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LAUNCH High Altitude Testing

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ONE TEAM MENTALITY

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M18™ FORCE LOGIC™ 12 Ton Utility Crimper

Air Pressure

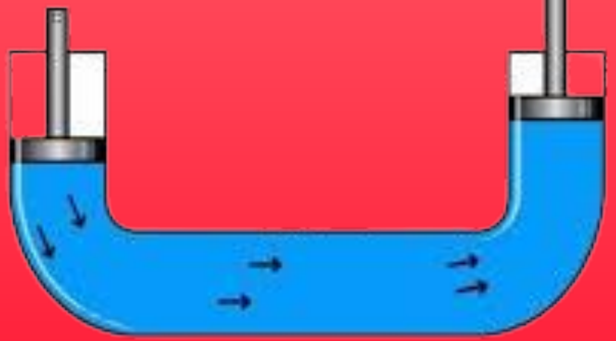
What is Air Pressure?

- The force the air exerts on a surface below it
  - 14.7 psi
- Decreases as altitude increases
- Air pressure can never reach zero.
  - Theoretically this would be known as a total vacuum which is caused by a complete absence of air, air pressure and matter.

Hydraulics

Force

Reacti
on



The Basics of Hydraulics

- A mechanical function that operates through the force of liquid pressure.

How does air pressure affect hydraulics?

- When the pressure decreases (high altitudes), little air bubbles trapped in the hydraulic fluid will start to foam.
    - This causes momentary lapses of pressure in the system.

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Project Statement

