DISCOVER THE SECRETS OF...

ADDING AMAZINGLY LONG LIFE TO YOUR VEHICLES & EQUIPMENT

BY BRID WALKER

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The aim of this book

This book was written to help all machinery and vehicle operators, owners and maintenance people improve the life and operating efficiency of their equipment.

The majority of people believe they can do no better than have the dealer service their equipment, or alternatively follow the manufacturer's recommended service schedule. While both these methods should produce acceptable results, it doesn't produce the benchmark for efficiency and longevity! This book shows you how to re-set the benchmark for machinery life, operating efficiency and maintenance costs.

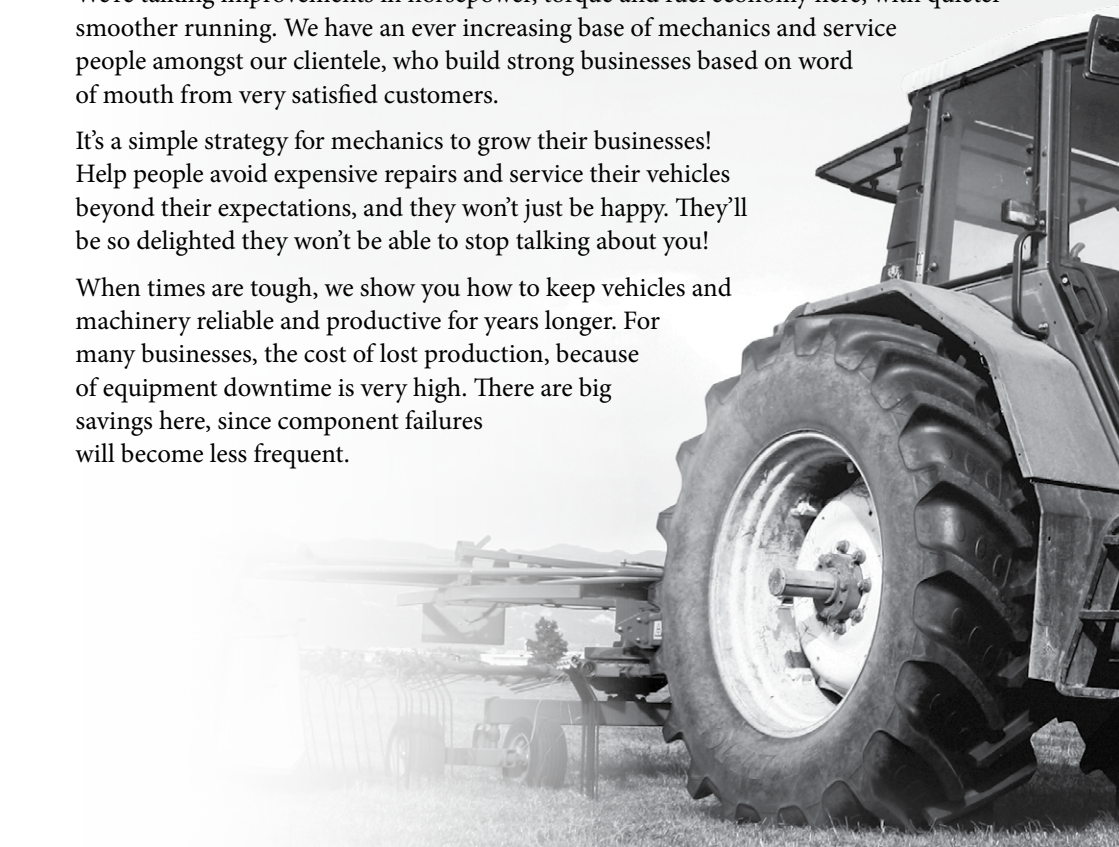
And surprisingly, the little extra things the owner can do are not hard, nor do they take a lot more time. And, they are not expensive! In fact, they will save you $1000's in repairs and maintenance over the life of your equipment, and gain many more $1000's in resale value.

By following the guidelines contained in this book, you not only look after your vehicles and equipment much better, but you'll also make them much more pleasant and efficient to operate.

We're talking improvements in horsepower, torque and fuel economy here, with quieter smoother running. We have an ever increasing base of mechanics and service people amongst our clientele, who build strong businesses based on word of mouth from very satisfied customers.

It's a simple strategy for mechanics to grow their businesses! Help people avoid expensive repairs and service their vehicles beyond their expectations, and they won't just be happy. They'll be so delighted they won't be able to stop talking about you!

When times are tough, we show you how to keep vehicles and machinery reliable and productive for years longer. For many businesses, the cost of lost production, because of equipment downtime is very high. There are big savings here, since component failures will become less frequent.



Finally, the environment will also benefit, through more efficient use of resources. Think of the energy and resources that go into producing all the engines and transmissions of the world. By keeping them in service longer, there are considerable environmental savings. Harmful engine emissions can also be reduced. Fuel efficiency can be improved, saving energy reserves and greenhouse emissions. The effect on greenhouse gases really is quite staggering. Did you know that for every tonne of diesel burnt, over 3 tonnes of carbon dioxide are produced?

Please enjoy this book as you learn how to really get the most out of your machinery. Most importantly, be sure to use only safe practices when working on any machinery. I'll quote some good advice given to me years ago, "If it's not safe, either make it safe or don't do it."

I sincerely hope this book will encourage its readers to partake in a more rewarding way of maintaining their vehicles and equipment.

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1.

Look, listen, feel and smell... the essentials of longer machinery life

As the owner and user of a vehicle or piece of machinery, you have a distinct advantage over the mechanic who services it. You know when there's "something different". To get the most from machinery, you must focus on observing how it runs, feels, sounds, looks like, etc. Do this consciously for a while, and it'll soon become habit.

For example, when you walk to your car, look how it stands. If it's lob-sided, tyre pressure could be low on one corner. There may be a drop of oil under it. What do you hear or feel when you open the door and hop in? Was there a rattle or loose feeling in the door? How quickly did it start? Did it puff out smoke? When you're driving, any rattles or vagueness in steering? Did you notice any unusual smells?

When you wash the car look at the paint work for stone chips, rust at the edge of glass rubbers, scratches, dents, loose fittings, etc. The point is that all this takes no more time or effort than what you're doing anyway, but it gives you important information about your vehicle and warning signals of potential problems and cost. You have the opportunity to nip it in the bud early.

If you do your own servicing, the story continues. You've got to check the oil, water, brake fluid, battery, etc., so spend a couple of extra minutes checking radiator and heater hoses, fan belts for softness or deterioration. Look at vacuum hoses, fan belts and look for oil and water leaks, too. When you dip the oil, look at the colour. Compare it with how the fresh oil looks. Feel it between your fingers, and compare it with fresh oil. You'll soon get to realize if you're leaving your oil in service too long. If anything looks suspect and you cannot fix it yourself, it's best to ask your mechanic. If you have your own car ramps, ensure they're safe and get under the vehicle. Look for rust, dents, cracks in flexible hoses (brake, clutch and fuel), oil and coolant leaks. Look at brake pads and linings for wear, dirt and fluid leaks. The exhaust system should be secure and tight. If it's loose, it will fatigue and crack prematurely.

Are there any signs underneath the vehicle or under the bonnet of anything rubbing? This may be obvious by polished, shiny areas on metal parts, hoses, etc. Are all bolts and nuts tight? Go around with a spanner and check; especially spring U-bolts, suspension and steering parts.

2.

The importance of cleanliness, and the importance of cleaning

Dirt and grime in all its forms accelerates deterioration and wear. Painted surfaces, rubber fittings, moving parts, etc. all last longer if kept clean.

Clean the interior of vehicles. Dirt trapped in carpets, seat covers, under mats causes abrasive wear to these materials, and also absorbs moisture, which allows rust to develop. While you're cleaning, it doesn't take any more effort to look for anything unusual, e.g. paint scratches, bare or rusting metal under the floor mats, brake fluid around the back of brake and clutch cylinders (indicating a leak in one of those systems). It's the same story when you wash the outside.

UNDER THE BONNET: Oil, dirt and grime reduce the engines cooling ability. Take the time to degrease the entire engine and engine bay, taking care to avoid wetting ignition parts, air intakes, clutch and brake hydraulic reservoirs. It's better to hose down engines after they've been warmed up, so any electrics that are accidentally wet, dry off quickly. Once it's clean, it's easy to keep it clean. But more importantly, it's then easier to see if a problem is developing.

- A quick look around and you can spot an oil or coolant leak, an exhaust leak, etc.
- A quick wipe around with a rag to remove dust, especially from high tension leads gives you the chance to have a good look around.

REMEMBER: SAFETY FIRST... IF IT'S NOT SAFE, DON'T DO IT!

UNDER THE VEHICLE: Under the vehicle is just as important, and often pretty neglected. Ensure the vehicle is secure before getting under. Remove all mud, oil and grease from body work, differential housings, gearboxes, steering parts, suspension, wheels, hubs, etc. Keep wheel arches, door sills, etc. particularly clean. If you don't, rust will develop. As you clean, look especially for rust, broken paint, cracks, sagging or cracked springs, shock absorber leaks, and look especially around heavily loaded areas, e.g. shock absorber towers, cross members, engine and transmission mounting parts, etc. Look for play in the steering. Have someone rock the steering wheel to and fro, while you look closely at tie rod ends, relays, etc. for any play, indicating a worn part. Suspension bushes can be checked using a suitable lever to take the weight off bushes and pins, as you check for wear (play).

3.
Vehicle/machine operation

It's well recognized that about 80% of an engine's wear takes place at start up. Proper lubrication does not take place until the oil reaches full operating temperature. A similar situation exists with all lubricated components in a machine.

For component longevity, do not apply full load to equipment, until it is close to its normal operating temperature. Operate equipment lightly just after start up. For example, drive off easily first until the oil is circulating through transmissions, differentials, final drives, etc. and full film lubrication is taking place. For hydraulic equipment, operate the hydraulics with no load through its full extension first.

From this point operate the equipment fairly gently. Once equipment is at operating temperature, full load may be applied. But don't exceed reasonable limits, or the risk of wear and tear will increase substantially.

Correct machinery operation is only a habit. It doesn't cost much time. In fact, it will save downtime due to early failures of components. It's one of the easiest things you can do to extend machinery life.

Phil Riseley's immaculate Freightliner thrives on Cost Effective Maintenance's products

4.

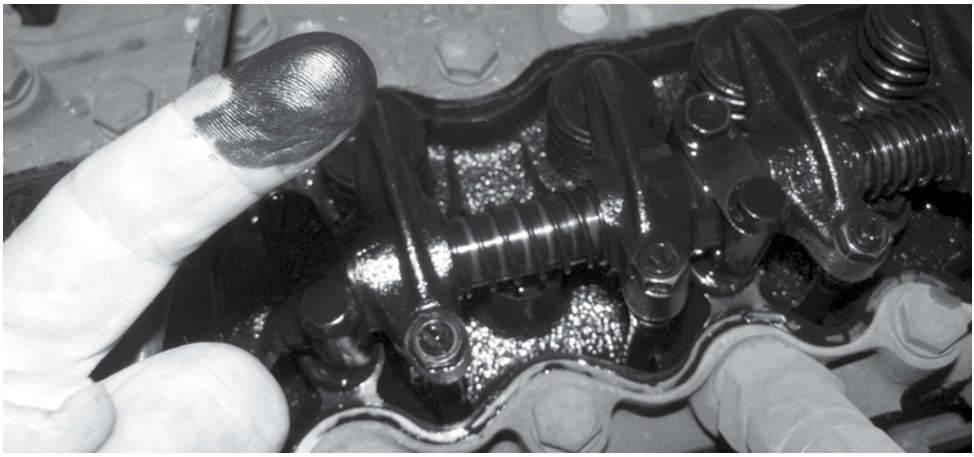
Special maintenance tips from the experts

4.1 Oil... Do this simple test and you'll get more life out of your diesel engine.

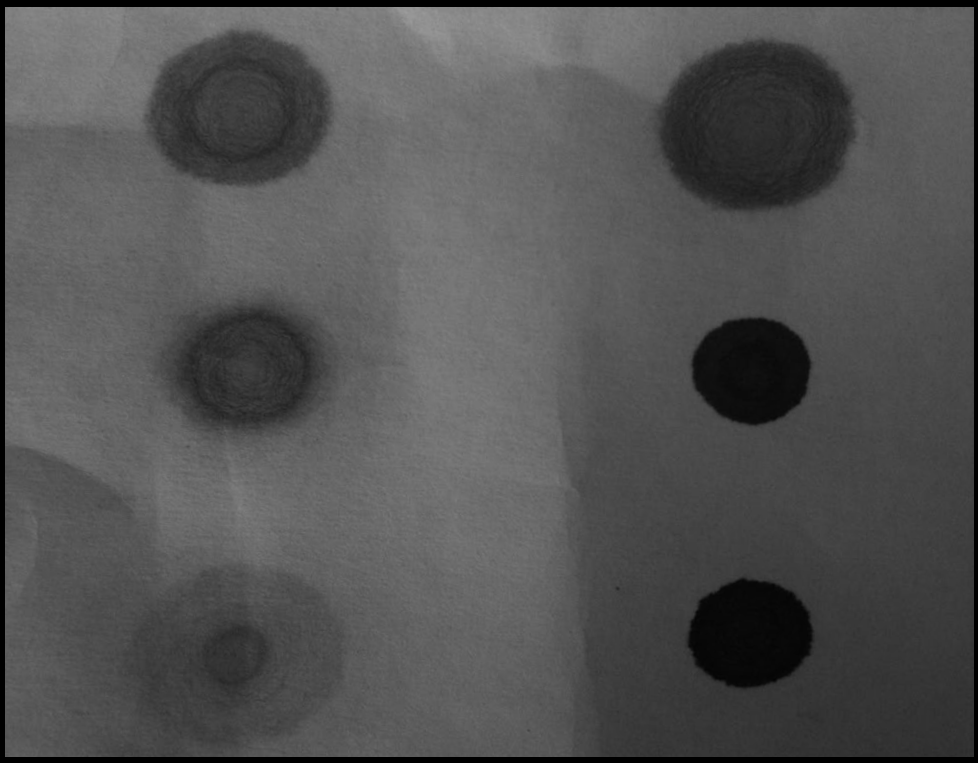
When you next check the dipstick, rub some of the oil between your thumb and forefinger. Then wipe it off. The pores of your skin should be left nice and clean looking. But, if it's blackened the prints of your fingers, you've got problems, and you should change the oil immediately. Its cleaning ability is exhausted! Your engine is accumulating sludge and deposits, and this black abrasive soot is causing excess wear!

Here's what to do… Change your oil more frequently. Ensure air filters and injectors are clean. Ensure fuel delivery, timing and valve clearance are correct, and check that the turbocharger, governor, intercooler, etc. are right. Avoid excessive idling and light work. For bad cases, Cost Effective Maintenance have a special flushing oil concentrate, and fuel chemicals to restore internal cleanliness and give your engine a clean start. *See **Products that can help**, page 56.*

Petrol engines do not suffer from the same degree of soot as diesels, but you should still be able to feel when the oil's goodness has gone. Bear in mind that the feel of the oil is not the "be all and end all" to determining whether it's still OK. But if it doesn't feel OK, then it will not be fit for further service. Compare this with new oil of the same type and grade as you are using. Oil will eventually feel thinner and less oily than new oil. This could be from fuel diluting the oil or "shearing effects" on the oil itself from prolonged service, and reducing the oil's viscosity. Always make a mental note of the oil's degree of discoloration. The darker it is, the more contaminants it holds, and the less its ability to protect your engine.



Definitely not a good look for any engine!



OIL SPOT TEST

Top left spot – NORMAL
Land Rover diesel. Good migration of contaminants through filter paper. Low contaminant level.

Middle left spot – UNACCEPTABLE
Mitsubishi 557 Truck. Poor migration of contaminants, well behind oil front. Oil soot is very coarse and abrasive. Combustion problem was the cause, due to a badly sludged and coked engine.

Bottom left spot – NORMAL (PETROL)
Honda Civic. Good migration pattern, low contaminant load.

Top right spot – NORMAL
Caterpillar mine truck using FTC Decarbonizer. Inner part of patch is much cleaner than outside, indicating very fine soot size, which migrates much faster.

Middle right spot – UNACCEPTABLE
Caterpillar mine truck at high altitude. Very poor migration because of large soot particle size. Contaminant load is high even at this early stage of the oil service period.

Bottom right spot – UNACCEPTABLE
Caterpillar mine truck at high altitude. Very poor migration, large soot size, extremely high contaminant load.

4.2 Some simple oil science anyone can do...

OIL SPOT TEST. All you need is a piece of ordinary blotting paper for this test. Place one drop only of used oil (usually engine oil) onto the blotting paper. It's a good idea to also compare with the clean oil of the same type, until you learn what to look for. Wait for the oil to migrate through the blotting paper. It may take several hours to fully stabilize. Hot oil will migrate faster. As the oil migrates, it carries with it contaminants which may not move as fast as the oil body. Ideally, the contaminant band should migrate with the oil, to leave a fairly even discoloration. Both total contaminant load and particle size of the contaminants have a bearing on the pattern formed. When the oil is too heavily contaminated, the contaminants clump together and do not migrate easily with the oil front. Or alternatively, they may migrate in a very heavy even pattern. In each case, it indicates that the oil's dispersancy power is exhausted, and deposits will be forming throughout your engine. In addition, abrasive wear will be occurring at an accelerated rate.

You should change your oil immediately! A flushing oil concentrate may also be recommended, to re-suspend contaminants that have settled throughout the engine.

OIL SPATTER TEST: If you suspect water contamination in your oil (e.g. slight loss of coolant without outward signs of leaks). A milky appearance of the oil will confirm a substantial amount of water content. However, if there is no visual sign of water in the oil, you can try this test. Heat an old (so you don't get into trouble with the lady of the house) saucepan, piece of steel etc, on a stove to a bit over 100˚C (the boiling point of water). Test the temperature, by dropping a small amount of water on the heated surface. It should boil off instantly. Now, put 2-3 drops of suspect oil onto the hot surface and watch. If the oil spatters, crackles and dances about, water is present. If it doesn't, water is not present. If in doubt, of course, compare with some clean oil. This test will not rule out entirely a coolant entry, since if it is a slight leak, the water may evaporate during operation. A laboratory analysis could identify this by measuring traces of coolant additive chemical, commonly sodium (Na).

