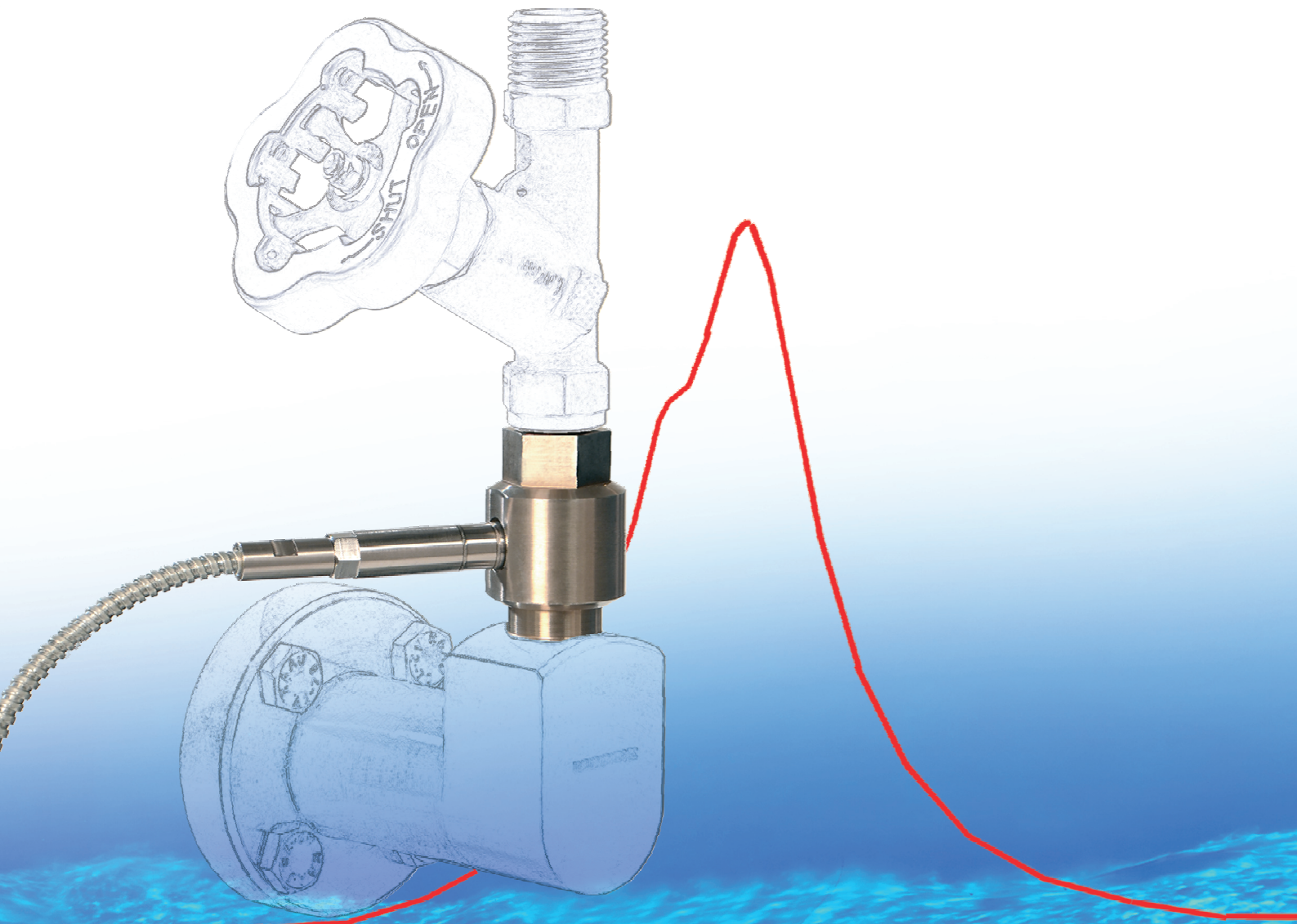




the cylinder pressure people

## CCM Marine

Optimise your engine performance



[www.imes.de](http://www.imes.de)

# CCM Marine - Combustion Monitoring Systems

CCM is an easy to use plug and play system, which enables in real time data acquisition of cylinder pressure on engines. Data can be recorded from up to 20 cylinders for closed loop control applications and to diagnose malfunctions or to assist in the setting and optimising of engine parameters e.g. balancing cylinders.

CCM Marine is a modern system for advanced engine balancing on 2- and 4-stroke marine diesel engines. At the centre of the efforts is cylinder balancing – the equalisation of output across all cylinders. Well balanced engines minimise fuel consumption between 2% and 3%. The smoother engine running will decrease wear and tear in the engine.

As an additional benefit, emissions of the greenhouse gas carbon dioxide can be reduced by some 2% which is of high importance in times where environmental regulations are becoming increasingly stringent (e.g. IMO TIER III limitations in Emission Control Areas).

We offer fixed and portable CCM systems for diesel and gas engines.



