Organic Refrigeration Chamber

Created by:

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College of Engineering and Applied Science
University of Cincinnati

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Thesis Advisor:

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ABSTRACT

For my senior design, I wanted to do something that was difficult and outside the norm. I wanted to create a product that can and be taken to market to be widely used. I decided to make a portable organ refrigeration chamber for organ preservation. The inspiration behind this idea, was the lack of convenience for all of those on long waitlists in desperate need of an organ transplant. I also was a refrigeration engineering co-op at Cincinnati Sub Zero, where I learned a great deal of background into the refrigeration process and the process of creating a refrigeration chamber. My expertise in refrigeration mixed with the need of a better organ carrying solution was the driving force for this senior design. The goal is to create a chamber that is portable yet creates a nurturing environment for the fragile organs. Hopefully after the creation of this product, I am able to patent my work and take this chamber to market. Designing this chamber is a large task but I am ready to take on this challenge. Throughout this design process, I will learn skills that will benefit my development through college and into the real world.

Problem Statement

For my senior design project, I have decided to make a Portable Chamber for Organ Preservation. This device will be used to hold organs at a desired set point during medical transport. The set points I will try to reach will be 0, 20 and 40F. The purpose of this chamber will be for simple loading, storage, and relocation of organs while maintaining an environment suitable for a successful transplantation.

Background

Organ Transplantation was introduced in the 20^{th} century and today has expanded to become one of the greatest innovations of the 21^{st} century. If a person's organ were to start failing and they needed a new one, there is a process in place to receive a new heart, intestine, liver, lungs, and many more. Organ Transplantation started in 1954 with the first successful kidney transplant from a living donor. In 1962 the first successful kidney transplant from a deceased donor took place and that discovery revolutionized the idea. (1) Throughout the 60's there were successful innovations such as Lung, Pancreas, Liver, and Heart transplants. After removal of the organ, the difficult part is finding a way to preserve the organ's vulnerable condition. Another thing to consider is your method of transporting the fresh organ as any bump or drop can seriously damage the organ and it cannot be used.

The science of organ preservation has grown with transplantation but the same principle technique has remained. The organ must be removed than preserved by cooling. It was found that cooling the organ worked well with decreasing inflammation. Cooling is also necessary to reduce cellular metabolism and the requirements for oxygen to prevent tissue injury (2). Cooling treatment and organ performance are related to the method of preservation.

As expected, there are less available organ donors than there are people needing an organ. This creates a shortage of organs and it is important that all available organs are being transported carefully to ensure proper functionality. The main goal of organ preservation is to maintain organ function while it is being relocated to the recipient (2). There are two ways of preserving transplantable organs; Static or Dynamic Preservation. Static cooling preservation relies on cooling alone to preserve the organ, while dynamic preservation activates the organ metabolism (2). Although both methods have proven to yield similar results, the common way of organ preservation is Static Cooling Preservation.

Current State of the Art

The market of Organ Transplantation devices is very small and almost unexplored. Most modern residential hospitals transport their organs by wrapping them in a couple plastic bags filled with saline and placed in a picnic cooler filled with ice. Not much expertise is spent on what is a precious investment to the recipient. With the current transportation method, organs quickly deteriorate and are completely unusable after 4 hours. (3) This huge limitation creates problems with the organ's function and success rates. This limits how many people can get an organ, and also the proximity in which the recipient needs to be for them to receive the organ.

Recently private companies are getting into the organ transplantation market offering services to transport organ by air, ambulance, medical evacuation, and commercial medical escorts. A few companies have sprung up that produce small cooling devices that are

designed to carry organs. 1999, Organ Transport Systems, Inc. created the LifeCradle Heart Perfusion System. This device uses an oxygenated hypothermic solution that provides life-sustaining nutrients, and a temperature controlled environment to cool the organ and can preserve a single organ for up to 12 hours. (3)

Another Company, TransMedics has created its own organ care system. This system utilizes the technique, Living Organ Transplant. This system maintains the organ in a warm, functioning state outside of the body which allows for continuous evaluation. (4) The market is now producing amazing discoveries but I believe there is much more potential for the organ preservation and transportation market.

Customer Profile

The portable refrigeration chamber I will create, will be a device that will be beneficial to many people in all facets of life. It will be relatively small, and will maintain the desired set temperature. The main feature of this product will be its Portability. The ideal use of this device will be its mounting ability in any medical vehicle and its easy transportation into any medical facility. This device will be great for helicopter or ambulance transport which will appeal to the interest of private research facilities and medical facilities. Hospitals and research facilities have been slowly producing their own devices and some have moved on to outsourcing to private retailers for cooling solutions. This chamber is designed for quick mobility and functionality which makes this device good for standby operation. These portable coolers could be strapped into Safety Patrol Vehicles or could be in the operation room assisting in organ transfer. The ease of use and quick mobility is what makes it very versatile in its capabilities.

The most important person affected by this process will be the patient receiving the organ. Around the world there are thousands of people waiting on an organ transplant. Once you begin the process of requesting an organ transplant, you are put on a long waiting list for the next available organ. The odds of receiving a new organ quickly is slim to none. According to the Global observatory on Donation and Transplantation, around 120 thousand organs are being transplanted annually. 41.6% being kidney transplants and 20% being liver transplants. In America alone there close to 40 thousand organ transplants in 2016. (5) With that amount of transplants occurring, patients shouldn't be waiting months to get organs. The turnaround for organ transplant needs to be much better to help the patients as well as the medical world itself. If the market is analyzed well and the customer requirements are met, this product could be bought and sound around the country and even the world.

Research Conclusions

Seeing what challenges this market faces with the shortage of organs, there is an opening for a reliable solution. Cooling has been proven to be the best and most widely used practice in preserving organs and will be used as the basis of this design project. Investigating the customer needs, this device needs to be very maneuverable, low weight, and effective. I believe if I accomplish these goals this cooler will be top tier in its abilities. I have a few resources from my previous co-op and will get the manufacturing done on my own. Once the design is complete and manufacturing begins, I believe this chamber can be created in a couple months. The objective of this device will be to create a safe and reliable organ preservation device, while maintaining mobility, and requiring the least amount of handling possible. This chamber will also be able to store multiple organs at low temperatures to preserve the organ for an extended period of time.

Customer Features (List of Needs/Concerns)

- ***Easy to use***
- ***Maneuverability/Mobility***
- ***Light weight***
- ***Load Capacity***
- ***Easy to maintain***
- ***Cools to desired temperature***
- ***Inexpensive***
- ***Cools quickly***
- ***Battery Powered/Utility Cable***

House of Quality

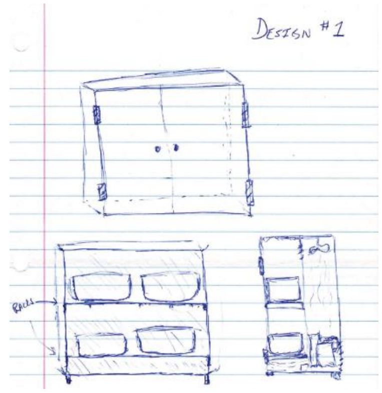
	Importance Weights	Hinged Door With Latch	Wheels/Casters	Weight (lb)	Holds Multiple Organs	Cleanable Surfaces	Reaches 0 degrees F	Insulated	120 Volt Battery	Cost	Painted Finish
Ease of use	0.1	9									
Manueverability/Mobility	0.2		9	3		1		1			
Light Weight	.1		1	9	3	1		1			
Load Capacity	0.05			3	9						
Easy to maintain	.1					9					
Maintains desired Temperature	.2						9	3			
inexpensive	0.05									9	
Battery Powered	0.1								9		
Low noise	0.05							3			
Good Appearance	0.05										9
Engineering Requirement Importance		0.9	1.9	1.65	0.75	1.1	1.8	1.05	0.9	0.45	0.45

Product Objectives

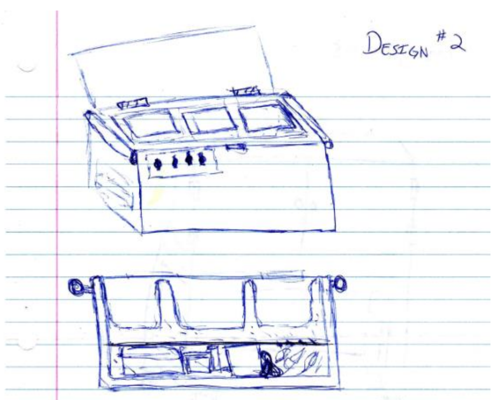
- ***Portable (Wheels or Casters)***
- ***Low Weight***
- ***Reaches Desired Set Points***
- ***Easy To Use***

Concept Selection

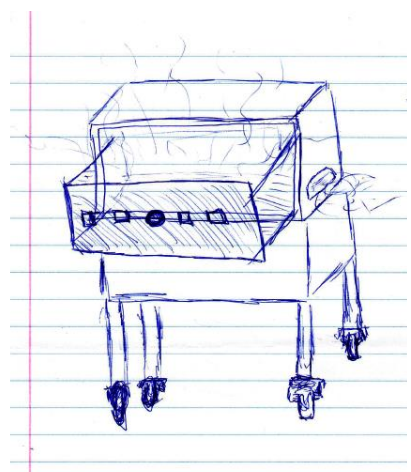
The most creative part of this design process was coming up with different concepts to select from to create my final concept. The first concept I created was a cabinet style chamber with two hinged doors. When you open the doors, there will be racks that will hold individual organ holding containers. These containers will be removable. Also, the refrigeration compartment on his concept will be in the back of the chamber. This size will be somewhat large and meant to be set on a bench top.



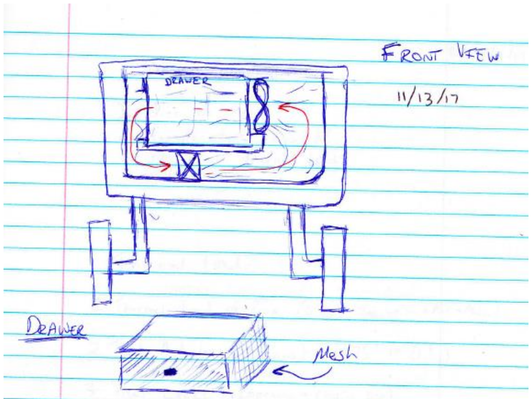
The second concept I came up with was a treasure chest style design with a hinged door on the top. When you open the chamber, there will be 3 padded slots that will be a good cushioned surface for the organs to rest on and remain cool. For this design, the box itself will be a lot shorter than the last, but a bit wider. The width of this box will allow it to be easily tucked away against a wall. Also there will be two steel bars for lifting and the refrigeration compartment on this chamber will be underneath the organ holding slots.



My third and final design concept is a drawer design. This drawer design has the same width as the last concept, but the door will be on the front of the chamber. When you pull out the cooled drawer, the organs will be able to be set into individual padded sections for comfortable transport. The refrigeration will be under the holders, and all of this will be supported up by legs and wheeled casters for mobility. Like the last design, the cooling compartment will be below the organs. Cold air will be blown past the drawer causing it to cool the organs.

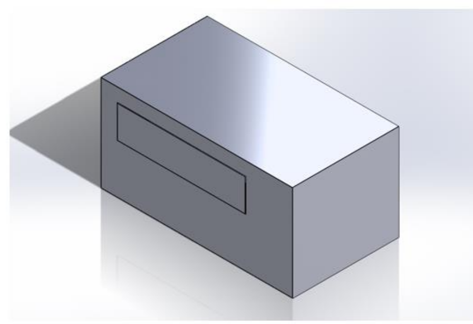


The Design concept I decided to go with is the Drawer Design. I chose this one because ergonomically this chamber will be easiest for the end user. The drawer only requires one hand to open it, where the other concepts may have required two. Also on this concept, there



are legs and wheels for mobility which will be a key asset. The final reason why I decided to pick this concept is the fact that the top of the chamber is another surface that things can sit on. This is the best use of space while still maintaining a great environment for the organs.

