Skidmore Air Vent

Understanding Vent Properties to Propose Redesign Solutions

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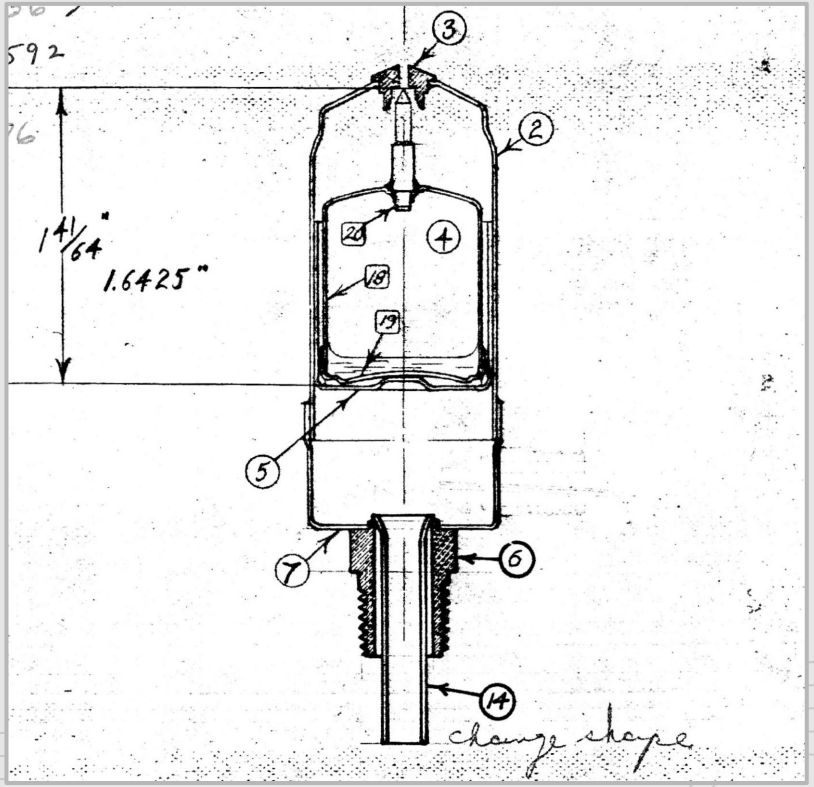
Introduction

- Skidmore Pump is a company that manufactures air vents as a part of their Main Vent production line
- Air vents are a vital part of any steam distribution system, as they are able to vent out air in the midst of a steady flow of steam

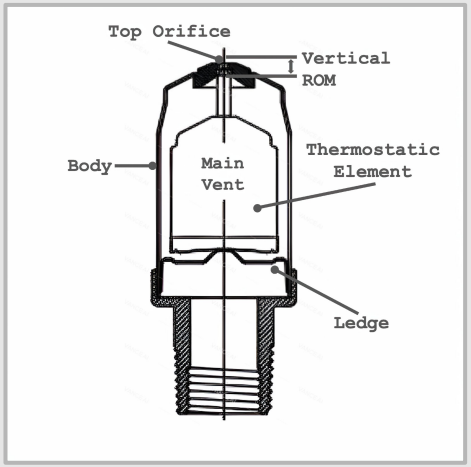


Introduction

Vent Composition:

