

## CEC Direct Injection, Common Rail Diesel Engine Nozzle Coking Test - CEC F-98-08 (DW-10)

### Q. Why is there a need for a 2nd industry test when we have the CEC F-023 (XUD-9) test?

A. Modern diesel passenger car engines have evolved from indirect injection (IDI) to direct injection (DI) in order to meet new emissions standards requirements. Accompanying this shift was a change in the fuel injection equipment to high pressure common rail technology.

These technology changes have meant the mechanism and effect of the coking in the engine is different. As a result, the current industry standard coking test, CEC F-023 (XUD-9) originating from 1993, no longer meets the needs of the modern car parc. A new test was therefore required to monitor the performance of market quality fuels to ensure that modern passenger cars are protected against deposits that can cause a loss in designed performance. These losses result in:

- flow reduction leading to *power loss*
- spray pattern degradation resulting in *increased emissions*

### Q. Where do you find common rail DI?

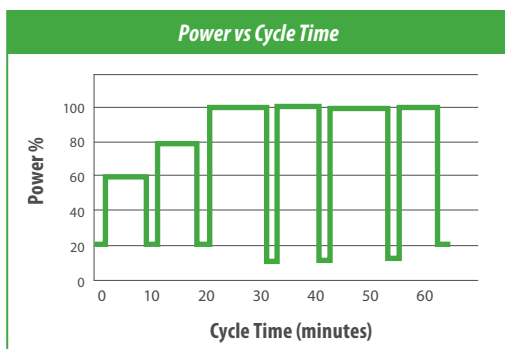
A. The last 15 years has seen a revolution in diesel engine technology driven by the need for reduced fuel consumption and emissions with 1997 seeing the first commercial use of common rail in a diesel car. Now all vehicles designed to meet the stricter emissions standards use DI diesel engines.



### Q. What is the protocol of the DW-10 test?

A. The CEC F-98-08 DW-10 test is a “keep clean” test run on a specially designed rig using:

- Peugeot 2.0 litre HDi DW-10 engine
- Multi-hole ‘sensitive’ injectors indicative of Euro V applications supplied by Siemens/Continental
- Reference base fuel containing 1 ppmw zinc added as zinc neodecanoate



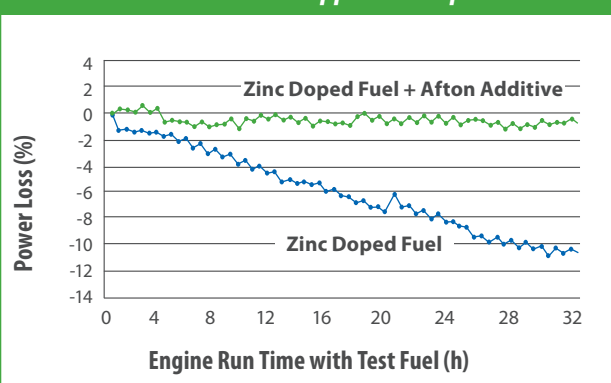
Engine power loss is evaluated during a 72-hr test cycle of alternating high speed/load and low speed/load. A cumulative engine run time of 32-hrs is performed on the tested fuel. Afton believes that the vehicle manufacturers will expect no more than 2% power loss as an acceptable performance limit. >>>

# Performance Additives Update

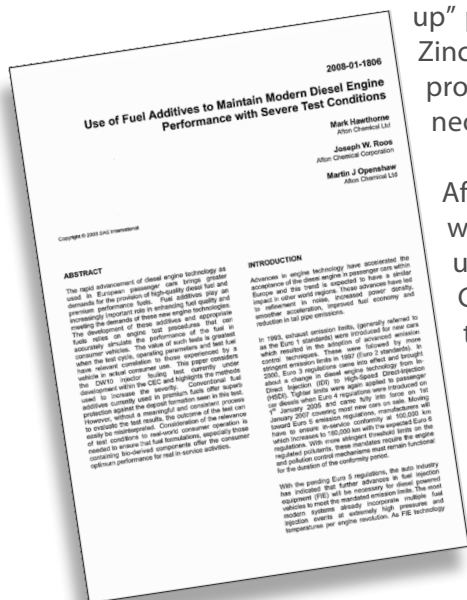
## Q. Where does Afton Chemical stand on this test?

A. Afton Chemical has nearly a decade of experience in DI nozzle coking testing, and was a contributor to the development of the DW-10 "keep clean" test. This provided Afton with the opportunity to develop a deep theoretical and practical understanding of the test before it was released. Our Greenclean® additive technology is validated on our own CEC accredited DW-10 test bed and is retested by CEC accredited independent test houses. Afton Greenclean® additive technology has been proven to give optimal keep clean performance in the CEC F-98-08 DW-10 test.

DW-10 Performance - 1ppm Zinc Doped Fuel



Afton recognizes the need for an industry standard engine test for "keep clean" performance demonstrations; however Afton continues to have concerns regarding the use of zinc neodecanoate to accelerate the formation of injector deposits. The use of this adulterant may be warranted in a test designed to show "keep clean" performance, such as the CEC F-98-08 DW-10 test. However, using zinc neodecanoate to demonstrate "clean-up" performance of additives goes beyond the original intentions of the CEC. Zinc neodecanoate is not a real-world diesel fuel contaminant and there is no proven correlation between "clean-up" of coking deposits formed from zinc neodecanoate and those found in the real-world.



Afton is committed to developing "clean up" tests that will provide real-world data that is meaningful to the consumer. These tests include clean-up of internal injector deposits and real-world coking deposits. Afton's Greenclean® detergent technology has been proven to be effective on both types of injector deposits.



**Greenclean®**  
DETERGENT TECHNOLOGY

## Summary

The CEC F-98-08 DW-10 engine test was developed to demonstrate superior performance of market quality fuels to ensure that modern engines are protected against injector coking deposits.

The DW-10 test is a "keep clean" test using 1 ppmw zinc as zinc-neodecanoate as a means to demonstrate the ability of fuel additives to protect injectors from deposits.

Afton's patented Greenclean® detergent technology has proven performance in the CEC F-98-08 DW-10 test. And, as market leader in diesel performance additive technology, Afton continues to develop proprietary tests that demonstrate the ability of Greenclean® to "clean-up" real-world injector deposits.

For more information please contact your local Afton representative or visit [www.aftonchemical.com](http://www.aftonchemical.com)

The CEC F-98-08 is owned by the CEC and the full test can be purchased via: [www.cectests.org](http://www.cectests.org)

The trademarks shown are owned by the respective automobile companies named and are not the property of Afton Chemical Corporation.

© 2011. Afton Chemical Corporation is a wholly owned subsidiary of NewMarket Corporation (NYSE:NEU). Greenclean® is a trademark of Afton Chemical Corporation. 12/11.

The information in this bulletin is, to our best knowledge, sure and accurate, but all recommendations or suggestions are made without guarantee since the conditions of use are beyond our control. Afton Chemical Corporation and its affiliates disclaim any liability incurred in connection with the use of these data or suggestions. Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing patents covering any material or its use.

