DEFN-14-*[group #]*

PROJECT DEFINITION

APPROVALS

ROLE	NAME	SIGNATURE	DATE
Team Leader	*Katie Leong*		*[04/23/15]*
Advisor	*Prof. McDonell*		*[03/13/15]*
Head Engineer	*Richard Hack*		*[03/13/15]*

[Insert Logo]

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Version: *A*

Engine Test Bed

Revision History

REV	DESCRIPTION	DATE	APPROVED BY
-	Initial Release	*[12/10/14]*	*Vince McDonell*
A	2nd Version with some revisions	*[4/24/15]*	

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1 PROJECT OVERVIEW

1.1 Executive Summary

The Advanced Power and Energy Program (APEP) at the University of California, Irvine has multiple gas turbines that are used for evaluation of how operation on alternative fuels impact system operability and emissions. However, APEP does not have a reciprocating engine for evaluating the impact of alternative fuels. This project was conceived to address this shorting. As a starting point, a defective natural gas Generac engine generator set was donated to us by a contact of our chief engineer, Rich Hack. The engine runs on compressed natural gas but can be modified to run on other alternative gaseous fuels. Once the engine is operating, the focus will be on implementation of measurement tools and verification of the engine/generator's reliable functionality. Completion of the test bed will allow for future monitoring and testing of varying fuel efficiencies, flow requirements and exhaust emissions including $PM_{2.5,}$(particulate matter 2.5 microns or smaller in size emitted by the engine).

The objective of this project is to turn this donation into a full functioning reciprocating combustion engine test bed and to use it to evaluate the impacts of fuel composition on performance. Such a test bed will give APEP the ability to test alternative gaseous fuels in an engine that mimics those of vehicles and generators in use today. The goal is to provide additional knowledge to the ongoing research of the impact of alternative fuels on more common engines. Conventional gaseous fuels (natural gas, propane) as well as alternative gaseous fuels (such as those based upon biomass derived fuels, etc.) are generally accepted as being cleaner fuels with lower greenhouse gas impact. However, there is concern and evidence that these fuels can result in undesirable emissions of larger chain organics (aldehydes, ketones) and can result in unwanted particulate matter emissions ($PM_{2.5)}$.These processes have been studied to some extent with gas turbine engines but little investigation in reciprocating engines has occurred to date. The development of this fuel flexible Otto cycle engine will provide the necessary test bed.

The reason behind testing alternative gas fuels is to see how they respond in the reciprocating engine and analyze how much $PM_{2.5}$ they release into the air. Currently it is favorable to utilize fuels more economically and those with a lower carbon signature and near zero emissions. Although some of the alternative gaseous fuels we will be testing are better with CO and NOx emissions, they might not do well with $PM_{2.5}$ emissions. It is important to consider the presence of fine particles and analyze the fuels based on all emissions to avoid short-term health effects to the public. Exposure to these fine particles can also affect lung function and worsen medical conditions such as asthma and heart disease.

In conducting these tests, there may also be pertinent results that give supporting data for usage of alternative gaseous fuels in other applications than just primarily electricity generation. Since our generator engine is a GM 5.7L V8 automotive engine, we may be able to extrapolate our results as beneficial in vehicular applications for gaseous fuel usage as well. If this were to prove feasible, we would be able to reduce the need for new vehicle types and be able to simply modify current technology to complement a wider variety of fuels.

2 PROJECT DETAIL

2.1 Project Objective(s)

Objective 1 – *Diagnose and Fix Generator Engine*
We received a donated but broken Generac generator set. It is necessary to diagnose and fix the problems with the engine.

Objective 2 – *Design and Implement Measurement Equipment*
Once we have an operating engine, we will begin to assess flow measurement points and designing and manufacturing appropriate flow meters to apply to the system in preparation of testing for the next quarter.

Objective 3 – *Testing and Verification of Test Bed Reliability*
In the third and final phase of the project, we will implement the measurement equipment assembled in the previous quarter. Following this, we will test to be sure that the test bed is functioning properly, in accordance to our expected measurements. Furthermore, we will devise a monitoring system for real-time data collection.

2.2 Scope Details

For the completion of our first objective, we have worked to take apart the generator, clean and assess the components. Before doing too much work to the engine itself, we set off to find any documentation on our specific generator for some guidance on how to diagnose the problems. As of the beginning of the Winter Quarter, we successfully ran the engine on natural gas.
Through the second quarter and the Spring Quarter, we have obtained the estimated flow rates and efficiency of our engine running on the standard natural gas. Currently we are in the process of designing the venturi for coolant flow and air flow. Additionally, we fixed the cooling (fan belt) system for the engine.

2.3 Project Milestones

Milestone Name	Target Date	Comments
Operating Generator Engine	12/12/14	Officially met by Jan 2015
Design and Implementation of Measurement Equipment	3/13/14	IP
Testing and Verification of Test Bed Operation	6/5/14	IP

2.4 Project Team

#	Name	Project Role	Email	Phone	Standing	Units
1	Katie Leong	Team Lead	Katie.a.leong@gmail.com	(310) 418-2693	Senior	3
2	Daniella Lopez	Member	lopezdm1@uci.edu	(562) 832-4696	Senior	2

3	Ivan West	Member	hanagriu@uci.edu	(949) 241-0195	Senior (Exchange)	0
4	Christopher Ferro	Member	ferroc@uci.edu	(626) 872-8925	Senior	3

2.5 Steering Team

#	Name	Title	Steering Role	Email	Phone
1	Vince McDonell	Professor	Advisor	mcdonell@apep.uci.edu	(949)-824-7302 ext. 11121
2	Richard Hack	Head Engineer	Advisor	rlh@apep.uci.edu	(949)-824-7302 ext. 11122

2.6 Project Costs Estimation

Project Expense	Comments	Est. Amount ($)
New Battery	Found existing battery to be dead	$113.39
New Pressure Regulator	Current was missing crucial components	$132.65
New Spark plugs (3)	Team member accidently broke one	$10
New Rotor	No rotor was in the distributor	~$30
Generac Service	In need of professional second opinion	~$600
Battery Switch	To avoid draining battery from constant connection	$44.80
Battery Charger		$103.66
Replacement V-Belt	Fan belt for sheave	$22.67
Oil	Shell Rotella 15W-40 Gallon	$17.28
Fan Belt Shaft Connection Plates		~$37
	Total	*$1,981.45*

2.7 Resource Estimation

Name	Est. Hours	Rate ($/hr)	Est. Total ($)
Project Role (3 Team Members)	32 hrs/wk total	$31/hr (ME median)	$9,920
Steering Role (Advisors) [meeting participation]	2 hrs/wk	$45/hr (Nat'l Avg)	$1,800
Total	*34 hrs/wk*		$11,720

3 Project Risks and Communication

3.1 Risk Mitigation Plan

Risk	Severity	Probability	Mitigation
Unable to fix the oxygen sensor	Medium	Low	Purchase new oxygen sensor
MAF sensor can't be implemented	Low	Medium	Design Venturi

3.2 Communication Plan

Communication Type	Audience	Frequency	Responsibility
Weekly Meetings	Everyone	Every Thursday	Team Lead: Katie Leong
Project Team Meetings	Project Team + Chief Engineer	Every Tuesday and Thursday	Project Roles

4 Additional Project Details

http://www.ucimaeprojects.com/projects/engine-test-bed-development/