

Portable
Solutions for
Diesel Engine
Condition and
Performance
Monitoring,
Combining
Accuracy, Ease
of Use and
Durability

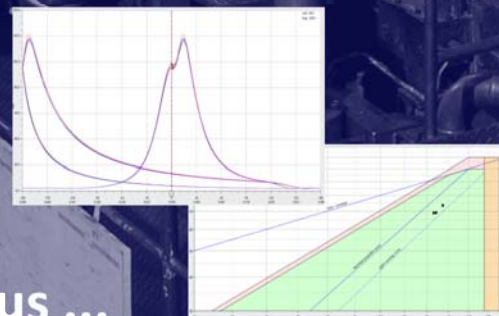
**Diesel Engine
Condition &
Performance
Monitoring**

**THE DIESEL
DOCTOR**

DOCTOR

DK-20

Analyser from
Icon Research



Plus ...

**Doctor
Version 6
Software**

DK-20 Portable Analyser

FEATURES

High accuracy instrument and sensor with 0.1 degree resolution

Rigorous measurement checks ensure reliable data every time

Easy-to-use full colour touchscreen

Highly ruggedised design to meet the needs of real marine users

Operates with inductive or optical shaft pickups

Simple drag-and drop of measurements to Doctor V6 software



Portable Doctor DK-20

Over a period of 25 years, the *Doctor* DK series from Icon Research has become a standard for diesel engine monitoring and analysis in the marine industry, as well as many on-shore applications, having built its reputation on reliability, accuracy and ease-of-use.

The latest DK-20 provides unparalleled precision combining high accuracy design and a top of the range Kistler pressure sensor with 0.1 degree resolution. This ensures precise pressure measurement and accurate power values.

Its built-in intelligence ensures the integrity of data when measuring at the engine, and its drag-and-drop transfer method ensures that all data goes into the correct cylinder on the correct engine. Straightforward setup and the user-friendly touchscreen ensure that inexperienced engineers can use the equipment with ease. And the database setup service provided by Icon Research means that the instrument is ready for use 'straight out of the box'.

The DK-20 is smaller and lighter than its predecessor and incorporates a large high-resolution colour touchscreen behind impact-resistant glass. However,

a complete set of cylinder measurements can still be taken without having to remove protective gloves by simply pressing the GO button.

Engine Measurement

Stricter emission controls and the continual drive for increased fuel efficiency means that engine timing settings are varying more than ever before, and change dynamically with engine load. The DK-20 system enables operators to track and understand the operational details of their engines far more clearly. This is in addition to being able to pinpoint ongoing engine issues associated with piston ring and liner wear, fuel pump/injector problems and power balance.

Your Investment

The latest '*Diesel Doctor*', as it is often known, is housed in an extremely rugged plastic case and is fully sealed against moisture and dirt. A complete system, including sensors and cables, fits into a convenient shoulder bag and can be taken as hand luggage on an aircraft. The instrument carries a two-year warranty and regular software updates ensure that your investment will be paying for itself many time over in future years.

DK-20 Technical Specification

PRESSURE MEASUREMENTS

No of Channels:	single channel (DK-20) two channel simultaneous (DK-20 F/V)
ICP Interfaces:	3.6mA at 24Vdc nominal
Input Voltage Range:	+/-5V
Connector Type:	TNC
Bias Voltage Check:	25Vdc range for ICP bias voltage
Amplitude Accuracy:	±1% typical

CRANK INPUTS

No of Channels:	2
Modes:	TDC ONLY or DUAL (TDC and FLY) with Auto-Select
Connector Type:	6-way milspec
Crank Sensor Types:	inductive or optical
Crank Sensor Supply Voltage:	24Vdc nominal (provided by DK-20)

RECOMMENDED CYLINDER PRESSURE SENSOR (KPS-3)

Type:	Kistler 6613CP, piezoelectric
Nominal Sensitivity:	20mV/bar nominal (calibration certificate supplied)
Indicator Cock Adapter:	Thompson Adapter with tube spanner for disassembly
Operating Temperature:	350°C at sensor head
Cable:	high temperature cable supplied with sensor, length 1m

