INDUCTION MOTOR:

Energy Efficiency Replacement Charts and Report

MARKET • PRODUCT • APPLICATION • CUSTOMISATION • LOGISTICS • INFRASTRUCTURE

know-how makes the difference

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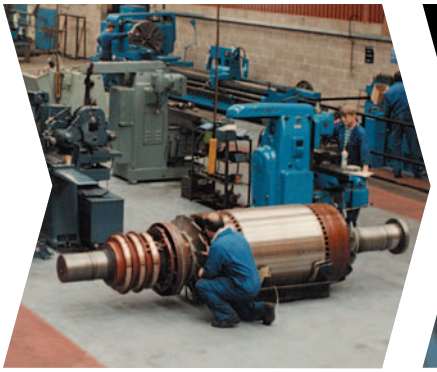

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3. Information about this document

In the past there have been claims that rewinding a motor, decreases efficiency this is despite studies that confirm this is not as true as it is perceived.

This document is to help assist in identifying the actual efficiency rating of an electric motor and provide a rating to better advice when a motor should be replaced or rewound, the latter will become clear later on in this document.

All the information based in this document has been obtained using practical test methods as used by EASA & AEMT in their research, and various manufacturers' motor characteristic charts, WEG, TECO WESTINGHOUSE & BROOK CROMPTON our main focus in this report has been on the EFF1 & EFF2 motors manufactured by WEG.

The contents of this document, uses actual evidence, provided in a study conducted by EASA / AEMT and actual motor output readings of new Efficiency I & Efficiency II motors which data was obtained from Manufacturers web sites, all detailed references stated in the **Appendix 1**

Within this document we have excluded any motor that has an efficiency greater than Efficiency I, this is due to not having any research on the characteristics after repair and the data would not be conclusive enough to provide a report with sufficient evidence.

4. Introduction

Electric Motors are used in every aspect of daily life through-out the world, and more so as time goes by. We ERIKS are the largest group of companies that repair Electric motors in the UK, and have looked at the practice with large concerns to how efficient our repairs are.

This document is comprised of charts and a table which show the actual facts and figures gathered to come to our conclusion as well as information on the data and to help our customers better understand the way we rate when a motor should be replaced or rewound.

We are aware of the constraints cast upon industry today and this is only to be used as a reference.

We hope this document helps in process of identifying when a motor should be replaced.

5. Losses

Within a motor there are a number of losses that cannot be reclaimed, this is due to the materials being used in manufacturing and the physical / mechanical characteristics of the materials involved when in use; these are as follows and identified by the principle standards relevant to rotating equipment as Appendix 2:

- Stator I2R losses
- Rotor I2R losses
- Core loss
- Friction and Windage loss
- No-load losses

See Appendix 1 for description on losses

The losses above account for an average of 15% reduction in the efficiency of a motor. The rest of this report will automatically take into consideration this value and show 100 % as a percentage of the remaining 85% of power remaining in the motors referred to.

LOSSES	2 POLE AVERAGE	4 POLE AVERAGE
CORE LOSSES	19%	21%
FRICTION & WINDAGE	25%	10%
STATOR I2R	26%	34%
ROTOR I2R	19%	21%
STRAY LOAD LOSSES	11%	14%

Table 1 shows a break down of where the losses are present and the value of these.

6. Actual Motor Power and Efficiency

Charts 1 & 2 below, show actual readings of the full load output power of AC induction motors at various full load percentages. See Appendix 2 for reference information.

