



FINAL TIER 4 DIESEL ENGINE FIELD GUIDE

FOR PORTABLE PUMPS IN THE US MARKET

Xylem is with you every step of the way

As the deadline to meet Final Tier 4 (FT4) emissions standards for diesel powered portable pumps approaches, Xylem is with you every step of the way.

The US Environmental Protection Agency's (EPA) Clean Air Act sets out emission reduction standards for diesel engines. The standards demand a reduction in the six common criteria pollutants - particulate matter (PM), ozone, sulfur dioxide, nitrogen oxides (NOx), carbon monoxide and lead. Implementation of the standards has occurred in stages, or tiers, with the deadline for compliance under the final stage - Final Tier 4 (FT4) - now looming.

Diesel engines in every industry, in every application, from large-scale marine engines to small landscape equipment engines, are subject to

these regulations. While deadlines are contingent on engine size, FT4 engine requirements will be fully implemented for all off road diesel engines by the end of 2018.

Whether you work in construction, mining, municipal wastewater or at an industrial plant, the emission reduction technologies on Final Tier 4 (FT4) diesel engines for portable pumps are no doubt on your mind. Xylem is here to help.

We understand that the transition to FT4 demands change, and we have been working hard to make this as seamless as possible for you. We are the first company in the industry in the US to provide complete FT4 solutions that deliver high performance while significantly reducing carbon emissions. We first introduced FT4 engines on our Godwin pumps in 2014 and have thousands of hours of hands-on service and maintenance experience.

We know FT4 and we're here to share our expertise and guide you through the change.

Having first introduced FT4 engines on our Godwin pumps in 2014, Xylem is leading the dewatering industry in the EPA-required transition to FT4. Our unrivalled experience is based on thousands of hours of hands-on application experience and testing to simplify maintenance requirements while ensuring even longer service intervals. When it comes to FT4, you don't need to go it alone - we are ready to help and guide you through this process.

Understanding the change

Some of the advances in FT4 engines for Godwin portable pumps include enhanced engine control technology, Field Smart Technology (FST), and PrimeGuard controller systems to fully comply with the US EPA's reduced emissions requirements.

The emission control methods and configurations used by manufacturers depend on variables such as horsepower range and equipment type. Emission reduction technologies fall into two general categories: in-cylinder technology and after-treatment methods.

In-cylinder technology targets the combustion event when diesel fuel, injected into the engine's cylinders, meets oxygen and is compressed. With enough compression, the diesel-oxygen mixture combusts, creating force that continues to move through the system. The primary goal of in-cylinder technology is to create a maximum efficiency combustion event, meaning that as much fuel is burned at a desired temperature with the least amount of resulting soot. The less particulate matter (PM) made, the less soot is carried out in the engine's exhaust.

After-treatment methods treat the immediate diesel exhaust as it exits the combustion area using filters, metals and fluid additives to trap PM and chemically neutralize pollutants that develop in the combustion process.

FT4 - Challenge And Solutions

The EPA's primary pollution targets in engine exhaust are particulate matter (PM) and nitrogen oxides (NOx).

Particulate matter (PM) is the exhaust soot that is a result of an incomplete combustion of diesel fuel. It is made up of nitrates and sulfates, organic chemical, metals and carbon debris. Nitrogen oxides (NOx) is the generic name for a group of highly reactive gases made up of nitrogen and oxygen that form when fuel is burned at high temperatures, as in a combustion event found in a diesel engine.

Combined with oxygen, NOx creates ground-level ozone and also forms nitrate particles

and acid aerosols. **When NOx reacts with water in the atmosphere, nitric acid forms, causing acid rain.**

Reducing nitrogen oxides (NOx) and PM pollutants in diesel exhaust is complex. High temperatures and excess oxygen within a diesel engine's combustion chamber increases the amount of NOx formed.

While it might be expected that lowering the in-cylinder temperature of the engine and limiting the amount of oxygen would reduce NOx levels, lower temperatures increase the production of PM because less of the fuel is converted into energy, leaving behind soot.

Here Are Some Of The Diesel Exhaust Clean-Up Technologies You Will Find:

DEF

Diesel exhaust fluid is synthetic urea used in the selective catalytic reduction process. DEF reacts with NOx in the exhaust and converts pollutants into nitrogen, water and tiny amounts of carbon dioxide.

DOC

The diesel oxidation catalyst is a flow-through device where exhaust gases contact materials that oxidize unburned hydrocarbons and reduce carbon monoxide.

DPF

The diesel particulate filter is designed to physically capture PM from the exhaust stream. The trapped PM eventually oxidizes within the DPF during passive regeneration, a cleaning process that automatically activates and uses exhaust heat created under normal operating conditions.

