

---

# Powder Recovery Device

---

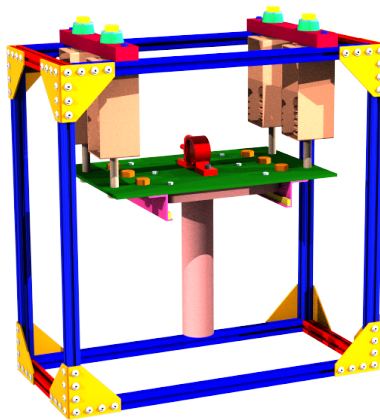
Arlan Ohrt

Joshua Dorfman

Kevin Richter

Noah Tipton

Vincent Giannetti



# Contents

<b>Project Overview</b> . . . . .	<b>1</b>
<b>Device Diagrams</b> . . . . .	<b>2</b>
Frame . . . . .	3
Damping . . . . .	5
Mounting . . . . .	7
Pneumatics . . . . .	9
Additional Tools . . . . .	10
<b>Assembly</b> . . . . .	<b>11</b>
<b>Device Operation</b> . . . . .	<b>12</b>
Warning . . . . .	12
Directions . . . . .	12
<b>Troubleshooting and Maintenance</b> . . . . .	<b>16</b>
<b>Part Drawings</b> . . . . .	<b>17</b>

## Project Overview

The Air Force Research Lab sponsored a senior design project at the FAMU - FSU College of Engineering. The design team was tasked with designing a device that increased the amount of recovered powder from objects fabricated using a laser powder bed fusion additive manufacturing process. This operation manual covers the use of this device.

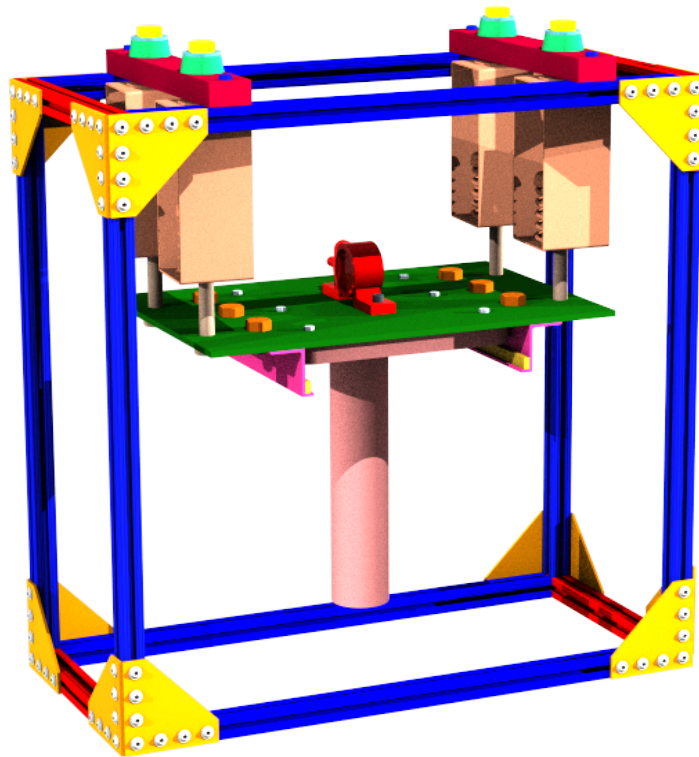
The device should only be used by trained personnel for the purpose of powder removal. As an industrial tool, those untrained in its operation should seek assistance prior to operation to avoid potential injury. For any questions, feel free to contact Team 501 from the FAMU-FSU College of Engineering located at 2525 Pottsdamer St, Tallahassee, FL 32310.

### **Contact Information:**

Joshua Dorfman, [jd16s@my.fsu.edu](mailto:jd16s@my.fsu.edu)  
Vincent Giannetti, [vjg15b@my.fsu.edu](mailto:vjg15b@my.fsu.edu)  
Arlan Ohrt, [ago16b@my.fsu.edu](mailto:ago16b@my.fsu.edu)  
Kevin Richter, [kr15@my.fsu.edu](mailto:kr15@my.fsu.edu)  
Noah Tipton, [nrt15@my.fsu.edu](mailto:nrt15@my.fsu.edu)

