Electric motors fail for a number of reasons wholly unrelated to their age and to the hours that they have been operating. Problems with power supplies, overheating, contamination, insufficient or unsuitable lubrication and unusual loads can all play their part in impairing the efficient operation of motors, leading to premature - and usually costly - failure for the motor user. Addressing these factors is crucial, therefore, for any enterprise that is seeking to extend motor life, reduce downtime costs and improve OEE.

In any study of the factors that cause motors to fail, the logical place to start is the power supply.

With a properly conditioned and regulated power supply, the output to the motor should be a perfect sine wave on each phase at the motor's rated voltage and frequency.

However, this is rarely achieved, and the result can be a host of problems including: harmonics, which cause overheating and decreased efficiency; overvoltage and undervoltage, the former reducing efficiency and power factor, while the latter increases current and causes overheating; voltage imbalances, which cause overheating and reduce efficiency.

Added to these problems can be others such as voltage spikes - from capacitor switching and VFD cable trays - which cause motor insulation failures; frequencies under 50Hz from VSDs - which require additional cooling for the motor; and motor bearing damage from shaft currents - also the result of using VSD.

This problem can be overcome using an insulated bearing sleeve, electroconductive grease, or a shaft grounding system.

In addition to their negative effect on motor efficiency, supply problems need to be addressed promptly; because they are they are one of the major causes of motors overheating; a condition that causes motor insulation to degrade at a rate that can double for every 100C of overtemperature.

Excessive temperature also causes separation of greases and the breakdown of oils, causing bearing failure.

To overcome the effects of overheating, the user first has to check the operating conditions of the motor; in particular, is the ambient temperature too high?

Is the motor adequately ventilated?

Is the motor correctly loaded?

(ie it is not overloaded).

And is the regime of motor starting and stopping too frequent for normal cooling to be effective?.

Overheating is one of the major causes of lubrication break down; however, even without this condition, the pitfalls with lubrication are many.

Users tend to underlubricate and overlubricate in equal measure, and do not take enough care to ensure that the lubricant does not introduce contaminants into the motor bearings.

In addition, the practice of mixing greases with different bases can cause grease constituents to separate and run out, with disastrous results for the motor.

The contamination that can be introduced into motors by lubricating motor bearings can be excluded with care.

However, contamination, generally, cannot be completely excluded, either by total enclosure or by using explosion-proof enclosures.
This is a concern as in many operating environments the resulting problems of abrasion, corrosion and overheating can destroy motors very quickly.
The problem with abrasion is that motor coils flex when in use, and contamination with abrasive particles can eat away at the wire coating.
As regards corrosion, some substances such as salts can exploit any weakness in the motor insulation, especially when assisted by moisture.
Finally, any heavy accumulation of contaminants usually obstructs cooling passages, either internally in open motors or externally in closed motors; this results in overheating.
Another major source of contamination is humidity.
This becomes a problem when a motor is de-energised long enough to drop near the dew point temperature.
At this point moisture ingresses the motor, weakening the dielectric strength of electrical varnish and other insulating materials.
It also contributes to the corrosion of bearings and other mechanical components.
The key to avoiding these problems is to keep the motor(s) warm.
Where possible, motors stored in humid environments should be pre-warmed several hours - or even longer - before start-up to drive out insulation moisture.
Last but not least is the problem of unusual or unbalanced loads.
A variety of mechanical conditions exist that can either overstress bearings, leading to early failure, or distort the motor frame causing asymmetric air gap, which in turn can cause vibration and bearing failure or winding overheating.
The conditions that cause these problems are to be avoided; they include: couplings that are misaligned; drive belts that are overtightened, or sheeves that are misaligned; dynamic imbalances of the load or internal balance of the motor rotor; motor feet not in the same plane, and/or poorly shimmed; and misapplied bearings.
A motor preventative motor maintenance schedule that checks for all of the above conditions will ensure a healthy motor stock.
However, consider for an instance that the schedule has not been adhered to, and that a motor has failed.
The question, now, is: should it be repaired or replaced?
And if replacement is the best option, should a high efficiency motor be purchased?.
The high cost of energy means that energy efficiency is a major consideration when the question of repairing or replacing an existing motor arises.
However, the repair-versus-replace decision is quite complicated and depends on such variables as the rewind cost, expected rewind loss, energy-efficient motor purchase price, motor size, and original efficiency, load factor, annual operating hours, electricity price, availability of a government rebate, and simple payback criteria.
Among these variables 'expected rewind loss' is notable because when a motor is rewound its efficiency is reduced, and, according to many manufacturers, its reliability also.

The effect the expected rewind loss can have on system efficiency and, hence, long term operating costs can be demonstrated by using the formula below.

The calculation for the energy cost per annum of any electric motor is calculated as the product of the hours used per year multiplied by the kilowatt-hour tariff and by the operating power (in kilowatts), divided by the operating efficiency.

Applying this formula to a typical pumping system using a high efficiency motor rated at 95%, operating at 70kW for 8200h per year and at a tariff of 4.5p/kWh yields a total cost of GBP 27,190 per year.

Using the same formula for a rewound motor with a 92% efficiency rating the result would be GBP 28,076 per year.

What must be borne in mind is that the saving of GBP 886 per year is for just one pump motor - there may be many more on plant, and although the cost of purchasing a high efficiency motor is greater than that for rewinding, offsets in the form of Enhanced Capital Allowances on purchases of high efficiency motors, plus long term energy savings - which are a direct contribution to a company's profit - make the high efficiency motor the best long term alternative.