

# The Drive to Reduce Emissions

What every farmer needs to know



Beginning in 2011, the United States Environmental Protection Agency (EPA) will require off-road diesel engines, such as those in tractors and combines, to meet stringent Interim Tier 4 emissions regulations. Here are some common questions and answers around this issue.

## What's the background on these regulations?

The drive to reduce emissions has been in the works for more than 10 years and has followed a tiered approach (see chart below). Tier 1 regulations set limits on particulate matter and oxides of nitrogen emissions. Final Tier 4 regulations take effect in 2014 and require the air coming out of the exhaust to be virtually as clean as the air going into the engine.

## At what tier are we today?

Tier 3. The engines in our current large-horsepower tractors and combines are Tier-3 compliant. While Final Tier 4 takes place in 2014, there's a step between it and Tier 3. That's Interim Tier 4 (IT4) and it's the biggest step yet.

IT4 takes effect in 2011 and requires diesel engines with 174 horsepower or more to reduce particulate matter emissions by 90 percent, and oxides of nitrogen emissions by 50 percent.

## What is particulate matter and oxides of nitrogen?

Particulate matter is called "smoke" because it comes out of the exhaust pipe in the form of smoke. It's essentially an incomplete combustion of diesel fuel – just like a smoky fire that provides less heat than a hot, clean-burning fire.

Oxides of nitrogen, or NOx, are sometimes called "smog" because they contribute to the formation of atmospheric pollution.

## How do IT4 engines reduce oxides of nitrogen and particulate matter?

There are two ways to reduce these emissions: The first is with cooled exhaust gas recirculation (EGR) and an exhaust filter. EGR lowers oxides of nitrogen and the exhaust filter reduces particulate matter.

The second way to reduce these emissions is with selective catalytic reduction (SCR) and a diesel oxidation catalyst (DOC). The SCR system lowers oxides of nitrogen while the diesel oxidation catalyst reduces particulate matter.

## How does cooled EGR work?

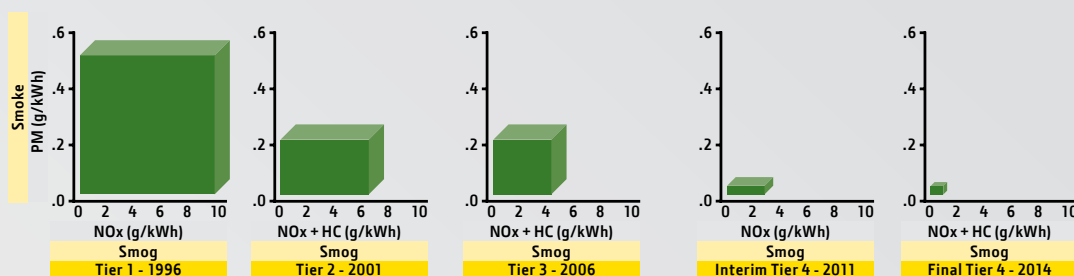
Cooled EGR is essentially the opposite of SCR. It cools and mixes measured amounts of exhaust gas with incoming fresh air to lower the engine's peak combustion temperature, thereby reducing oxides of nitrogen to an acceptable level.

Because of the lower combustion temperatures used to reduce oxides of nitrogen, there is an increase in particulate matter. To reduce particulate matter to acceptable levels, exhaust gases are routed through an exhaust filter containing a diesel oxidation catalyst and a diesel particulate filter. Particulate matter is trapped in the filter and – through a process called regeneration – oxidized into nitrogen gas and carbon dioxide, then expelled through the exhaust pipe.