- Outer Body
- Thermostatic Element
- Ledge
- Threaded Bottom

Main Vent #35 #75 and #77



Labeling of parts

Physical construction

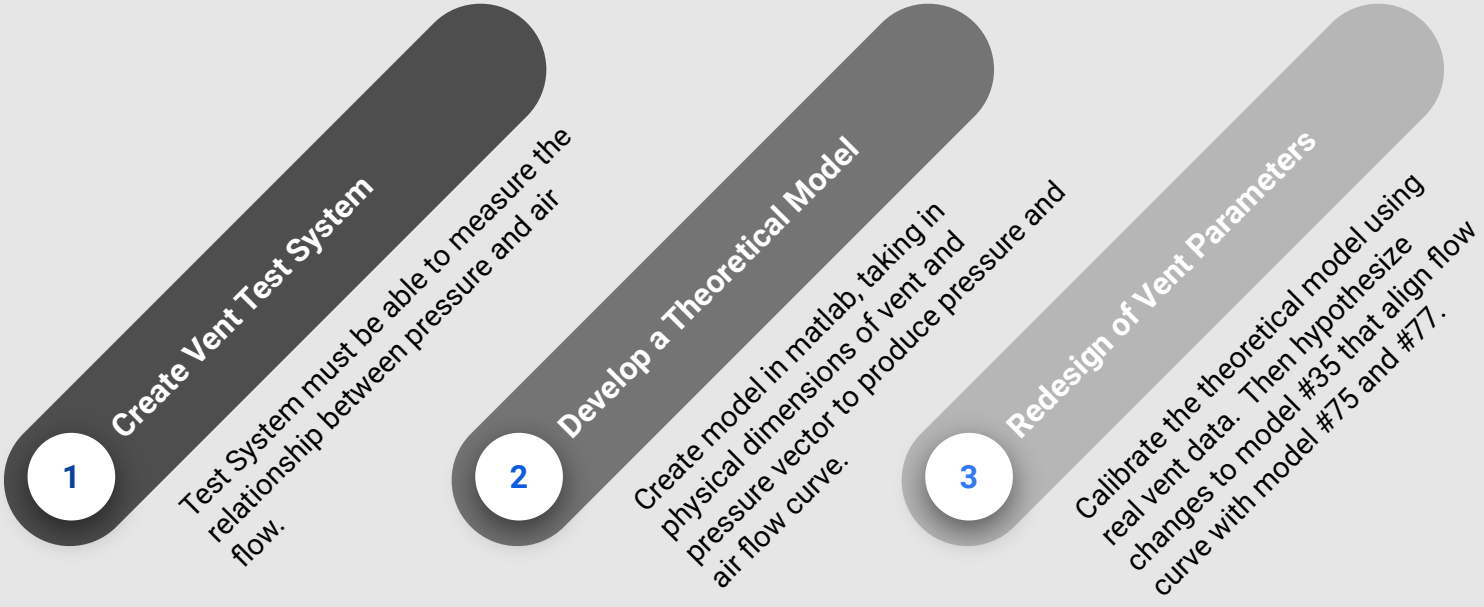
Problem to be Solved

- Parts for Main Vent #75 and #77 will be phased out due to high unprecedented tooling and manufacturing costs
- Tasked to determine a viable design remodeling of Main Vent #35 to obtain the performance characteristics of Main Vent #75 and #77

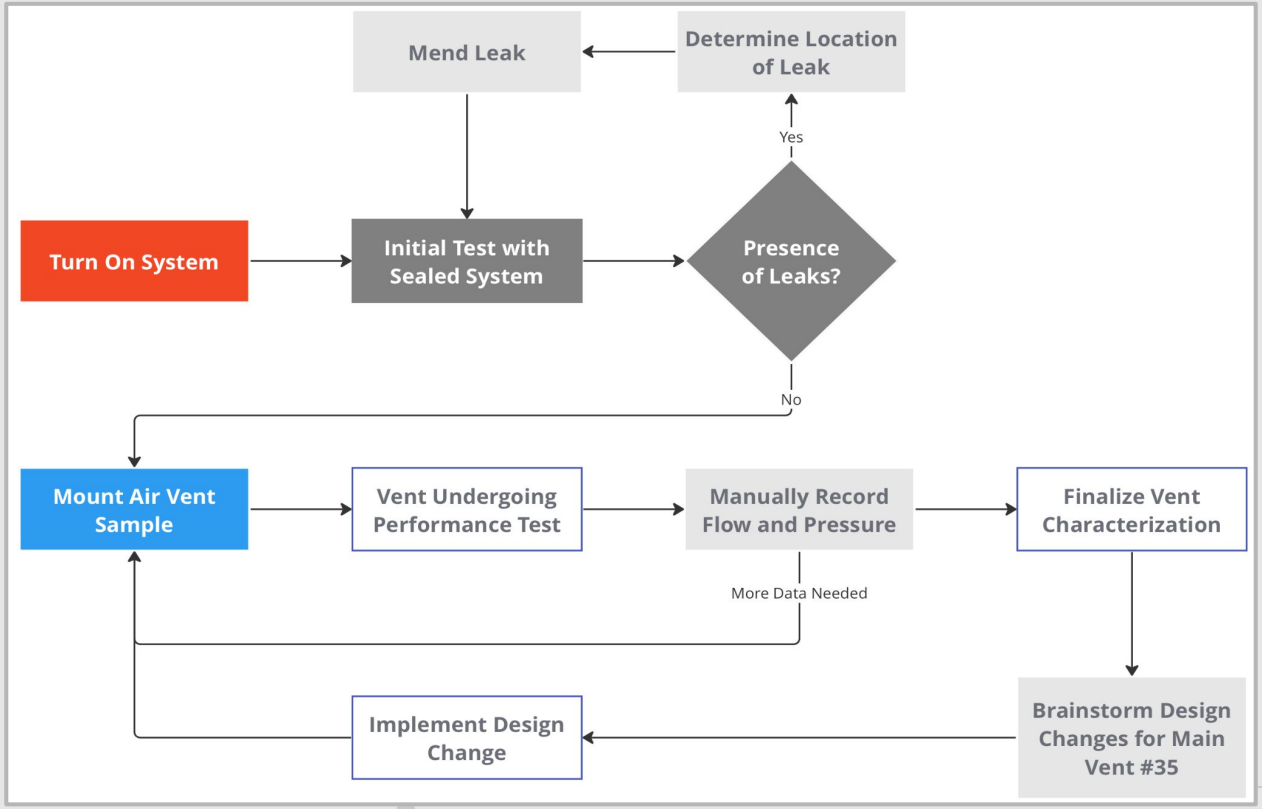
Vision and Goals

- Present to Skidmore Pump two sets of design modifications to be done to Main Vent #35 that match the performance characteristics of Main Vent #75 and #77
- Creation of a test fixture to reliably measure air vent characteristics
- Obtain a comprehensive knowledge of general performance characteristics for each model

