Program Progress Performance Report for University Transportation Centers
Marine Engine Testing and Emissions Laboratory (METEL)
Led by Maine Maritime Academy

Federal Agency and Organization Element to Which Report is Submitted:
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Project Title: Tier 1 Marine Engine Testing and Emissions Laboratory

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Recipient Organization: Maine Maritime Academy, Pleasant Street, Castine Maine 04420

Recipient Identifying Number or Account Number: Not Applicable

Project/Grant Period: October 1, 2013 – September 30, 2019

Reporting Period End Date: September 30, 2017

Report Term or Frequency: This report covers the period from March 31, 2017 to Sept 30, 2017 per the Grant Deliverables and Requirements for UTCs instructions

Signature of Submitting Official:

1. ACCOMPLISHMENTS

What are the major goals of the program?
The Marine Engine Testing and Emissions Laboratory (METEL) focuses on research and development of practical and commercializable emissions reductions technologies and engine efficiency enhancement technologies for marine and related power plants (US DOT strategic goal focus area of environmental sustainability).

METEL also provides maritime transportation workforce development and educational opportunities for undergraduates, graduate student as well as middle and high school students (Through its STEM activities).

METEL has nine projects as the focus of the UTC funded activities which are:

Project 1: Field Testing of Diesel/Glycerin Emulsion fuels as a low cost, low emissions, drop-in fuel for marine diesels. This fuel is being developed and commercialized by the startup SeaChange Group LLC

Project 2: At Sea testing of a hydrogen injection system on MMA Work Vessel for emissions reduction. This system is being developed by Global Marine Consulting

Project 3: Development and engine testing of Forest Biomass fuel derivatives being developed at UMaine's Chemical Engineering Department and Forest Bioproducts Research Institute.

Project 4: Development and testing of an exhaust heat recovery thermoelectric generator (TEG) for marine engine efficiency improvement using current advances in thermoelectric materials.

Project 5: Development of a Marine Engine Continuous Emissions Monitoring System which operates on actual at-sea vessels as well as in the lab.

Project 6: Studies the capability of particular Algae strains to produce Glycerin fuel for use as a low cost low emissions transportation fuel.

Project 7: Development of Medium Speed Engine Testing Laboratories for Efficiency Improvement and Emissions Reduction Technology Evaluation.

Project 8: Sustainability Education and Laboratory Training for Workforce Enhancement

Project 9: Efficiency Improvement of Workboats through Hull Form Optimization Develop a high efficiency, advanced hull form for application to the coastal fishing fleet.

All of the projects work with commercial partners and have the potential to be practical solutions which can be implemented into the maritime industry in a timely, cost effective manner. Testing at METEL is a vital step toward proving out these technologies for practical use in the real working environment for which they would be subjected.

What was accomplished under these goals?

Major Activities and Specific Objectives

General METEL accomplishments for the performance period:

- Successfully completed first test on Medium speed diesel engine for a commercial customer and are working on second larger contract for lube oil evaluation
- Competed first emissions test on a Marine Medium Speed diesel engine using Glycerin Emulsion fuel
- Introduced and offered two courses in the MMA Environmental sustainability minor.
- Awarded a Maine Technology Institute subaward to the Maine Landing School to build a 25foot model of our Trimaran Lobster boat.
- 20 l TDO biofuel produced for hydro-treating
- Awarded NSF MRI Award(~$350k) to purchase a Gas Spectrometer Mass Spectrometer as a major analytical tool for fuels and oils to the METEL lab
- Constructed first Bismuth Telluride Thermoelectric device using nanoparticles. Testing of the device underway.

The following summarizes the tasks for each project which were accomplished over the reporting period:

Project 1: Diesel Glycerin Emulsion Fuel Project

The summarized accomplishments for the reporting period are:

- Conducted medium-speed diesel engine tests of a 23 wt% glycerol/biodiesel/diesel emulsion fuel for performance comparison with traditional marine fuels.
- Performed combustion heat release analysis and characterized emissions is accordance with ISO 8178 protocols.
- Submitted combustion results to Journal of Marine Engineering and Technology.

We examined the combustion and emission characteristics of glycerol emulsion fuels at commercially-relevant scales and under field operational conditions. Testing was completed at Maine Maritime Academy's Medium Speed Engine Laboratory (MSEL) on a 1 MW marine generator to draw comparison data with ultra-low sulfur diesel (ULSD) and 380 cSt. heavy fuel (RMG 380) to determine fuel utility in marine operations. Resulting gas emissions and particulate matter were characterized and in-cylinder pressure monitoring determined combustion quality.

Glycerol emulsion fuel was compatible with testing fuel handling procedures. Glycerol emulsions did not require heat tracing and maintained consistent viscosity of between 9.8-10.6 cSt., varying with load. No adverse pressure drop was observed across filter housings when compared to ULSD or RMG 380. The emulsion fuel, however, exhibited operational range limitations due to combustion quality and low energy density compared to ULSD and RMG 380. Cylinder pressure trace data, taken from cylinder number six, shows greater delay in pressure rise for the glycerol emulsion (24.5 CAD) at idle compared to RMG 380 (22.3 CAD) and ULSD (21.2 CAD) as shown in Figure 1 resulting in rough operations. Peak load was also reduced for the glycerol emulsion fuel, achieving only 90% maximum power output.

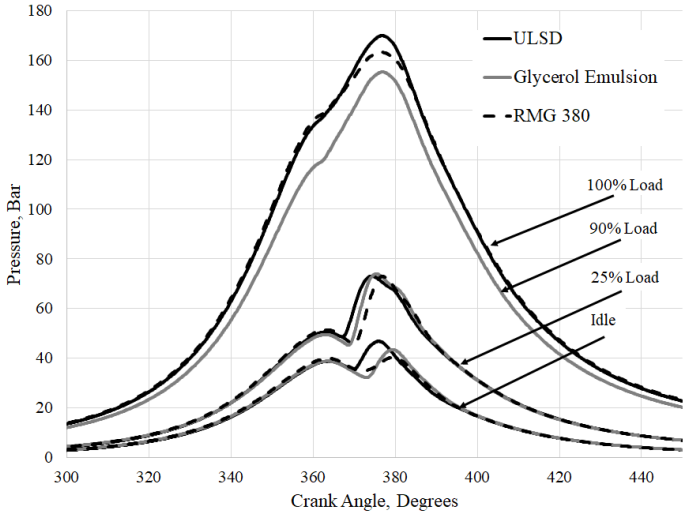

Figure 1: Pressure trace comparison detailing combustion phasing of ULSD, RMG 3680 and glycerol emulsion fuel.

