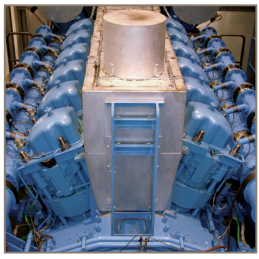

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Ferrous Wear Meter *plus*

Instruction Manual

Parker Kittiwake

ENGINEERING YOUR SUCCESS.

Contents

1 Introduction

This manual covers use and operation of the Ferrous Wear Meter*plus* (FWM+). The instrument provides an accurate means of detecting and measuring the quantity of ferrous material, such as iron or steel, suspended in oils and greases and other fluids. The rugged, compact and stable monitor delivers retrievable data quickly and simply, ensuring fast, accurate and consistent management of lubricant samples.

Condition monitoring of machinery lubricants is an established method of predicting and avoiding impending machinery breakdown. Worn components can be identified early and replaced before any serious damage occurs. Production can be maintained, machinery life extended and the return on capital investment increased.

The FWM+ is an important tool for optimisation of cylinder oil feed rates for slow-speed diesel (two-stroke) engines and can be used, in conjunction with other products in the Parker Kittiwake range, to develop a much deeper understanding of health and operating parameters of these engines. Please see **Section 13** for more information.

Key to Symbols

Caution

Note - important information and helpful hints and tips

2 Safety Summary

Please read and understand this user document before attempting to use the FWM+.

Caution

- Never use the FWM+ near highly combustible gases or liquids.
- While the FWM+ is designed to be usable without any special training or qualification, this does not negate requirements for any specific training or qualifications required by the owner/operator of the location where the FWM+ is used.
- If the FWM+ is used in a manner or for a purpose, other than that described in this manual, any safety protection may be impaired.

Warning! This equipment has not been approved for use in an explosive atmosphere.

3 Technical specification

Rated Input Voltage	24 V d.c.
Rated Input Current	0.3 A
Operating temperature	15 to 40°C
IP Rating	IP22
Instrument Weight	1.1 Kg
Measurement Range	0 to 15% by mass (mg/kg)
Displayed Resolution	5 ppm between 0 and 2495 ppm 10 ppm between 2500 and 9990 ppm 0.01 % between 1.00 and 9.99 % 0.1 % between 10.0 and 15.0 %
Sample Container	FWM+ Test Tube
Test time	<3 seconds
Unit dimensions	250 mm (W) x 230 mm (D) x 75 mm (H)
Standard	ASTM D8120 Standard Test Method for Ferrous Debris Quantification

Repeatability Limit[1]	
0 ppm to 9999 ppm	± 4% at 189 ppm ± 2% at 531 ppm ± 2% at 922 ppm ± 1% at 1936 ppm ± 2% at 9794 ppm
1% to 15%	± 0.1% at 4.6% ± 0.1% at 10.3% ± 0.4% at 14.1%

[1]Refer to ASTM E177-14 where 'repeatability limit' is defined as the value below which the absolute difference between two individual test results obtained under repeatability conditions may be expected to occur with a probability of approximately 0.95 (95%).

% to ppm Conversion Table	
15%	150,000 ppm
10%	100,000 ppm
1%	10,000 ppm
0.1%	1,000 ppm
0.01%	100 ppm

4 Manufacturer information

Please contact the manufacturer for service, consumables, spare parts, repair and recalibration.

Parker Kittiwake
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West Sussex
BN17 7LU

Tel: +44 1903 731470
Email: kittiwake.support@parker.com
Web: www.kittiwake.com

5 Spares/consumables

Part Number	Description
FG-K30362-KW	FWM+ Consumables Pack (500-off FWM+ Test Tubes & 500-off Sampling Pipettes)
FG-K30366-KW	FWM+ PSU Pack (Power Supply with UK, US & EU Adaptors)
FG-K30368-KW	FWM+ Recalibration
FG-K31307-KW	FWM+ Grease Sampling Kit (25-off)

6 Cleaning and maintenance

Cleaning

If the instrument requires cleaning, use a soft cloth and mild detergent only. Do not use other solvents or cleaning products on the FWM+ as these may damage the instrument.

It is important that the instrument measurement hole (**Section 9**) remains clean at all times, otherwise test data could be variable and inaccurate. Carefully clean with a soft cloth and mild detergent.

Maintenance

The FWM+ does not have any user serviceable parts. Do not attempt to dismantle the FWM+. Warranty will be void if the instrument is dismantled. For service, maintenance and repair, contact the manufacturer.

Returns and Packaging

Return the instrument to the manufacturer for all servicing and repair. Please retain all original instrument packaging for return shipping. The manufacturer will not be liable for damage to returned goods resulting from inadequate packaging.

7 Recalibration

The proven long-term accuracy of the FWM+ makes regular recalibration unnecessary.

