Design for Manufacturing, Reliability, and Economics

Team 7

Solar Sausage for Desalination

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ABSTRACT

Much of the world lacks access to clean, drinking water. This system utilizes the Solar Sausage to desalinate saline water. The Solar Sausage concentrates light onto the trough, providing a less expensive alternative to a parabolic concentrator. This heats the trough and thus heats the water inside of it. By evaporating the saline water and then collecting and condensing the vapor, this system is able to produce clean drinking water for the consumer in need. The system is designed to have a long lifetime, continue to be reliable in production and durability, and all the while remain low-cost for the consumer staying consistent with the given entrepreneurial project scope. The design has a projected output of 3 gallons per day of clean, drinking water. With this, the consumer (being a small family) will have no more worries in regards to one of life's most crucial necessities.

ACKNOWLEDGMENTS

The group would like to thank Dr. Shih and Dr. Gupta for the direction and guidance throughout the project. Thank you to Dr. Devine for the well-timed feedback following meetings and presentations as well as marketing advice for our entrepreneurial project. Also, a special thanks to Dr. Lin for his valuable input and assistance with each aspect of the project. Finally, the group would like to thank Ian Winger for assisting in the construction of the Solar Sausage as well as supplying the materials for it.

1. Introduction

The Solar Sausage for Desalination was designed with the purpose of using the Solar Sausage technology in order to desalinate water. The system surrounding the Solar Sausage was developed in order to be strong and rigid, reliable in production given suitable conditions, and inexpensive. The final design of this prototype was created to fill a need while maintaining consistent with all of the objectives in mind.

The entire system (aside from the Solar Sausage) was made of aluminum to maintain its strength while also having favorable conductive properties for the heat transfer required in the system. Bolts and nuts connect the different components allowing for simple construction and deconstruction. Quick, easy deconstruction was desired in case of inclement weather conditions of which the Solar Sausage itself would be unable to withstand. Stakes allow for the system to be immobile regardless of wind or reasonable weather conditions. Aluminum has great conductive properties allowing for heat to pass from the Solar Sausage's focal point to the water and from the vapor to the ambient air. Also, aluminum is one of the most inexpensive, rigid materials readily available on the market which allows for low-cost manufacturing. Being a strong and rigid system, this allows for a long lifetime of the system bringing our final cost per gallon of water down well below the market. This permits the project to remain within the scope of an entrepreneurship and provides for better marketing of the final prototype.

2. Design for Manufacturing

The objective was to design a simple system that reduced manufacturing and assembly time. All components excluding the solar sausage are constructed of aluminum. Aluminum is light weight and easily machinable reducing tooling requirements [1]. Steel and copper were potential material choices but didn't fit our design specifications. Assembly of the system will take place on site, by the operator, and will be covered in the operation manual. Detailed drawings for all manufactured components can be found in Appendix A.

2.1 Components

The system was designed to be operated manual to reduce the number of components and each component was designed to reduce the number of pars (Table 1). The stands and trough are constructed using 3/8 in hex nuts and bolts. Bolts and nuts are not considered parts but the system required 44 nut and bolt sets, 20 per stand and 4 for the trough. The components of the system will be discussed in the other in which they were manufactured.

Table 1: Desalination System Components: List of components, parts, and their manufacturing time for each component

Desalination System Components		
Component	Number of Parts	Manufacturing Time (minutes)
Stand (x2)	9	96
Trough	3	55
Storage Tank	4	55
Solar Sausage	4	180
Condenser	7	217
Total Manufacturing Time (minutes)		588

2.1.1 Stands

The stands, being the support structure of the system, were manufactured first. The parts of the stand, their manufacturing time, and type of aluminum used are shown below in Table 2. The legs and both cross bars are made of 1 in. square aluminum tubing and only required simple 3/8 inch holes to be bored through them. The L-plates were cut using a water, greatly reducing the manufacturing time. A L-plate was chosen to connect the legs and cross bars because they can be used to square the legs and cross bars, making the stand easier to assemble. Directions for assembling the stand are in the operation manual. A bar stock T is welded to the top of 2 legs for the pressure gauges.

Table 2: Desalination System Components: List of components, parts, and their manufacturing time for each component

Stand			
Components	Manufac. Time (minutes)	Material	Number Required
Leg	15	Al6061 T6	2
Upper Cross Bar	5	Al6061 T6	1
Lower Cross Bar	5	Al6061 T6	1
L-Plate	2	Al3003H14	4
Circle Hooks	0	Galvanized Steel	1
Total Manufacturing Time (minutes)			48

2.1.2 Trough

The trough is constructed of two 60 inch aluminum channels and two trough walls. The channels were purchased and the trough walls were cut out of the same material as the L-plate using a water jet (Table 2). The two aluminum channels are welded together at the center giving the trough a total length of 120 inch (Figure 1). A trough wall was welded at each end of the trough, allowing it to be bolted to the stands and hold water (Figure 1). The stands and trough bolted together create a free standing structure capable of supporting large loads.

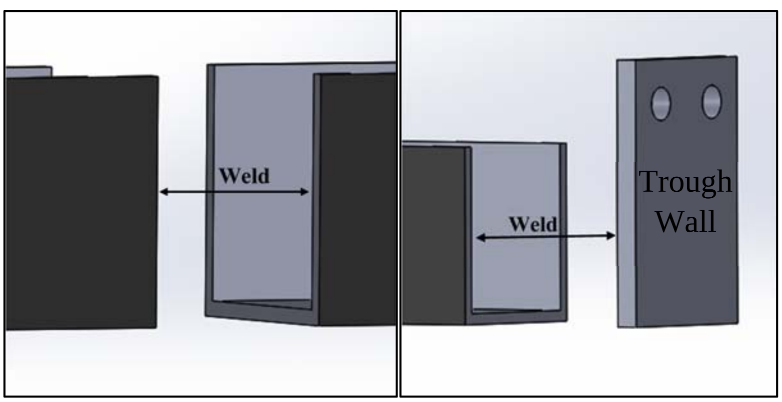

Figure 1: Trough components and their welds. The two 60 inch channels are welded together at the center giving a through length of 120 inch A trough wall is welded at each end of the trough allowing the trough to be attached to the stands and hold water.

2.1.3 Solar Sausage

The Solar Sausage is constructed of a two rectangular pieces of transparent plastic and one rectangular piece of Mylar Polyester. Through a series of folds and the use of industrial hot melt glue, the three pieces are bonded together to form the Solar Sausage. Pressure ports are cut into the upper and lower chamber at one end, then the ends are folded and sealed giving it the sausage-like appearance. The team attached an adhesive tie down on each side of the Solar Sausage half way down where the folds are joined together. The team also attached a steel wire loop to each end allowing it to be attached to the circle hook on the lower cross bar of the stand. The Solar Sausage will be inflated through the use of foot pumps and pressure regulated using needle-valves and pressure gauges.

Sun Tracking

The sun tracking system used is adapted from a system used in commercial application that translates the lateral motion of a bar to rotational motion of the Solar Sausage. For the system, a 72 inch long, 1.5 inch square aluminum tube is used to hold the Solar Sausage in place. The bar had two 3/8 inch diameter holes bored in them for eye bolts. The rest of the parts, the 2 steel connecting wires and the two adhesive tie down were purchased and simply installed minimizing the manufacturing time.

2.1.4 Storage Tank

The storage tank is made of four components: a ½ in. ball valve, the storage tank platform, a through-wall fitting, and a five gallon bucket. The bucket, ball valve, and through-wall valve were purchased. The storage tank platform was constructed of a 13.65 inch by 6 inch metal plate, with a 1.5 inch bore through the center that has two legs welded to it at the ends (Figure 3). The legs have 3/8 in. holes bored into them so the storage tank platform can be inserted to the top of the stand legs with the pressure sensors.

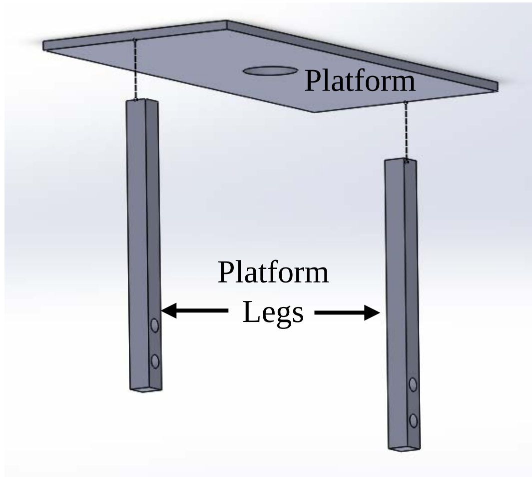

Figure 2; Storage tank platform. The dotted lines represent where the parts connect and are welded together

2.1.5 Condenser

The condenser was constructed last. The condenser was not necessary for testing until evaporation can be achieved which requires the stands. The total time to manufacture the parts and weld them together was 217 minutes (Table 3).

Table 3: Condenser Components and their manufacturing time

Condenser Parts			
Components	Manufac. Time (minutes)	Material	Number Required
Channel	40	Al6063	2
Condenser Wall	10	Al6061 T6	2
Channel Connector	6	Al6061 T6	2
Condenser Stand	60	Al3003 H14	1
Condenser Hood	45	Al3003 H14	1
Total Manufacturing Time (Minutes)			217

All components except for the channels were cut from a water jet. The channels were in 96 inch segments. Two 28 inch channel segments were cut and welded to the 96 inch segments giving the channels the desired length. The rest of the components had to be welded together.

Condenser Assembly

All parts of the condenser had to be welded together making the condenser the most expensive components of the desalination system. The assembly of the parts are shown in the figure below (Figure 3).

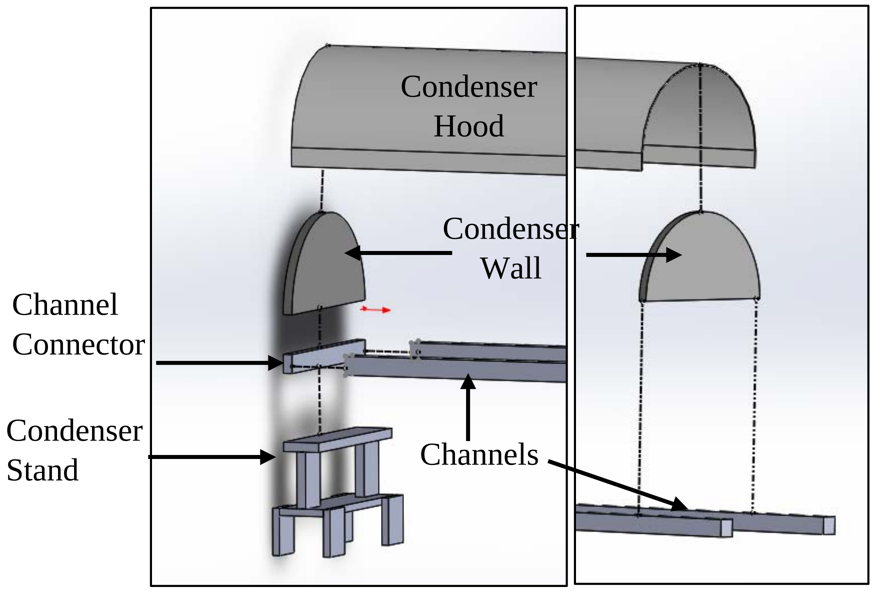

Figure 3: Exploded view of each end of the condenser. The dotted lines shows the location of the welds.

2.2 Manufacturing Time

The total manufacturing time for the system was just under 6 hours. This does not include the time that it took to prepare drawings and procure material for manufacturing. The manufacturing time was far less than expected. This was due to the use of a water jet cutter and the simplicity of the machining. Upon further inspection of the manufacturing times areas of improvement were found.

