

Extending the Diesel engine oil change interval and even achieving an annual oil change is now a proven reality

This paper outlines the variables involved in extending the engine oil change and Winchester Globals' development of the ProtxL® (Protects all) by-pass oil and fuel filter, the fields of application, increased asset life and reduced servicing cost in the marine industry. It concludes by assessing the implications to engine design of environmental legislative requirements for waste oil.

## INTRODUCTION

This paper will cover the following topics:

### General Discussion

- 1 The variables involved in extending the oil change; includes quality of oil and fuel, handling methods.
  - 1 Lubricant consolidation
  - 2 Lubricant training
  - 3 Storage and handling
  - 4 Lubricant coding system
  - 5 Performance trending
2. The development of a filter that removes contaminants and sludge and the variables closely associated with extending and even confirming an annual oil change are:
  - 1 Oil condition Mineral or Synthetic oil.
  - 2 Age of the engine.
  - 3 Condition of the Cooling System and Air supply.
  - 4 Filtration performance
  - 5 Condition of the injection system
  - 6 Warranty
  - 7 The fields of application
  - 8 The Cost Benefit analysis
3. Engine design for emissions legislation has increased the need for high performance oil and filters- Implications for waste oil legislation.

## DISCUSSION

The engine oil-change procedure has been in use since the first diesel engine was developed. In essence the oil is changed because all spin on and centrifugal oil filters are not designed to remove sludge and maintain the contaminants at an acceptable level for longer and

certainly not for 7,000 hours.

The marine industry rides on a film of oil, the quality and management of which directly relates to duty of care responsibilities for the safety of the vessel, crew and the protection of the environment.

The single most direct impact a marine organisation could make on maintenance practices would be to examine how fluids were handled stored and applied. It is rarely the lubricant itself that's the problem- it's how we use it. For instance, cross-contamination between two lubricants is a commonly observed problem. There may be a bit of hydraulic fluid mixed with the engine oil. It only takes a drop of motor oil in hydraulic fluid to lose all the demulsifying properties of that lubricant. This amount of cross contamination to most maintenance people seems negligible but in reality it can be very severe and can reduce the life of the lubricant by over 90%.

## THE VARIABLES INVOLVED IN EXTENDING THE OIL CHANGE THE QUALITY OF OIL AND FUEL HANDLING METHODS.

Lubrication is often overlooked as a strategic maintenance function until a significant event, usually a failure or other threat to the business, reveals the need for a different approach. The failure that prompts change usually results in an injury/ or a loss of production, and or the asset is expensive to repair. In extreme marine situations the threat to vital vessel systems and safety breaks the cycle of poor practice.

*The following operational practices will assist the operator achieve the basic levels of performance required to allow the oil change to safely be extended.*

## LUBRICATION CONSOLIDATION

There can be many products in use on an oil rig, military platform, ship or workboat. Employing too many lubricants creates confusion among personnel, especially those that have recently joined the vessel. One cannot effectively lubricate machinery without getting the right lubricant in the right machine. Reducing unnecessary confusion is a good first step.

## LUBRICATION TRAINING

Often there may be little understanding company wide about the importance of lubrication cleanliness, contamination control and best practices for storing and handling lubricants. Products may be delivered in drums and stored open to the atmosphere, there is no monitoring of the quality of bulk diesel and oil being delivered. Of

course water is the common marine environment contaminant.

Additionally, the proper methods for delivering lubricants from stores to the machines are often not defined. The lack of lubrication precision results in the ingress of atmospheric contaminants and frequent mixing of lubricants; some of which are not compatible. Training on the proper method of lubrication selection, handling, contamination control, sampling and routine care of lubricants should be given a high priority and is one of the first action steps that will improve the process.

### **STORAGE and HANDLING**

It is common to find no specific containers dedicated to each type of fluid. Consequently, the lubricants are transported from stores to the equipment in any container that is available, including open cans, plastic bottles, buckets, etc. This leads to a significant amount of lubricant contamination in mechanical systems. The implementation of dedicated Oil Safe® lubricant dispensing bottles that are labelled for use with a particular product will significantly reduce the number of cases of lubricant contamination.