Check Standards are provided with the instrument to allow confidence checking of instrument. The unit may need recalibration if measurements do not fall within the ppm values on the standard.

Contact the manufacturer for details on service and recalibration.

8 Sample preparation

Samples to be measured by the FWM+ must be contained in a FWM+ Test Tube. Using other tubes may damage the instrument and give inaccurate results. For slow-speed Diesel applications, please also refer to **Section 10** for more information.

The following applies to oils and liquids. To measure grease, follow the instructions provided with the FWM grease kit.

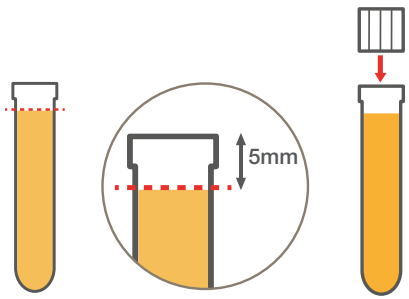
Ordering information for additional FWM+ Test Tubes, as well as other accessories, can be found in **Section 5**.

In order to ensure maximum accuracy, the following steps should be taken to ensure the measured sample is representative of the main body of fluid:

- Any containers used to store or collect samples (including the FWM+ Test Tubes) should be clean and free of contamination before use.
- If possible, fill the FWM+ Test Tube directly from a test / sampling point in the system. Refer to **Section 14** for further guidance on taking oil samples from a system.

  If the test tube cannot be filled directly from the system, use a clean bottle, such as those used for routine oil analysis, and transfer a representative sample into the FWM+ sample tube - pipettes are included with the FWM+ for this purpose. Use a pipette only once to avoid cross-contamination.
- The FWM+ Test Tube should be filled with at least 5mL of sample to the line shown in the picture below and securely fit the cap.

  Do not over-fill as this could lead to the sample fluid contaminating the outside of the FWM+ Test Tube and FWM+ instrument.



- It is good practise to shake the sample before measurement as samples can settle with time – if the ferrous material is not evenly mixed throughout the sample, the FWM+ may over, or under report the ferrous content of the sample.

  Ensure lid is fitted securely.
- The instrument and the sample to be tested should both be at approximately the same temperature at the time of testing. Significant temperature differences can affect the measurement accuracy.

- The exterior of the FWM+ Test Tube must be free of contamination.
- The FWM uses an optical sensor to detect when a sample has been inserted. If the sample is transparent and colourless / light coloured, the FWM may not detect the sample. To rectify this attach a suitable label to the exterior of the FWM Test Tube. Ensure that the size and thickness of the label does not impede the smooth insertion and removal of the tube from the sample receptacle. Be aware that some inks contain metal that can affect readings.

Ensure the lower half of the FWM+ Test Tube is covered by the label.

9 FWM+ instrument location

Locate the FWM+ in accordance with the following guidelines:

- Put the FWM+ on a flat, level surface such as a workbench or a desk.
- For best results, keep the FWM+ in temperature stable environments away from strong drafts and heat sources such as air conditioning vents or heaters.
- Avoid placing the FWM+ near strong magnetic fields, such as large electronic motors or generators, power transformers, loudspeakers or microwave ovens (these can even affect the instrument through walls).

10 Method

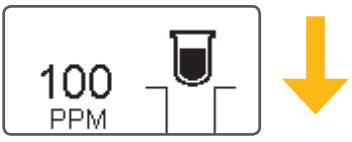
The FWM+ kit is supplied with three resin check standards. These are intended to provide the user with a set of confidence checks across the instrument's measurement range.

Do not use excessive force to locate the FWM+ Test Tube into the instrument as this could result in variable and inaccurate test data. Once the test tube is fully inserted into the FWM+ instrument remove your hand and await on-screen instructions. Only when the display graphic indicates, remove the test sample in smooth action.

Follow the on-screen messages.

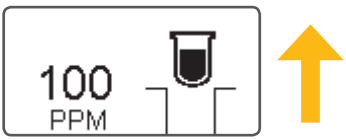
Screen 1: Test tube moving downwards

This screen indicates that the instrument is ready to measure a new sample. The previous reading will also be displayed. Insert the sample to begin measurement.



Screen 2: Test tube moving upwards

This screen indicates that the instrument has measured the sample. The previous reading will also be displayed. Remove the sample with a swift, smooth action.



Screen 3: Measurement

The new sample measurement will be displayed:

The FWM+ will return to screen 1 ready for the next measurement:

Note that above 9990ppm, the measurement will be displayed as a % iron. Refer to **Section 15** for recommended sample numbers and sampling frequency.

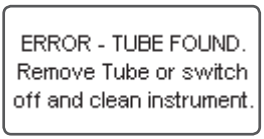
11 Troubleshooting

The Error Screens will display the firmware part number and version on the bottom line (FW-K30257 vN.NN).