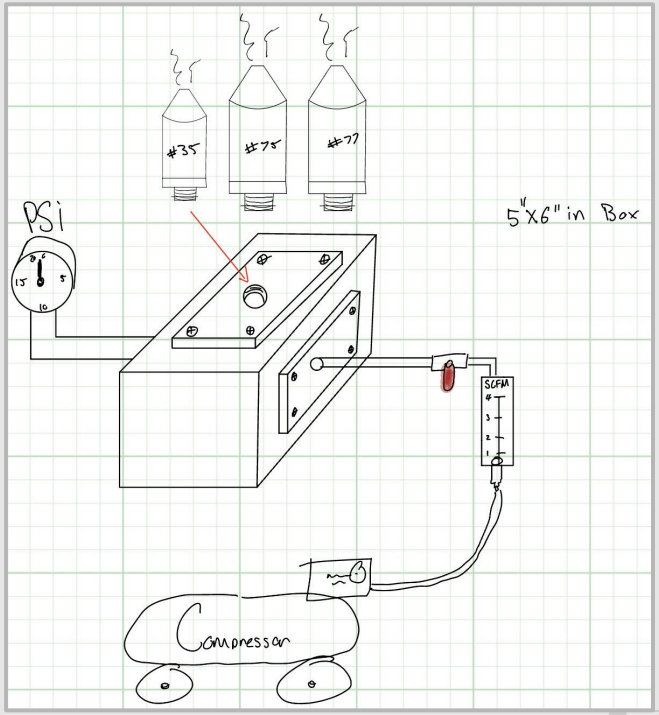
Decision Making

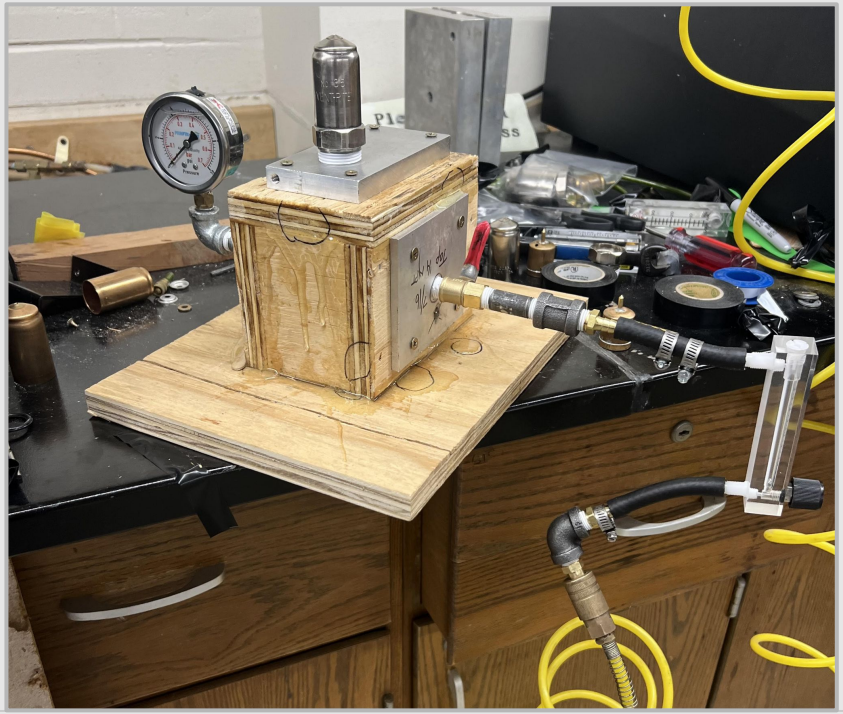


Operational Flow Chart



Experimental Model

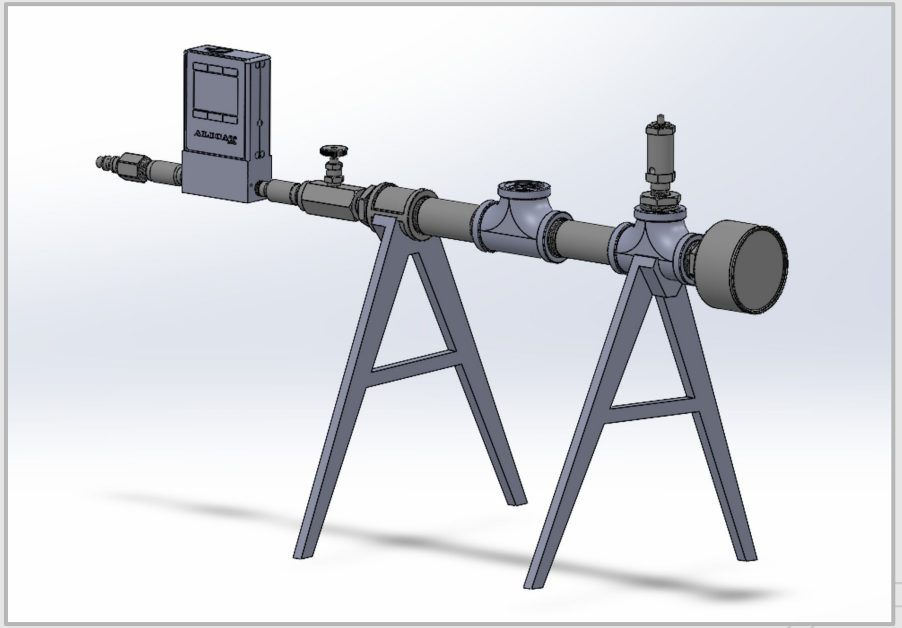




Test Fixture Requirements

Scale	200g x 0.01g
Flow Meter	0 - 90 SCFH
Pressure Gauge	0 - 10 PSI
Vent Pipe Thread	3 / 4 inch National Pipe Thread
Accuracy of Measurement	10%