Exhaust gas emissions of glycerol emulsion fuel exhibits high carbon monoxide (CO) and total hydrocarbon (THC) concentrations at idle conditions resulting from incomplete combustion. Idle CO emissions approach 10.5 g/(kW-hr) and THC approaches 3.7 g/(kW-hr) which exceeds RMG 380 as shown in Figure 7A and 7B. As engine load increases, and combustion efficiency improves, CO and THC emissions are comparable to both ULSD and RMG 380 below 1.0 g/(kW-hr). Oxides of nitrogen emissions, shown in Figure 7C, exceeds ULSD at all engine loads and is comparable to RMG 380 emission rates with a maximum output rate of 6.2 g/(kW-hr) at 90%, 787 kW, power.

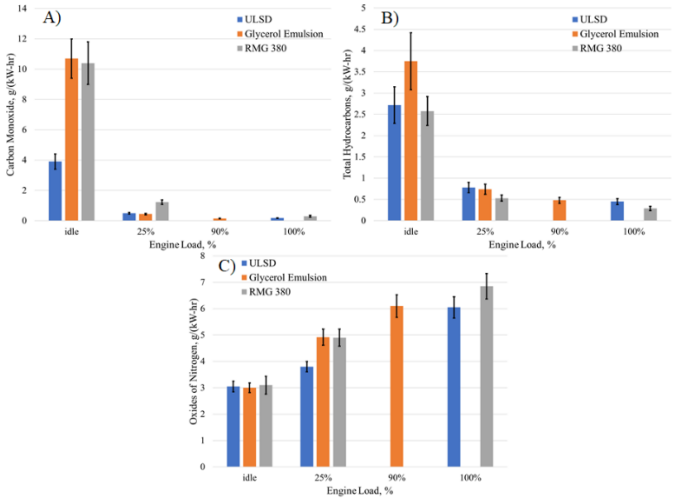

Figure 2: Gas emissions resulting from ISO 8178 testing protocols for ULSD, RMG 380 and glycerol emulsion fuel at A) Idle, B) 25% and C) Full load.

This work is the first known example of a glycerol-biodiesel emulsion fuel in a marine style generator. The fuel is shown to be compatible with existing large-bore diesel powerplant technologies. No engine modifications or additional fuel handling operations are required for this blend of emulsion fuel. Emulsified glycerol-biodiesel based fuels have the potential to reduce the carbon footprint of marine transportation and stationary powerplants. Sourcing of crude glycerol feedstock from domestic biodiesel production is expected to reduce re-fueling costs within

targeted geographic locations. Glycerol emulsions are shown to be prepared in commercially-relevant processes and resulting fuels are stable and with favorable droplet size ranges capable of maintaining low viscosity and compatibility with filter assemblies

Significant Results and Outcomes:

- Glycerol/biodiesel/diesel emulsion fuels were found to be operable without need for engine modification indicating the fuel may be viable. Combustion delay, especially at idle, resulted in higher CO and THC emissions and may require cetane improvement additives.
- The glycerol/biodiesel/diesel emulsion fuel showed nearly equivalent performance and regulated emissions as traditional marine fuels.
- This is the first reported test of a glycerol emulsion fuel in a medium-speed engine.

Project 2: Hydrogen Injection Fuel Project

The summarized accomplishments for the reporting period are:

- No work performed during this reporting period
- Focus on the medium speed engine lab has temporarily taken time away from this project. We plan on returning to it over the next several months.

Description of accomplishments for the Hydrogen Injection Fuel Project:

We anticipate finishing research and closing the project out during the final year period activities.

Project 3: Forest Biomass Diesel fuel project

Lead by UMaine – this project is exploring multiple forest biomass processing routes for the commercial production of liquid transportation fuels. These materials are projected to displace fossil fuel consumption and reduce greenhouse gas emissions within the transportation industries. Two candidate processing routes explored through this center project are formate assisted pyrolysis (FAsP) and thermal deoxygenation (TDO).

The summarized accomplishments for the reporting period are:

- Approximately 20 L of TDO oil was prepared for hydrotreating

Project 4: Thermoelectric Exhaust heat recovery generator (TEG) project

Summarized accomplishments:

- Initial materials development completed
- Material characterization completed
- Initial device couple created and evaluation has commenced

A procedure for rapid, controllable and repeatable production of nanoscale thermoelectric material was developed at the Laboratory for Surface Science and Technology (LASST) at UMaine using only bulk thermoelectric materials, surfactant polymers and ball milling. The resultant powders were then pressed into 5mm diameter cylindrical pellets (~4 mm thick) using a hydraulic press for materials testing. To initiate particle sintering and remove polymers, pellets were heated either during the press using a barrel heater or post pressing using an inert atmosphere quartz tube furnace. The cold pressed pellets resulted in good thermal and electrical properties, but poor mechanical properties (frequent macroscopic cracking). Simultaneous pressing and heating resolved this issue.

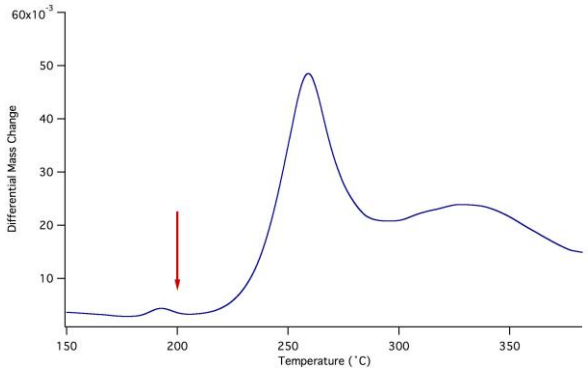

Figure 3. Thermal gravimetric data from a powder of bismuth telluride with a mean particle diameter of 40 nm.