## Combustion control Module CCM

The main component of our CCM systems is the combustion control module. It is a smart combustion signal processing device for marine engines and stationary gas engines. Its function is to acquire and process in real time data from cylinder pressure sensors. Every combustion cycle will be evaluated on every cylinder for to calculate key parameters engine builders need to implement cylinder pressure based control on engines.

CCM is designed as a plug and play module, that means CCM communicates via CAN bus with the engine control system and it can be integrated to the engine management system. A further important function is that all data can be transmitted via internet to the server of the engine operator. This enables to control the engine from land.



CCM combustion control module- the heart of our CCM systems

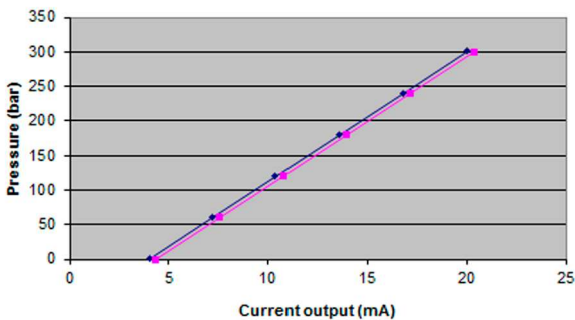


## for continuous and periodic operation

### High precision cylinder pressure sensors

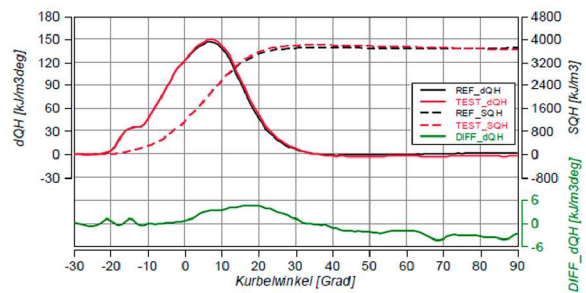
Our various types of cylinder pressure sensors are suitable for installation on 2- and 4-stroke engines and mesh with our CCM systems. Depending on engine type we offer sensors with various thread (M8 x 0,75, M10 x 1, M14 x 1,25), various sleeve and cable length and different measuring cells.

They all convince with their long term accuracy with minimal signal drift over long periods. Designed for a minimum of 16,000 operating hours they enable the acquisition of highly accurate processable data during periodic checks and during continuous monitoring of combustion pressure.



— IMES HTT-04 sensor 2008 — IMES HTT-04 sensor 2012

Long-term stability of IMES sensor HTT-04. Evaluation after more than 10,000 operating hours.



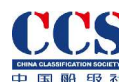
Thermodynamic comparison of IMES sensor CPS-01 to watercooled piezo electric sensor.

### Marine Type Approvals

Large engine manufacturers are required to fulfil numerous international safety standards. Marine Type Approval is therefore a mandatory requirement for voyage and safety critical devices installed on any ship.

Our sensor types have received Marine Type Approval from all significant international classification societies, such as Bureau Veritas, DNV GL, ABS, Lloyd's Register, Class NK or China Classification Society.

For our combustion control module CCM, Marine Type Approval from Bureau Veritas and Class Nk are in preparation. Other approvals will follow shortly.



# CCM Marine Performance

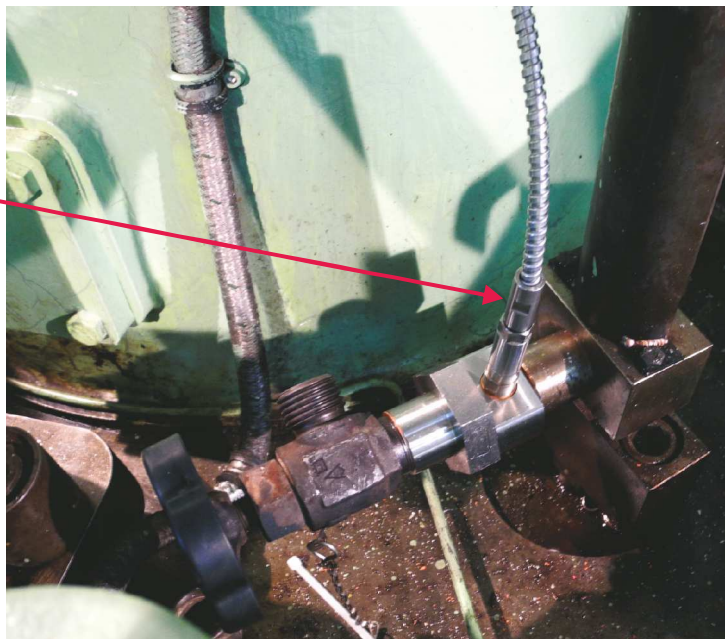
CCM Marine Performance designed for fixed and continuous operation is a system which includes a high speed data acquisition unit (CCM) for up to 12 cylinders, permanently installed cylinder pressure sensors and an advanced visualisation- and performance software .

