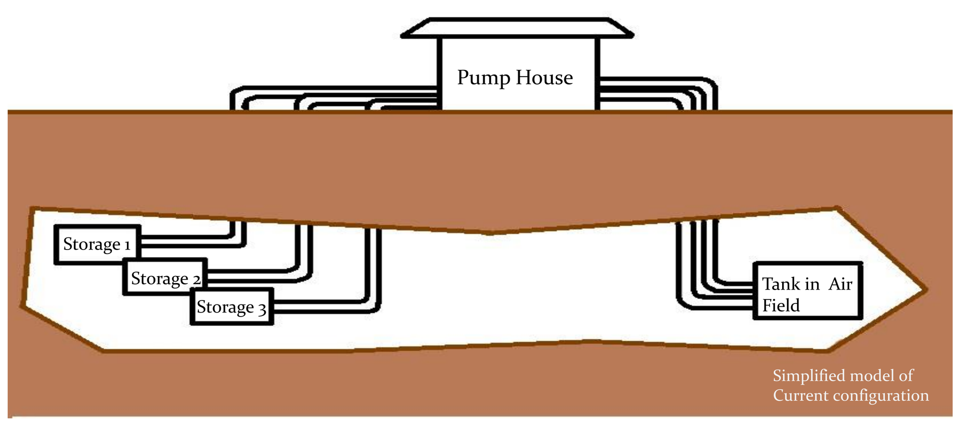
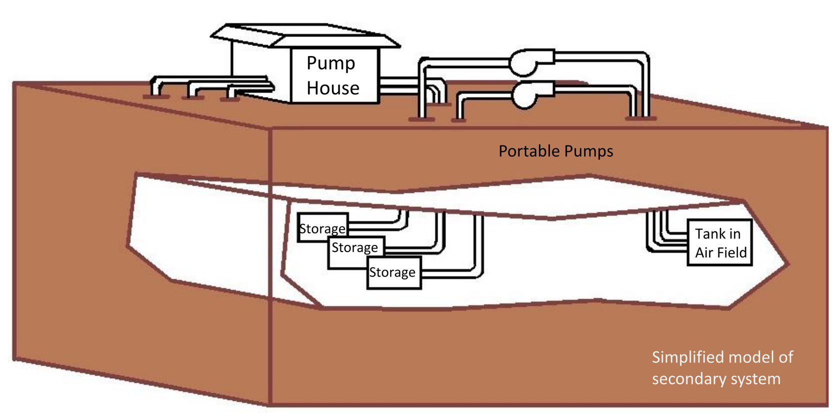
Increasing the Resiliency of Navy Fuel Pipelines

Sara Carmona, Andres Coronel, Rafael Gopar
Graduate Student Mentor: Elyce Bayat, UCSB Mechanical Engineering
Navy Mentor: Galen Marks, NAVFAC EXWC, Public Works Department

The Current Design & Our Objective

In many locations the U.S Navy receives, stores and transports jet fuel to Air Force Bases utilizing underground pipelines. The project location's infrastructure includes three low pressure pipelines that run from storage tanks to a fixed pump house where the fuel is then transferred to the Air Force Base through two high pressure pipelines. The most vital section is the pump house and if it became non-operational, the transportation of fuel would be disrupted. To maintain constant fuel supply, our team's objective was to design a backup piping system consisting of portable pumps and preinstalled connections to bypass the pump house.





Design Constraints and Requirements

- Connections of different size pipes (e.g. 14 in. to 6 in. diameter)
- Stationary Pipeline System must be underground
- Avoid use of welding on portable section
- Pressure transition from 150 to 1000 PSI
- Must be able to transport 1600 GPM(Gallons Per Minute)

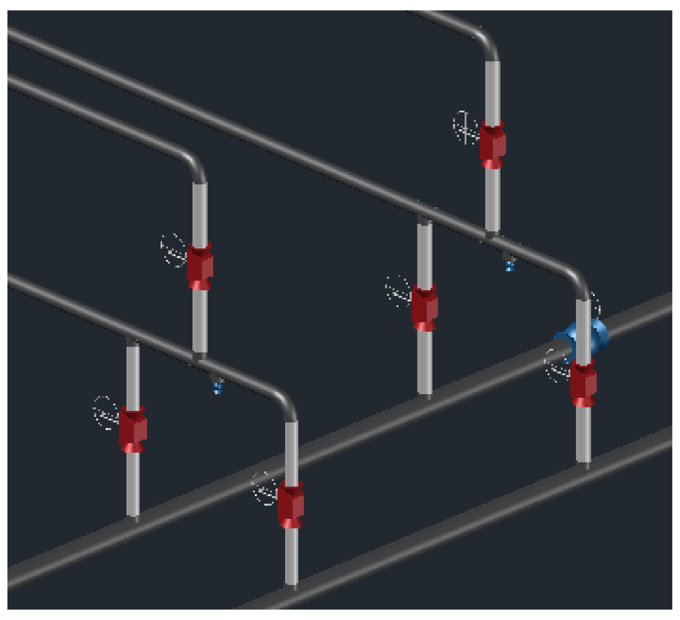
Comparing Already Existing Piping Systems