RECOMMENDED FUEL PRESSURE SENSOR (KFS-1)

Type:	Kistler 6729A, piezoelectric
Nominal Sensitivity:	2.5mV/bar nominal (calibration certificate supplied)
Mechanical Fitting:	1/2" BSP male adapter (fitted to sensor) to fit standard fuel isolation valves
Operating Temperature:	200°C at sensor head
Cable:	high temperature cable supplied with sensor, length 1m

DISPLAY

Type:	640 x 480 full colour VGA
Keypad:	integrated touchscreen (capacitive)
Measurement Start:	sealed GO button or screen touch

PERFORMANCE

Engine Speed Range:	20 RPM - 3000 RPM
Resolution:	0.1° up to 1820 RPM 0.2°, 1820 RPM to 3000 RPM
Max Sampling Rate:	102.4kHz
Measurement Storage:	500 full engine tests

COMMUNICATIONS

Communications Port:	USB 2.0
Connector Type:	mini-B, sealed

MECHANICAL

Case:	high impact HPX plastic (yellow), press & pull latches, softgrip handle
Dimensions:	30cm x 25cm x 12cm (meets airline carry-on regulations)
Weight:	2.6kg

ENVIRONMENTAL

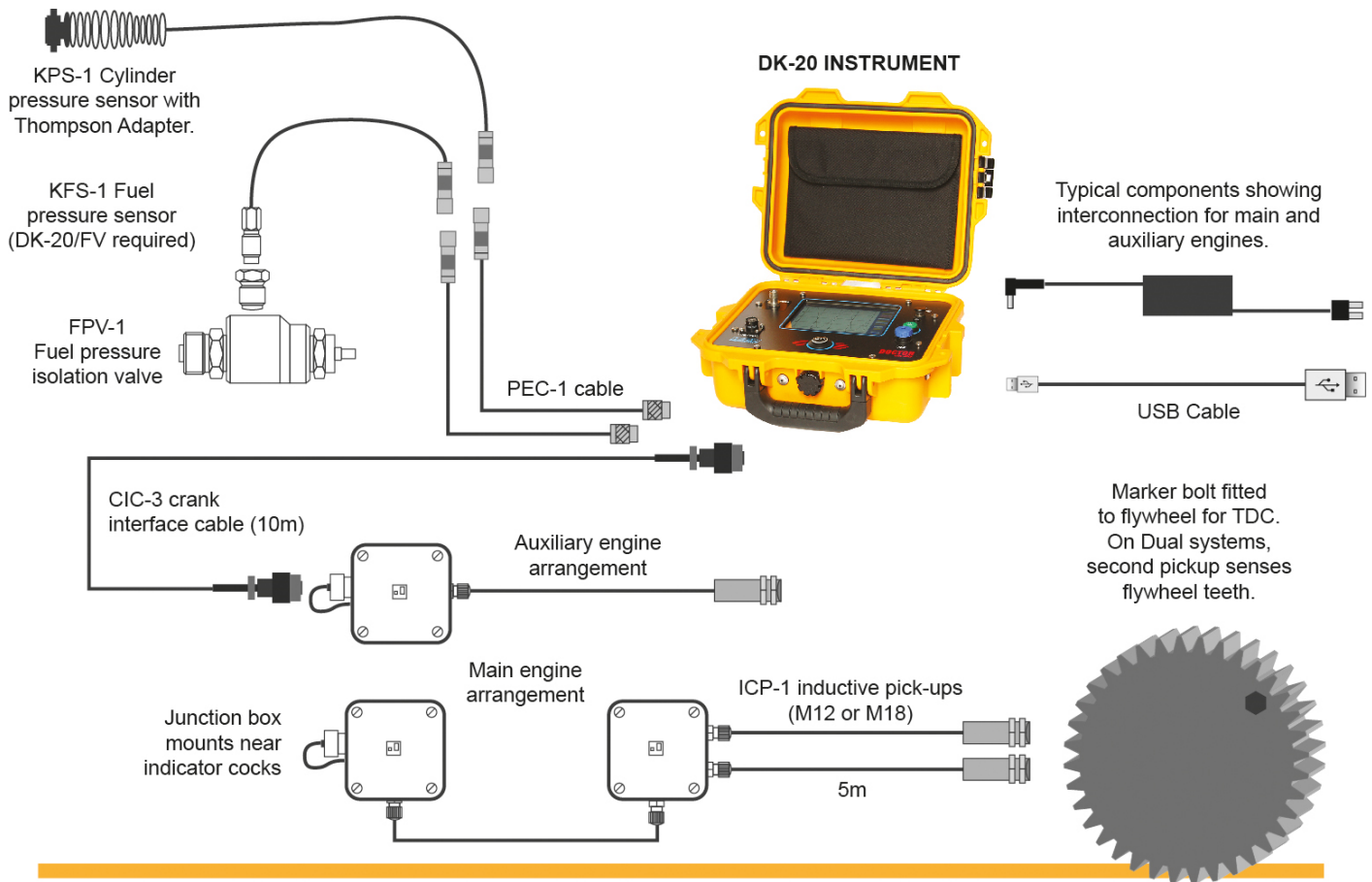
Operating Temperature:	-10°C to +55°C
Sealing:	IP66 (IP67 with lid closed)
Compliance:	CE, RoHS

