2015 WJTA-IMCA Conference and Expo
November 2-4 • New Orleans, Louisiana

Paper

THE EFFECTS OF TIER 4 EMISSION STANDARDS ON THE WATERJET INDUSTRY

J. Van Dam Director of Product Development
NLB Corporation
Wixom, Michigan, USA

ABSTRACT

This paper documents the impact of Tier 4 final engines on the water jetting industry. Diesel engines, which have been the most common means of providing power for portable water jetting pumps , have been subject to the EPA's tightening standards for the emission of harmful exhaust gases. The final stage of the reduction process is now at a point that both the manufacturers and users of water jetting pumps are learning what it is like to operate these new diesel engines.

While the cost to procure a Tier 4 Final engine is typically greater than that of a Tier 3 or Tier 4i, the cost savings during the life of the engine can be significant. In addition they greatly reduce harmful exhaust gases like nitrogen oxides, carbon dioxide and carbon monoxide. Owning a Tier 4 Final engine also ensures that owners/operators will be able to take their diesel powered pump anywhere in the U.S. and operate it in the future.

1. EPA EMISSION STANDARDS - A BRIEF HISTORY

For nearly two decades, the Environmental Protection Agency (EPA) has been tightening standards for the emission of harmful exhaust gases from diesel-powered equipment, such as high-pressure water jet units. Until January, 2015, these regulations applied only to new engines under 750 hp, but the latest rules (known as Tier 4) mandate lower emission levels from larger engines as well.

Until recently, the engines driving water jet units were not designed to meet these standards, but today engine manufacturers are adding new technology. While this adds cost to the engine (and, therefore, to the water jet unit it powers), it also improves fuel economy, which reduces operating expense. These savings offset a substantial portion of the investment.

2. EMISSIONS REDUCTIONS

2.1 EPA goal

Tier 4 standards are part of a national program by the EPA to reduce emissions from non-road diesel engines, a category that includes water jet pump units as well as excavators, generators, compressors, and a host of other equipment. These reductions are to be accomplished using the Best Available Control Technology, or BACT. Full details can be found at the EPA website, http://www.epa.gov/otaq/nonroad-diesel.htm. Essentially, the EPA wants non-road engines to have the same sort of advanced emission control technologies required of trucks and buses.

In 1996 the EPA announced that future emissions of nitrogen oxides (NOx) had to be limited to 10% of then-current levels and particulate matter (PM) emissions to 5%. (PM is the black soot or smoke in the exhaust of a diesel engine.) The agency estimated that its new standards would reduce NOx emissions by about a million tons per year by 2010… the equivalent of taking 35 million cars off the road. Reductions in carbon monoxide (CO) and non-methane hydrocarbon emissions (NMHC) were also mandated.

Recognizing that achieving these changes would not be simple (or inexpensive) for manufacturers, the EPA decided to phase them in. Diesel engines of 11 hp to 750 hp would have to reduce emission levels to a certain level (called Tier 1) by 2000, followed by progressively lower levels in 2006 (Tier 2), and 2008 (Tier 3).

An even stricter set of standards — Tier 4 — was established for engines above 750 hp. This was implemented in two stages, with Interim (Tier 4i) taking effect in 2011 and Final (Tier 4F) in January, 2015.

2.2 The importance of compliance

Compliance with Tier 4F standards is now mandatory in areas that have not yet attained current EPA air quality standards, and in some areas that have. It is required by the California Air

Resources Board (CARB) and written into bid specifications and site permits for DOT and public works projects in various states, including New Jersey, Pennsylvania and Massachusetts.

In addition, a growing number of companies, especially large, publicly-owned firms — are making environmental goals key elements of their business strategies. Dow Chemical Company and3M, for example, now require that all diesel-powered equipment brought into their facilities (wherever they are) be Tier 4F-certified.

This puts water jet contractors whose equipment is not Tier 4F-compliant at risk of being shut out of projects. Furthermore, should they be caught using older, non-compliant equipment where it is not allowed, they can be liable for fines of $37,500 per violation, as well as the costs of litigation and lost time. Water jet users who want to be competitive in the future — or get ahead of competitors today — need to consider investing in new equipment.

3. THE ENGINES

3.1 Advanced engine technology

The two primary technologies that enable diesel engines to achieve Tier 4F emission levels are exhaust gas recirculation (EGR) and selective catalytic reduction (SCR). Some engines use a combination of the two.

EGR refers to cooled exhaust gas recirculation, which recirculates some of the exhaust gases back to the combustion chamber. This has the dual effect of reducing the combustion temperature and reducing the formation of NOx. Large engines (like those used on stationary generator sets) may also have an exhaust pre-heater and Diesel Particulate Filter (DPF) to jumpstart the NOx conversion process. Together, they can heat the exhaust to 450°F in as little as nine minutes.

SCR a technology widely used in Europe, is becoming more common in North America. It sprays diesel exhaust fluid (DEF), or aqueous urea, into the exhaust stream, where the urea reacts with the exhaust NOx. This reaction reduces NOx emissions to an average of less than 0.67 g/kW-hr. The DEF dosing system, supply and return tubing, and control and monitoring functions are all integrated into the engine's electronic controls. Additional emissions controls are added to the exhaust system, where the traditional muffler is typically replaced by a catalytic converter or particulate filter.

Despite the additional technology, water jet units with Tier 4F-compliant engines operate much the same as older units. Displacement is more efficient (more torque at lower horsepower), and some users report better cold weather starting.

3.2 Fluids, fuel efficiency and operating costs

- Users should be aware of some differences, however. Tier 4F engines are designed to run on environmentally-friendly fluids, including:

- Ultra-low sulfur diesel fuel (ULSD), with sulfur content of no more than 15 ppm

- Low-ash oil meeting CES 20081 CJ-4, typically
- 15W-40 (this can also be used in older engines)

- Fully-formulated coolant, 50/50, meeting
- ASTM D6210

- Urea meeting ISO 22241-1, such as AdBlue
- DEF 32.5%

While these fluids cost more than those typically used in Tier 3 or Tier 4i engines, this expense is more than offset by the Tier 4F engine's greater fuel efficiency.

Payback periods depend on the user's particular circumstances, but 1,000 hours a year is a conservative figure (for many water jet users, 2,000 hours is more common) and units used more frequently will pay for themselves sooner.

4. CONCLUSION - SUMMARY: THE CASE FOR TIER 4 COMPLIANCE

Advancements in technology, including increased pump horsepower and automated traversing devices have made the cleaning of heat transfer tubes in power plants easier and safer.

Water jet units that meet Tier 4F requirements deliver the cleanest water jet power ever, minimizing pollution and enhancing public health. But even without these "big picture" advantages, there are solid business reasons to use them:

1. Better fuel economy and lower operating costs

2. Opportunities to do jobs virtually anywhere

3. Avoiding fines and legal costs for non-compliance

4. Customer and public goodwill for reducing air pollution