TEAM 3 : MECHANICAL DUMP VALVE (MDV)

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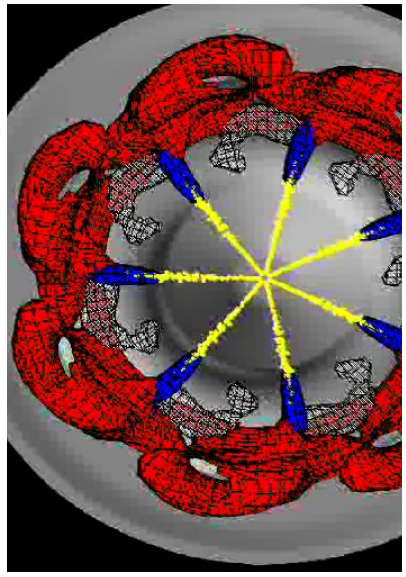
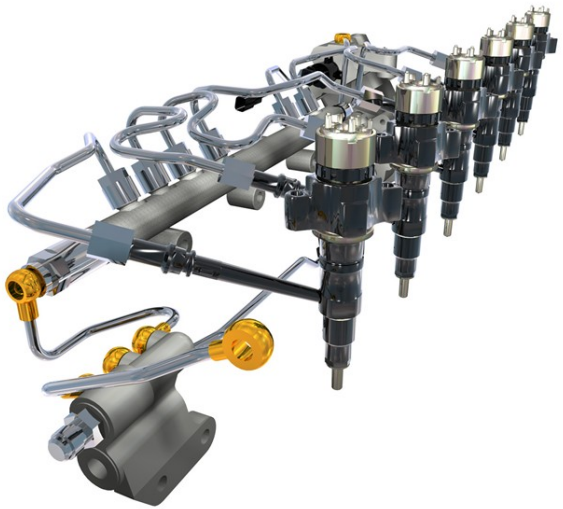
DATE : October 24th , 2013





OUTLINE

- Problem Statement & Objective
- Background
- Non Disclosure Agreement
- Product Specifications (Technical Profile)
- Design Concepts (1, 2, 3)
  - Detailed Concept Review & Evaluation
- Challenges and Risks
- Relevant Information
- Future Plans
- Gantt Chart
- Summary
- References
- Q&A

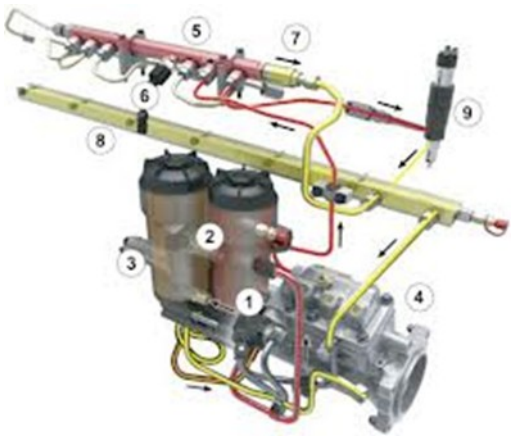


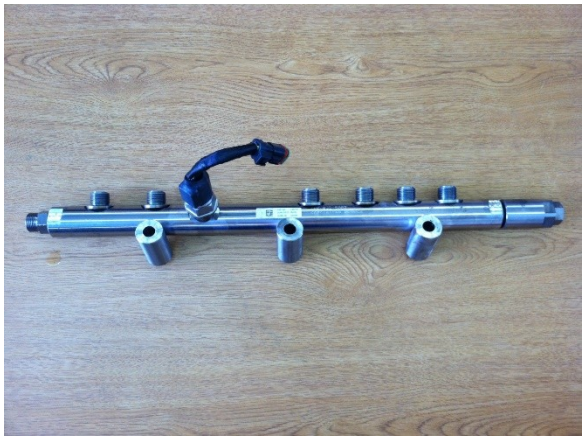
Problem Statement & Objective

- There is a need for mechanically controlling 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.
- To design a MDV that meets Cummins FS XPI Confidential Technical Profile.