Pellets were pressed at 200, 250 and 300˚C and then tested by Dr. Joshua Henry for thermal and electrical conductivity and Seebeck coefficient at the Cornell Center for Materials Research (CCMR, Ithaca, NY). The data shows that samples pressed at 200˚C have similar Seebeck coefficients and thermal conductivities to samples pressed at higher temperatures, but significantly lower electrical conductivities. This is consistent with thermal gravimetric data (Figure 3), which shows that polymer removal only begins to occur at 250˚C. Seebeck coefficient and thermal

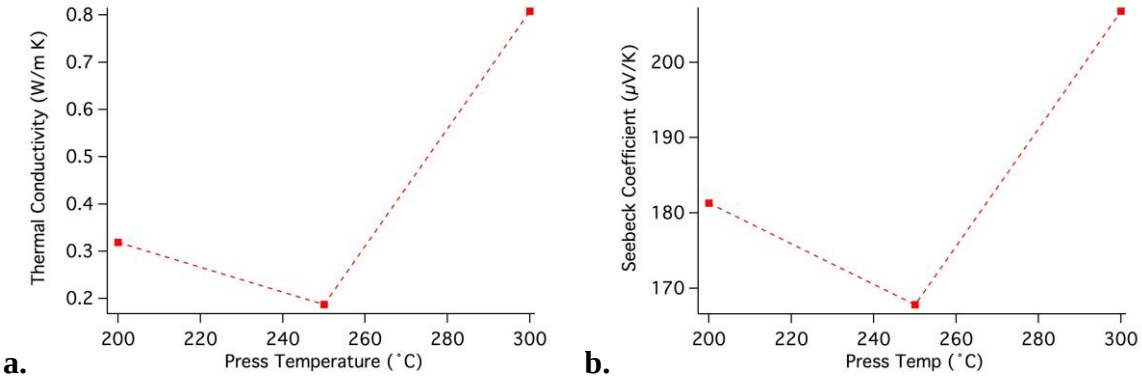

Figure 4 Room temperature thermal conductivity and b. Seebeck coefficient data from pellets made with 40 nm particle, p-type BiTe powder

conductivity data is less straightforward, with better/lower thermal conductivities in pellets pressed at 250˚C and better/higher Seebeck coefficients from pellets pressed at 300˚C (Figure 4).

The effect of average particle size on thermoelectric materials properties was also investigated. Electrical conductivity changed nominally with particle size, but fairly significant changes in

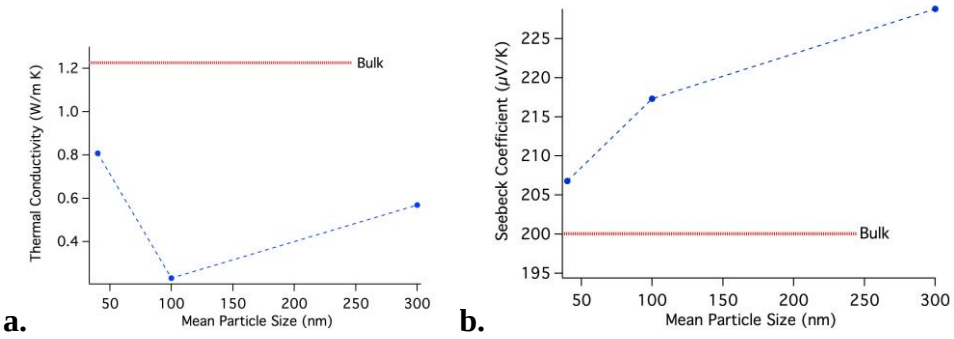

Figure 5 Room temperature thermal conductivity and b. Seebeck coefficient data from pellets made with p-type Bi_2Te_3 powder processed to average particle diameters of 40, 100 and 300 nm.

Seebeck coefficient and thermal conductivity were observed (Figure 5). At this point we do not have a good explanation for these observations and follow up experiments are underway.

For actual device fabrication and testing both p-type and n-type pellets were pressed at 300˚C and mounted into a traditional π shaped thermoelectric couple, shown in the figure below, and tested inside a vacuum chamber at LASST, also shown in the figure below, for its performance. The two graphs below show the results of the Peltier performance testing, where the current was increased gradually from 0A to 1A and the voltage drop, power input, hot side temperature, and cold side temperatures were measured and recorded. The graphs show the results as compared to a commercially available thermoelectric couple, and show that the power input is much higher due to an increased voltage drop across the couple. It is believed that joule heating at the contact interfaces is occurring and causing the higher resistances.

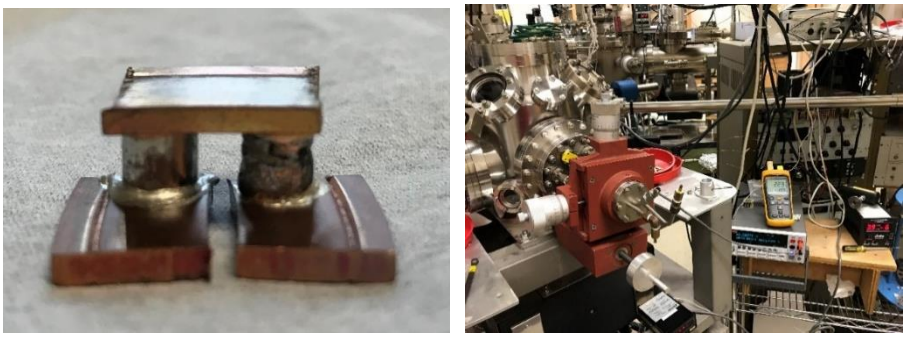

Figure 6: Thermoelectric couple Peltier testing; left, TE couple, right, vacuum chamber testing setup