POWER

Power Source:	internal rechargeable Li-ion battery
Battery Charger (supplied):	9Vdc output rated at 3A mains input voltage 100-240Vac, 50-60Hz (unit can also be trickle-charged via the USB port)

Subject to change without notice

Typical System Interconnection



The **Doctor** instrument is available in two versions, namely the single-channel DK-20 for cylinder pressure only measurements, and the two-channel DK-20/FV which incorporates a second channel for simultaneous fuel or vibration measurement. Fuel injection sensing can detect issues with injectors while vibration sensing with an accelerometer can detect valve timing within the cylinder. The diagram above shows how the sensors connect to the DK instrument.

Both instruments use single or dual pickups to synchronise pressure measurements with crank (and therefore, piston) position. Dual pickups are generally used on slow-speed direct-drive engines (usually 2-stroke) where the speed of the engine can vary during a revolution. One pickup senses the once-per-rev 'TDC' marker while the second pickup senses the flywheel teeth, thus minimising the effects of speed variations during each rev. This improves the accuracy of power figures. For medium-speed engines (typically auxiliaries that are driving generators), a single 'TDC ONLY' pickup is sufficient.

For reliable long-term operation, inductive pickups on the crankshaft and flywheel are recommended. These

are permanently mounted on the engine with a local junction box (or a combination of boxes on large 2-stroke and V-engines). A CIC-3 cable connects the junction box(es) to the instrument. For service work or a temporary installation, an optical pickup is available for TDC ONLY mode.

Engine details are uploaded into the instrument prior to taking measurements. To take readings at the engine, simply connect the CIC-3 cable to the local junction box and move the pressure sensor from cylinder to cylinder, pressing the **GO** button once for each cylinder. Key results and a trace are shown on completion. A full set of main engine readings can be made in under 15 minutes.

Results for indicated power are within 2% or better once system setup is complete. The repeatability of the system is within 0.5% or better. Results are available in the instrument immediately a reading is taken.

After readings are made on all cylinders, they are transferred into the *Doctor Analysis Software* for full analysis and diagnosis.

Doctor V6 Analysis Software

Summary

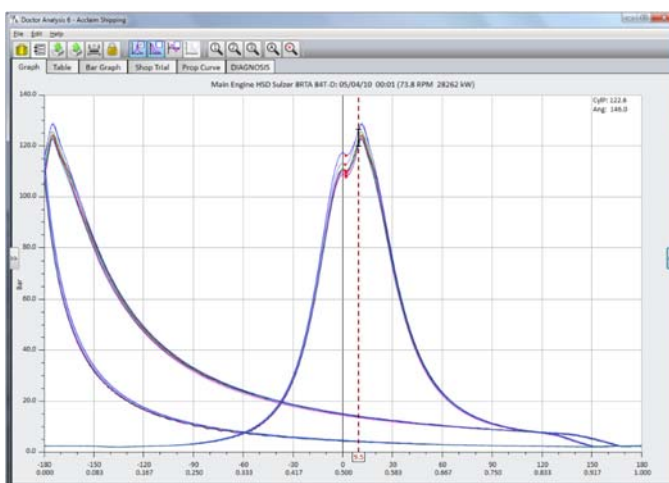
For over 25 years, the Doctor has been helping engineers to manage their engines' condition and maintenance. The latest version V6 has been developed to take advantage of latest operating systems and is Windows™ 7 and 10 compatible. Version V6 retains many of the standard features that current users are familiar with, but adds many new features for faster and easier engine measurement and diagnosis. Ship operators can easily and efficiently handle single engines up to entire fleets. The performance of similar vessels can be compared to determine where improvements can be made.