The construction of the Solar Sausage was a hands on learning experience for the team. The team learned how to construct them by constructing one by hand. This greatly increased the manufacturing time. There is machine available capable of producing a 50 foot. long Solar Sausage in under 5 minutes [2]. All holes were bored manually, the use of a CNC in the future will decrease the time necessary to bore said holes.

2.3 Design Improvements

The design could be improved in a few small ways. With the constant desire to lessen the overall cost of the system, one could get thinner material for the stands. The stands were firm and provided much more durability than even necessary. By reducing the material in the stands, one could reduce the overall cost as well. Better pressure pumping systems could also be implemented given the long pumping time required to fill the Solar Sausage with air. Lastly, the condenser is the most crucial part of the output rate of clean water so modifications in the design could be made in order to increase the output. This could include an improved material, design, or even cooling to the condenser material which heats with the vapor constantly pushing against it.

3. Design for Reliability

The prototype produces 3 gallons per day and performs well. The system was tested in different weather conditions regarding temperature, wind effects, and sunlight exposure. The prototype should perform the same whether used 1 or 10,000 times assuming all parts aren't damaged or have been replaced if so. The desalination system will be outdoors thus all components will be constructed of aluminum with good structural properties and resistance to corrosion. The system has no electrical components and is operated manually. These design decision increased the operating lifetime of the system [3].

3.1 Part Replacement

The components and parts used were selected and designed so they can be easily substituted or replaced using common items found in developing countries, meaning long-range import is not required. The storage tank is to be composed of a five gallon bucket, an item attainable around the world. The storage tank can be substituted for any comparably-sized container, offering multiple alternative options. An alternative can be used to replace the filter so long as it is comparable to the filter provided. Comparable items include canvas bags and cloths that can be found worldwide.

3.2 Reliability Concerns

One of the largest reliability concerns are that the condenser's temperature is too high and the condensation rate is reduced, unable to keep pace with the evaporation rate and thus impeding the system's output production of potable water [4]. This can be caused by the steam's high temperature constantly heating its underside or even the top side being heated by the sun directly. One way this issue is being addressed is by applying a reflective material to the top of the condenser in order to block this incoming radiation from heating the top side of the condenser. Since the underside is designed to capture this steam and its purpose is to take on the incoming steam, nothing is being done to prevent this heat gain to the condenser. Another simple solution is to pour cold saline water over the condenser hood (Appendix B). Other concerns

4. Design for Economics

The Solar Sausage for Desalination is designed for deployment into developing countries to assist families in obtaining clean, drinking water. This product was designed at low cost for mass production. The Solar Sausage for Desalination is to be as low-cost as possible in order to provide for a greater number of people requiring access to clean water.

4.1 System Cost

The parts for the system were purchased at market price bringing the total cost of the system to just below $935.61 (Table 4). This greatly increased the cost of the system compared to if the parts were purchased at wholesale prices. The cost per component can be found below (Table 4). The condenser is the second most expensive component because of the cost of welding. The Solar Sausage cost $10 in material. The parts to keep the Solar Sausage inflated and in line with the sun made up the majority of the cost making it the most expensive component. A cost per component breakdown in available in appendix A.

Table 4: Cost per component for the desalination system

Cost Per Part			
Part	Cost/Part	# Needed	Total Cost
Stand	$ 58.50	2	$ 117
Trough	$ 121.78	1	$ 121.78
Storage Tank	$ 92.49	1	$ 92.49
Condenser	$ 277.38	1	$ 277.38
Solar Sausage	$ 326.61	1	$ 326.61
		Total	$ 935.26

4.2 Scalability

Although designed to provide for a smaller number of people, the modular system can be adapted to be used in a large farm of Solar Sausages for an entire community. This would require a smaller number of people to maintain the system(s) and provide for an entire community. Previously, Solar Sausages have been used in large farms containing multitudes of Solar Sausages to provide for a common goal. With a modular design, energy is produced for a smaller number of people. It is cheaper for families of a community to procure one Solar Sausage for Desalination rather than invest in an entire farm of Solar Sausages at once. With the modular design, both options are available. After a community obtains a multitude of Solar Sausages, the design can be adapted to be used in a large farm.

4.3 Versatility

The design is incredibly versatile as it allows for a multitude of substitutions as described and potential design adaptations. The system, although determined for the purpose of desalination, can be easily adapted to be used for pasteurization. In order to pasteurize fresh water so that it is potable, the water must be raised in temperature and held for an extended period of time. The current Solar Sausage for Desalination design is focused on increasing temperature vastly to create an evaporative environment within the condenser. Less heat would be required to pasteurize the water. This means the Solar Sausage for Desalination can be used inland and is not restricted to desalination use along the coastline. Inland opportunities will provide for a greater consumer base to be reached.

4.4 Competitors

A multitude of products can be found that compare to the Solar Sausage for Desalination when focused on the function of the system. These are the primary competitors to the Solar Sausage for Desalination. Also utilizing the evaporative nature of water, the Solarball is also designed to produce 0.79 gallons of potable water daily. This would not be sufficient to satisfy the hydration needs of one person every day. Another primary competitor is the Eliodomestico. The Eliodomestico aligns with the Solar Sausage design as it utilizes solar power to produce evaporation of salt water for the purpose of producing potable water. The economical design allows for a variety of materials that can be substituted. The materials used are widely available and inexpensive. The Eliodomestico can produce a total 1.3 gallons each day, significantly less when compared to the 3 gallons that the Solar Sausage for Desalination will produce [6]. The Eliodomestico is a less expensive product compared to the Solar Sausage design; however, this design is composed of a brittle material, increasing its likelihood of damages. The Solar Sausage has an estimated lifespan of 10 years. Throughout a decade, minor exchanges and adjustments will be required. When accounting for the lifespan of this product and the anticipated additional expenses, the Solar Sausage will produce water with a cost of $0.16 per gallon. Distilled water purchased in a store within in the United States has an approximate cost of $0.99 per gallon.

5. Conclusion

In conclusion, the Solar Sausage for Desalination is a system that is easily constructed and deconstructed, inexpensive, durable, reliable, and fills a void the developing world greatly needs. With the system's construction entirely made of aluminum (aside from the Solar Sausage), the many advantages mentioned above are provided giving this prototype great potential in the market. The entrepreneurial aspect of the system has been successful as the projected output of 3 gallons per day, combined with a long lifetime, gives water to those that need it at a well below market price. The design was established with good reliability in mind and all other reliability concerns have been addressed. Manufacturing was made to allow for a simple assembly for the consumer operating the system. All parts and operation instructions are given to the consumer making for a system that anyone could interpret and construct. To summarize, the Solar Sausage for Desalination is the complete product.

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Appendix A CAD Drawings for Manufacturing

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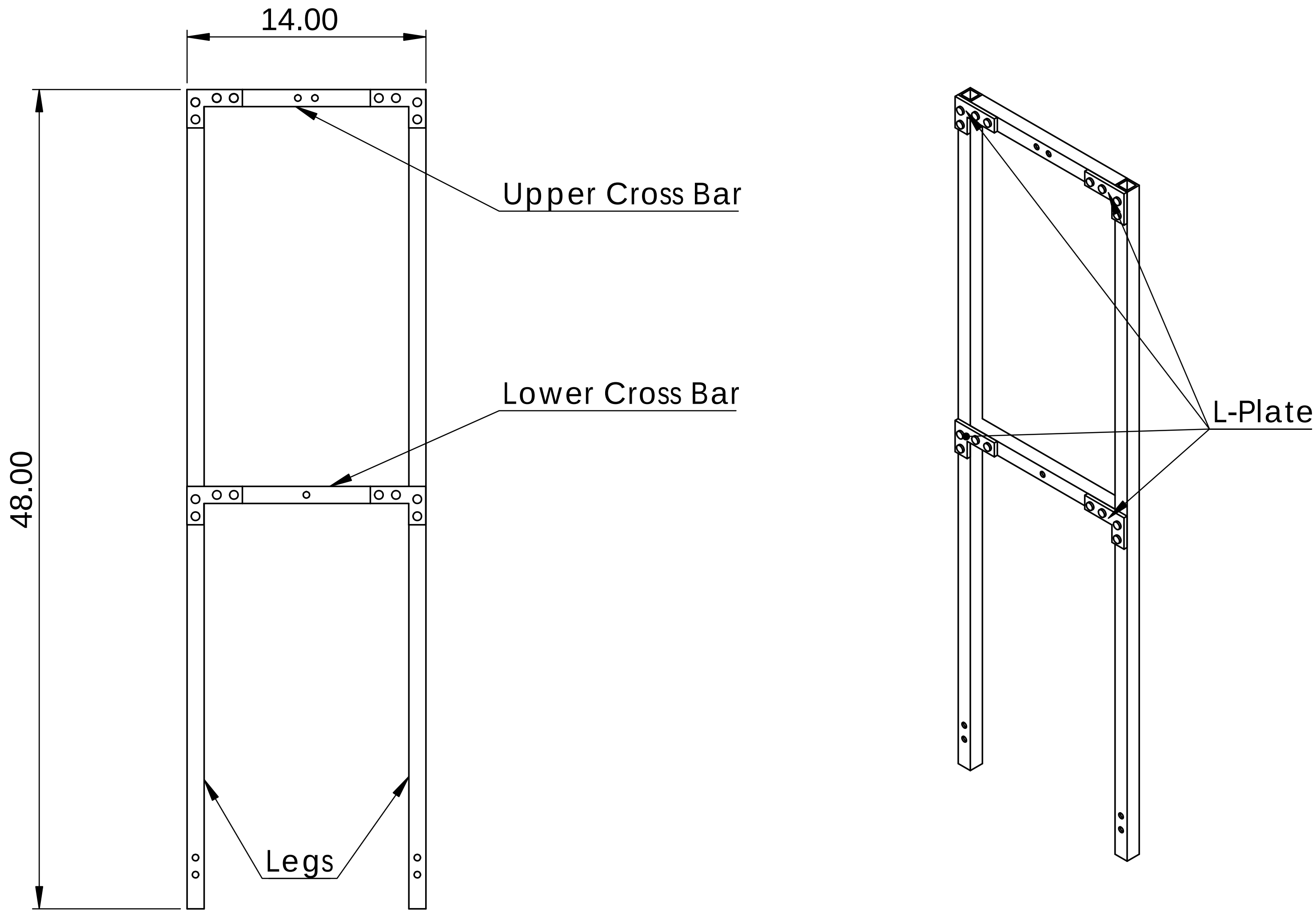