The combustion pressure is measured on each cylinder continuously and in all speed ranges. It is easy to use as an online solution for condition and performance monitoring.

The data can be transmitted for evaluation directly via LAN / Ethernet to a PC where the CCM software is installed. The software allows an easy collection, management and comparison of engine performance data. This enables a quick overview about engine condition for an optimal engine performance. It is also possible to transmit the data via satellite to the server of the engine operator. This allows engine control from land and the active regulation of emission as well as cost optimisation.



CCM Marine performance installed on container ship Hedda Schulte



Installation of two-stroke combustion sensor TCS-01CA including adaptor on a Wärtsilä 6 RTFlex84 engine

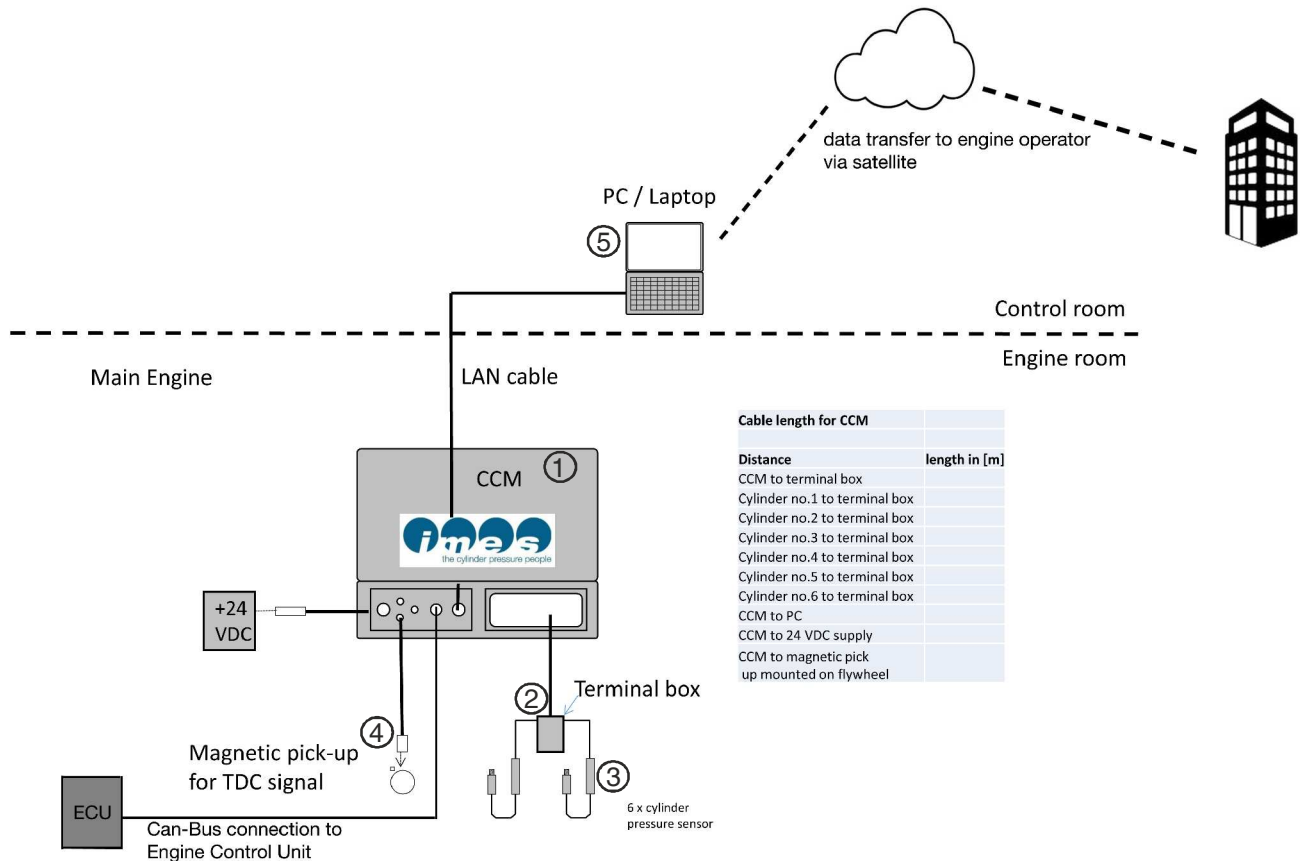
## Technical data:

CCM Combustion Control Module	
Multichannel data acquisition unit	Max. 12 analog inputs
	Resolution: 0.1° CA
	Interface: Can-Bus, Ethernet
	Power supply: 24 VDC

Cylinder pressure sensors	
Measuring range pressure	0...300 bar
Over pressure	400 bar, 1200 bar, 1500 bar
Thermal shock 1500 RPM pmi=9bar	<+/- 0.5 bar
Accuracy	≤ 1% Full scale

## for fixed and continuous operation

CCM Marine Performance can be directly installed at the engine. A sophisticated plug- and play concept enables an easy fitting of cylinder pressure sensors and pulse inputs to the CCM housing.