Design and develop a prototype to simulate high altitude testing for hydraulic tools in-house.

PROJECT DELIVERABLES

- Research, design and 3D model a prototype vacuum chamber to be able to perform high altitude tests.

OUT OF SCOPE

- Build a prototype
- Test prototype, due to time constraints
- Implement prototype, due to time constraints
- Determine vacuum effects on the system (load applications)

Project Requirements

Force rank feature requirements table

TARGET	Priority
Factor of Safety > 2 (For all parts)	1
Achieve a vacuum of 12 PSI (24.42 “Hg) in under 30 seconds	2
Cost Effective	3

= Accomplished

= Unaccomplished

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Solution Concepts

Solution concepts

Narrowing in on solutions

CONCEPTS

Size

- Full room is to expensive and not practical

Check Valve

- Ball valve works better with liquid
- Gate valve will wear down faster

Pump

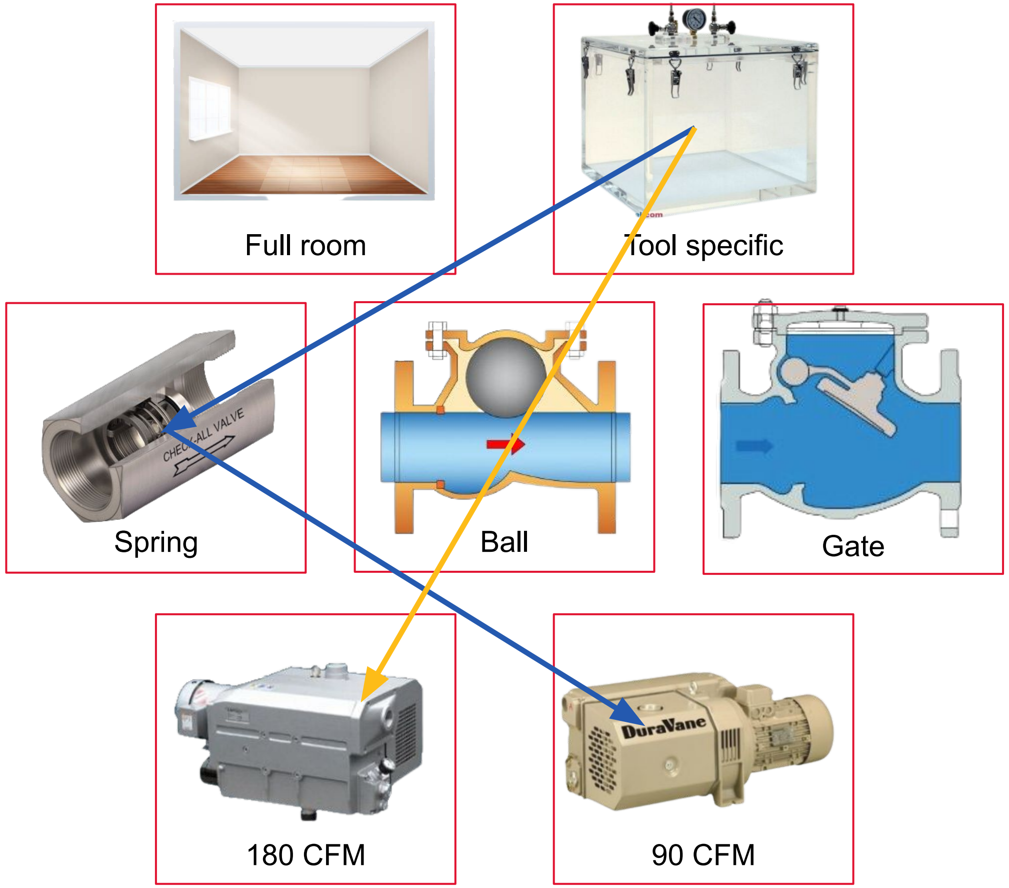
- 90 CFM pump can’t reach desired pressure fast enough