Background

- Common Rail Overview
- Fuel Systems XPI (Extreme Pressure Injection)
- MDV Overview
- Current Cummins MDV issues, data availability



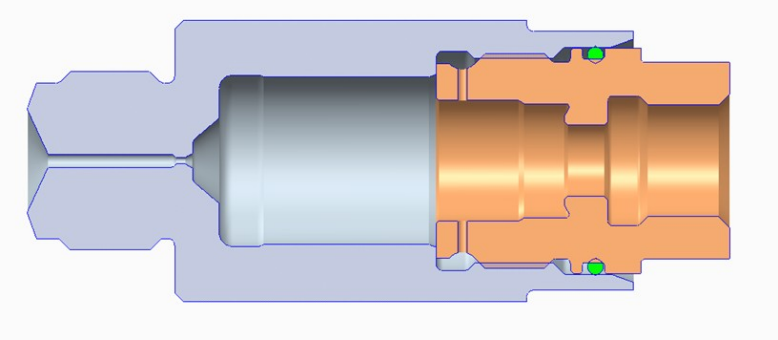


Non Disclosure Agreement

- Product potential for patenting and Competitors
- Intellectual Property
- College of Engineering specific NDA
- Student specific NDA
- Information disclosed in presentations and reports

Product Specifications

- 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: 1.5 times operating pressure
  - Cost: <$26.00 per valve (Including man hours)



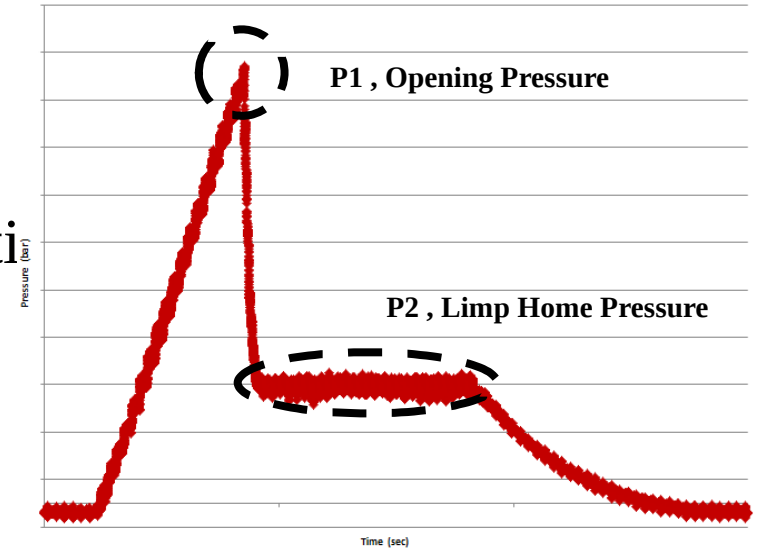
Product Specifications

- 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.