### System overview - example for connection to 6 cylinders

#### Main components:

- ① Combustion Control Module CCM - high speed data acquisition unit
- ② Terminal box with 10 or 12 connectors for IMES pressure sensors
- ③ IMES high precision cylinder pressure sensors - various types for 2- and 4-stroke engines available
- ④ Magnetic pick-up for TDC signal
- ⑤ PC / Laptop with installed data acquisition- and visualisation software and performance evaluation software

## CCM Marine portable

CCM Marine Portable for periodic operation is a multi cylinder combustion monitoring system for 2- and 4-stroke marine diesel engines. It is designed as a portable box, a comprehensive, transportable system which can be rapidly installed on-site to enable acquisition of cylinder pressure data on engines in the field. Data can be recorded from up to 20 cylinders.



The easy installation of CCM Marine Portable enables a quick data acquisition. The recorded data can be transferred via Ethernet to a PC where the data acquisition and visualisation software can be used to diagnose malfunctions or to assist in the setting and optimising of engine operating parameters. At the centre of efforts is cylinder balancing - the equalisation of output across all cylinders of an engine.



HTT-04 sensors mounted on special Thompson adaptors for continuous combustion monitoring on a MAN L48/60B 4-stroke diesel engine. The adaptors have cooling fins to keep the operation temperature for continuous operation of the HTT-04 sensors below 300°C.

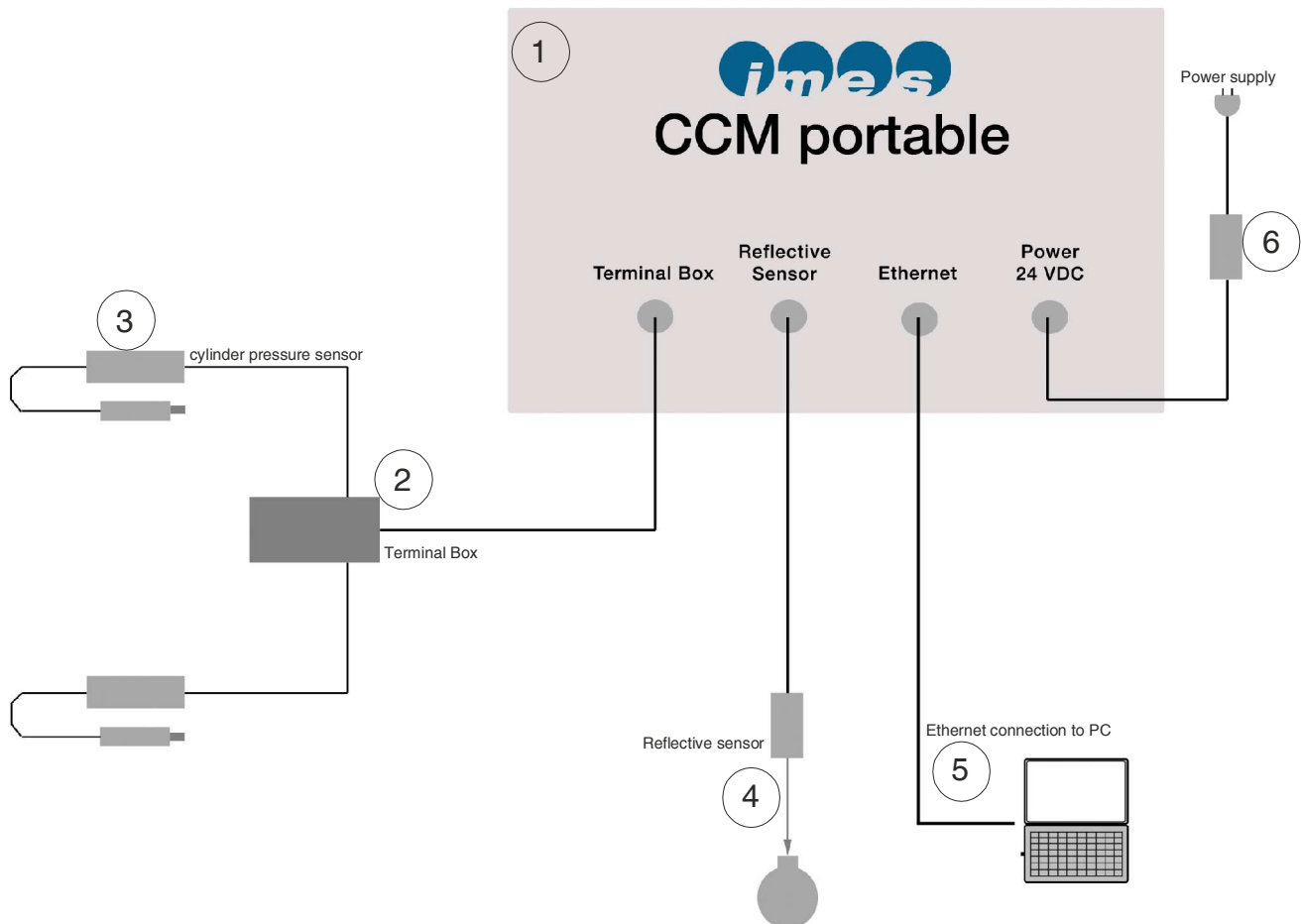
### Technical data:

CCM Combustion control unit
Max. 12 analog inputs (option: extension to 24 analog inputs)
Sampling resolution: 0,1°C
Interface: Fast Ethernet LAN 100 Mbits/s
Wide range power supply 90...264VAC
Optical Pickup for TDC position

Cylinder pressure sensors	
Measuring range pressure	0...300 bar
Over pressure	400 bar, 1200 bar, 1500 bar
Thermal shock 1500 RPM pmi=9bar	<+/- 0.5 bar
Accuracy	≤ 1% Full scale

## for advanced engine balancing

The easy installation of CCM Marine portable enables periodic simultaneous balancing of all of an engine's cylinders in the field.



System overview - example for connection for up to 12 cylinders

### Main components and technical data:

- ① CCM Marine portable box
- ② Terminal box with 10 or 12 connectors for IMES pressure sensors, option: extension to 24 analog inputs
- ③ IMES cylinder pressure sensor: various types for 2- and 4-stroke engines available
- ④ Reflective sensor: Pick-up sensor providing a position signal from crankshaft or camshaft
- ⑤ PC / Laptop with installed CCM Visualisation software connected via 100Mbit/s industrial Ethernet cable
- ⑥ Wide range power supply : 90...264 VAC



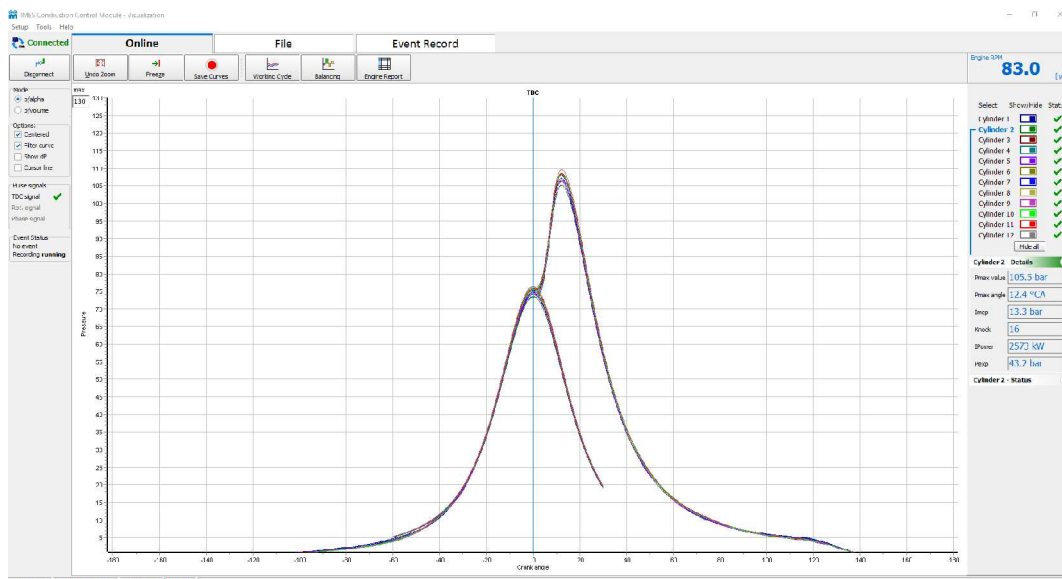
# Advanced visualisation software

The CCM Marine PC software is a modernised version for online combustion monitoring on marine diesel engines. The recorded data can be used to diagnose malfunctions or to assist in the setting and optimising of engine operating parameters.

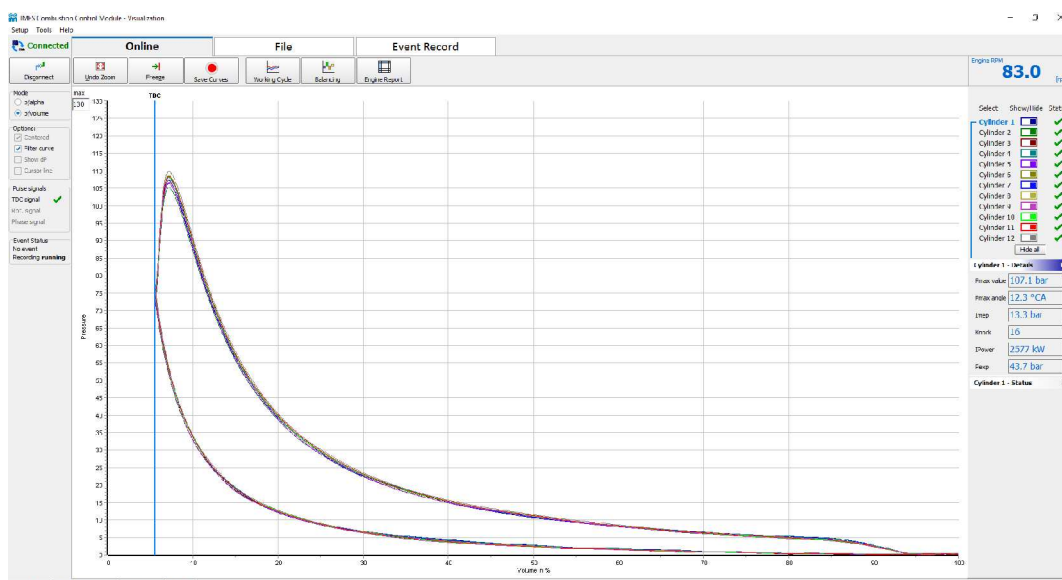
It offers the possibility of selecting advanced monitoring functions in the following diagrams and reports: **Pressure curve diagram, Pmax and Pcomp diagram, Pmax balance, Pressure volume diagram, Engine report**