Mechanical Design

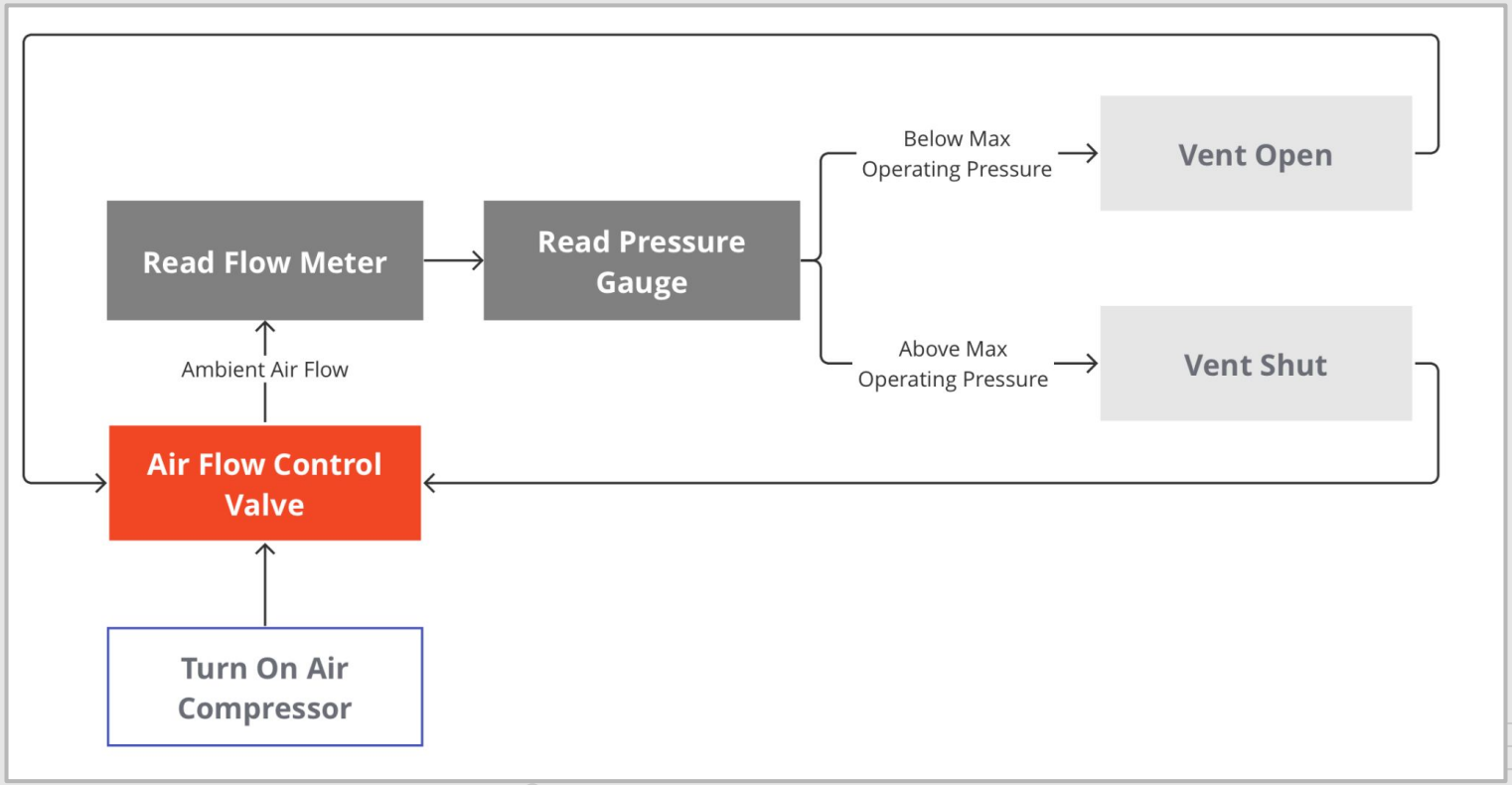


PART #	Description	Size	Quantity
SKIDMORE https://www.mcmaster.com/44615K455/	3/4 pipe	3in Length ¾ male thread both ends	2
SKIDMORE https://www.mcmaster.com/4638K124/	Pipe T Connectors	¾ Female on all 3 sides.	2
SKIDMORE https://www.mcmaster.com/4464K268/	Reducer for Pressure Gauge	¾ Female ¼ Female	1
SKIDMORE https://www.mcmaster.com/5498T12/	Low-Pressure Iron Pipe Fitting	¾ female ¾ female	1
SKIDMORE https://www.mcmaster.com/4549K931/	Standard-Wall Galvanized Steel Threaded Pipe Nipple	¼ male ¼ male	1
4026K37	High-Accuracy Low-Pressure Gauge (BUY! McMaster)	1/4 NPT Male 0-10 PSI	1