SIze

Check valve

Pump

CONCEPT COMBINATION



= Ideal Concept = Backup Concept

Concept selection

Decision-making matrix

	High Factor of Safety > 2 (x3)	Quickly Achieve Desired Vacuum (x2)	Cost Efficient (x1)	Total
180 CFM Pump Design	2	2	1	11
90 CFM Pump Design	1	1	2	6

= Ideal Design

2 = Best 1 = worst

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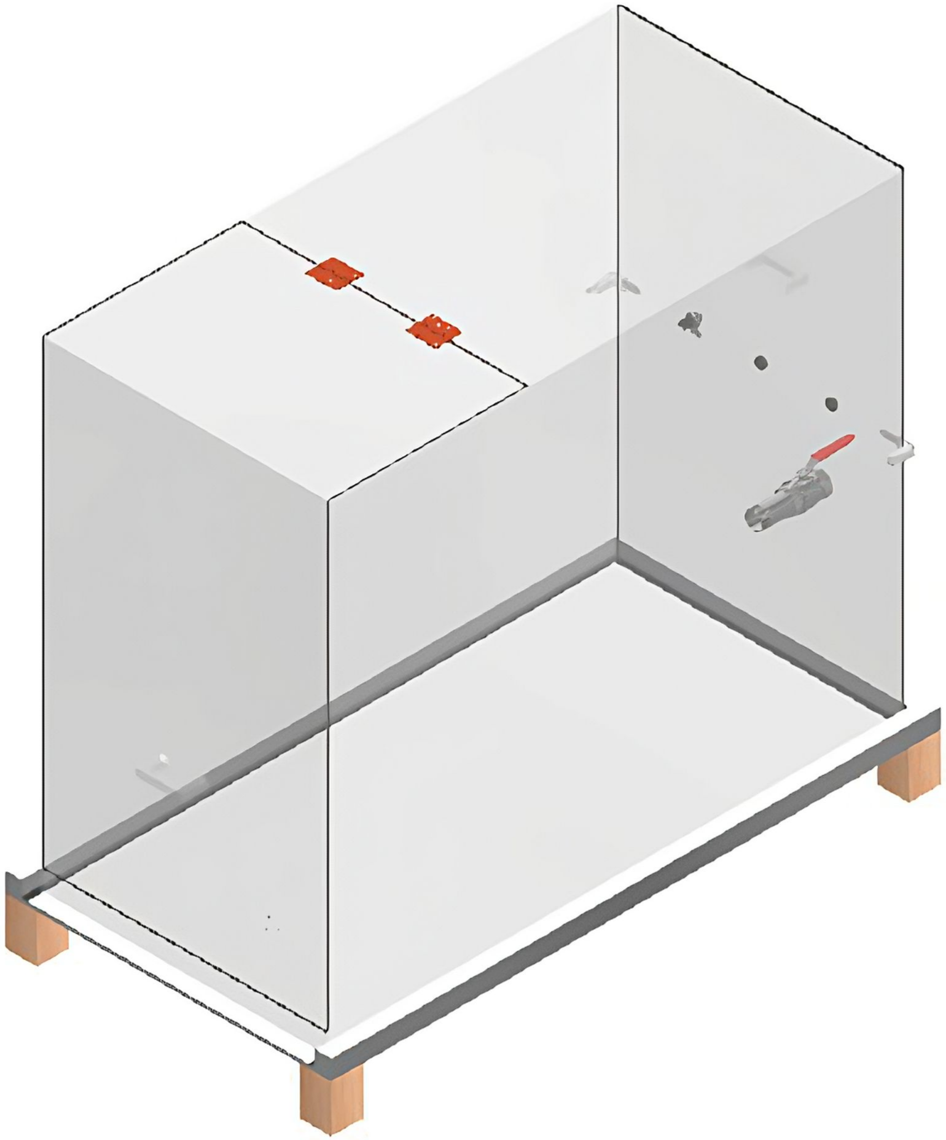
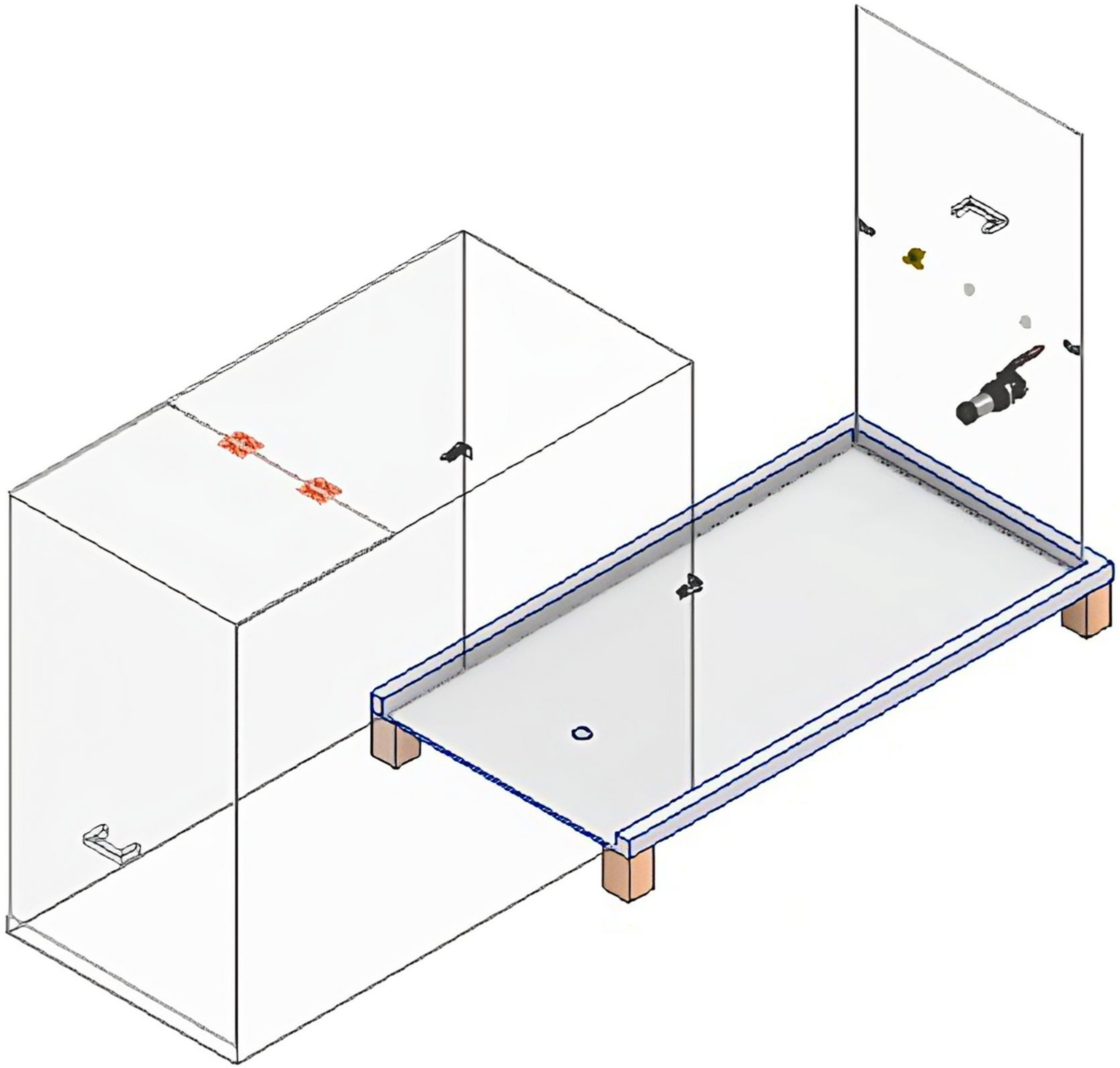
Solution