## Event Record

CCM Marine offers an event storing, this means that a large memory buffer records combustion data and pressure curves from the latest 40 cycles on 4-stroke engines or rather the latest 80 cycles on 2-stroke engines. This function allows to analyse the data before, during and after a failure. This enables the engine operator to determine the cause of failure and to find possibilities how to prevent it in the future.



Pressure curve diagram

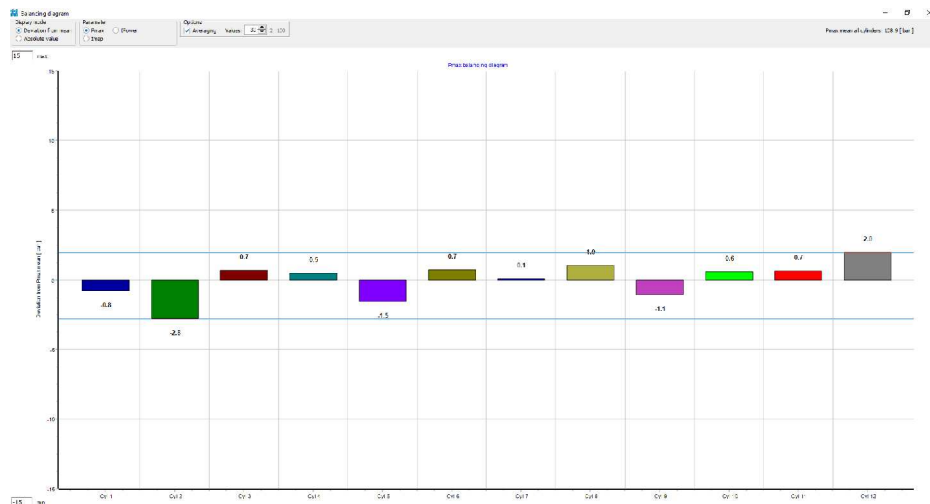


Pressure volume diagram

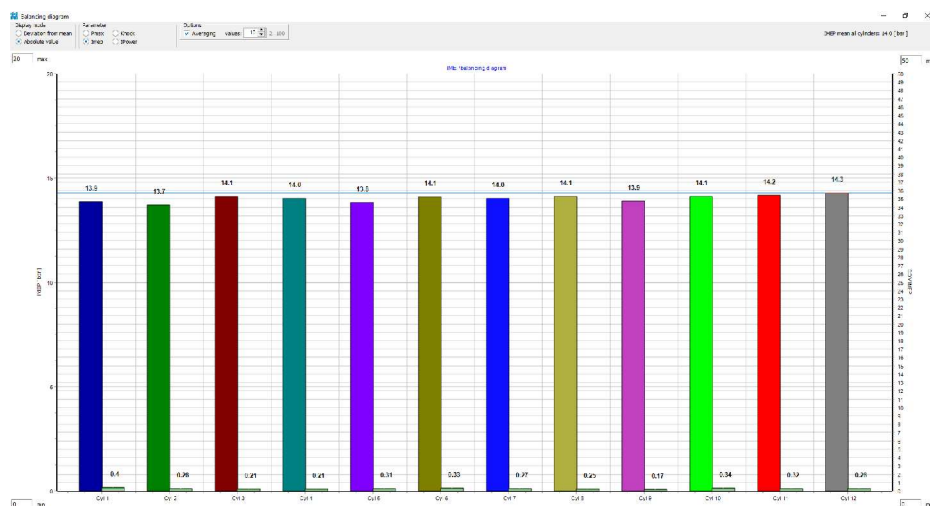


## for an optimal engine adjustment

The visualisation data delivered can be used for much more than combustion monitoring, the main focus is periodic simultaneous balancing of all of an engine's cylinders. Since unbalanced engines use more fuel than well balanced engines, the process has come into sharp focus at a time when shipowners are being squeezed by low freight rates and higher and higher fuel prices.