	Time of Construction and Repair	Applicability to other systems	Portability	High Pressure ($\geq$ 1000 PSI)
Gathering (Non-domestic gas line)	✗	✗	✗	✗
Transportation (oil line across states)	✗	✗	✗	✓
Distribution (domestic gas line)	✗	✗	✗	✗

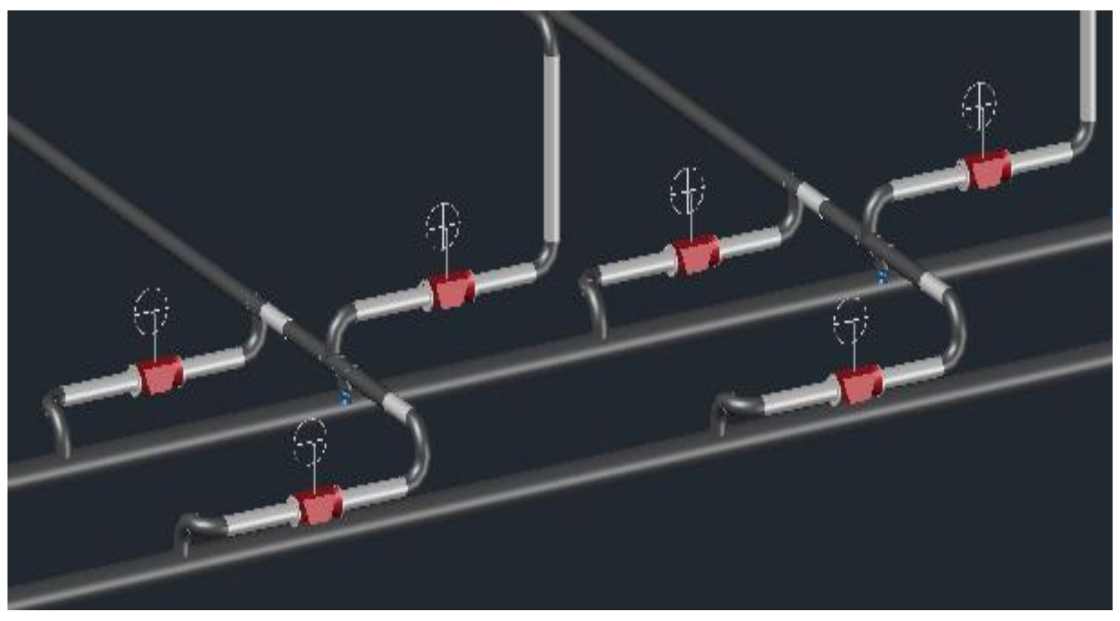
✗ Does Not Meet Expectation ✓ Meets Expectation

Analysis

In order to keep fuel flowing at the desired flow rate, a certain pressure is required to drive the flow. Therefore, we analyzed the system using fluid mechanics principles to ensure that all sections had the appropriate pressure drop for desired flowrate. This analysis guided design changes, including reorienting the valves to be horizontally mounted, which allowed for a decrease in pressure drop.