4995K13	Precision Flow-Adjustment Valve (BUY! McMaster)	1/4 NPTF FEMALE Both ends	
ALICAT	Flowmeter For Gases ALICAT	0-20 LPM 1/8 NPT Female	1
https://www.mcmaster.com/6534K56/	Brass Industrial Quick-Disconnect Hose Coupling (BUY! McMaster)	¼” Coupling ¼” NPTF Female	1
https://www.mcmaster.com/7818K231/	Thick-Wall Pipe Nipple Reducer	¼ male ⅛ male	2
CUSTOM	A Bracket Support (3D print)	H 9.46” x W 9.95”	2
https://www.mcmaster.com/4772K4/	Fast-Acting Pressure-Relief Valve	¼ NPTF male	1

Methodology

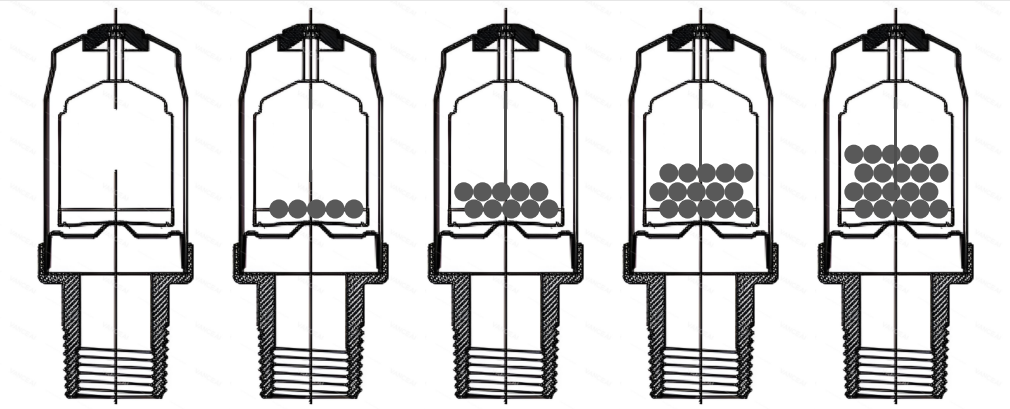
- 10 vent samples per vent model (30 samples total)
- Tested each vent 3 times at 0.2 PSI increments from 0 PSI - Max PSI