Once I had picked my concept, I had to think deeper into how the product would work. Just like I had mentioned, the refrigeration compartment will be below the drawer, so there needs to be an air flow coming from under the drawer, through the drawer, and back down to the refrigeration compartment. I decided to have my compressor, condenser, and evaporator below the drawer, with small fans mount on both sides of a mesh drawer that will allow cold air to pass through. This is just the beginning of the design process, but I feel like I have a decent idea of how the product will work.



Detailed Design

To begin the design process, I had to understand the scope of the task at hand. To create this refrigeration chamber I knew there would be various rounds of calculations, solid works modelling, and sheet metal work, but wasn't quite sure where to start. I first started with creating a basic concept of my drawer chamber with overall dimensions 36"W x 18"T x 18"D. I figured this design of a box could be great for ledge mounting and the drawer will be big enough to store multiple organs at once. Once I had this design complete, I had to do heat

75F to 0F	**75F to 20F**	**75F to 40F**
$In\ 1\ Hour: 1618.95\frac{Btu}{hr}$	$In\ 1\ Hour: 1187.185\frac{Btu}{hr}$	$In\ 1\ Hour: 775.485\frac{Btu}{hr}$
$In\ 30\ min: 2676.25\frac{Btu}{hr}$	$In\ 30\ min: 1962.53\frac{Btu}{hr}$	$In\ 30\ min: 1188.89\frac{Btu}{hr}$
$In\ 15min: 4790.95\frac{Btu}{hr}$	$In\ 15min: 3513.22\frac{Btu}{hr}$	$In\ 15min: 2377.78\frac{Btu}{hr}$

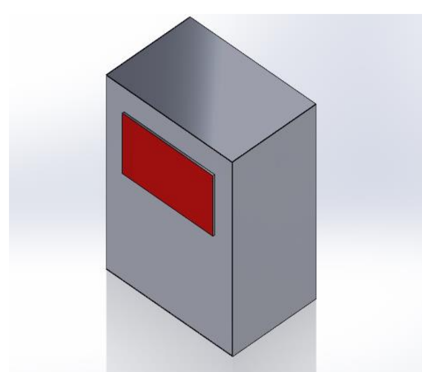
load calculations to get an understanding of the amount of thermal load this box would create, and how much capacity will be needed to overcome this thermal load. Once I had a thermal load calculated and converted into BTU's I could now begin sizing my refrigeration components. The thermal load helps determine what size compressor to use, which will in turn size your condenser and evaporators. The process seemed straight forward as I was on my way to sizing and selecting all of the refrigeration components needed for this project.

Problems/Concerns

Problems began to arise about a month into the detailed design phase. I had my prototype chamber complete, and was finalizing my component selection when I realized the problem. There was a key mistake I made during the calculation stage. Without a full understanding of the design, I didn't account for how the chamber was going to be powered. Because the main function of this chamber was its portability, there couldn't be wires and power cables coming from the chamber. The chamber had to be battery powered and all of the components I had selected were based off a compressor unit that runs using a 460V power supply. This type of power supply will not work for portable functions, so all of my design needed to be reconsidered.

Redesign

I immediately began redesigning my refrigeration chamber to be ran off a battery cell. This task proved to be more difficult than I had previously imagined. To begin the redesign process, I had to find a compressor that would run off battery power, and a corresponding battery. My search on the internet turned my attention toward, mini condensing units. A condensing unit is a unit that come fully equipped with a compressor, condenser, blower fan, and can run off a 12 volt battery pack. This miniature sized condensing units seemed perfect for my steady state chamber, but there was only one problem. None of these small condensing units, could overcome that large amount of thermal load that my current design generates. Stuck in a pretty large predicament, I decided to redesign my chamber again. My goal was to shorten its dimensions to create a smaller cooling area, with less thermal load. While I was shrinking the box, I had to also consider the size of the drawer. I wanted to maintain the large



size of the drawer to accommodate multiple organs. My solution was to a chamber with the dimensions 18"W x 20"T x 12"D. This box is roughly half the size of the first box, which

75F to 0F

$$In\ 1\ Hour: 964.52\frac{Btu}{hr}$$
$$In\ 30\ min: 1459.16\frac{Btu}{hr}$$
$$In\ 15min: 2448.44\frac{Btu}{hr}$$

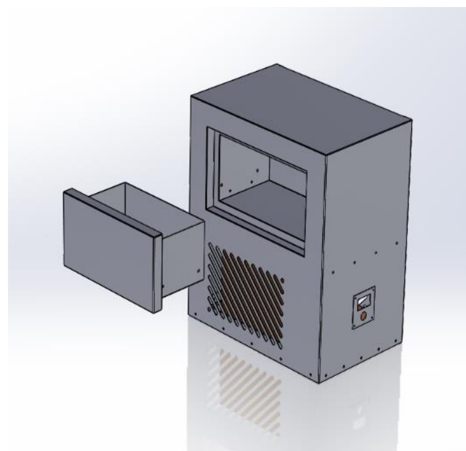
75F to 20F

$$In\ 1\ Hour: 707.327\frac{Btu}{hr}$$
$$In\ 30\ min: 1070.068\frac{Btu}{hr}$$
$$In\ 15min: 1795.55\frac{Btu}{hr}$$

75F to 40F

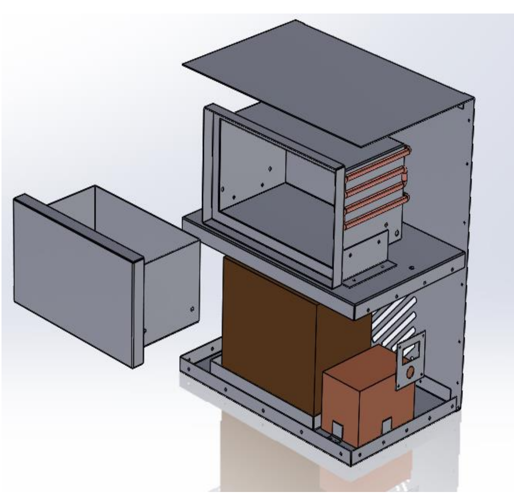
$$In\ 1\ Hour: 450.224\frac{Btu}{hr}$$
$$In\ 30\ min: 681.062\frac{Btu}{hr}$$
$$In\ 15min: 1142.738\frac{Btu}{hr}$$

meant I effectively cut down half the load of the chamber. Luckily after performing these calculations, I found that the thermal load of the chamber was significantly less than the capacity of the condensing unit. Now, I had a condensing unit and box design that will work for this application. Now that I had a finalized idea of the things that would be needed, I started to order parts and began to look forward to manufacturing of the chamber.



Manufacturing Process

Going into it, I knew the manufacturing process was going to be the hardest part of this design. Coming up with prototypes and concepts is the easy part but actually coming up with a way to get things created is the hard part. My first step was to create manufacturing drawings that will be the reference for how the sheet metal cabinet will be created. To do this, I had to alter my solid works prototype toward something that can be successfully made. A few of the considerations I had to make were the sheet metal fit ups, bolt hole sizes, bend radii, and clearance gaps. It took a couple iterations but I was able to successfully create a design packet including various exploded views and detailed dimensioning.



Once my drawings were finished I turned them into the shop technicians at Cincinnati Sub-Zero, who were going to help me create this chamber. My drawings were uploaded into the program of a laser cutter which quickly cut my parts. Once the sheet

metal was cut, the pieces were moved to be bent and then welded. Once the pieces were bent and welded, there were 5 main components that needed to be assembled. These parts were then moved to the assembly section of the shop. Here is where I had more hands on involvement in the project. Assembling the parts was somewhat simple, I used rivets and bolts to put together the frame. The difficult part would be the bending and braising of pipe running from my condensing unit and around my cooling

compartment. This technique is what is called a 'Wrapped Evaporator'. I was a bit skeptical about how effective this wrapped evaporator would be in my application but I didn't have any time for other alternatives. The key with the wrapped evaporator is having enough length of pipe to ensure proper evaporation temperatures, as well as having enough metal to metal contact to actually cool the cooling compartment itself. I worked closely with a refrigeration technician during this stage of the assembly. A critical part of the refrigeration piping is filling the newly created circuit with the refrigerant needed, which is called

'Charging' the unit. For this specific condensing unit, I used 3.25 ounces of R-134a refrigerant. Next challenge was getting the refrigerant into the system which is a tricky process. R-134a cannot just be poured into the condensing unit, doing so will cause the refrigerant to mix with the air and damage the properties of the refrigerant. To add the refrigerant, the circuit was vacuumed to remove all air present, then the low pressure created by the vacuum pulls the refrigerant into circulation throughout the system. Once the refrigeration system was charged and the cabinet frame was assembled, the last couple of steps were to insulate the cooling compartment using fiberglass and complete some simple wiring. Getting the design to this point was no easy task. The last step is to test the chamber's functionality.

PROJECT MANAGEMENT SCHEDULE

- ***Research Presentation 10/2***
- ***Senior Design II – 10/12***
- ***Week of 10/16 – Visit CSZ run ideas by Kale begin drawings***
- ***Week of 10/23 – Work on Drawings and Design***
- ***Week of 10/30 – Continue Working On design***
- ***Week of 11/6 – Finish Design work, create wish list of parts***
- ***Week of 11/13 – Revisit CSZ, Review Parts List***
- ***Week of 11/20 – Time for Rework of Design***
- ***Week of 11/27 – Finalize Drawings and Concept of Cooler***
- ***December – Get Ahead with Manufacturing. Get materials together, possible order parts***
- ***1/8 – Begin Manufacturing Drawings***
- ***1/28 – Preliminary Design Review (CSZ)***
- ***1/28 – Begin Redesign & Change all drawings***
- ***1/30 - Condensing Unit Arrives***
- ***1/30 - @ CSZ (Finalize Requirements)***
- ***2/6 - @ CSZ (Design Review)***
- ***2/16 - @ CSZ (2nd Design Review)***
- ***3/2 - @CSZ (3rd Design Review)***
- ***3/5 – Submit Final Drawings/ Begin Manufacturing***
- ***3/9 – Sheet Metal has been cut***
- ***3/12 – Begin Assembly***
- ***3/19 – Finalize Evaporator, Charge Unit, Insulation***
- ***3/29 – Finalize Assembly***
- ***4/2 – Begin Testing***
- ***4/5 – Tech Expo***
- ***4/16 – Final Design Presentation***

PROPOSED BUDGET: $2,000.00

ADJUSTED BUDGET: $500.00

Final Project Management

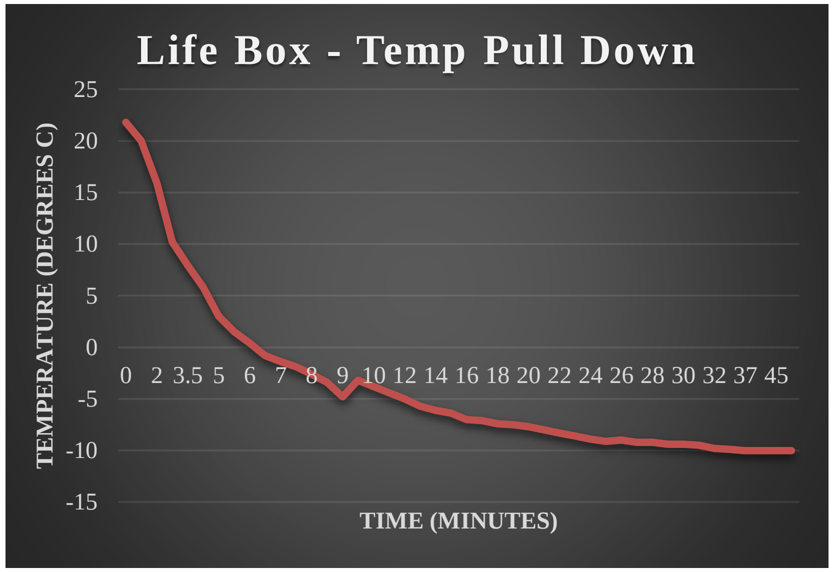
The time management aspect was the hardest part of this whole project. I had created a plan of action to get this design done, but there were unforeseen road blocks that kept stopping me, which lead to the redesign. Once I had to rethink my entire chamber, my initial project schedule had to also be redone.