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	FUNDING APPR.	Crystal Wells		
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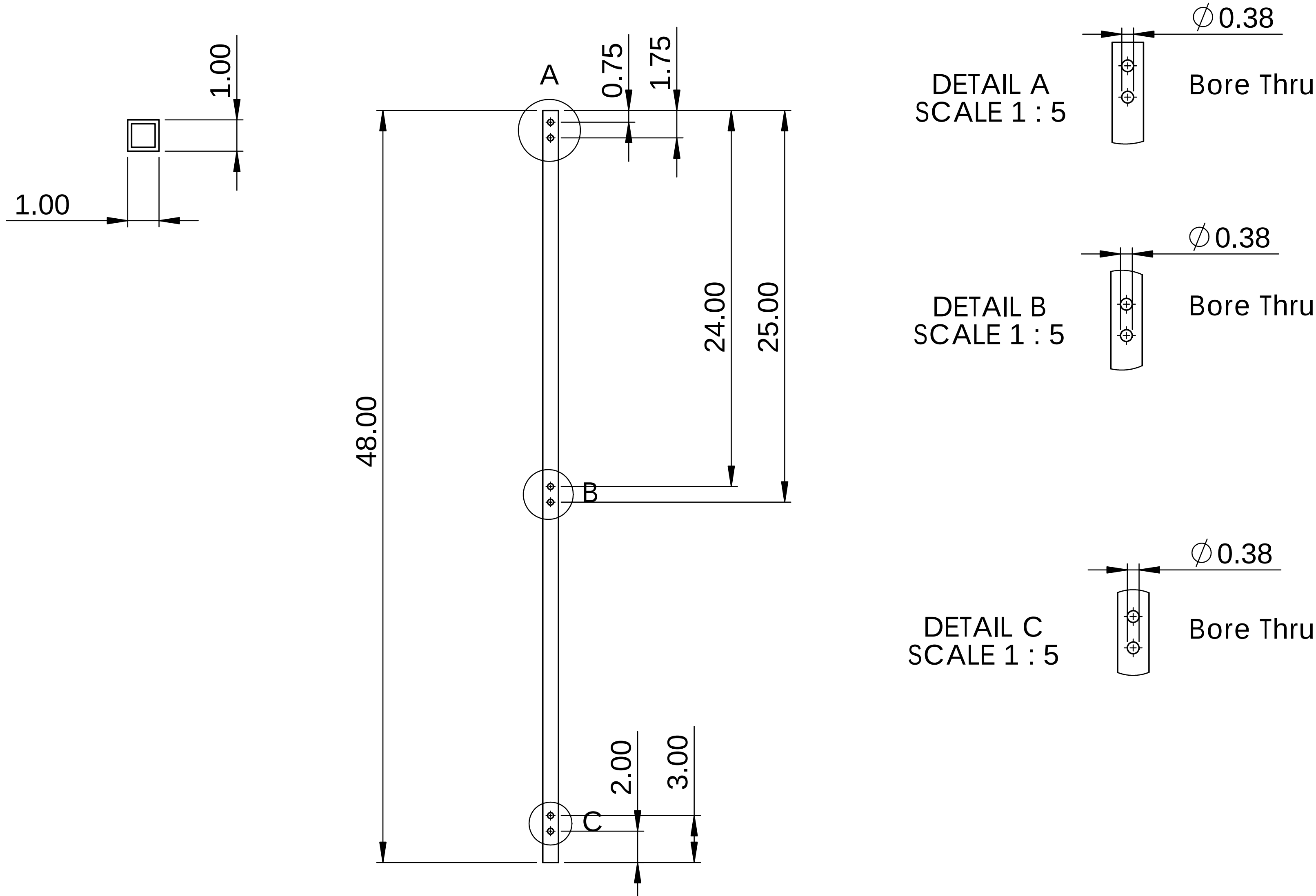

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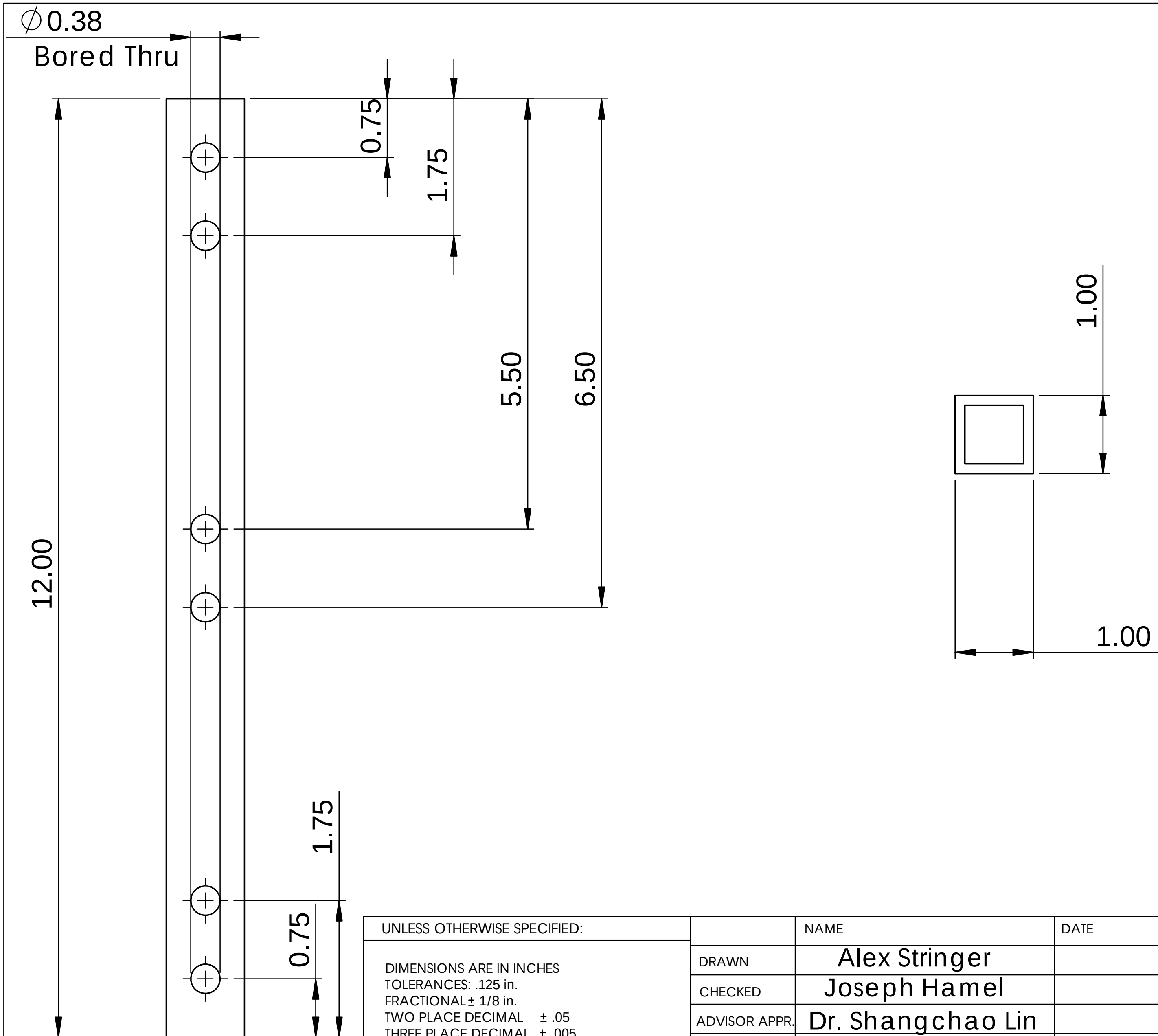

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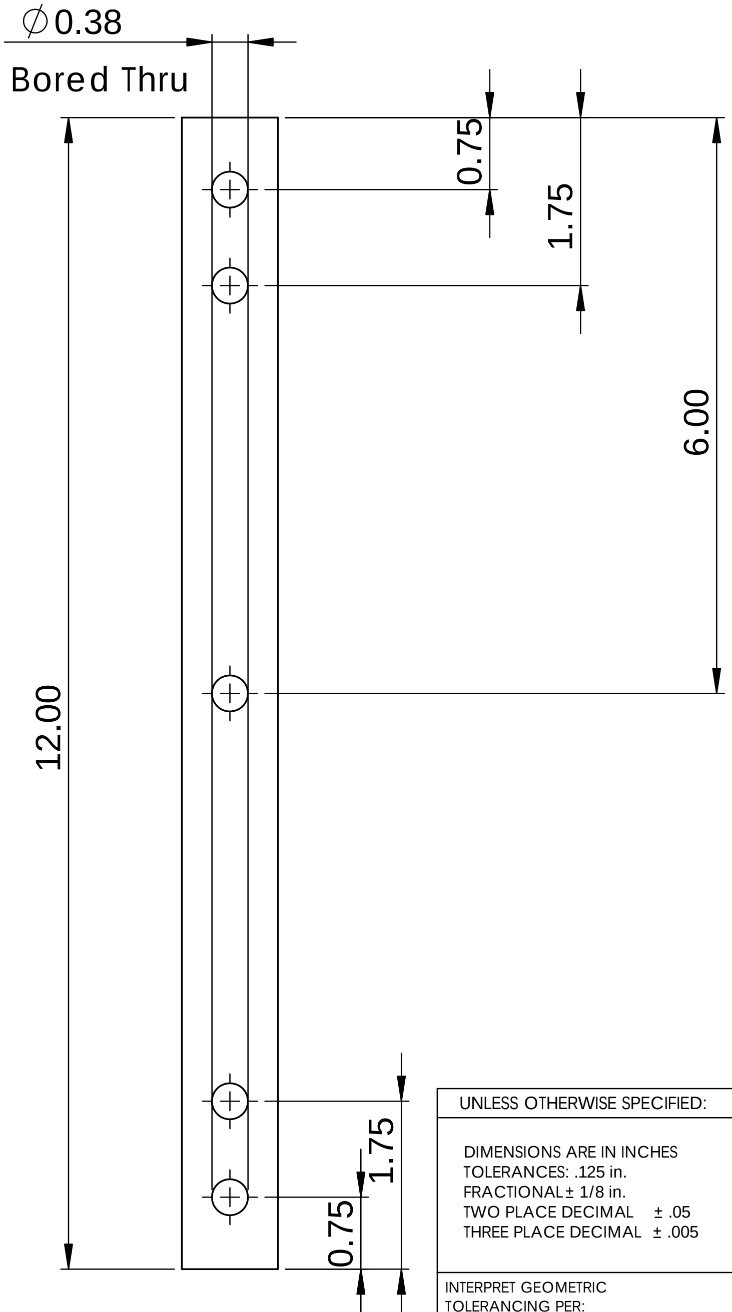