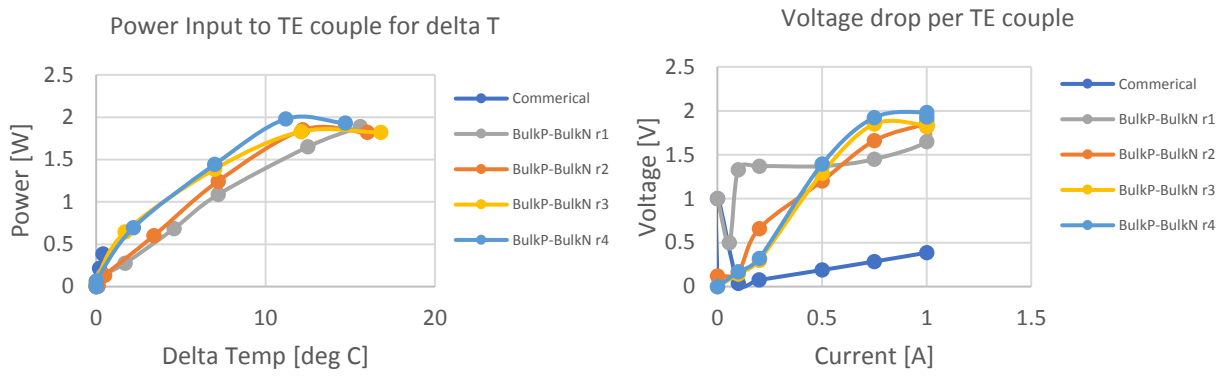

Figure 7: Results from TE Peltier testing; left, temperature differential generated per power input, right, the voltage drop across the TE couple per amp

Project 5: Marine Engine Continuous Emissions Monitoring System

The summarized accomplishments for the reporting period are:

- Completion of first stage continuous emissions monitoring system installed in medium speed diesel engine lab
- Performance and emissions data of several fuels were collected in the medium speed engine lab as part of client testing.
- Performance and emissions data of glycerol emulsion fuel was collected in the medium speed engine lab as part of a publishing effort focused on glycerol emulsion emissions.

The continuous emissions monitoring system was installed in the medium speed diesel engine lab during this reporting period. New equipment measuring generator output power, voltage, and current were integrated into the previously developed CEMS system. Outputs from the fuel skid including mass flow, viscosity, and density of fuel were also integrated.

The new CEMS system was used to conduct two research projects this reporting period. Several fuels were evaluated as part of client testing. A glycerol emulsion fuel was also tested in the medium speed diesel engine lab utilizing the new CEMS system. Figure 8 demonstrates the average fuel consumption of ULSD and emulsion fuels at different engine loads highlighting the difference in heating values of the two fuels and accuracy of the new fuel measurements.

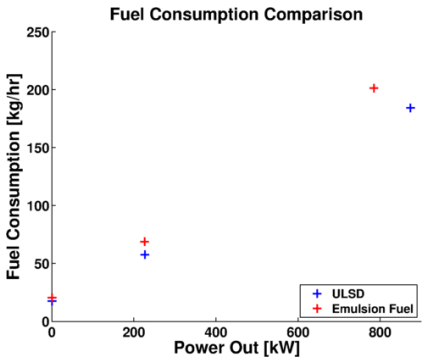

Figure 8: Fuel consumption of ULSD and emulsion fuels

Figure 9 illustrates energy weighted mass emissions of NOx, CO, particulate matter, and total hydrocarbons for ULSD and emulsion fuels. The data collected for the glycerol emulsion fuel was used in a publication submitted this reporting period.

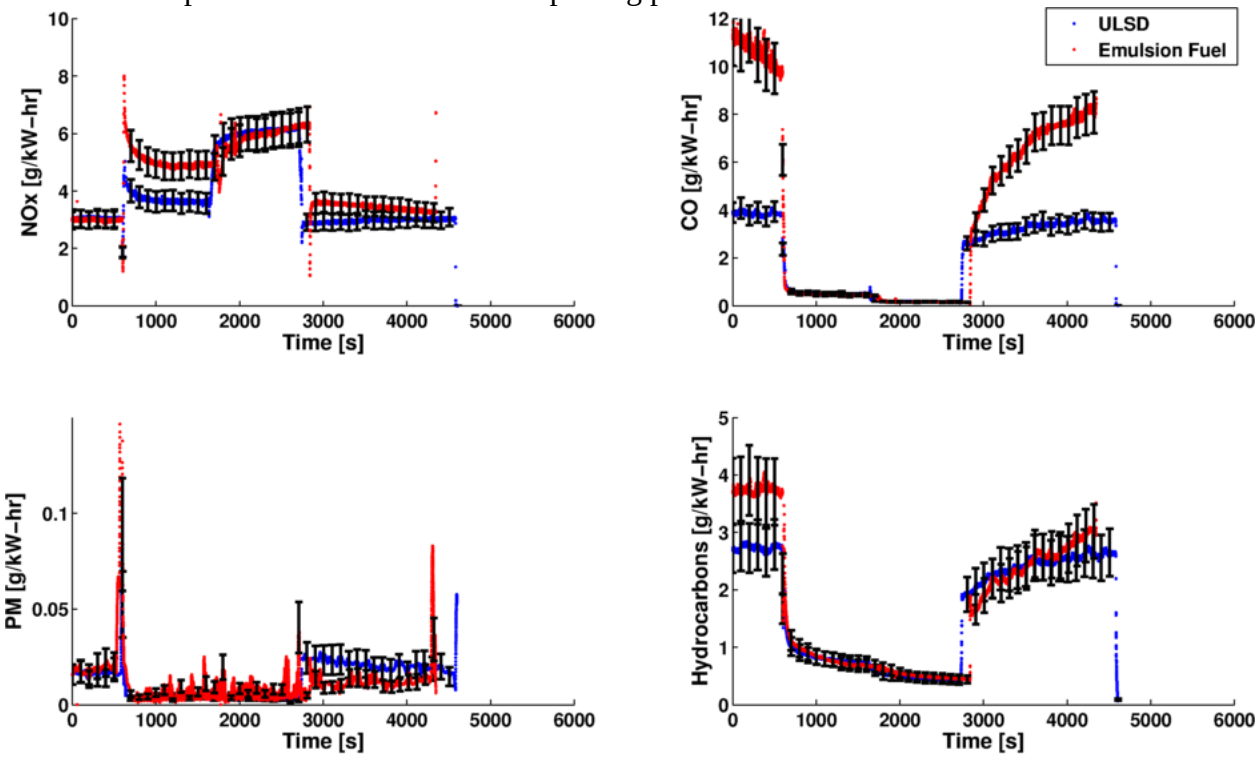

Figure 9: Energy weighted mass emissions of NOx, CO, particulate matter, and total hydrocarbons for ULSD and emulsion fuels.