### **LUBRICANT CODING SYSTEM**

Management will also need to coordinate the equipment requirements with the labelling of lubricant storage and lubricant containers by creating a coding system that uses words, images and colours to define the specific product for each application. Once identified, the products are then matched with the correct storage and transfer container. The result will be a visual system that clearly communicates which lubricant the machine requires and which container held that particular lubricant. The technician or mechanic requires no special knowledge to use the simple matching system.

### **PERFORMANCE TRENDING**

The only possible way to know when oil should be changed and how the oil and the parts being lubricated are performing in the engine-operating environment is to regularly analyse the oil.

### **THE DEVELOPMENT OF A FILTER THAT REMOVES CONTAMINANTS AND SLUDGE FROM OIL AND THE VARIABLES CLOSELY ASSOCIATED WITH EXTENDING AND EVEN CONFIRMING AN ANNUAL OIL CHANGE**

For the workboat or military operator to be comfortable with working through the ProtXL® process of progres-

sively confirming – by oil analysis – the optimum oil change. Then having confirmed the optimum oil change for that particular engine with its own particular variable restraints.

We need to realise that several important maintenance decisions have to be made prior to the engine going into service.

### **DECISIONS: -**

The choice of Filtration

Having chose the correct recommended lubricant oil filtration is the next decision to be made to obtain the full benefits.

### **REASONS: -**

The most important property of our chosen oil is its VISCOSITY.

To obtain maximum long-term use from our lubricant its original VISCOSITY must be maintained.

PROTXL through their research and development program now manufacture an oil by-pass filter whose in field use has proven this By-pass filter is capable of totally completing the action of the lubricant by removing all contaminants' so service life is extended..

3. The remaining decisions are directly related to AIR/FUEL/COOLING SYSTEMS.

These areas are discussed later in this document.

Simply put, there are 5 major areas of maintenance to a diesel engine.

1. Lubricant.
2. Filtration.
3. Fuel.
4. Air intake.
5. Cooling System.

If these 5 areas are correctly maintained one can expect: -

1. The longest efficient service life of engine.
2. The longest service life of lubricant.
3. The least possible running costs.
4. The least possible down – time.
5. The highest possible return for capital investment.

The ProtXL® (Protects all) bypass oil filter has been developed over several years to address the issue of maintaining oil contaminants at an acceptable level for longer. The evaluation program has been exhaustive with the entire engine inventory of the MG Kailis fleet of 69 trawlers for over 6 years, running ProtXL and synthetic oil with an end of season oil change of 3,500 hours on main engines and 5,500 hours on auxiliaries. Even the Detroit Diesel V12 92 TA and V8 92 TA engines that have a Detroit recommended 150 Hours oil change with mineral oil due to excess readings of soot etc. Run a 2,000 Hours with zero soot readings and only slight soot readings occurring up to 2,500 hours.

When implementing ProtXL and Synthetic oil the decision to extend the oil change is conditional on a progressive 250-hour oil analysis, decision to extend the oil change. Clearly ProtXL does maintain a sludge free engine, as this extensive replicated result could not be achieved otherwise.

### **1 - MINERAL OR SYNTHETIC OIL**

One of the main limiting variables in confirming the annual oil change is the choice of engine oil. The use of non-synthetic mineral oil is justified when used in conjunction with standard filters as the oil change-out time is largely determined by the limited filter performance. From our experience the best ProtXL and mineral oil-diesel analysis result of 1,500 hours is from one of our power station clients operating a Cummins KT50 – 1,200 HP.

When a filter that does address the basic issues is used on new engines it is then justified and economical to use synthetic oil that has the high thermal & viscosity stability, with an increased dispersency and detergency additive package that has been proven by oil analysis to extend the oil change.

Winchester Global do not have any other clients that have confirmed the annual oil change when using mineral oil. However it is economically viable to continue to use mineral oil.

Increasingly the marine industry operators are realising the cost benefits of extended engine oil change because of the issues of logistics, weight and space, disposal problems in carrying new/used oil and their environmental obligations. The Miami based Carnival Corporation, operator of 40 cruise liners pleaded guilty in April 2002, to Federal US charges of falsifying ships records to cover up illegal oil dumping at sea and was

financed US\$32 million dollars.