Pmax balancing diagram



IMEP with balancing diagram with COV

### Main benefit

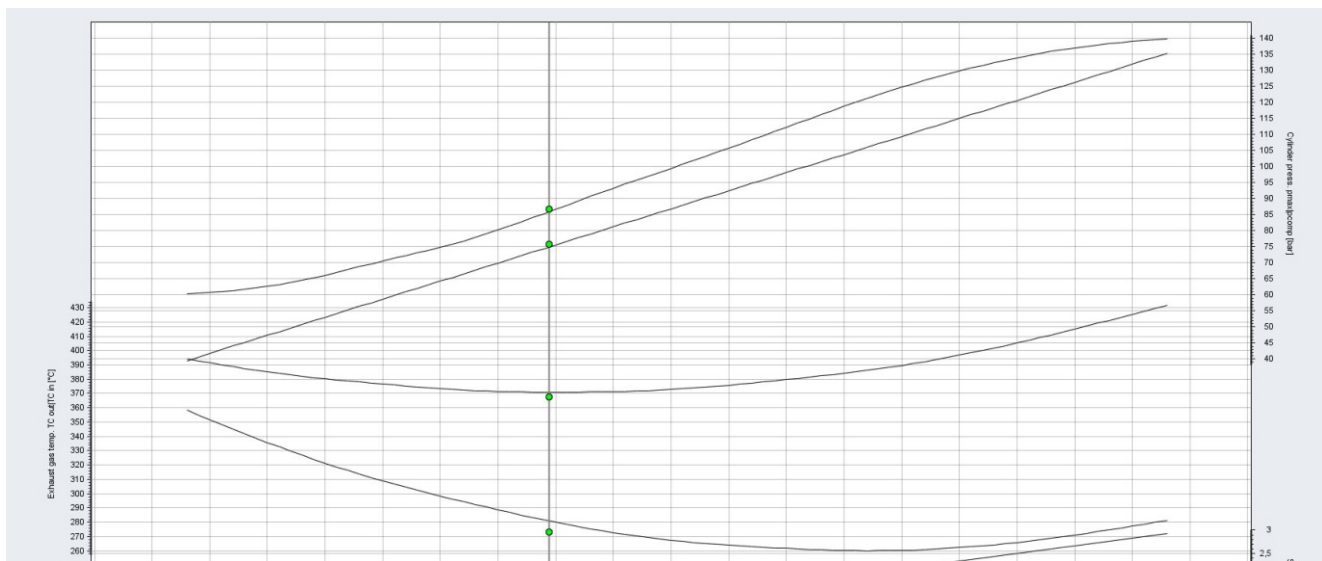
The stored data enable to adjust engine optimally. An engine report shows the measurement results of each cylinder and the complete engine as an average.

The cylinder conditions can be optimised and the engine can be easily balanced and tuned in order to improve the running performance. The result is minimising fuel consumption and environmental impact and a more durable engine.

- less fuel consumption up to 3 %
- reduction of maintenance and service costs
- less costs for engine repair
- improved emissions, reduction of CO<sub>2</sub> and No<sub>x</sub>
- engine control by the engine operator from land

# IPE Performance Evaluation Software

The measured data can be transmitted to the IMES Performance Evaluation software (IPE). In addition to IMES data acquisition software it offers advanced functions to facilitate the collection, evaluation, management and comparison of engine performance data for marine diesel engines. The software evaluates the current engine performance automatically by comparing the actual ISO corrected measurement with the reference data at any load point. Due to this the user receives a quick and reliable overview on many operational aspects.



Performance graph showing deviation of engine performance compared to engine characteristic curve

## Main features

- ISO correction
- automatic evaluation of current engine performance data
- easy collection, management and comparison of engine performance data
- performance graphs and reports show deviation and suggest actions to take
- clearly illustrated commercial calculations that allow to save money by reducing fuel and oil consumption
- automatic data transfer from CCM to IPE
- pressure curve analysis software module full integrated

# for a comprehensive analysis of engine performance data

The chief engineer only needs to fill in the requested information so the programme can do ISO correction and compare against new engine performance benchmarks. Performance graphs and reports give a quick status of an engine and suggest actions to take for optimising engine condition. This enables extensive savings by reducing fuel and oil consumption as well as engine repairs caused by inadequately adjusted engines.

