# Maximizing Engine Efficiency Utilizing Existing Assets
# by Matthew Bailey

The information contained within this presentation is essentially encompassing Efficiency recreation for older engines with aged service life. I am planning to start at the very front of these matters, as this is not an engineer's conference, and I ask for some patients from those who may already understand of the early parts of this presentation. For those that would like to know a little more about the engineering aspect of how this all comes together, then there are two options:
Firstly, you will find all of this information on our new website in the coming weeks, or
Secondly, you will find me an extremely approachable person, especially if bribed with a beer. So at any stage of this conference, please feel free to approach me, as I would only be too happy to answer any questions that you may have.

## INTRODUCTION:

Firstly, I would like to stipulate that this presentation does not cover any of the aspects in regards to engine reliability. This is simply a performance and efficiency based presentation.

## WHAT IS EFFICIENCY?

Essentially efficiency is about maximizing the output per input - or in our case today, KW/H per Liter of Diesel. This is the result of the combustion process that occurs within the internal combustion engine. – not breaking any new ground yet!
it therefore is only logical that to increase our efficiency, we must optimize the combustion process with our generator sets.

Combustion to put it VERY simply is essentially the result of the equation of Air Fuel and Compression. There is of course much more detailed than that;
However on a simplistic level it always comes back to Air Fuel and Compression.

Optimizing the combustion process is a very much a precision engineering field all to itself. Gone are the days of adjusting fuel quantities and timing on individual cylinders on the side of the engine to optimize combustion. This is an extremely haphazard approach that will never be as precise as setting actual known values rather than adjusting approximations.


## FUEL

This is the extremely critical aspect of the combustion process where the fuel system has to ensure that the fuel put into each cylinder is all Exactly the same in regards to atomization, injection timing and duration. fuel volume etc.

## AIR

The air supply to the engine is a critical and technical process to ensure we reach the correct air/fuel ratio.

## COMPRESSION

This simply means we have enough compression to instigate and maintain the combustion process.

Now we all understand that technology moves fast. These technological changes demand a change in maintenance standards and that therefore creates a need for a shift in Maintenance Awareness. This change is to reflect to what is now actually possible by simply implementing some modern ideas. Building, calibrating, and test and measuring plans.

It was only i0 years ago that diesel's were seen as slow and dirty things meant for trucks, commercials and 4WD, these days they are seen as the fast and green alternatives and now the kike of Mercedes Benz and BMW are selling more diesels then petrol cars. This has been a direct result of advancements made to the fuel injection and air charger systems providing far more favorable conditions for combustion than previously available.

Many times people associate the only way forward in terms of increasing their efficiencies is to simply purchase a new and more efficient engine. Whilst it is true, it is the result of millions invested by various Fuel injection OEM's, Turbo OEM's and not in the least MAN, Wartsila, Cummins and similar engine builders has resulted in new engines that are definitely more efficient.

But with this new research and development, there is the potential to employ many of these technologies and solutions into these older engines to see a marked improvement.

Speaking from personal experience, many of the engines around the pacific that we have worked on to date has seen a decrease in fuel consumption in the range of 5 - 12%. Whilst the final figure may not be as great as the latest technology engines, it is up to each of the utilities to weigh their options in terms of required goals and outcomes versus the capital expenditure requirement to reach their own way forward.

Another point that needs to be added here, is that the purchase of these newer engines, and the subsequent benefits will be short lived unless all the parties involved start to use these new Maintenance Procedures, otherwise we will be putting the same old problems into the new engines.

Through the rest of this presentation, I will show you firstly how to measure indicators to these issues, and also provide I you with details of the new 5 benchmarks in terms of current best practice. And then the best means to elevate these issues.

## Test and measure of efficiency:

Firstly, I would like to state how totally and utterly important it is to have PROPER and ADEQUATE engine monitoring systems in place. These form a basis of performance monitoring to ensure you are gaining the maximum power output per unit fuel input, but probably more importantly, they serve as an invaluable asset protection system.

Now in terms of efficiencies which are the premise of this presentation, we simply cannot test and measure, rectify, trial or enforce any efficiency goals with out solid, accurate equipment supporting your findings. This becomes particularly important in just a minutes time.

l guess that it goes without saying that, in terms of this presentation here today, that the two most critical pieces of equipment in terms of efficiency are your KW/H meter and the fuel flow meter.