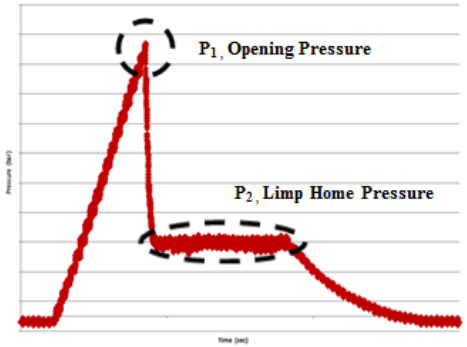
  - Temperature Fluctuati

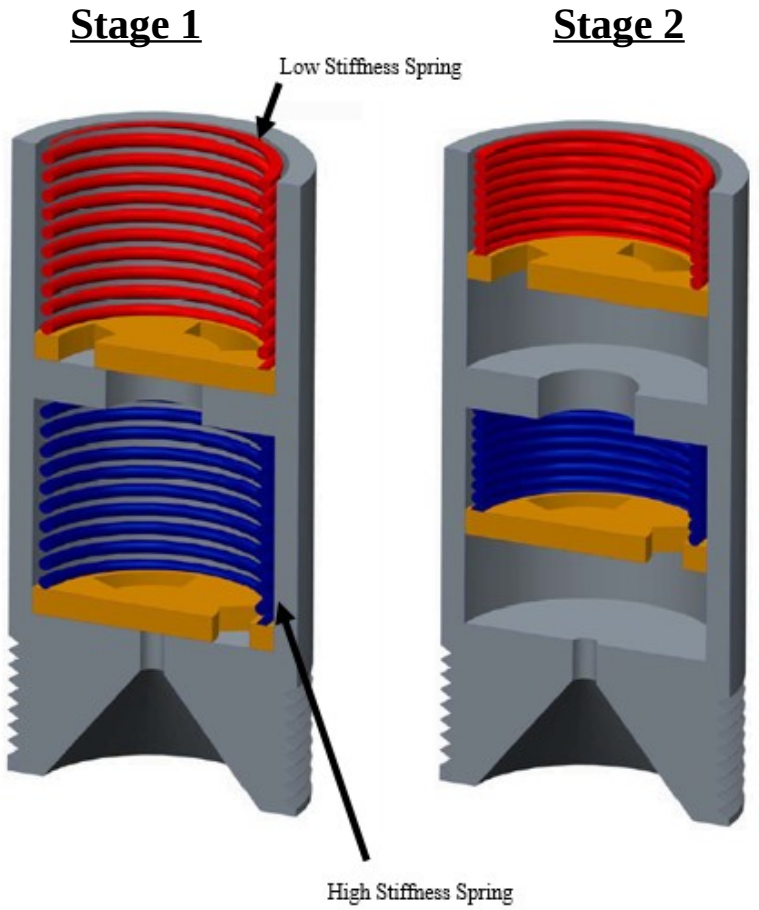
100 – 200 °C



Design Concept S

- 2-stage spring system
- At peak pressure High stiffness-spring compresses (stage 2).
- Lower stiffness spring will compress as soon as fluid flows in lower compartment.
- High stiffness spring stays open as fluid flows in and low stiffness will keep it at the required steady state.