Initial Valve Orientation

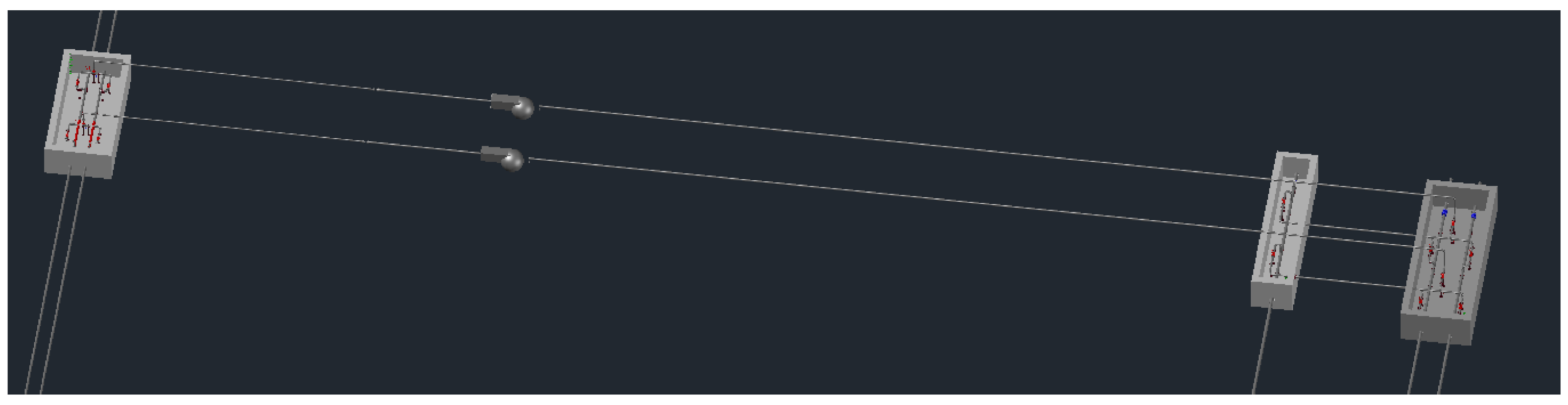


Redesigned Valve Orientation

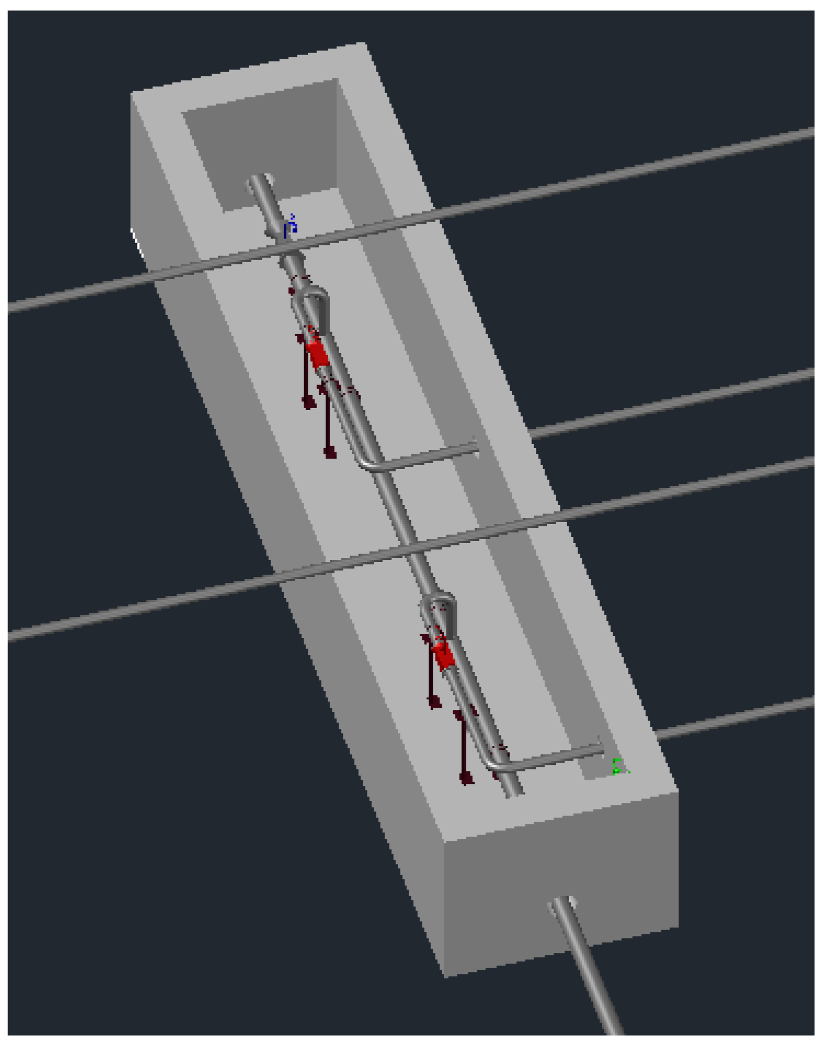
Key advantages of Proposed Design

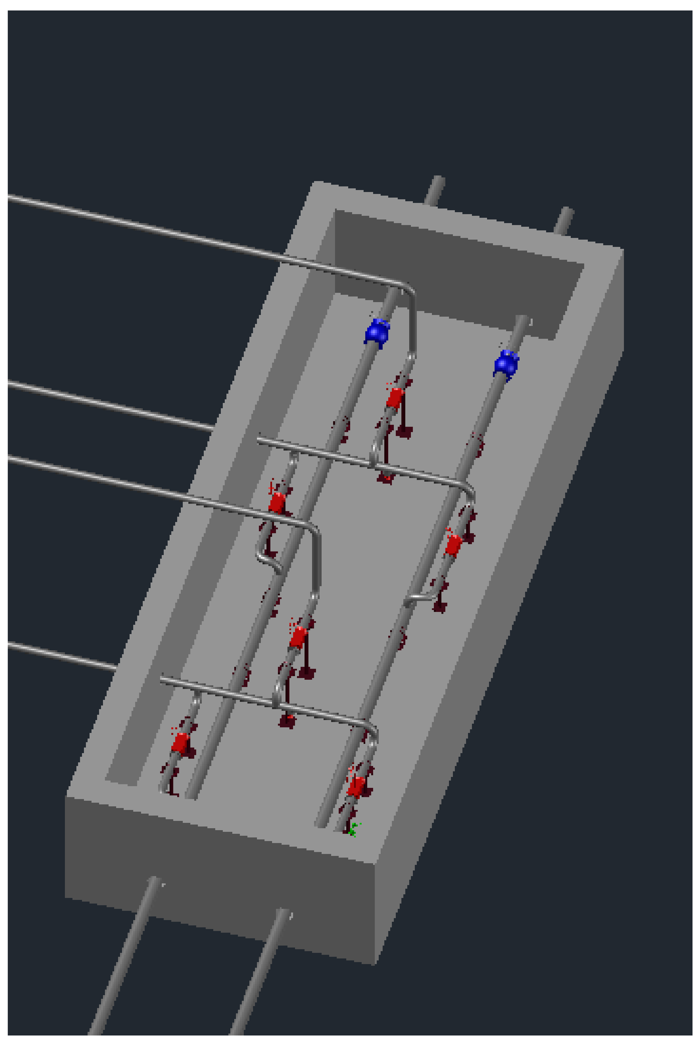
- Allows for connection of different pipe sizes
- Permanent portion underground whereas portable portion is above ground
- Rapid and simple assembly of sections
- System can withstand and achieve the pressure transition of 1000 PSI

Full System