Final Solution

180 CFM Vacuum Pump Chamber

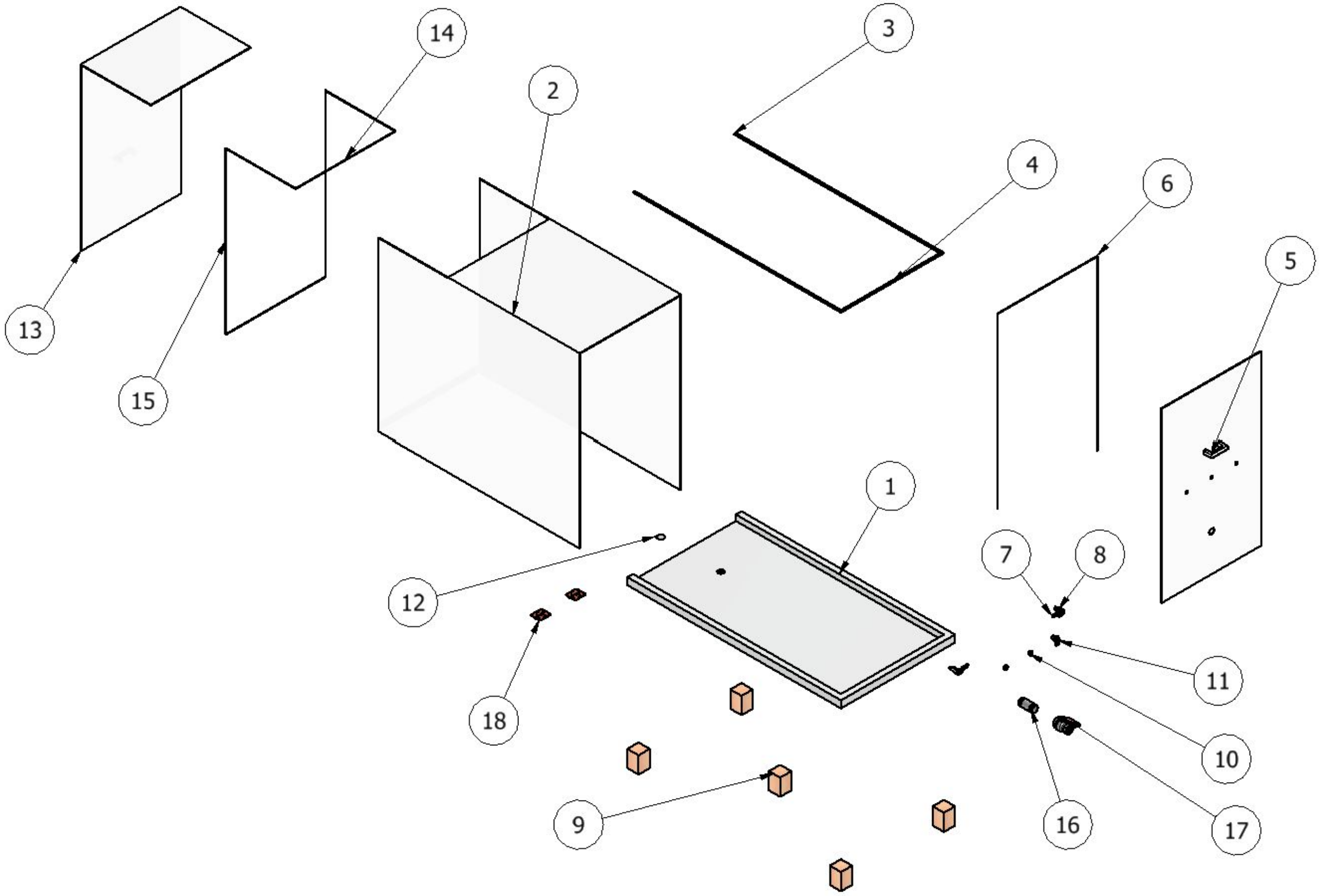




Final Solution

180 CFM Vacuum Pump Chamber

PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	Aluminium Base
2	1	Chamber
3	2	Length Edge Seal
4	1	Width Edge Seal
5	1	Hole Wall
6	1	Hole wall Gasket Seal
7	2	Latch Conection
8	2	Latch Base
9	5	4 by 4
10	2	Hole Seals
11	1	Hole plug
12	1	Pump filter
13	1	Door
14	1	Top door gasket
15	1	Bottom door gasket
16	1	Pipe
17	1	Valve
18	2	Door Hinge