Tube Detection Error

On power-up the unit checks that the sample receptacle is clear. If the receptacle is not clear, this is either because a tube has been left in, that something has fallen into the receptacle or that the receptacle sides need cleaning. It may be possible that a component has failed.

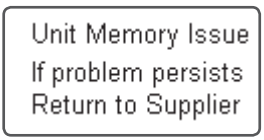
The following message will be displayed.

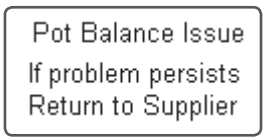


If the unit is thoroughly cleaned and the message still appears, return the unit to the supplier.

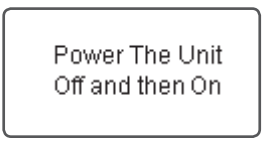
Error screens

If a unit has become damaged or a component fails an appropriate message will be displayed. These include the following:





The message will alternate with the following instruction:



Operational Problems

Symptom	Possible Cause	Possible Solutions
Results are erratic	Interference from nearby objects	Make sure the FWM+ is located away from sources of magnetic fields such as heavy machinery, motors, transformers, and heavy power cables. Move the instrument to a different location and repeat the measurements. Large metal jewellery or watches need removing
	Excessive force applied when inserting sample	Apply minimal force when inserting the FWM+ Test Tube. Allow the sample to drop under its own weight and release hand prior to removal. Remove sample in a smooth and controlled action.
	Unclean instrument	Ensure there is no contamination of the exterior of the test tubes or of the sample measurement hole on the FWM+. If necessary clean the sample measurement hole, following the guidelines from **Section 6**
	Temperature changes	Ensure the FWM+ and the sample are at similar temperatures before measuring. Ensure there are no sources of heat or cold close to the FWM+. Allow the instrument to warm up for approximately 3 minutes after powering on.
	User interference	Keep hands away from the instrument while the readings are taking place. Do not attempt to anticipate screen instructions; wait until instructed before inserting / removing the sample.
Results are changing with time	This is a result of particles settling in the sample due to gravity and is normal	In order to gain consistent results always ensure the same sampling routine is followed. Use the supplied FWM+ check standards to verify instrument measurements.
Results from the FWM+ are different to those from a laboratory test	Ferrous material is not evenly mixed throughout the sample	If the ferrous material is not evenly mixed throughout the sample, the FWM+ may over, or under, report the ferrous contents of the sample - shaking the sample before measurement may improve the accuracy of readings.
	FWM+ uses different measurement principals than laboratory tests	Refer to **Section 12**
FWM+ does not detect a sample	Sample is not triggering the optical detector	Ensure there is no contamination of the exterior of the test tubes or of the sample measurement hole, refer to **Section 6.** If the sample is transparent and colourless / light coloured, the FWM+ may not detect the sample. Affix a suitable label to the exterior. Refer to **Section 8**.

12 Technical explanation

The FWM+ generates a small alternating magnetic field and detects the change in this field caused by the presence of microscopic particles of ferromagnetic materials such as irons and steels. It is factory calibrated so as to display the total particle mass per unit mass of oil as a value in parts per million and this measurement is independent of the number, size and shape of the individual particles. It may not give correct readings for “non-magnetic” stainless steels. The circuitry is designed to reject any effect from non-ferromagnetic metal particles such as aluminium and bearing metals. The FWM+ is also insensitive to chemically combined iron, this allows it to be used in conjunction with the Parker Kittiwake Cold Corrosion Test Kit to independently quantify mechanical and corrosive wear.

Understanding readings when compared to laboratory results

To get the most from the FWM+, it is important to understand how Fe readings derived from laboratory analysis of used oil may differ from the Fe readings derived from the FWM+.

Why are FWM+ measurements higher than laboratory analysis?

Nearly all oil analysis labs use one of two types of atomic emission spectrometer, either an inductively coupled plasma (ICP) instrument, or a rotating disc electrode (RDE) instrument.

In both instruments, oil samples are vaporised and the atoms excited by the high-energy source. The light emitted by the excited atoms is split into light of different wavelength or colours into discrete wavelengths. The light intensity at each wavelength is measured and the resultant signal converted to a concentration in parts per million based on a simple calibration procedure.

Both ICP and RDE instruments suffer from size limitation effects, that mean they fail to vaporise and measure particles greater than 5 microns (>0.005 mm).

Therefore, it is not uncommon to obtain higher ppm readings from the FWM+ when compared to laboratory results, since laboratory methods often miss large particles.

Why are FWM+ measurements lower than laboratory analysis?

The principles employed in the FWM+ to detect Fe means that it will only detect uncombined or elemental ferromagnetic material. Ferrous Oxide (Fe_2O_3 or rust) is not detected. In other words, if the sample contains a significant proportion of Fe derived from a corrosive process, it is not uncommon to obtain a lower ppm reading. Refer to **Section 13** for more information on detecting non-ferromagnetic Fe.