FT4 - Challenge And Solutions

Exhaust gas recirculation happens when the EGR valve opens and directs measured amounts of exhaust gas back into the intake manifold to mix with incoming fresh air. The process removes oxygen levels in the cylinder so temperatures in the following combustion event are lower. Less heat, less NOx.

EGR

EUI & ECU

The electronic unit fuel injector and the engine control unit electronically control fuel injection timing for precise control for the start, duration and end of the injection process.

Variable geometry turbocharger varies the exhaust pressure based on load and speed to ensure proper EGR flow.

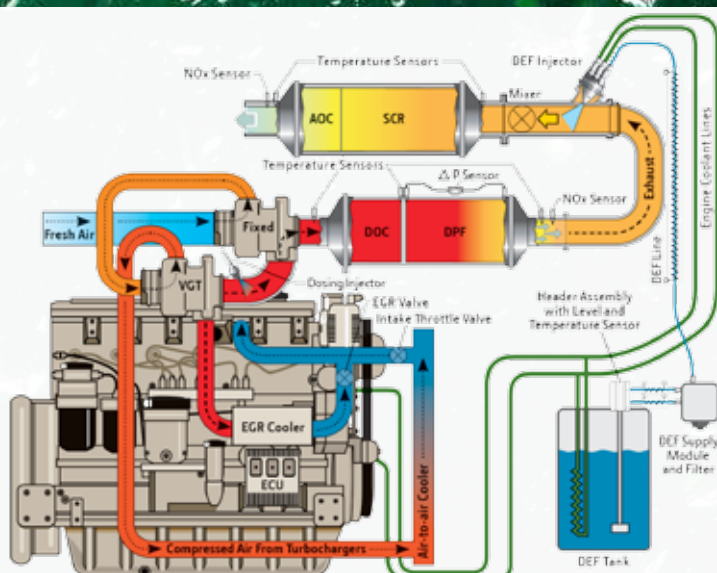
VGT

VVA

Variable valve actuation controls the intake valve closure timing. When the valve closes later, it reduces the effective compression ratio, which results in lower temperatures and lower NOx.

Final Tier 4 Building Block

Photo courtesy of
John Deere Power Systems



Sizing An Application LESSONS LEARNED



Xylem experts **MIKE RAMOS**, *Director of Engineering*, and **KEVIN SNOW**, *Godwin Global Product Manager*, answer some frequently asked questions (FAQs) about purchasing or renting pumps equipped with FT4 engines. Since Godwin pumps in the 25 to 74 hp range represent a vast majority of equipment sold or rented, our experts focus on FAQs in this range of equipment.

What differences will I see in the FT4 engines in the 25 to 74 hp range?

A **Mike Ramos (MR):** The FT4 emissions standard does not alter required NOx reductions, but does require a major reduction in PM.

Kevin Snow (KS): Some FT4 engines require additional components such as diesel particulate filters. In this horsepower range, Xylem has focused on high performance engines that utilize diesel oxidative catalyst technology over FT4 engines that require particulate filters that can potentially undergo lengthy and unpredictable regeneration cycles.

Are the engine components mounted on to it, and will they take up more of the pump's footprint?

A **MR:** Most of the changes and additions to the pump engines are well located and convenient for customer application.

Will there be a difference in initial purchase costs of the new 25 to 74 horsepower FT4 compliant pumps?

A **KS:** Generally, yes. This is due to the added emissions components and electronic controls required to operate the fully electronic FT4 engines. However, Xylem is working to minimize the power and footprint of diesel engine drivers as much as possible, and is focused on choosing diesel engine solutions that maximize the power available, minimize the engine cost and maintenance required, and improve fuel economy.

Can my older pump be retrofitted with a Tier-compliant engine? Some applications are subject to more stringent local emissions regulations

A **MR:** Yes. According to the EPA, older Tier engines can be replaced with FT4 engines.

How will operation procedures change for pumps with FT4 engines?

A **MR:** Excellent question! It will be very important to size the horsepower of your pump to your application. A pump with too much horsepower running at less than maximum efficiency will create more soot or PM, which will affect performance and require more frequent cleaning. It is better to match a proper sized engine running at peak levels than create more power than you need.

What about regeneration? Should I be concerned?

A **MR:** Some FT4 engines use passive regeneration that is triggered automatically and is a seamless part of the pump's operation. For applications where there is any doubt as to pumping capacity during a regen process, we recommend putting in place two smaller pumps that will compensate for the other during the regeneration periods.

In the past, I've been able to make adjustments to the pump engine in the field. Can I do that with FT4 engines?

A **KS:** A Xylem engineer can help you set up the best performing pump/engine configuration for your job so that you don't need to make on-the-fly adjustments.

