

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

## Diesel Engine Condition & Performance Monitoring

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# DOCTOR

## New DK-20

Analyser from  
Icon Research



Plus ...

## Doctor Version 6 Software

### *DK-20 and DK-20/FV Portable*

#### **FEATURES**

*All New Compact Instrument*

*Proven Reliability and Accuracy*

*Cylinder Pressure Only & Cylinder with Fuel Pressure Versions*

*Easy-to-use Full Colour Touchscreen*

*Choice of Inductive or Optical Crank Synchronisation*

*Easy Carrying in Compact Shoulder Bag*

*Designed to Meet the Requirements of Real Marine Users*



#### **Portable Doctor Systems**

Over a period of 20 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 new DK-20 is a next-generation instrument that builds on the strengths of the earlier products, but incorporates many new features that enable even easier and more accurate measurements.

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.

#### **System Checks**

To ensure the reliability of data, measurement integrity is enhanced by a series of system checks prior to readings being taken. For example, the instrument checks that the operator has connected the pressure sensor to the correct cylinder, and checks that engine speed signals are within tolerance. All the operator has to do is press the large GO button.

To protect the investment already made in instruments purchased from Icon Research, all pressure sensors, crank pickups and accessories are the same as used with the DK-2. Indeed, the DK-20 can be simply used in place of the DK-2 with no changes to supporting hardware whatsoever.

Two versions are available. The DK-20 is a single channel unit for measuring cylinder pressure while the DK-20/FV measures cylinder and fuel pressure simultaneously. Both systems use **Kistler** pressure sensors for long-term reliability and accuracy.

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.

#### **Your Investment**

The marine industry, like any other, operates in a dynamically changing environment. Particular issues in the marine industry are fuel economy, reduction of emissions and improved uptime, to name but a few. The DK instruments and software from Icon Research continue to adapt to these changes and combine to provide an invaluable tool in helping to address the new challenges in the marine market.

# DK-20 Technical Specification

## PRESSURE MEASUREMENTS

No of Channels:	single channel (DK-20) two channel simultaneous (DK-20 F/V)
ICP Interfaces:	2.4mA 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 (with Auto-Select)
Connector Type:	6-way milspec
Crank Sensor Types:	inductive or optical
Crank Sensor Supply Voltage:	24Vdc nominal

## RECOMMENDED CYLINDER PRESSURE SENSOR (KPS-1)

Type:	Kistler 7613C, 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:	over 200,000 traces

## 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

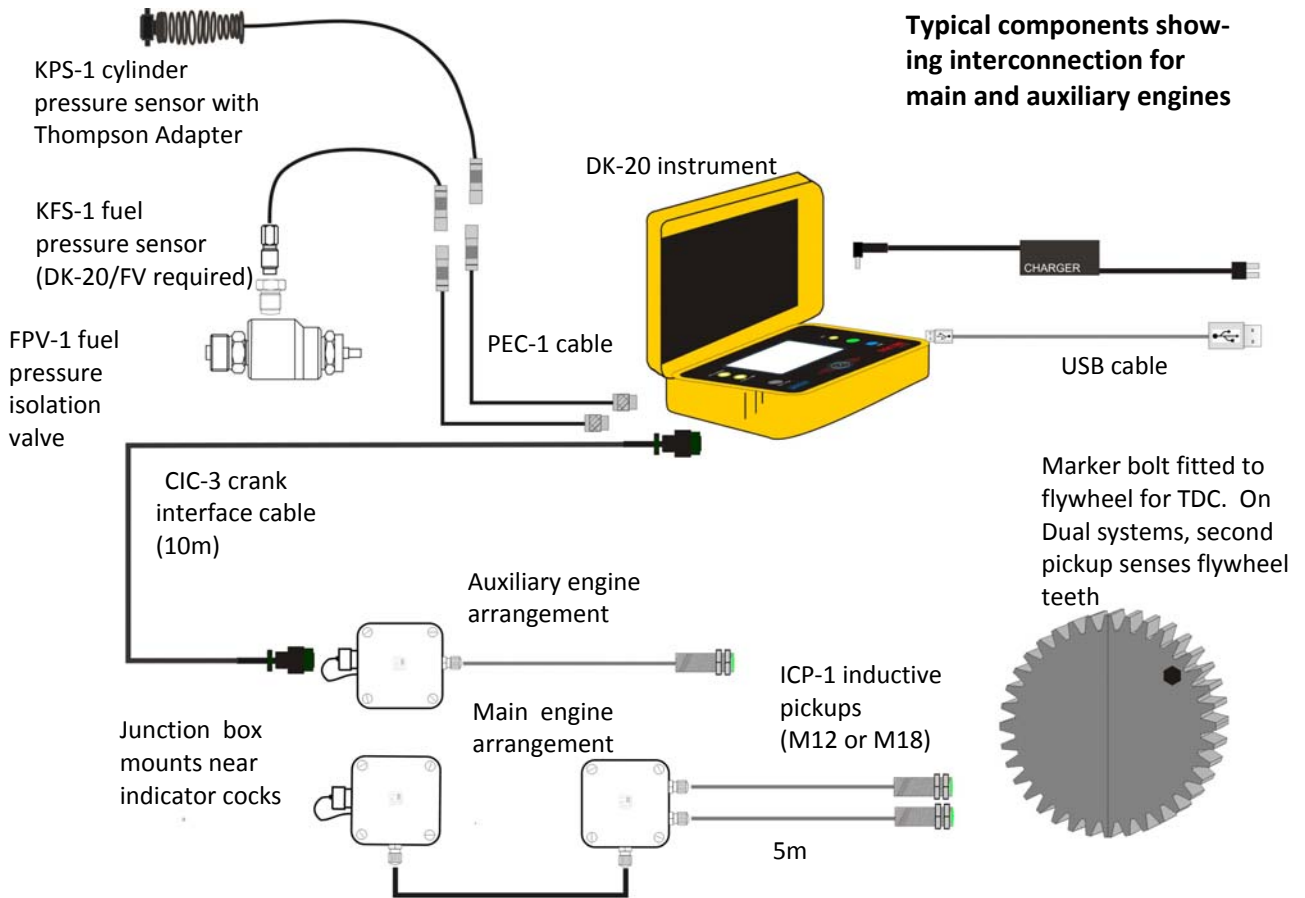
Operating Temperature:	-10°C to +55°C
Sealing:	IP66 (IP67 with lid closed)
Compliance:	CE, RoHS