Not being an electrical engineer I have absolutely no idea as to what a good or poor KW/H meter is, though l must say, given that this is what the utilities all bill out, of the ones i have seen, they are all very accurate.

The part that l have seen as not so accurate or reliably used by engine operators in general is the fuel flow meters. Personally speaking, I have found that the positive displacement worm drive volumeter to be the most user friendly, and most accurate with minimal maintenance requirements.

The magnetic style flow meters from my experience have trouble with fouling up and require very frequent cleaning to ensure accurate results.

Most importantly, your fuel consumption figures should be generated by a unit with temperature compensation and pulse pressure compensation at a minimum. More desirably, the units should have specific gravity compensation as this allows for consistent accurate results again and again even when delivered fuels are not always exactly the same specifications.

The following parameters are also important in terms of understanding engine performance which in many cases requires theoretical and practical training for engine operators:

| | |
|---|---|
| Exhaust Gas Temperatures - Cylinders | Exhaust Gas Temperatures - Pre and Post Air Charger |
| Air Inlet pre and post Intercooler | Charged Air Pressure Pre and post Intercooler for Each bank |
| Exhaust post air charger | Between air Filter and air charger inlet |
| Fuel supply pressures | Peak Pressure (BMEP) Pressures |

## Bench Marking: What is an acceptable level of efficiency?

This is the most important part of this speech in my opinion.
Given the newer technologies and utter precision required when dealing with the performance aspects of the engine, these items cannot be serviced on site.
Therefore we will focus on what can be done on sight, and that is self-appraisal and problem identification.

Important note to add here; regardless of engine type or age, if proper maintenance has been completed over the life of the engine, that engine should maintain **NAME PLATE OUTPUT (KW'S) AND EFFICIENCY.**

The engine performed that way when it was new, and every time an operator pays for an overhaul, they are paying to have all the key components refurbished to that same level, therefore there is no reason why engines should be downgraded or expect them to use more fuel over the life of the engine. This is not a logical outcome and should not be tolerated.

lt goes with out saying that if at some stage there has been make shift' repairs carried out to keep the engine running - such as oversized bearings, and the subsequent undersized and therefore weakened crank, will mean that you may no longer be able to run that same engine safely at the required KW output.
These are the exceptions not the rule!
A great place to start to look in terms of identifying efficiency issues is at original engine commissioning tests in which the engine was first load tested and all of these invaluable figures are written on these load sheets.

**CASE STUDY:**

I have taken some examples kindly donated to us by a current client and these show the original engine specification readings, the current readings and the general tolerances.

Now instead of going backwards and forwards to see the results, here is the tabulation with all of these figures contained. You will also notice that l have colored all of the sections that fall with in tolerance Green and those outside the allowable tolerance are Red.
One interesting thing that always pops up in a large number of these tabulations is that all of the readings that are to do with reliability - for example,
bearing temperature, are Green and OK. Whereas all of the performance based criteria such as rack readings and charged air pressures are consistently red.


## MAIN STORIES

### Methods of achieving:

As previously stated, efficiency or performance, is a direct relation of ain fuel and compression. Air Charger systems and fuel injection systems cannot be repaired on site. Therefore, what is achievable for utilities to reach these goals are performance based contracting.

Essentially, the scope of works needs to provide your' suppliers with not only a work order; but also your REQUIRED outcomes. Scope of works should, in my opinion have the following requirements:

- The allowable tolerances taken from the manual adhered to as an ABSOLUTE MlNlMUM. - With out this written into the contract; you have no matter of re-course.

- Should have a target efficiency (e.g. l97grams/KWH) written in with disincentives for suppliers who cannot reach (or as a supplier we'd love it if you could include incentives for people who can better it!)

These goals are completely realistic and have not been pulled from thin aiii All tolerances and figures used in this presentation have been pulled directly from the engine manuals in question, and similarly, your bench marking points will come from the same.

l thank you all for your attention and concentration during this presentation, l hope that you found it of use and that you are able to implement these strategies for instant merits and benefits to your organizations.