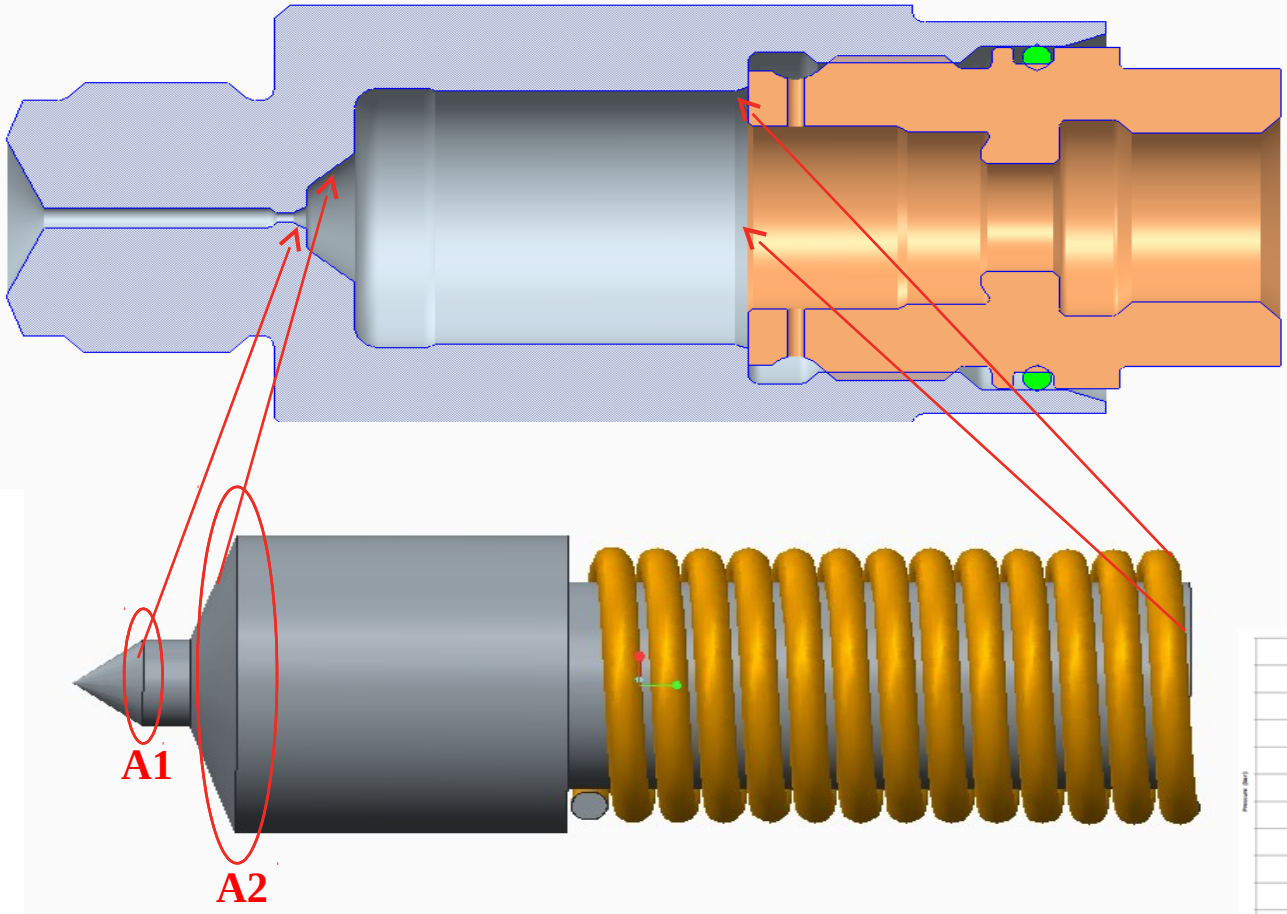




Design Concept S

Pros	Cons
Easy to manufacture	If fluid pressure goes lower than the “limp home pressure” lower plunger closes.
Easy to assemble	May not work appropriately with required response.
Low Cost	Harder calculations as we dealing with a 2 spring systems

Design Concept D



Initial Pressure Force:

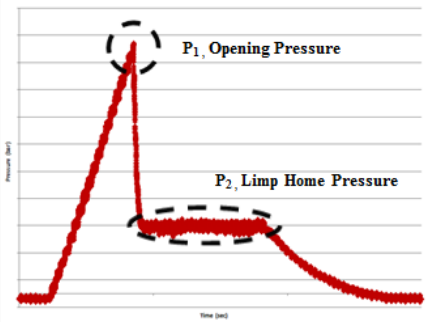
F1 = A1 P1

For Opening Conditions:

F1 = K x

Limp Home Conditions:

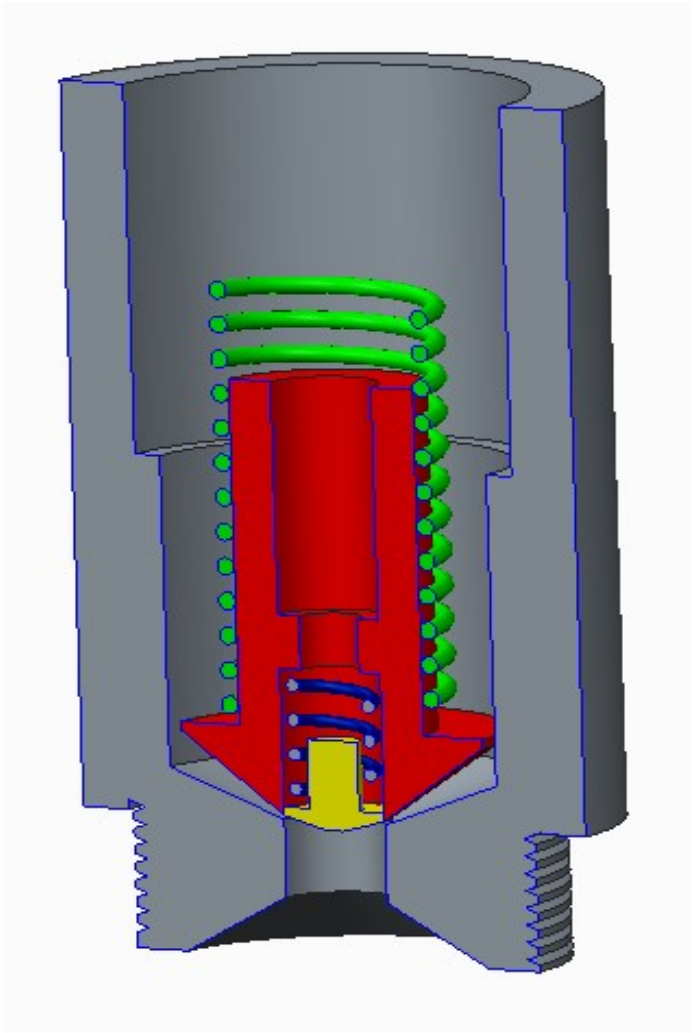
F2 = A2 P2



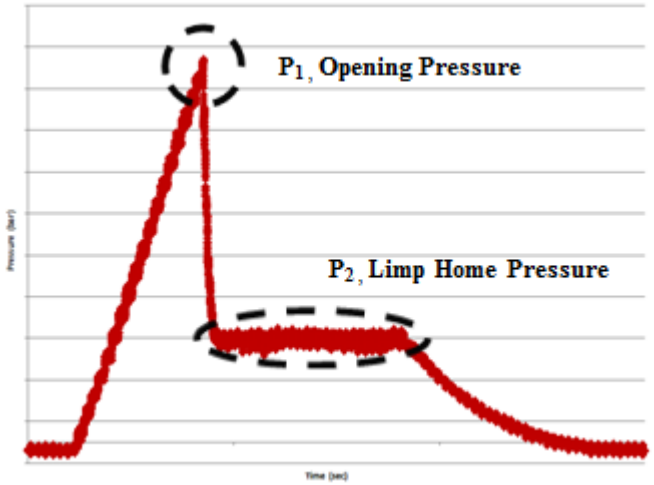
Design Concept D

Pros	Cons
Easy to machine	Material restrictions for plunger due to high pressures
Few Components	Impact - Wear
Low Cost	Plunger – High pressure seat beating could damage sealing surface creating a leak
Simple design could reduce modes of failure	

Design Concept A



- 2 plunger and 2 spring mechanical dump valve design
- Green Spring with a lower spring constant (k2) than Blue Spring (k1)



Design Concept A

Pros	Cons
Multiple Springs and plungers makes it easy to regulate the pressure.	Complex Design
	Expensive
	More Parts to Fail

Challenges and Risks

- Each design has Cons
- Cost must be kept < $26.00
- Technical Profile Constraints & Specifications
- Material hardness and wear resistance
- Consider high temperatures and vibration within the engine
- Upcoming meeting at FSP Columbus, IN will most likely modify current concepts and calculations

Relevant Information

- Current MDV Materials:

  Body: 4140

  Hardness:43-47 HRc

  Lower Plunger, A2 Tool Steel

  Hardness: 58-62 HRc

  2nd stage plunger, 52100

  Hardness: 60-64 HRc

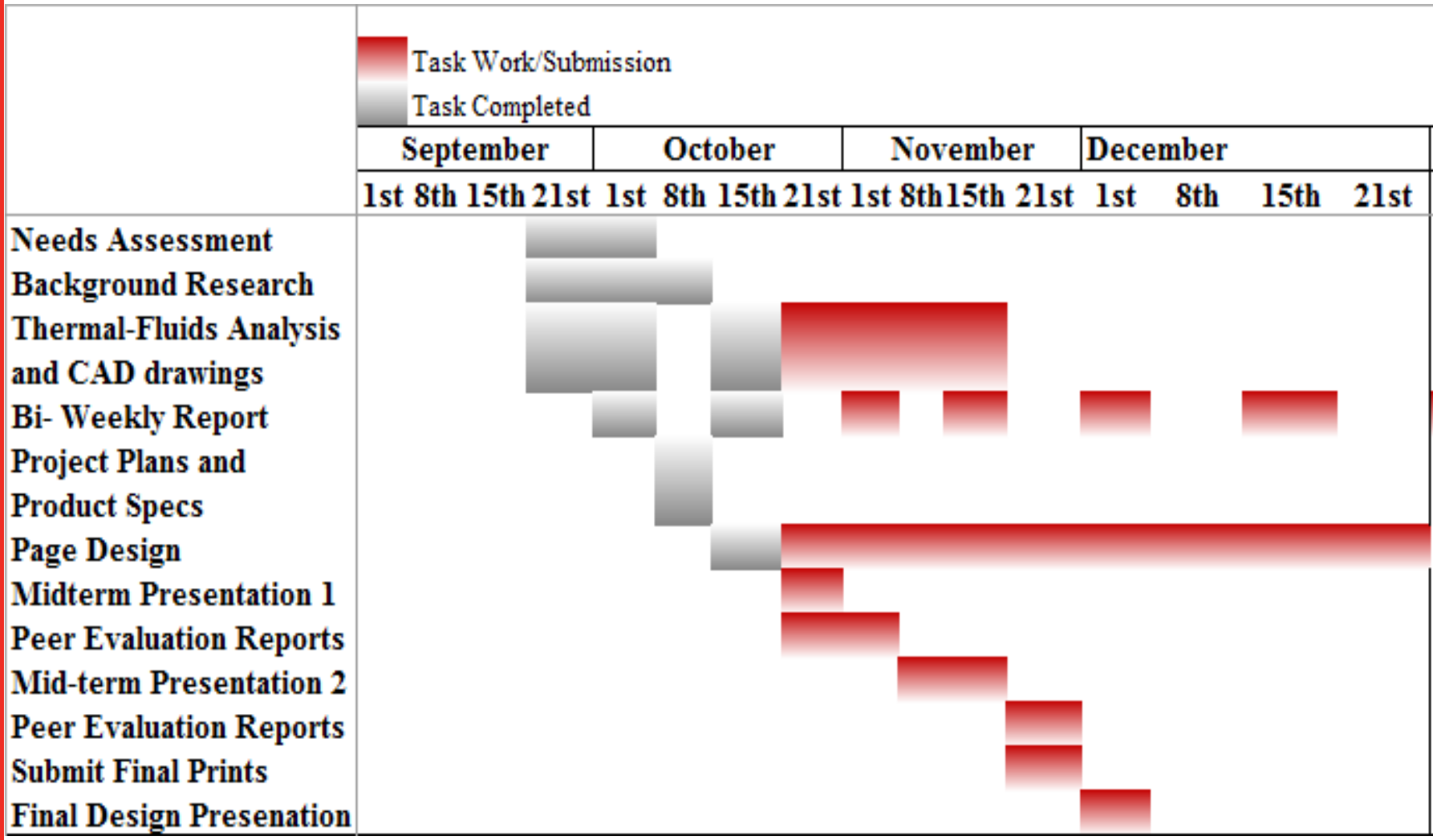
  Retainer, 4140

  Hardness: Not an issue

Future Plans

- A Complete a full materials analysis, cost analysis, patents analysis and other general background research needed has been finalized.
- Finalize ideation and concepts phase after meeting at FSP Columbus, IN.
- Full design of a concept 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).

Gantt Chart


Task Work/Submission
Task Completed
September
October
November
December
1st 8th 15th 21st 1st 8th 15th 21st 1st 8th 15th 21st 1st 8th 15th 21st
Needs Assessment
Background Research
Thermal-Fluids Analysis and CAD drawings
Bi- Weekly Report
Project Plans and Product Specs
Page Design
Midterm Presentation 1
Peer Evaluation Reports
Mid-term Presentation 2
Peer Evaluation Reports
Submit Final Prints
Final Design Presenation

Summary

- Problem Statement and the need of creating an affordable MDV
- Non Disclosure Agreement
- Product Specifications
- Design Concepts (1, 2, 3)
- Challenges, Risks, Relevant Information
- Future Plans and Gantt Chart

References

- http://www.motoringmatters.com.au/news/cummins-announces-new-global-heavy-duty-engine-platform
- www.dieselnet.com
- www.cummins.com

Questions… Comments?