## 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

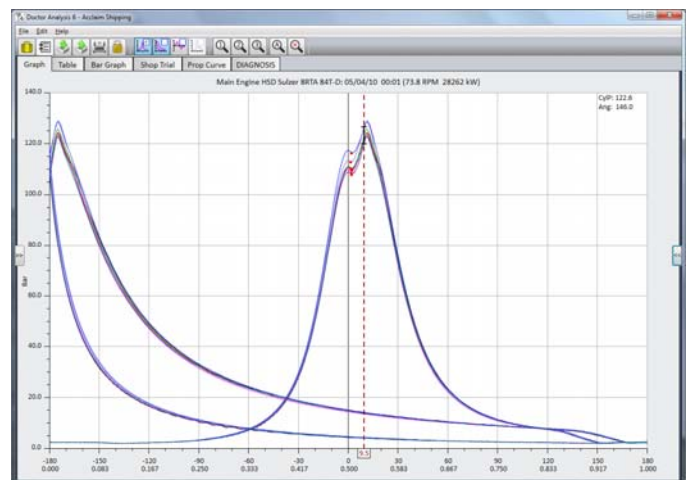
For over 20 years, the Doctor has been helping engineers to manage their engines' condition and maintenance. The latest version V6 has been completely rewritten and is Windows™ XP, 7 and 8 compatible. Version V6 retains many of the standard features that current users are familiar with, but adds many 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 will automatically start up with a samples library that will let you try out the features of the software. 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

Windows™ XP, 7 and 8 compatible (32- and 64-bit)  
Converts earlier Doctor database formats

#### Engine Configurations

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

#### Displays

Trace, bar graph or table of results  
Pressure-Angle, Pressure Volume, Derivative, Fuel Pressure or Vibration trace combinations  
Overlay of any test with any other combination of tests for any engine, or similar engine tests from the same or from different ships  
Quick-Smart Zoom with Favourite Zoom stores  
Flexible cursor options  
MIP, Power and other results calculated automatically  
Ability to re-calculate results  
Notes can be tagged to test or engine  
Password locking of key parameters

#### Data Exchange

Copy or move results, engines, ships etc. between libraries  
Fully network compliant  
Drag-and-drop data exchange

#### Analysis Tools

On-screen single click switching between traces, tables, bar graphs and diagnostics  
Point and click trace highlight  
Sort traces by cylinder or firing order  
Compare between multiple engine diagnostic reports  
Ignition point markers on traces  
ISO normalisation  
Propeller curves for 2-stroke engines  
Shop/Sea trial comparisons with settable deviation limits

#### Fleet Analysis

The user can select results from several engines at once. This powerful tool allows comparison of engines on the same ship, on different ships and even between different operators. It is the ideal tool for Fleet Analysis of engines.