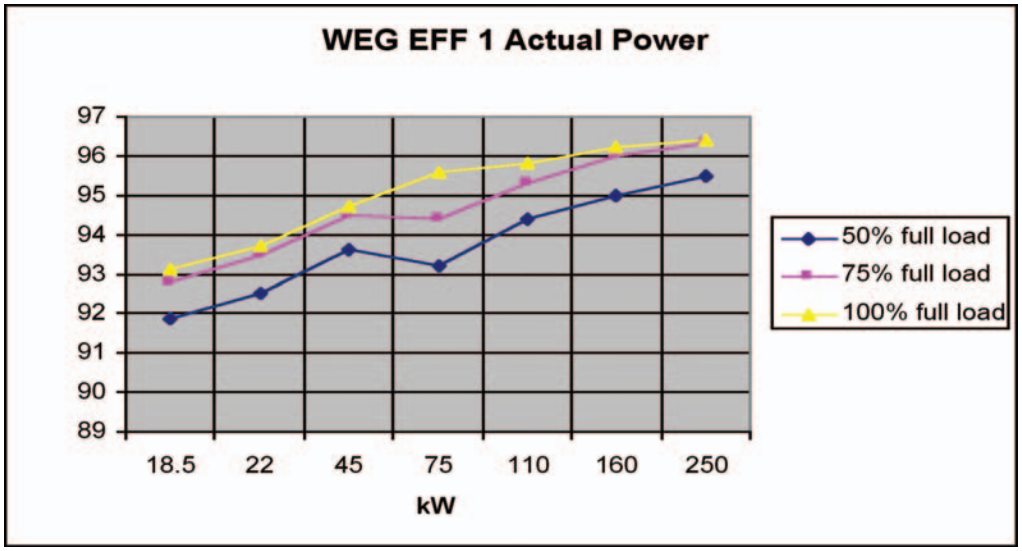

CHART 1

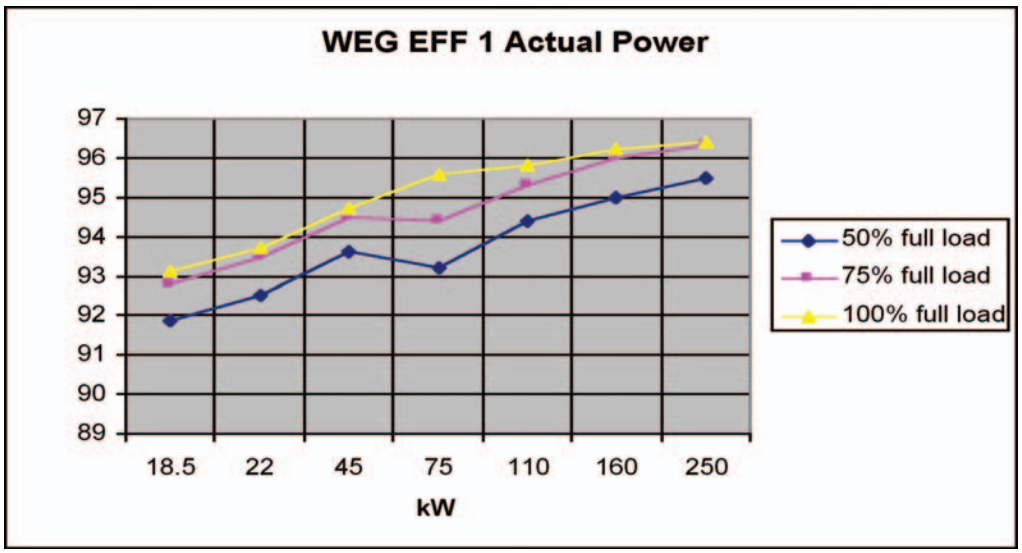

CHART 2

As we can see from the charts, when a motor is not at full load there is a greater loss of power. This is a loss in efficiency and when a motor is not at full load the initial losses are increased, (see Table 1 for initial above for losses).

7. Motor Efficiency Replacement chart

Charts 3 & 4 show when either an Efficiency I, or Efficiency II motor should be replaced based on the actual mechanical output power.