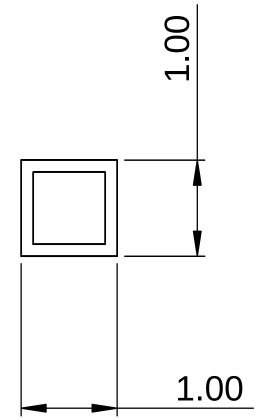

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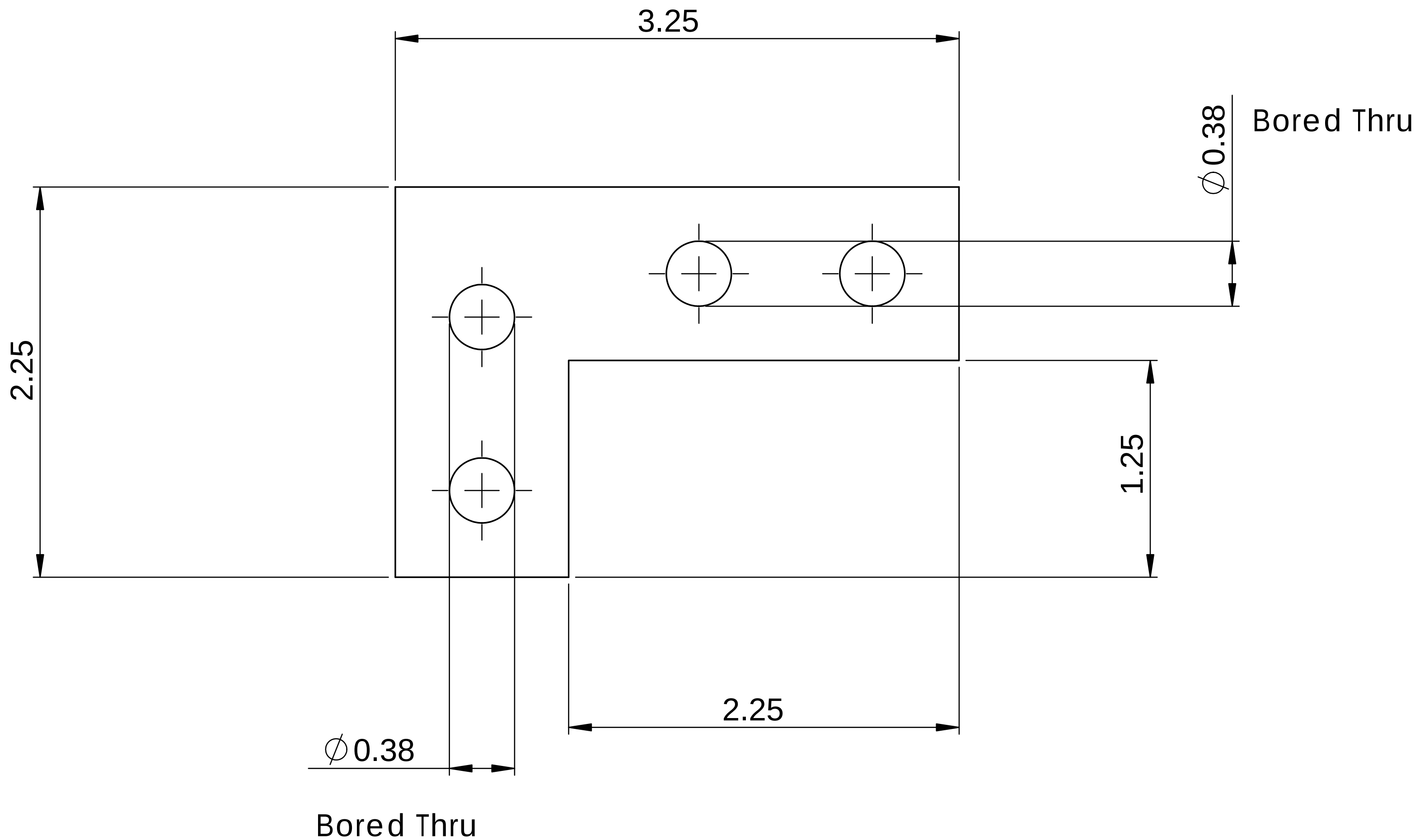

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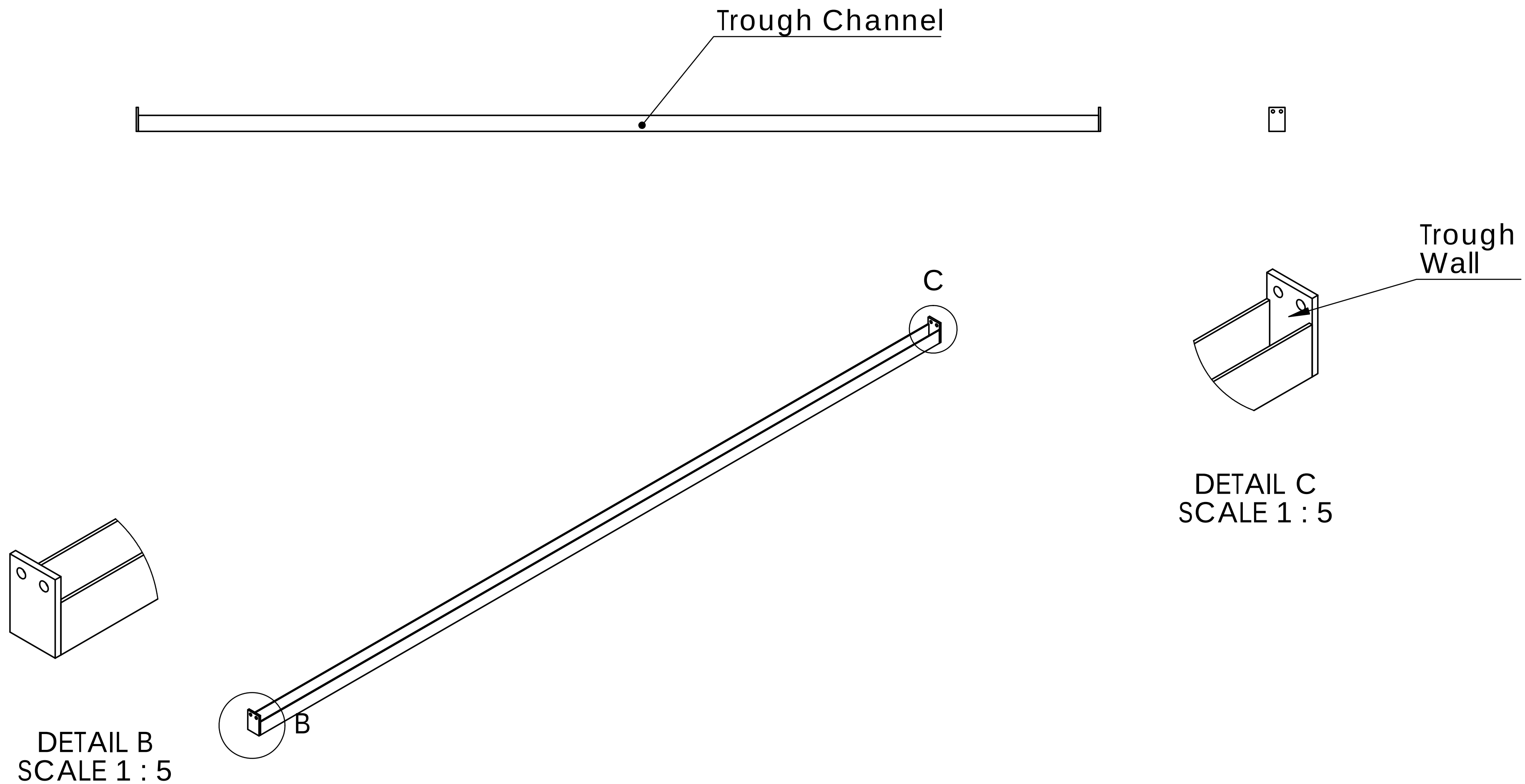

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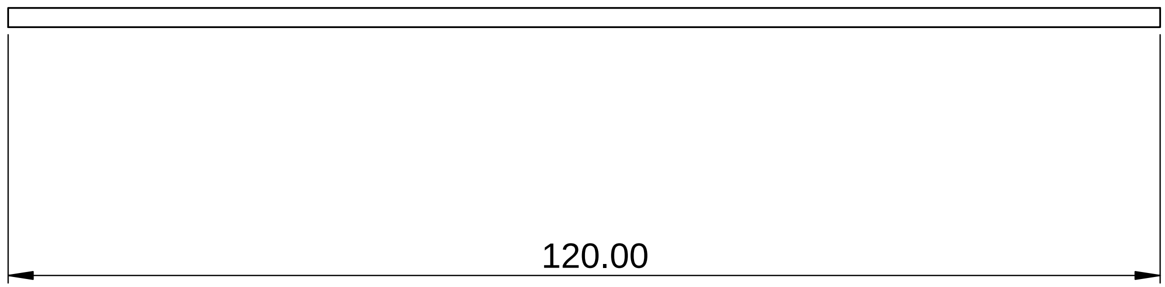

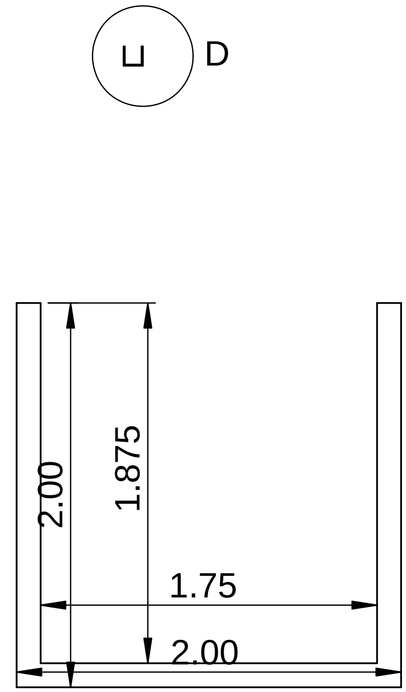

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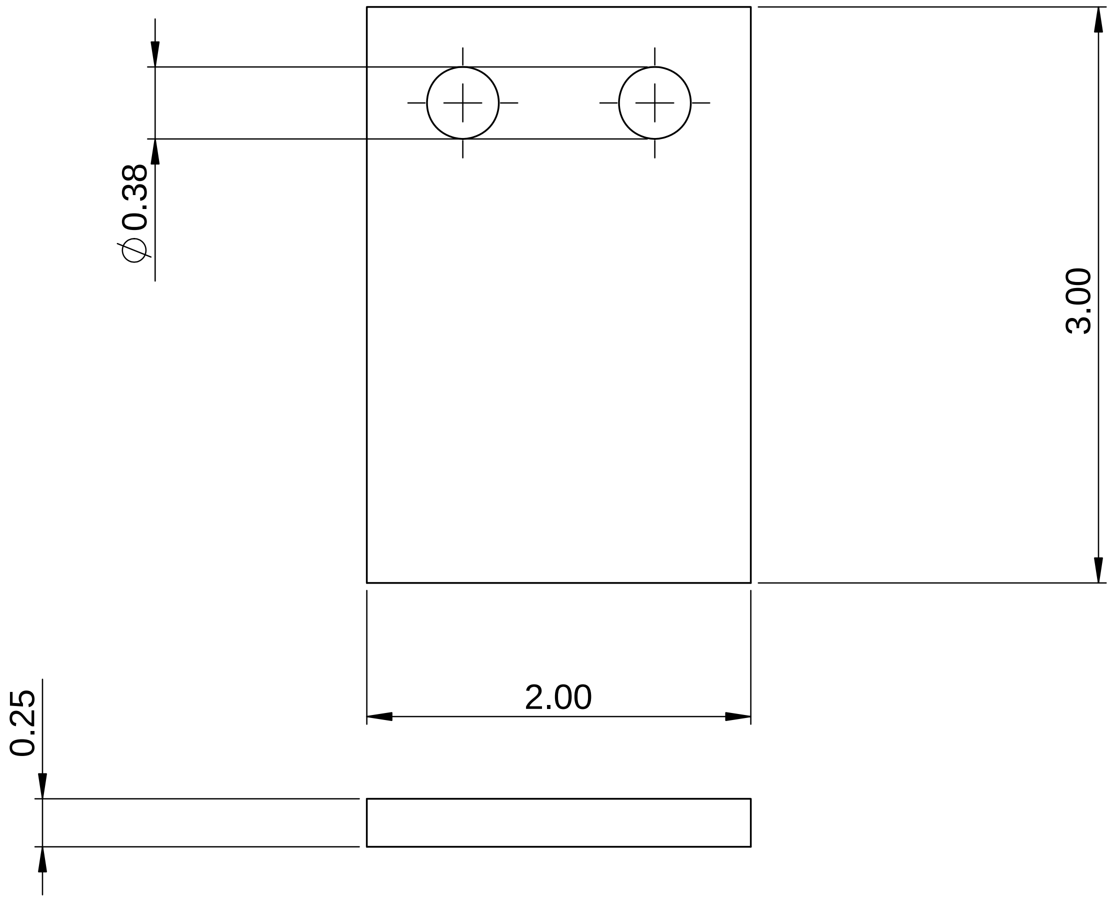