Fleet owners that have established the ProtXL program - have the comfort of not having to rely on personnel to change the engine oil on time.

### **2 - AGE OF THE ENGINE**

Of course the optimum oil change cannot be achieved with a worn engine. The optimum time to implement the ProtXL program is when the motor is new or recently rebuilt. It is not advisable to put synthetic oil in an old engine. Many customers with older and smaller engines that use mineral oil have confirmed with ProtXL the ability to extend by a factor of 2-3.

### **3 - CONDITION OF THE COOLING SYSTEM AND THE AIR SUPPLY.**

Efficiently operating "Cooling Systems" are without doubt the "life-Blood" of internal combustion engines and is also the least properly maintained component of all operating engines. The design of the workboat should incorporate adequate air ducting preferably drawn from above the bridge. We have found that in smaller vessels with the air drawn from just above the water line, the oil analysis invariably shows an unacceptably high sodium analysis.

Research by the S.A.E. (Society of Automotive Engineers) has clearly shown some 50%-65% of all repairs to engines and automatic transmissions are due to Cooling System malfunction.

### **4 - FILTRATION PERFORMANCE**

It is the soot and acid that wear out the diesel engine. The metal contaminants are measured in parts per million and the oil wedge is 3 micron where carbon of less than this size does not wear. Most standard spin on oil filters are designed to filter contaminants down to 30-40 micron and can not maintain the contaminants at an acceptable level, because they operate at engine oil pressure and do not have the volume of suitable medium capable of absorbing the sludge. While centrifugal filters perform well, they can generally remove heavy water but are unable to remove sludge. So like spin on filters sludge builds up affecting the TBN and the oil has to be changed.

The ProtXL filter is a bypass filter plumbed into the pressure side of the oil pump and returned at a low pressure point. The OEM (Original Equipment Manufacturers) design the engines for their by pass oil filter systems but are unable to achieve the optimum

outcomes of an annual oil change. There are plugs already in to the oil galleries for ready installation.

The ProtXL flow rate is reduced at the orifice to 2 litres per minute, and the differential pressure is only minimal, so technically this is not a filter but a settling tank to condition the oil. Edge on filtration is used with a modified virgin fibre paper medium, free of bleach, chlorine and dyes that contaminate and effect oil performance.

ProtXL is a low technology, low cost solution to the problem of increasing carbon levels being dumped in the oil as the result of the OEM meeting exhaust emission regulations

## 5 - CONDITION OF THE FUEL INJECTION SYSTEM

It is necessary to maintain the designed performance of the fuel injection system, to be able to achieve the optimum oil change. In the marine environment it is common to find moisture and/or water mixed with the diesel and is the very combination, chemical wise, that causes the deterioration of the fuel through a process referred to as oxidation. Water in a disturbed state will emulsify with the fuel.

The ProtXL element was designed to be dual purpose, for use in the ProtXL fuel filter as well as the oil filter. This reduces logistic issues and reduces the inventory of a multitude of other disposable oil and fuel filters. One of our clients Mr John Goodbody of Captain Cook Cruises-Perth, has operated with ProtXL fuel filters for many years, had a set of injectors due for service at 7,500 Hours. At inspection they were asked why they had brought them in for service, as they were in brand new condition.

The ProtXL fuel filter range is designed for full flow of 4 to 50 litres per minute.

## 6 - WARRANTY

In reply to the question does the use of ProtXL void warranty? The common theme of written response is that the OEM neither approves nor disapproves any product not manufactured or sold by the OEM. The use of these products is at the discretion of the end user, and any problems attributed to these products would not be recognised as an OEM responsibility.

OEM warranty covers defects in workmanship and/or material as manufactured by the OEM, therefore any product sold in the market place not manufactured by the

OEM does not affect their warranty. However, any engine performance problem or failure caused by products not manufactured by the OEM is not considered a warrantable type of failure.

## 7 - FIELDS OF APPLICATION

The use of ProtXL® as they are designed for up to 13,000 Horse power has a universal application that extends to all reciprocating engines, hydraulic and fuel systems used in all industries.

## 8 - COST\_BENEFIT STUDY

See Appendix 1, The ProtXL KT-50 cost benefit study.