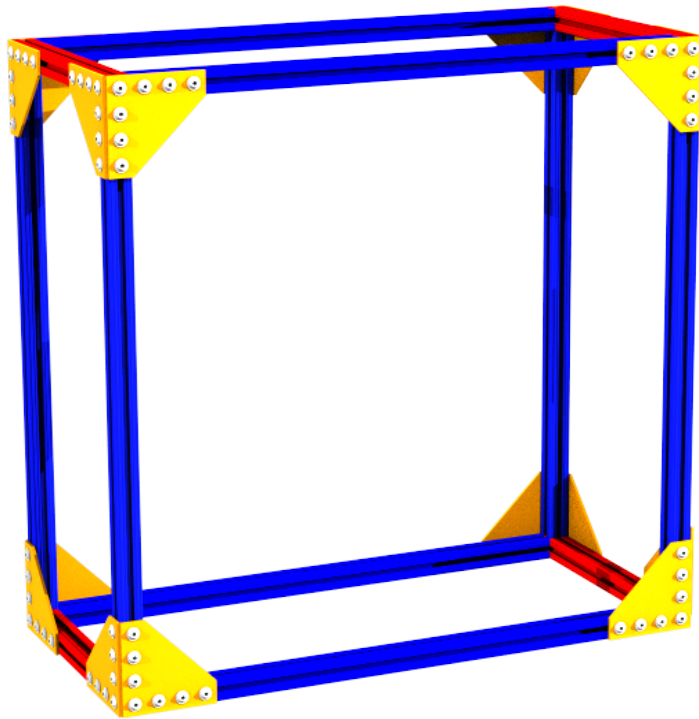
## Device Diagrams

The device may be divided into four subsystems: the frame, damping, mounting, and pneumatics subsystems. The image below highlights the parts associated with each subsystem (except the pneumatics because that is facility dependent) and is followed by a breakdown of each subsystem. A table of included parts and their cost and additional details will be included in each of these sections. Additionally, tables associated with any additional parts will be included.