4.3 How clean is your engine?

You wouldn't really know for sure how clean your engine is, unless you took it apart. For this reason, it's a good idea to periodically give it a flush out, say once every 3-4 oil changes. Now if your oil hasn't been changed as frequently as it should, and the Oil Spot Test should give you an idea of this, if you test it at the end of its usual service life, you'll need to flush it more frequently. Some engines are more problematic (e.g. Japanese indirect injection diesels, and any diesel that thickens and blackens the oil quickly), and a flushing oil concentrate should be added prior to each oil change. Common rail diesel technology should see cleaner crankcases and cleaner oil, but emission control systems regularly malfunction, resulting in dirty oil systems that need flushing. Generally any engine with 100,000kms or more will benefit from a quality flush.

An idea of the cleanliness of combustion chambers can often be gained by looking at spark plug deposits and injector tip deposits. It is sometimes possible to view, with the aid of a torch, the piston crown through the injector (direct injection diesels) or spark plug hole. Removing a glow plug from a diesel engine will also give you an idea of combustion chamber deposits. Sludge will often settle around valve rockers, so it can be useful to remove the rocker cover for a visual inspection.

4.4 Oil Filters.

Everyone knows that oil filters remove contaminants from your oil, but unless you cut your filters open and inspect them, you'll never know how much contamination you have, or if you have a serious wear problem. To inspect your filter, do this:

First allow the filter to drain for a couple of hours, by supporting it on a simple frame over a container, so that the filter does not dip into the oil. Use a hacksaw to cut off the open end, holding the oil filter vertically in a vice, with the open end facing down. In this way, metal from the hacksaw will not contaminant the filter paper to any great extent. There are also filter cutting tools available, for those who need to do this more regularly. These are handy, since they cut cleanly, with no metal debris being created. Remove the element from its housing, and brush off the bulk of the metal left from the hacksaw. Carefully cut and unravel the paper element, avoiding scattering any filings left. Ideally, the filter paper should look clean, but a little stained. You don't want to see any little specks of metal or heavy oil sludge. If you see metal (and it's not from the hacksaw), get a small magnet to test whether it's ferrous or non-ferrous. This may give a clue as to what part of the engine is wearing.

4.5 Differentials, gearboxes, transfer cases, final drives, etc.

Excessive loads, inadequate lubrication, dust and water entry can all promote wear in transmission type units. Neglecting them can be costly. Here's what to do.

1. Check the oil regularly. It should look "as new". If not, replace it. An exception is in some differentials where grease entry from a wheel hub or swivel pin housing has mixed with the grease. This will not have any adverse effects, but the faulty seal should be replaced. A goldy sparkling colour in the oil indicates wear to bronze parts, e.g. synchro rings.
2. Check that the breather is free, clean and operating properly.
3. A good idea is to fit magnetic plugs to the oil fill holes as well as drain holes. This makes for quick inspection. If you have wear matter on the fill plug, there'll be much more on the drain plug. Then any wear metal from gears, shafts, bearings, etc. will be obvious, and not lying on the bottom of the housing.

4. How hot does it get? Some transmission type units will get hotter than others, e.g. because of transferred heat (from engines), basic design, high duty cycles, etc. However, your goal should be to reduce operating temperature to the minimum. You should be able to touch most units at least briefly without much discomfort. If you want to get more serious about it, there are magnetic thermometers available, that you can attach to the outside of transmissions, hydraulics, etc. This won't work with alloy housings, however. Fitting permanent temperature gauges to such components can certainly be justified for hard working expensive machinery. Apart from outside heat sources, transmission heat is generated from two sources. Firstly, frictional heat when the oil film ruptures and allows metal to metal contact. In this case, a higher viscosity oil may be required. Alternatively, superior lubricants and anti-wear chemicals can also reduce this. The second cause is fluid friction, caused by the constant churning of the oil during operation. Selection of the best viscosity will minimize this. In some cases, it is a balancing act of selecting an oil of sufficient viscosity, but not so high, as to cause fluid frictional heat.

In some cases, where temperature is extreme, special purpose lubricants (including synthetic oils) may be required. Oil coolers are another alternative. But remember, extra oil coolers mean extra maintenance as well. It is best to keep things as simple as possible, whenever you can.

As a general rule, for higher ambient temperatures, heavier duty applications, sustained elevated duty cycles (e.g. country driving, towing) an oil with a slightly higher viscosity will be of advantage. These types of conditions lead to higher sustained temperatures, which decrease the oil's film strength, resulting in more metal to metal contact and wear.

4.6 Air Filters.

Dust and other abrasive matter entering with the inlet air are blamed for a considerable amount of total engine wear. The amount of air used by an engine is staggering. A 3L engine can consume ¾ million litres of air per hour! That's more air than contained in an average house! Even a small leak in an air filter can cause an engine to wear out. All connections on the air induction system must be secure and sealing effectively. You need to check them regularly. Ensure the filter element is fitted correctly and sealing against the housing. There will be a seal on the filter element, or alternatively, on the filter housing. A little Vaseline smeared on the seal face will help ensure a perfect seal. All air should enter through the filter media. Where leaks occur, there will usually be evidence of dust. Wipe your finger over the suspect area, and you'll be able to detect it. Working methodically from the air cleaner to the inlet manifold will reveal exactly where the leak has occurred. Unless a routine laboratory oil analysis detects it, dust entry is rarely detected before serious damage has occurred. Several years ago, I had an Isuzu diesel fitted to my Range Rover. As this was a second hand engine, I wanted to find out a bit about its condition, so I sent a sample of the first oil fill to the lab for

analysis. It detected an elevated Silicon (dust) level. Working as described above, I discovered that the fitter who installed the engine, used a dirty cross over pipe on the induction side. I cleaned it out properly and the next oil analysis confirmed that the problem was solved. For the price of a lab analysis, it was money well spent!

I recommend periodic laboratory analysis of used engine oil as a good means of looking after engines…especially expensive ones, which may warrant it on each oil change. If you suspect dust entry into an engine, here's what to do:

1. Check all sources of leakage, including breathers, as well as the induction system. Make sure the filter element is sealing fully along the full perimeter of the seal face.
2. Check for cracks, loose clamps and joints, including air compressor connections (where fitted), and ether cold start fittings.
3. Inspect the filter element for damage. A good method of doing this is to place a light bulb on one side and view from the other. Even a small pin hole will show up as a tiny star of light.
4. Ensure all gaskets, washers, etc. are correctly installed and sealing effectively.
5. Ensure the air intake does not draw air from a high dust concentration area. Ideally, it should draw cool air, rather than high temperature under bonnet air. This can make a significant difference to diesel engines, since they require a certain amount of excess air, to perform efficiently with low smoke levels.

4.7 If your engine's out of tune, it's wearing out faster, too.

An out of tune engine is not capable of burning its fuel efficiently and cleanly. Combustion bi-products are detrimental to an engine, and some will cause accelerated wear. This subject will be discussed in greater detail later in the book. Suffice to say that all engines should be kept in good tune for optimum life, as well as efficiency.

4.8 The easiest way to safely fix a glazed or carboned up engine.

Assuming your engine is in sound condition, but has glazed (or even carboned up) due to poor tune, light work, short runs, excessive idling, over-extended oil service, etc, it can be completely restored to clean condition using a unique product called FTC Decarbonizer. FTC is merely added to the fuel and the engine operated as normal. The action is a gentle and safe one, which actually burns off all carbon and glaze, without any abrasive or corrosive action. Even the hardest of carbon will, with time, burn away…carbon so hard you'd have to chip it away with a chisel!

Diesel engines are prone to glazing (i.e. covering the cylinder cross hatch with hard polished carbon), if driven under light load, run cool or idled too much. This cylinder cross hatch was originally machined into the bore, to provide sufficient surface roughness to hold a film of oil. The oil then is able to complete the seal between the piston ring and

the bore. Without it, compression loss and oil control would become a problem. This often results in excessive sump pressure, which can cause blow by out the breather pipe, oil leakage from the engine, smoke, oil consumption, hard starting and power loss. FTC can completely rectify this problem, so long as the engine is sound. The chemistry used in this product is quite remarkable, and we'll discuss it in more detail in a later section.

4.9 Chronic Overheating.

At CEM, we encounter literally thousands of people with chronic overheating problems in their engines. That is, despite going right through the cooling system, their engines still overheat. This is particularly so with pre-combustion (PC) diesels. Many customers have spent $3000 to $4000 on bigger radiators, water pumps, fan hubs, thermostats, chemical cleaning, etc. and their diesels still overheat under load.

Almost always in these cases, the problem lies with the lubricating system. The oil has an important duty to cool the engine, especially the underside of pistons (the hottest lubricated component). Oil cleanliness is vital, as any sludge can restrict the flow of oil under the pistons, and reduce its cooling effect. Just as important is cleanliness. Carbon in piston ring grooves acts as insulation which reduces heat transfer from the ring to the piston, and then to the oil. Deposits on the underside of piston skirts also insulate against heat transfer. The black soot that accumulates in diesel oil readily absorbs heat, but doesn't dissipate it as easily, and is also a factor in overheating.

CEM have developed a special cleansing product called Flushing Oil Concentrate (FOC) that targets the most persistent sludge and all hard baked on carbon to restore pristine cleanliness to all oil wetted parts of the engine. Clearly, it's more than just a rinse, and it solves the chronic overheating. We're confident that nothing else matches it.

4.10 Solving Common Rail Diesel problems.

The Common Rail Diesel (CRD) injection system is the most recent development to achieve ever more stringent diesel exhaust emission standards. However, it is currently associated with widespread problems, including engine rattles, expensive injector and fuel pump failures, injector sticking, stalling problems and rapid piston and liner wear. Problems have been documented across a wide range of engine suppliers, including Toyota, BMW, Volkswagen, Nissan and many more.

Cost Effective Maintenance have specifically developed the CRD Fuel Enhancer, to address rattles, and provide smooth operation of fuel pumps and injectors. Used routinely, it will increase the service life of fuel systems and minimize the potential for the above problems.

The CRD system requires a significant increase in operating pressure compared to earlier systems. Fuel system pressures of up to (and above) 29,000 psi are required, and combined with ultrafine tolerances of diesel pumps and injectors, achieve superior fuel atomization

for cleaner combustion. There are several factors that place significant additional stress on this system, compared to earlier diesel injection systems.

1. The increased operating pressure causes higher loadings on equipment, and this places a bigger demand on the fuel's lubricating ability.
2. The higher pressure causes much higher fuel temperatures, which can actually degrade the fuel, forming fouling deposits within pumps and injectors. Such deposits interfere with the fine tolerances, to cause sticking, malfunction and injector wear. This risk increases if using biodiesel blends, since biodiesel by nature, degrades faster.
3. The degraded fuel loses its lubricating power causing further injector sticking, as well as accelerated (and often sudden) wear to injection pumps and injectors. We've found that enhancements to fuel lubricity can completely avoid this degradation of diesel fuel in high pressure, high temperature diesel fuel systems. CRD engines are designed with much finer tolerances within pumps and injectors, as well as piston to liner clearances, making them much more susceptible to deposits, and also the presence of any water contamination in the fuel.

CRD injectors can be called on to inject diesel into the cylinder up to 5 or more times per firing cycle, so must respond instantaneously!! Any delay caused by contamination or poor fuel lubricity commonly results in excess fuel pumped in. This is one cause of poor fuel economy, but also means more soot out the exhaust, and through the EGR (exhaust gas recirculation) valve, and this is a major cause of choking inlet manifold build up. Mitsubishi Pajero and Triton CRD's have had severe inlet coking problems, but can be controlled using the CRD Fuel Enhancer/Flushing Oil Concentrate value pack. Naturally coking can extend into the combustion chamber, exhaust and turbo areas as well. For this, the FTC Decarbonizer needs to be run in the diesel, and during combustion, it will burn off deposits from these places.

CRD Fuel Enhancer provides strongly enhanced fuel lubricity, superior deposit control for fuel pumps and injectors, and exceptional anti-rust/anti-corrosion protection. While it's recommended as a routine preventative step for CRD engines, it has been shown to eliminate severe injector rattle, restore operating performance and economy. It is designed specifically for Common Rail Diesels, but is suitable for all diesel engines. It is not recommended for petrol engines.

Many Common Rail Diesels are also prone to building high levels of soot in the oil. For this reason, we also recommend using the Flushing Oil Concentrate. Look for the CRD Fuel Enhancer/Flushing Oil Concentrate Special (CRD/FOC).

5.

Blue, black and white smoke… what does it mean?

The colour of diesel smoke and when it occurs can tell you a lot about your engine's condition. Basically, there are three types of smoke…

BLACK SMOKE: Black smoke is the most commonly emitted from diesel engines and indicates poor, incomplete combustion of the fuel. Causes can vary widely and include:

- Incorrect timing
- Dirty or worn injectors
- Over-fuelling
- Faulty turbocharger
- Incorrect valve clearance
- Incorrect air/fuel ratio
- Dirty or restricted air cleaner systems
- Other engine tune up items
- Poor quality fuel
- Excessive carbon buildup in combustion and exhaust spaces
- Cool operating temperatures

In older technology diesels, black smoke can occur across the entire operating range, but is usually worst under full power or during the lag before the turbocharger boosts air supply to match the fuel usage.

For example, the early stages of acceleration, and during gear changes. Moderate turbo lag smoke is acceptable, otherwise black smoke should be hardly visible in a correctly running engine. With modern high tech computerized diesel engines, any smoke emissions indicate a problem.

BLUE SMOKE: Blue smoke is caused by oil burning. The oil can enter the combustion chamber from several sources, e.g.:

- Worn valve guides or seals
- Cylinder and/or piston ring wear
- Cylinder glaze
- Piston ring sticking
- Incorrect grade of oil (oil too thin, and getting past rings, valves, etc)
- Fuel dilution of the oil (oil thinned out with fuel)

At cold start, blue smoke is often evident, and can reflect reduced oil control due to fouling deposits around the piston rings and cylinder glaze. Blue smoke should not be evident at any stage. It should also be pointed out, that an engine in good condition can burn quite a deal of oil, without evidence of blue smoke. This is because it has good compression, and burns the oil quite cleanly. However, I am not suggesting that it is at all acceptable for any new engine to burn large amounts of oil.

WHITE SMOKE: White smoke is caused by raw, unburnt fuel passing into the exhaust stream. Common causes include:

- Incorrect injection timing
- Defective injectors
- Low cylinder compression (e.g. caused by leaking valves, piston rings sticking, cylinder and/or ring wear or cylinder glaze)

When white smoke occurs at cold start, and then disappears as the engine warms up, the most common causes are fouling deposits around piston rings and/or cylinder glazing. These deposits can be removed safely and cheaply with the FTC Decarbonizer and/or Flushing Oil Concentrate. Continuous evidence of white smoke indicates a mechanical defect or incorrect setting.

6.

Wear: Understand this and you'll add life to your machine

WEAR

The reason why machines don't last forever. Wear is more than just two parts rubbing together. There are seven important types of wear that occur in all machinery. Wear is one of the most costly factors in operating machinery, causing direct cost, inconvenience and lost production.

- **ADHESIVE WEAR** occurs when similar materials in sliding contact weld together, because of the frictional heat generated. This type of wear follows a "weld and tear" pattern, and can produce wear debris.
- **ABRASIVE WEAR** is due to gouging by debris trapped between two rubbing surfaces or by microscopic protrusions on one surface gouging into the other. It is a ploughing action. Debris may be wear metals, dirt, or even combustion bi-products (especially soot in diesel engines).
- **FRETTING WEAR** often occurs during transport of equipment. Small oscillating movements, due to vibration, can cause wear due to a combination of abrasive and adhesive wear.
- **FATIGUE WEAR.** Repeated load cycles placed on a part will eventually cause small cracks and eventual failure of that part. For example, rollers in a bearing concentrate stresses in front of the contact zone and slightly beneath the surface. After a number of cycles, failure occurs, and is evident as pitting.
- **CORROSIVE WEAR.** Any chemical reaction that removes material from the surface (e.g. rusting) is a form of corrosive wear. Sulphur in diesel fuel forms a corrosive acid during combustion, and this can damage engine parts. Lubricating oils contain additives that combat this effect.
- **EROSIVE WEAR.** This is due to the impact of particles that strike a surface at speed, cutting into that surface. Carbon deposits formed in exhaust parts from inefficient combustion tend to break away, and this is an example of erosive wear as they strike turbocharger blades.
- **CAVITATION WEAR.** This occurs when bubbles in a liquid collapse against a surface, e.g. in water pumps. The sudden change in pressure causes pitting on the component surface.

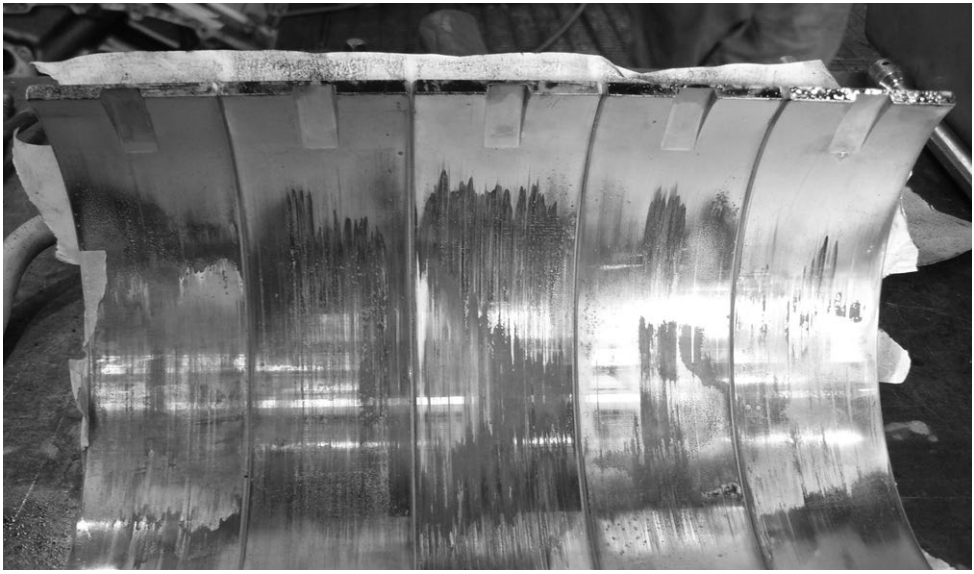
7.