The software comes on a self loading USB flash drive and includes a step by step manual, a tutorial, and many useful technical notes. The program can be installed on as many PC's as needed, and is fully network compliant. Data management is straightforward and intuitive using simple drag-and drop actions for transferring engine data and measurements. All information is passed using 'logbook' files which can be easily sent from ship to shore using the built in emailing tool. The look and feel of the Doctor has been maintained, with many enhancements to operation and data handling now added.

Getting Started

The programme is intuitive to use and contains an extensive demonstration library with real engine test results to allow evaluation of the software features. The *Doctor Setup Service* offered by Icon provides you with a library customised for your engines so, once the software is installed, no further setup is required.

For users with earlier versions of Doctor software, all data can be transferred into version 6 so all previous engine measurements remain intact.



Doctor V6 Features

Compatibility

Doctor V6 runs on Windows™ 7 and 10 (32- and 64-bit). Databases from earlier Versions of the software can be converted to V6 so no historical data is lost.

Engine Configurations

All engine types (2-stroke, 4-stroke, V or in-line, diesel, dual fuel or gas engines) are supported. Unlimited configurations can be entered and stored.

Editions

Three editions of Doctor V6 software are available, the features of each are shown in the table on the right. The *Standard* edition comes free-of-charge with the DK-20 instrument. There is a charge for the other two editions. The licence fee is a one-off charge with no ongoing annual support fees.

Software is licence key protected but multiple users are allowed on each licence. For example, a vessel could use the licence for on-board monitoring and the superintendent could use the same licence for on-shore analysis.



	EDITION		
	Standard 6	Diagnostic 6	Shop/Sea Trial 6
Downloading			
DK-2 / DK-20 compatible	•	•	•
Cylinder and Cylinder+Fuel	•	•	•
TDC only and Dual pickup	•	•	•
Views			
Graph views	•	•	•
Table views	•	•	•
Bargraph views	•	•	•
Scalars	•	•	•
Notes	•	•	•
Analysis			
P-A, P-V, Derivative	•	•	•
Zooms	•	•	•
Engine and cylinder overlays	•	•	•
Ignition point finder	•	•	•
ISO normalisation	•	•	•
Diagnostics and Reporting			
Summary graph/table report	•	•	•
Engine performance report	•	•	•
Engine diagnostic report		•	•
Propeller curves		•	•
Shop / Sea Trial			
Shop/Sea trial data entry			•
Shop/Sea trial comparisons			•

Shop/Sea Trial 6 includes the charts of any selected shop or sea trial comparisons.

The diagnostic statements are viewed within the program, where individual cylinders may be removed from the

A single button selects either a summary or a full report in pdf format. The full report includes the diagnostic statements, the draw and indicator charts, all the selected engine parameters in tabular and bar chart formats along with propeller curves for 2-stroke propulsion engines. If selected, all the shop and sea trial comparison charts will also be included in the report.

When finished, a single button click publishes the report in Excel format where any final changes may be made.

		<h1>Engine Report</h1>			
Operator Ship Name Engine Name Test Date Speed Power		Accalm Shipping M.T. Hillary Main Engine HSD Sulzer BRTA B4T-D 05/04/10 00:01 73.8 RPM 28262 KW 74.9%			

Validity Test

All traces for this test have sufficient integrity to permit automated analysis.

Compression Comparison at 0.0°

Average Compression	111.5 Bar
Compression Variation	7.6 %

*Compression variation is higher than ideal. The lowest is Cylinder 7.
Cylinder 3 has slight symptoms of early valve closure.*

Pre-Ignition

There are no symptoms of pre-ignition.