Project 6: Algae based Glycerin Fuel Project

Summarized Accomplishments

- Studies replicating previous work reinitiated using stabilized media developed recently
- Salinity shocking experiments show indications of enhanced Gylcerin production as indicated in prior studies
- Calibration map for glycerin and salinity calibrated in new media using refractive index, conductivity and pH for indicators of glycerin, salinity and dissolved CO2.

Current studies focused on salinity shocking to reproduce prior work of others (Chow 2015) The use of the calibrations methods using refractive index, conductivity and pH (RI/S/pH)are being developed and calibrated against known samples using the base media and validated using a high end GCMS systems due to arrive at MMA in December 2017. The RI/S/pH system is a vital part of the development of a farm grade monitoring system for detecting glycerin that is simple, reliable and low cost. A Senior Engineering Capstone project is working on continue this continuous monitoring algae system for the capstone project of 2 years ago, shown in the picture below.

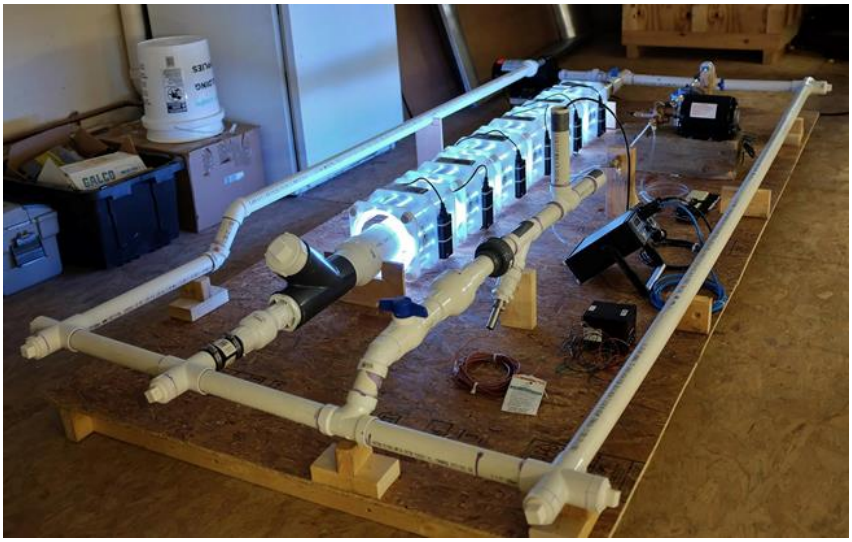

Figure 10: Continuous flow and monitoring algae growing system; MMA Capstone

Project 7: Development of Medium Speed Engine Testing
Summarized accomplishments:

- First customer testing contract completed
- Automation and data acquisition improvements and upgrades underway

METEL has completed its first testing contract using the medium speed engine lab. The testing followed an agreed upon test plan with the client and went very well. Many operational capabilities of the system were learned during this testing procedure, such as the ability to complete a condensed ISO 8178 loading schedule on a single 55 gallon drum of fuel, and the ability to start the engine with more viscous fuels once the temperature of the fuel and fuel injection equipment are at the appropriate higher temperatures.

There also have been a large number of instrument and data acquisition upgrades. The main improvement is a continuous engine monitoring system, shown in Figure 11, is being implemented to allow for an operator to monitor the conditions of the engine's operation from outside of the engine room. This system includes a dedicated desktop computer and multiple display monitors to show the various operating parameter and trends of the engine operation. This would be akin to an unmanned engine room onboard a vessel. The ability of alarm monitoring was also added to ensure that an operator is aware of engine parameters that are approaching automatic engine shutdown conditions. The capability of tracking the cooling water temperatures on both the HT and LT cooling loops for the engine, the charge air pressure and temperatures were also added. Figure 12 below show data collected from this new system during a test run to evaluate the effectiveness and function of the upgrades, including the HT freshwater cooling inlet and outlet to the engine, the LT freshwater cooling inlet and outlet to the engine, the ambient room temperature and the relative humidity inside the lab space. This test procedure consisted of running the engine at a constant 50% load for one hour and tracking the temperature stability at load. As can be seen, the HT and LT water temperatures were very consistent. At the one hour mark, the load was increased to 80% briefly to ensure that the system was registering any potential temperature changes.

Figure 11: Continuous Engine Monitoring station with data acquisition and emissions equipment