## Does the operator have to stop the machine for it to regenerate?

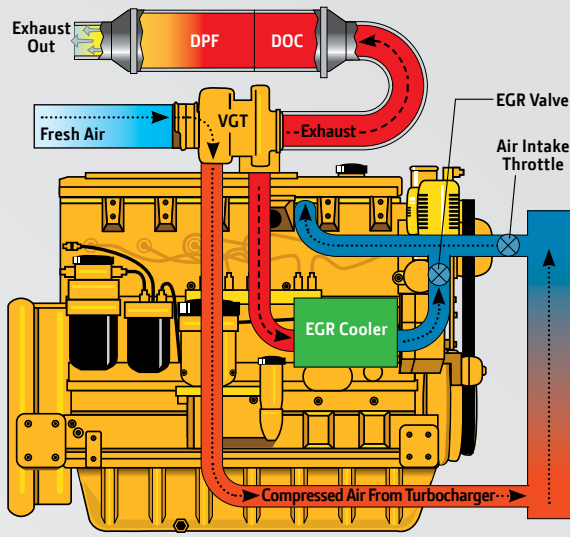
In most cases the regeneration process uses exhaust heat created under normal engine operating conditions. When necessary, the engine's control system can raise exhaust temperature to regenerate the filter. In either case, regeneration does not impact machine operation.

## EPA non-road emissions regulations: 174 – 750 Engine hp



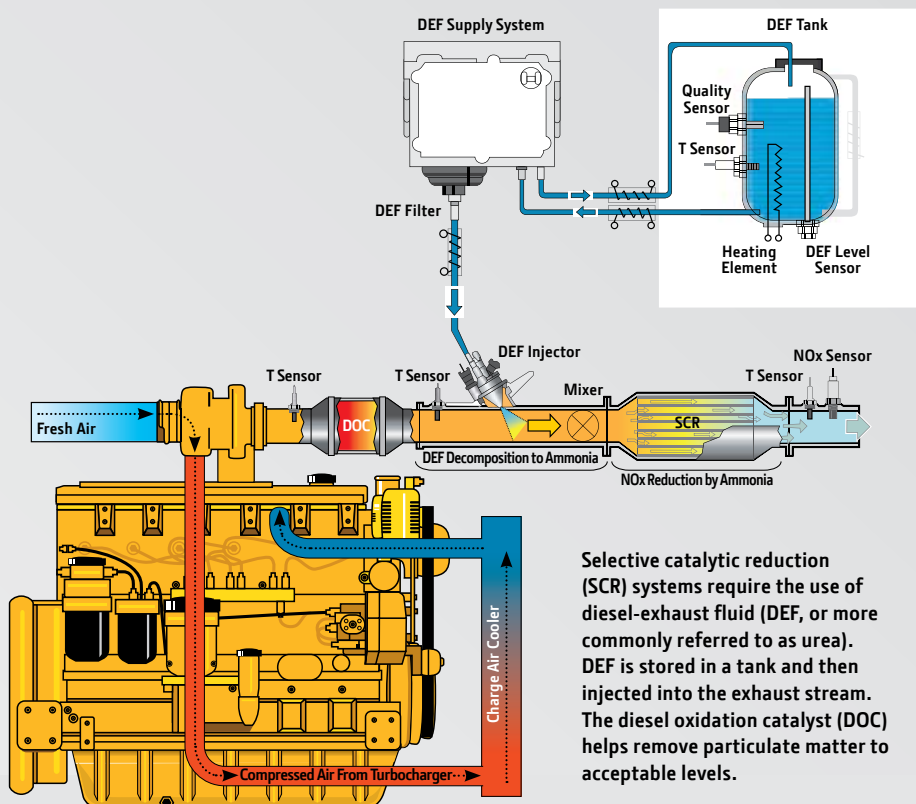
The move to Interim Tier 4 emissions regulations is unquestionably the most significant to date. The regulations call for a 90-percent reduction in particulate matter (PM) and a 50-percent drop in oxides of nitrogen (NOx). Final Tier 4 emissions regulations will take PM and NOx to near-zero levels by 2014.

## Interim Tier 4 PowerTech™ PVX technology utilizing cooled exhaust gas recirculation



John Deere was the first engine manufacturer to take advantage of cooled exhaust gas recirculation (EGR) and variable geometry turbocharger (VGT) technologies in off-highway applications. Interim Tier 4 engines will add a catalyzed exhaust filter that contains a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF) to meet emissions regulations.

## Interim Tier 4 with selective catalytic reduction and a diesel oxidation catalyst



Selective catalytic reduction (SCR) systems require the use of diesel-exhaust fluid (DEF, or more commonly referred to as urea). DEF is stored in a tank and then injected into the exhaust stream. The diesel oxidation catalyst (DOC) helps remove particulate matter to acceptable levels.