# Doctor V6 Diagnostics

## Diagnostic Reporter Module

The **Diagnostic Reporter Module** was introduced in version 5 of the Doctor software. This has now been greatly enhanced in version 6 with additional diagnostic rules and improved ease-of-use. The **Doctor** not only provides high accuracy results but it can evaluate them as well. This innovation truly empowers engineers and provides a valuable tool in their engine management portfolio.

The **Diagnostic Reporter** has been developed using 20 years of experience in diesel engine diagnostics. The analysis results help to point the engineers in the right direction regarding maintenance of their engines. And, when engines are healthy, a report with all green indicators gives a measure of comfort.

The Diagnostic **Reporter** uses a six step analysis procedure that has been developed over 20 years to perform an analysis. This process can be carried out manually but requires significant examination of cylinder data. The reporter does the analysis automatically and the results are available in seconds.

Diagnostic **Reports** include an analysis section where the results of the six steps are summarised, and diagnostic statements are given if problems are identified. Pre-selected graphs of the results are next, followed by tabular and bar graph data.

Moving between traces, tables, bar-graphs and the diagnostics summary can be carried out by single clicks on the computer report screen. Notes can be added at each section for further explanation or to suggest remedial work. A report can then be generated in pdf format for assessment by others within the organisation.

The diagnostics function can act as a useful training aid for less experienced engineers and is a valuable tool for pointing experienced technical staff in the direction of possible problem areas. Indeed, the reporter has been known to find issues that even the most experienced engineer could not see from examination of traces and other data.

The screenshot displays the Doctor Analysis 6 software interface. On the left, a 'Hierarchy' tree shows the engine components: Acclaim Shipping, M.T. Hillary, and Auxiliary 1. A table lists various test runs with columns for date, RPM, and kW. The selected test is '11/12/09 00:02' at 900.6 RPM and 1048 kW. The main window shows a diagnostic report for 'M.T. Hillary - Auxiliary 1 - 11/12/09 00:02' with RPM: 900.6 - kW: 1048 - Percent. The report includes sections for Validity Test, Compression Comparison at -3, Pre-ignition, Ignition, Spread of Flame, and Power Balance. A graph titled 'Main Engine HSD Sizer WFA 407 01-1000000-0002 71.8 BHP (52.52 kW 70.9%)' shows two power curves. A disclaimer at the bottom states: 'Disclaimer: While every effort has been made to provide accurate results, Icon Research Ltd. is not liable for the consequence of any actions taken based on any diagnosis whether automatically or manually produced from Doctor results. Automated analysis uses algorithms that can give false interpretation on occasions. The results from automated diagnostics should always be checked by other means before any action is taken.'

## Sea/Shop Trial and Propeller Curves

### Shop and Sea Trial Comparisons

Doctor Version 6 software enables ongoing comparisons to be made with measurements taken during Shop and Sea Trials. These can be recalled at the click of a button on the appropriate tab on the computer screen. Measurements can be ISO corrected so that measurements can be taken anywhere in the world for accurate comparisons. MAN and Wartsila ISO correction methods are both included.

Shop and Sea Trial measurement data is entered manually and allowable limits are then defined. A “traffic-light” green-yellow-red warning system is used to indicate if current readings are outside the pre-determined limits. A green symbol means that the current measurement is good, and yellow and red provide two levels of warning. A range of scalar values can be compared with shop/sea trial values, plotted against both % Load and RPM. Industry standard formats and terminology have been employed to ensure engineers can quickly understand and interpret data.