Types of lubrication

There are two main types of lubrication…

- **FLUID FILM LUBRICATION** occurs when contacting parts are separated by a film of lubricating fluid (grease, oil or even air). As the relative speed between the parts increases, the motion of the lubricant provides an increased film thickness. This is termed hydrodynamic lubrication. A higher lubricant viscosity will also increase the film thickness, but heavy loads and higher temperatures decrease it. Higher speeds also create greater fluid friction (internally) in the lubricant. It becomes obvious that correct viscosity selection requires a consideration of operating speed, amount of stop/start operation, duty cycle, component loading, operating temperature, variation in ambient temperature and more.
- **BOUNDARY LUBRICATION** occurs when the lubricant film no longer separates the moving parts. For example, the oil film may have ruptured due to a high loading, or the oil viscosity may be too light for the application. Some oil types provide inherently better boundary lubrication, but most commonly, the additive package contains some form of boundary lubricant. Anti-wear oil additives, EP (extreme pressure) additives for gear oils, molybdenum disulfide, PTFE (Teflon) and graphite are some of the more common additives providing boundary lubrication.

Beyond boundary lubrication, wear takes place.



This bearing wear indicates that fluid film lubrication was not maintained

8.

How to minimize the different types of wear

ADHESIVE WEAR

The aim must be to maintain a lubricating film at all times, so viscosity selection is important. Selection of lubricants with a higher viscosity index will provide a more constant film thickness across a wider range of temperatures at the point of lubrication. As a general rule, for Australian conditions, I prefer to recommend individual lubricants at the higher end of the viscosity range that is nominated for that type of equipment/ operation. Boundary lubricants are important to provide temporary lubrication when the oil (or grease) is not present, e.g. start up, during severe load, which ruptures the oil film, etc. A good boundary lubricant (anti-wear additive) will produce noticeable improvements to most commercially available oils when the going gets tough, or importantly in highly stressed components. An example of the latter is modern 5 speed manual transmission, drive trains of modern aerodynamic line haul trucks (the aerodynamics reduce cooling air that passes over gearboxes, etc).

ABRASIVE WEAR

Once again, the aim must be to separate the sliding surfaces by a strong lubricating film. Remove wear debris. Thorough cleaning or flushing of the component is sometimes necessary to remove as much wear debris as possible in a contaminated component. Reduce the amount of wear-causing debris entering the system. Change to an oil of higher anti-wear or higher viscosity, to reduce the wear rate. Be careful to ensure that the higher viscosity does not produce excessive churning and heat generation. The oil must be fluid enough to be easily pumped to all components that require lubrication. For diesel engines, reduce the size and amount of oil soot (produced by combustion) by improving engine efficiency. Keep it in tune. Use an oil of higher dispersancy, to keep the soot finely dispersed. For the ultimate soot control use FTC Decarbonizer in the fuel. (Further details later in this book). Prevent dust entry. Ensure all seals, joints, breathers and filtration equipment are working efficiently.

FRETTING WEAR

Reduce vibration to equipment. This may mean changing to more suitable mounts, better couplings, etc.

FATIGUE WEAR

Ensure the viscosity of the lubricant is as high as possible without compromising its pumpability, or producing excessive fluid friction (heat build up), etc. This allows the load to be spread further, rather than concentrated on a smaller area, which localizes the stresses.

CORROSIVE WEAR

For lubricated parts, the main method of control is chemical, through lubricant additive packages. For engines, be sure to match the oil TBN (acid neutralizing power), and the oil change interval with the level of sulfur in the fuel. For differentials, transmissions, hubs and final drives, ensure water contamination is avoided, (or managed properly after water crossings). Where the risk of damage from high sulfur fuel is high, engines can be treated with an impervious inert barrier that is totally resistant to chemical corrosion. One product that provides this is called Petro Tech 2000. It is also a dry film lubricant, offering boundary protection. The FTC Decarbonizer will also reduce oil sulfur levels. Oil analysis consistently shows that it has quite a marked effect. It is believed, that this is related to improved combustion, and better sealing against blow by, due to cleaner piston rings/ grooves. Condensation and the growth of algae are prevalent in diesel fuel, and can cause corrosion to fuel injection parts. You need to control this, by draining off sediments from stored diesel fuel, and where necessary, use a biocide to kill these organisms.

Example of bore polish where carbon on the piston side wears away the cylinder cross hatching

9.

Most of the fuel an engine uses is wasted!

Depending on the level of technology incorporated in an engine, only 25-40% of the fuel burnt produces usable power. And then, even more is lost through power transmission components, before it reaches the drive wheels. What happens? Where does it go? Consider the following formula…

Engine Efficiency (%) = Constant x VE x TE x ME

Where VE = Volumetric Efficiency (%)
TE = Thermal Efficiency (%)
ME = Mechanical Efficiency (%)

Volumetric Efficiency refers to how efficiently the cylinders fill with air. Complete filling cannot be achieved with naturally aspirated (non-turbo) engines, particularly at high speed. This is the reason for the use of turbochargers. They force air into the cylinders, rather than allow passive filling to take place. Naturally aspirated engines may have VE's of about 80%.

Thermal Efficiency is a measure of how completely the fuel is burnt to produce heat. Maximum efficiency occurs when the fuel is completely burnt in the quickest possible time.

Mechanical Efficiency, or how efficiently the heat of combustion is converted to flywheel power, depends on frictional losses within the engine. A Caterpillar 3406 engine loses about 25% to friction at 2100 RPM , about half this loss being attributable to friction between piston rings and cylinder walls. At 1900 RPM, frictional losses fall to about 20%

Heat (energy) produced from an engine may be distributed in the following proportions…

To power production	25%
To the cooling system	33%
To the exhaust	35%
To radiation	7%

Transmissions and differentials also consume significant amounts of power as frictional losses. So, the question is asked, "Can anything be done to reduce these losses?"

Racing enthusiasts modify and rebuild engines to produce more efficiency (power), but much of their work would improve fuel efficiency also. However, it is not the intention to cover these options in this book. There are simpler and cheaper options to ensure you reduce energy losses to the minimum. And importantly, many modifications can increase the stress on engine components. Since this book is aimed at improving reliability and longevity, these modifications do not fit our agenda.

VOLUMETRIC EFFICIENCY

Ensure the most efficient flow of air through your engine, by keeping air filters clean, and ensuring they are of an adequate size for your engine. Some manufacturers of modern 4x4's fit poorly designed air cleaners to their equipment. Why would manufacturers of 4x4's with 40-50 years experience, fit a relatively small capacity filter, that draws air from the front wheel arch (where considerable dust can be drawn in), into an off road vehicle? It might be OK for on road vehicles, but certainly not for vehicles clearly marketed as good off-road performers. The air intake may have to be re-routed to improve the design on such vehicles. In addition, ensure that air is drawn in from a cool source rather than hot under bonnet air. (This comment is relevant to most parts of Australia. It may not be applicable in cooler areas.) Snorkels provide a very good solution to providing a supply of clean, cooler (and denser) air over a longer service period.

Where fitted, ensure turbochargers are in top condition. Use good quality oil, changed frequently to ensure top protection to your engine. Don't shut your engine down until the turbo has cooled off a bit. Inter-coolers should be kept clean so that the charge of inlet air is as cool (and dense) as possible. The system must not leak.

Deposits in combustion, valve and exhaust spaces will prevent an engine from breathing efficiently, thus reducing VE. The most cost effective way to remove these deposits is by using the engine decarbonizer, FTC in the fuel. Decarbonizing machines offer an alternative but are more expensive, and do not remove all carbon from exhaust parts of the engine. FTC Decarbonizer can also be used on an ongoing basis to ensure "keep clean" efficiency.

THERMAL EFFICIENCY

Engine condition and tune must be spot on for top thermal efficiency. The idea is to burn the fuel completely and quickly. Ensure the engine gets to full operating temperature and reaches it quickly. In practice, a significant amount of fuel actually burns after it leaves the cylinders, that is, in the exhaust. FTC, which acts as a catalyst, causes the fuel to burn faster, allowing a larger percentage of the fuel to release its energy closer to piston top dead centre. Laboratory and field experiments have confirmed its ability to increase thermal efficiency (even in brand new, clean engines).

The fuel system must function properly. Any fouling deposits will alter fuel atomization patterns, and consequently, the burn efficiency. Here, efficient fuel system cleaners can be of benefit.

Always use good quality fuel. Quality does vary widely in places. Generally, today's fuels are a cocktail of a broad range of hydrocarbon types and molecule sizes…less pure than the pure distilled diesel of earlier years. This is because the oil companies simply have to make the barrel of crude go further, and utilize the heavier ends that used to find a ready market as boiler fuel.

Curiously enough, lubricant selection can make a difference to Thermal Efficiency, too. The oil must exhibit the best viscosity characteristics at the piston ring to cylinder wall. The high temperature and friction encountered here reduce the oil's viscosity considerably. But it must be adequate to minimize blow by (compression leakage). It is a balancing act that depends on the engine design, condition, duty cycle and ambient temperature. Thermal efficiency is affected by cylinder compression, and we have seen compression increase by 5 psi or more with a change of oil type, and also by decarbonizing the engine. Anti-wear additives can also have a bearing by reducing local temperatures in the ring area, thereby reducing the degree of thinning of the oil with heat.

MECHANICAL EFFICIENCY

Any reduction to be made here depends on reducing friction, both metal-to-metal and fluid friction. Careful selection of crankcase oil viscosity, and viscosity index is required to ensure adequate prevention of metal-to-metal contact at maximum loads, while not generating excessive fluid friction.

In some cases, (e.g. worn engines, high ambient temperatures, sustained high speed or high load applications) benefits can be achieved by using special oils. Synthetics or very high quality mineral oils and anti-wear agents offer benefit in these circumstances. We recently examined one anti-wear agent, which reduced frictional losses by 44%, as measured by the Falex Test. The emphasis here is on quality products. They do exist, but so do a lot of ordinary products. Do your homework properly. *See **"Products that can help"**, page 56.*

FRICTIONAL LOSSES IN TRANSMISSIONS AND OTHER RUNNING GEAR

Transmissions, differentials, final drives, torque convertors, and even universal joints and CV joints absorb energy, because of the internal friction produced. Combined, these losses are quite large. You can lose 20% of flywheel power through some drive trains. In fact, through the use of special high load carrying lubricants, economy gains of 6% have been achieved in 4x4's. This has been accompanied by quite dramatic reductions in transmission operating temperature. It should, however, be pointed out that such cases have usually involved transmissions in poor condition. In most cases, reductions in transmission friction are more modest. Keep it in mind though, that friction reduction does also mean wear reduction and improved reliability. Improved drivability is also generally another pleasant benefit.

Lubricant choice is very important. My advice is to pay a little more and use only "specialty products". Select the right product, and you can almost cut wear to zero. This subject is covered later in the book.

10.

How good are the oils you use?

Commercial oil quality does vary considerably. The cheapest oils available will also probably be the lowest quality. All oils are blended from refined base stocks with the addition of additive packages. These packages are developed to meet certain specification requirements (e.g. SG/CD, CF4, GL5, etc) and must be extensively tested at very high cost, and by recognized testing authorities. There are only a handful of additive manufacturers worldwide, who supply these packages to oil blenders, including the major oil companies, for use in commercially available formulations. The quality and amount of additive package can vary, as can the mix of additives used. The base oil quality can also vary. For an oil of specified viscosity, e.g. 20W50, the viscosity can vary within this range. It can be at the high end or the low end, or somewhere in between. If it's at the low end, the oil may shear out, and the viscosity fall below specification before its intended service period has past…you don't want to be using this! The Viscosity Index can vary too. This is a measure of how well the oil maintains its thickness or body with increasing temperature. The higher the VI number the better it holds its viscosity. VI is rarely advertised with oils, but it is useful in the selection of the better products, that will provide you better protection and performance.

The better commercial oils are usually hot blended, using virgin (newly refined) base oils and with higher levels of additive packages, and higher viscosity index. Queensland oil manufacturer, Prolube is the only producer of higher quality lubricants that I know of, who successfully use a cold blending process (albeit a specialized one). The better oils will not only meet the specification requirements, but they will exceed them, providing a good safety margin.

The cheapest oils will probably just meet the specification asked for, will be cold blended (and some settling out of additive package may result), and with a low viscosity index. They are likely to fall out of specification in a much shorter time. At the time you change your oil, you want it to be still within specification, although you expect it to be contaminated. It needs to provide the same protection right up to the time it is dropped.

If you are looking for the best protection, don't consider cheap oils.

At the top of the price range are the synthetic oils and "specialty lubricants". Synthetic oils are made in a similar way to the normal mineral oils, but use man made base oils, which are quite expensive. The advantage of synthetic oils is that they can be engineered, so they do not thin out as readily as mineral oils at higher temperatures. This means that the protective film remains stronger. Some synthetic oils will incorporate higher quality additives, since they are not competing directly on cost. Others will not, relying only on the superior base oil. Like most things sold, oils are a balance of price and quality. The major oil companies compete vigorously for their market share. Many small niche companies

blend specialty products of exceptional quality and performance, and it is from these where the best value really lies for people who are interested in the ultimate in protection, performance and long equipment life. Although synthetic oils have the greatest potential, some of the mineral oils are far superior to many of the synthetics available.

As I see it, any machine that is expensive, or whose parts are not readily available or the cost of lost production is high, or you just don't like the hassle or inconvenience of repairs…then that machine warrants superior lubrication.

Specialty lubricants can offer the best value in terms of machinery protection, but you may need to do some searching as prices vary enormously. By necessity, these products will have to be dearer than ordinary oils, if the quality is there. But marketing costs are also generally higher to reach niche market customers. So margins can also be very high.

To complicate the issue, there are the rip off merchants, whose products do not live up to their claims. They have created such a slur on this type of product that many of the more reputable products are offered only in professional markets (such as mining, industrial, etc).

But, choose the right product from the specialty field, and you'll dramatically extend equipment life. In engines, for example, about 80% of wear takes place at start up, when the oil has drained back into the sump. However, with the right oil chemistry, a protective oil film can be retained at all moving parts. This will ensure improved lubrication and less wear at cold start. The same quality is required throughout all transmissions, drive trains, final drives, etc. An increase in an oil's load carrying ability of just 20% can at times double the life of equipment. Anti-wear additives are available that carry three times the load (or more) of the anti-wear package already in the commercial oil.

Some specialty engine oils offer better protection by using "bright stock" base oil, which provides inherently higher viscosity. While viscosity index improvers thicken the oil, they will commonly shear out, causing the oil to lose viscosity. Bright stock, by comparison will maintain its viscosity completely, during normal service. Most oils do not use bright stock, and often they will drop oil pressure and increase oil consumption during the second half of the oil service period. When this happens, the oil film ruptures more frequently increasing wear. Heavy oil consumption can develop, which also leads to damaging deposit formation.

The addition of anti-wear agents provides benefit during boundary lubrication, when the oil film has ruptured. Some rupturing of the oil film occurs in even the best lubricated machines, and this is why the better oils are fortified with quality products.

Anti-wear additives chemically react with the metal components to form a bond which provides lubrication and friction reduction. Anti-wear products can offer a cheap alternative to using a specialty lubricant, but cannot offer all the advantages.

11.

Component design problems and superior lubrication

Despite all the amount of money spent by equipment manufacturers on research and development, design problems in equipment are very common indeed. For example, camshaft wear problems, differential wear and noise, transmission overheating. The list is endless. From a slightly different angle, manufacturers of large earthmoving, farming and mining equipment will often specify engine oils in transmissions, hydraulics, etc. They do this for convenience. There is an obvious advantage for fleet owners in reducing inventory, but if you're after the best protection, it is a compromise, since wear will not be controlled as well. In many cases, superior lubrication will totally solve such problems. Let's look at one of the more common problems in passenger cars and light vehicles.

Ford Ranger 6 Speed manual transmission and transfer case. Clunky gear changes, top gear whine and noisy 3rd gear under load are widely reported issues with Ranger owners, and the Ford dealers generally advised customers that this was normal for the model. We were approached by a customer for a solution.

He'd already used a Molybond product in the gearbox and transfer case, which had made some improvement, but it was still unsatisfactory. We recommended he changed the oil and added our AW10 Antiwear to both boxes. The gear box was way quieter straight away, changed smoothly and the top gear whine had gone. A little noise from 3rd gear under load, but much reduced.

Most interestingly, his fuel economy improved by 0.5L/100km!!! Just by using AW10 in the same oil type. He noticed that when backing off the accelerator to approach a red light, he actually had to brake more, since there was less drag through the drive train!

Some manufacturers will specify an engine oil for manual transmission applications. There will generally be specialty lubricant suppliers, who will produce a high quality oil of equivalent viscosity, but importantly, with specific gear oil additive packages incorporated. This will generally provide better long term performance and protection. The result is, if you choose the right product, gear operation will be smoother, quieter and with faster gear changes. Transmissions will run cooler, with much, much less wear.

Solutions can be found for many other common design problems. When you think about it, what the manufacturer should have done, was to design the transmission (or other component) using the oil as one of the engineered parts. The oil should be thought of as an integral engineered part of that transmission, because its role is just as vital as a bearing, a gear or any other part. In practice this doesn't always happen, and that is why there is an important niche for specialty lubricants.

Now, as I implied initially, there are some design problems, that cannot be relieved by superior lubrication. Let me give you an example, since you should not view these superior lubricants as a cure all.

Land Rover Discovery and Defender had a common problem with their 5 speed transmissions for several years (early to mid 1990's). Because of the design of a transfer case gear, lubrication could not reach the spline on the main shaft, on which this gear is mounted. Any movement in the spline, would of course result in wear. There were many cases, where this lead directly to sudden transmission failure, as the spline was stripped. In this case, clearly no matter how amazing a lubricant may be, it's not going to help in the slightest.