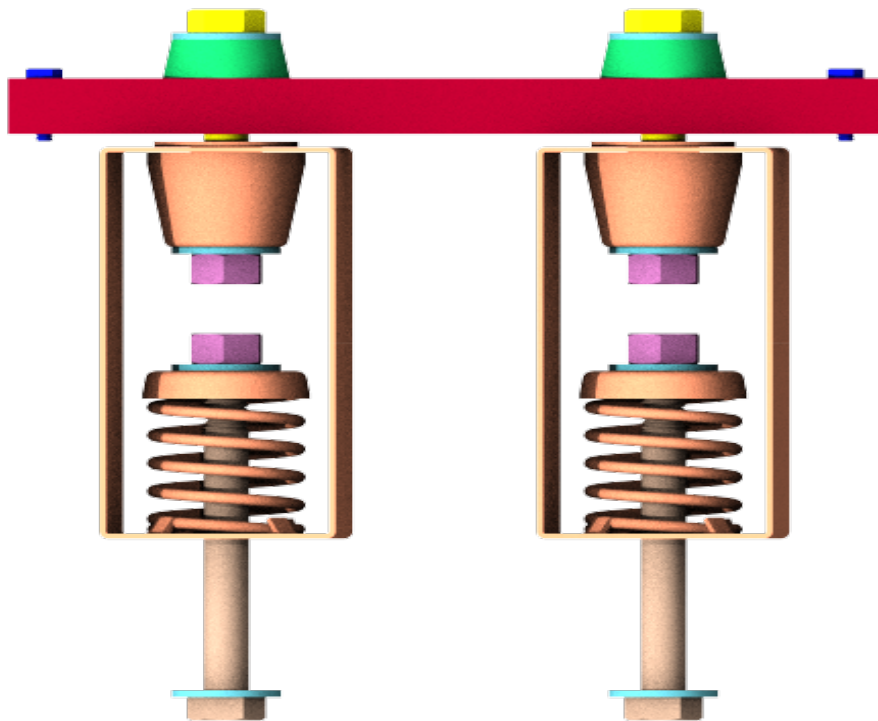


# Frame



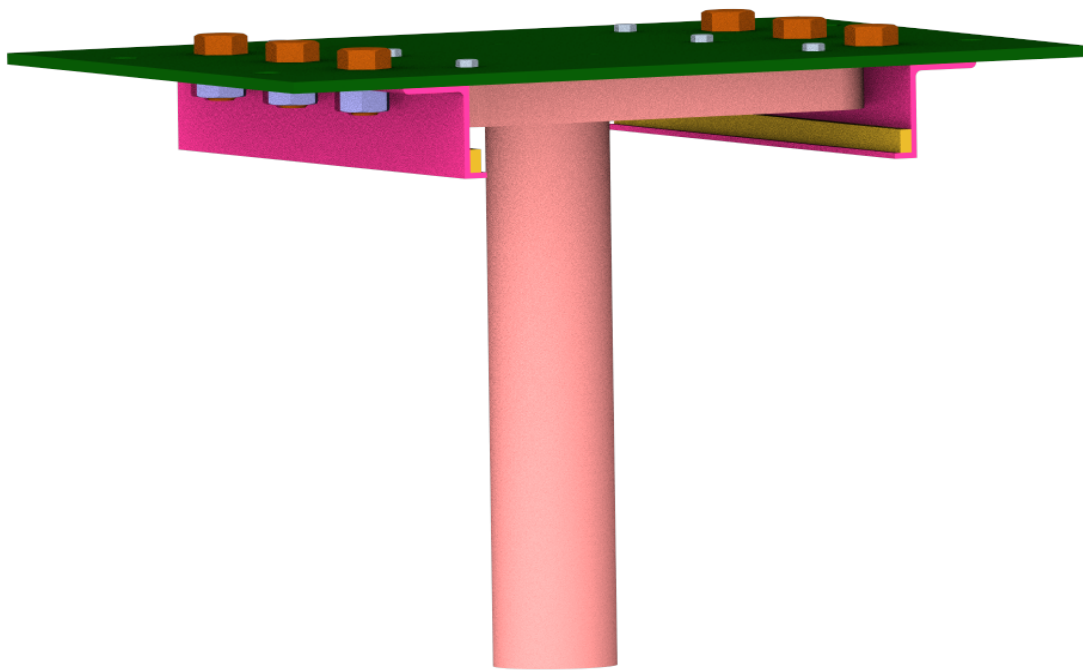
Color	Part Name	Part Details	Part Model	Fabrication Details	Cost	Where to Purchase
	Black-Oxide Alloy Steel Socket Head Screw	5/16"-18 Thread Size, 11/16" Long	90044A428	--	\$10.06	<a href="https://www.mcmaster.com/catalog/90044A428">https://www.mcmaster.com/catalog/90044A428</a>
	T-Slotted Framing	Single Four Slot Rail, Silver, 1" High x 1" Wide, Solid   1-foot length	47065T101	--	\$5.84	<a href="https://www.mcmaster.com/catalog/126/2052">https://www.mcmaster.com/catalog/126/2052</a>
	T-Slotted Framing	Single Four Slot Rail, Silver, 1" High x 1" Wide, Solid   2-foot length	47065T101	--	\$7.79	<a href="https://www.mcmaster.com/catalog/47065T101">https://www.mcmaster.com/catalog/47065T101</a>
	T-Slotted Framing	Silver 90 Degree Angle Bracket for 1" High Rail, 4" Long	3136N148	--	\$13.83	<a href="https://www.mcmaster.com/catalog/3136N148">https://www.mcmaster.com/catalog/3136N148</a>

# Damping



Color	Part Name	Part Details	Part Model	Fabrication Details	Cost	Where to Purchase
	Grade 8 Steel Washer	Black Ultra-Corrosion-Resistant, 9/16" Screw Size, 1.5" OD	98026A116	--	\$10.06	<a href="https://www.mcmaster.com/catalog/98026A116">https://www.mcmaster.com/catalog/98026A116</a>
	High-Strength Steel Hex Nut	Grade 8, Zinc Yellow-Chromate Plated, 5/8"-11 Thread Size	94895A035	--	\$9.03	<a href="https://www.mcmaster.com/catalog/94895A035">https://www.mcmaster.com/catalog/94895A035</a>
	Multipurpose 6061 Aluminum	1" Thick x 1-3/4" Wide	8975K626	Part Drawing 1	\$14.70	<a href="https://www.mcmaster.com/catalog/8975K626">https://www.mcmaster.com/catalog/8975K626</a>
	Oil-Resistant Vibration-Damping Mount	with Unthreaded Hole, 250 lbs. Capacity	64865K87	--	\$1.80	<a href="https://www.mcmaster.com/catalog/64865K87">https://www.mcmaster.com/catalog/64865K87</a>
	Threaded Rod Vibration Damper	with Spring and Cushion, for 5/8"-11 Rod, 100 lbs. Capacity	29895T45	--	\$33.79	<a href="https://www.mcmaster.com/catalog/29895T45">https://www.mcmaster.com/catalog/29895T45</a>
	Zinc Yellow-Chromate Plated Hex Head Screw	Grade 8 Steel, 5/8"-11 Thread, 4-1/2" Long, Partially Threaded	91257A812	--	\$2.82	<a href="https://www.mcmaster.com/catalog/91257A812">https://www.mcmaster.com/catalog/91257A812</a>
	Zinc Yellow-Chromate Plated Hex Head Screw	Grade 8 Steel, 5/8"-11 Thread Size, 6-1/2" Long	91257A819	--	\$4.19	<a href="https://www.mcmaster.com/catalog/91257A819">https://www.mcmaster.com/catalog/91257A819</a>
	Zinc Yellow-Chromate Plated Hex Head Screw	Grade 8 Steel, 1/4"-20 Thread Size, 1-1/8" Long	92620A545	--	\$3.14	<a href="https://www.mcmaster.com/catalog/92620A545">https://www.mcmaster.com/catalog/92620A545</a>

