Cylmate® Systems
Combustion under control
A modern engineer wants to feel secure and comfortable about the diesel engine performance. The Cylmate System will provide all the key knowledge for optimum engine operation.

ABB’s Cylmate® System is a comprehensive system for continuous engine performance measurement and performance monitoring. A unique combination of measurements of cylinder pressure and crank shaft position in combination with advanced mathematical modeling of the engine provides very accurate, real-time data for monitoring and diagnostic analysis.

The quality of the data ensures very significant benefits from improved reliability, reductions in operating costs and minimizing off-hire costs.

With the Cylmate® System you will get the key knowledge for obtaining optimum and reliable engine performance:
- Reduced fuel consumption
- Performance monitoring 24/7 will detect and identify errors in the engine at a very early stage.
- A “black-box function” will keep track of the history behind the combustion alarms.
- Condition-based maintenance will prolong the life of components and minimize the operating costs.
- An engine in good balance will avoid thermal and mechanical overloads by assuring that the power distribution is equal between the cylinders.
- An optimized engine will make it easier to comply with environmental regulations.
The Cylmate® System is a powerful tool developed by ABB for diesel engine performance monitoring. The system, which fits both marine and power plant applications, is designed to withstand marine environmental conditions and fulfills the requirements of classification societies. The combustion pressure is measured in each cylinder, continuously and in parallel, under all load conditions.

The Cylmate® analysis and monitoring functions mean that the risk of mechanical or thermal overload of individual cylinders or the engine itself can be avoided. Further, the cylinder conditions can be optimized and the engine can easily be balanced and tuned in order to improve the running performance. With the Cylmate System you will reduce the costs for maintenance and fuel – resulting in a short payback time.

Knowledge will become even more important. Therefore the Cylmate® System is designed to provide real-time information required by electronically controlled engines in order to optimize the engine operation by closed loop control of the combustion process. The Cylmate® System brings a new level of engine performance management.

By installing the Cylmate System, already at the shop tests, invaluable data can be recorded at different load conditions and used as future reference comparison.
Cylmate® System – key components

The pressure in each cylinder is measured continuously by ABB’s accurate and proven transducer based on the Pressductor® Technology. The position of each piston is determined by accurate measurement of the flywheel angle in combination with advanced crank shaft modeling. The pressure signal is then processed and plotted against the corrected piston position throughout the combustion cycle; the vital engine performance parameters are derived from this data.

The Cylmate® System consists of a Pressure Transducer on each cylinder and an Angle Transducer at the engine flywheel, which all are connected to the Cylmate Transducer Bus. The Controller collects all measured data within each engine working cycle via the Transducer Bus. A built-in mathematical engine model computes, in real-time, the crank shaft deflection in order to get the correct TDC angle and piston position of all cylinders. All combustion parameters such as Pmax, α-Pmax, Ptdc, MIP, Indicated Power and so on, are logged and monitored for each stroke and can be shown in trend diagrams. Any deviation from normal performance will be presented as an alarm. Evaluated data, alarms and events are transmitted via Ethernet LAN to the Cylmate Operator Station as well as to superior systems, if connected.

Pressure transducers, with 5 years warranty

The unique, patented, ABB Cylmate pressure transducer has proven its maintenance- and calibration-free performance and reliability during years of continuous operation. The transducer is factory-calibrated and designed for continuous combustion pressure measurement: 24h per day 365 days per year without any need of recalibration. The measuring accuracy is 0.5% over the full measuring range and the accuracy is not influenced by any clogging or heat flash from the combustion gases, which is a common problem of membrane-based pressure transducers.

All equipment is designed for tough marine installations and complying with the latest international quality standards.

The pressure transducer design permits blow-through cleaning to prevent any build-up of combustion residues.
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**Angle transducer**
The Angle Transducer is mounted close to the flywheel and is based on the Pulsed Eddy Current Technology, patented by ABB. It will find the middle of each tooth with an accuracy better than 0.05°.

Since the number of flywheel teeth may not be that big and the fact that the flywheel rotates with an irregular velocity, the system interpolates the angle value between two teeth using the speed information from the four closest tooth passage according to a 2nd order polynomial. The angle measuring concept gives an outstanding accuracy and repeatability of angle measurement independent of temperature, distance, rotating speed and speed variations.

**Controller**
The powerful Cylmate Controller has the capacity of data handling for all relevant engine and cylinder parameters in real-time.