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FUNDING APPR.	Crystal Wells	
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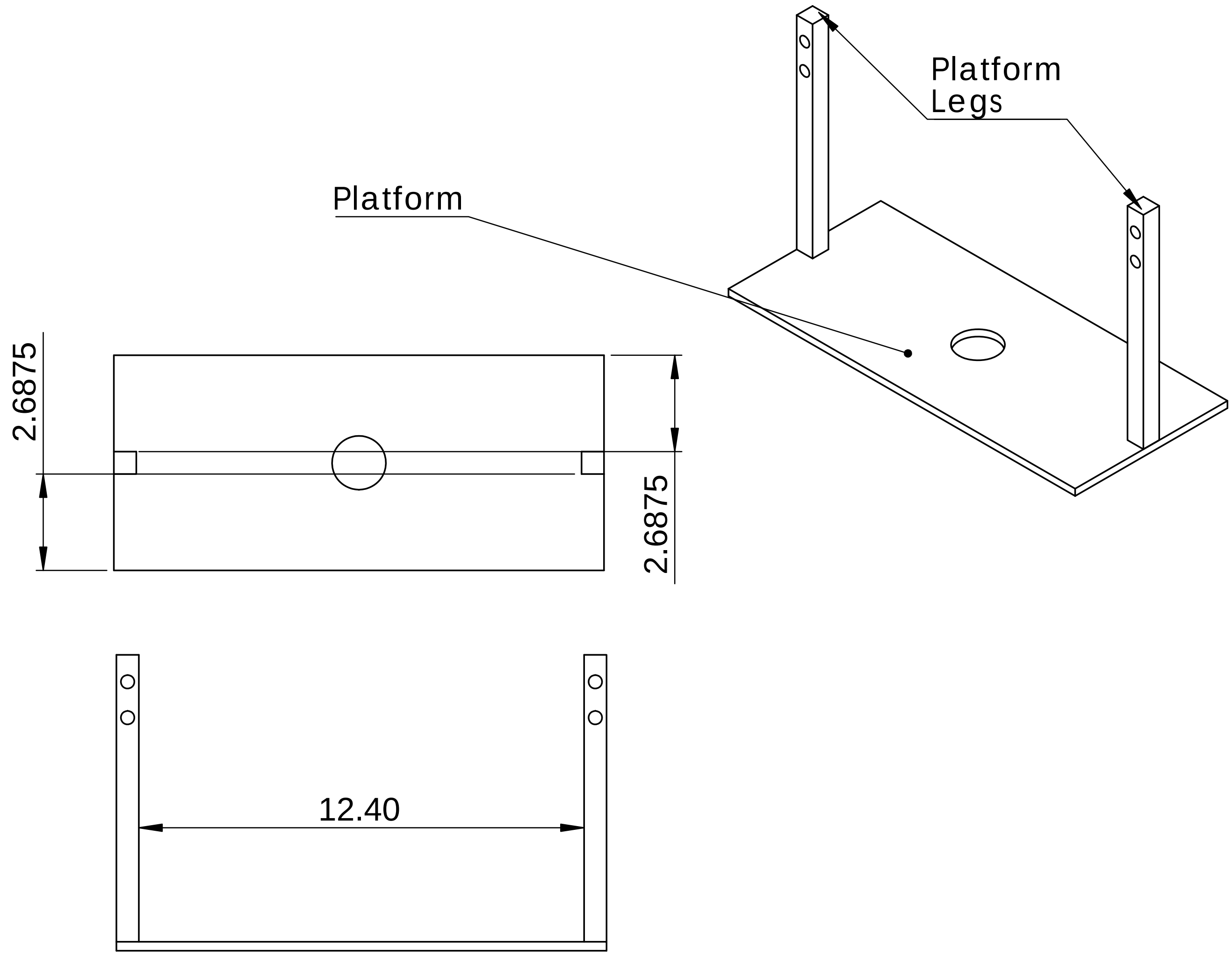

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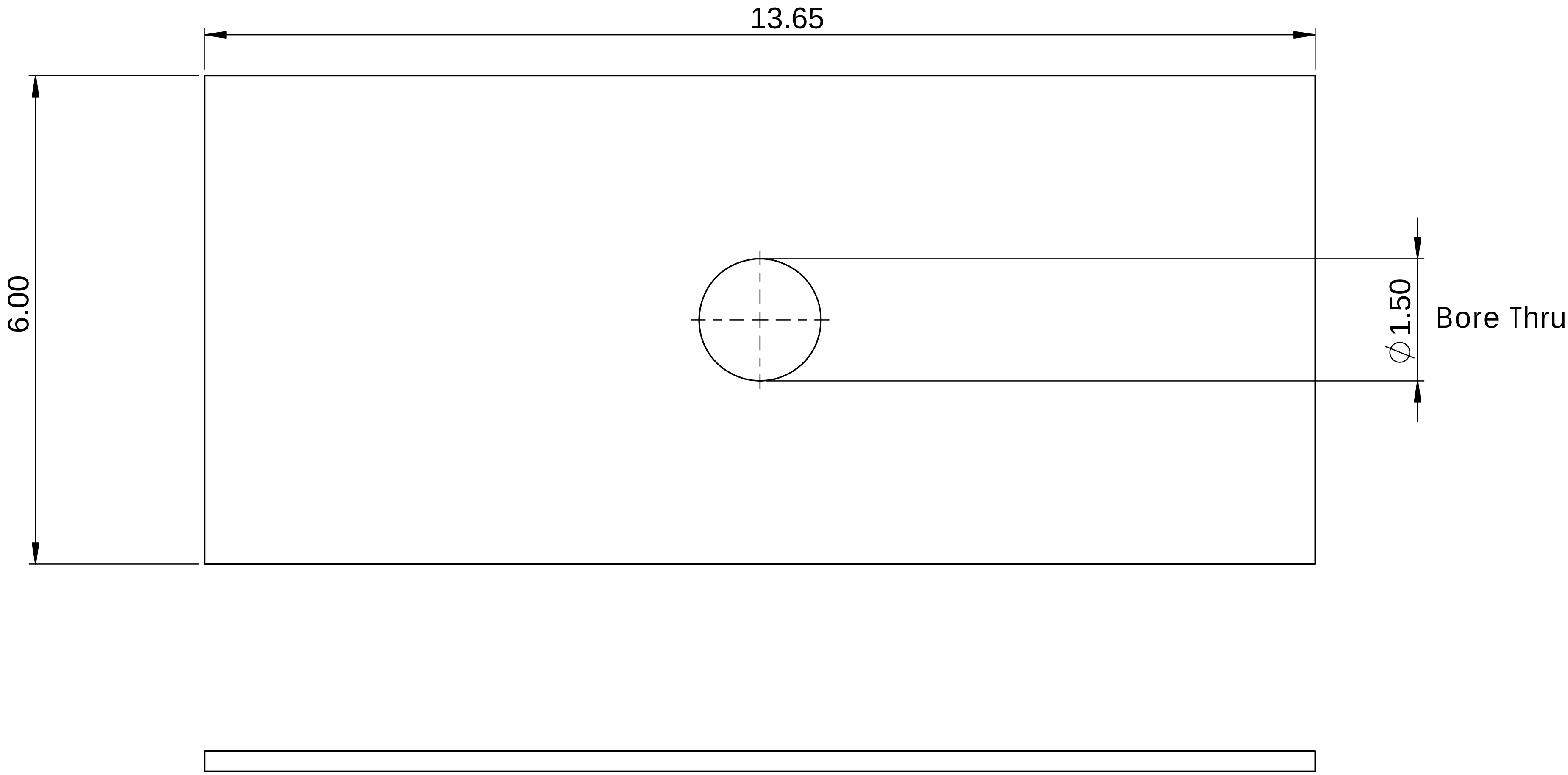

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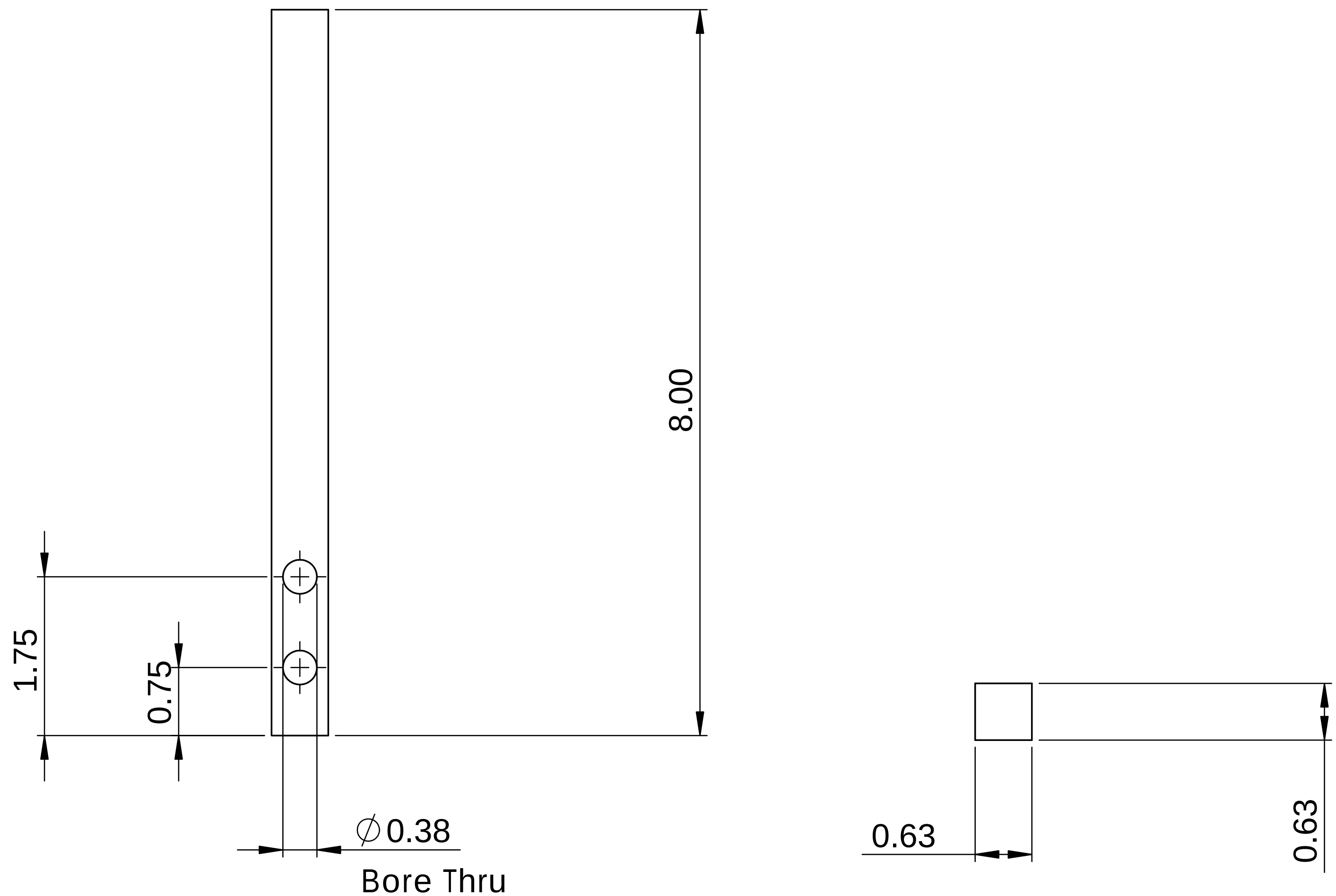