13 Large slow-speed two stroke engines

The FWM+ can measure the quantity of metallic iron (or iron alloys, such as steel) in a sample fluid. This measurement can be used to gauge the amount of mechanical wear occurring within a system, but is not suitable for detecting the effects of corrosive wear.

In applications where corrosive wear may also be present, such as within the cylinder of a large two stroke engine, it is recommended the Parker Kittiwake Cold Corrosion Test Kit (CCTK) is also used to complement the FWM+ and provide a total iron measurement (Abrasive + Corrosive). The CCTK provides a quick, simple on-board test to measure just the corroded (Fe^{2+} and Fe^{3+}) iron content within a used scrape-down oil sample.

Parker Kittiwake also offers a residual Base Number (BN) instrument. Together, the FWM+, CCTK and BN instrument provide key information necessary for cylinder oil feed-rate optimisation.

Parker Kittiwake offers a comprehensive range of on-board testing solutions.
See **www.kittiwake.com** for more details on viscosity, water-in-oil, fuel compatibility, density and bunker sampling solutions.

14 Taking cylinder drain oil samples

General advice

For consistency and trending purposes, it is important to sample when the engine is under the same operating conditions, ideally with the measurement of other key data such as Pmax, individual cylinder exhaust temperatures, engine power and engine rpm. In addition to filling the sample bottle, additional drain material should be collected at the same time for on-board BN measurement, if required.

Samples of cylinder drain oil can tell a lot about the wear that may be occurring in an engine, but this is only true if each sample is taken under the same conditions of engine load and engine speed.

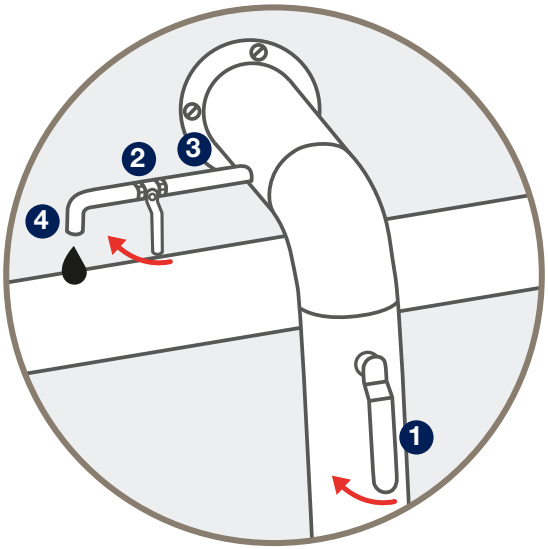
Scavenge drain lines are under pressure. When taking a sample, observe the appropriate health and safety requirements in operation on the vessel, with particular attention to the use of protective eye wear and gloves.

Taking a sample

- Shut main drain valve (1).
- Carefully open sampling valve (2) and purge into a suitable container - oil to be disposed.
- Close sampling valve (2) after purging.
- Keep main valve (1) closed and allow liquid to build up in drain line (3).
- Place sample bottle under sampling line (4).
- Carefully open sampling valve (2) and collect sample.

  Collect enough additional sample material at this time to check corrosive wear (CCTK) and residual Base Number (BN). Refer to **Section 13**.

- Close sampling valve (2) and re-open main drain valve (1) or reset to correct running position.



15 Number of samples required and sampling frequency

Sample intervals should initially be every 250 hours when collecting data to establish an analytical baseline. The number of samples required to produce a baseline will depend on how quickly a clear trend of analytical results is seen. The objective is to produce an analytical trend with sufficient confidence to allow monitoring of wear performance. Between five and ten samples is the expected requirement for a reasonable baseline. The recommended practice is to take a sample and check with the FWM+ every 250 hours. Sending a sample for laboratory analysis every 1000 hours for a more in-depth analysis.

16 Declaration

EC Declaration of Conformity

Manufacturer:

Parker Hannifin Manufacturing Ltd
3-6 Thorgate Road
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West Sussex
BN17 7LU
United Kingdom

Tel: +44 (0) 1903 731470
Fax: +44 (0) 1903 731480
kittiwakesales@parker.com
www.kittiwake.com
www.parker.com

Hereby declares that the following apparatus:

Product Name: Ferrous Wear Meter (FWM+)

Model Number(s): AS-K30286

Are in conformity with the following Directives and Standards:

Electromagnetic Compatibility EMC Directive 2004/108/EC

EN61326-1: 2013 Electrical equipment for measurement, control and laboratory use – EMC requirements

Manufacturers Signature:

Andrew Baldwin
Technical Manager, Parker Hannifin Manufacturing Ltd. Date : 02 February 2015

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