Ignition

Average Ignition Angle	1.9°
Ignition Variation	0.5°
Earliest	Cylinder 2
Latest	Cylinder 1

Ignition points are well balanced.

Spread of Flame


Flame spread is indicated as consistent.

Poor spread of flame is normally a symptom of poor atomisation and is often associated with injector nozzle clogging.

Power Balance

Indicated Power	28262 KW
Power Variation	5.9 %
Highest	Cylinder 1
Lowest	Cylinder 5

Power balance is acceptable.

SERVICE DATA		Engine Type		4000AC		Name of vessel		M T Hilly			
Engine Number		MAN B&W		Engine No.		A88753		Hord			
Laid out		800		Laid out		800		Type		Serial No.	
Turbocharging		No. of TC		3		No. of Cyl.		6		Inch	
Make		ABB		Type		ANER55		Cylinder Constant (kW bar)		1014.0000	
Max. RPM		127		Max. Temp. °C		150		Lubrication Oil System (Pick box)		Mase Friction Press. bar	
Comp. Slip Factor		Comp. Diam. in.						Internal		External from M. E. System	
TC specification										External from Quake Tank	
Observation No.											
Fuel Oil Viscosity before Engine: 680 cSt Temp: 55 °C											
Barber Station		ABERNETHY		Heat value, kcal/kg		44000		Cylinder Oil		ENERGOL	
Oil Brand		ENERGOL		Injector, %		2.36		Cooling Oil		ENERGOL	
Density at 15 °C		1000.00		Injector, %		2.36		Turbo Oil		ENERGOL	
Test Date		Load		Antiside		Engine RPM		Total Running Hours		Governor index	
(500 mm yds min)		73.5		inbar		119.2		11025.0		bar	
23 Feb 17 12 23		73.5		1027		119.2		11025.0		60	
Speed Setting		VLF		Control		bar		bar		bar	
Shaft Power		Indicated power		Eff. Fuel Consumption		ISO conversion		Displacement		Draft Force, m	
kW		kW		g/kWh		g/kWh		Sea State		Draft AR, m	
5000		5767		124.00		120.00		14.2		21.0	
Cylinder No.		1		2		3		4		5	
R, bar		15.2		15.0		15.2		15.5		14.9	
P, bar		117.3		116.9		116.6		118.6		117.5	
Pump, bar		96.7		95.6		95.3		97.7		95.4	
Indicated Power kW		131.0		113.0		112.0		117.0		114.0	
Fuel Pump Index mm		65.0		66.0		65.0		66.0		65.0	
VIT index mm											
Exhaust Gas Temp. °C		342		344		358		355		358	
J C Water Outlet Temp. °C		84		84		84		85		84	
Exhaust Water Temp. °C											
57.6											
Cooling Water Temperature °C		Exhaust Gas Temp. °C		Exhaust Pressure		Turbo Charger		Aux. Blower		Scavenge Air Pressure	
Inlet		Inlet		Turbine		Receiver 1		Turb. Out. mmHg		RPM	
On/Off		On/Off		On/Off		On/Off		On/Off		On/Off	
1		1		1		1		1		1	
36		41		379		262		mmHg		12700	
2		2		2		2		2		2	
35		40		72.0		365		233		Receiver 2	
3		3		3		3		3		3	
33		41		73.0		370		235		12490	
4		4		4		4		4		4	
34		40		73.0		371.3		243.3		12613.3	
34.7		40.7		73.0		371.3		243.3		12613.3	
57.6											
Engine room Temperature °C		Inlet Blower		Before Cooler		After Cooler		Pressure, bar		Temperature, °C	
40		35.0		1		1		2.80		Inlet Engine	
		2		2		2		2.80		42.0	
		3		3		3		3		Inlet Cam	
		35.0		132		34		Cam Shaft Oil		Outlet Cam	
		3		3		3		Cam Shaft Oil		Outlet Cam	
		4		4		4		Turbine Oil		Thrust Segment	
		35.0		131.0		33.5		Cylinder Oil Consum. in 10 / hr		Specific Cylinder Oil Consumption in g/kWh	
		35.0		131.0		33.5					
		35.0		131.0		33.5					
		35.0		131.0		33.5					
		35.0									