The engine parameters are continuously monitored against load-dependent performance limits.

The Controller has an I/O interface, which enables the connection of external engine parameters in order to get a total picture of the engine and the combustion performance. There is also a 100Mbit TCP/IP port for Ethernet connection to the Cylmate Operator Station.

**Mathematical model**
The Cylmate Controller also includes a Mathematical Engine Model. The model calculates the crank shaft deflection in order to obtain the correct crank angle and TDC at each cylinder, independent of load variations. This guarantees an accuracy of the crank angle of 0.1°CA..

The MIP value is strongly related to the accuracy of the crank angle. An error in the crank angle of 1°CA gives about 8% error in the calculated MIP value.
Cylmate® Operator Station

The Cylmate® System offers one system concept for all applications. It is installed as stand-alone with the possibility to communicate with superior systems and can handle single as well as multi-engine arrangements.

Increase the engine safety by keeping track of the engine performance 24/7. The unique feature is that every single stroke is measured and used in the data evaluation. This feature makes it possible to identify errors in the engine at a very early stage, and to follow up and analyze the running conditions of the engine.

Protect your main engine by continuous monitoring in order to detect any deviation from recommended running condition according to the performance curves issued by the engine builder.

Use the performance curves, to set up load-dependent alarm limits for desired performance parameters. Any deviation from normal performance will be monitored, according to the alarm limits.

An alarm will be generated when a monitored parameter value exceeds its alarm limit. The alarm is presented on the alarm page as well as on a digital output, which can be connected to the main alarm system.
The Cylmate® Operator Station is based on an industrial version of a standard PC, and includes the Cylmate Software, which is running under Windows. The Cylmate® System has comprehensive on-screen presentation of all collected data, both current and historical. Alarm, event and trend pages as well as graphic and tabular forms of the engine parameters are available e.g. Pcomp, Pmax, -Pmax, MIP, Indicated Power, engine speed, SFOC, etc.

Specific Fuel Oil Consumption (SFOC)
The Fuel Economy Monitoring function will calculate the actual fuel consumption, independent of load and operating conditions. The engine tuning impact on SFOC will easily be verified.

The SFOC calculator will calculate the accumulated indicated energy (kWh) with high accuracy – better than 2%.

Logging
The Cylmate logger continuously records engine and combustion data stroke-by-stroke, and the log files are stored on the hard disk.

These long-term trend chart clearly indicates the trends of the logged parameters, which help you to predict emerging faults.

The short-term trend chart, which is a real-time trend logging, always shows the latest 6000 strokes. This chart will instantaneously show the effect of any tuning adjustments.

The Cylmate logger is a tool for:
- Trend analysis
- Fault prediction
- Fault tracing
- Voyage recording
- Performance optimization
- Performance history
As important as continuous monitoring of all cylinders is the performance logging and reporting. Engine Performance Reports can be seen as an engine logbook that clearly presents an average summary of all important combustion parameters over a selectable number of strokes.

A clear and consistent Performance Report of all relevant combustion parameters will form the base for reliable verification of the engine condition. The Report will also compose a powerful tool for advanced engine analysis and diagnosis, and will directly inform the engineers if the engine performance is optimal or not.

The content of the Report can easily be selected from a set-up page, and it can be customized by marking relevant boxes. You can also select if the Report should be previewed, saved and/or printed. Saved Report files can later be copied to a CD/DVD.

The Engine Performance Report, which can be stored on the hard disk, printed or copied to a CD/DVD, gives comprehensive information about the engine performance and condition.
Cylmate off-line reference and analysis function
The Cylmate System has a large memory buffer where live combustion performance is recorded. The buffer always contains all combustion data and pressure curves from the latest 70 strokes. This information is used for creating snapshots of the engine performance under different load and environmental conditions. For example snapshots can be taken during shop test, sea trial and at different climate and load conditions as well as after engine overhaul. The snapshot function can also be used to record abnormal behavior for later off-line comparison and analysis. Each snapshot recording is stored as a file on the hard disk and can later be copied to a CD/DVD or transmitted to the home office.

Performance Reference and Performance Alarm
A Performance Reference snapshot is taken manually whenever needed. A Performance Alarm snapshot will be created automatically in conjunction with a combustion alarm.

The Performance Alarm snapshot is an indispensable tool for engine fault analysis. As soon as the Cylmate System has detected an engine combustion fault, a snapshot of the latest strokes is automatically stored. The stored snapshot includes all combustion data for 62 strokes before the alarm, data for the stroke at which the fault was detected and data for 7 strokes after the alarm stroke.

