

DRY SYSTEMS TECHNOLOGIES®

OPERATION AND MAINTENANCE MANUAL

DST DRY SYSTEM®

SECTION A
ON BOARD CLEANING SYSTEM

M301-016-01

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OPERATION AND MAINTENANCE MANUAL PART A, M301-016-01

INSTRUCTIONS FOR USING THE ON-BOARD CLEANING SYSTEM AND FOR REPLACING THE EXHAUST PARTICULATE FILTER

Background:

The Dry System™ supplied by Dry Systems Technologies® consists of a unique patented arrangement of components that provide an explosion proof MSHA approved diesel power package and superior emissions reduction from diesel engines. The system can operate at very minimal maintenance, but requires some attention by the operator to maintain its permissibility and clean exhaust.

The Dry System™ is fitted with a tube-and-shell heat exchanger. It reduces the exhaust temperature from about 950-1150° F in the manifold to a safe temperature of less than 300° F before exhausting to the atmosphere.

Because of the rapid cooling of the exhaust gases inside the heat exchanger, the airborne sub-micron diesel particles agglomerate (cling to each other) and form larger particles. However, some of these particles attach themselves to the cold tube walls, where they accumulate over time. This process is completely normal as part of the operation of the Dry System™, or any system that cools the exhaust gases.

After the particle accumulation has reached a certain thickness, the tubes become partially restricted, and both exhaust backpressure and temperature increase. The exhaust backpressure and the exhaust gas temperature can be monitored on the exhaust-backpressure gauge and the exhaust-temperature gauge which are conveniently mounted in the operator's compartment.

It is the responsibility of the operator to monitor the exhaust backpressure and exhaust temperature gauges frequently while operating the diesel machine.

Activating the On-board Cleaning System

Once the exhaust backpressure increases, the removal of these internal deposits is necessary to maintain a clean and safe exhaust system. The Dry System™ is equipped with a patented **On-board Cleaning System™** that allows removal of the soot deposits while operating the machine. The **On-board Cleaning System™** consists of a small water supply bottle, a metered actuator and an injection nozzle. The 1 quart (1 liter) water bottle is located inside the engine compartment, contains several shifts supply and must be filled with clean water (such as bottled water or drinking water) only. The flameproof injection nozzle is located near the inlet of the heat exchanger. A cab mounted valve is all the operator needs to perform the cleaning process while operating the machine.

When activated by the operator with the cab-mounted valve, a very small metered amount of water is injected into the hot exhaust inlet of the heat exchanger. The water flashes into steam and expands to more than 200 times of its original volume. This sudden pressure rise (and not the water itself) causes the soot deposit to dislodge from the tube walls to be carried downstream by the exhaust gas to the particulate filter where it is trapped.

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This procedure is the most important action the operator has to take. Neglect of this operation will cause high exhaust backpressure which will inevitably lead to reduced filter life and triggering of the safety shut-down system. Using the On-board Cleaning System™ properly is the responsibility of the machine operator.

There will be no visible water vapor or smoke emitted from the exhaust system while the on-board cleaning system is activated. The only indication to verify proper injection is to monitor the exhaust gauges. Initially, the exhaust backpressure will rise, followed by a drop to below its starting point. There should also be a small simultaneous reduction in exhaust gas temperature.

The most effective time to activate the On-board Cleaning System™ is when the engine is hot and under load. At a minimum, the On-board Cleaning System™ should be activated **twice** each operating shift, and while the engine is hot and working hard. There is no harm done if the On-board Cleaning System is used more often, except that the water supply gets depleted quicker.

The On-board Cleaning System™ will not function on a cold engine or at idle. Using the on-board cleaning system on a cold engine and without load on the engine is ineffective. **Do not activate the On-board Cleaning System™ on a cold engine.**

Frequent use of the on-board cleaning system is a very important step to keep the DST Management System operating efficiently and safely. The amount of water each time the valve is pulled is fixed. The valve needs to be re-set after about one minute to re-charge the actuator. Holding the valve open longer than needed will have no impact on the operation or the amount of water injected. The On-board Cleaning System is ready for additional use after about 3-5 minutes from resetting it.

It is the responsibility of the operator to activate the On-board Cleaning System at least twice a shift with the engine hot and under load, more often if judged necessary. It is safe to activate the On-board Cleaning System in any part of the mine where diesel equipment may be operated.

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Diagnosing High Exhaust Backpressure

The typical life cycle of the Disposable Exhaust Particulate Filter (DPM Filter) can range from 40-100 hours, depending on the operating cycle of the machine. Once the exhaust system backpressure can no longer be reduced by the On-board Cleaning System™, the DPM Filter maybe loaded to its capacity. Before changing the filter, a quick diagnostic test should be performed to determine if the filter is fully loaded, or if the heat exchanger is fouled and needs flushing. An optional diagnostic gauge that measures the differential pressure across the heat exchanger is installed inside the engine compartment. The reading of this gauge, together with the backpressure gauge, taken under full engine speed and no load (high idle), can be used to determine the next action.