Another design example (although related to combustion problems rather than lubrication), could be cured by superior combustion enhancements. When Caterpillar introduced their D11R dozer with monotherm pistons, there was a high incidence in Australia of accelerated wear and catastrophic engine failures. Engines typically experienced heavy carbon build up on piston top lands, resulting in rapid cylinder liner wear, and engine service life of 35% to 70% of customer expectations. The severe carbon deposits led to numerous catastrophic failures, such as exhaust valves breaking, destroying pistons, cylinder heads and turbos. Others experienced pistons grabbing resulting in broken con-rods, and cylinder blocks. Customers following Cost Effective Maintenance's advice didn't experience such problems.

Catastrophic failure in this Caterpillar engine was likely due to excessive carbon build up on the piston top land, destroying the block as well.

12.

Cooling systems... a quick death to engines, if they fail!

It's been said that more than half of all engine failures can be traced to cooling system problems. It may be the obvious failures due to a loss of coolant or broken fan belt. Or it may be that a complication of an overheating episode some time ago (e.g. loss of oil control due to overheated piston rings losing their tension) could cause an oil usage problem that eventually builds carbon deposits. The result, for example, could be a deposit related valve failure.

Cooling systems need protection from several different sources.

- **SCALE.** The use of hard water (containing minerals of calcium and sodium especially) can form deposits that insulate, and thus prevent effective heat transfer away from cylinder heads and cylinder bores. These same deposits can cause blockages in radiator tubes. Where possible the use of rain water is recommended to minimize this problem. Conventional management of such scale deposits calls for periodic flushing of the system with a radiator cleaner. This should be used in conjunction with a quality corrosion inhibitor.
- **CORROSION AND RUST.** Protection of cast iron and steel components and also corrosion of acid susceptible aluminium components are the main concerns here. But with modern engines, the use of solder, brass and plastic is common. Complete materials compatibility is required with cooling system inhibitors. This includes rubber hoses and seals, which can become hard in service.
- **ELECTROLYSIS.** This is a major problem these days with all the electronics fitted on engines! It is not uncommon for brand new radiators to be eaten out by electrolysis in 18 months! Electrolysis describes the electrolytic attack on metals, primarily aluminium, e.g. thermostat housings, water pumps, cylinder heads, etc. It is commonly evident as a white powder-like coating under radiator hoses. A coating of silicone water repellent sealant applied to the mating surfaces of hoses to provide a barrier is useful, since only a few cooling system treatments are entirely effective in this respect.
- **CAVITATION EROSION.** This is a problem commonly experienced in wet cylinder liners and water pumps, and is caused by bubbles, which form and collapse against the surface of these parts. Cavities form at the surface and can eventually perforate liners and other parts.
- **HOSES, RUBBER SEALS AND O-RINGS** especially around water pumps require protection to preserve their original properties. Most common inhibitors unfortunately harden rubber seals and O-rings, and often form granules, which become abrasive to these parts.

The cooling system should be checked at every oil service. Inspect all radiator and heater hoses for signs of deterioration, e.g. leakage, softness, perishing or cracking. Check all hose clamps for security and tightness. It's also a good idea to pressure test the system. It's a quick, but useful test, and can detect small leaks before they become serious ones.

For best life and efficiency, the cooling system should be drained, flushed with a descaler and recharged with a quality inhibitor on an annual basis, preferably just before Summer. Anti-boil/anti-freeze should be used when conditions demand it. At this stage we know of only one cooling system treatment that provides complete protection to all materials, minimizes electrolysis and cavitation erosion and keeps rubber seals and O-rings soft and pliable. In addition, it breaks up and suspends scale, as well as lubricating water pumps. *Refer to **"Products that can help"**, page 56.*

There is one more thing you can do to protect against engine damage from an overheated cooling system. Time and again, I have come across cases of severe engine overheating, which should have resulted in a completely wrecked engine. Yet, little damage occurred! While writing this book, I was made aware of yet another case. My daughter came home the other night to tell me the Volvo was running roughly and down on power. Oh yes, it was also running hot! In fact it was way into the red, for the last 15-20 minutes! Also refer to Chronic Overheating in our "Maintenance Tips from the Experts" section.

On inspection, six hours later the engine was still pretty warm. All the coolant had been lost through a failed water pump gasket. The engine should have been a wreck, yet it turned over by hand normally, and then started and ran normally, with no apparent damage. As with all the other cases, this engine was using a specialty oil, capable of withstanding extreme temperatures and high loads. In this case it was treated to an additional anti-wear agent. Specialty lubrication had just saved me in excess of $5000. Just a word of caution, though… Specialty lubricants are cheap insurance for such unexpected problems, but never rely on them to replace the cooling system's job.

13.

Brake hydraulics

The essentials of maintaining brake and clutch hydraulic parts (e.g. cylinders, rubbers, pipes, etc) in good condition are two-fold…

1. Keeping everything clean
2. Keeping moisture out

Ensure hydraulic reservoir caps fit securely, to keep out moisture, dust and grime. To facilitate this, wipe clean the reservoir body and cap to ensure against ingress of contaminants. Most brake fluids are very hygroscopic (absorb water readily). Water can and does enter these systems through condensation in the air, so it's more of a problem in humid areas, and especially where daily temperature variations are large.

Glycol based brake and clutch fluids (DOT 3 and DOT 4) are the most common by far, and should be changed annually. If it's not completely drained from all parts of the system annually, at least remove and replace all fluid from the reservoirs on a six monthly basis. This is easily performed with a syringe and short piece of tubing. Then every two years, drain the whole system. In high humidity areas, change the fluid completely on an annual basis.

There is, however, an alternative… Silicone brake fluid (DOT 5)! This does not absorb moisture, and so does not deteriorate or promote rust and corrosion problems. In fact, it imparts far superior lubricating qualities, and is a true long life alternative. Manufacturers claim that it will last for the entire life of the brake system. It is quite a deal more expensive, as you would expect, but the long term savings are considerable. It is best to renew all hydraulic rubber components prior to converting to silicone fluid, and make certain that the replacement parts are compatible with DOT 5 fluid. All lines and parts should be thoroughly flushed to remove any trace of glycol based fluids. Methylated spirits will do a good job, but ensure it is completely dried before filling the system with DOT 5 silicone fluid.

Once converted, you should never have to replace brake components such as master cylinders, wheel cylinders, etc. again. It's that good! At this stage, however, I do not know of a supplier of silicone brake fluid. I will try to locate a source for readers who are interested.

14.

Tyres, brakes and wheel bearings

TYRES: Good tyre life is dependent on a few simple rules…

- Select the appropriate type and quality of tyre for your particular application.
- Regularly check and maintain the correct tyre pressure for your operating conditions. Low tyre pressure causes heat build up, and heat is a major contributor to tyre wear.
- At every service, measure the tread depth with either verniers or a depth gauge. Do this for each tyre, at the outside, centre and inside of the tread. The depth should be even across the tread. Record this data and compare it with the "as new" tread depth. This is particularly important with steer tyres.
- Ensure there is not any excessive wheel bearing play or drag.
- Ensure there is no brake drag. Brakes must operate evenly. You don't want one wheel locking up first.
- Ensure that wheel alignment, and balance is accurately maintained.
- Ensure that there is no wear in steering and suspension parts (e.g. ball joints, tie rod ends, shock absorbers, panhard rod bushes, steering dampers, etc). Good quality, double acting shock absorbers will benefit tyre life also. Faulty shock absorbers can cause flat spotting on tyres.
- Where dual wheels are fitted, ensure the tyre diameters are identical, otherwise excessive wear will occur on the taller tyre.

Now, just a word from personal experience… On a number of occasions, I've had a wheel alignment done on a vehicle, and still had uneven wear on steer tyres, and this had cost me several sets of tyres. Eventually, I decided to make myself a gauge to measure "toe-in". I found that right after a wheel alignment, "toe-in" was out by 2-3 mm! Now, I don't know whether this was a result of the tyre dealer's alignment equipment being faulty, or if this is a means of increasing tyre sales, but from that point on, I have always done my own alignment. And curiously, tyre life has improved dramatically. Usually, "toe-in" is the only adjustment to be made, during a wheel alignment. Castor and camber are usually pre-set. If tyre wear is nice and even, I don't bother about getting specialists to check the alignment for me anymore.

BRAKES:

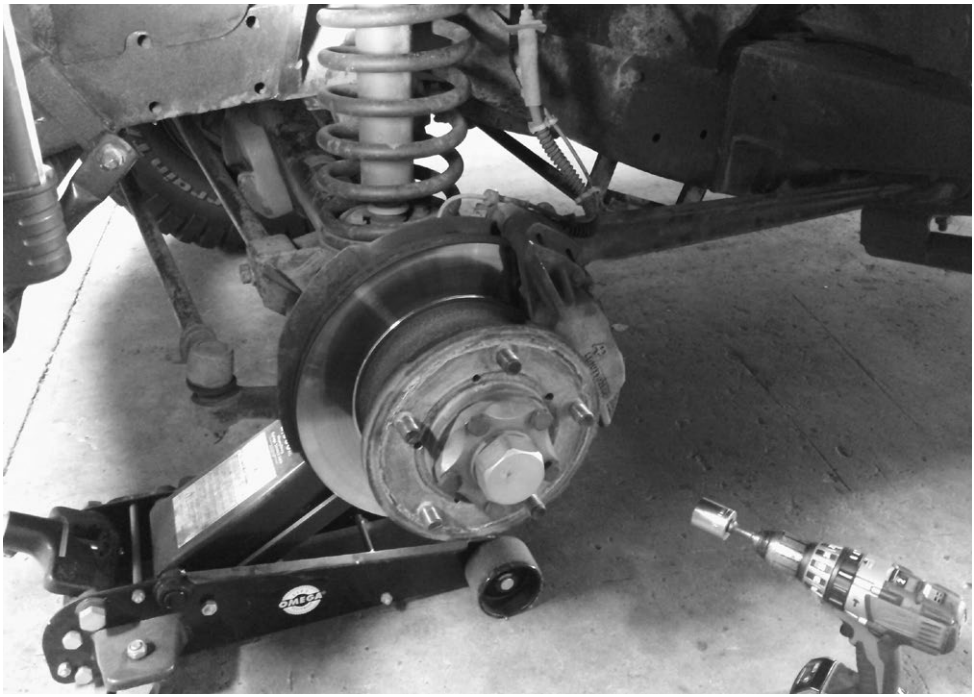
- Check that brakes are clean, and free of dirt, grease and brake fluid contamination. Wash off brake dust carefully with a gentle stream of water that does not blow the asbestos (or other brake material) into the air.
- Regularly check that the brake pads and/or linings have not worn excessively.
- At the same time, check discs and drums for scoring, warp, etc.

- Check that disc calliper slides are not sticking.
- Check for fluid leaks at all connections, and wheel cylinders, master cylinders, callipers, pipes and hoses.
- Check that brakes are working evenly, and that there is no drag.

WHEEL BEARINGS:

- Jack up the vehicle and rotate the wheel. Feel and listen for any noise. If necessary, remove brake callipers to isolate any other source of noise.
- Holding the wheel diagonally, check for any play when the wheel is rocked.
- Expose outer bearing and check for presence of water, and appearance of grease. This is especially important after fording any water crossings. If water contamination is evident, the bearings should be repacked.
- Half fill the bearing cap with grease. Use a high quality, water resistant and high temperature grease.
- For improved wheel bearing life, repack bearings with specialty grease.

Closely inspect brake discs, pads, calipers, hoses. And look for anything unusual while you're at it.



15.
Additional oil filters

An engine's main oil filter is normally of the full flow type. That is, all the lube oil passes through the filter on its way to lubricate the engine. This puts a limit on how much of the finer contaminants can be removed, without restricting oil flow. Filter size would have to increase enormously to remove most of the smaller contaminants.

Most after-market filters are of the by-pass type, and work like this. Part of the excess oil supply, from the oil pump, is diverted through the by-pass filter. With this system, a greater pressure drop (due to filter clogging) can be tolerated. Slower flow rates, that may result, do not hinder engine lubrication, while fine particles can be removed.

So long as the filter has the ability to remove contaminants at a rate faster than the contaminant accumulation rate, the additional filter will be very effective.

Strictly speaking, any additional oil filter that increases the oil capacity is beneficial to engine life, merely by increasing the amount of oil circulated. The oil will remain (marginally) cleaner, since there's more of it to dilute the contaminants.

There are many good after-market filters available, and these are generally classed as by-pass filters. They are capable of removing finer contaminants that pass through the main (full flow) filter unhindered. They need to have a fairly large dirt holding capacity to be effective for the full service period. This is particularly so for the light diesel market, especially the pre-combustion types, which produce massive amounts of soot.

There are a few different types of after-market filter available…

- **PAPER ELEMENT TYPE.** This type is similar to the main filter construction, only with a finer grade of filtering paper. It consists of pleated paper, offering a large surface area to the oil, but with quite a small dirt capacity. This is fine for petrol engines and low soot diesels, but isn't the best choice for the small high soot diesel.
- **DEPTH TYPE.** The oil has to pass through a mass of filter material (media) which progressively traps contaminants. Filter media can be provided as a replaceable semi-deep element, sock or paper roll. The paper roll type uses a knife edge type action, as oil migrates between the paper layers. So long as the layers do not allow tracking through gaps, this method is very efficient. The dirt holding capacity is high. The downside is, however, that it offers a small surface area to the oil, which may clog prematurely in some applications, e.g. light high soot diesels. The sock (which is basically a bag filled with filter material) and semi-deep element offer a much larger surface area. The dirt capacity of the semi-depth type is not as large as the other types.
- **MICRO-SCREEN TYPE.** This filter uses an ultra-fine stainless steel mesh to remove contaminants. Generally they will offer a medium surface area, but would have limited dirt-holding capacity.

- **CENTRIFUGE TYPE.** These units are very common on large diesel engines powering ships, power generators and earthmoving and truck applications. Strictly speaking, they are not filters, since they do not utilize a filter medium. They use electrical power, or the engine's excess oil pressure to pass oil through a centrifuge bowl, mounted on a spindle. The oil is forced out rapidly through a pair of jets, which cause the centrifuge bowl to rotate at very high speed. Contaminants are forced to the walls of the bowl, where they are compacted to a state resembling hard rubber. They offer very large dirt capacity and will cope very well with high soot production. One other advantage is that some models allow you to clean out the bowl and re-use it, eliminating costs of servicing it. All that needs to be replaced is an inexpensive O-ring. The option also exists with some models to simply replace the bowl, which is, of course a lot cleaner.

Additional oil filtration can offer the prospect of extended oil drains, since with the right application, oil cleanliness will be significantly improved. If your aim is to reduce the cost of oil used, first do your calculations on how much extra oil will be needed to service the additional filter. In some cases, there will be no benefit at all.

Caution is recommended when extending oil drain intervals, even when the filters are working well. Oil additive packages do become depleted in service. Viscosity Index improvers do shear out with time (resulting in reduced oil viscosity and strength). Raw fuel can get past the piston rings to thin out the oil, especially if injectors are faulty, or rings are worn or sticky, or even if the engine does a lot of cold running). Traces of coolant leaking into the oil become more damaging as they build up. The word is…take care if you choose to extend the oil service life. While it is practical, you'll need to check oil quality through an oil analysis program to ensure safety.

16.
Grease

Grease is a semi-solid (or semi-liquid) lubricant. It has special applications where there are requirements for…

- Lubricating slow moving, highly loaded parts
- Providing a good seal for an open load bearing surface
- A lubricant that doesn't drain away or is thrown off by centrifugal force

For most applications, a grease of NLGI #2 consistency is best. This will cover most automotive applications. In some applications, especially earthmovers and excavator pins, an NLGI #3 grease will be beneficial. There are many qualities good grease must have. Load carrying capacity is important, but does not necessarily dictate how successful a grease will be in a particular application.

For most automotive applications, grease must:

- Be pumpable enough to get to the load bearing site
- Stay put and not run out, be thrown out under impact, sling off, etc.
- Withstand the local temperature at the load bearing site
- Carry the load fully on the bearing surface
- Protect by cushioning against a shock load
- Seal off against the outside environment (e.g. dust and water)
- Be resistant to water washout

For wheel bearings, grease must be fairly fluid, and be able to withstand high local temperatures, especially for disc brake applications. For drive shafts, U-joints, shackle pins and loader pins, and other earthmover applications, tackier grease is best. Where possible, the inclusion of a boundary lubricant is always advantageous. Molybdenum disulfide is the most common. Caution should be used with its use in roller bearings, since unless the particle size is very small, problems can result.

Lithium based greases are the most common general purpose greases, while clay bentone based greases are most popular for high temperature applications, e.g. disc brake type wheel bearings. Some specialty lithium based greases will cope very well with disc brake temperatures, and this can be useful, when the one grease for all applications is required.

Specialty greases exist that can literally multiply component life, and dramatically reduce the re-greasing intervals. They are more expensive, but are always well worth it in terms of equipment life.

17.

Advanced preventative maintenance… practical ways to ensure reliability and long service life

There are four general methods of maintaining equipment…

1. **BREAKDOWN MAINTENANCE** When it breaks, you fix it. Followers of this method justify it by saying, "If it's not broken, don't fix it!" Where equipment is cheap compared to labour cost, downtime costs, parts, etc, and equipment is not worked hard, it's probably an economic proposition. However these cases would be few and far between.
2. **ON TIME MAINTENANCE** This is the most common method of maintaining equipment. All routine service procedures are conducted on a schedule, based on kilometers driven or hours operated, or on a time basis (e.g. once a month). These service intervals have been set by equipment manufacturers and should ensure satisfactory service life.
3. **PREVENTATIVE MAINTENANCE** In reality, preventative maintenance probably starts with your choice of equipment. Ensure you purchase something that will do the work required without undue stress. Preventative maintenance programmes usually encompass on-time maintenance plus additional practices and procedures designed to alert the owner to any possible future problems, and thus provide superior service life. This means incorporating a system of methodically checking components and monitoring lubricating oil and other fluids. These will reflect what has been happening since the last oil/fluid change. For example, laboratory analysis of used oil samples may indicate a fault that if left unattended, may shorten equipment life, and/or cause costly downtime. Problems frequently detected in engines, for example include…coolant leaks, dust entry, fuel dilution of the oil, or excessive ring, bearing or camshaft wear. By detecting problems in their early stages, they can often be rectified before serious damage or failure occurs.

