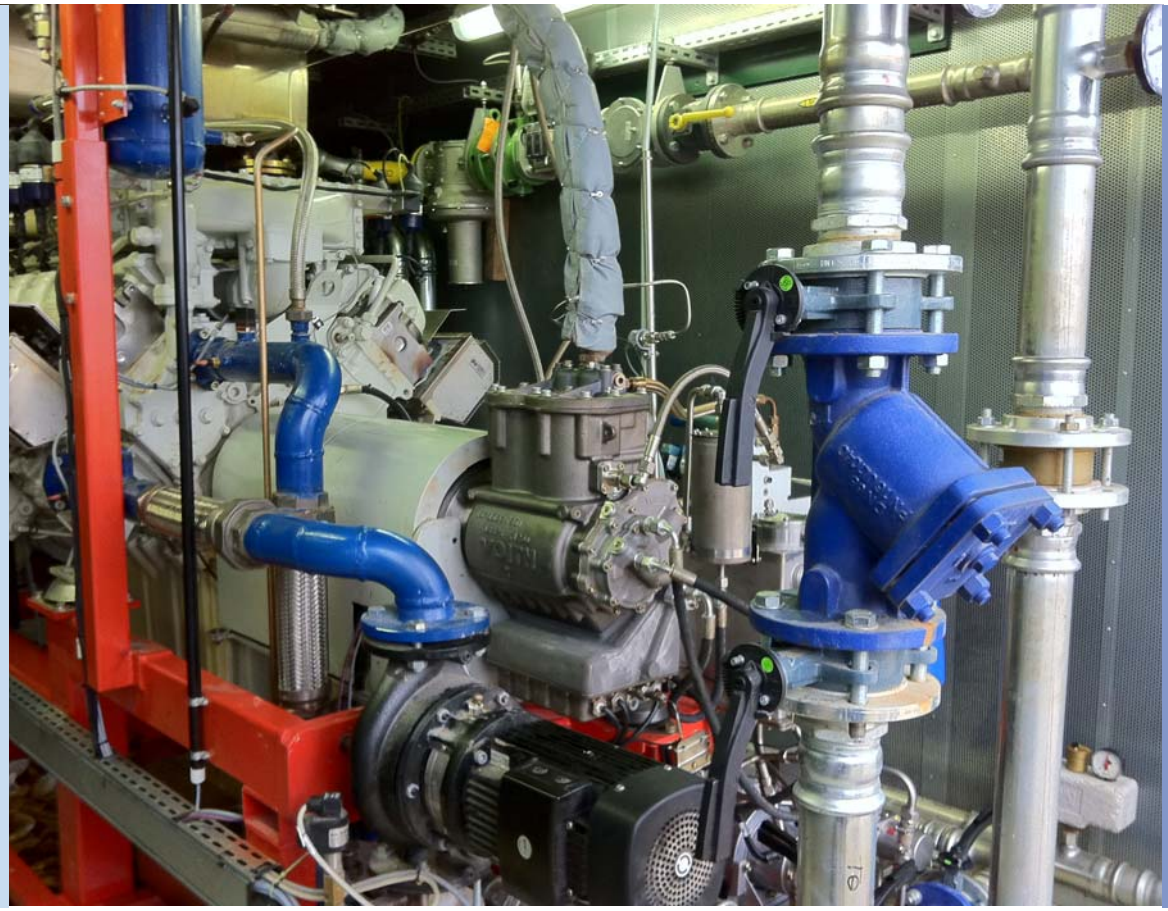
- SteamTrac system R2/800
- Testing period from April 2011 till October 2011

Voith SteamTrac - Project ThyssenKrupp Veerhaven X

SteamTrac - Project ThyssenKrupp Veerhaven X



SteamTrac – Test facility




VOITH
Engineered reliability.