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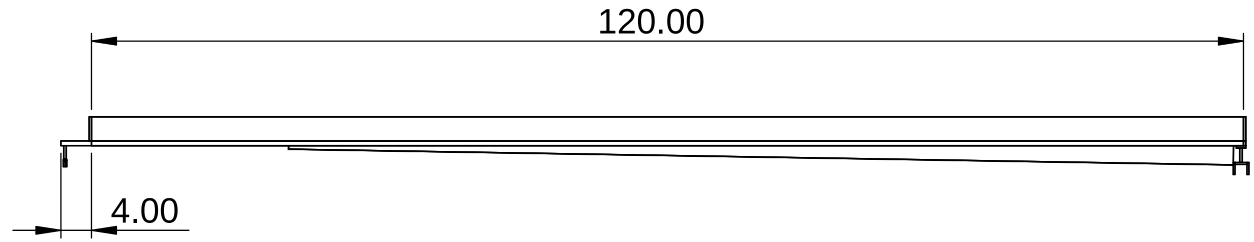
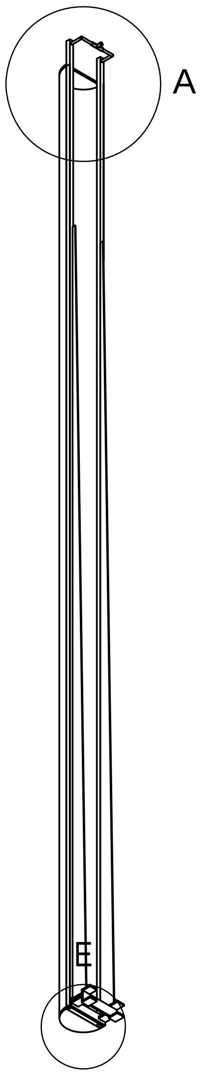
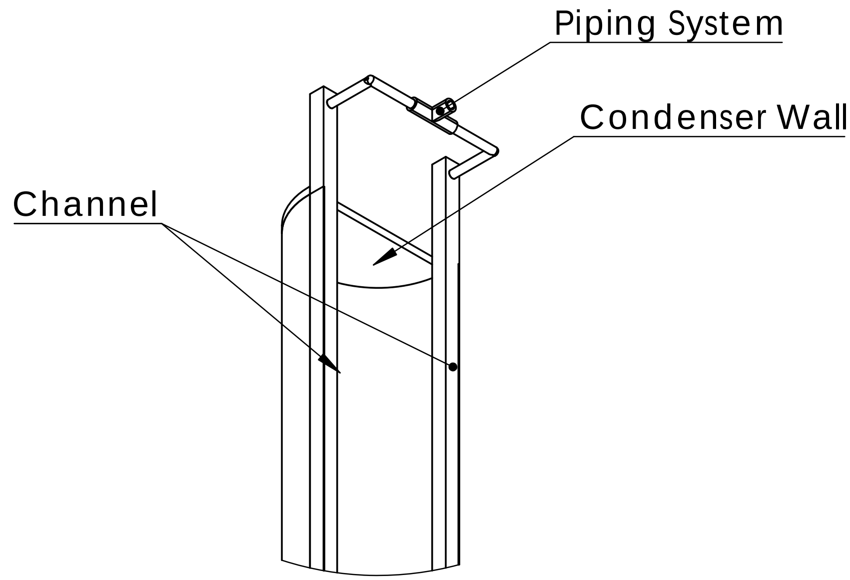
DIMENSIONS ARE IN INCHES TOLERANCES: .125 in. FRACTIONAL ± 1/8 in. TWO PLACE DECIMAL ± .05 THREE PLACE DECIMAL ± .005	DRAWN	Alex Stringer		TITLE:
	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A · DWG. NO. Platform Legs · REV
FINISH				
DO NOT SCALE DRAWING				WEIGHT: · SHEET 3 OF 3

All Dimension in Inches
Needs Sheet metal







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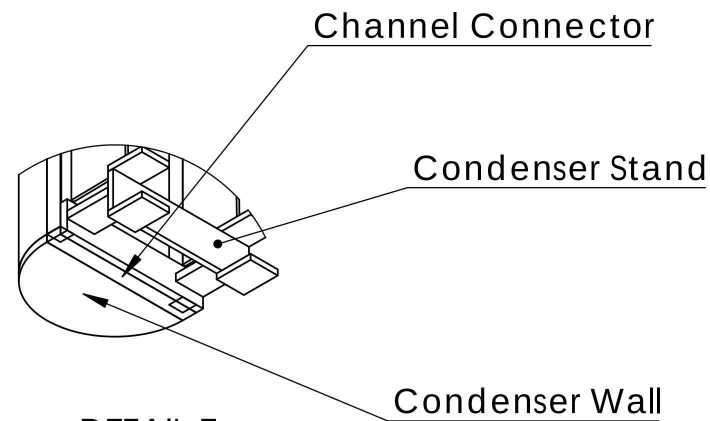

DETAIL E
SCALE 1 : 5

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Team 7
DIMENSIONS ARE IN INCHES TOLERANCES: .125 in. FRACTIONAL ± 1/8 in. TWO PLACE DECIMAL ± .05 THREE PLACE DECIMAL ± .005	DRAWN	Alex Stringer		TITLE:
	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A · DWG. NO. Condenser · REV
FINISH				
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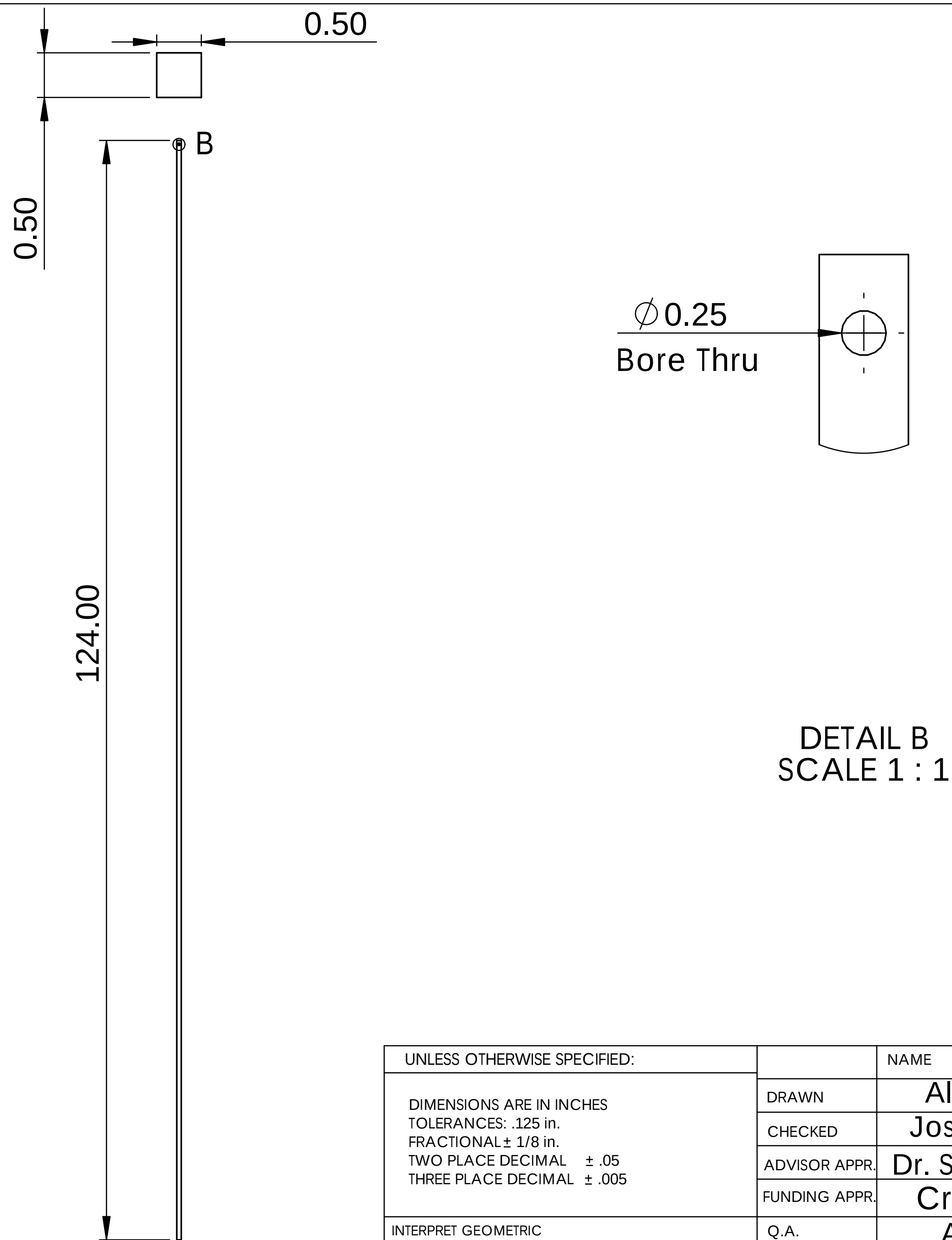
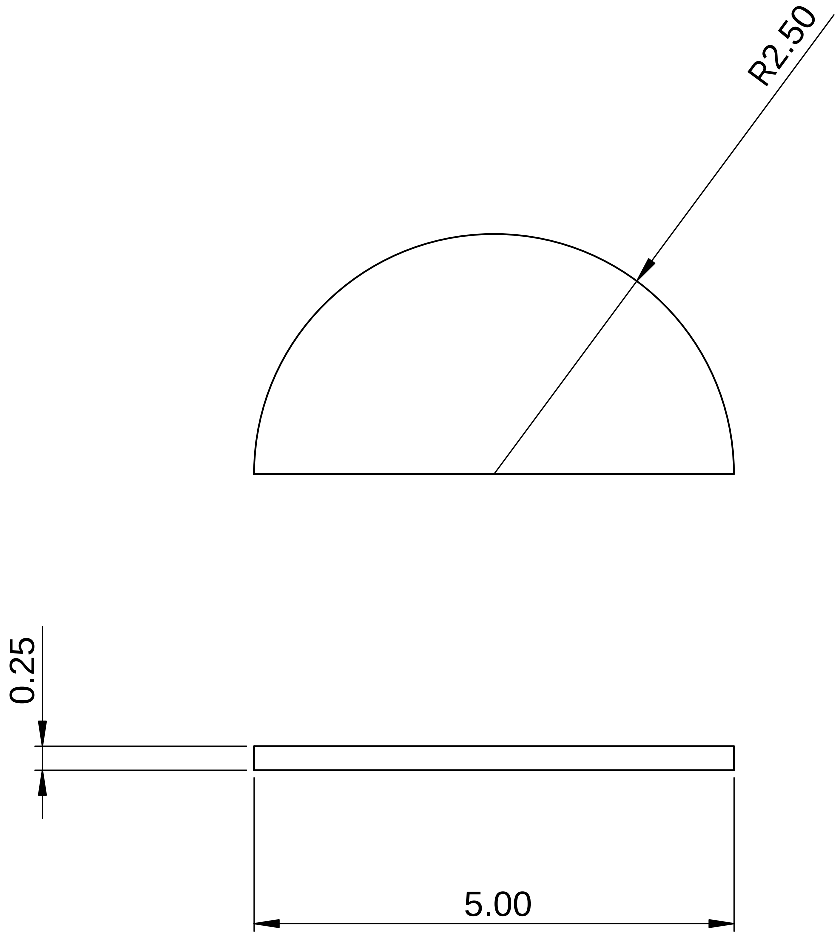


Material Suppled
Need 2

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Team 7
DIMENSIONS ARE IN INCHES TOLERANCES: .125 in. FRACTIONAL ± 1/8 in. TWO PLACE DECIMAL ± .05 THREE PLACE DECIMAL ± .005	DRAWN	Alex Stringer		TITLE:
	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A · DWG. NO. Channel · REV
FINISH				
DO NOT SCALE DRAWING				WEIGHT: · SHEET 2 OF 6