After talking to the laser cutter operator, I found out that my parts could be done relatively quickly, about 4-5 days. Once I heard this, this drastically changed my outlook on the new manufacturing timeline. I had about a month left until the tech expo, but the shop technicians kept reaffirming me that this could be done in 2 or 3 weeks' time.

Just like they had said, I was able to complete the chamber just before the tech expo. My stress level was at an all-time high, but I there was a couple days left to do my testing. At the end of the day, I was happy to create a working chamber although the path to getting there wasn't quite as I had planned. The next and final step was to do the testing analysis of the chamber's performance and accessibility.

Testing

There were various tests I wanted to perform on the chamber to verify how it would work in the field. The first set of test I did were ergonomic tests to see the mobility of the device. I first did a weight test to see how much it weighed, and it came out to being 60lbs. This is a decent amount of weight, but not immovable. My next test was a pick up and put down test to see how easy it is to lift off the ground. I tested this with two other students and they both were able to lift the chamber off of a table and lift it from the floor. Although they were able to do this easily, they mentioned that it is a bit heavy after multiple times picking it up. The last test I did was a carrying test. I wanted to see how far one could carry the chamber before fatiguing. For this test, I went to a parking lot and tried to carry the chamber for as long as I could. I was able to carry the box roughly 100 meters before fatigue. My conclusions from these personal tests were that this box is easily movable in short distances but if one were to transport this box over a long distance, it may require additional assistance or the use of a cart. The next set of tests were Technical Tests. These tests are where I am going to get useful information about the chambers performance. The first one I did was a Temp Pull down test to see what the lowest possible temperature is. Once the chamber temperature stabilized, it was about -10C or 14F. I immediately went into the 2nd test which was to test the temperature duration. I ran the chamber for 4 hours and it held at -10C the entire time. Looking at the data, the chamber performed extremely well. Majority of its pull down occurred within the first 10 minutes. This will be an asset toward marketing its performance and will appeal to those who want to use it for quick use application. The chamber's performance in the duration test, also showed that it can be a reliable tool for at least 4 hours. This will be great for the long distance travel in helicopters or medical evacuations.



Final Conclusions

After going through this grueling process of producing a portable refrigeration chamber, I have learned a lot about what it takes to create a product from start to finish. At the beginning of this design, I had underestimated the amount of time and energy it would require. At the final tech expo, my chamber performed well and the audience really enjoyed hearing about my final product. I have decided to call this device the "Life Box", and to my surprise it received the 2nd place award at the MET Tech Expo. I was beyond ecstatic to hear the good news because at one point I didn't know if I had a workable design. My plan going forward is to keep furthering this design to making it even better. There is a large void in the market for a specialty refrigeration transport device, and the "Life Box" has great potential. Reflecting back on the time spent, this was such an important journey in my professional development and one of the largest accomplishments of my life.

REFERENCES

1. **Organ Transplantation History.** ***Live On NY.*** **[Online] Blue Mountain Media, 2017. http://www.liveonny.org/all-about-transplantation/organ-transplant-history/.**

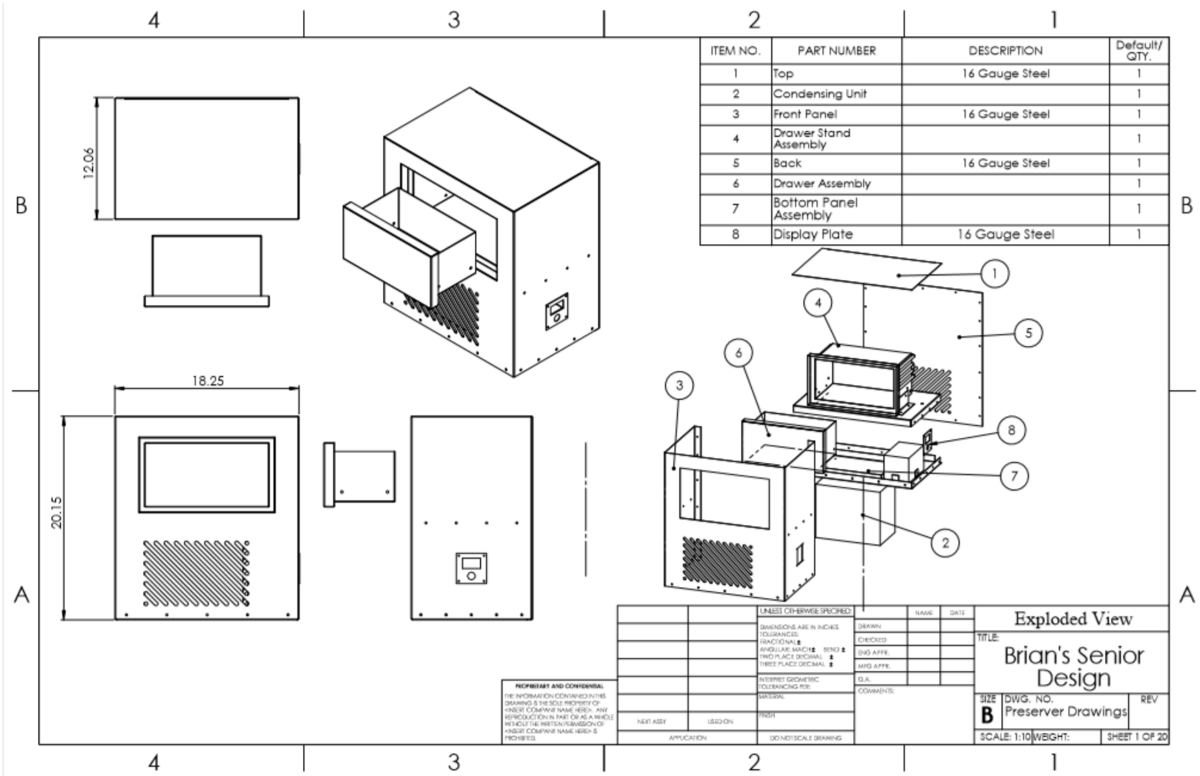
2. Organ Preservation: Current Concepts and New Strategies for the Next Decade. ***US National Library of Medicine.*** **[Online] Karger Publishers, 2017. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3088735/.**

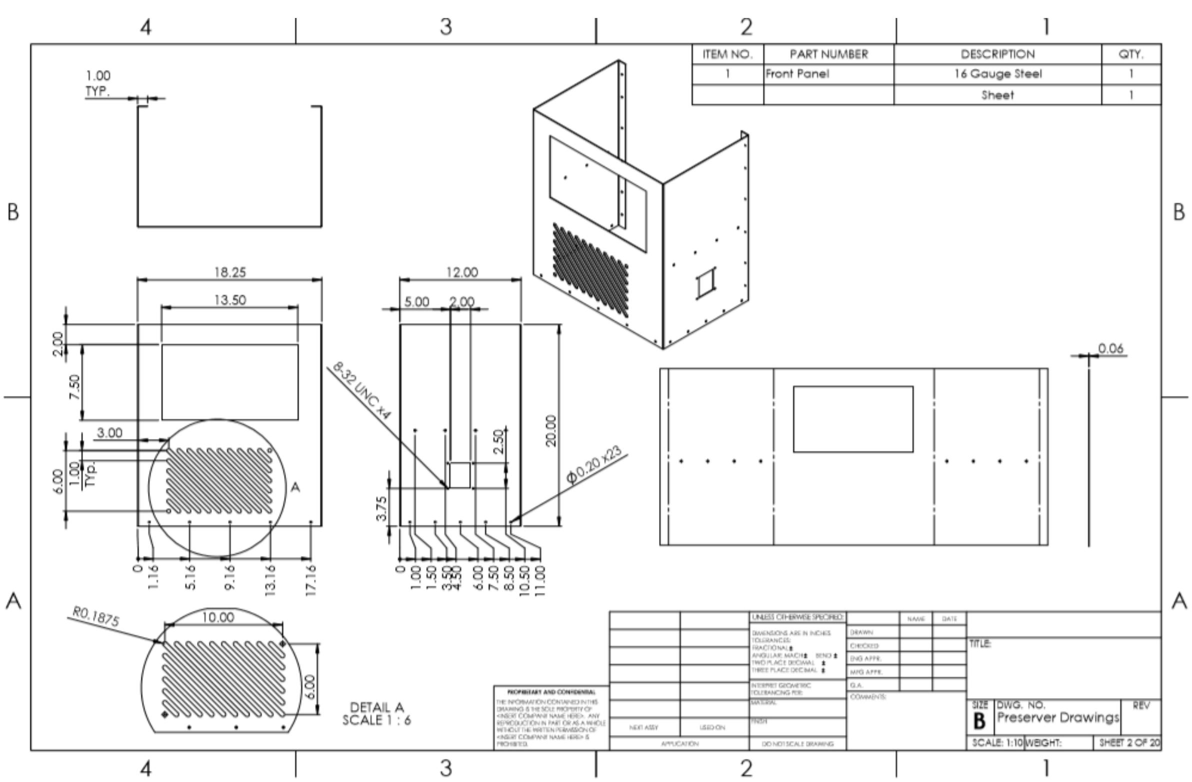
3. Our Technology. ***Organ Transport Systems Inc.*** **[Online] Organ Transport Systems, 2012. http://organtransportsystems.com/OurTechnology.html.**