Remarks:

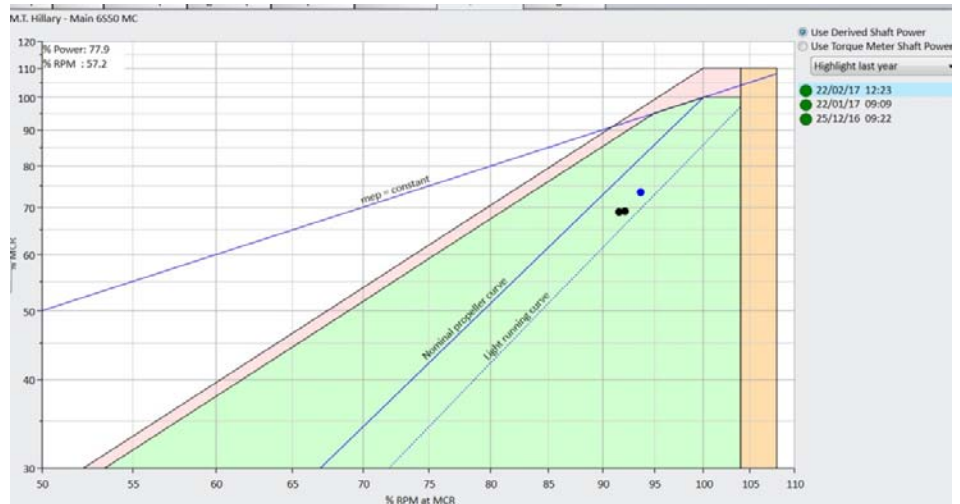
This template is provided to you as an example of a typical engine report for a main engine. It can be used as is or can be published in Excel and modified to meet specific requirements. If preferred customers can report their own usage report for Excel format, and can use it as their own template.

Propeller Curves

Propeller curves are an invaluable tool to graphically show the loading of a 2-stroke propulsion engine and ensure it is within the normal operating boundaries. Any overloading due to issues such as hull fouling can immediately be identified.

Any number of test results can be selected and will appear on propeller chart. Latest results can be colour identified to show latest loading trends.

Propeller curves are included in reports produced from Diagnostic 6 and Shop/Sea Trial 6 software versions.



Sea/Shop Trial

Shop and Sea Trial Comparisons

Comparison between an engine's current performance and that during its shop and/or sea trials are extremely useful to identify and pinpoint problems.

The Doctor software enables this and takes it a stage further by automatically flagging when selected parameters are outside user settable thresholds.

