

What is Tier 4?

Tier 4 is a series of EPA-mandated regulations for the reduction of harmful exhaust gases produced by diesel-powered commercial equipment. Tier 4 standards require significant emission reductions of particulate matter (PM) and nitrogen oxides (NOx). PM is unburned fuel and is the black smoke/soot seen in diesel engine exhaust. NOx is nitrogen monoxide and nitrogen dioxide, and is created during the heat of combustion.

What is a Diesel Particulate Filter?

A diesel particulate filter (DPF) is a device used to remove diesel PM (soot) from the exhaust gas of a diesel engine. The DPF consists of two components:

- Diesel oxidation catalyst (DOC), which helps create heat and convert carbon monoxide (CO) and other compounds into carbon dioxide (CO₂) and water vapor.
- The soot filter is made of ceramic. It removes the particulate matter from the exhaust gases that flow through it.

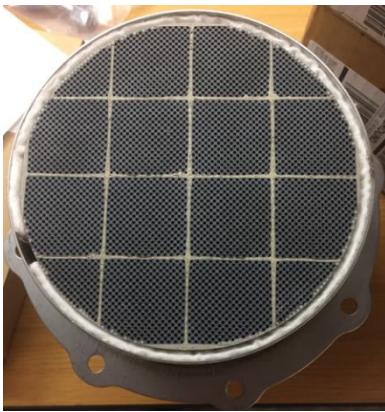


Figure 1 - A DPF filter from a normally operating engine. Regeneration is keeping the PM burned off.

What is soot and ash?

Soot is the particulate matter or incompletely burned fuel in the engine exhaust. Ash is the incombustible material (heavy metals) resulting from the regeneration process.



Figure 2 - This DPF filter is clogged with PM due to prolonged low-load engine operation, extended low rpm idle time, or lack of maintenance.

What is Regeneration?

Regeneration is the process of incinerating the soot that has collected in the soot filter. High heat burns the PM captured within the filter, and turns it into ash. The ash collects in the soot filter. The filter will eventually require cleaning as a normal maintenance requirement, as regeneration will no longer clear the system completely.

Regeneration Fundamentals

The engine control unit (ECU) monitors the soot levels in the DPF and automatically initiates the regeneration process when engine conditions are optimal. Currently, Yanmar engines use five different regeneration methods: three are automatic, while two others require the operator or technician to perform procedure steps.

Automatic Regeneration Methods:

1. **Passive (Self)** – This occurs automatically as the engine operates at higher rpm ranges and generates enough exhaust heat to burn off the PM.
2. **Assist** – Uses the throttle valve to reduce the amount of fresh air coming into the engine, and increases the exhaust temperature as a result.
3. **Reset** – Uses a combination of the intake throttle and post fuel injection to further raise the exhaust temperature and burn off the particulate matter.

Manual Regeneration Methods:

4. **Parked (Stationary)** - Is used when the passive, assist, and reset regenerations did not clean the soot filter. This process requires the operator or technician to start parked regeneration through a PIN-protected option within the InfoCenter's Service menu. This regeneration is performed while the machine is parked, and combines throttle control and additional post-combustion fuel injection while running the engine at higher rpm levels. The machine cannot be in service while you are performing a parked regeneration. **If this regeneration request is ignored, engine performance will degrade and unplanned machine downtime may result.**

5. **Recovery** – This backup regeneration process requires assistance from your distributor and is used in the event automatic regeneration methods did not clean the soot filter. The engine will enter a reduced-power (backup) mode, and triggers a fault code. A recovery regeneration is an extended-length process carried out by a Toro distributor service technician using special diagnostic software.

Once the recovery regeneration process completes, the engine returns to normal operation.

What are the Operator's and Technician's roles with Tier 4 vehicles?

Machine Operator:

- Operate the engine at full throttle and under load whenever possible
- Do not allow the engine to idle for long periods of time
- Know and understand the various regeneration icons that appear on the InfoCenter (see table)

Machine Technician:

- Know and understand Tier 4 engine maintenance requirements
- Know how to initiate a Parked (stationary) regeneration process
- Understand all of the regeneration-related functions of the InfoCenter
- Know how to properly instruct a new operator on proper engine usage
- Reference the latest Operators Manual for Tier 4 maintenance requirements

Is There a Special Diesel Fuel Requirement for a Tier 4 Engine?

Ultra-low sulfur diesel fuel is absolutely required for use in all Tier 4 engines for both regulatory and technical reasons. Ultra-low sulfur fuel is defined as having less than 15 parts-per-million (PPM) sulfur content. Diesel fuel with higher than 15 ppm sulfur content can degrade the DOC, which can potentially cause operational problems and may jeopardize long-term component life.

InfoCenter Icon Meanings and Actions

Regeneration Symbol	Event/Meaning	Operator Action
	Assist or Reset Regeneration is in process.	No action required from operator. Continue operating machine normally.
	Parked (stationary) Regeneration NEEDED NOW.	<ul style="list-style-type: none"> • Parking Brake Applied • Fuel level min. ¼ full • Engine at Idle • Coolant Temp greater than 140 °F • Follow InfoCenter prompts.

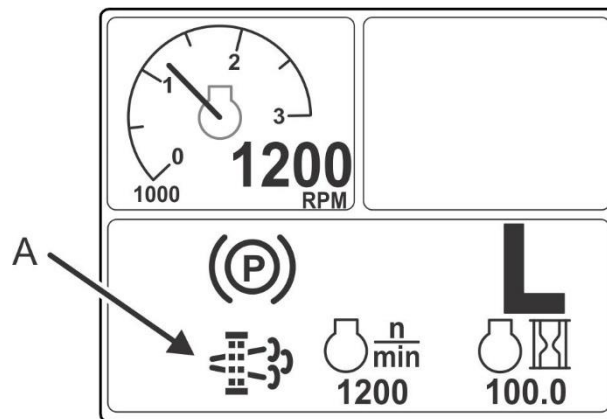


Figure 4 - When a stationary regeneration is needed, this icon (A) will appear on the InfoCenter screen (5-button shown). Ensure adequate fuel is available to complete the process.

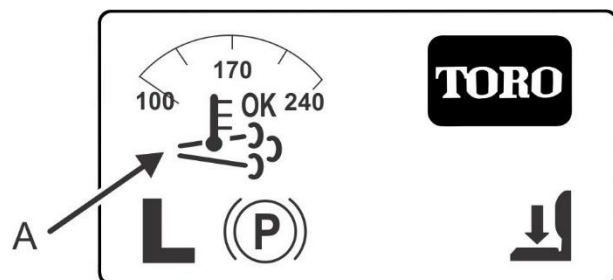


Figure 3 - When this icon (A) is shown on the InfoCenter screen (3-button shown), the regeneration is in progress. The thermometer symbol will fill as the temp rises. When it is full (as shown), the process is nearly complete.

Are there specific engine oil requirements for a Tier 4 engine?

Tier 4 diesel engines require CJ-4 specification (or higher) low-ash oil. The CJ-4 oil is approved for all pre-Tier 4 machines as well, so owners need to keep only CJ-4 oil on hand.

What is special about CJ-4 Low Ash engine oil?

CJ-4 engine oil is engineered to sustain emission control system durability with diesel particulate filters and other advance after-treatment systems used on higher-power Tier 4 engines. Using engine oils other than CJ-4 can cause premature clogging of the DPF and a subsequent reduction in engine performance.



For more information about Toro Tier 4, visit:

www.toro.com/en/customer-support/tier-4

Diesel Particulate Filter (DPF) Regeneration