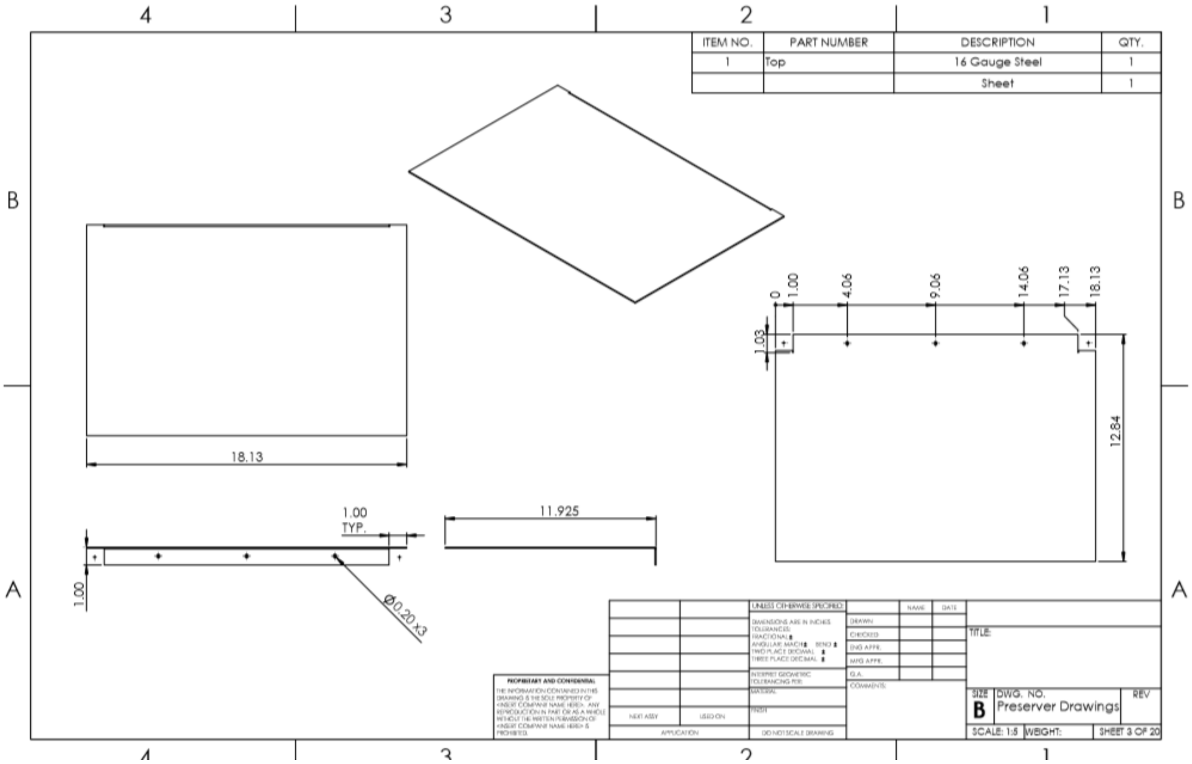
4. Transmetics Organ Care System. ***TransMedics.*** **[Online] 2017. http://www.transmedics.com/wt/page/organ_care.**

5. Transplpant Observatory. ***Global Observatory on Donation and Transplantation.*** **[Online] Global Observatory on Donation and Transplantation, 2016. http://www.transplant-observatory.org/.**

<u>CAD Drawings</u>



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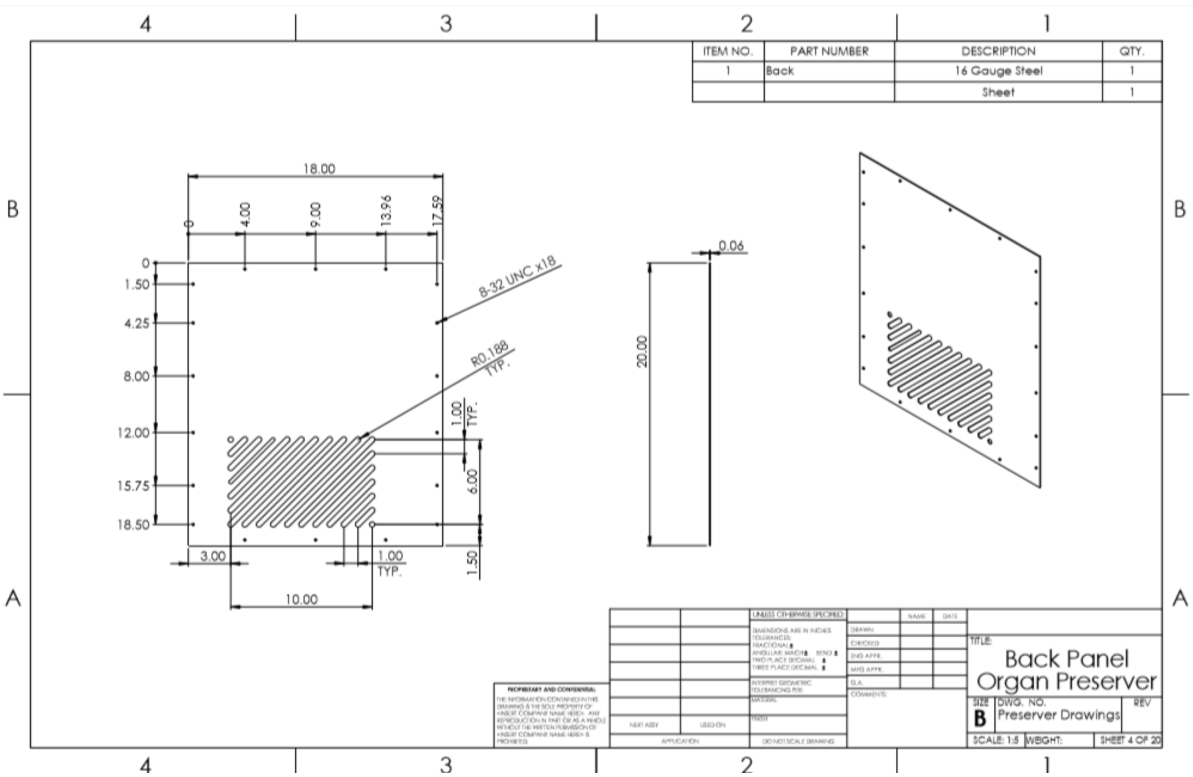
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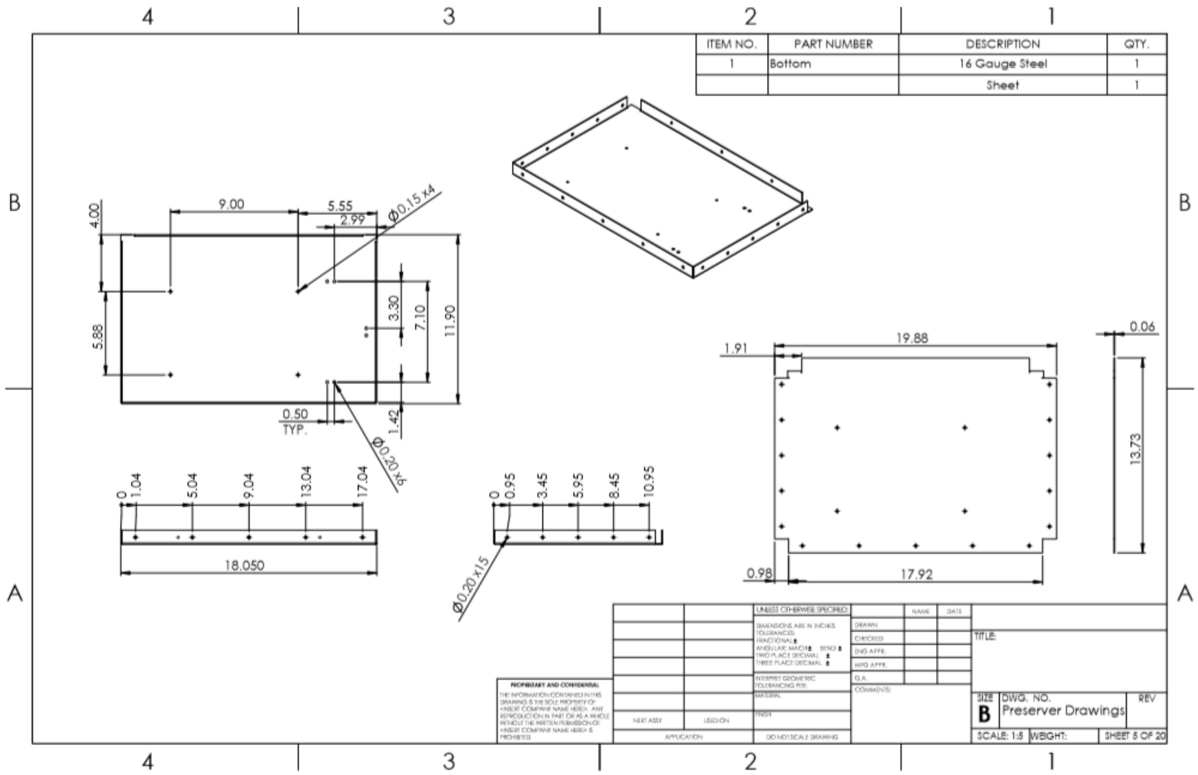