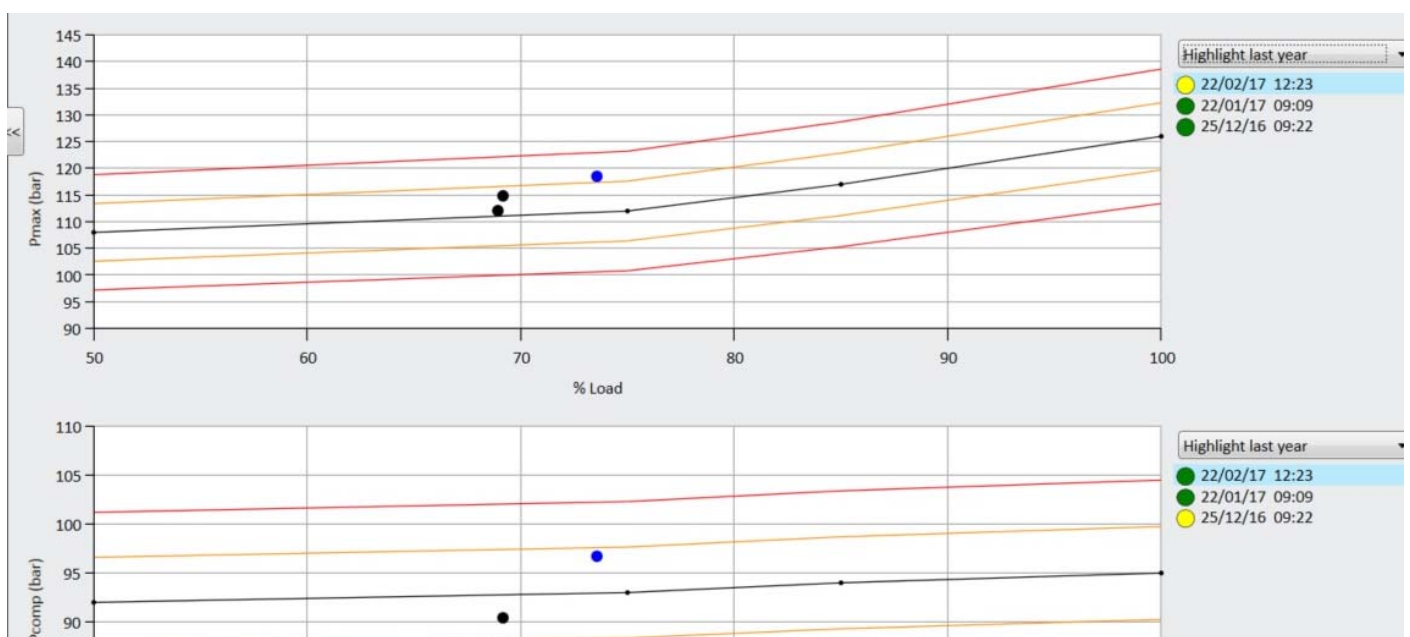
Multiple test results are plotted on the charts to identify any developing trends and the results of any remedial

action can be instantly observed.

Values can be ISO normalised to take account of ambient conditions and ensure comparisons are viable.

Specific fuel consumption can be automatically calculated by the program and displayed against the fuel used when the engines were new.

All parameters selected Shop/Sea Trial comparisons are included in Diagnostic reports along with coloured indicator and comments flagging any anomalies.



Service and Support

Installation and Commissioning

The Doctor system has been designed to make installation as straightforward as possible. To save on expensive installation and commissioning costs, we encourage our customers to carry out installation work using their own staff, supported where necessary from Icon's own in-house engineers. The large majority of Doctor systems are 'crew-install' and this approach has proven to be very successful over many years. Comprehensive installation and trouble-shooting guides are available. Installation and commissioning services can be arranged through Icon and there are agents in several locations throughout the world who can supply these services.

Doctor Setup Service

To ensure quick and accurate setup of your Doctor system, Icon offers a *Doctor Setup Service*. Here's how it works:

1. Icon provides a simple form that is completed by the customer and which contains details of the engines on his vessel. The form is returned to Icon.
2. When the Doctor system is shipped, Icon provides a customised logbook for the vessel based on the form supplied on a USB flash drive. Once the Doctor software is installed on the local computer, the logbook is simply 'dragged and dropped' into the software and the system is ready to go.
3. The vessel takes the first set of readings and sends the results via email to Icon using the simple auto-email facility in the software. Icon checks the results and carries out TDC offset adjustment (in software)

to take account of the positioning of the crank pickups on the shaft.

4. Icon emails the corrected file back to the vessel and setup/commissioning is complete.

This option is the most cost effective and fastest way to start up a Doctor system. There is no need to wait for a convenient port or short sailing where an engineer could attend the vessel, and the corrected logbook file is normally emailed back to the vessel within a couple of days of the initial readings being taken.

If any major problems with the engines are seen, these will be mentioned in the reply message.

Training

Training Courses: Although many marine engineers have seen 'cards' and are used to interpreting them, the Doctor offers much higher resolution and detail.

Icon's training courses cover a simple 6 step analysis method that covers all major engine problems and gives a structured approach to analysis. Courses can be arranged at locations to suit the customer.

Lifelong Support

When you purchase a Doctor system from Icon Research, you can look forward to ongoing support that has set the standard in the marine industry. Icon is renowned for its responsiveness and willingness to assist customers, many of whom we have been working with for over 25 years. Should any operational problems be encountered, telephone support is available during office hours and email queries are normally answered within 24 hours.

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