

GE Marine 6L250 EPA Tier 3 Development

Task #4 Report

for:

New Technology Research and Development Program

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Submitted by:

GE Transportation

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Abstract/Executive Summary

This project involves the prototype build and engine performance testing of a marine compression-ignition engine that meets US Environmental Protection Agency (EPA) Tier 3 emissions standards. In particular, it is a goal of this project to manufacture and certify an engine that meets Tier 3 emissions standards ahead of the January 1, 2014, compliance deadline.

This task in particular consisted of the necessary software strategy and code development to operate the engine within the necessary performance guidelines. In particular, this task involved the production and release of engine control unit (ECU) level software capable of operating the engine per regulatory compliance guidelines.

Introduction/Background

The GE family of inline engines is EPA Tier 2 certified. This project seeks to modify the current inline engine design such that it is capable of meeting the more stringent EPA Tier 3 emissions standards. Given that the EPA guidelines on Tier 3 marine engines only apply to engines with a rated load of less than 2000 kilowatts, the inline engines in GE's portfolio will be subject to the Tier 3 standards starting in January 2014.

Project Objectives/Technical Approach

From the Grant Activities (Scope of Work):

"1.1. The objectives for this work are:

1.1.1. Certify a marine 4-stroke six and eight cylinder engine rebuild kit to American Bureau of Shipping (ABS) class standards and EPA Tier 3 marine emission standards ahead of the 2014 EPA regulatory deadline."

This report in particular is in regards to the engine system software development necessary to run the engine in a compliant and safe manner.

Tasks

Task 4: System Software Development

From the Grant Activities (Scope of Work):

"2.4. Task Statement: The PERFORMING PARTY will develop and validate software capable of operating the 6L250 engine and controlling all engine accessories"

Software Development

From the Grant Activities (Scope of Work):

"2.4.1. The PERFORMING PARTY will develop and validate software to implement all of the timing maps developed by the performance engineers. Models for turbo speed, manifold air pressure, and cylinder pressure will be included in the new version of the software. The control strategy for any wastegate valve on the engine will be included and validated."

A production release of software has been created that implements all of the performance operating parameters as developed during the work required under Task 3 of this grant. The validation results of this build of software are shown in the compliant engine test results as described in Task 5 of this grant. During the performance development of this engine, it was found that a wastegate valve is not required to

meet the engine system level performance requirements. As such, the wastegate control strategy did not need to be verified for this task. Additionally, the models for turbo speed, manifold air pressure, and cylinder pressure are only necessary on an engine that utilizes a wastegate valve. Similarly, these models have also not been included in this task as they are no longer necessary.

Schedule

From the Grant Activities (Scope of Work):

“2.4.2. Schedule: The PERFORMING PARTY shall complete this task within 17 months of the signed Notice to Proceed Date as issued by TCEQ.”

The Notice to Proceed Date was July 11, 2011. The software testing was completed and verified during the certification testing that on November 21, 2012.

Deliverables

From the Grant Activities (Scope of Work):

“2.4.3. Deliverables: The PERFORMING PARTY shall submit a report to the TCEQ upon completion of this task. This report will include but is not limited to results of the completed and validated software package that can be implemented on the prototype Tier 3 engine controllers.”

The engine regulatory compliant emissions data is taken to be the proof of the completed and validated software package. This data is shown in the form of completed engine compliance submittals to the EPA as necessary under this grant. The application for certification was submitted to the EPA on December 12, 2012. This application included all required test data that showed the software was generating engine emission data to meet EPA requirements for marine Tier 3. Following figure shows the electronic confirmation that the submittal was received by EPA.

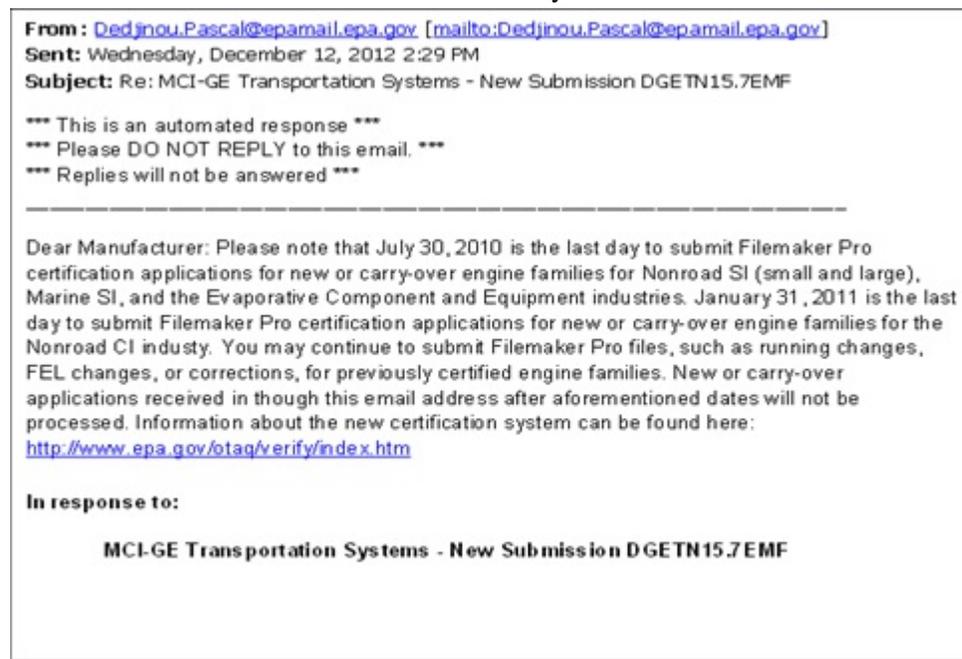


Figure 1. EPA Certification application

Discussion/Observations

Objectives vs. Results

All desired objectives have been met for this portion of the grant objectives. The software build has been created and functioned properly for the use of engine certification testing. The software development process is ongoing however, for each new engine build and compliance recipe, the software build must be updated and built with the necessary performance characteristics. This software update process is currently implemented and followed for all pre-release and production engine models.

Critical issues

The only critical issue encountered thus far has been with regard to schedule, due to test lab resource availability. This liability in test lab resources has caused a delay in the program, but has been mitigated by testing over weekends or during over-time.

Technical and commercial viability of the proposed approach

All aspects of this project to date are deemed achievable and technically viable. Some activity is still to be undertaken to ensure that the engine software is compliant for all developed engines; however this work is expected and will last of the entire life of the engine family.

Scope for future work

Future work is to involve the upkeep and necessary modifications to the engine software as deemed necessary by future engine work and software improvements. Additionally, the performance development process for the 8L250 will be completed, and the software requirements for the 8L250 will be included in the build of software per the above noted process.

Intellectual Properties/Publications/Presentations

All information provided in this Task Deliverable Report is the property of GE Transportation. It has been supplied in accordance with the agreed upon terms of the NTRD contract as proof of task completeness.

The commercialization process of the GE EPA Tier 3 L250 engine has begun in the fourth quarter of 2012.

Summary/Conclusions

The elements of this part of the grant activity focused on the system software development and release necessary to run the 6L250 engine in a safe and performance compliant manner. All tasks specified in this

deliverable report have been completed. The results of this task are not readily shown however are taken as the baseline for certification testing as noted in Task 5 of this grant. The remaining scope of this grant activity includes the standard software build maintenance as noted above, along with the performance development, testing, and certification of the 8L250 prototype engine.

Contact Information

For further information about this project please contact:

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