IMES Performance Evaluation

File Help

Input Evaluation Remarks Performance Chart Engine Layout Hull / Propeller Efficiency

Measurement	Active	Load point	Measurement date	Report created	Name	Engine Type	Voyage	Remarks
1	●	49.4 %	2017-03-09 13:43	2020-01-09 14:24	Vessel name	Wartsila 12RTA96C-B AA1805	La Spezia to Valencia	Sea Trial

Add measurement

General parameters

Nautical parameters

Ship speed over ground	kn	18	Wind force	bit	1.5	Draft fwd	m	10	Towing resistance	kn	2040	Slip (apparent)	%	7.53
Ship speed through water	kn	18	Wind direction (geo.)	°	350	Draft aft	m	11	Propeller type	FP	-	Propeller efficiency	-	0.93
Sea scale direction (geo.)	°	350	Wind direction to vessel	°	10	Draft mid	m	10.5	Propeller diameter	m	7	Hull efficiency	-	0.93
Sea scale direction to vessel	°	10	Cargo total	mt	5230	Draft trim	m	1.80	Propeller blades	5	EEOI	g/tm		179.64
Sea scale height	m	1.5	Cargo type		Container	Thrust	kN	2185	Pitch	m	8			

Power / Speed

	kW	CALCULATED		MEASURED		ESTIMATED BY ADDITIONAL ENGINE PARAMETERS								
		MCR	% of MCR	by Indicator	by Torquemeter	by Fuel index	by Piscav	by TC rpm	by MEP	by rpm				
Engine power effective	44216.00	49.43	21856.52	22490	24625.91	22633.77	23447.00	21658.54	31276.43					
Select power reference to use				by Indicator										
Engine speed	84.00		89.41	75.10										
Mechanical efficiency	%		89.26	Power Margin	%	22.84	Sea Margin	%	10.34	Load Balance	%	11.92		

Injection

Legend

- REF - Reference value based on shop test data
- AVG - Arithmetic average value based on your input values
- CALC. - ISO corrected value based on AVG
- MEAS - Measured value
- Enter or select data
- No input value (automatically calculated value)
- Necessary value for further program analysis
- Valuation normal
- Valuation low / high
- Valuation very low / high

The user only has to fill in the required information in addition to the usual cylinder pressure measurement. For a quick overview regarding the engine condition a traffic light system is implemented.

Cylinder pressure

	bar	ISO CORRECTED				MEASURED BY EFM-XP/ICM											
		REF	ISO	AVG		Cyl 1	Cyl 2	Cyl 3	Cyl 4	Cyl 5	Cyl 6	Cyl 7	Cyl 8	Cyl 9	Cyl 10	Cyl 11	Cyl 12
Maximum pressure	85.84	86.07	86.07	85.50	88.31	86.82	87.26	89.15	89.78	87.48	88.45	82.73	84.27	82.19	80.86		
Maximum pressure deviation				-0.56	2.24	0.75	1.20	3.09	3.71	1.41	2.38	-3.33	-1.78	-3.87	-5.21		
Compression pressure	74.83	75.78	75.24	74.88	76.34	75.14	76.02	75.44	75.11	76.39	74.99	73.73	74.87	74.61	75.32		
Compression pressure deviation				-0.36	1.11	-0.09	0.78	0.20	-0.13	1.15	-0.25	-1.51	-0.37	-0.63	0.08		
Mean indicated pressure	10.09			9.01	9.14	9.13	9.20	8.76	8.93	8.89	9.44	9.45	9.08	9.37	8.36	8.37	
Mean indicated pressure deviation				0.13	0.12	0.19	-0.25	-0.08	-0.12	0.43	0.44	0.07	0.36	-0.65	-0.64		
Power indicated				24886.10	2071.43	2067.19	2080.88	1984.67	2022.38	2012.91	2138.76	2135.37	2056.82	2123.43	1695.54	1696.61	
Load balance deviation	%			1.52	1.31	1.98	-2.74	-0.89	-1.35	4.62	4.65	0.80	4.06	-7.19	-7.88		
Mean effective pressure (MEP)	bar	9.01		8.04													
Pmax - Pcomp	bar	11.01	10.89	10.63	10.63	11.97	11.68	11.25	13.72	14.67	11.09	13.45	9.01	9.41	7.58	5.54	
Pcomp / Piscav	-	35.39	34.90	34.65	34.49	35.16	34.61	35.01	34.74	34.59	35.18	34.54	33.97	34.49	34.37	34.69	

For the purpose of comparison the measurements are ISO corrected and displayed as reference to the shop test.

Main Parameters

Parameter	Indication	Possible Problems
Fuel index ENGINE	Okay	
Maximum pressure ENGINE	Okay	
Compression pressure ENGINE	Okay	
Charge air pressure	Okay	
Exh gas temp TC in	Okay	
Exh gas temp TC out	Okay	
TC speed	High	Late combustion because of wrong injection timing or poor fuel atomization or poor fuel quality
SFOC	Okay	

Additional Parameters

Parameter	Indication	Possible Problems
Maximum pressure CYL 12	Very Low	Fuel injection too late / Injection valves or fuel pump afflicted / Injection pumps or cams are set incorrectly / Leakage because of damaged piston rings or exhaust gas valve (blow by)
Maximum pressure CYL 11	Low	Fuel injection too late / Injection valves or fuel pump afflicted / Injection pumps or cams are set incorrectly / Leakage because of damaged piston rings or exhaust gas valve (blow by)

Based on the traffic light system the valuation of the most essential operational parameters are displayed. Depending of the indication possible problems / reasons / malfunctions are given.





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