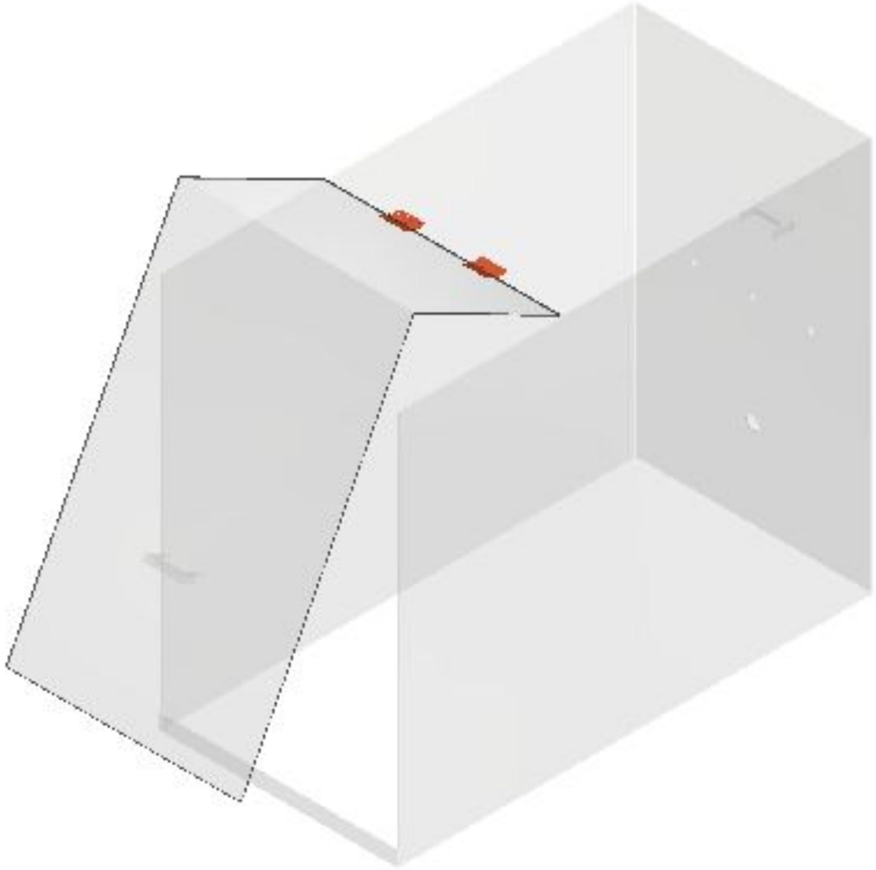


General Info

- Can get to 12 PSI (24.42 “Hg) in 25.42 seconds
- Oil-Flooded rotary vane pump
  - 1.75 gallons of ATO-1000 oil
- TEFC high efficiency motor
- 74 db
- 407 lbs
- $22,074

Features

- Build in anti suck back valve
- Standard connection
- External pressure gauge



Chamber

- 6 ft length, 3 ft width, 5 ft height

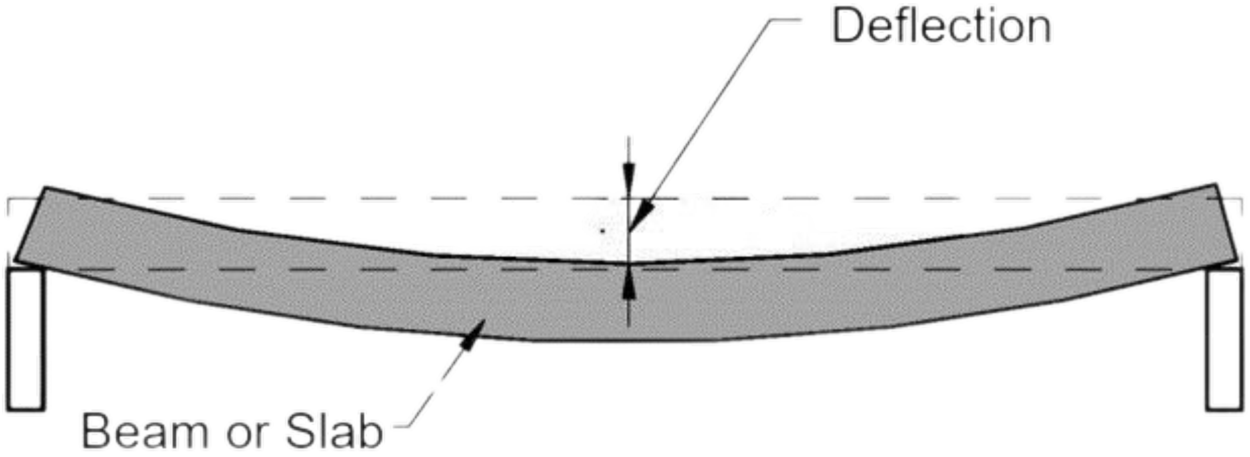
- ¼ inch Polycarbonate
  - Tensile strength 8,500 PSI
    - Indoor pressure of 12 PSI and atmospheric pressure (14.7 PSI) will exert 2.7 PSI on walls
    - Factor of safety of 3,190.8