## ENGINE DESIGN FOR EMISSIONS LEGISLATING HAS INCREASED THE NEED FOR HIGH PERFORMANCE OIL AND FILTERS IMPLICATIONS FOR WASTE OIL LEGISLATION

There are many factors that have to be considered. Its best to break them down under categories.

### Legislative:

- The United States and the European Union are all planning for dramatic reductions in emissions on marine engines:
- More regional and local guidelines coming up every day
- United Nations International Maritime Organisation-MARPOL 73/78 still not ratified but gaining more country acceptance. Operators need to check their government's position on this treaty.
- New or pending rules by various marine classification societies concerning engine design and safety.
- Greater acceptance of high-speed diesels in traditionally medium speed vessels.
- Increased demands for increased engine life and lower cost of operations.
- Continued need for running engine data and ways to optimise engine life.
- Meeting pending emission regulations.
- Plan for re-powers and change out of old engines.

Expect more complex engine installations, designed exhaust after treatment systems and machinery arrangement complexity. This will be a new frontier for smaller work boats.

Considerations for owners, naval architects, marine engineers and builders looking forward

"The engine technology needed for the tougher emission standards has challenged the speed at which oils are being developed and released." Previously, oil formulation was separate from engine development and now many operators of these engines find increased soot levels, oxidation and acidation. To meet emissions standards demanded by US-EPA, some engine makers have had to retard the timing, which has resulted in the increase in soot levels. The reason for the raised soot levels is due to burning fuel meeting oil on the cylinder liner. The resulting soot gets dragged into the sump by the piston rings where it has the potential to plug filters and increase engine wear. Certainly, the more modern the engine the more demand it puts on the oil-and operators have to go for higher quality oils.

The implications for Naval architects, vessel owners and builders is that this increased pressure on engine oil requires the use of oil and filters with higher performance standards.

Clearly meeting arbitrary emission standards has replaced customer expectations for bottom line improvements as the main design criteria for new engines.

It is this increased pressure on engine oil with the resultant increased waste oil that is affected by Environmental legislation now starting to apply to the production and disposal of waste oil. For example Italian Legislation determines that new oil and new oil filters cannot be sold unless at the point of sale the used product is returned at the same time. While the EEC has been debating applying a tax on the oil change, France has now passed that legislation with draconian penalties for default. Such is the scourge of waste oil in the environment.

The requirements imposed through SOLAS and MARPOL conventions and the British standards BS 7750 and now ISO 14000 and ISO 19000 of social, economic and environmental responsibility can be addressed by the reduction of lubricating waste oil.

ISO 14000 and ISO 19000 will cover 6 main areas:

- 1 Environmental management systems
- 2 Environmental auditing
- 3 Environmental performance evaluation (waste oil)
- 4 Environmental labelling

5 Life cycle assessment

6 Environmental aspects in product standards (waste oil)

Similar to ISO 9000-ISO 14000 environmental management standard may become a defacto requirement for being able to do business in Europe and other regions.

When the EEC government and ISO realise that the annual oil change is a reality this may affect the continued use of current oil maintenance practices.

## CONCLUSIONS

This is a significant development that has never before been achieved. The variables that influence extending the oil change have been described. The advantages of extending oil change intervals and even achieving an annual oil change are readily accepted. It has been clearly shown that the initial implementation involves a process of the operator progressively deciding to extend the oil change based on oil analysis results.

The results show the cost benefit study on larger engines reduces the cost of oil and standard filters by 40 to 57%. The fact that one client has achieved this over 69 vessels for 6 years is very significant, as this client initially monitored engine performance with a 250 hour oil sampling regime using oil analysis and now periodically monitors oil analysis.

In summary the Social and Political timing of delivering this product combination to the world market is perfect in this time of increasing environmental legislation covering emissions as well as waste oil. The USA National Energy Policy Development Group set up by the Bush administration to search for new ways to make the US less dependent on foreign energy sources, must concentrate on more efficient use and less waste. The marine industry has historically produced the most visual pollution with oil tankers sinking at sea. The industry is responding under pressure from international maritime conventions. One problem being the increased production of waste oil caused by emissions legislation that now drives engine design and the continued use of a service regime that has been left over from the 1930s. The ISO 19000 standards of social, economic and environmental responsibility can be addressed by reducing the use of waste oil. The triple bottom line or corporate social responsibility approach will increasingly affect the marine industry and by reducing the quantity of waste oil generated, the marine industry significantly reduces operating, maintenance costs and sets an example in environmental responsibility by



not creating what is the medias most powerful tool “the slick on water.”