Need 2



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	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A — DWG. NO. Condenser Wall — REV
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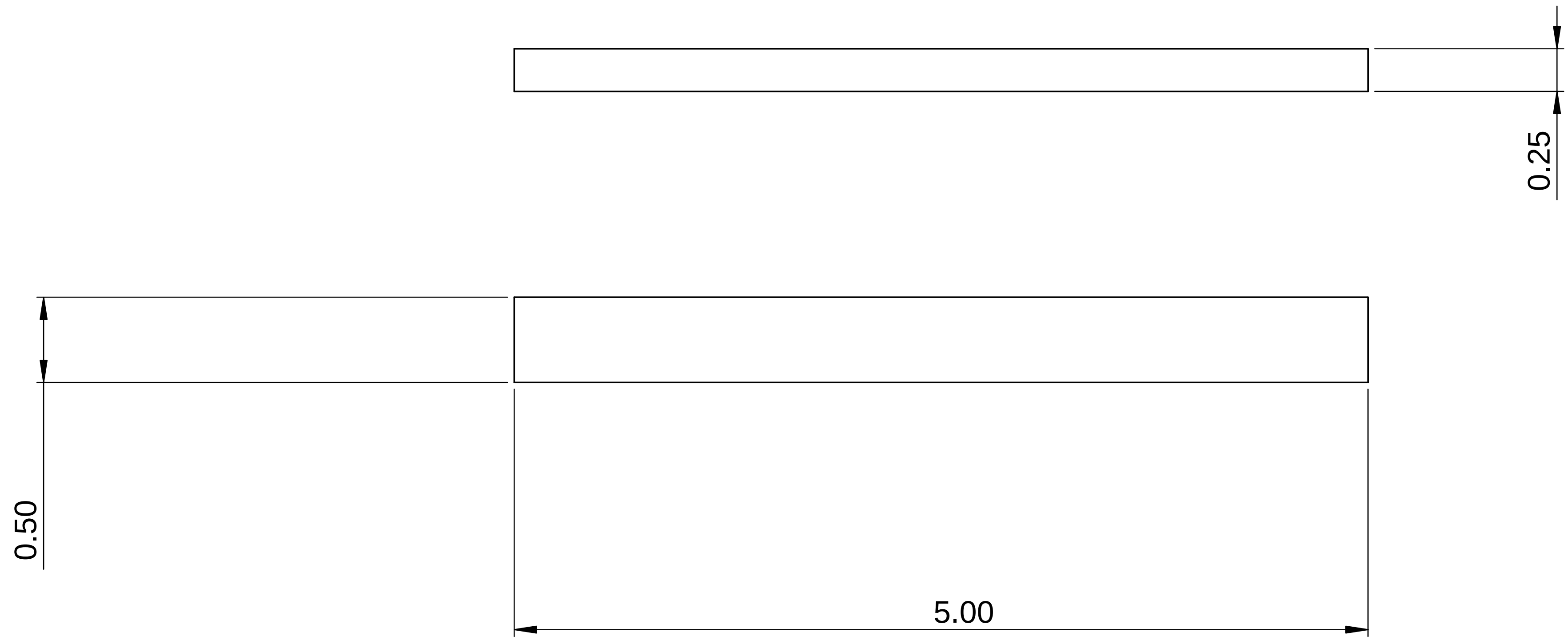

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DIMENSIONS ARE IN INCHES TOLERANCES: .125 in. FRACTIONAL ± 1/8 in. TWO PLACE DECIMAL ± .05 THREE PLACE DECIMAL ± .005	DRAWN	Alex Stringer	
	CHECKED	Joseph Hamel	
	ADVISOR APPR.	Dr. Shangchao Lin	
	FUNDING APPR.	Crystal Wells	
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo	
MATERIAL	COMMENTS:		
FINISH			
DO NOT SCALE DRAWING			

Team 7

TITLE:

SIZE	DWG. NO.	REV
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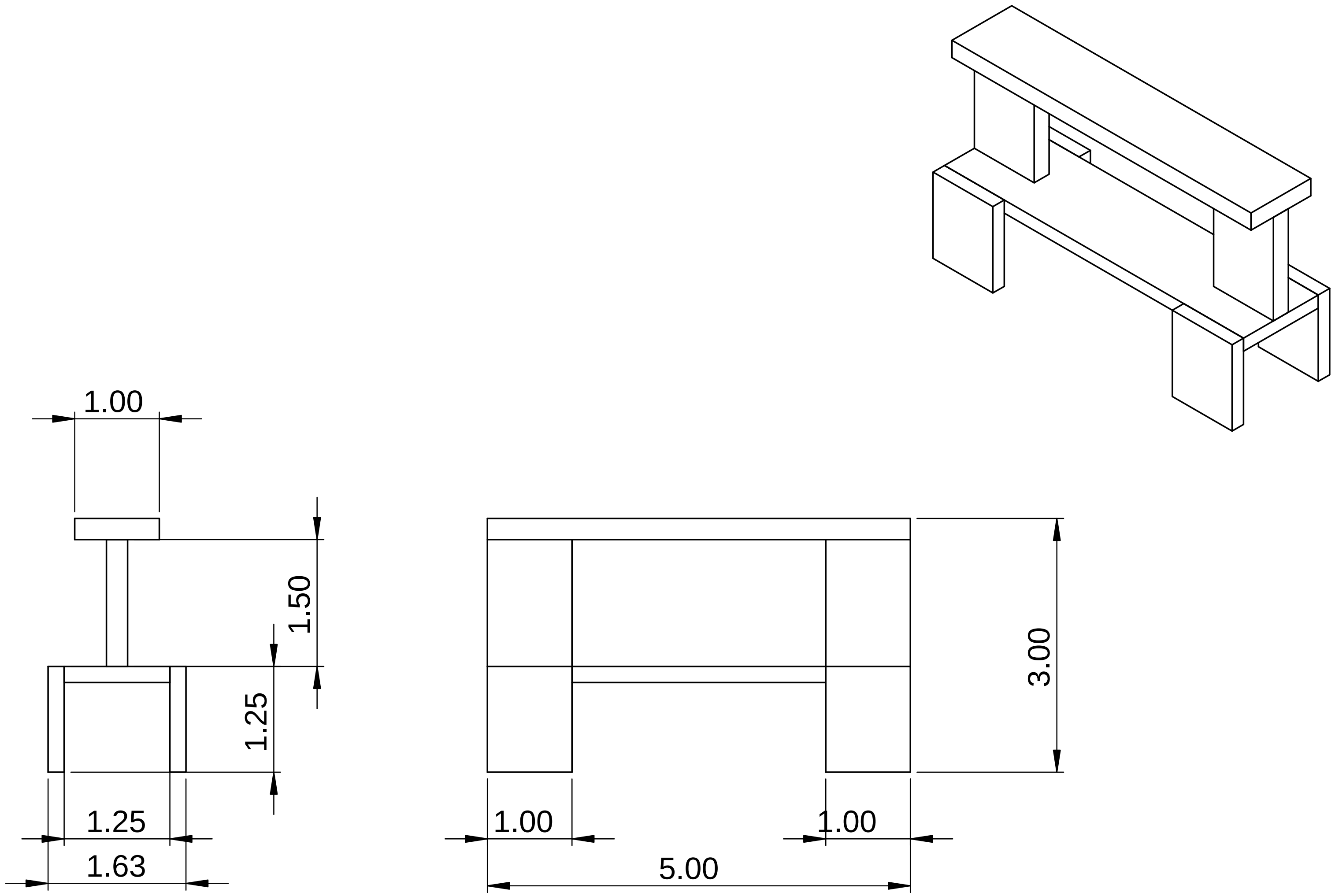

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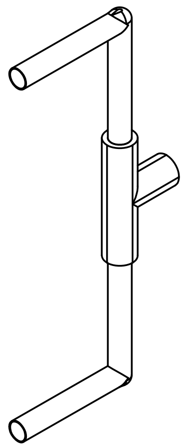
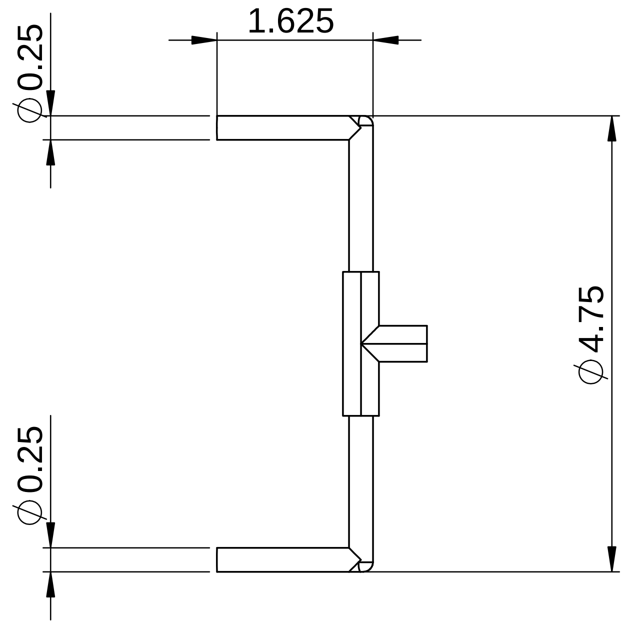
	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A · DWG. NO. Condenser Stand · REV
FINISH				WEIGHT: · SHEET 5 OF 6
DO NOT SCALE DRAWING				





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	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A · DWG. NO. Piping System · REV
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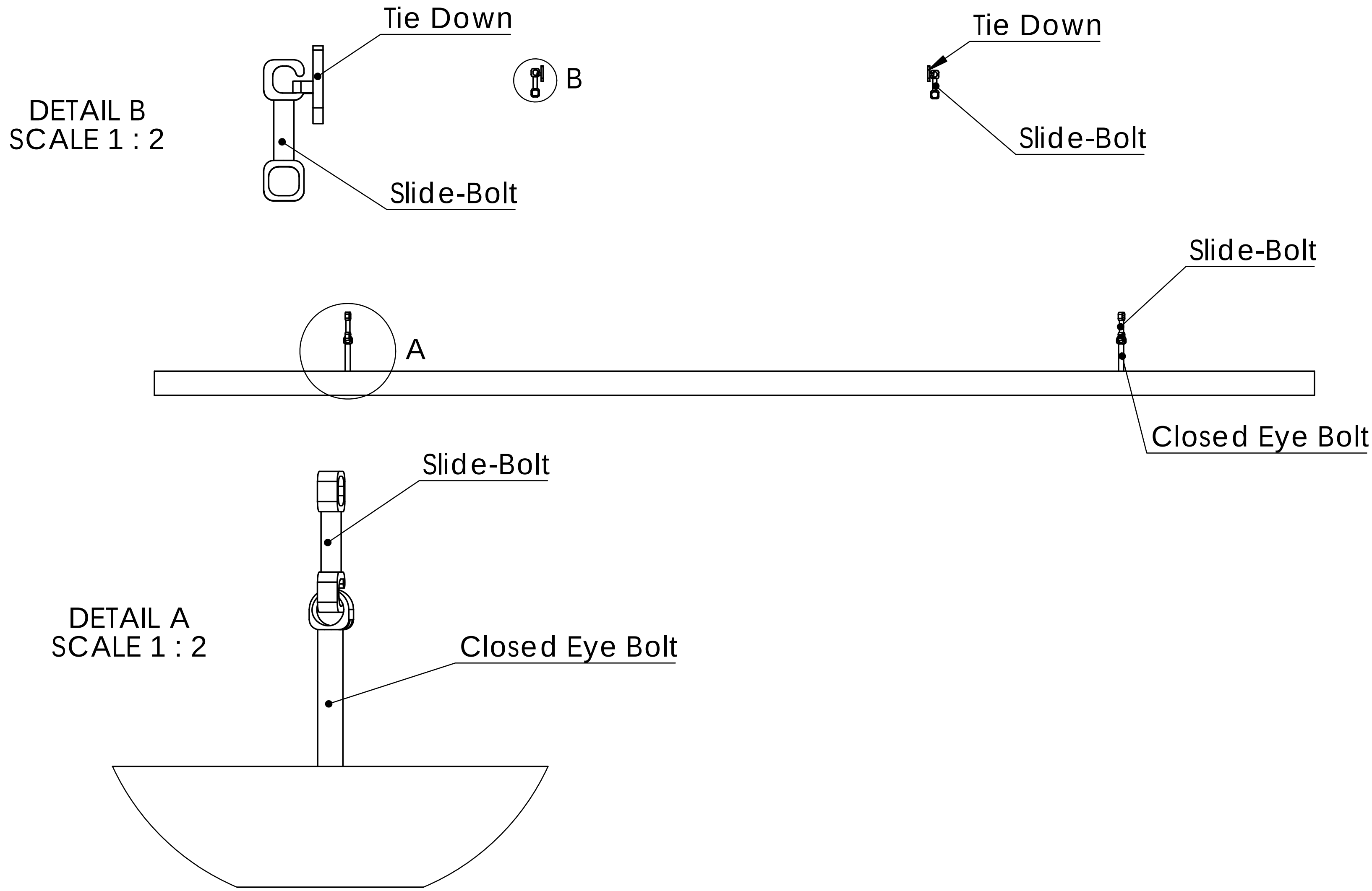