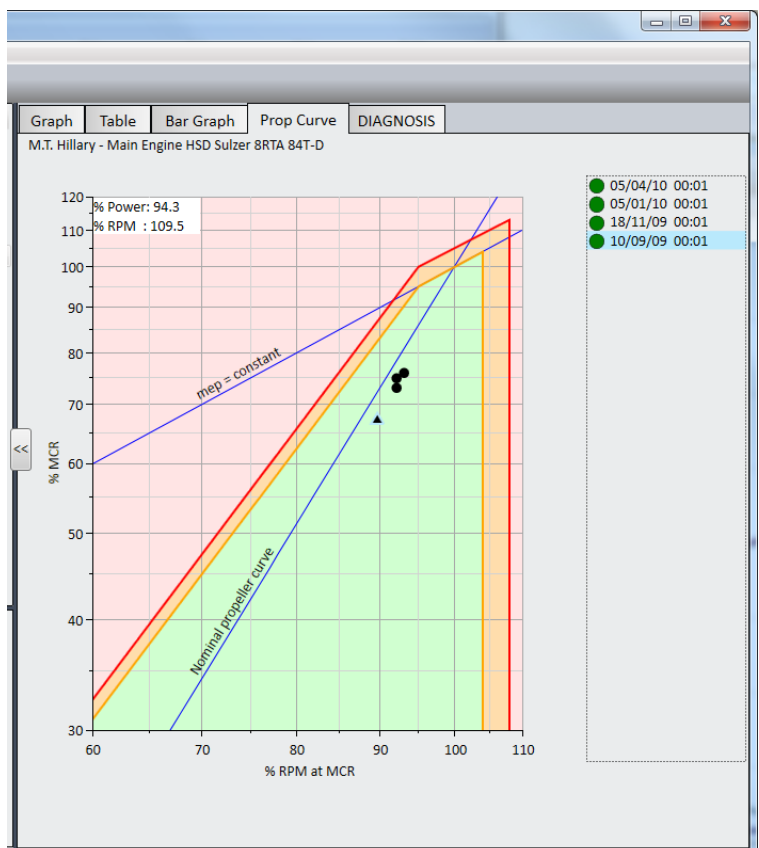
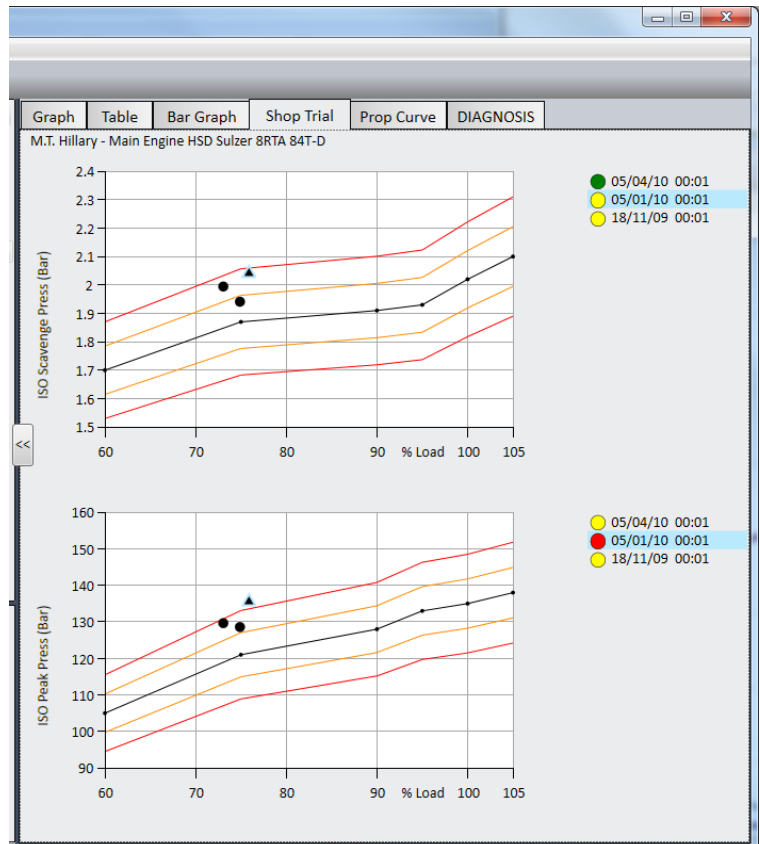
Shop and sea trial comparison can be analysed by the diagnostic reporter and the results included in the engine report. This procedure is ideal for the typical monthly engine reports produced by vessels.

### Propeller Curves

As soon as readings are transferred from the DK instrument, the propeller curve graph can display whether the engine is running in its safe zone or if the engine is being overloaded. This is achieved by a single click on the appropriate tab on the computer screen. The same “traffic light” system is applied to indicate the status compared with pre-determined limits. The graphical output is in a standard format that is easily understood by technical staff.

The propeller curve is used for 2-stroke main engines. Observing that the engine is operating in the green zone is once again a comfort factor that the engine is not being inadvertently overloaded.

Propeller curve comparisons are included in the engine report.



### **Installation and Commissioning**

#### **Self Install - the Easy Option**

The Doctor DK 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 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. This service is included irrespective of whether the Doctor Setup Service is being used.

#### **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 almost 20 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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