   Preventative maintenance can also incorporate the use of higher quality/higher duty components (e.g. HD clutch, suspension, gearbox, axles, etc), and also including lubricants and other fluids. Lubricants, for example, can be selected from the following groups:

   - **Cheapest oils**... don't bother with them if you're looking for better equipment life.
   - **Oil company products**... a good balance between quality and price.
   - **Specialty lubricants**... as duty cycles increase, this group can offer the best value by far, BUT do your homework, because it can be quite a minefield.

4. **PREDICTIVE MAINTENANCE** This is the highest level of maintenance, and would normally encompass a good preventative maintenance programme. In addition, procedures are included, which provide information as to the expected life of various components (e.g. engine, transmission, final drive, etc.). The amount of wear metal appearing in used oil can be logged graphically over the life of the component. A knowledge of oil service hours at the time can help establish a wear rate in parts per million per hour (ppm/hr). This can then be related to an expected life for that component. However, this can be complicated where oil is topped up, due to oil burning or leakage. If the amount of oil top up is known, the wear rate can be corrected to more closely reflect what has happened. Predictive maintenance can also include vibration analysis and ferrography, and because of the additional expense, is normally reserved for high cost equipment, with high downtime costs. Such equipment may include ship engines, sugar mill equipment, large crushers in mining applications, etc.

   Cost Effective Maintenance have phrased a fifth type of maintenance category… "Corrective Maintenance". This refers to the use of simple intervention procedures to restore proper operating performance to engines, transmissions, hydraulics, etc. that would otherwise require significant and expensive mechanical intervention. *Refer to **"Products that can help"**, page 56.*

Advanced Preventative Maintenance. By combining traditional preventative maintenance with "corrective" maintenance, and the use of superior performance fuel and lubricating products, a much higher level of protection, performance and drivability is achieved, resulting in considerable extensions to vehicle and component life.

NOW, FOR A PRACTICAL EXAMPLE:

Let's consider Jim Freeman, the owner of a 1988 Toyota Landcruiser fitted with the ubiquitous 2H diesel engine. It's used for a variety of purposes, including around town, beach and bush work and occasional highway use.

The manufacturer's recommended services are as follows…

Engine oil and filter	5000km
Gearbox, transfer case, Diffs, CV Joints, and Power Steering oils	40,000km
Grease drive train, steering	10,000km
Renew brake and clutch fluids	18mths/30,000km
Drain and refill cooling system	24mths/40,000km
Renew cooling system hoses	80,000km

What sort of preventative maintenance procedure can Jim introduce to make his Landcruiser last longer?

1. Upgrade to higher protection (specialty) lubricants for the engine, power steering, gearbox, transfer case, both differentials and swivel pin housings.
2. Use a higher grade water resistant grease.
3. Replace the clutch and brake fluids with Silicone DOT5 brake fluid.
4. Fit magnetic plugs to the gearbox, transfer case and differential oil fill holes, to enable him to monitor wear metal accumulation more closely.
5. Use a quality fuel system cleaner regularly.
6. Use FTC Decarbonizer routinely in the fuel. This will reduce oil soot (and wear) as well as keeping the engine totally free of any hard carbon.
7. Every oil change, Jim performs the "Oil Spot Test" as per Maintenance Tips.
8. Every fourth oil change, send an oil sample to the laboratory for analysis.
9. Half an hour before every oil change, Jim adds a flushing oil concentrate to remove any sludge accumulation.
10. Jim installs a centrifugal oil filter on the engine to remove excess soot and other oil contaminants.
11. Jim visually inspects all oils and filters. Refer to ***Maintenance Tips***, on page 9.
12. Jim checks the temperature of gearbox, transfer case, differentials and hubs when at operating temperature on a regular basis. He does this merely by touching these units with his hand.
13. Whenever operating temperatures, oil appearance or oil tests appear abnormal, Jim investigates and sends an oil sample to the laboratory with an URGENT REQUEST.
14. Jim regularly cleans the Landcruiser outside, inside, under the bonnet and underneath. And while he cleans, he is always looking for anything out of the ordinary.
15. Jim maintains rust protection to the body work and chassis. Prior to and after beach driving, Jim washes the underside of his Landcruiser thoroughly, then carefully applies a mix of old vegetable oil and water (1:4) through a hand pressure pump.
16. Jim has also modified his driving habits. He now starts his engine before fitting his seat belt and adjusting his driving position. In this time, the oil has reached all parts of the engine. He drives off gently while his total drive train builds up to full hydrodynamic lubrication. He then progressively increases the power as required, as the Landcruiser warms up.

18.
Turbochargers

Turbochargers operate at very high speed (up to 100,000 RPM) and very high temperatures… straight from the exhaust! They require a good reliable source of quality lubrication to ensure long service life. But the environment they offer the lubricant is hostile. Oils for turbocharged engines are required to be very heat stable.

A minimum flow of oil to turbo bearings is required not only for lubrication, but also for cooling the bearings. Note that it is more important in a turbocharged engine to maintain clean oil. Soot laden oil, while it readily absorbs heat, does not disperse it efficiently. It is also abrasive, and a major cause of chewing out turbo seals, leading to failure. Turbos do not like sooty, sludgy engine oil!

Do not allow the turbocharger to become coked up on the exhaust side. Coking is another major cause of turbo failure, but will also cause power to drop off, and delayed turbo boost. In variable geometry turbos (VGT), coking will foul movement of the adjustable vanes causing performance issues and potential failure through interference with the compressor vanes. Using FTC Decarbonizer is one good way to ensure clean, carbon free condition, and superior life from turbos of all types. Using high quality lubricants is also essential.

Certain operating procedures for turbocharged engines should also be observed…

- Allow the engine to idle until full oil pressure is reached.
- Operate below turbo boost pressure (when the turbo cuts in) initially, to ensure adequate oil supply.
- Operate normally.
- Where possible, operate the engine below boost prior to parking the equipment.
- If the previous step was not possible, allow the engine to idle briefly (15 seconds to 2 minutes, depending on how hard it has been working).

Focus on keeping turbos free of carbon and low oil soot levels is a step in the right direction to longer, trouble free turbo life.

19.

Lubricant types: Mineral oil vs. synthetic

The cost of synthetic oils is considerably higher than conventional mineral oils. The manufacturers are sometimes prepared to spend more on improved additive packages for these oils and greases, and when they do, they become even more costly. So the performance benefit of synthetic oils over their mineral counterpart can come from two sources…a more stable base oil, and in some cases, superior additive packages. However, bear in mind that the specialty mineral oil field can also offer the top shelf additive packages.

The greatest asset of synthetic oils is that they possess the inherent advantage of a very high viscosity index. That means that the oil's thickness does not vary as much from cold start to high temperature working conditions, as does mineral oils. Fluid friction is decreased, especially during cold running. The frictional losses in engines are from two sources:

- 70% hydrodynamic (friction due to the oil's viscosity)
- 30% boundary (friction between two moving parts)

Synthetic oils provide a lower cold viscosity, while providing higher viscosity (relative to mineral oils) at the high temperature extremes.

The user benefits are as follows:

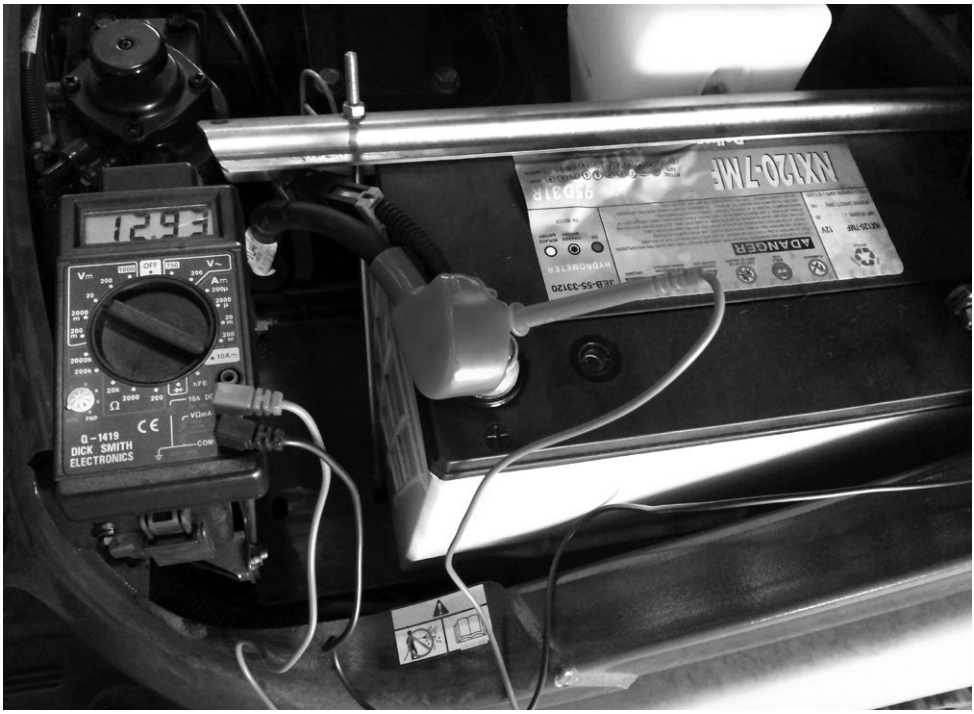
- Fuel savings of 2-3% from reduced hydrodynamic friction
- Reduced oil evaporation at high temperatures (approx 25% less)
- Longer oil service life (up to 4 times for engine oils, and more for transmission and hydraulic oils)
- Better oil cleanliness (more stable, less oxidation)
- Longer component life under harsh (e.g. high temperature, high load) conditions

Synthetics can offer the ultimate protection and performance, at this stage, but as with mineral oils, quality does vary within this category also. Choose carefully.

20.
Batteries

For the best service life from batteries, start with quality when you purchase one. Ensure there's plenty of reserve for extended cranking on the coldest days. Put simply, buy the heavy duty option for your model. Hard rubber cases should generally give better protection than plastic cases, especially when vibration is a factor. Screw caps on the battery cells reduce the evaporation and top up necessary, compared to the press on caps.

Once you've bought your battery, you can minimize sulphation and buckling of the plates by adding a cadmium sulphate solution. Buckling plates can cause internal shorting and is a major cause of battery failure. The addition of cadmium sulphate will provide much longer life for a large percentage of batteries. The last 4x4 battery I replaced did 6 years and 10 months...well above the expected life these days. Modern battery chargers often have a pulse charge cycle, which rids the battery plates of sulphate build up. It is recommended to pulse charge all batteries at regular intervals to get maximum effective life from them. This particularly applies to batteries in vehicles and equipment that is not used regularly, e.g. seasonal use equipment, standby generator sets, fire fighting equipment, etc.



A fully charged battery in good condition.

Another major cause of battery failure is breaking of the internal circuitry…open circuit. I tend to think this is sometimes designed to happen by the manufacturer. Look for a quality brand.

Batteries should always be fully charged, so if machinery is left parked for long periods, batteries should be kept on trickle charge. Batteries should always be kept clean. Dirt, debris, grease, etc. (especially around terminals) will act as conductors on the surface of the battery, allowing it to discharge. Batteries should be mounted firmly in a secure position. Some batteries require different charging. For example, Calcium batteries charge at a higher voltage…up to 16V.

Batteries should never be left sitting on concrete. Well, I'm not sure whether this is an old wife's tale or not. Scientifically, I can't explain why this should be so, and I'm not even certain if it's fact, but I'm told that this seems to flatten good batteries quickly. At any rate, I make a habit of sitting them on a rubber mat in preference, and making sure they remain clean and dry to minimize discharge by tracking across the battery top.

Heat is a big killer of batteries also, so it is advisable to position them well away from the exhaust system. Where radiated under bonnet heat is directed towards the battery position, some form of insulation may be useful, if placed on the heat side of the battery.

Vibration is a bigger problem with off road applications (e.g. 4x4, earthmoving and agricultural). It can be helpful to place some cushioning material under the battery before securing it into the frame. Soft rubber matting about 1cm thick is ideal.

Electrolyte levels must be maintained just above the battery plates at all times. Top up as necessary with distilled or rain water.

Lastly, you need to protect against battery terminal corrosion. Those white-to-greeny/blue fluffy deposits frequently seen on terminal posts and battery leads are evidence of corrosion. It's caused by battery acid attacking the posts, terminal clamps and cable wire. Apart from causing corrosive wear of these parts, weakening them and destroying the good fit, conductivity is reduced. Starting performance and charging performance is reduced.

To protect against this, first disconnect the battery leads (earth first) and thoroughly clean all parts. Use bicarbonate of soda and hot water. You need to coat all exposed parts (but not the mating surfaces of the terminal clamp and posts) with an impervious, protective coating. A light penetrating, rust-proofing compound that dries tack free is ideal. Try to obtain it in a spray pack form for ease of use.

Ensure you deposit a coating into any visible exposed cable wire, and the base of battery posts, where acid can sometimes leak. Acid leakage will be indicated by blackening of the battery posts.

Re-fit all connections to the battery, and spray the terminal again with the coating.

21.

Combustion efficiency… there's more to it than just saving fuel!

It makes good dollars and sense to optimize fuel efficiency, but, it's more important than just saving a few bucks at the bowser! Sure, equipment will give better performance if correctly tuned, but it's also a vital part of maximizing engine life. If fuel does not burn thoroughly, the products of its combustion are more harmful to engines. Ideally, fuel should burn **completely** to carbon dioxide and water. However, the ideal is not achieved. Some combustion products are corrosive, others are abrasive and others form deposits. Under good conditions, a tiny amount of these bi-products reaches the oil past the piston rings. When combustion efficiency deteriorates, the concentration of these bi-products increases, so greater amounts enter the oil.

The oil's additive package must control these contaminants, by neutralizing acids, and finely dispersing abrasive and deposit forming contaminants. Depending on the oil in question, varying amounts of these contaminants can be safely controlled. Thereafter, deposits, wear and corrosion increase. This can be a big problem with diesel engines, because of the higher potential to produce abrasive and deposit forming products.

Here's what can happen in a diesel engine that loses combustion efficiency: The start of the problem could be dirty injectors, over-extended oil change intervals, a clogged air cleaner or too high a fuel pump setting…all very common problems. The first signs are an increase in black smoke. Increasing amounts of black smoke (called soot) enter the oil past the piston rings. The oil becomes thickened, fully saturating the oil's dispersancy additive, to the point where it cannot control deposits, or further ingress of soot. Soot particles clump together, since the oil can no longer keep them dispersed. These large particles are more abrasive, since they bridge the oil film between lubricated parts of the engine more easily.

Deposits form on the piston, valves, cylinder head and turbocharger. Excessive piston top land deposits will rub against the cylinder wall to cause wear, or bore polish. (This is different from bore glaze, where a deposit forms on the bore.) Piston rings become stuck in their grooves, allowing oil consumption to increase, and cause further (oil related) deposits. Hard deposits form on the back of valves and on the valve seat area. Valve failure can result. Wear increases in bearings, rings, liners, valve stems, turbochargers, camshafts and other critical parts.

In short, the wear profile of the engine is **dramatically accelerated!** All because of neglect to the fundamentals of combustion efficiency. It is a major reason for poor engine life. And amazingly, it is poorly understood by most maintenance people!

Similar problems can develop, not through poor maintenance, but because of poor operating conditions. Diesel (and also petrol) engines operate most efficiently at higher

engine loads and in the maximum torque RPM band. Efficiency is measured in terms of fuel usage per unit of power produced. Engines that run cool, idle excessively or are operated lightly loaded do not operate efficiently with respect to combustion. These are also causes of bore glazing, a condition where the cylinder cross hatch grooves are filled with a carbon type varnish, that is worked to a glassy finish by the action of the piston rings. The purpose of the cylinder cross hatch is to hold a film of oil, which is necessary to complete the seal between the piston ring and the cylinder bore. With a glazed bore, oil control and cylinder compression control are lost.

Fuel specification is another factor that has been of increasing influence in recent years. Rather than waste the heavy parts of crude oil (that were commonly used as fuel for furnaces), oil companies treat this by "cracking" (or breaking it down to "cycle oil"), and adding it to diesel fuel. Some heavy crude oil molecules are added untreated, and to provide an overall balance, some lighter fractions are also included. The point is that these cycle oils and heavier fractions do not burn as easily as the higher specification components. If maintenance levels are adequate and operating conditions are ideal, this should not pose a major problem. However, operating conditions are not always ideal, and oil change intervals may need to be shortened to maintain cleanliness.

As a corollary, if you can improve combustion efficiency, even above the standard set by good maintenance and operating conditions, even greater engine life is available. Chemistry is currently available that improves power and fuel efficiency, even under conditions already ideal for combustion. That chemical is marketed as FTC Decarbonizer, and it acts as a catalyst to increase the speed of combustion, and lower the combustion temperature of carbon deposits. What also results, is a major reduction in the size of the abrasive soot particles. In numerous tests using FTC and involving large mining equipment, the diameter of soot particles (found in the oil), was consistently reduced to 1/3rd of the control group. Mean soot size was reduced to less than 0.2 micron, whereas, without FTC, it was averaging 0.6 micron diameter. Because of this, a reduction in engine wear rate of 24% (or more) is typically achieved in well maintained engines. Where problem conditions exist, engine life can be easily doubled, with a dramatic correction in combustion efficiency. Of equal importance is FTC's effect on hard engine carbon. Carbon so hard, that it would have to be chiselled off at overhaul, is burnt away by the catalytic action of FTC.

Chemical fuel treatment to provide fuel system cleanliness can also be of benefit. Many fuel additives are, at best, only marginally effective, but there are some excellent ones available, and these will correct faulty fuel spray patterns, that are caused by injector tip or carburettor deposits. Refer to ***"Products that can help"*** on page 56 for further information.

22.