- Accessibility
  - All walls can be lifted vertically
  - Door for easy access

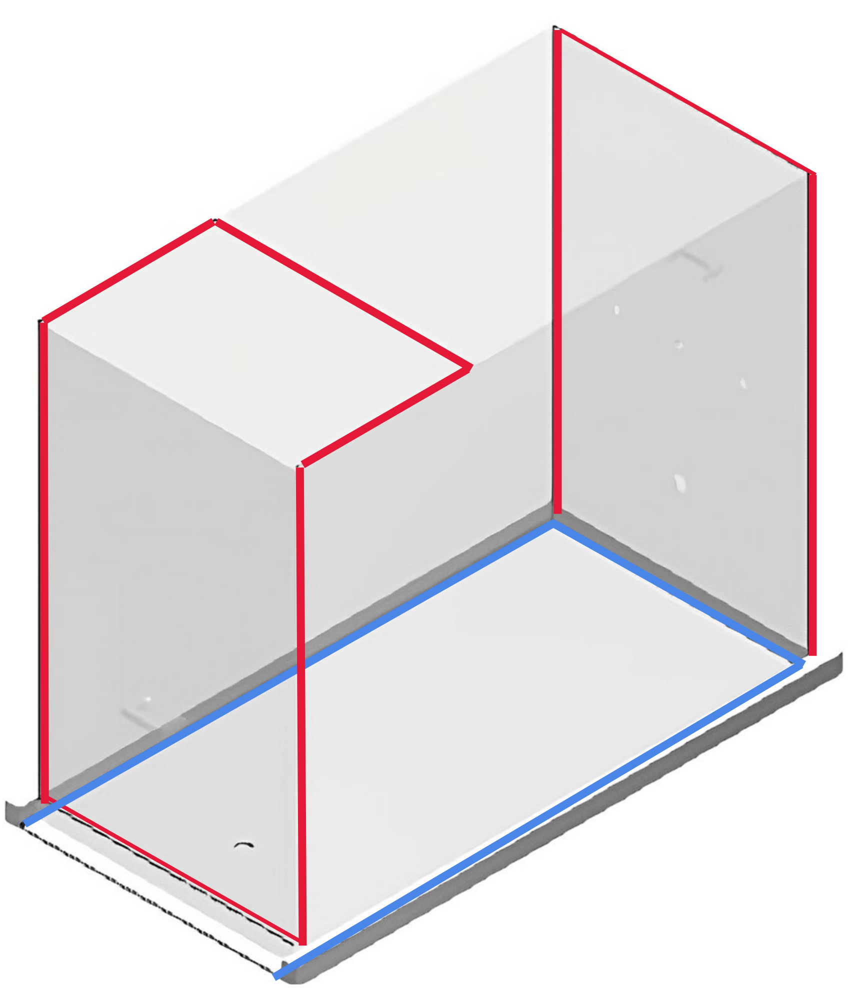
Aluminium Base

- ¼ thick aluminum 6061 base
  - Tensile strength of 14,000 PSI
    - 200 lbs appendix
  - Deflection of 0.00010 in
  - $495.73

- Pump filter
  - 40% open air



Solution Parts
Seals



Gasket seal

- Angled design
  - Higher vacuum equals better seal

Edge seal

- Rounded design
  - Will compress when chamber is inserted for better seal

= Gasket seal = Edge seal

Potential Failure Mode	Severity	Occurrence	Detection	Risk (RPN)	Risk Reduction	After Risk Analysis
Not holding a vacuum seal.	2	5	8	80	Check sealant before testing.	Lowers RPN by 60%.
Hydraulic oil starts leaking.	4	2	7	56	Easy access Release valve.	Lowers RPN by 35%.
Combustion of hydraulic oil.	8	2	2	48	Manual for correct operation and maintenance	Lowers RPN by 12%.

