The Path to Dual Fuel Conversion

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The purpose of this document is to provide an overview of what is needed (or the path required) for converting large stationary or off road diesel engines to dual fuel operation, which is understood to mean a combination of diesel and natural gas fuels that are being combusted concurrently in the engine. Economics is driving these conversions, and one large Original Equipment Manufacturer (also referred to as an OEM or engine manufacturer) Caterpillar (CAT) is selling dual fuel conversion kits that they have developed at a very rapid rate and estimates that the market of Tier 2 CAT engines that could be converted (i.e. engines that are old enough that they only have to meet Tier 2 EPA emission requirements) will be saturated by the end of 2015.

Naturally, the EPA devotes its resources in proportion to the relative importance, or emissions contribution, that each segment of the US economy has. So it is not surprising that EPA's primary focus is on the automotive and truck sectors, which are composed of roughly 300 million vehicles. But the off road or Non Road (NR) sector, which is comprised of agriculture, mining, construction, rail, mining, electrical generation, and marine, still represents 8% of the energy used in the US economy, so the large engine group, is not an insignificant portion of the total emissions from internal combustion engines, and does receive some attention from the EPA.

In general, the EPA looks very unfavorably on any modifications made to internal combustion engines that have received EPA certification. In short, there is no such thing as a small change, and any such change is against the law. Anyone who owns an engine to which an uncertified change has been made, is subject to large punitive fines.

Naturally, the modifications that the EPA are most concerned with involve anything with the fuel, combustion, or after treatment systems; things that can directly influence the emissions from that engine. According to EPA regulations, making changes in these systems will require recertification of the engine, or a new engine Cert. The testing required to obtain a new engine Cert is time consuming and expensive, costing well over $100,000 for engines in the hundred horsepower range. Obviously, engines in the NR class are larger and their engine certs are more costly. In addition, the certification process has to be done in a controlled environment where very specialized equipment is present. Although expensive, it is possible, to recertify vehicle engines, and, in fact, this is done on a routine basis in the vehicle industry. Recertifying a large stationary engine is much more difficult, and from a practical standpoint is virtually impossible, since it would involve transporting the engine to a certification lab. In such cases, the transportation and certification costs for such large engines would eliminate any economic advantage offered by the dual fuel operation that the engine cert would allow.

But the EPA has given evidence that they may go even further, to the point where changes in ancillary systems, such as electrifying the air conditioning compressor, or the water pump, may also require the engine to be recertified. This is just an indication of how seriously the EPA views engine emissions and the overall certification process.

Certainly, any change to the fueling system, will automatically require a recertification of the engine. For example, in the heavy-duty trucking sector, a number of companies have sprung up that offer conversion kits that can transform the diesel engine of the vehicle to dual fuel operation. The EPA has stipulated that for intermediate life vehicles, as defined by vehicles that have traveled less that 430,000, or are less than 10 years old, each engine family that a kit is built for, must be recertified for the particular conversion kit in use. Installing a conversion kit that has not been EPA certified makes the owner of the vehicle liable to very large punitive fines.

In the case of class 8 trucks that are older than 10 years, or that have more than 430,000 miles, emissions testing can be done on the road. The test has to demonstrate that in 100 miles of dual fuel operation, there are no more gaseous or particulate emissions than in 100 miles of operation on straight diesel.

In the case of large stationary engines, the situation is slightly different. In a 2013 e-mail from Steve Debord of the EPA he states: "Until EPA formulates a releasable public document outlining our current position or expected future position on alt fuel conversions for NR, I am unable to make any statements as such. I can say that there are now three paths available for NR conversions: Full certification, Memo 1A with an established "reasonable basis" that means generally engine dyno FTP testing, and our newest – Field Fix available to the cert holding OEM."

By way of explanation regarding the above quote from the EPA, the first option, involves a full engine cert as described above for an engine with the conversion kit installed. The second option is slightly less cumbersome but still involves removing the engine to a facility with an engine dyno, and following the FTP or Federal Test Procedure, to measure emissions with the conversion kit installed on the engine. The third option, involves a work around that the EPA has made for OEMs. This is the so-called Field Fix memo, which allows engine manufacturers to make a fix to a problem with an engine in the field if they have first done an emissions test on that fix installed on an engine in their test facility. In the case of a conversion kit, EPA does not actually certify the conversion kit, but allows the engine manufacturer to install the kit on engines in the field, if the OEM has tested the conversion package on an engine in their test facility.

In conversations with the EPA, they have acknowledged that dual fuel conversions are, for the most part, advantageous, and that instrumentation does exist that could be used to test these large engines in the field after dual fuel conversion kits have been installed, to verify that the engine's emissions have not increased after the kit has been installed. But allowing these field tests to certify engines that have conversion kits installed on them, would require a change in EPA regulations, something that is not currently being planned by the agency.

The implication is that kits that are made by non-engine manufacturers are not approved by the EPA and that installing them on an engine, could make the owner of the engine liable to EPA enforcement. Another issue that can arise from non-OEM based conversion kits is engine damage. If the conversion kit is not properly calibrated with the engine control unit (ECU), the ECU does not properly back out the diesel fuel as the natural gas is added, and too much fuel ends up in some or all of the cylinders at a particular load condition which leads to eventual (and in some cases catastrophic) engine problems.

In summary, anyone looking to install a dual fuel conversion kit on a large NR engine must be cautious. Kits from non-OEMs are not approved unless the engine has been re-certified, which in practice, is never done. This means that non-OEM kits are not in compliance with EPA regulations, and the owner of the engine is subject to EPA enforcement and large fines. Another difficulty of non-OEM conversion kits is the possibility of engine damage if the engine control unit does not back out the diesel fuel properly as the natural gas fuel is admitted, which can overload the engine and lead to damage that can result in increased maintenance costs.