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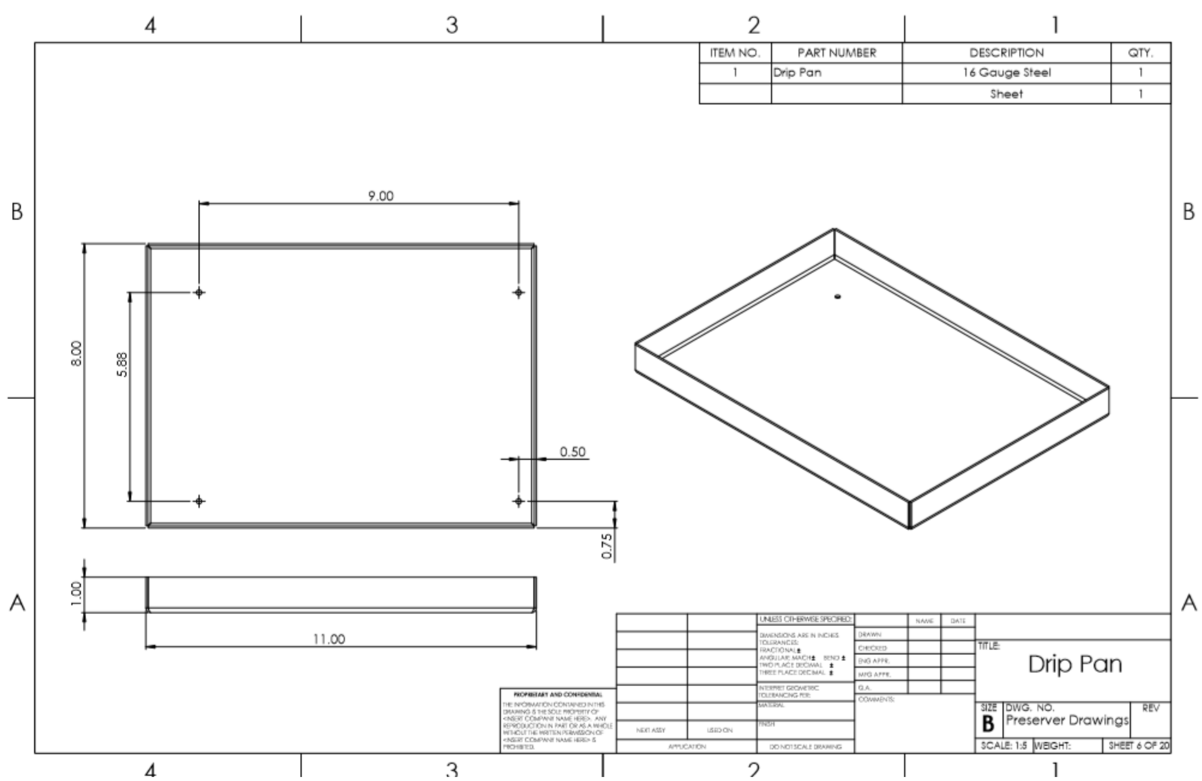
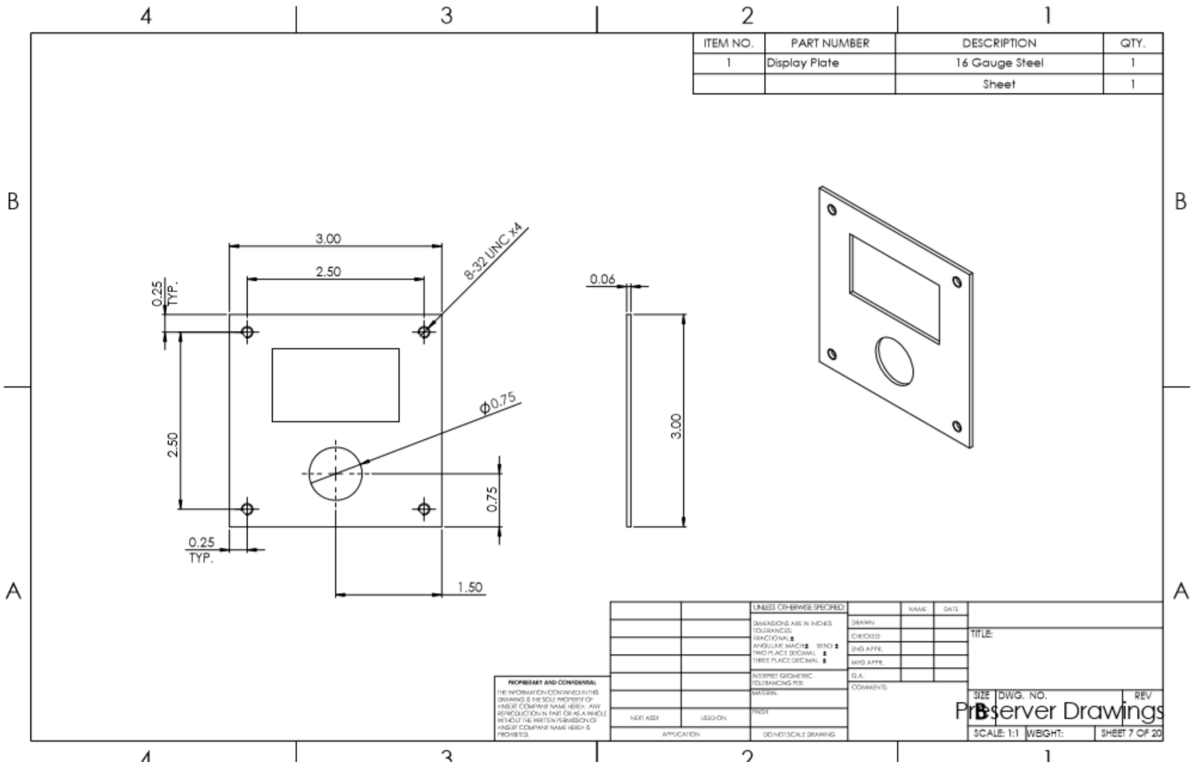
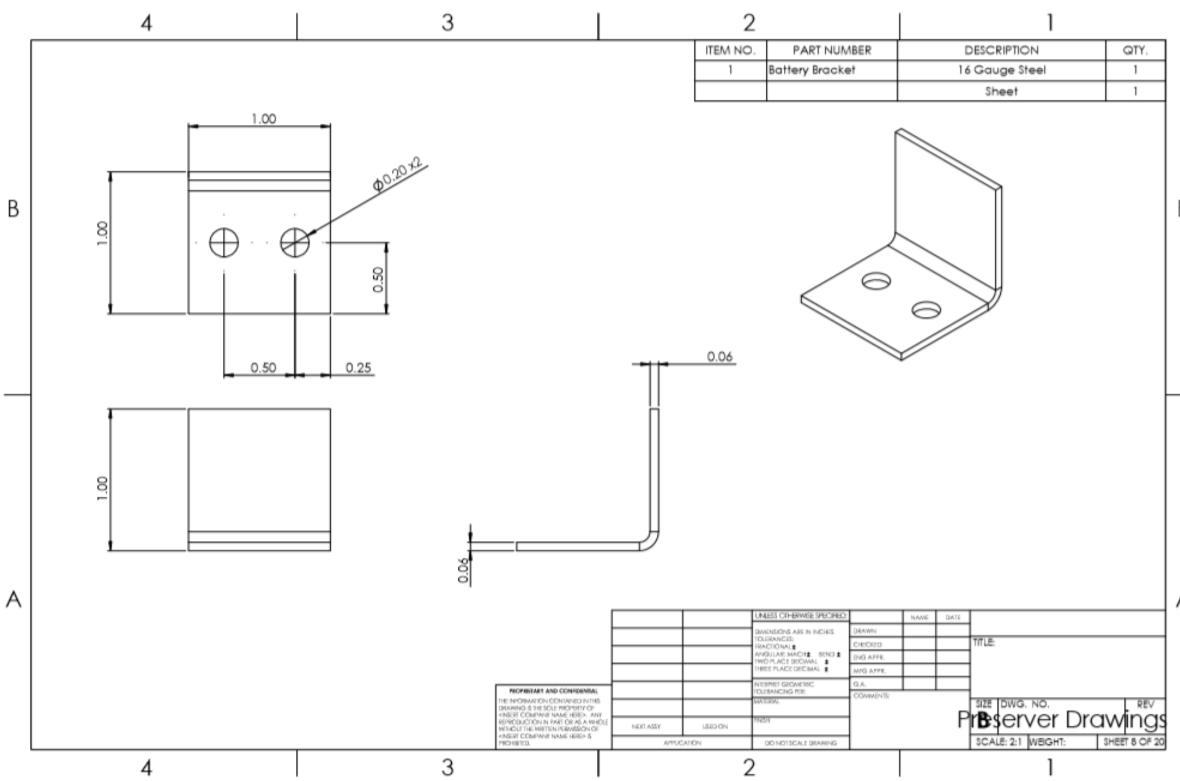
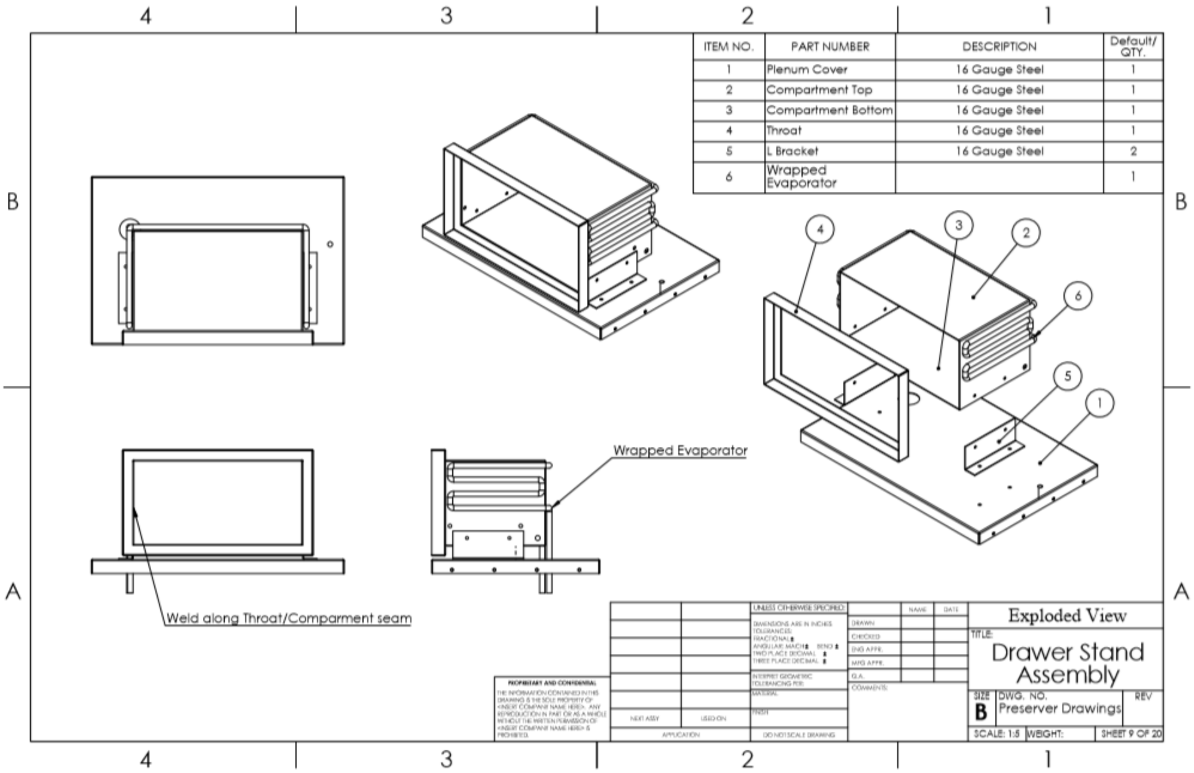
WEIGHT:
SHEET 5 OF 20