Methodology



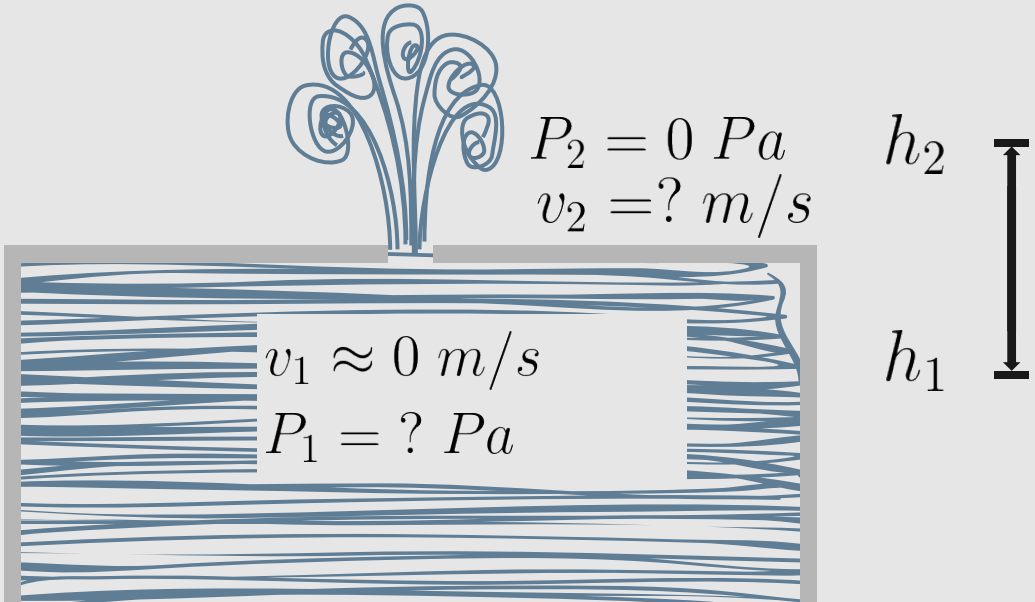
Methodology

- Testing adding weight to the float to observe max operating pressure
- Create a relationship between weight and max operating pressure



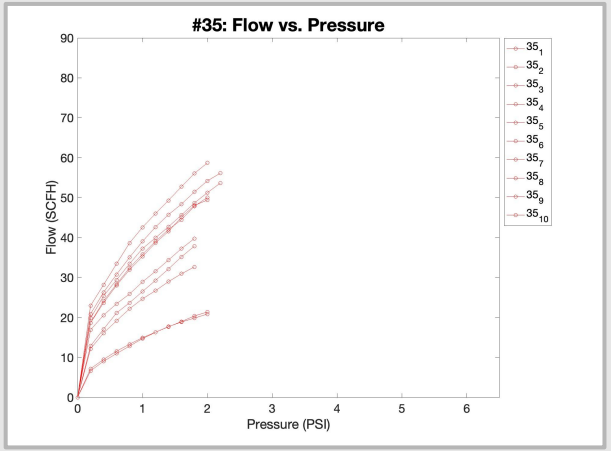
Theoretical Model

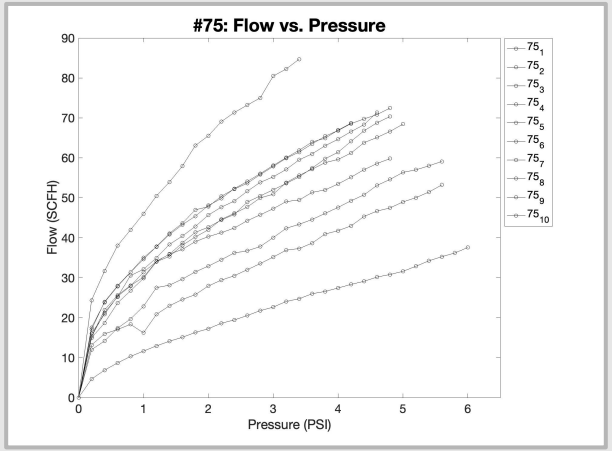
$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

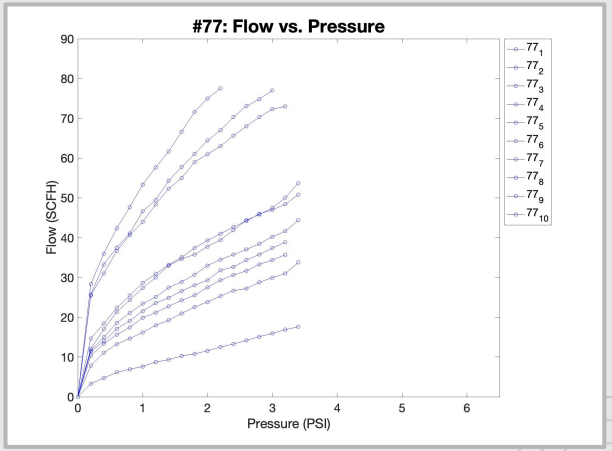


Results

Pressure and air flow data for 10 samples of Main Vent #35, #75, and #77 recorded at 0.2 PSI increments. All vents tested are unaltered, and will serve to create a baseline for each model.