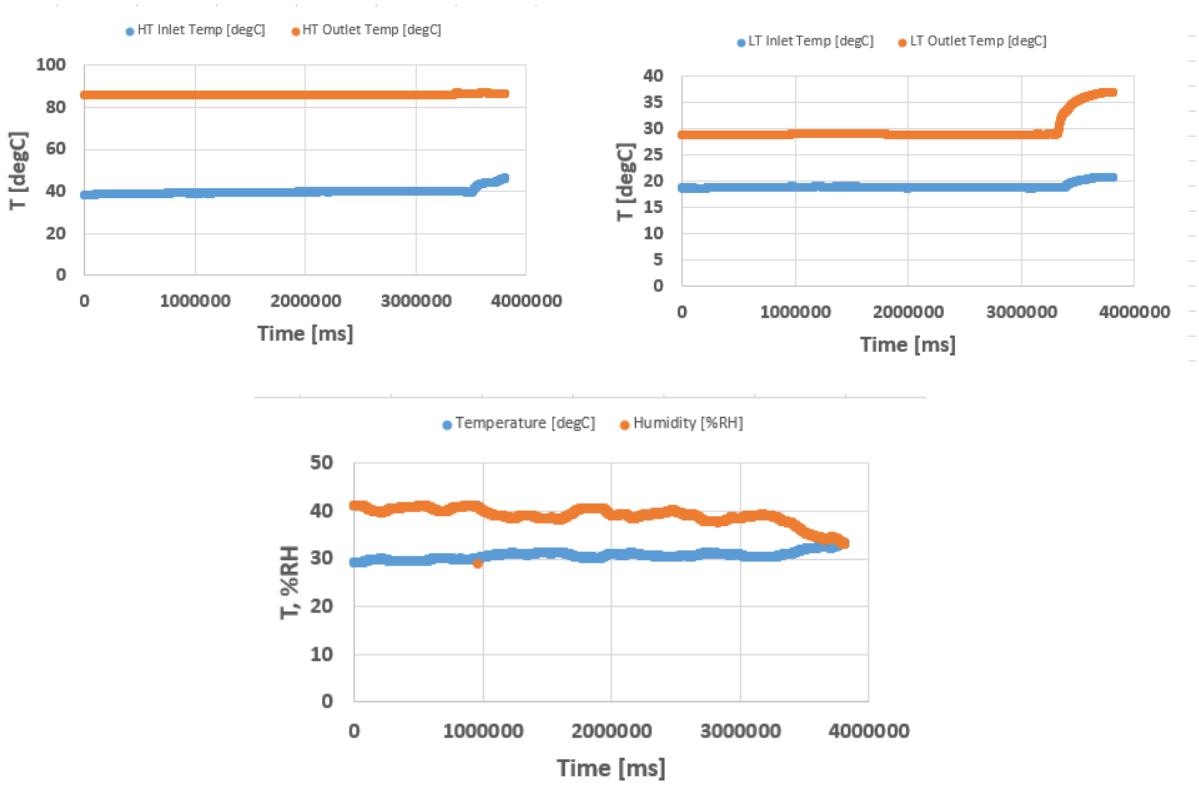

Figure 12: Selected data graphs from new continuous engine monitoring system; top left, HT FW cooling in and out of the engine, top right, LT FW cooling in and out of the engine, bottom center, ambient room temperature and relative humidity

Project 8: Sustainability Education and Laboratory Training for Workforce Enhancement
Summarized accomplishments:

- New Environmental courses offered in spring and fall semesters under the environmental sustainability minor include: EN202:Intro to Sustainability; EN232:Pollution Control and Remediation
- Incorporation of METEL lab facilities and capabilities into existing marine engineering courses including EG101: Fund of Engineering Operations; EG234 Power equipment lab; EG392 Diesel Power II and ET351 Thermo/Fluids Lab.

MMA's Engineering Department is implementing the recently developed Environmental Science Minor comprised of six new courses. This minor combines thermodynamics and other key STEM classes that utilize the new labs as key training tools for workforce development in mitigating and remediating transportation related environmental concerns.

In addition, the medium speed engine laboratory (MSEL) has been a valuable resource for many courses offered at Maine Maritime Academy. These courses were able to bring students into the MSEL for the METEL staff to assist in fostering the student's practical and theoretical skill formation. The specific courses that were able to utilize the MSEL and METEL staff were: EG101 Fundamentals of Engineering Operations, EG234 Power Equipment Laboratory, EG392 Diesel Power II, and ET351 Thermal Fluids Laboratory.

EG101 Fundamentals of Engineering is a course designed to teach entry level students introductory skills, safety awareness, and familiarization with standard marine and power plant systems, equipment, and piping components at an operational level. The students in this course were given tours of the MSEL with an explanation of the function of supporting equipment and system layout. Students were also given homework exercises to trace out the support systems piping layout and equipment arrangements.

EG234 Power Equipment Laboratory is a sophomore level course intended to give students an opportunity to learn about marine and stationary power plant operations and maintenance though a hands-on practical experience. Students dismantle and reassemble a number of fluid system components and pieces of equipment, as well as develop skills in proper maintenance techniques for the same. Students in this course were exposed to updated fuel and lubricating oil centrifugal purifiers that are used in the MSEL, as well as usage of plate type heat exchangers, shaft couplings, and duplex strainers.

EG392 Diesel Power II is a course that student expand their working knowledge of the mechanisms and components of a diesel engine, as well as discuss requirements and fluids needed for the proper operation of the engine. Students in this course were brought down to the MSEL throughout the rebuild of the engine to witness the process of tearing down the engine and reinstalling the components.

ET351 Thermal Fluids Laboratory is a senior level course that is experimentally-based laboratory. The course is designed to have students complete exercises and experiments geared toward building knowledge and skills in the areas of data acquisition, calibration, error analysis, and communications using experimental setups that include heat exchangers, diesel engines, gas turbines, and air turbines. A new experimental exercise was created for the diesel engine exercise component of this lab using data collected during the MSEL operation. This exercise included power generation, heat balance, fuel consumption and efficiency calculations.

Project 9: Efficiency Improvement of Workboats through Hull Form Optimization

Maine Maritime Academy has developed a high efficiency, advanced hull form for application to coastal fishing and transportation. The design has undergone extensive model testing and exhibits improved performance in the typical cruising speed range of these vessels. Reductions in fuel consumption and emissions are in the range of 15% to 25% depending on loading condition and sea state. The design achieves these reductions through the use of an optimized trimaran hull, allowing for the large required deck space without the large waterline beam and power requirements of current boats.

The summarized accomplishments for the reporting period are:

- Start of construction of a 3/5-scale technology demonstrator at The Landing School in Arundel, Maine. Grant includes funds for engineering, workforce development, and construction cost for a 22 ft. prototype.
- Completion of structural calculations and laminate schedule for the prototype.
- Scaling and lofting of the prototype lines from original 38 ft. fishing boat.
- Development of hybrid composite-wood construction technique to balance performance and carbon footprint of prototype hull.

Results:

To further reduce risk on a radical new hull design, MMA is constructing an approximately 3/5-scale prototype at The Landing School, to be launched in May 2018. The collaboration has led to the investigation of not only the lifetime emission reduction of the vessel, but to reducing the carbon footprint of the hull itself. The Landing School recently built three 19-foot vessels with near-zero carbon footprint for hull construction. In addition, this opportunity provides significant opportunity for workforce development, as the hull will require new construction techniques and structural arrangements. Two full-time boatbuilding apprentices are currently employed on the project. The total value of the grant is $97,257.

Several technical investigations continue for the project. Engineering calculations for refinement in the areas of stability, maneuvering, seakeeping, and propeller design took place during the performance period. The prototype has been designed to include a replaceable bow section for future investigations of resistance and maneuvering. This change will also allow the prototype to be re-configured to study other types of vessels such as coastal ferries.