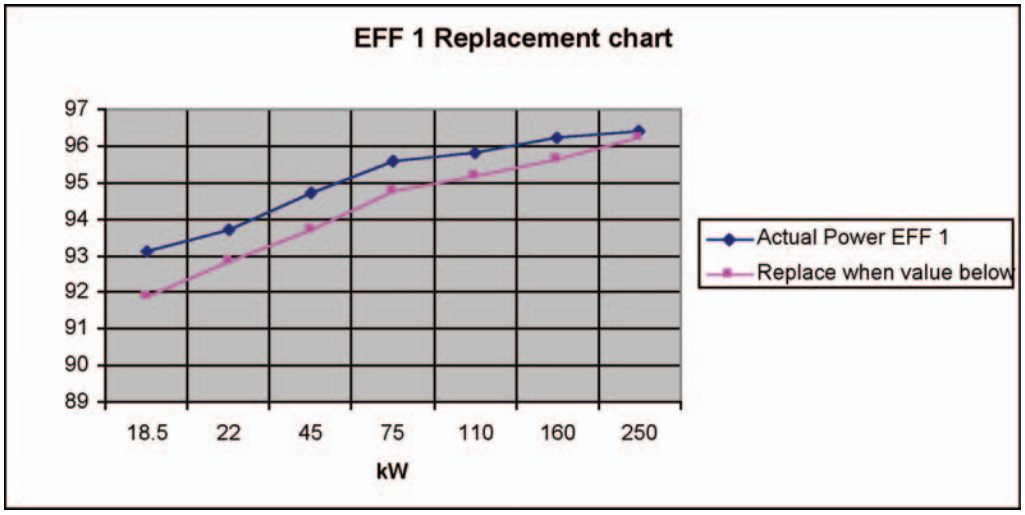

CHART 3

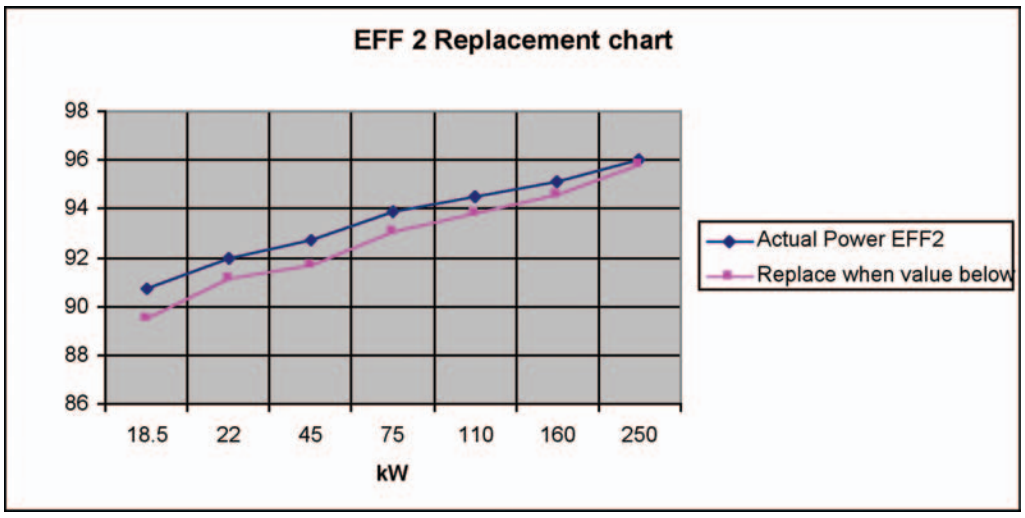

CHART 4

There is a fine line and little difference between the actual output power of Efficiency I and Efficiency II motors. However this small difference does; within a year; make a large difference to expenses on the unit involved, as an asset.

8. Values used to Rate Motors

Following the Rewind study carried out by EASA/AEMT clarifies that a motor; if rewound using good practise; as well as loose a small percentage (maximum on motors tested of - 0.6 %) of efficiency, also has a possibility of gaining efficiency for further reading refer to EASA/AEMT Repair Rewind study.

Below is a chart determining the efficiency rating a motor shall hold, this can only be determined after repair and based on the actual mechanical output obtained from that motor upon test using a load test Torque meter which ERIKS have.