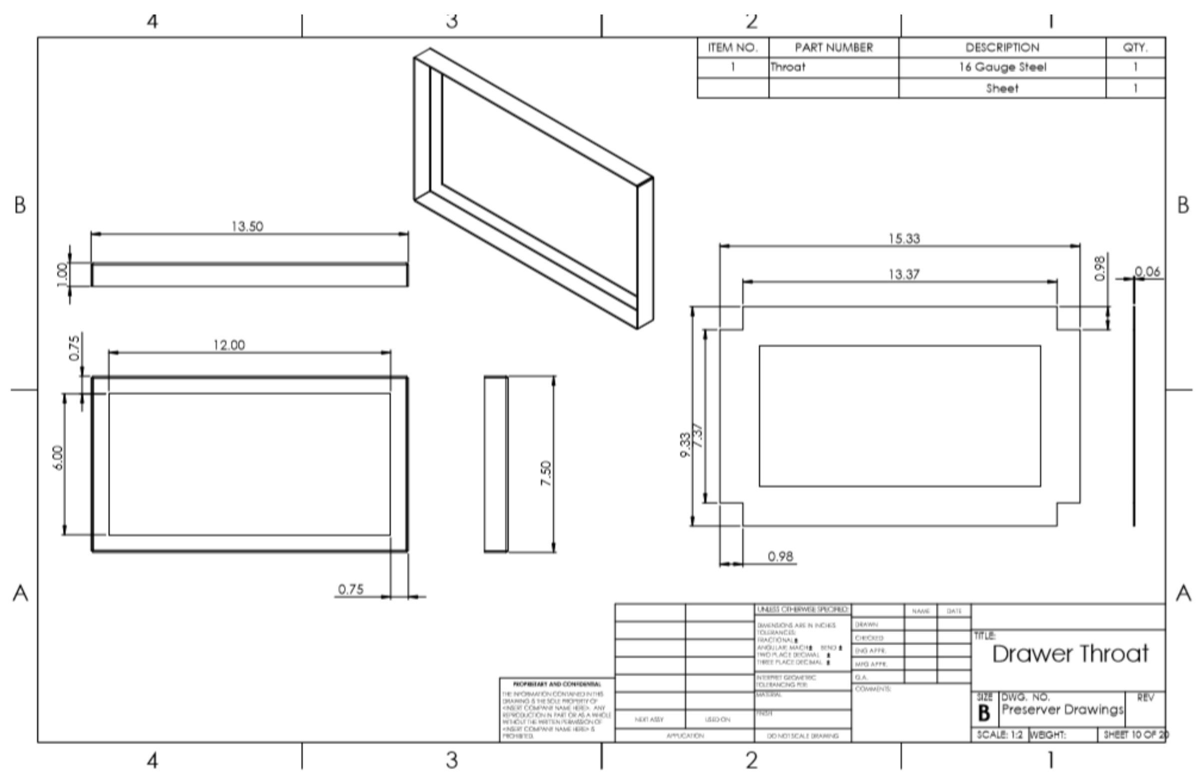


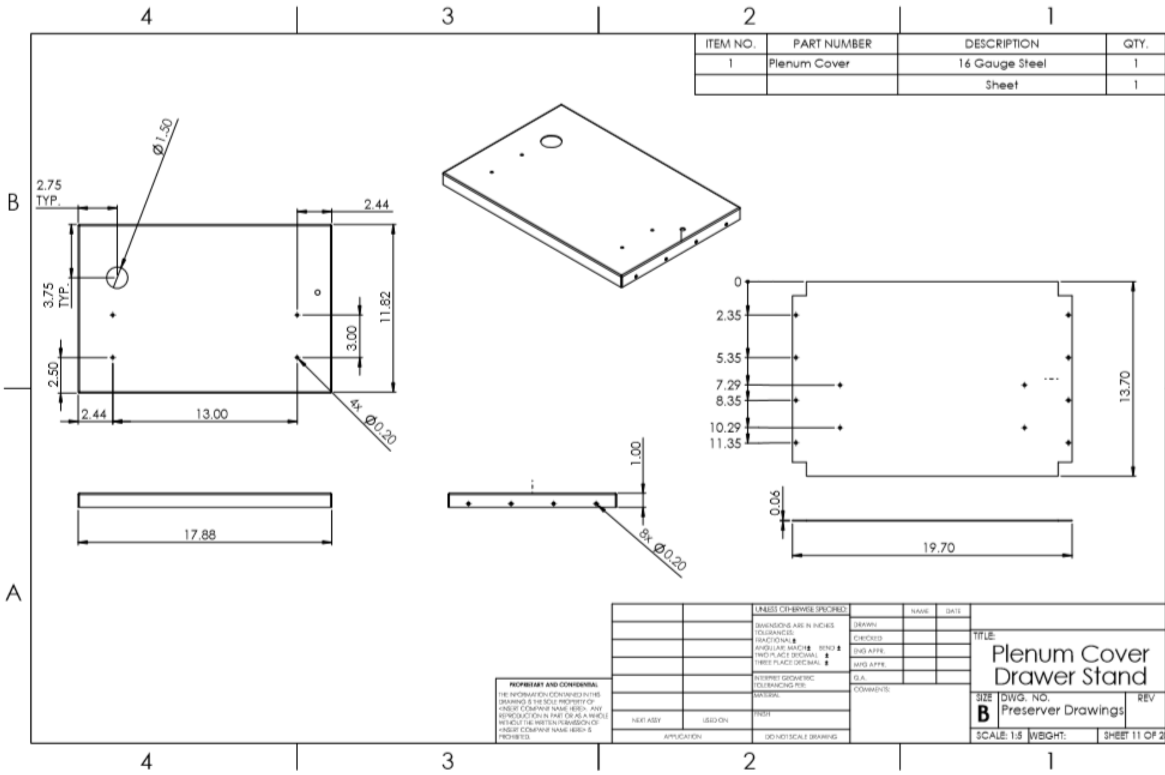
ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Drip Pan
16 Gauge Steel
1
Sheet
1
9.00
8.00
5.88
0.50
0.75
1.00
11.00
UNLESS OTHERWISE SPECIFIED:
TITLE:
Drip Pan
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:5
WEIGHT:
SHEET 6 OF 20

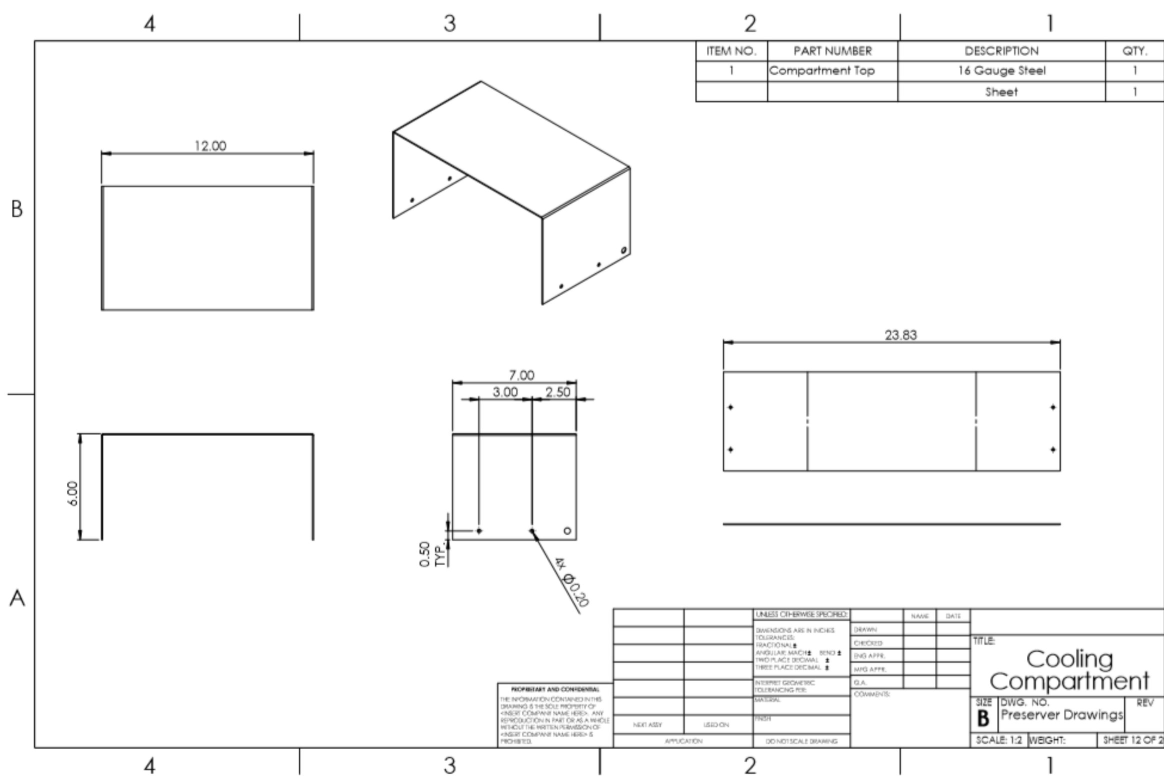

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Display Plate
16 Gauge Steel
1
Sheet
1
3.00
2.50
8-32 UNC x4
0.25 TYP.
0.06
2.50
3.00
⌀0.75
0.75
0.25 TYP.
1.50
UNLESS OTHERWISE SPECIFIED:
TITLE:
PROPRIETARY AND CONFIDENTIAL
SIZE DWG. NO. REV
B
Preserver Drawings
SCALE: 1:1 WEIGHT: SHEET 7 OF 20

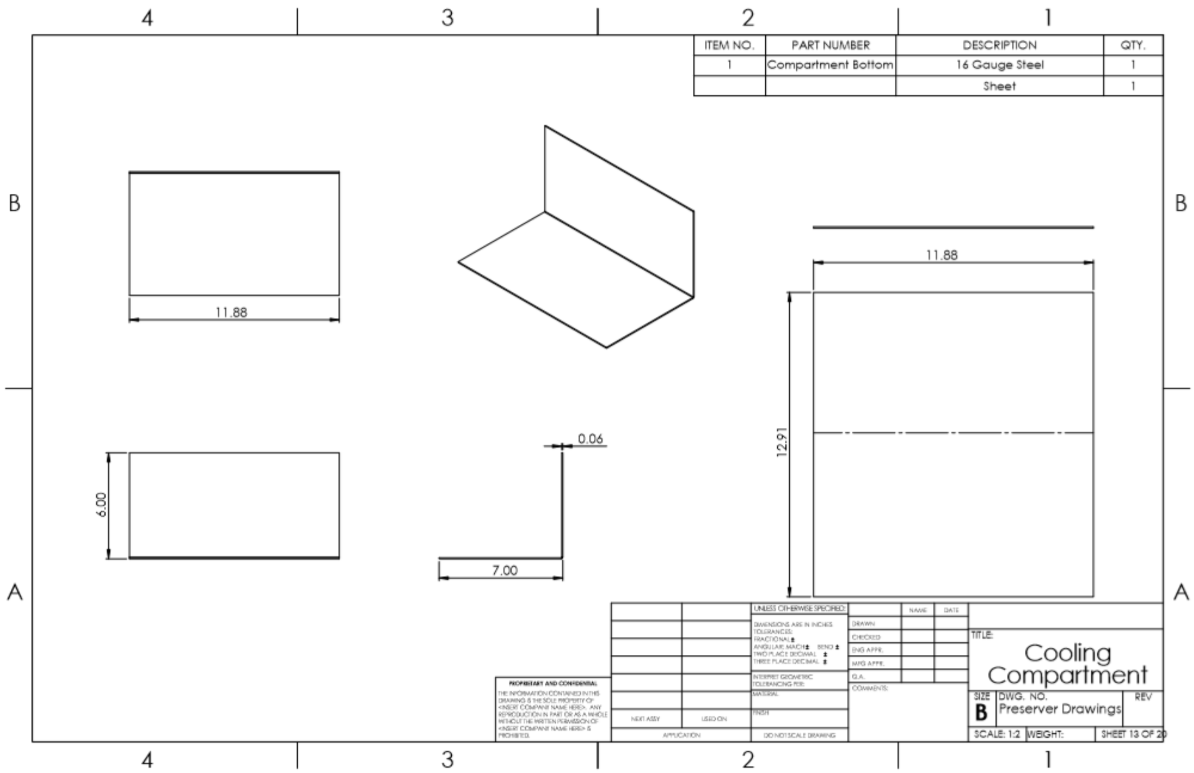

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Battery Bracket
16 Gauge Steel
1
Sheet
1
1.00
⌀0.20 x2
1.00
0.50
0.50
0.25
0.06
1.00
0.06
UNLESS OTHERWISE SPECIFIED:
TITLE:
PROPRIETARY AND CONFIDENTIAL
SIZE DWG. NO. REV
B
Preserver Drawings
SCALE: 2:1 WEIGHT: SHEET 8 OF 20