Notable milestones include start of construction of the prototype, calculation of load cases and required section modulus for the prototype, and selection of laminate schedule for the important composite horizontal hull panel.

Figure 13 shows the construction sub-assemblies, demonstrating the critical composite horizontal hull panel joining the upper and lower hull components. Figures 14 shows new hull panel and upper structure for the prototype, scaled at a different ratio in height, to accommodate the vertical geometry requirements of operators, which don't change between full- and prototype-scale. Finally, the hull construction is shown to be underway in Figure 15.

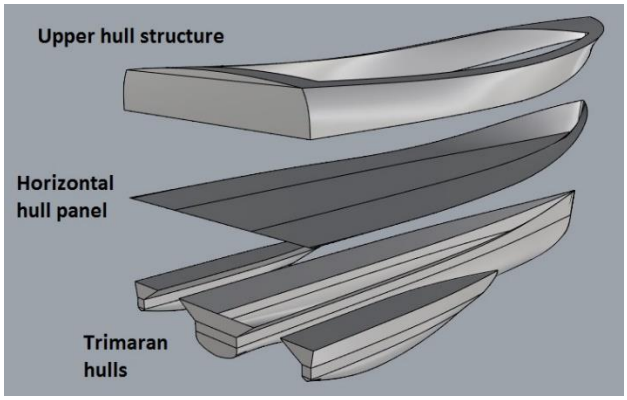

Figure 13: Component breakdown of demonstrator under construction at The Landing School.

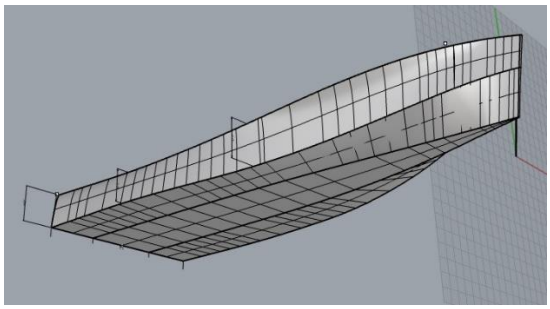

Figure 14: Upper hull structure and horizontal panel scaled to prototype dimensions.

Figure 15: Construction jig for upper hull structure in place at The Landing School.

Education, Workforce development and STEM accomplishments

STEM Events:
Maine Maritime Academy is preparing plans to develop a STEM center on campus to inspire, engage, and educate students to prepare them for careers in maritime transportation. Plans are anticipated to be completed in July 2017 and funding development activities will commence in September 2017.

The medium-speed engine lab project provided hands-on learning for approximately 8 engineering students to assist in the design, construction, maintenance and operation of the laboratory systems. The students worked intermittent shifts with duties running parallel with their USCG licensing track and academic responsibilities.

In addition, METEL supported two part time student assistants, and is supporting one Ph.D. student on the TEG project.

Significant Results:
None to report at this time

Key Outcomes:
How have the results been disseminated?
Project 1: Diesel/Glycerin Emulsion fuel project
- One journal article has been submitted for publication in a refereed journal

Project 3: Forest Biomass Diesel fuel project
- Three conference presentations

All other Projects:
- Nothing to report for this period

What do you plan to do during the next reporting period to accomplish the goals?
Over the next reporting period we plan the following goals and accomplishments for the projects:

Project 1: Diesel/Glycerin Emulsion fuel project
- Complete soot particle morphology testing of glycerol/biodiesel/diesel emulsion fuel diesel combustion using 3-D tomography and FTIR measurements.
- Prepare a manuscript for submission to a refereed journal on the characterization of soot morphology of glycerol/biodiesel/diesel emulsion fuel diesel combustion

Project 2: Hydrogen Injection Fuel Project
- Conclude Hydrogen project and write up final report

Project 3: Forest Biomass Diesel fuel project
- Publish Formate-Assisted Pyrolysis Paper
- Submit manuscript for hydrotreating of Formate-Assisted Pyrolysis Oil
- Hydrotreat and fractionate TDO oil for blending
- Blend fractionated crude TDO oil for delivery to MMA

- Conduct economic sensitivities to distributed pre-processing of pyrolysis feedstocks for centralized pyrolysis processes

Project 4: Thermoelectric Exhaust heat recovery generator project
- Future experiments will focus on producing materials with smaller, more uniform nanoparticles and on controlling annealing conditions to prevent oxidation and maximize electrical conductivity.

Project 5: Continuous Emissions Monitoring System
- Install and integrate (6) in-cylinder pressure monitors on Medium spped diesel engine and incorporate data acquisition software with emissions measurement system.

Project 6: Algae Based Glycerin fuel project
- Apply glycerol calibration procedures to lab growth samples and verify with GCMS

Project 7: Development of Medium Speed Engine Testing
- Complete initial client testing contracts and write the final report for the project.

Project 8: Sustainability Education and Laboratory Training for Workforce Enhancement
- Continue to offer the courses developed in the Environmental sustainability minor
- Graduate first students with Environmental Sustainability minor

Project 9: Efficiency Improvement of Workboats through Hull Form Optimization
- Completion of 25 foot hull model at Landing School
- Setup boat for initial sea trials
- Run sea trials and determine powering and seakeeping characteristics

Education, Workforce development and STEM:
- Developing STEM education center at Maine Maritime Academy who will collaborate with local stakeholders, including the Maine Ocean School, local High Schools to increase the number of interested young people in transportation careers.

2. PRODUCTS: What has the program produced?
Publications, conference papers, and presentations

Journal publications:
Project 1: Diesel/Glycerin Emulsion fuel project:
- One Journal article submitted for publication

Project 2: Hydrogen Injection Fuel Project
- Nothing to report

Project 3: Forest Biomass Diesel fuel project
- Nothing to report

Project 4: Thermoelectric Exhaust heat recovery generator project
- Nothing to report

Project 5: Continuous Emissions Monitoring System
- Nothing to report

Project 6: Algae Based Glycerin fuel project
- Nothing to report

Project 7: Development of Medium Speed Engine Testing
- Nothing to report

Project 8: Sustainability Education and Laboratory Training for Workforce Enhancement
- Nothing to report

Project 9: Efficiency Improvement of Workboats through Hull Form Optimization

- Nothing to report

Books or other non-periodical, one-time publications: Nothing to report

Other publications, conference papers and presentations: Oral/Poster Presentations:

- Khlewee, Abdulazeez, "Characterization of Catalysts for Hydrodeoxygenation of Bio-Oils using Phenol as a Model Compound," University of Maine M.S. Thesis, 2017.
- DeSisto, W.J. and Wheeler, M.C., "Formate-Assisted Pyrolysis of Biomass," Presented at the New England Energy Research Forum, Worcester MA, June 28, 2017.
- Gunukula, S., DeSisto, W.J., Pendse, H.P., and Wheeler, M.C., "Economic and Modeling Analysis of Product and Energy Driven Biorefineries Based on Thermal Deoxygenation Pathway," Presented at tcbiomass, Chicago IL, September 20, 2017.