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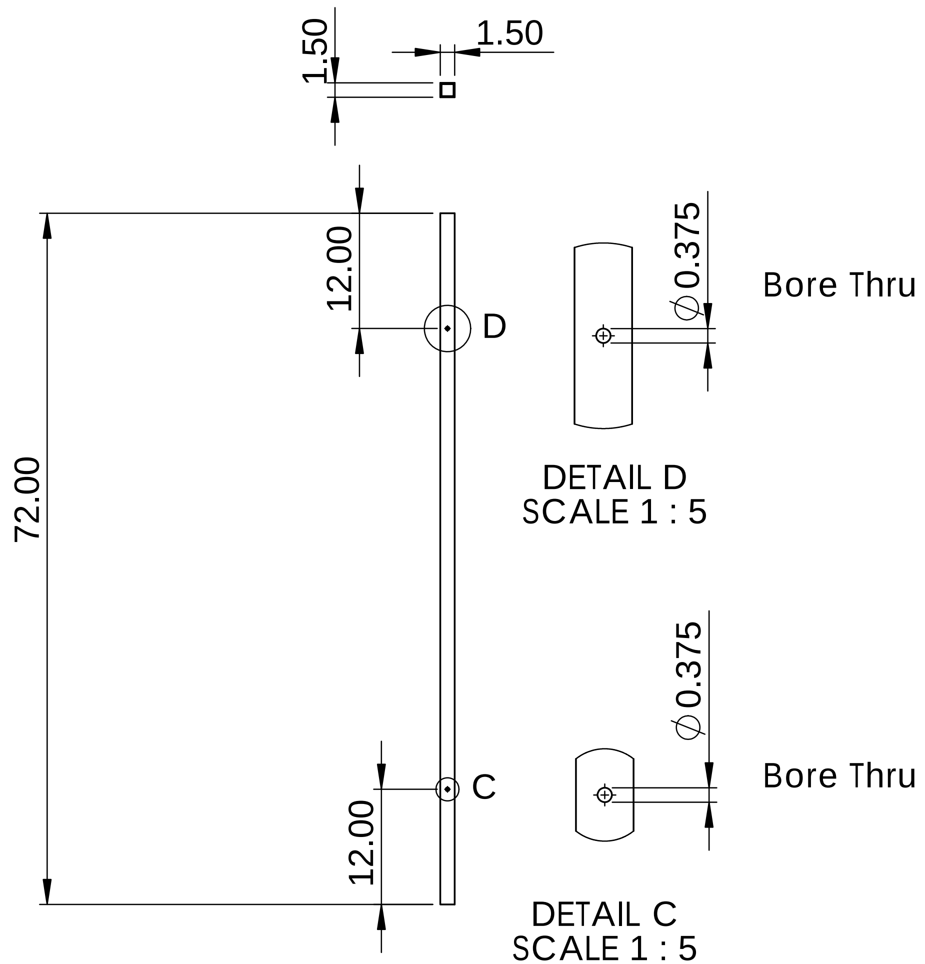
DIMENSIONS ARE IN INCHES TOLERANCES: .125 in. FRACTIONAL ± 1/8 in. TWO PLACE DECIMAL ± .05 THREE PLACE DECIMAL ± .005	DRAWN	Alex Stringer		TITLE:
	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A — DWG. NO. Sun Tracking — REV
FINISH				
DO NOT SCALE DRAWING				WEIGHT: — SHEET 1 OF 2



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DIMENSIONS ARE IN INCHES TOLERANCES: .125 in. FRACTIONAL ± 1/8 in. TWO PLACE DECIMAL ± .05 THREE PLACE DECIMAL ± .005	DRAWN	Alex Stringer		TITLE:
	CHECKED	Joseph Hamel		
	ADVISOR APPR.	Dr. Shangchao Lin		
	FUNDING APPR.	Crystal Wells		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	Alex Filardo		
MATERIAL	COMMENTS:			SIZE A — DWG. NO. Sun Tracking Bar — REV
FINISH				
DO NOT SCALE DRAWING				WEIGHT: — SHEET 2 OF 2

Apppendix B
Failure Modes Effects Analysis

Team #:	TEAM 07
Project Title	Solar Sausage for Water Desalination

Key Process Step or Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN	Actions Recommended	Resp.	Actions Taken	SEV	OCC	DET	RPN
What is the Process Step or Input?	In what ways can the Process Step or Input fail?	What is the impact on the Key Output Variables once it fails (customer or internal requirements)?	How **Severe** is the effect to the customer?	What causes the Key Input to go wrong?	How **often** does cause or FM **occur**?	What are the existing **controls** and procedures that prevent either the Cause or the Failure Mode?	How well can you **detect** the Cause or the Failure Mode?		What are the actions for reducing the occurrence of the cause, or improving detection?	Who is Responsible for the recommended action?	Note the actions taken. Include dates of completion.				
Storage Tank holds, partially filters, and preheats saline water	Leak causes saline water to leak out of storage tank	Water doesn't reach trough and entire process is stopped	6	Poor valve sealing	1	Good valve seal	2	**12**	O-rings inserted for proper seal between valve and bucket	Operator	O-rings inserted	6	1	2	**12**
	Filter doesn't take out large salt particles	Large salt particles remain in water	2	Poor filter manufacturing, bad placement of filter	2	Proper manufacturing and placement	8	**32**	Replace filter	Operator	Filter replaced	2	2	8	**32**
	Saline water doesn't heat enough	Evaporation rate is reduced	7	Not enough heat transfer to storage tank	4	Placed in direct sunlight	2	**56**	Longer pre-heating time	Operator	Not Necessary	7	2	2	**28**
	Saline water evaporates prematurely	Some saline water doesn't reach trough	5	Too much preheating of the saline water	4	None	2	**40**	Shorter pre-heating time	Operator	Current condition	5	4	2	**40**
Trough evaporates saline water	Temperature isn't high enough to evaporate	Evaporation rate is stopped	10	Poor focal point from Solar Sausage	2	Better pressurization and alignemnt of Solar Sausage	3	**60**	Two pressure guages for initial pressure and visual alignment	Operator	Pressure guages replaced and working	10	2	3	**60**
	Trough's too hard to level and keep water from bunching	Evaporation and condensation rate reduced	8	Trough isn't leveled	4	Proper height adjustment through stake depth in ground	2	**64**	Visually level water in trough by adjusting stake height	Operator	Done with assembling	8	4	2	**64**
Solar Sausage concentrates sun onto trough	Pressure difference isn't maintained	Temperature from focal point is improper	5	Wind or shading decreasing pressure, sun increasing pressure	5	Constant pressure regulation from workers	5	**125**	Regular check ups and adjustments for optimal focal point	Operator	Done with routine maintenance	5	5	5	**125**
	Focal point is too hard to keep and maintain	Sun doesn't focus onto trough	9	Sun's movement without proper alignment	4	Constant worker supervision	2	**72**	Regular check ups and adjustments for optimal focal point	Operator	Done with routine maintenance	9	4	2	**72**
Condenser condenses water	Evaporation rate too high for condensation	Water is unable to condense quickly	5	Trough is reaching too high of a temperature	5	Solar Sausage pressure regulated	4	**100**	Widen the focal point to lower temperature	Operator	Done with routine maintenance	5	5	4	**100**
	Evaporated water doesn't reach condenser	Condensing process can't begin	9	Water vapor escapes through ends	1	Guard rails on sides, wider condenser than trough, accept minimal losses	7	**63**	Redesigning the entire condenser	Team 7	Fixed during testing accepting minimal losses	9	1	7	**63**
	Condesing dome slope causes loss of clean water	Clean water is lost	7	Dome's angle of declination isn't optimal	2	Circular dome design of 2 inches	3	**42**	Adjusting the condenser slope	Team 7	Fixed during testing	7	2	3	**42**
	Sun heats condenser and impeads process	Condeser rate is diminished or depleted	9	Heat reaches condenser from top surface	3	Reflective prevention	4	**108**	Pour saline water to cool material	Operator	Done when deemed necessary	9	3	4	**108**
Channels run water from condenser to clean water storage	slope doesn't allow for proper water runoff	Clean water stays in channels and doesn't reach storage	8	Improper slope design of the condenser	1	Proper calculated slope design	2	**16**	Design better slope runoff angle of declination	Team 7	Fixed during testing	8	1	2	**16**

Appendix C Cost Per Part

Table 1: Stand cost per part breakdown

Stand Cost		
Part	# Needed	Cost
Leg	2	$ 26.40
Upper Cross Bar	1	$ 5.50
Lower Cross Bar	1	$ 5.50
Circle Hook	1	$ 1.98
L-Plate	4	$ 14.00
Nuts and Bolts	16	$ 5.12
	Total	$ 58.50

Table 2: Trough cost per part breakdown

Trough Cost		
Part	# Needed	Cost
Trough Channel	2	$ 54.78
Trough Wall	2	$ 7.00
Labor	45 min.	$ 60.00
	Total	$ 121.78

Table 3: Storage Tank cost per part breakdown

Storage Tank Cost		
Part	# Needed	Cost
Bucket	1	$ 13.40
Ball Valve	1	$ 40.43
Platform	1	$ 38.66
	Total	$ 92.49

Table 4: Condenser cost per part breakdown

Condenser Cost		
Part	# Needed	Cost
Condenser Channel	2	$ 23.85
Condenser Wall	2	$ 8.38
Stand	1	$ 16.77
Channel Connector	2	$ 8.38
Condenser Hood	1	$ 20.00
Labor	150 min.	$ 200.00
	Total	$ 277.38

Table 5: Solar Sausage cost per part breakdown

Solar Sausage Cost		
Part	# Needed	Cost
Solar Sausage Cost	1	$ 10.00
Foot Pump	2	$ 21.98
Pressure Gauges	2	$ 120.00
Needle Valve	2	$ 40.60
Barstock Tee	2	$ 14.10
Sun Tracking Bar	1	$ 45.87
Adhesive-Backed	2	$ 22.00
Steel Wire Rope Clamps	4	$ 14.12
Closed-Eye Bolts	2	$ 3.92
Stainless Steel Wire Rope	1	$ 26.50
Slide-Bolt Spring	4	$ 7.52
	Total	$ 326.61