Using science to extend equipment life

Lubricating oil changes both physically and chemically during its service life. For example:

- Accumulation of wear debris
- Entry of external contaminants (dust, water, fuel)
- Deterioration due to heat and chemical effects
- Build up of combustion bi-products

In the broadest sense, scientific analysis of used lubricating oil can tell us three things…

1. **Is the oil condition OK for further use?** Oil viscosity should still be within a satisfactory range. Contaminant levels should not be excessive. Oil additive packages should not be excessively depleted.
2. **Are operating conditions normal?** Entry of dust, coolant, fuel, soot, sulphur and high oxidation levels reflect a problem that if left unattended, **will** shorten the life of components. This knowledge allows the owner to take preventative maintenance measures well ahead of expensive repairs becoming necessary.
3. **Is excessive wear taking place?** All wear metals are measured in parts per million (ppm). Where levels exceed a normal upper limit, wear is designated as abnormally high. These levels do vary with engine type. For example, for mining equipment, the following upper limits are set as "normal" at the end of the oil service life…

Wear metal type	Cummins engines	Detroit Diesel Engines
Iron	24 ppm	50 ppm
Chromium	1 ppm	4 ppm
Copper	5 ppm	10 ppm
Lead	26 ppm	5 ppm

Some manufacturers can extrapolate the economic life of a diesel engine by plotting the wear rates from each oil sample taken. Once you get everything running well and within the normal limits, by stepping up your monitoring efficiency, you'll find that it is possible to set new standards for wear rates by using higher quality lubricants, combustion chemistry and filtration.

Oil analysis can save the life of your engine, transmission or other component of machinery. For example, suppose you have a loose hose from your air cleaner to your manifold in your 4x4, and you do a lot of dusty outback work. Your next oil analysis alerts you to **high silicone**. Silicone is the major element in dust, and points to a faulty air induction system. Quite likely, this will be accompanied with elevated **iron** (from cylinder liners), **chromium** (piston rings), and **lead** (bearings). If you correct the problem early, a catastrophic engine problem is avoided.

A routine laboratory analysis on my Range Rover engine (diesel) identified elevated sodium, indicating coolant entry. The level was not large, but elevated, and I was not losing excessive coolant. I re-tensioned the cylinder head, and sent another sample for analysis on the next oil change. The problem was solved, well ahead of any damage to the engine, or even visible signs of water in the oil.

A very common problem with small pre-combustion diesels (especially Japanese) is high soot, derived from combustion. The oil change interval is generally recommended at 5000km, however, depending on operating conditions, kilometres travelled and quality of service, they may be well and truly overloaded with soot by this stage. Factors which can exacerbate this include engine sludge being resuspended by the fresh oil. In severe cases, this can overload the oil instantly! Other problems, which can cause excessive soot include:

- Over-fuelling (fuel pump setting too high)
- Excessive idling
- Dribbling injectors
- Incorrect timing
- Restricted air filter or intake system
- Cool operation (e.g. stop-start, sticking thermostat)

High sodium indicates a coolant leak usually, as sodium is a common element in cooling system inhibitors. **High lead** can indicate bearing wear. **High aluminium** can be from pistons.

The higher the wear metal value, the more severe the wear. It sounds simple enough, but the interpretation of oil analysis results can be complicated by many factors, including:

- The sample taken should be representative. The oil should be hot and well mixed, and sampled cleanly.
- The oil service life must be taken into consideration, low contaminants at low oil hours/kms can mean things aren't as good as it might seem.
- The amount of oil top up must be considered, since topping up dilutes the contaminants.

Development of trends over a series of oil samples provides a better idea of how an engine is performing.

Used oil laboratory analysis sampling kit

23.

Harmful oil contaminants

Contaminant	Source	Method of Control/Action
Dirt	External, enters past air filter or seals	Locate and repair fault
Coolant	Cooling system leak, due to corrosion, faulty gasket, etc.	Oil will disperse and control small amounts. Locate and repair the fault
Water	Cooling system leak, condensation, combustion.	Oil disperses small amounts. Minor water entry is removed by evaporation. Locate and repair fault. Change oil and filter. Flush system if severe problem.
Soot	Poor combustion of diesel fuel	Oil disperses soot until additive package is exhausted (then sludge is produced). Check for over-fueling, timing, restricted air inlet, turbocharger, injectors, fuel quality, etc. Change oil and filter. Flush the oil system out. Use FTC Decarbonizer to minimize soot production.
Oxidation products	High temperature operation, high temperature at lubricated points, other contaminants can accelerate oxidation.	Oil disperses. Go to a higher quality oil with more stable base oil stocks and anti-oxidant. Use of anti-wear will reduce high point temperatures.
Fuel	Over-fueling, dribbling injectors, leaking fuel line, worn rings liners, sticking piston rings	Oil disperses, but loses viscosity rapidly, increasing wear. Change oil more frequently until fault repaired. Use high quality flushing oil concentrate to free sticking piston rings.
Sludge	Formed by soot, water, oil residues and dirt.	Insoluble in oil. Use quality flushing oil concentrate to resuspend and remove sludge. Go to higher quality oil. Check as per soot. Use FTC Decarbonizer.

Harmful oil contaminants (cont.)

Contaminant	Source	Method of control/Action
Gum, varnish and lacquer	Fuel, fuel and oil, and baked varnish respectively	Use high quality crankcase oil. FTC Decarbonizer will burn off from combustion spaces, where a glaze is formed.
Ash	Fuel and additive packages from crankcase oil	Control fuel quality. Additional finer filtration of fuel may be necessary. Reduce oil burning. Use of FTC Decarbonizer will burn the carbon from the deposits that is the binder for the ash, allowing it to deplete.
Carbon	Fuel and oil	Check as for soot. A detergent/dispersant type fuel additive with upper cylinder lubricant is recommended to deplete inlet port deposits for carburettor and port fuel injection systems, and to correct fuel spray patterns. FTC Decarbonizer should be used to burn off carbon from cylinder heads, piston crowns, top lands and top ring grooves, turbochargers, exhaust manifolds, etc.

24.

The FIVE duties of an engine oil

There's really more to engine oils than meets the eye. Modern engine oil formulations are heavily fortified with several types of additives to enable them to perform the following duties…

1. **SEPARATE SLIDING/CONTACTING PARTS TO PREVENT METAL-TO-METAL WEAR** Viscosity is the single most important factor in preventing such wear. A minimum viscosity should be maintained at all times to ensure good hydrodynamic lubrication. Viscosity index improvers are used in conjunction with the selection of base oils of specified viscosity to achieve the desired viscosity properties. Remember that viscosity decreases with higher temperatures. It also usually decreases with oil service life, due to shearing of VI improvers and sometimes fuel dilution. Anti-wear additives are used to provide some boundary lubrication, when the oil film is not present (e.g. start up, and where local component loading is high).
2. **COOLING** The oil has a very important duty in removing heat from components, especially pistons, and all high load areas. Full, unrestricted flow of clean oil to all parts is essential to provide proper cooling ability to the engine. Amazingly, this duty is almost universally ignored by mechanics investigating over-heating issues in diesel. So often customers of 4x4's have already wasted $3000-$4000 on cooling system components, before coming to us to solve their problem!
3. **CORROSION PROTECTION** Engine parts are exposed to hostile and hot environments, with acidic combustion products, water vapour and oxygen readily available to promote rust and corrosion. If you lift the cylinder head off a petrol engine, three days after it was shut down, you'll see evidence of rust on the cylinder walls. Anti rust and anti-corrosion additives are selected to control this situation.
4. **CLEANING** Should oil contaminants be allowed to settle out, they will block oil galleries, form deposits on critical engine parts and reduce an engine's performance and life. Appropriate selection of detergents and dispersants enable engine oils to pick up and suspend deposits as a fine dispersion. In such a way, sludge, gum, dirt and wear metals are controlled.
5. **PROVIDING A SEAL** Engine oil must assist in sealing, to prevent combustion gases blowing past the piston rings to contaminate the oil. It must also provide a fluid seal around crankshaft (and other) seals, to contain the contents of the sump, and prevent ingress of outside contaminants.

Additives are used for other purposes also, and some of these include acid neutralization, anti-foaming, extreme pressure anti-wear (has only limited use in engine oils), oiliness and tackiness additives.

The oiliness additives, commonly called friction modifiers, reduce friction and increase performance, but a word of caution…

Most of these products are derived from vegetable and/or animal oils, which do not withstand high temperatures well. They can deteriorate in the combustion areas, to leave a deposit on cylinder walls, i.e. a glaze.

25.

Rust protection for four wheel drives

Beach going 4x4s need special protection and attention to prevent, or at least minimize rust. Professional rust-proofing is the obvious place to start, as this will provide a chemical barrier, where it has been properly applied. Highly susceptible places, such as wheel arches, insides of doors and sills, and under body components can receive excellent protection. Bear in mind also, that the rust proofer's application wand will not be able to reach every nook and cranny on your vehicle. Your rust protection will also need additional maintenance after a few years, since it may eventually crack or peel back.

In addition, thorough washing after beach work is essential. It is necessary to clean inside and outside. Unfortunately, there is no short cut. It is time consuming.

PRE-BEACH PREPARATION. It is a good idea to give your vehicle an anti-rust spray, prior to going on the beach. Some old timers used to spray old sump oil on the underside of their 4x4s, but mineral based oils tend to wash off very easily with water. I've found that vegetable oil (as in old cooking oil) is far more resilient to water wash off. It's easy to apply, if you mix it one part with four parts water, then spray it on with a garden pressure spray outfit. It will easily form an emulsion, if mixed in a blender, and once sprayed on, the water will shed off, allowing the oil to adhere strongly to the vehicle.

While that's pretty good prior to each visit, if you want something more permanent and long term, check Xtroll Rust Convertor, in our recommendations in ***"Products that can help"**, page 56*.

ELECTRONIC RUST PROOFING is another alternative, that I believe works quite well, so long as the vehicle has enough moisture to complete the electrical circuit. Rust is a form of electrolysis, which can be prevented by passing a negative charge through all metal surfaces, to form a field of excess ions. These systems operate from the vehicle's battery system. You need to be sure that all body parts, for example mirrors and spot lights, are properly earthed to the vehicle, otherwise protection will not be afforded.

NOW! THE PUBLIC RELEASE OF NEW FINDINGS THAT PINPOINT A MAJOR CAUSE OF DIESEL ENGINE WEAR

26.

Engine wear problems a factor of oil soot particle size

Used diesel engine oil is readily identified. It's black! It's black because of soot produced by incomplete combustion of diesel fuel. This soot is also evident as black smoke coming out the exhaust. Some of it passes the piston rings and reaches the engine oil. The amount entering the oil depends on numerous factors, including temperature, operating condition, engine condition, load, RPM's altitude, etc. Everything else being equal, the amount of cylinder "blow-by" controls the rate of soot entering the oil.

Well, that's how it gets there, but what's the problem? If combustion was 100% efficient, diesel engine oil would not turn black with soot, and no black smoke could be measured. However, for numerous reasons, including diesel fuel performance level, engine design, engine condition, etc, 100% efficiency is never achieved. The problem is that soot is an abrasive, like valve grinding paste, but on a smaller scale. Between two sliding surfaces (e.g. piston ring and liner, or bearing and journal), the presence of soot can create abrasive wear, if it bridges the minimum lubricating oil film thickness, and interferes with the metal-to-metal clearance. The more soot, the greater the potential for wear.

So then, what is the minimum oil film thickness in diesel engines? This varies with engine design, condition, load, oil temperature, pressure and viscosity, type of oil, and more. However, it is widely recognized that approximately 80% of engine wear takes place during start up, when the bulk of the oil has drained back into the sump, leaving little for effective lubrication. The presence of soot will be most damaging during start up.

Over a period of many years studying combustion of diesel and its effects on lube oil soot, I have noted that the size of soot particles varies considerably. Because of oil company advertising, this was initially thought to be a factor of varying oil dispersancy packages. However, in experiments with large open cut mining equipment, it became obvious that combustion efficiency had a greater influence on soot size, than the oil type. With considerable experience with the FTC Decarbonizer/Combustion Catalyst, I knew I had

a tool, that I could use, at will, to change combustion efficiency. This experience gave me a unique edge in this type of research, since it is the easiest and cheapest way to alter combustion efficiency.

Almost universally, it is accepted that combustion efficiency is inefficient, but the effects of this on engine condition and life are not fully understood.

It was also evident that, since the diesel fuel formulations had departed considerably from the straight run distillate of years gone by, combustion characteristics were less than ideal. Considerable research had already shown that combustion efficiency could be improved by 3-10% in engines of good condition, with FTC, depending on applications.

At the time, I was acting as a consultant to the large Porgera Joint Venture gold mine in the Central Highlands of New Guinea, looking into ways to reduce black smoke emissions from their underground operations. Porgera had the additional problems of machinery operating at high altitude, where the air is thin. Soot was viewed microscopically, and the average soot diameter used as a benchmark for comparison. Soot size was approximately 1.0 micron. After stabilizing on FTC Decarbonizer, it was reduced to 0.2 micron.

By comparison, well maintained similar equipment at modest elevations averaged 0.57 micron, reducing to 0.2 micron on FTC. An effect of that magnitude would be expected to lead to substantial reductions in abrasive wear. And this has been confirmed repeatedly. Laboratory analysis confirms wear reductions of from 15-24% for well-maintained equipment to over 50% for problem situations. The ***Oil Spot Test*** *(see page 10)* is particularly useful in evaluating soot particle size.

Just as a point of interest, the laboratory method of analysis for soot does not take into account the effect of soot particle size. The common method involves measuring how much light (of a set wavelength) can pass through a small sample of used oil. The same amount of soot will produce a different result using this method, where the soot particle size differs.

In summary, there is considerable scope to reduce diesel engine wear rates and increase engine life, by focusing strongly on improving combustion efficiency, and reducing soot particle size.

27.

Products that can help

NOTES:

- To achieve the maximum vehicle and equipment life, it is absolutely essential to use superior lubricants, fluids and other products. It is not the intention of this book to monopolize the supply of these products, however it would be remiss of me not to provide examples of what is available, to assist readers to achieve much longer equipment life.
- Some of these products are available only from Cost Effective Maintenance, and I know of no alternatives to them. With others, you will find that there is a wider choice of some very good products. Be aware, that there will also be some that make claims that they do not live up to, so please investigate these options carefully. It is not my intention to be the only source of your maintenance products, as there will be others that will be more convenient. However, we already supply products Australia wide and internationally, and are happy to extend this service to anyone who wishes to deal with us…

COST EFFECTIVE MAINTENANCE
PO Box 3877 MT OMMANEY QLD 4074, AUSTRALIA
Phone: (07) 3376 6188
Fax: (07) 3376 6199
Email: sales@costeffective.com.au
Website: www.costeffective.com.au

27.1 FTC Decarbonizer

Applications (Petrol and diesel engines):

- Extend life of all engines by 24% or more. Extend life of turbochargers, catalytic convertors, diesel particulate filters (DPF's), valves, EGR valves, emission control equipment
- Reduce or stop black smoke, blue smoke and white smoke
- Reduce or stop oil consumption, due to fouling deposits (not wear)
- Provide easy starting (cold and hot)
- Decarbonize and de-glaze engines SAFELY
- Run in new engine. FTC provides clean bed in for petrol and diesel engines

- Improve power and economy, even in brand new engines
- Kill and control fuel algae, fungi and bacteria that clog fuel filters, wreck fuel pumps and injectors, and more
- Keep oil cleaner for longer and eliminate engine sludge formation
- Excellent preventative maintenance for ongoing use, providing total carbon control
- Magnificent for small petrol two stroke engines. They stay cleaner, last longer, start easier, and don't build carbon around exhaust ports and spark plugs

This is a unique chemical, and one of the most useful I've ever encountered. To my knowledge, there is no equivalent product, and it is not to be confused with injector cleaners and fuel conditioners. FTC promotes the ability to safely burn off carbon deposits from anywhere touched by the fuel flame, e.g. injector carbon, cylinder glaze, top piston ring deposits, cylinder head, exhaust valves and ports, turbochargers and exhaust systems. It will gently remove carbon so hard, that it would have to be chiselled off at overhaul.

There are now thousands of people who have prevented an engine rebuild by using FTC. Bear in mind that many engines when rebuilt are not excessively worn, but they are heavily fouled, and these are the ones that can be restored chemically.

FTC is suitable for all engines, diesel and petrol, 2-stroke and 4-stroke. It is highly recommended for all engines, so long as they are in sound condition. FTC will reduce oil consumption in an engine that is carbon fouled, but not worn badly.

Case Examples: One pleasure boat owner saved himself $40,000 by avoiding rebuilding his twin 8V53 Detroit Diesel engines. They had lost power and were blowing huge amounts of blue smoke, due to piston ring sticking and cylinder glazing. FTC quickly restored full power and eliminated all visible smoke.

Four wheel drives powered by pre-combustion type diesels rapidly blacken and thicken the oil, quickly depleting its cleaning power. Regular FTC use keeps the oil noticeably a lot cleaner.

Available from: **Cost Effective Maintenance and their agents ONLY**

27.2 Flushing Oil Concentrate (FOC)

Applications (petrol and diesel engines, transmissions, hydraulics, etc):

- Remove sludge from engines, transmissions, etc
- Free up sticking piston rings
- Helps remove cylinder glaze
- Highly recommended for light commercial and 4x4s with pre-combustion diesels

Unless oil changes are carried out in line with an engines mechanical condition, operating cycle as well as oil service time, deposits and sludge will accumulate throughout the oil system, and also around piston rings. Once the cleaning power of an oil becomes exhausted, because of its contaminant load, sludge and deposits rapidly accumulate.

At each successive oil change, the level of residual contaminants increases, while the engine's performance and efficiency declines.

FOC is added to the oil prior to an oil change, to remove deposits, and re-suspend sludge. It will thoroughly revitalize a heavily sludged engine.

Case examples:

Owners of Landcruiser diesels, of moderate to high kilometres, regularly drop out 2-3 litres of sludge from their sumps, when the oil is flushed with FOC.

A Caterpillar D6C dozer was throwing oil out the exhaust, due to glazed bores. FOC deglazed the engine and stopped the oil throwing in 40 minutes from cold start. It was the safest and cheapest option to rectify the problem. After all, the engine proved to be quite sound.

Nissan Patrols and other diesels regularly encounter over-heating issues, which have nothing to do with the cooling system at all. Flushing Oil Concentrate has solved many thousands of such over-heating issues.

Available from: Cost Effective Maintenance and their agents ONLY

Note: There may be other alternatives to this product, although I am unaware of any that are as effective.

