FAMU-FSU COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

SENIOR DESIGN I – EML 4551

PROJECT PLANS AND PRODUCT SPECIFICATIONS

Submission Date: 10/11/2013

MECHANICAL DUMP VALVE – TEAM 3

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1.0 Problem Statement

There is a need for mechanically monitoring the fuel pressure in a highly pressurized common rail diesel engine, as well as relieving the fuel in case of over pressurization. The means of achieving this should be inexpensive and the mechanical component should be lightweight and easy to install on an engine to allow for maintenance as well as easy replacement.

2.0 Background

Cummins Inc Fuel Systems XPI (extreme pressure injection) department currently has an MDV (mechanical dump valve) operating in all their common rails as a mean of safely relieving the pressure in the rail in case of over pressurization. This valve is dormant while the rail pressure is within the limits desired for the engine and while the pressure sensor is able to regulate the fuel flow into the rail. In case of a failure of the pressure sensor the ECM (engine control module) has no way of telling the IMV (inlet metering valve) how much fuel it needs to allow to get pumped into the common rail, in which case over pressurization could happen. As a safety back up, a purely mechanical valve is installed on the common rail. The function of this valve is to allow the fuel out of the rail and therefore reduce the pressure within it, which ultimately avoids thermal events. The valve would then take over the system and act as a mechanical controller to regulate the amount of fuel in the common rail. The fuel the valve is relieving goes back into the fuel storage through a line to be reused.

This MDV is durable, as well as reusable. The part is designed to reset once the engine is turned off. After the engine is turned back on, if the pressure sensor continues to fail the valve will once again begin to operate until the driver can get to a location where the sensor can be replaced. If the sensor is in working status the valve will be once again dormant until it is needed. The engineers at Cummins FS XPI wish to obtain a valve that continues to do these tasks but it is also more lightweight, more inexpensive, and with improved functions.

3.0 Objective

The main objective of this project is to design, test and prototype a working valve that achieves the requirements stated in the confidential technical profile provided by Cummins FS XPI.

4.0 Fall 2013 Goals

- Complete a full materials analysis, cost analysis, patents analysis and other general background research needed.
- Fully design a mechanical dump valve that meets the specifications on the technical profile. This includes thermal-fluids analysis and CAD drawings.
- Submit prints to Cummins FS XPI for machining and then building the prototype. (Testing will take place on spring 2014).

5.0 Methodology

The team in conjunction with the engineers at Cummins FS XPI has devised a plan of action to achieve the previously mentioned goals. The team is currently researching patent work from other companies that have MDVs so that no issues arise with a design. Once the patent study is complete, a complete materials and cost analysis research will be performed. This research will determine which materials are available to be used at a low cost. After the general background research and analysis is completed the design on CAD and thermo-fluids analysis will begin. Given that various ideas might arise at this point, a decision matrix and failure modes analysis will be completed on the designs that are being worked on, which will ultimately aid us in the selection of a model. The selected design will be reviewed once again and then submitted to Cummins FS XPI for machining and assembly will occur shortly after. During this period there will be constant communication between the faculty advisor Dr. Lou Cattafesta, the Cummins sponsor Christopher Besore, and the team to ensure the project is on track.

6.0 Expected Results

As mentioned in section 3 of this report, the objective of this project is to design, prototype and test a working MDV. The Spring 2014 semester will be employed for testing of the valve and optimizing if time allows it. Cummins FS XPI wishes to make this valve a profitable component, which stresses the need of meeting all requirements on the confidential technical profile. At the end of the year 2013-2014 school year, the valve should be fully working and ready to be validated at Cummins Inc so it can be installed on an engine.

7.0 Constraints

- Time: There are deadlines to be met at the end of this semester, including the finished drawings submitted to Cummins FS XPI for machining.
- Budget: Cummins will provide $2000. The cost of materials needs to be assessed throughout the duration of the project given that Cummins will be handling machining.
- Confidentiality Agreement: Various issues arise with the confidentiality of the material in this project, this affects presentations and information sharing on the team's website.

8.0 Deliverables:

For the remainder of the semester this team has several tasks and reports to work on and present. The best way to schedule this project's development plan is by creating a Gantt chart. The chart can be seen in the appendix section as Table 1, it shows a clear schedule and plan for the deadlines to be met in the matter of assignments and time they are due. The chart is color-coded, tasks shown in gray have been completed, and the red are tasks that are to be completed in the future. This method of scheduling allows for proper prioritizing of tasks and a more efficient workflow. All the deliverables are listed in the chart; the team has also prepared task assignments for these deliverables which will be discussed the next section.

9.0 Assigning Tasks

In order to work efficiently through the flow of the Gantt chart, the team has agreed upon specific tasks that each team member will take on. From the Code of Conduct the general task assignments are as follows:

Team Leader: Dianelis Sonora Lopez

The team leader is responsible for planning, managing, organizing and developing tasks for the project. This person will plan, develop and organize all the team meetings, tasks, and delivery schedule for the project. The leader is responsible for keeping a record of all meeting and biweekly reports as well as communicating the minutes of the meetings to the team mentor and sponsor. Dianelis is also responsible for communication within the team, ensuring all views are respected, responding emails, and making sure all the team members get a fair chance at communicating their ideas. She will also be responsible for delegating tasks within the team and the progress of the project. Dianelis must always ensure the team's and project's needs are being answered and completed successfully. The team leader is also responsible for reviewing all documents before they are submitted.