## How does SCR work?

Let's go back to the smoky fire example. SCR raises the peak combustion temperature in the engine so the engine runs like a hot, cleaner-burning fire. As a result, there is less particulate matter created. Any further reduction in particulate matter is accomplished by a chemical reaction in the diesel oxidation catalyst (see SCR illustration, below). However, because of the higher combustion temperatures, the engine creates more oxides of nitrogen.

To reduce oxides of nitrogen, a diesel-exhaust fluid (commonly called urea) is injected into the exhaust stream. When the exhaust gases combine with the urea in the SCR catalyst, oxides of nitrogen are broken down into nitrogen gas and water vapor and expelled through the exhaust pipe.

## What technology will John Deere use to meet IT4 regulations?

Cooled EGR. We're taking our proven Tier 3 PowerTech Plus engine platform with cooled EGR and adding an exhaust filter. It's a more operator-friendly technology and less complex to maintain when compared to SCR systems. In addition, it's field-proven. We were the first manufacturer to widely commercialize off-highway Tier 3 cooled-EGR diesel engines. We've used these engines with a proven record of reliability.

## Why not SCR?

There are a number of reasons. First is the fact urea is not widely available today. You may have to drive a distance to get to a urea retailer. Its price also can be high and it can be difficult to store. For example, it will turn to a gel and even freeze in cold temperatures. Not only do you need to store diesel around your operation, you also have to store urea and keep it from freezing. These IT4 regulations take effect in 2011, which is just around the corner, and we believe the infrastructure for the delivery and storage of urea to our rural customers will not be adequate by that time.

Second, we're looking to the end result, and that's Final Tier 4 in 2014. Proven technologies such as cooled EGR and exhaust filters will be the foundation for meeting Final Tier 4 regulations. If we removed the EGR components from



our engines to meet IT4, we would need to put them back on for Final Tier 4. So from a logical engineering progression, it makes more sense to build upon our already-proven cooled EGR technology for IT4 and add the exhaust filter.

**Some agricultural-equipment makers are going with SCR. Is this the first time John Deere chose a different path to meet emissions regulations?**

Certainly not. Most manufacturers chose a different path to meet Tier 3 emissions regulations. We took the cooled-EGR approach and ended up building the most fuel-efficient tractor ever tested. In fact, the fuel-efficiency record the John Deere 8430 set at the Nebraska Tractor Test Lab<sup>1</sup> established the standard for total-vehicle efficiency by which all tractors have since been measured.

In addition, the new John Deere 8320R, which replaced the 8430, was recently tested at the Nebraska Tractor Test

Lab and set two fuel-efficiency records, outperforming every tractor in its class, in these two tests: (1) Drawbar Performance at 75 Percent of Pull and at Reduced Engine Speed, and (2) Power Take-Off Performance at Rated Engine Speed.<sup>2</sup>

With the proven success of the 8030 Series and now the new 8R/8RT Series, it's clear we chose the right path then and we're confident we're choosing the right path now.

**Is cooled EGR the right choice for farmers?**

Cooled EGR is what our customers told us they want on their farm equipment for IT4. It's a simple solution for the operator that leverages the proven fuel-efficiency of our PowerTech Plus engines and is part of an integrated vehicle design. That's something John Deere excels at as we design, manufacture, and service the engine, drivetrain, hydraulics, exhaust filter, cooling system, and other vehicle

systems as part of a complete package to improve performance, convenience, and value. Finally, cooled EGR is easy to maintain. If it needs service, our customers are backed by the most responsive dealer network in the industry. Our dealers and their service technicians will be highly trained on these new engines and can even help you improve total vehicle efficiency.

**Where can farmers go for more information?**

Farmers can go to our Web site at [www.JohnDeere.com/Tier4](http://www.JohnDeere.com/Tier4) for an in-depth look at our IT4 solutions. And of course, they can always see their local John Deere dealer.

1. Nebraska OECD Tractor Test 1873 – Summary 527.  
2. Nebraska OECD Tractor Test 1963 – Summary 660.  
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