27.3 Cleanpower Fuel Treatment (Super-concentrated)

Applications (Petrol and diesel engines):

- Reduce diesel smoke
- Faster starts (hot and cold)
- Smoother running
- Prolonged injector life
- Keeps fuel filters cleaner
- Optimizes fuel efficiency and performance
- Provides upper cylinder lubrication
- Anti-rust protection
- Cleans carburettors and fuel injection systems

Petrol and diesel fuels today don't burn as well and contribute to deposit formation in fuel systems and combustion and exhaust spaces. Cleanpower, with its extremely effective detergents and dispersants removes these deposits, quickly restoring performance that has gradually deteriorated over a period of time. Upper cylinder lubrication and anti-rust characteristics provide excellent preventative maintenance protection.

Approximately 80% of fuel injectors repaired could be made serviceable purely by cleaning. Cleanpower is one of the cheapest and most effective solutions.

In petrol carburettor engines, Cleanpower will solve one of the modern problems, by removing inlet port and inlet valve deposits that develop because of fuel volatility.

Case example: The owner of a Nissan Patrol 4.2L diesel was told by the dealer, that the injectors needed overhauling, and that this would cost him $650. By first trying Cleanpower, he found that this was not necessary. A hill, which normally required 3rd gear, was now taken in 5th!! Starting was much better; fuel economy improved; smoke reduced.

Available from: Cost Effective Maintenance and their agents ONLY

Note: Other similar products of varying quality exist.

27.4 AW10 Antiwear (lubricant assistant)

Applications:

- Suitable for petrol and diesel engines, transmissions, power steering, hydraulics, final drives, tractor transmission, hydraulic rear ends, etc.
- Reduce wear
- Reduce friction
- Reduce heat
- Excellent in high load applications
- Exceptional anti-rust protection
- Also gives outstanding results in small 2 stroke engines

AW10 multiplies an oil's load carrying ability without increasing its viscosity (or drag). A reduction in temperature of 69˚C was recorded at a high load bearing point. It is common for engines, transmissions, etc. to have some highly loaded components that under high duty cycle put excessive demands on the oil. The heat that is generated causes oil degradation, further reducing its ability to protect. Component wear increases.

AW10 provides the strength to cope in severe duty applications. The increase in power in engines can be quite startling, particularly under high load and high RPM, when friction is greatest, for example, racing cars, bikes, etc. and hard working trucks and earthmovers, etc.

AW10 provides massive improvements in small petrol 2-stroke engines, including chain saws, brush cutters, mowers, bikes, etc. Just mix into the 2-stroke oil and use normally.

Prime mover trucks see reductions in gearbox and diff temperatures of 15–25˚F, easier gear shifting, and elimination of gear stick rattle at idle. AW10 has prolonged the necessity to rebuild gearboxes and diffs by years for many users.

Available from: Cost Effective Maintenance and their agents ONLY

Note: There may be other suitable alternatives to this product.

27.5 RMI-25 Cooling System treatment

Applications: All cooling systems, automotive and other

To my knowledge, RMI-25 is unique, as in one product it carries out the following duties:

- Cleans entire cooling system
- Protects against corrosion
- Lubricates all internal cooling system components (including water pumps)
- Doubles the life of coolant and heater hoses
- Prevents heater valves from freezing up
- Reduces over-heating by 7˚C or more
- Stops electrolysis that can corrode aluminium radiators in rapid time
- Avoids water pump failures
- Lower cost than glycol type inhibitors (so long as you don't need anti-freeze)
- Can be added to all glycol type inhibitors, if anti-freeze is required

RMI-25 dissolves and suspends rust, mineral deposits and corrosion, while machinery is working. These deposits are then unable to recombine and form solids. There is no need to use special de-scalers and cleaners, since RMI-25 does this in the same action.

By just adding RMI-25 to your radiator, your water pump becomes a powerful cleaner, circulating thousands of litres of cleaning solution per hour, as you operate your vehicles and equipment.

RMI-25 can be used with other cooling system chemicals, or used alone. Its manufacturers claim that it protects all modern cooling system materials, including solder and plastics.

Case example: One large Western Australian gold mine, with a fleet of over 100 Toyota Landcruiser diesels, averaged 19-24 water pump failures a year. In two years on RMI-25, they suffered no failures. RMI-25 is completely NON-toxic and bio-degradable. This alone makes it unique, to my knowledge.

Available from: Cost Effective Maintenance and other stockists

27.6 Xtroll Rust Conqueror UV

Stops existing rust AND prevents further rust in all light, medium and heavy vehicles, trailers, fixed plant, buildings, wash areas, etc.

- Rust Conqueror UV has exceptionally high penetration ability to migrate into seams, as well as encapsulating existing rust, isolating it from the atmosphere, and bonding it back to the metal surface
- It dries to a hard wearing varnish like finish, that is dry (non-tacky), and flexible
- It leaves a barrier that's highly resistant to acids and chemicals
- When welding is necessary, there are no toxic fumes
- It will prime, seal and penetrate a wide range of material surfaces
- Rust Conqueror UV needs little preparation
- Suitable for all metals and other materials (refer below)
- Coverage up to 30^{2}m/Litre (by brush, spray, roller, etc.)
- Excellent UV resistance
- Smooth finish acts as a mud repellent to make cleaning easier
- It can be painted over if required
- Environmentally safe product (organic based)

How good is the penetration? A demonstration was given on a rusty trawler deck by treating a 1m square area by brush, using a wet on wet application technique every 5 minutes as the treatment would disappear into the ¾" steel deck. While this was underway, they were told that it was dripping into the cabin below! To stop complete penetration, they applied to the underside of the deck first, and allowed to dry for 24 hrs. Then it was applied wet on wet to the surface to avoid dripping through. They used about 1L per sq metre on the almost fully rusted deck!! On lightly rusted surfaces, coverage is about 25-30sq m/L.

You'll find it highly beneficial in most areas of the coal industry, both as corrosion control, and mud release agent for vehicles and equipment.

Seals, coats, preserves and protects a wide range of materials:

- Steel and Iron
- Stainless Steel
- Aluminium
- Galvanised products
- Copper and Brass
- Colourbond
- Concrete
- Marble
- Tiles
- Slate
- Granite
- Porcelain
- Timber
- Particle Board
- Fibro cement
- Asbestos materials
- Particle board
- Fibro cement
- Canvas
- Plastics
- Leather
- Rubber
- Vinyl
- and more

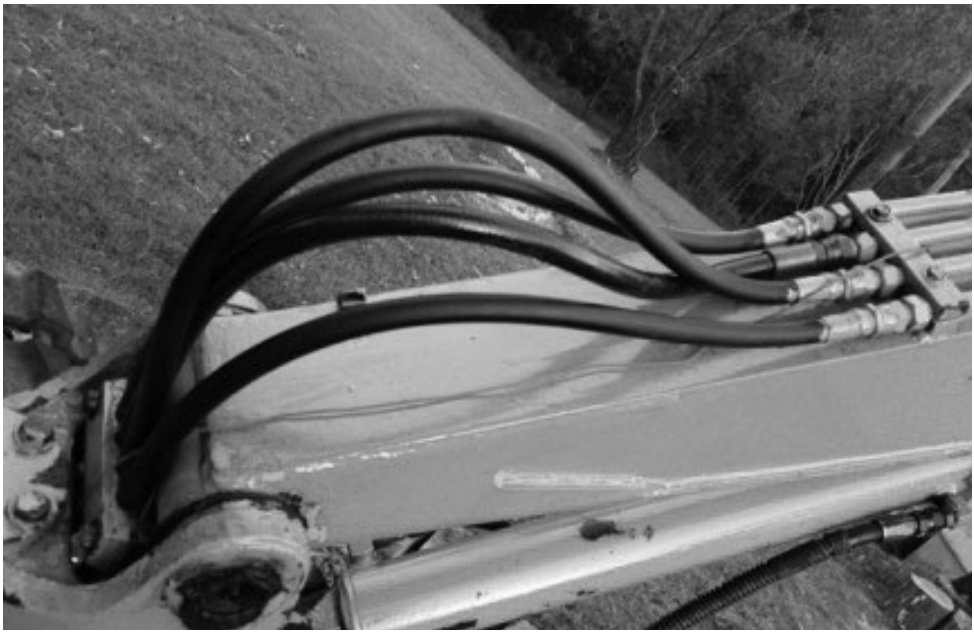


Image: Parked under a gum tree for 12 years, this excavator had severe rust, badly oxidized paint, vinyl and rubber. A quick pressure blast, followed up by Xtroll application had the paint shining, rust encapsulated to stop further advancement. Those hydraulic hoses were grey due to the UV attack, but now take on a fresh look with UV protection.

Available from: Cost Effective Maintenance

27.7 CRD Fuel Enhancer (for common rail diesel engines)

There are no shortages of horror stories about common rail diesel problems, and our fuel system cleaner, CRD Fuel Enhancer is the real life FIX for most Common Rail problems!

- Cleans the entire CRD fuel system
- Boosts diesel lubricity
- Anti-corrosion protection for pumps and injectors
- Restores power and economy
- Complete fuel treatment
- 250ml treats 2000L of diesel

SAVINGS HISTORY: $1500 TO $20,000 IN INJECTOR AND/OR PUMP REPLACEMENTS

Common Rail Diesel problems can be incredibly expensive!
Try a fuel system additive before you rebuild!

- Prevent, eliminate or minimize noisy injector rattle from your CRD engine! (The rattle can sound like noisy valve tappets, or rapid machine gun type rattle. The injector could be fouled by contaminant or is seizing due to inadequate lubrication. Excessive fuelling could be causing detonation inside the combustion chamber, instead of smooth combustion.)
- **CRD Fuel Enhancer** cleans pump and injector deposits, and disperses contaminants as they form
- Boost your diesel fuel's performance
- Provide exceptional anti-rust protection to pumps and injectors
- Fuel consumption going through the roof?
- Performance suffering?
- Save $1500 to $20,000 on CRD fuel pumps, injectors and expensive engine repairs!

CRD Injectors and Fuel pumps are very expensive ($1000 to $2000 per injector is not uncommon). They run incredibly fine tolerances, and are highly stressed due to enormous pressures and high temperatures. Compared to older technology diesel fuel systems, they are totally unforgiving when it comes to fuel contamination. Very small amounts of water or contamination will wreck pumps and injectors. They're pretty much non-repairable, so it means new components.

But the damage doesn't always stop with injectors and pumps. Sticking injectors can cause gross over-fuelling resulting in melted pistons! Start thinking $10,000 to $20,000, and for a 3-4 year old vehicle you'll probably be over-capitalizing repairing it! Compare THAT to the cost of our fuel treatment and treat any injector rattle very seriously indeed!

CRD engines have been developed to meet the latest emission standards, and diesel fuel sulphur is now very low for the same reason. But low sulphur fuel happens to compound another problem… lubricity! At a time when pumps and injectors rely even more on diesel fuel for lubrication, it has actually reduced.

Knight's Toyota dealership had a 2007 Hilux arrive with bad injector rattle. All injectors scored off scale readings, and shaking, rattling and knocking a lot… indicating that $4000 worth of new injectors was required. As $4000 was out of the question, they offered the owner a bottle of CRD Fuel Enhancer. It wasn't until the next service when they saw the Hilux again. This time, the injectors produced an "as new" test reading, and they performed perfectly.

Available from: **Cost Effective Maintenance and their agents ONLY**

27.8 Glacier Centrifugal Oil Cleaner

Glacier centrifuges are compact, yet offer approximately five times the dirt holding capacity of element type filters. Their high efficiency rate is maintained throughout the entire service period, unlike element types, that lose performance as they accumulate contaminants.

Most oil pumps produce 30-40% excess oil supply, and Glacier centrifuges are designed to use approximately 10% of an engine's oil supply. So engine lubrication should not suffer. Where low oil pressure occurs at idle, a cut off valve can be supplied.

These centrifuges are particularly useful for any high soot application, such as Japanese 4x4s and light commercials. The soot level in these engines is the factor that restricts oil service life to 5000km. Glacier centrifuges are one way to improve on this.

The centrifuges work like this…Oil enters the centrifuge chamber under pressure, and exits at the base through two horizontally opposed jets, that are directed to rotate the centrifuge bowl at high speed. A centrifugal force exceeding 3000G forces contaminant particles to adhere to the chamber wall, forming a dense cake. This occurs continuously, at a rate faster than the contaminant accumulation rate, thus keeping the oil clean. Laboratory tests with samples of used oil, have demonstrated that in 30 minutes operation, a Glacier centrifuge can remove 90% of all contaminants, including sub-micron sizes.

However, the main benefit is extending engine life, by removing particles that the main filter cannot remove. Even particles well under 1 micron are removed. Since the oil film thickness can be squeezed to about 1 micron in some loaded parts of the engine, this can have a major bearing on engine wear.

Glacier people demonstrated, in accelerated engine wear tests, that with a Glacier filter fitted to an engine, piston ring wear (as measured by ring weight loss) was reduced to about 25% of that where only the main filter was fitted. By comparison, a by-pass paper element type filter was only half as effective in their test. This test did not evaluate all element type filters, and there may well be some as effective as the glacier. Note that this test is an accelerated wear type. Glacier people suggest that engine life can be extended by 50% with their product.

Glacier centrifuges can double oil service life, and can double the life of the main full flow oil filter, providing important environmental and disposal benefits.

Please note, that if using FTC Decarbonizer continuously, there is generally little benefit in fitting any centrifuge type oil cleaner. Because FTC use results in such a clean fuel burn, the size and amount of soot migrating into the oil is dramatically reduced, leaving little for centrifuges to remove from the oil.

27.9 Grease

SUPER EARTHMOVER #3 GREASE: An extremely tacky NLGI #3 lithium based grease containing an over-treat of exceptionally effective Extreme Pressure additives. Copes easily with extreme load conditions, and strongly resists water washout. Provides excellent protection from shock loading. Does not spit out under impact. Does not run in high temperatures. Maintains its consistency, and does not readily shear out during service. Seals out against dust entry. Provides exceptionally long service life, sometimes 4 times as long. You won't use anywhere as much grease! Features a Timkin OK load of 30KG.

Recommendations: General chassis applications for trucks, 4x4s, earthmoving, farming and mining equipment. Particularly useful for excavators, backhoes, loaders, dozers, tractors, bobcats and all other earthmovers. Can be used in earthmoving wheel bearings also. A good truck turntable grease. Excellent for marine applications because of exceptional water resistance.

SUPER RED LITHTAC #2 GREASE: Provides all the features of Super Earthmover #3 grease, but in an NLGI #2 (lighter) consistency. Ideal as "the one grease for everything", as it can be used in automotive wheel bearings (it does handle disc brake temperatures), U-joints, shackles, earthmover buckets and pins, steering, ball joints, truck turntables. This grease is very tacky and sticky. High resistance to water washout. Excellent for marine and boat trailers wheel bearings. Long lasting, and that means you won't use anywhere as much grease. Features a Timkin OK load of 28KG.

SUPER MOLYTAC LITHPLEX #2 GREASE: This is an NLGI #2 extreme pressure grease containing a very fine grade of molybdenum disulphide, making it suitable for all bearing types, even tapered roller bearings. It resists water washout and has excellent anti-wear characteristics for high load applications. Tackiness additives provide resistance to hammer-out and fling off. Another "one grease for all applications" for those who prefer a MOLY type grease. Features a Timkin OK load of 28KG. Suitable from -20˚C to 175˚C continuous, and 200˚C intermittently. Ideal for automotive, agricultural, marine and earthmoving.

A quality grease gun makes sure your superior grease gets where it's needed.

28.

Problem Solver Checklist

Simply use this checklist to find the most cost effective solution for many common problems faced by vehicle and machinery owners today. Whether it's yesterday's technology or the most modern hi-tech equipment available today, we have low cost solutions to very expensive problems.

Problem	Example or Reason	CEM's Solution
Common Rail Diesel injector problems, blamed on "bad fuel"	Hilux, Landcruiser, Prado, Navara, VW's, Colorado's, Hino's, Isuzu's, you name it... ALL CRD diesels	CRD Fuel Enhancer
Carbon Fouling of Exhaust Gas Recirculation (EGR) Valve & Inlet Manifold	V8 Landcruiser diesels, Pajero DID's, Tritons... ALL CRD diesels. Due to excess exhaust soot and crankcase fumes.	FTC Decarbonizer, Flushing Oil Concentrate, CRD Fuel Enhancer
Sludge and filthy oil	Series 60 Detroits, old Landcruisers, Hiluxes, Patrols, etc. are real problems, but almost any diesel (by 100,000kms) use will have sludge.	Flushing Oil Concentrate
Diesel Smoke	Refer: "Diesel smoke tells YOU a story!"	FTC Decarbonizer, Flushing Oil Concentrate, CRD Fuel Enhancer
Overheating engine	4.2 Patrol diesels, 2.8L Hiluxes, and many older pre-combustion type diesels. Modern petrol engines now run a lot hotter, and are also prone to bad sludging (Camry V6, VW, Commodores, BMW, Hyundai, etc).	Flushing Oil Concentrate
Power Loss	Dirty oil, coked up combustion chamber, carbon weighted turbo, fouled emission equipment, carbon build up in catalytic convertors, diesel particulate filters and mufflers are a few reasons	FTC Decarbonizer, Flushing Oil Concentrate, CRD Fuel Enhancer (or Cleanpower)
Blowby	Series 60 Detroits, Cummins Signature and ISX engines, Cats on light work, 4x4's older gummy engines. Plus anything getting a few kms up is usually a bit fouled around the rings, before they get bad wear.	FTC Decarbonizer, Flushing Oil Concentrate
Poor fuel economy	Coked up engines and turbos, coked inlets, EGR's fouled, poor maintenance, sludge, sticking rings, fouled emission controls and more.	FTC Decarbonizer, Flushing Oil Concentrate, CRD Fuel Enhancer (or Cleanpower)

Problem	Example or Reason	CEM's Solution
Glazed cylinders	Usually due to light duty, excess idling, cold running. Sometimes changing oil type will also glaze.	FTC Decarbonizer, or you can use Flushing Oil Concentrate (if oil related, or vehicle cannot be driven at the moment)
Hard Cold Starting	Compression drop from sticky rings, poor fuel atomization, deposits, mechanical reasons, etc	FTC Decarbonizer, Flushing Oil Concentrate, CRD Fuel Enhancer (or Cleanpower)
Diesel Fuel Growths	Fungi, algae and bacteria can grow in any diesel to create a slimy growth	FTC Decarbonizer
Notchy Gear changes	Manual transmissions in Cars, 4x4s, trucks	AW10 Antiwear
Engine rattles and noises	Inadequate lubrication due to sludge and carbon	Flushing Oil Concentrate, AW10 Antiwear, FTC Decarbonizer to clean up then enhance protection
Dirty fuel pump and injectors	Common rail diesels and modern petrols particularly susceptible as well as older types	CRD Fuel Enhancer (or Cleanpower)
Coked up engine and exhaust	Prolonged light work, idling or poorly maintained engines	FTC Decarbonizer, Flushing Oil Concentrate
Sticking piston rings	Older or poorly maintained diesel and petrol engines	Flushing Oil Concentrate
Manual or Auto Gearbox running hot	Mitsubishi Pajero automatics. Truck gearboxes and diffs. Dozer final drives	AW10 Antiwear
Noisy hydraulic lifters	We do plenty of Commodores, but really any petrol or diesel engine	Flushing Oil Concentrate, AW10 Antiwear
Hydraulics running hot. Also Automatic Transmissions running hot.	Hard working hydraulics, eg bobcats, excavators, mining shovels. Pajero automatics are one of the more common for heating up excessively	AW10 Antiwear
"I just want to give it the best protection possible!"	So do we! In the long run, it's cheaper! You get much longer life, better power and economy, fewer repairs and enhanced driving pleasure.	FTC Decarbonizer, Flushing Oil Concentrate, CRD Fuel Enhancer (or Cleanpower) and AW10 Antiwear

29.