Fuel Handling And Storage

LESSONS LEARNED

ULTRA-LOW SULFUR DIESEL

Ultra-Low Sulfur Diesel (ULSD)
- ULSD fuel is the only fuel used in FT4 engines. ULSD is highly refined and formulated to contain less than 15 ppm of sulfur. Interestingly, this low sulfur recipe is the main reason why it is imperative that fuel storage containers are clean and free of condensation. Water in diesel fuel is the perfect incubating medium for fungus and assorted bacteria that form a slime that floats on top of the fuel. The slime reacts with metal to produce corrosive hydrogen sulfide that corrodes metals in fuel tanks, fuel injectors, connectors, etc.

LESS THAN
15 ppm
SULFUR

ULSD
FUEL

DIESEL EXHAUST FLUID (DEF)

Diesel Exhaust Fluid (DEF) – Engine manufacturers that use Selective Catalyst Reduction (SCR) systems require DEF, a precise mix of 67.5 percent de-ionized water and 32.5 percent highly pure synthetic urea.

DEF bonds to and converts NO_x into simple nitrogen and water. DEF purity is vital. Even small concentrations of trace elements can contaminate an entire tank of DEF.

If the required chemical interactions do not occur or the catalyst's baffles are compromised,

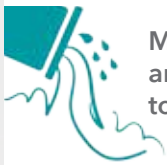
the SCR system will malfunction and cause the engine to shut down.

Although DEF is nontoxic and not hazardous, it is corrosive.

Corrosion leads to particles, so the ISO standard recommends that DEF does not come in contact with: copper, copper alloys, zinc, lead, chromium, nickel, aluminum, aluminum alloys, metal-coated plastics or solder containing lead, silver, zinc or copper.

Tips For Effective Maintenance

CLEAN FUEL TIPS



Mount portable fill tanks at an angle with a drain at the low end to eliminate water



Maintain portable tanks and nozzles to keep out surrounding dust, water and debris



Biofuels have a short shelf life of only two to three months. Use it up. Xylem recommends use of petroleum-based diesel fuel



Store bulk fuel inside and out of sunlight to avoid temperature extremes that cause condensation



Consider treating large stores of ULSD with an EPA-approved biocide to treat microbe waste

TIPS FOR FT4 ENGINES USING DEF



Never attempt to make your own DEF recipe



Do not use containers used for other materials, even if they have been cleaned. Detergents and contaminants in tap water will foul DEF



Use a coupler designed to limit air exposure during fills



Air can cause DEF to form crystals, so keep small containers tightly closed



Keep DEF storage areas at a constant temperature. Fluctuations affect DEF stability



Use corrosion resistant containers and accessories



Do not use tap water to top-off or stretch DEF. Contaminants can alter the DEF properties

OPTIONS

Smart Monitoring For Anytime, Anywhere Control

Final Tier 4 engines are electronic and feature the Godwin PrimeGuard controller, a fully programmable engine control system. Engine operating conditions are monitored continuously. PrimeGuard is also capable of varying the engine rpm in response to changing pressure/level transducer signals and can be programmed to exercise the diesel engine on a routine basis. A diesel engine warm up/cool down cycle is always in place. Timing of warm up and cool down can be changed.

Pumps with Godwin Field Smart Technology (FST) can be monitored and controlled from

any smartphone, tablet or desktop computer, anywhere in the world.

Built with onboard cellular and satellite connectivity, and GPS, you can track, monitor and communicate with your pump in real-time, no matter if it's hitched to a truck cruising down the highway, tucked in a municipal lift station, or even standing guard at an out-of-the-way construction site.

Keep track of multiple pumps on multiple sites from one screen and always know what's going on.



FST integrates with our Prime Guard pump & engine controller, and provides invaluable control and information about your pump such as:

- ▶ Start/stop/RPM control
- ▶ Fuel Consumption/Levels
- ▶ Soot accumulation monitoring for models with DPF
- ▶ Engine load
- ▶ Warning and error codes
- ▶ Suction pressure/vacuum readings*
- ▶ Discharge pressure readings*
- ▶ Flow meter readings*
- ▶ Sump level monitoring*

*Additional equipment required

Xylem's Final Tier 4 Commitments

Xylem is committed to providing the most reliable, durable, and efficient EPA compliant pumps in the industry, while helping our customers meet Final Tier 4 engine standard requirements.

Xylem is the first company to provide a complete set of Final Tier 4 (FT4) pump solutions that maximize performance, minimize maintenance and downtime, and meet the most stringent US EPA diesel engine regulations.

All Godwin portable pumps sold to the US market are now fitted with FT4 diesel engines. The seamless configuration of electronic controls and emissions technology in Xylem's pumps ensures unrivalled reliability.