Website(s) or other Internet site(s)
The METEL website can be found at: www.mainemaritime/metel
This is the main website for the DOT UTC Center, describing the center's mission as well as the projects, key personnel and serves as a repository for the research reports generated by the project. It is kept current and updated minimally on a monthly basis.

Technologies or techniques Nothing to Report
Inventions, patent applications, and/or licenses Nothing to Report
Other products Nothing to Report

3. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS: Who has been involved?

What individuals have worked on the program?
The tables below summarize the information for the individuals who have worked on the program:

Name	Dr. Richard Kimball
Program/Project Role	P.I. /Technical Director
Work Effort during reporting period	2 months
Contribution to Program/Project	METEL Technical Director
Funding support	DOT UTC
Collaborated with individual in foreign country	No
Country of Foreign Collaborator	NA
Travelled to Foreign Country	No
If travelled to foreign country(ies) duration of stay	NA

Name	Thomas Lokocz
Program/Project Role	Research Engineer (Full time)
# Hours worked during reporting period	1040 hrs

Contribution to Program/Project	METEL Research Engineer for all projects
Funding support	DOT UTC
Collaborated with individual in foreign country	No
Country of Foreign Collaborator	N/A
Travelled to Foreign Country	No
If travelled to foreign country(ies) duration of stay	N/A

Name	Dr. Brendyn Sarnacki
Program/Project Role	Research Engineer (Full time)
# Hours worked during reporting period	960 hours
Contribution to Program/Project	METEL Research Engineer for all projects
Funding support	DOT UTC
Collaborated with individual in foreign country	No

Name	Travis Wallace
Program/Project Role	Research Engineer (Full time)
# Hours worked during reporting period	960 hours
Contribution to Program/Project	METEL Research Engineer for all projects
Funding support	DOT UTC
Collaborated with individual in foreign country	No

Name	Dr. Joshua Henry
Program/Project Role	Research Engineer (Part Time)
# Hours worked during reporting period	520 hours
Contribution to Program/Project	METEL Research Engineer; TEG project and STEM Algae project
Funding support	DOT UTC
Collaborated with individual in foreign country	No

Name	Dr. Scott Eaton
Program/Project Role	METEL Senior Personnel, all projects
# Hours worked during reporting period	250
Contribution to Program/Project	Mechanisms of TDO, Emulsion Fuels
Funding support	DOT UTC 1 month (DOT)
Collaborated with individual in foreign country	No

Name	Dr. Clay Wheeler
Program/Project Role	UMaine Co-P.I.
# Hours worked during reporting period	0
Contribution to Program/Project	Lead P.I. for UMaine effort; Leading the TDO/FAsP project at UMaine
Funding support	0 month (DOT), 0 month (UMaine)
Collaborated with individual in foreign country	No

Name	Dr. William DeSisto
Program/Project Role	UMaine Senior Personnel
# Hours worked during reporting period	57
Contribution to Program/Project	Co- P.I. for UMaine effort; Co-supervising graduate student research.
Funding support	0.34 month (DOT) 1.0 month (UMaine)
Collaborated with individual in foreign country	No

Name	Nathan Hill
Program/Project Role	UMaine Research Technician
# Hours worked during reporting period	520
Contribution to Program/Project	Equipment design and fabrication. Production of TDO oil.
Funding support	3 month (DOT) 0 month (UMaine)
Collaborated with individual in foreign country	No

Name	Mubarak Khleewee
Program/Project Role	M.S. Student
# Hours worked during reporting period	520
Contribution to Program/Project	HDO of FAsP oil
Funding support	0 month (DOT) 0 month (UMaine)
Collaborated with individual in foreign country	No

Name	Abdulazeez Khleewee
Program/Project Role	M.S. Student
# Hours worked during reporting period	520
Contribution to Program/Project	HDO of phenol
Funding support	1.05 month (DOT) 0 months (UMaine)
Collaborated with individual in foreign country	No

Name	Raliat Alabi

Program/Project Role	M.S. Student
# Hours worked during reporting period	520
Contribution to Program/Project	High Pressure Pyrolysis
Funding support	6 month (DOT) 0 month (UMaine)
Collaborated with individual in foreign country	No

Name	Karl Olson
Program/Project Role	M.S. Student
# Hours worked during reporting period	520
Contribution to Program/Project	Alternative uses for glycerol
Funding support	6 month (DOT) 0 month (UMaine)
Collaborated with individual in foreign country	No

What other organizations have been involved as partners?
Organization: SeaChange Group LLC (SCG) , Brunswick Maine
Contribution to Project: SCG is providing the Diesel/Glycerin Emulsion fuels for testing in MMA's test engines and marine vessels. They finished their contract on 12/31/2016 to supply glycerin/diesel emulsion fuels and assist with testing at METEL

What other collaborators or contacts been involved?
Nothing to Report

4. IMPACT:
What is the impact on the development of the principal discipline(s) of the program?
Nothing to Report
What is the impact on other disciplines?
Nothing to Report
What is the impact on the development of transportation workforce development?
Nothing to Report
What is the impact on physical, institutional, and information resources at the university or other partner institutions?

Physical resources such as facilities, laboratories, or instruments;
What is the impact on technology transfer? Nothing to Report
What is the impact on society beyond science and technology? Nothing to Report

5.CHANGES/PROBLEMS
Nothing to report

6. SPECIAL REPORTING REQUIREMENTS
Nothing to report