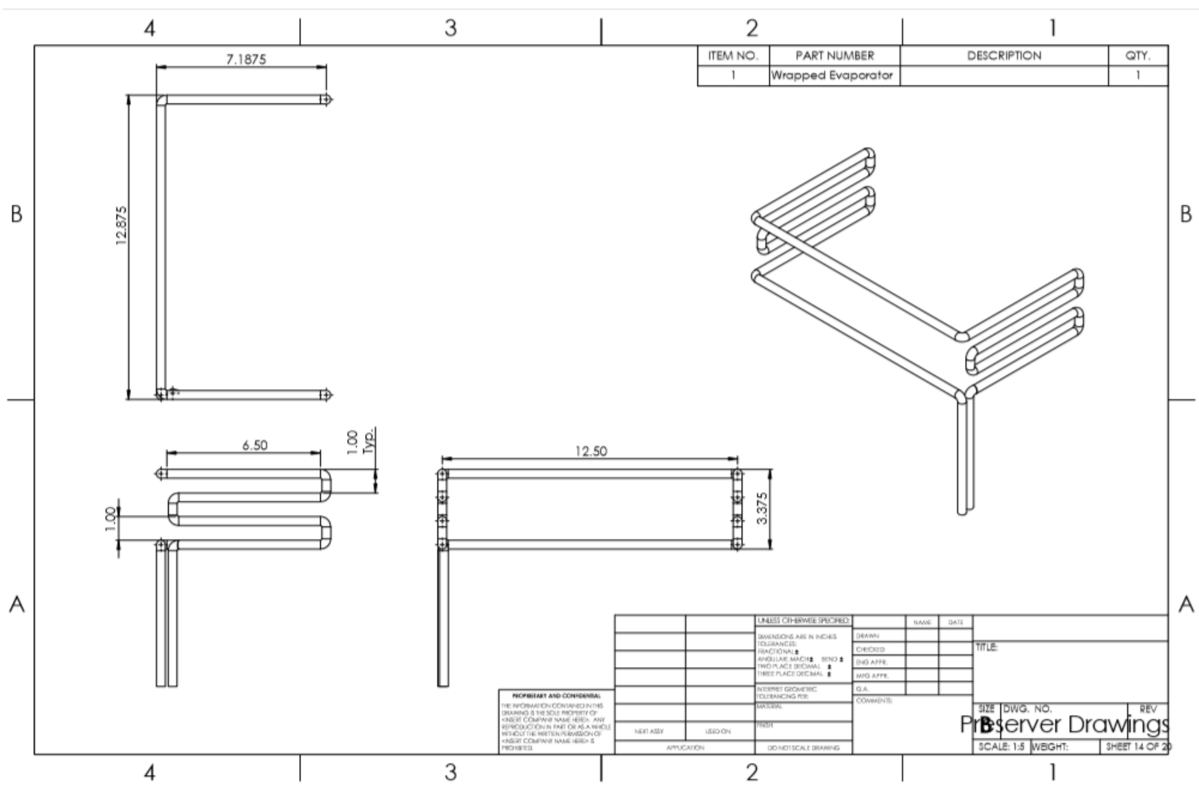

ITEM NO.
PART NUMBER
DESCRIPTION
Default/ QTY.
1 Plenum Cover 16 Gauge Steel 1
2 Compartment Top 16 Gauge Steel 1
3 Compartment Bottom 16 Gauge Steel 1
4 Throat 16 Gauge Steel 1
5 L Bracket 16 Gauge Steel 2
6 Wrapped Evaporator 1
Wrapped Evaporator
Weld along Throat/Comparment seam
Exploded View
TITLE:
Drawer Stand Assembly
SIZE B
DWG. NO. Preserver Drawings
REV
SCALE: 1:5
WEIGHT:
SHEET 9 OF 20

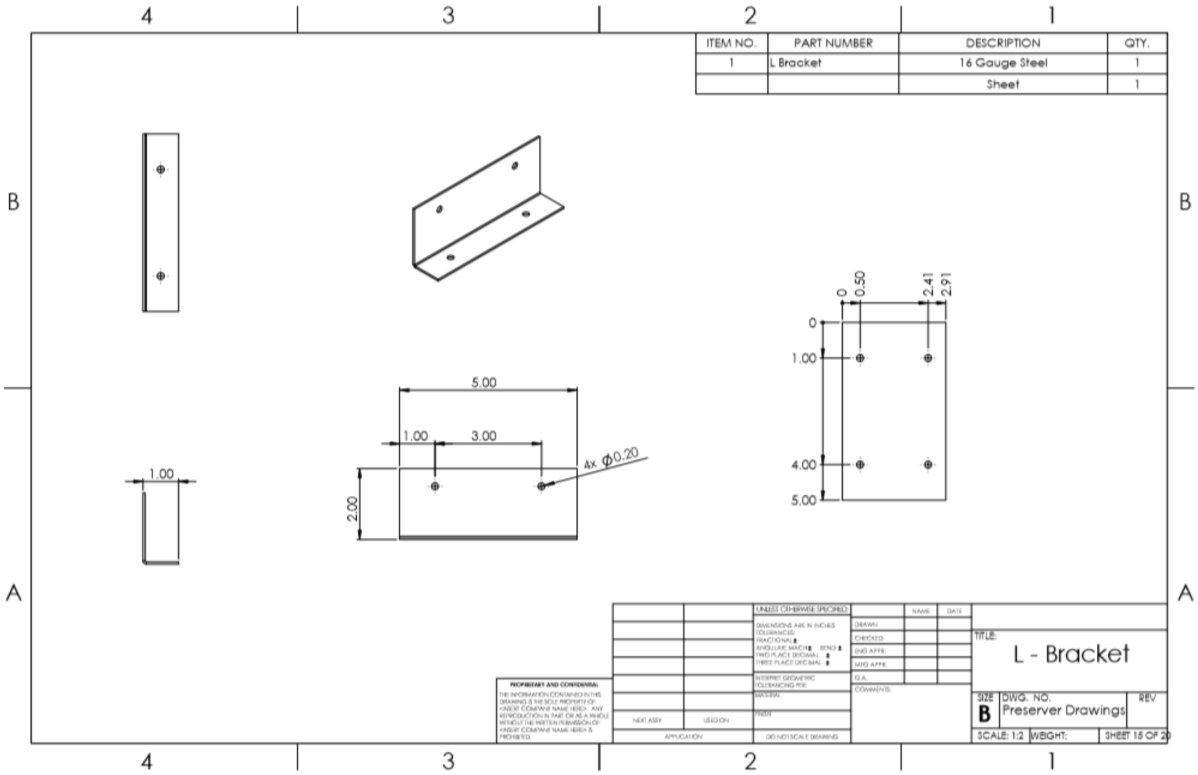

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1 Throat 16 Gauge Steel 1
Sheet 1
13.50
1.00
12.00
0.75
6.00
7.50
0.75
15.33
13.37
0.98
0.06
9.33
7.37
0.98
TITLE:
Drawer Throat
SIZE B
DWG. NO. Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 10 OF 20

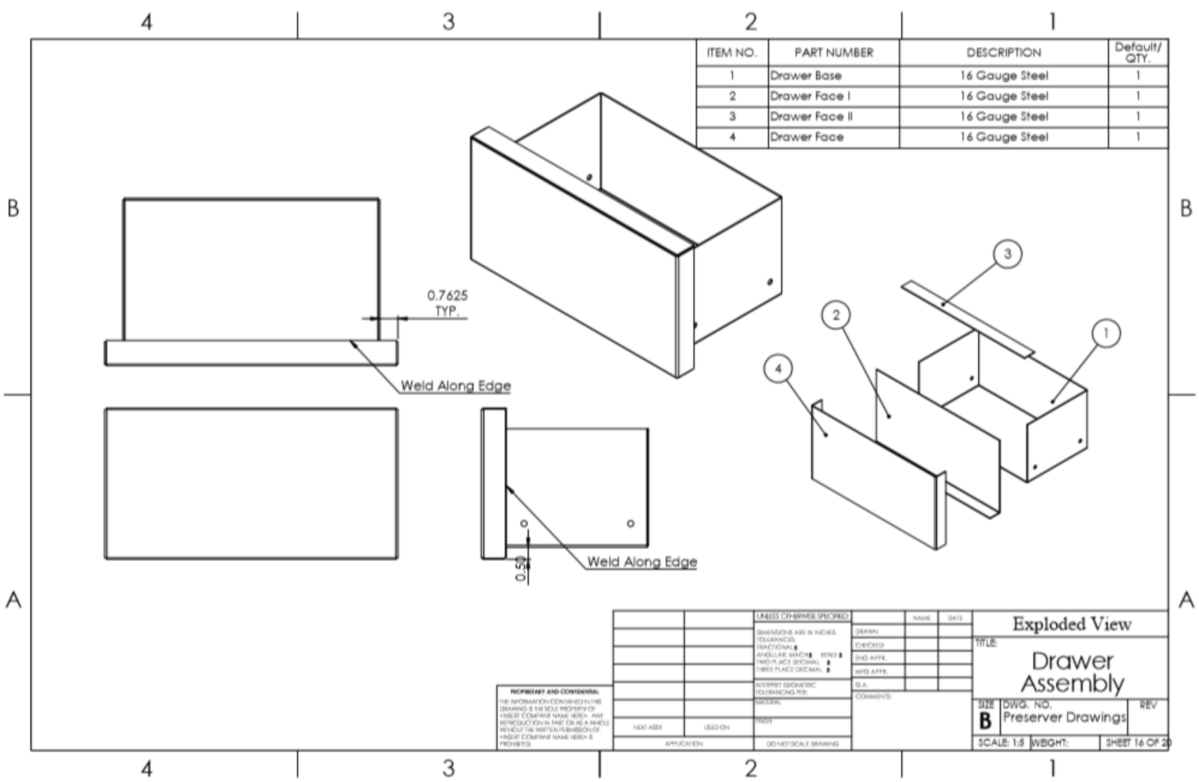

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Plenum Cover
16 Gauge Steel
1
Sheet
1
Ø1.50
2.75 TYP.
2.44
3.75 TYP.
11.82
3.00
2.50
2.44
13.00
4x Ø0.20
17.88
1.00
8x Ø0.20
0
2.35
5.35
7.29
8.35
10.29
11.35
13.70
0.06
19.70
TITLE:
Plenum Cover Drawer Stand
SIZE B
DWG. NO. Preserver Drawings
REV
SCALE: 1:5
WEIGHT:
SHEET 11 OF 20

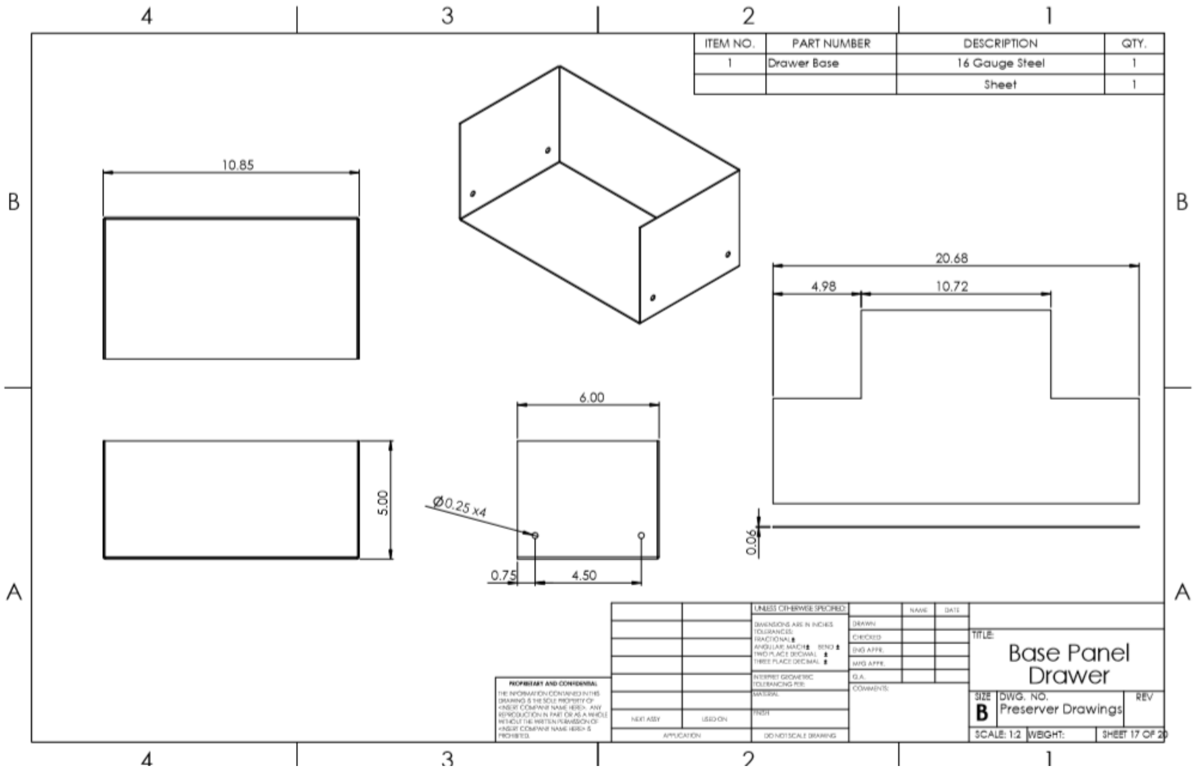

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Compartment Top
16 Gauge Steel
1
Sheet
1
12.00
23.83
7.00
3.00
2.50
6.00
0.50 TYP.
4x Ø0.20
TITLE:
Cooling Compartment
SIZE B
DWG. NO. Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 12 OF 20