Xylem's commitment to offering FT4 diesel powered portable pumps reflects our focus on advancing efficient, sustainable solutions for the toughest dewatering challenges.



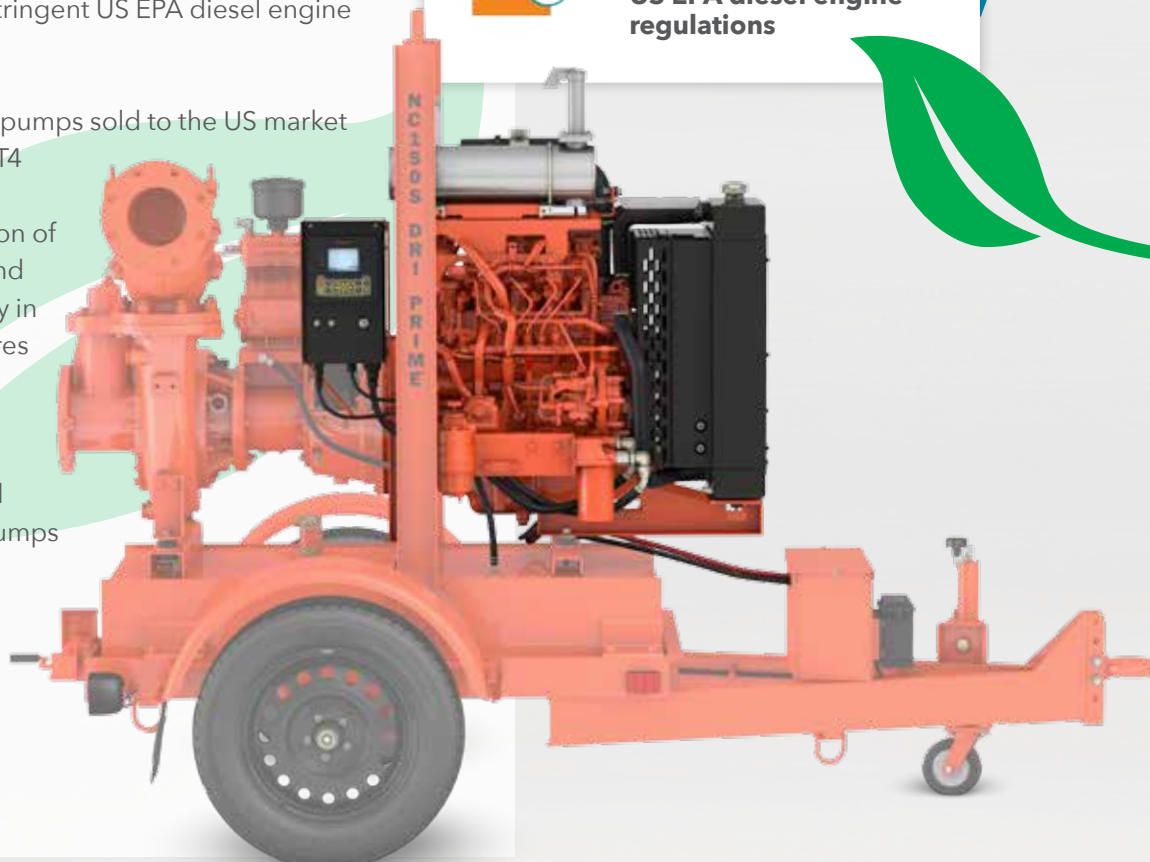
▶ **Maximum performance**



▶ **Minimum maintenance and downtime**



▶ **Compliant with the most stringent US EPA diesel engine regulations**



xylem.com/tier4



RESOURCES

Tier 4 Diesel Engines



- ▶ Diesel Technology Forum: www.dieselforum.org
- ▶ EPA National Clean Diesel Campaign: www.epa.gov/cleandiesel
- ▶ DieselNet: www.dieselnet.com
- ▶ Construction Equipment Magazine: www.constructionequipment.com
- ▶ Animated Engines: www.animatedengines.com

- ▶ Isuzu: www.isuzuengines.com
- ▶ John Deere: www.deere.com
- ▶ Caterpillar: www.cat.com
- ▶ JCB: www.jcbna.com



**TIER 4
DIESEL ENGINE
ORIGINAL ENGINE
MANUFACTURERS**

Xylem ['zīləm]

- 1) The tissue in plants that brings water upward from the roots;
- 2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services, and agricultural settings. With its October 2016 acquisition of Sensus, Xylem added smart metering, network technologies and advanced data analytics for water, gas and electric utilities to its portfolio of solutions. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com



Xylem, Inc.
84 Floodgate Road
Bridgeport, NJ 08014
Tel: 800-24-Pump4
xylem.com

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