SPEC-14-*[group #]*

PROJECT SPECIFICATION

APPROVALS

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Engine Test Bed

Revision History

REV	DESCRIPTION	DATE	APPROVED BY
-	Initial Release	*[12/10/14]*	*Vince McDonell*
A	*2nd Version with some revisions*	*[04/23/15]*	*[an approver]*

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1 PROJECT SPECIFICATION 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 PM2.5,(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 (PM2.5).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 PM2.5 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 PM2.5 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 Product Description

The goal of this project is to produce a reciprocating engine test bed by the end of the academic year. In order to do so, we require a suitable, functioning reciprocating engine. We will need to determine measuring techniques for the engine flow requirements and exhaust, as well as complementary equipment to allow the engine to run on various different gaseous fuels. This testing will be geared towards determining the effects of different fuels on performance and emissions for the engine.

2.1 Product Context

The reciprocating engine test bed was originally intended to be fitted with a generator to generate electric power with the work being done by the engine from the various fuels. However, since we managed to remedy the donated Generac generator engine, we only need to integrate measurement tools directly to the system. These measurement tools will be designed to allow us to document and observe fuel/air flow rates, temperatures and exhaust emissions.

2.2 User Characteristics

Currently the test bed is not completed and therefore the user characteristics listed below are preliminary assumptions.

i. Know all safety precautions necessary for operation of the engine test bed
ii. Know the operation of the engine test bed and criteria for fuels used
iii. Know how the measurement equipment works and how to assess the results
iv. Know how to carry out data collection

2.3 Assumptions

i. Now that the engine is working, our revised assumptions include:
    a. The generator component is functional when connected to a load bank
    b. The current load bank in our possession will work when connected
    c. The measurement equipment is compatible with LabView program for data collection

2.4 Constraints

i. Load Bank information (lack of manual)
ii. Generator system information (lack of service manual)
iii. Time (due to purchases, troubleshooting, etc.)
iv. Alternative gaseous fuel compatibility
v. Venturi/flow meter designs (for manufacturing)
vi. Reliability of engine for test bed

2.5 Dependencies

In order to complete the engine test bed, we need to ensure our measurement equipment is accurate and the engine provides a reliable source of data.

3 Requirements

[This section lists the critical parameters, specifications, and requirements for the product (research) you are designing. List all requirements in order or priority. This section is constantly evolving and is subject to change as the project progresses and as more information is learned. As details are added, removed, or modified, remember to update the revision level of this document.]

- Generator aspect of the system operates well
- Engine runs for an extended period of time without complications
- Engine runs properly and accurately serves its purpose
- Assess varying conditions for different fuels
- Design and manufacture of venturi meters

3.1 Functional and Performance Requirements

These requirements will be contingent on the standards compliance in addition to having the engine (and generator system) fully operational.

3.2 User Requirements

i. Decent knowledge base on topics of thermodynamics, fluid mechanics, combustion chemistry, and problem solving
ii. Understanding of the use and maintenance of the engine test bed
iii. Fuel and condition requirements of the engine when performing tests

Much of the basic information on the generator can be found in the Owner's manual. This PDF manual contains many schematics and diagrams that are helpful, and also has troubleshooting advice.

3.3 Maintenance Requirements

Just like a normal Chevy engine car would be taken to the shop for maintenance, it should be given an oil check/change, air filter change, engine coolant check, battery maintenance, and serpentine belt idler bearing check every 1000 hours.

3.4 Standards Compliance

EPA emissions standards are typically designated based on the DG system and we can designate these after further testing

3.5 Deleted or Deferred Requirements

The requirements have been set for every quarter. Some goals from this fall quarter that are requirements for the next quarter, have been deferred due to weather, shipping time, and poster presentation preparation.

4 Appendix

4.1 Definitions, Acronyms, and Abbreviations

[List any definitions, acronyms, and abbreviations here.]

4.2 References

[List any references here.]

PDF of the owner's manual of the power systems
http://www.generac.com/service-support/product-support-lookup/product-manuals?modelNo=0041651