= Low (1-3) = Medium (4-7) = High (8-10)

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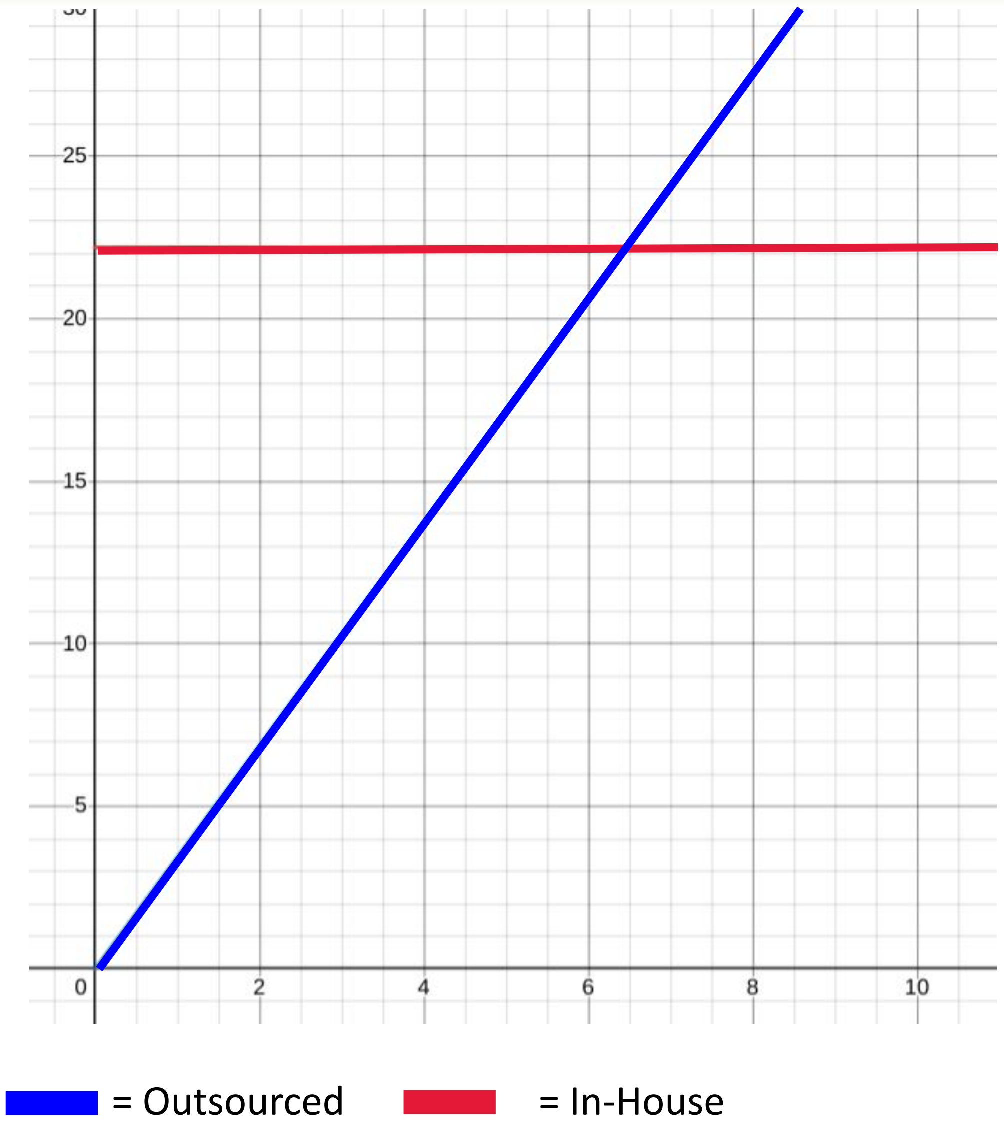
Next Steps

Comparison
Outsourced vs. In-House



Outsourced Altitude Testing
- $3,440 for 1-3 tools (Till failure)

In-House Altitude Testing
- One time cost of $23,200

Outcome
- After 7-21 tools being tested Milwaukee Tool will make their money back

What are the next steps for Milwaukee Tool?

- Begin implementing and building in-house
  - Provided with basic design
    - Could be used with different tool in the future

- According to research and mathematical evidence, design theoretically reaches MVP.

- Full construction of the model would be necessary to determine if chamber meets requirements.