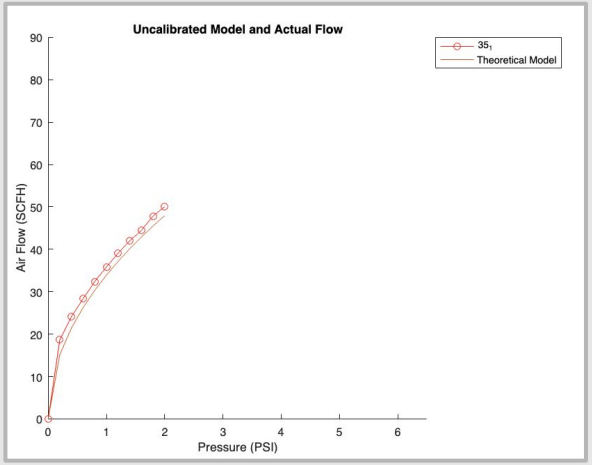


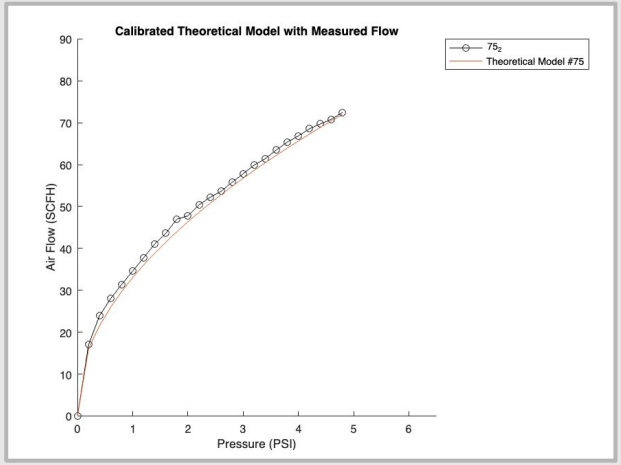


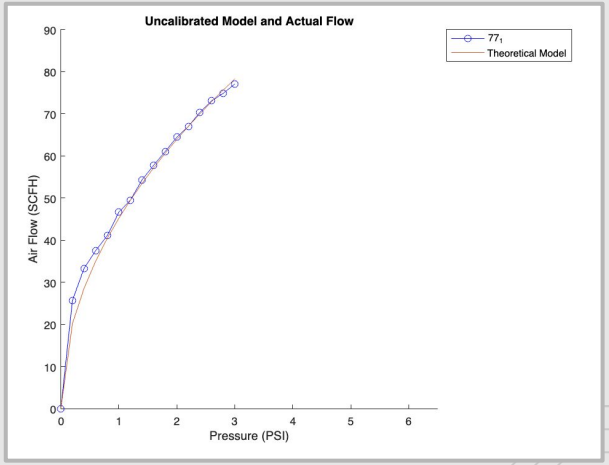


Calibration of Model

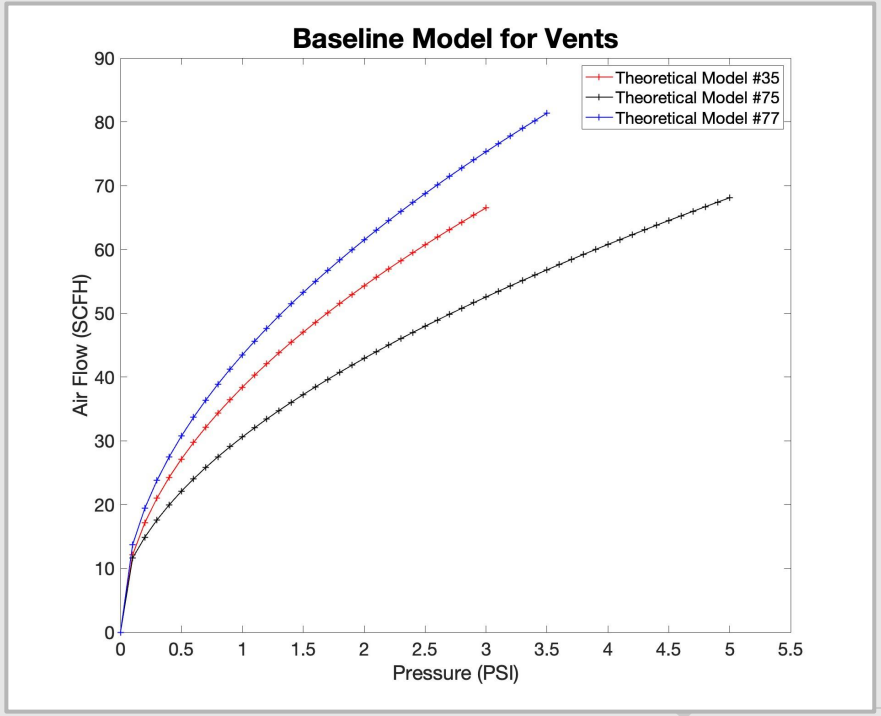
- Theoretical Model was overlaid with each of the 30 sample tests and adjusted to fit curves
- Adjustments can be done by multiplying model with a constant
- Constant = linear + directly proportional to pressure + inversely proportional to pressure