- A reading of the backpressure gauge at or near the maximum, combined with a pressure differential across the heat exchanger (diagnostic gauge) in the range of 8-12" WG is an indication of a loaded filter. The next step should be to exchange the loaded exhaust particulate filter with a clean exhaust particulate filter.
- A reading of the backpressure gauge at or near the maximum combined with a pressure differential across the heat exchanger (diagnostic gauge) greater than 20" WG is an indication of excessive soot deposit in the heat exchanger. The higher the reading on the diagnostic gauge, the more soot has built up inside the heat exchanger. THIS MAY BE AN INDICATION THAT THE ON-BOARD CLEANING SYSTEM HAS NOT BEEN USED PROPERLY OR FREQUENTLY ENOUGH. As a first step, the On-board Cleaning System should be used (with the engine hot and under load) to see if the pressure across the heat exchanger can be reduced.
- If the backpressure in the heat exchanger can not be reduced significantly, the next step should be to schedule the machine for flushing of the exhaust system by a trained and qualified mechanic.
- **REF:** MWM 916, The maximum allowable exhaust backpressure is 40" WG.
Caterpillar 3300 PCNA The maximum allowable exhaust backpressure is 34" WG.
Caterpillar 3300 PCTA , C-10 The maximum allowable exhaust backpressure is 27" WG.
Cummins C8.3 The maximum allowable exhaust backpressure is 41" WG or 60" WG.
Isuzu 6BG1, The maximum allowable exhaust backpressure is 41" WG.
FPT N45, The maximum allowable exhaust backpressure is 40" WG.

It is the responsibility of the operator to perform the initial diagnostic test. It is safe to activate the on-board cleaning system in any part of the mine where diesel equipment may be operated. Any flushing operation must be scheduled through maintenance.

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Flushing of the System

If the On-board Cleaning System™ is used as described above, and if engine operation under light load and excessive idling are minimized, flushing of the exhaust system should seldom become necessary.

Flushing of the exhaust system must be performed by a trained and qualified mechanic and at an approved location. Should flushing become necessary, keep in mind that this not the same as on-board cleaning.

Flushing of the DST Dry System™ is performed by attaching an external water supply hose to the connecting port. For convenience, a quick connect coupling is provided with every DST Dry System. Unlike during On-board Cleaning™ that uses only a few ounces of water, significant amounts (several gallons) of water are passed through the exhaust system during flushing operation. This will remove the soot deposited inside the heat exchanger that is not removed during On-board Cleaning™. Flushing may be performed during any time of the operating cycle, but only at a suitable location, as follows:

- The machine **MUST** be located at an outby area of the mine or a shop.
- Ventilation in the area should be into the return air.
- Water must be available at the area.
- Remove the exhaust filter according to the “Particulate Filter replacing procedure” and make provisions to capture water from the filter housing.
- Attach the external water hook-up to the system.
- Start the engine; make sure it is up to operating temperature.
- Run the engine at high idle speed and record the heat exchanger differential pressure.
- At high idle speed, open the water valve to allow continuous water-flow through the water injector for about 1- 2 minutes.
- Close the water valve and continue running the engine for 3-5 minutes to allow the exhaust system to dry out. Check for the change in the heat exchanger differential pressure gauge. A normal reading would be 8-14” WG. A higher reading indicates that there still are soot deposits inside the system.
- If needed, repeat the flushing as described above.
- If successful, install a new exhaust filter according to the “Exhaust Filter replacing procedure”.

Do not perform the flushing procedure underground without a filter in place, or if there are indications that the filter has become damaged during the flushing.

Flushing without a particulate filter installed must be performed as follows:

- Remove the particulate filter and provide for some means to capture the water from the exhaust system.
- Re-install the lid to the filter housing.
- Make sure there is proper ventilation to remove the unfiltered diesel exhaust from the work area.

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- Install the external water hook-up to the system.
- Set the brakes and start the engine; make sure it is up to operating temperature.
- Run the engine at high idle speed and record the heat exchanger differential pressure.
- At high idle speed, open the water valve to allow continuous water-flow through the water injector until the water out of the exhaust system is clear. (Typically 10-15 minutes)
- Close the water valve and continue running the engine for 5 minutes to allow the exhaust system to dry out. Check for the change in the heat exchanger differential pressure gauge. A normal reading is 8-12".
- If successful, install a new particulate filter according to the "Particulate Filter replacing procedure".

Do not perform the flushing procedure without proper ventilation and without a provision to capture the soot and water from the exhaust.

Procedure to replacing the Particulate Filter

Replacing the DST particulate filter may be performed in any part of the mine where diesel equipment can be operated. **The diesel engine must be stopped during the entire time while the exhaust filter is being replaced.** Proceed as follows:

- Open the lid to the exhaust particulate filter housing.
- Release the manual clamp or clamping cylinders with the valve at the end of the filter housing.
- Remove the new exhaust filter from its shipping box and inspect for damage from shipping and handling.
- Remove the loaded exhaust filter from the filter housing, inspect for obvious damage or leaks and place into the empty shipping box and mark the box with "Used" or "Dirty". Do not grip on the inside of the filter where the soot is deposited. Gloves should be worn while handling the dirty filter.
- Check the inside of the exhaust filter housing and the flame arrestor outlet. Report any soot deposits or a plugged flame arrestor to the Maintenance Department.
- Inspect the seal groove inside the filter housing. Make sure there are no remains of seal material or other matter in the seal groove. If necessary, remove any remains with a screwdriver or similar tool.
- Insert the clean exhaust filter, after visual inspections for damage, and seal.
- Set the manual clamp or clamping cylinders with the valve at the end of the filter housing
- Close the lid to the exhaust filter housing.
- Remove the box with the used filter according to disposal procedures at the mine.
- Start the engine and check the exhaust backpressure at high idle to be in the normal range.

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Replacement Exhaust Particulate Filters

The Model M30 and M40 exhaust particulate filters are supplied exclusively by Dry Systems Technologies®. The filter is part of the MSHA Approved Diesel Power Package.

OPERATION OF THE DIESEL POWER PACKAGE WITHOUT A DST EXHAUST FILTER OR THE USE OF AN AFTERMARKET FILTER WILL AUTOMATICALLY VOID ALL MSHA APPROVALS FOR THIS MACHINE