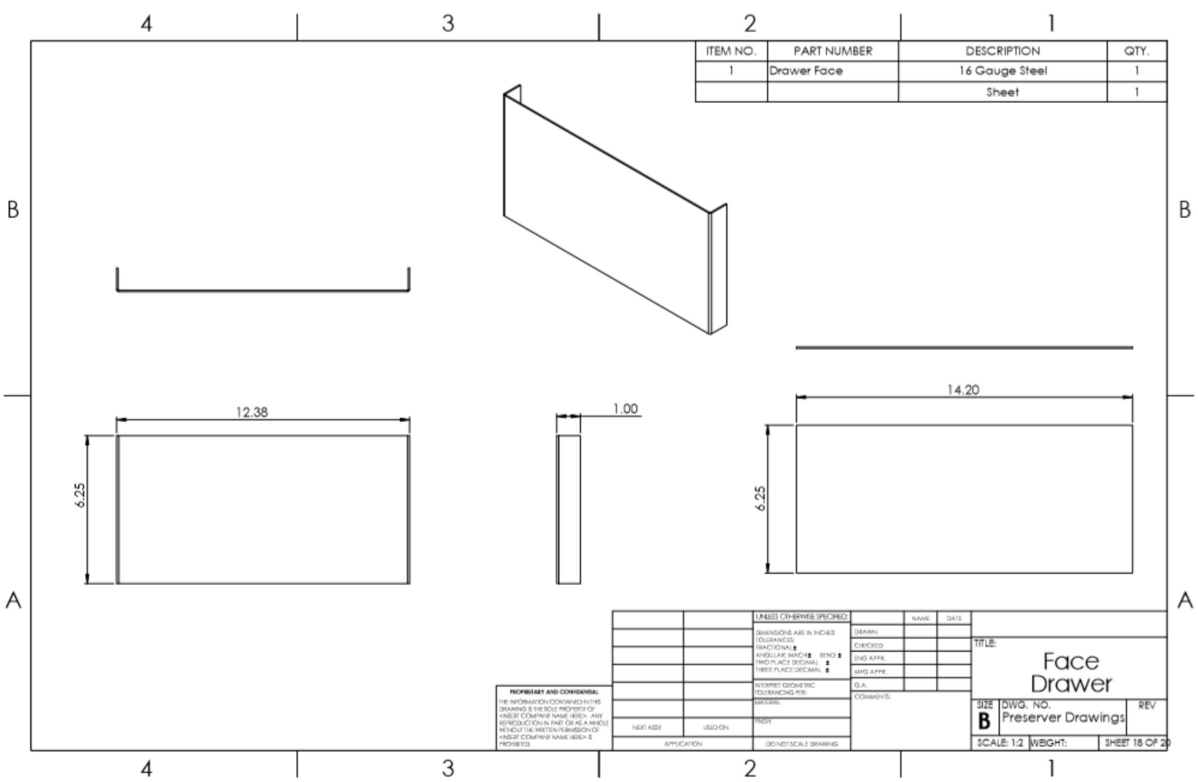

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Compartment Bottom
16 Gauge Steel
1
Sheet
1
11.88
6.00
0.06
7.00
11.88
12.91
PROPRIETARY AND CONFIDENTIAL
UNLESS OTHERWISE SPECIFIED:
TITLE:
Cooling Compartment
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 13 OF 20

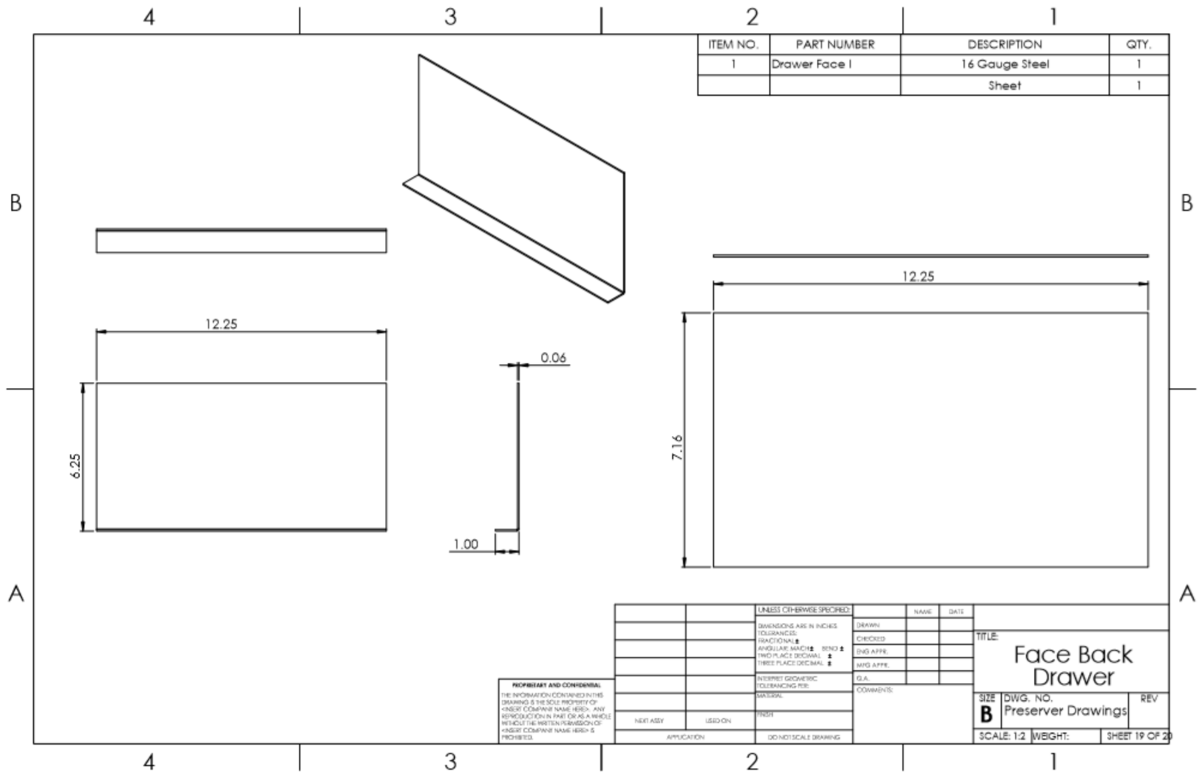

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Wrapped Evaporator
1
7.1875
12.875
6.50
1.00 Typ.
1.00
12.50
3.375
PROPRIETARY AND CONFIDENTIAL
UNLESS OTHERWISE SPECIFIED:
TITLE:
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:5
WEIGHT:
SHEET 14 OF 20

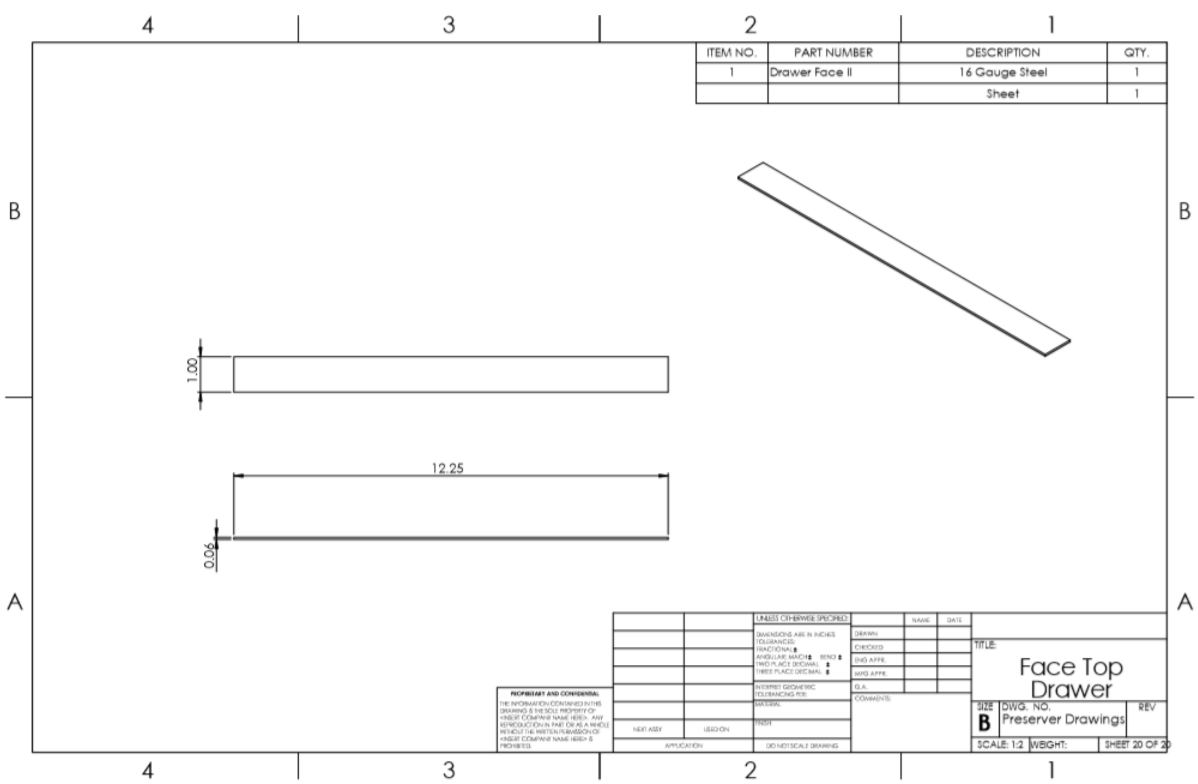

ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
L Bracket
16 Gauge Steel
1
Sheet
1
5.00
1.00
3.00
1.00
2.00
4x ϕ0.20
0
0.50
2.41
2.91
0
1.00
4.00
5.00
TITLE:
L - Bracket
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 15 OF 20


ITEM NO.
PART NUMBER
DESCRIPTION
Default/ QTY.
1
Drawer Base
16 Gauge Steel
1
2
Drawer Face I
16 Gauge Steel
1
3
Drawer Face II
16 Gauge Steel
1
4
Drawer Face
16 Gauge Steel
1
0.7625
TYP.
Weld Along Edge
Weld Along Edge
0.50
Exploded View
TITLE:
Drawer Assembly
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:5
WEIGHT:
SHEET 16 OF 20


ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Drawer Base
16 Gauge Steel
1
Sheet
1
10.85
20.68
4.98
10.72
6.00
5.00
Ø0.25 x4
0.06
0.75
4.50
TITLE:
Base Panel Drawer
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 17 OF 20


ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Drawer Face
16 Gauge Steel
1
Sheet
1
12.38
6.25
1.00
14.20
6.25
TITLE:
Face Drawer
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 18 OF 20


ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Drawer Face I
16 Gauge Steel
1
Sheet
1
12.25
6.25
0.06
1.00
12.25
7.16
TITLE:
Face Back Drawer
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 19 OF 20


ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Drawer Face II
16 Gauge Steel
1
Sheet
1
1.00
12.25
0.06
TITLE:
Face Top Drawer
SIZE
B
DWG. NO.
Preserver Drawings
REV
SCALE: 1:2
WEIGHT:
SHEET 20 OF 20