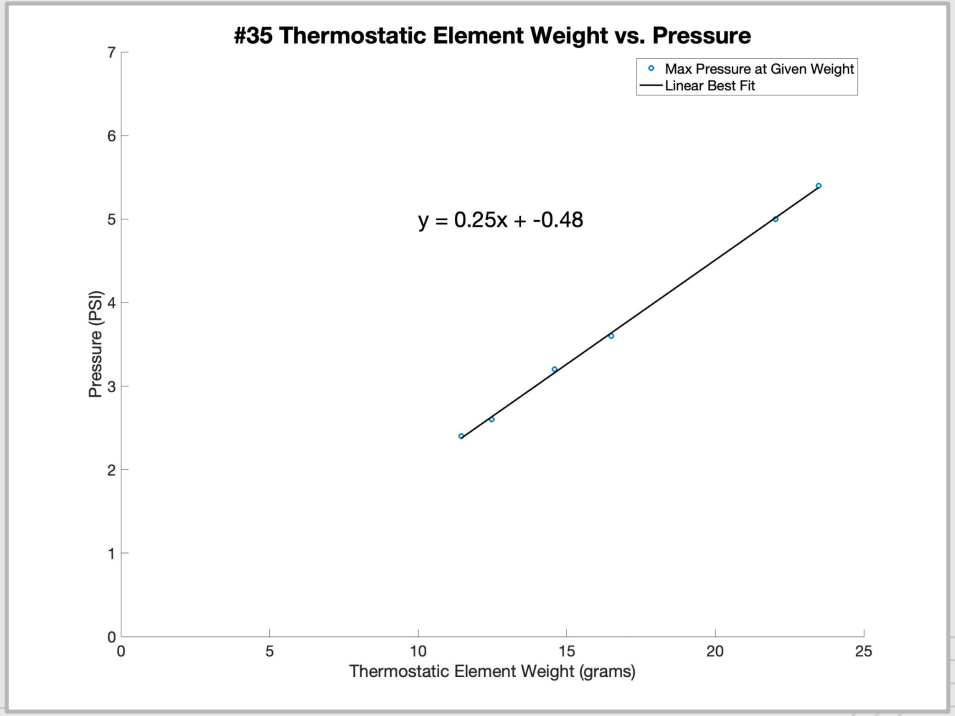






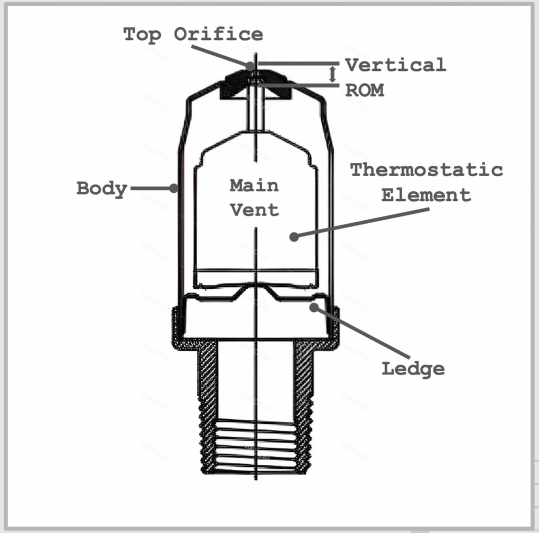
Theoretical Models Created

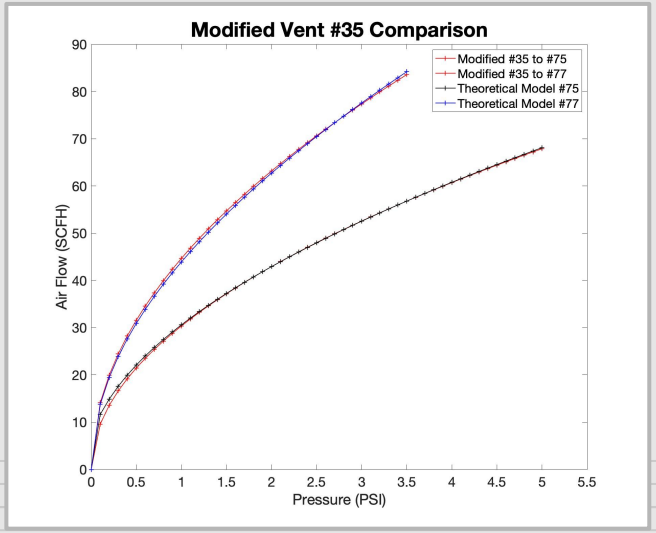




Design Suggestions to Vent

- To match the performance of Main Vent #75 and #77, the altered ranges of motion were 0.022 in. and 0.035 in. respectively. At the same orifice size of 0.09375, the calculated weights of the thermostatic element were 22.0 grams and 16.0 grams respectively.





Design Limitations and Challenges

- Vents for same model gave significant differences in flow readings
- Complications in similar flow meter readings between digital and acrylic flow meters
- Skidmore is currently not capable of creating air vents with such great precision to compare results with
- Thus, the models cannot be confirmed with prototypes at this time

Future Work

- A physical realization of the vent prototypes built using the changes specified in the results
- For ease of data gathering, a digital pressure gauge could be used in tandem with the digital flow meter to quickly gather data at higher resolution. With both a digital flow meter and pressure gauge, data can automatically be imported into a excel document

Bibliography

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Acknowledgements

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