**REFERENCES**

1 The Good Oil- Australian Mining Monthly Oct 2002- by Marian Hookham  
 2 Nigel Abraham -Primary Lubrication  
 3 Geoff Conrad Cummins Marine USA-2002- Current and future Marine Diesel Trends in Work Boats. Conference paper Ausmarine West, Fremantle.  
 4 Standards must be lifted- Dr Keith Sherwood Australians Mining Monthly OCT 2001  
 5 GM invests in Lube Program Upgrades by Ed Bohn General Motors Corp, Machinery lubrication magazine  
 Published by the Society of Automotive Engineers (SAE) International  
 6 Engine Coolants and Cooling Components

Ref Number SP – 1162  
 7 New Engine Design and Cooling Systems Ref Number SP – 918  
 8 Engine Coolants, Cooling System Materials, and Components Ref Number SP – 960  
 9 SAE Vehicle Cooling Systems Standards Manual 1996 edition Ref Number SAE HS-4040  
 10 Petro - Jet Technology Workshop - Engine Cooling Technology  
 11 Cat Ref – SEBD 0970 SI SI Coolant  
 12 Cat Ref – SEBD 0640 Oil Magazine  
 13 Cat Ref – SEBD 0717 SI Diesel Fuel  
 14 Alan Smith ASM Perth

**COST BENEFIT STUDY USING MINERAL OIL**

**For:- Cummins KTA 50 1,200 – Horsepower  
 7,000 hours running time per annum @ 500-hour Service intervals  
 EXISTING ANNUAL SERVICE REGIME OIL & FILTERS**

COMPONENT	CAPACITY	SERVICES	AMOUNT	UNIT PRICE	COST
OIL		500HOURS			
ENGINE	400 LITRES	14	5600 LITRES	\$3.56	\$19,936.00
OEM		14	28 UNITS	\$40.00	\$1120.00
<b>TOTAL COST PER ANNUM</b>					<b>\$21,056</b>

COMPONENT	FILTER	HORSE POWER	QTY	UNIT	COST
ENGINE		1,200			
FILTER	W01600HP		1	\$900.00	\$900.00
FILTER KIT			1	\$150.00	\$150.00
LABOUR			2	\$50.00	\$100.00
TOP UP OIL			18Ltrs	\$3.56	\$64.00
<b>INSTALLATION COSTS</b>					<b>\$1,214.00</b>

**NEW ANNUAL OPERATING COSTS**

**For:- Cummins KTA 50**  
**1,200 – Horsepower**  
**7,000 hours running time per annum**  
**Note:- New service intervals**  
**Engine 1,400 hours**  
**OEM filters 1,000 hours**  
**Winchester filter element change**  
**250 hours**

COMPONENT	NO. OF SERVICES	TREATMENT	AMOUNT	QTY	UNIT	COST
ENGINE	5(1400hrs)	OIL	400	2000	\$3.56	\$7,120.00
		OEM FILTERS	2	10	\$40.00	\$400.00
WINCHESTER	28(250hrs)	ELEMENTS	2	56	\$55.00	\$3,080.00
OIL	28	OIL	9	252	\$3.56	\$897.00
<b>ANNUAL OPERATING COST</b>						<b>\$11,497.12</b>

**Engine oil change intervals may only be extended subject to Client progressive evaluation of 250 hours oil analysis results and deciding the optimum oil filter and oilchange interval.**

## **COST BENEFIT SUMMARY**

<b>1.</b>	<b>EXISTING SERVICE</b>	<b>\$21,056-00</b>
<b>2.</b>	<b>INSTALLATION</b>	<b>\$1,214-00</b>
<b>3.</b>	<b>NEW SERVICE</b>	<b>\$11,497-00</b>
<b>4.</b>	<b>ANNUAL COST SAVINGS OF CONSUMABLES</b>	<b>\$9,559-00</b>
<b>5.</b>	<b>ANNUAL SAVINGS</b>	<b>OVER 45%</b>