Cost savings boost fleet production

It doesn't matter if you're an owner driver, small fleet operator of a major mining company, here's how with just one of our products we provided an enormous return on investment (ROI) for our customer…

According to the laws of physics, power is the rate of performing work. When applied to a diesel powered coal mining fleet, an increase in power results in an increase in production. Of course, a production drive is a little more complicated, but never the less, more power is one method of increasing production, and it just happens by itself. In the background! With no additional effort!

A well-established means of increasing power (without compromising equipment warranties, durability and service life) is by utilizing the ferrous picrate based fuel borne combustion catalyst, FTC/FPC. A four year study on this product was recently completed at the University of Western Australia. It was sponsored by a major mining company, and confirmed more power per unit of fuel as well as cleaner exhaust emissions from diesel engines.

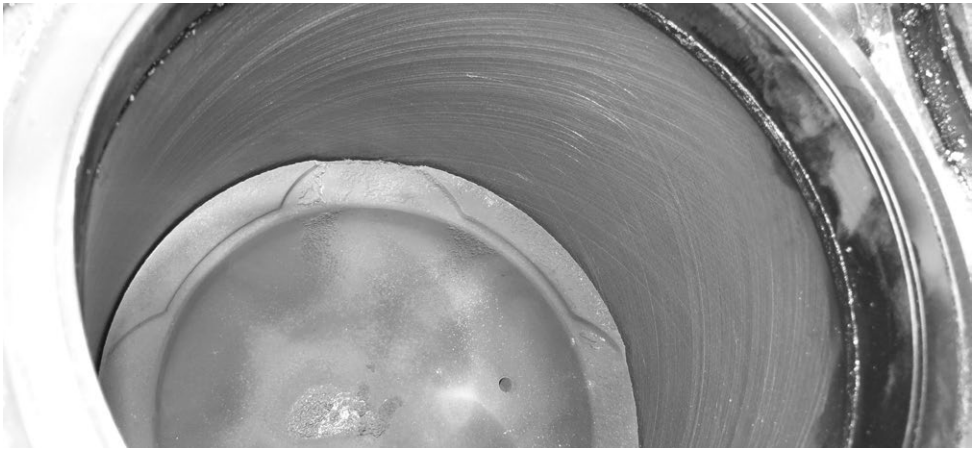
One of these tanks will treat 10 million litres of diesel, and save 10 or more B-Double truck loads of fuel!!

One Queensland thermal coal mine, using the FTC/FPC Combustion Catalyst, analysed their operating records after the first 12 months. While their main interest was in cutting fuel costs, the records indicated an increase in truck haulage rates from 430.8 to 452.7 Tonnes/truck hours operated. That's a 5.1% increase in material shifted! And it was created with no additional effort at all! Also noted, the Tonnes shifted per litre of diesel increased by 8.3%.

These sorts of figures demand further comment, as apart from productivity gains, there are further strong "bottom line" economies. These include direct energy cost reductions (5-9%), reductions in carbon footprint per unit of production and extended engine service life (24% or more). So just how is this achieved?

The FTC/FPC Combustion Catalyst is known to burn fuel at a faster and more efficient rate (more closely approximating ideal combustion). More of the fuel's energy is released closer to piston top dead centre, with less wasteful tail-end burning in the exhaust system. As a result of this, the faster FTC/FPC fuel burn increases developed power per unit of fuel consumed. At any specified power requirement less fuel will be required. At maximum fuel delivery, maximum outputs of power and torque are increased, enabling more work to be performed, and with reduced stress.

What this means for haul trucks is faster haul times, and more cycles achieved per month. When governed speed is reached, less fuel is required with the FTC/FPC Catalyst. However, diesel loaders, excavators and shovels always work at full power, and provide an important overall contribution to truck productivity, by reducing truck queuing. The increased power results in greater "break out" forces, faster response and faster truck loading cycles. In turn, that results in improved truck utilization, as idle time in queues is reduced.



So little wear that the pistons and liners could all be reused at over 23,000hrs on FTC/FPC use.

Equally important to production is equipment availability. The FTC/FPC enhanced combustion also oxidizes carbon deposits from combustion and exhaust spaces. Hard carbon build-up is a major cause of engine wear, increased stresses, and can cause catastrophic failures resulting in unplanned downtime. The improved fuel burn also results in lower oil soot levels with subsequent reductions in abrasive engine wear profiles. FTC/FPC use results in longer intervals between rebuilds, and reduced carbon related failures of valves, turbochargers and injectors. Identifying, minimizing and avoiding maintenance defects is a major task in successfully pushing out production figures, and this method contributes strongly by improving internal engine operating conditions. As already stated, no additional planning inputs are required.

Energy savings are significant, due to the more efficient fuel combustion. In the example above, some 8.3% higher tonnage of material was handled per litre of diesel, enhanced by the FTC/FPC's action. It's what every mining operation actively seeks...higher production efficiency, and lower cost per unit of production.

FTC/FPC is likely the lowest cost combustion catalyst on the global industrial market, ensuring returns on investment of 600%-1200% in fuel savings alone!

Environmental effects are also positive, with reductions in CO2, CO, hydrocarbons and diesel particulate emissions (DPE). Importantly both the mass and number of DPE's is reduced substantially. Competitive products contain hundreds (if not, thousands) of times the active material as FTC/FPC requires, and increase total number of particles, especially the more health damaging ultra-fines, even though they may reduce the overall mass of DPE's.

LARGE AUSTRALIAN COAL MINE USING 90,000,000L DIESEL PA (TREATED WITH FTC DECARBONIZER):

Benefit using FTC	Cost Benefit ($) per annum
After cost Fuel Savings	$4.83 million
Savings on engine rebuilds	$2.25 million
Downtime saved on rebuilds alone	$2.69 million
Productivity gains of 1.5%	$21 million
TOTAL Return on Investment	**$30.7 Million**

30.

How to keep older equipment in service for much longer... with better reliability!

1. Clean up and keep all systems clean.
2. Maintain full lubrication.
3. Protect against corrosion.
4. Reduce component stress. The less stress and loadings placed on each individual part within engines, transmissions, etc. the longer everything lasts.

Admittedly, while that's easier said than done, it's actually not hard at all! Let's look at the practical aspects of exactly what needs to be done in specific detail.

Clean up and keep all systems clean. First up, of course, good housekeeping principles are always essential. External contaminants (dust, water, paint flakes or whatever) should be prevented from entering major components through seals, breathers, air intakes, fuel systems, contaminated oils or other sources. Regular cleaning provides the opportunity to remove built up dirt and grime, as well as spot any damaged seals, leaks and other potential problems, before they become costly.

Deposits formed internally increase stress, wear and shorten component life. They form in engine oil galleries, sumps, piston ring grooves, fuel systems, cooling systems, combustion chambers, exhaust spaces, turbochargers and more. Deposits also form in transmissions, diffs, final drives, automatics and hydraulics. Commonly, deposits form by degradation of fuel and oil during service, oxidation, effects of heat and oil aging. These deposits inhibit efficient operation and full lubrication, so are counter-productive to our goal. With time and age, most components will generally have enough internal deposits to reduce operating efficiency and lubrication efficiency.

Cleanpower tidies up petrol and diesel fuel system deposits, while CRD Fuel Enhancer looks after common rail and modern high tech diesel systems. Clean fuel systems are critical for injector and fuel pump life, accurate fuel metering and correct spray patterns, and will reduce deposit formation in combustion spaces.

FTC Decarbonizer safely burns off all hard carbon from combustion and exhaust spaces (including turbos). This carbon build up increases stress, wear and hinders the flow of air and exhaust gases, so engine efficiency also suffers. Catastrophic failure (dropped valves, piston seizure, turbocharger failures, etc) often results from excessive carbon deposits. FTC also catalytically enhances combustion to produce a cleaner burn, with less combustion soot passing the piston rings causing abrasive wear. The amount of soot is much reduced and smaller in diameter, so wear to all lubricated parts is also reduced… so much so that engine service life is normally increased by 20-25% by FTC use alone!!

Some engines, of course, do have severe carbon issues, and very poor engine life, and service life can be dramatically improved in these cases.

Oil system deposits are another major contributor to accelerated wear and higher component stresses. Problems of over-heating, reduced lubrication, piston ring sticking, turbo bearing failure and excessive cylinder blow by are commonly the result of oil system deposits. In transmissions and hydraulics, hydraulic response and cooling are adversely affected. Lubrication to bearings may be inhibited due to oil system deposits to the point where a whine becomes audible. Flushing Oil Concentrate, which contains a specific detergent chemical that targets stubborn, normally hard to remove deposits, is used to soften, dissolve and disperse deposits in engines, transmissions and hydraulics so that they can be safely removed to allow full lubrication to all parts requiring it.

Cooling system failure is reputedly the biggest killer of engines, so it is vital to maintain them properly. Water pumps, radiators, thermostats, fan hubs, hoses, electrolysis of cylinder liners, scale build up, etc. are common problems with cooling systems. RMI-25 Cooling System Treatment cleans up and keeps clean all cooling systems by removing rust, sediment and scale. Cooling efficiency is restored, while all components are protected. Water pump failures normally start with seal failure. Abrasive sediment and scale chew out the seal resulting in bearing failure after water entry. RMI-25 is very effective in prolonging water pump seal life and reducing pump failure.

Maintain full lubrication. A film of oil (or grease) must be fully maintained on every part requiring lubrication, so that metal-to-metal contact is minimized. Higher loadings during equipment service result in more metal to metal contact than at no load situations. Also, cold starts after a period of shutdown result in the oil draining back, and are a major contributor to wear. Use of AW10 Antiwear is recommended, as it creates a semi-permanent bond to lubricated parts, which is present and effective during cold start up in engines and transmissions in particular. The high load carrying ability ensures far superior protection against abrasive and adhesive wear. It's suitable for engines, transmissions (including automatic) as well as hydraulics… a very effective step in keeping all equipment in service for much longer. (It is not recommended for wet clutches.)

With grease applications, we recommend always going for high quality, long life, water resistant products that stay put, with enough tackiness to seal out extraneous contaminants, while providing the necessary mobility to ensure continued lubrication.

Protect against corrosion. Both internally and externally. AW10 Antiwear also provides a powerful anti-corrosion barrier to protect internal components against rust and other forms of corrosion. For panel work and all nuts and bolts and components that are exposed to corrosive environments, Xtroll Rust Conqueror is recommended, as it penetrates seals and encapsulates rust, and is stable against UV radiation. It leaves a dry tough film that

enables easy removal of mud and dirt, and can be painted over if required. With ever increasing electronics, stray current is a bigger concern now than it ever was. Radiators, cylinder liners and thermostat housings are destroyed by stray current. Even radiator hose life is shortened by electrolysis, which initially affects the reinforcing between the rubber layers. RMI-25 eliminates stray current by encapsulating electrolytes, dissolved solids and salts. It can double the life of water pumps and hoses, while eliminating corrosion throughout the cooling system.

Reduce component stress. The less stress and loadings placed on each individual part within engines, transmissions, etc, the longer everything lasts. This is achieved by a combination of the above, and is usually evident by smoother operation, cooler operating temperatures, improved performance and/or efficiency, less noise and vibration.

At Cost Effective Maintenance, we consistently produce outstanding results due to the quality of our products. After all, this IS our core business. We are a "one stop shop" to cover all your needs, and since our range of products is highly concentrated, we can easily deliver solutions, no matter how remote your location is.

31.

Mechanics! Car, truck, machinery dealers! How to boost YOUR business...

What if that average mid-life car or truck in your yard could be revitalized from being a half worn old thing to something that's crisp, quiet, smooth and more impressive to drive? It'd be easier to sell, right? What if, when you service a customer's car, truck or machine, it actually runs, sounds and drives so much better than expected, that the owner is not just satisfied, but so delighted, he can't stop talking about it? Would that help business? Well, that's where Cost Effective Maintenance can help.

Used car, truck, boat and machinery dealers, as well as mechanics, can substantially improve the presentation quality of their vehicles by simply using CEM's products. While a nice clean, detailed car or truck catches the eye of a potential buyer, when it doesn't start so well, runs poorly, fumes, is a bit noisy or just feels tired, buyers are quickly put off.

Yet in most cases, simply removing years of accumulated fuel system deposits, engine sludge, cylinder glaze, and enhancing lubrication will eliminate these issues. In fact, with mid-life cars, trucks and machinery, it can noticeably transform their performance and operation, making it a more pleasant experience for the potential buyer. Importantly, for both the customer and the buyer, the chances of major component failure can also be substantially reduced, by reducing internal stresses in all lubricated components.

Prestige European cars seem to be prone to performance sapping deposits, making them run rough, idle poorly and lack acceleration. The simple addition of Cleanpower fuel system treatment and FTC Decarbonizer quickly has them ticking over smoothly, and providing crisp, willing acceleration.

Minor engine rattles, lifter noise, gear and diff whines can disappear with AW10 Antiwear. This Lubricant Assistant carries a much higher load than the oil itself is capable of, making every lubricated part more slippery, efficient and wear resistant. Manual gear changes become silky smooth, and engines, gearboxes, power steering units and diffs run smoother, quieter, and are less stressed, and less likely to fail.

Sometimes trucks will sit in the dealers' yards for a long time, and as a consequence of ongoing short idle periods, they'll glaze the bores and coke up, causing them to fume and smoke excessively. FTC Decarbonizer cuts smoke, and simply burns away glaze and engine carbon. It is the easy, low cost solution to a clean running, crisp sounding engine.

Change the oil in a diesel, and it can go black again straight away! That's sludge and it'll also cause smoke, fuming and rattles. You just need to use Flushing Oil Concentrate, to safely dissolve and remove engine sludge and free up sticking piston rings. It's great for quietening down hydraulic valve lifters in petrol engines too.

About the author...

Born in 1951, Brid Walker's career started in research with CSIRO, but it wasn't until a further 12 years, when he turned his passion for vehicles and machinery into a career, and founded Cost Effective Maintenance (CEM). For over 30 years, he has focused on helping his customers reduce their machinery maintenance problems, by using specialized, innovative products and procedures.

The close association that CEM has always had with their many private owners and small fleet operators has been crucial in providing essential feedback on the variety of problems they encounter. This was (and will always be) an efficient and essential component of CEM's problem solving strategies.

Brid has worked extensively in the mining industry to achieve fuel efficiency benefits in large open cut mining, and diesel power generation equipment. His personal studies linking combustion efficiency with engine deposits and wear have made him an authority on the subject. His approach to finding solutions to the many and varied problems displayed by vehicles and machinery always starts at the very basic level, whether that be chemical or what's happening at the microscopic level.

Walker has acted as a consultant to the large Porgera gold mine, in the Central Highlands of Papua New Guinea, where because of the high altitude, diesel smoke emissions were just shocking. His recommendations resulted in dramatic reductions. With another client, a large Australian bauxite mine, Walker guided them to better engine life, by focusing on changes that reduced diesel smoke particulates.

Career Landmarks

1986. Pioneered the fix for diesel engine oil turning black as soon as it's changed.

1986. Pioneered procedures that have saved literally thousands of engines from mechanic recommended rebuilds.

1986. Keeping older vehicles and machinery in commercially productive service for much longer.

1987. Provided a safe means of deglazing diesel and petrol engines.

1991-2. Eliminated valve failures in Cummins 1710 and Caterpillar D348 engines at both BHP and Rio Tinto mine sites.

1991. Lowering horrific levels of diesel smoke from PNG's high altitude Porgera gold mine.

1992. Reducing operating temperature, stress and wear rates in gearboxes (both manual and automatic), diffs, final drives, hydraulics.

2001. Demonstrated an effective, low cost means of eliminating locomotive exhaust spark emissions that are a known source of rural fires and property damage.

2003. Increased coal production efficiency by 5.1% at a Rio Tinto mine.

2007. Operators of Caterpillar D11R dozers were getting 8000-10,000hrs engine life, with many failures as early as 3000-4000hrs. This was against a Caterpillar recommended 12,000hr overhaul. Caterpillar couldn't come up with a fix, yet CEM brought a fleet of 10 x D11R's at a BHP mine to 18,000hrs service life… a clear 50% above Caterpillar target!

2011. Pioneered a low cost fix for common rail diesel engine problems.

While mining and other large consumers are important, Cost Effective Maintenance are still passionate about the needs of their private and small fleet customers, many of whom have become like family. Working closely with individuals and small fleet operators has been a vital part of both our research, and the field stages of our research and development work.