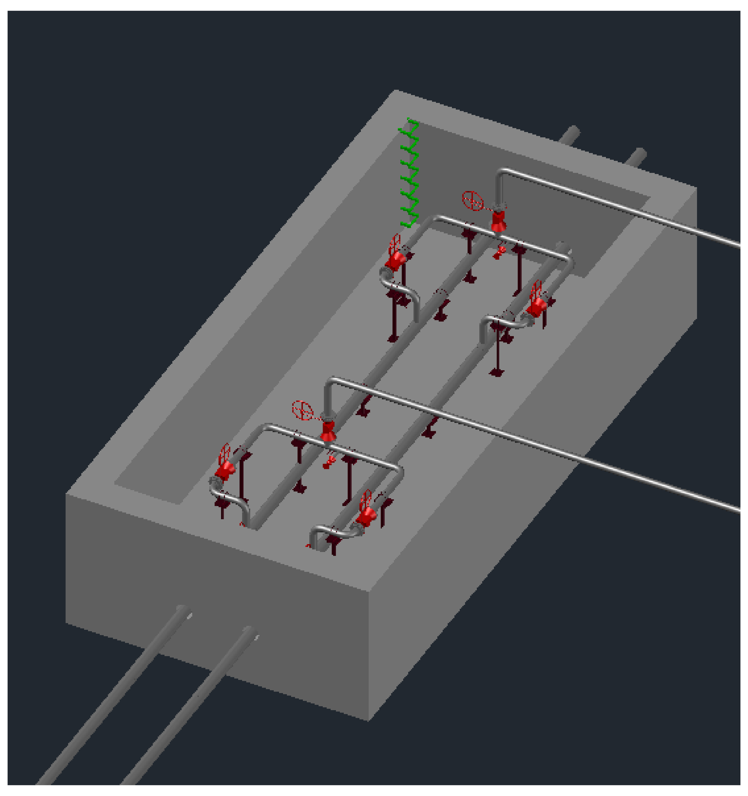


Low Pressure System





High Pressure System



References

- *"Mechanical Engineering Reference Manual for the PE Exam"*, Michael R. Lindeburg, PE 13th Edition, Professional Publications, Inc., 2013
- "*Fundamentals of Fluid Mechanics*", Bruce R. Munson, 7th Edition, Wiley, 2012
- BPS Supply Group, 2018, http://www.bpssg.com/
- Cameron- Schlumberger, 2018, http://www.products.slb.com/

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