- **There is the additional benefit of extended engine life as the wear of lubricated machinery is almost totally determined by the amount of contamination of the lubricant.**
- **A strong oil package or the use of synthetic oils will further extend the savings, backed by oil analysis.**
- **The oil analysis regime will confirm the optimum ProtxL element change out time and also the optimum oil change interval. The above figures for the new annual operating costs are conservative so expect savings to increase. With the additional cost benefit of reduced repairs, labor and waste disposal costs.**
- **If OEM long life filter elements are used, their change out time may be further extended, resulting in a savings increase.**

# COST BENEFIT STUDY using ProtxL and Synthetic Oil



## *Existing annual service regime oil & filters*

For:- Cummins KTA 50 1,200 – Horsepower      500-hour Service intervals  
Castrol Enduro oil @ \$3.56 plus GST – Ltr  
205 Ltr – \$817.3 inclusive of GST

COMPONENT	CAPACITY	SERVICES	AMOUNT	UNIT PRICE	COST
OIL		500HOURS			
ENGINE	400 LITRES	14	5600 LITRES	\$3.56	\$19,936.00
OEM		14	28 UNITS	\$40.00	\$1120.00
<b>TOTAL COST PER ANNUM</b>					<b>\$21,056</b>

## SUPPLY AND INSTALLATION

COMPONENT	FILTER	HORSE POWER	QTY	UNIT	COST
ENGINE		1,200			
FILTER	W01600HP		1	\$900.00	\$900.00
FILTER KIT			1	\$150.00	\$150.00
LABOUR			2	\$50.00	\$100.00
TOP UP OIL			18	\$3.56	\$64.00
<b>INSTALLATION COSTS</b>					<b>\$1,214.00</b>

## **NEW ANNUAL OPERATING COSTS**

**For:- Cummins KTA 50 1,200 – Horsepower**

**7,000 hours running time per annum**

**Note:- New service intervals**

Engine	7,000 hours
OEM filters	3,500 hours
ProtXL	250 hours
Synthetic Oil 205L	\$2,725.63
Add GST	<b>Total \$2,998.18</b>
Winchester filter element change 250 hours	

COMPONENT	NO. OF SERVICES	TREATMENT	AMOUNT	QTY	UNIT	COST
ENGINE	1(7000hrs)	OIL	400 LITRES	400 LITRES	\$13.40	\$5360.00
BALDWIN LONG LIFE	2	FILTERS	2	4	\$65.00	\$260.00
ProtXL	28(250hrs)	ELEMENTS	2	56	\$55.00	\$3,080.00
OIL Canister Top up	28	OIL	9	252	\$13.30	\$3,351.00
<b>ANNUAL OPERATING COST</b>						<b>\$12,051.00</b>

***Engine oil change intervals may only be extended subject to Client evaluation. Oil analysis at every 250 hours will help determine the optimum oil filter and oilchange interval.***

## COST BENEFIT SUMMARY

<b>1.</b>	<b>EXISTING SERVICE</b>	<b>\$21,056-00</b>
<b>2.</b>	<b>INSTALLATION</b>	<b>\$1,214-00</b>
<b>3.</b>	<b>NEW SERVICE</b>	<b>\$12,051-00</b>
<b>4.</b>	<b>ANNUAL COST SAVINGS OF CONSUMABLES</b>	<b>\$9,005-00</b>
<b>5.</b>	<b>ANNUAL SAVINGS</b>	<b>OVER 42.5%</b>

- **There is the additional benefit of reduced repair costs and extended engine life as the wear of lubricated machinery is almost totally determined by the amount of contamination of the lubricant.**
- **The oil analysis regime will confirm the optimum ProtXL element change out time and also the optimum oil change interval. If a 500 Hr ProtXL element change is confirmed the new Service Regime is reduced to \$9,095 and annual savings of \$11,961 – This would be a 56.8% reduction in annual oil and filter cost.**
- **If OEM long life filter elements are used, their change out time may be further extended, resulting in a savings increase.**
- **ProtXL does not void warranty.**
- **When the ProtXL element is changed, the canister is drained of about 9 Ltrs and reused to top up the 18 Ltr canister.**