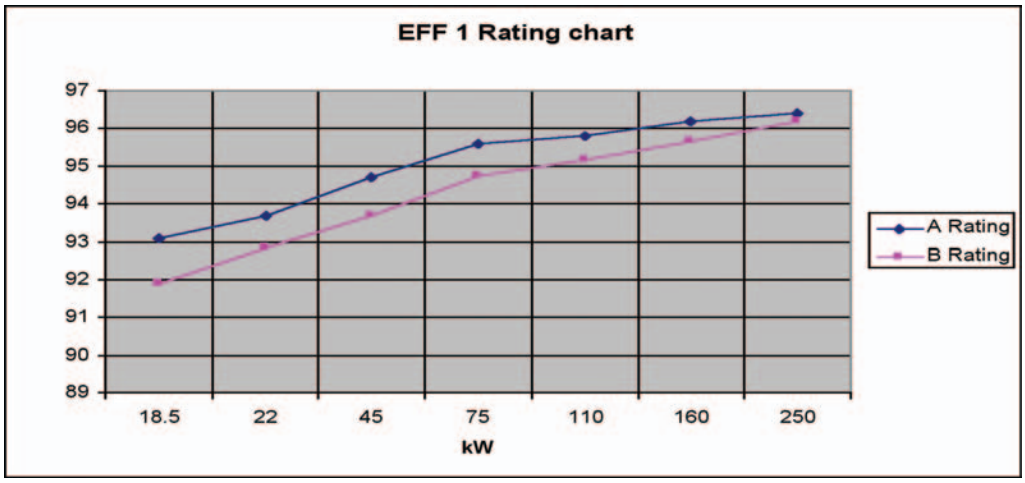

CHART 3

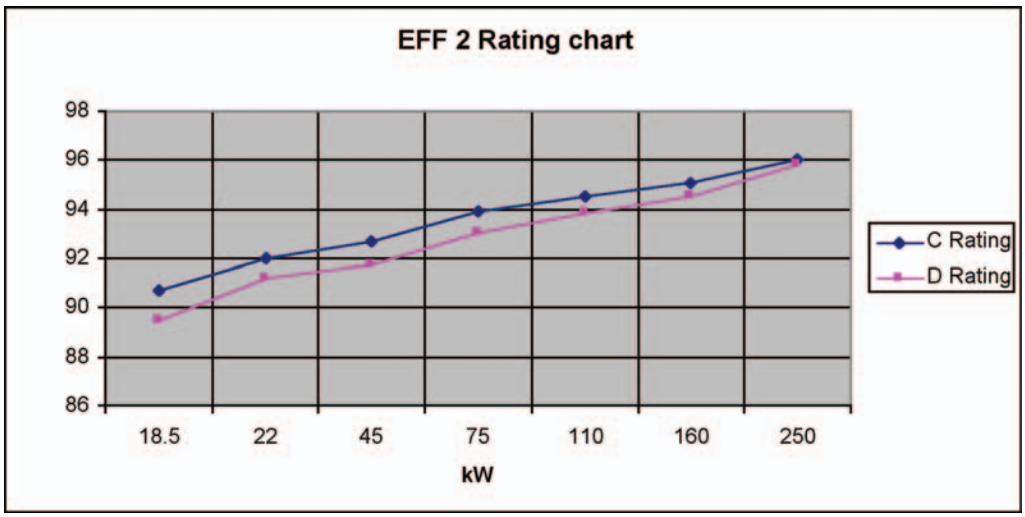

CHART 4

Due to the small changes in percentage of efficiency, an 'A' Rating motor is an EFF 1 as calculated by the manufacturer; the same is applicable to the 'C' Rating EFF II. The 'B' Rating EFF 1 motor is the lowest value estimated before that motor is deemed in-efficient. This is due to the fact being at this stage of the motors output power it will be nearer the 75% full load rating shown in Chart 1, 18.5kW motor, hence more initial losses will occur causing the motor characteristics to change. This is also applicable to the 'D' Rating EFF II.

10. Conclusion

The data in this report has been obtained through experience, from a joint study between EASA & AEMT and also where required other data has been from manufacturers websites, further details to be found in Appendix.

The philosophy within the ERIKS Electro Mechanical Services Group is to repair motors to best practise and ensure that the mechanical and physical properties remain in a correct functional order.

As we can see from the results and through further reading it does benefit to work to best practice and ensure all employees follow these. However ERIKS monitors both workshop practice and employees though our quality control and continuous improvement assessment programmes, to ensure the customers equipment is repaired in a way that would be expected and ensure that we are working to the best possible standards with a very professional workforce.

ERIKS know the repair / replace decisions have many variables and can only be made when the time comes to repair a motor. Due to the Know-How and experience ERIKS have in the repair industry, and the technology available to us, we are in an excellent position to provide a full asset management programme which not only has been proven to reduce down time but has also shown to our existing customers that we can monitor rotating equipment to ensure maximum efficiency, also when you the customer has the confidence that when we rewind / replace a motor we will ensure that this is carried out in the most efficient way possible.

11. Appendix A: Terminology

Stator I2R losses:	The stator I2R loss (Watts) is 1.5 x I2R for 3 ~ machines I = Calculated or Measured rms current per line terminal at the specified load. R = The DC resistance between any two line terminals corrected to the temperature
Rotor I2R losses:	The Rotor I2R loss should be determined from the per unit slip, whenever the slip can be determined accurately using the following formula; (Measured stator input power – Stator I2R loss – core loss) x Slip.
Core loss:	These occur owing to hysteresis and Eddy current losses set up in the iron of the magnetic circuit, which is due to alternating and varying flux.
Friction and Windage loss:	This is found by running the machine as a motor at rated voltage and frequency without connected load. To ensure the correct value of friction loss is obtained the machine should be operated until the has stabilised.
No-load losses:	The losses occurring in a motor when operating but giving no output.

12. Appendix B: Data Sources

EASA:	Electrical Apparatus Service Association – www.easa.com
AEMT:	Association of Electrical & Mechanical Trades www.aemt.co.uk
BS:	British Standards 60034-2-1
IEC:	International Electro Technical Commission 60034-2-1
Larousse:	Dictionary of Science & Technology
WEG:	WEG Electric Motors www.wegelectricmotors.com
EASA/AEMT:	The effect of Repair/Rewinding on Motor Efficiency

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