Webmaster: Samuel Botero

The team's webmaster takes charge of making sure the website is up to date with all the available deliverables and documents. He takes the responsibility of creating a professional and unique website, getting the website online, uploading the documents and updating the information displayed. Any problems encountered with the website shall be discussed with the team leader. All changes made to the website shall be previously discussed with the team members.

Team Financial Manager: Alexander Atchison

The team financial manager is responsible for managing the team's budget. He will ensure the team stays within budget at all times and makes no irresponsible expenses. Alexander is responsible for communicating the current team finances in staff meetings. He is also responsible for reaching out to our sponsor, mentor and advisor whenever there is the need of using the budget. He is also responsible for expense reports and any travel expenses the team may have.

As per specific deliverables, the tasks are decided as each deliverable and presentations dates arrive. For general research Alexander Atchison is in charge of researching cost of previous valves designs, which includes cost for parts, manufacturing, testing, etc. He will be contacting the sponsor to acquire this information. Samuel Botero will be researching and analyzing patents from other companies, he will be using class resources that he has acquired the previous semesters to perform this research. Dianelis Sonora Lopez will be researching current valve materials and acquiring information from the sponsor. The team will also be requesting mechanical and mathematical models for the current Cummins valve that has failed as well as data for working valves. The requested information will aid the team in creating an appropriate design while steering clear from current issues. As a team, there is also current design and modeling tasks that are to be worked on together.

Currently, Alexander Atchison is working on preparing the team's visit to Cummins Fuel Systems Plant during October 31st, 2013. Dianelis Sonora Lopez has prepared the itinerary in conjunction with the sponsor.

10.0 Product Specifications

Due to the Non-disclosure agreement with the sponsor, the information pertaining this section cannot be fully disclosed therefore range values were given. The following design and performance specifications are ranges in which the target values for this design fall within.

10.1 Design Specifications

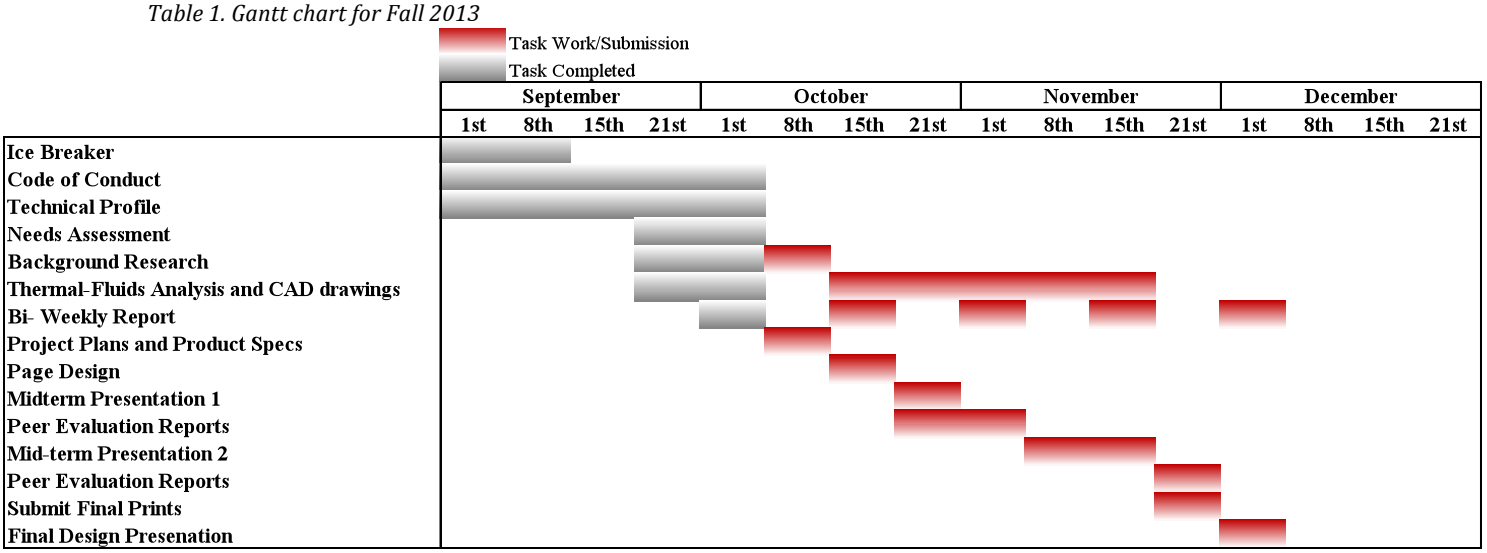
External Connection:	M20 x 1.5-6g threads
Internal Drain Connection:	M14 x 1.5-6g threads
Length:	30 – 60 mm
Sealing Pressure:	4000 Bar

10.1 Performance Specifications

Opening Pressure:	2400 – 2900 Bar
Limp Home Pressure Range:	200 – 1100 Bar between 0.15 L/min – 4.5 L/min flow rates
Minimum Limp Home Time:	Unlimited.
Temperature Fluctuations:	100 – 200 ˚C

Appendix

Table 1. Gantt chart for Fall 2013



References

1. Team 3 Mechanical Dump Valve Code of Conduct.
2. Team 3 Mechanical Dump Valve Needs Assessment.
3. Team 3 Mechanical Dump Valve Technical Profile.