The off-line analysis and comparison of these snapshots is done by means of a freestanding tool, the Cylmate Viewer. The Viewer is a part of the Operator Station, but it can also be installed in any Windows-based PC as a tool for engineers, superintendents and the ship owners’ technical departments.

The Viewer works like a video player that can replay the recorded strokes, stroke-by-stroke, forward or backward. It will for each stroke show the pressure curves and related combustion data.

The Cylmate Viewer is the first commercial tool on the market that has all information of the combustion process stroke-by-stroke, before the alarm, at the alarm, and after the alarm. That means it is possible to see the development of a fault and to get understanding of the mechanism that led to the fault.

7.3 million strokes measured during 81 days.
Recognized, Verified and Proven

Over the years the Cylmate® System has been recognized with the CIMAC President’s award, technically verified by many installations and the accuracy has been proven during engine shop tests.

NSB’s large container vessels successfully running with Cylmate Engine Monitoring systems

We ask Mr. Bögemann, Chief Engineer onboard “M/V Ever Conquest” about the installation:

“Before Cylmate we had movable monitoring systems and it took us just about an hour to measure all cylinders. Since Cylmate is a continuous, on-line system it is a very helpful tool in our daily work. We can see the condition inside the cylinders and before something serious happens get an early warning, a very good pro-active function in Cylmate.

Several times per day, me and my crew look at the Cylmate-screen and the most important and frequently visited pages are mainly:

- Engine Main Data, showing numerical values of Pmax, etc.
- Cylinder Pressure, where you can compare two or more pressure curves between selected cylinders.

In general, it is very easy to navigate in the Cylmate System and I think there is a good level of information available.”

M/S Hanjin Ottawa

Mr. Michael Haufmann, Chief Engineer at M/S Hanjin Ottawa, has extensive experience using portable systems for combustion pressure measurement. He has seen the potential and benefits with a continuous monitoring system:

“My personal summing-up of the experience with the Cylmate System is very positive. The system is extremely helpful in the daily engine operation, condition supervision and maintenance planning. The system worked totally reliably and without any failure. Due to its permanent monitoring functions, we were able to detect defective engine components at a very early stage. During my duty time onboard, two defective injection valves were detected, as well as a sneaking leakage of the air spring chamber piston of an exhaust valve”.

Chief Engineer Mr. Michael Haufmann employed by NSB, one of Germany’s largest management companies. NSB has good contacts for success in business with well-known charter business companies such as CMA-CGM, Hamburg Süd, MSC, P&O Nedlloyd in Europe; CP Ships in North America; HANJIN, Evergreen, K-Line, Yang Ming in Far East.
**M/V Malmö Link**

The first Cylmate System was installed on M/V Malmö Link in year 2000 and has been in operation ever since. Mr. Christer Bruzelius, President of Nordö-Link Management AB, has experience of traditional pressure measurement systems and engine maintenance.

“So far, the real benefit with ABB’s Cylmate System has been to keep track of the fuel valves. If you don’t detect a malfunctioning fuel valve in time, it can inject oil in the wrong way and this could end up with an uneven distributed wear on the cylinder lining. You cannot be sure that a bad fuel valve will indicate a fault when you are using a temporarily measurement system. A continuous measurement system will indicate a fault right away. Not having a continuous monitoring system installed can be a very expensive experience for us. Just to change one cylinder lining will cost us more than US$18,000.”

**Mr. Christer Bruzelius, President of the shipping company Nordö-Link Management AB. Nordö-Link is a subsidiary of Finnlines PLC, one of Europe’s biggest shipping companies.**

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**Shop test**

An increased number of ship owners has understood the advantage by using Cylmate, already at the shop test. It is now – for the first time – possible to do live snapshot recordings and logging of all engine and combustion data under all load conditions.

With the Cylmate Viewer all recordings from the shop tests can be replayed. The recorded data will be an invaluable source for coming reference comparisons and analyses.

The measuring of the crank angle and combustion pressure is done with outstanding accuracy. This is the base for the power calculation, which is within 2 % compared to the power value measured by the engine builders.

**The shop test installation can be temporary as shown in the picture or more permanent, which will reduce the installation work at the shipyard.**

**The mechanical arrangement for the Angle Transducer is seen as a part of the engine.**
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