## Mounting



Color	Part Name	Part Details	Part Model	Fabrication Details	Cost	Where to Purchase
	High-Strength 2024 Aluminum Z-Bar	1/8" Wall Thickness, 2" High, 1-1/2" Outside Width	9931T34	Part Drawing 2	\$43.82	<a href="https://www.mcmaster.com/catalog/9931T34">https://www.mcmaster.com/catalog/9931T34</a>
	High-Strength Steel Hex Nut	Grade 8, Zinc Yellow-Chromate Plated, 5/8"-11 Thread Size	94895A035	--	\$9.03	<a href="https://www.mcmaster.com/catalog/94895A035">https://www.mcmaster.com/catalog/94895A035</a>
	Multipurpose 6061 Aluminum	1/4" Thick, 12" x 48"	9246K425	Part Drawing 3 & 4	\$101.75	<a href="https://www.mcmaster.com/catalog/9246K425">https://www.mcmaster.com/catalog/9246K425</a>
	Ultra-Strength Multipurpose Neoprene with Certificate	Adhesive-Back, Sheet, 6" x 6", 1/2" Thick	1312N15	Cut To Size	\$29.23	<a href="https://www.mcmaster.com/catalog/1312N15">https://www.mcmaster.com/catalog/1312N15</a>
	Zinc Yellow-Chromate Plated Hex Head Screw	Grade 8 Steel, 5/8"-11 Thread Size, 1" Long	92620A794	--	\$9.38	<a href="https://www.mcmaster.com/catalog/92620A794">https://www.mcmaster.com/catalog/92620A794</a>
	Zinc Yellow-Chromate Plated Steel Hex Head Screw	High-Strength, M6 x 1 mm Thread Size, 18 mm Long	90854A411	--	\$10.70	<a href="https://www.mcmaster.com/catalog/90854A411">https://www.mcmaster.com/catalog/90854A411</a>

## Pneumatics

Part Name	Part Details	Part Model	Cost	Where to Purchase
304 Stainless Steel Threaded Pipe Fitting	Low-Pressure, Tee Connector, 1/8 NPT Female	4464K47	\$7.83	<a href="https://www.mcmaster.com/catalog/4464K47">https://www.mcmaster.com/catalog/4464K47</a>
Air-Powered Iron Vibrator for Dry Materials	for 660 lbs. Content Weight, Base Mount with Side Inlet	5807K69	\$138.00	<a href="https://www.mcmaster.com/catalog/5807K69">https://www.mcmaster.com/catalog/5807K69</a>
Black-Oxide Alloy Steel Socket Head Screw	5/16"-18 Thread Size, 11/16" Long	90044A428	\$10.06	<a href="https://www.mcmaster.com/catalog/90044A428">https://www.mcmaster.com/catalog/90044A428</a>
Bushing Adapter	1/8 NPT Female to 1/4 NPT Male Adapter	4429K521	\$3.87	<a href="https://www.mcmaster.com/4429K521">https://www.mcmaster.com/4429K521</a>
EPDM Air Hose	1/8 x 1/8 NPTF Brass Male Fittings, 200 PSI   1 foot	1593N45	\$5.63	<a href="https://www.mcmaster.com/catalog/1593N45">https://www.mcmaster.com/catalog/1593N45</a>
EPDM Air Hose	1/8 x 1/8 NPTF Brass Male Fittings, 200 PSI   5 foot	1593N45	\$8.48	<a href="https://www.mcmaster.com/catalog/1593N45">https://www.mcmaster.com/catalog/1593N45</a>
Industrial Quick-Disconnect Hose Coupling for Air	Size 1/4, Zinc-Plated Steel Plug, 1/8 NPTF Female End	6534K18	\$2.18	<a href="https://www.mcmaster.com/catalog/126/357">https://www.mcmaster.com/catalog/126/357</a>
Inline Air Flow Control Valves with Flow Indicator	1/8 NPTF Female Inlet x 1/8 NPTF Female Outlet	3019N12	\$40.72	<a href="https://www.mcmaster.com/catalog/3019N12">https://www.mcmaster.com/catalog/3019N12</a>
Single Scale Pressure Gauge with Plastic Case	1/8 NPT Male Bottom Connection, 1-1/2" Dial	3847K71	\$12.38	<a href="https://www.mcmaster.com/catalog/3847K71">https://www.mcmaster.com/catalog/3847K71</a>

## Additional Tools

Tool	Purpose
10mm Size 7, Reversible Ratcheting Combination Wrench	Needed to join zinc yellow-chromate plated hex head screw (92620A794) with the build plate.
Air Compressor	Needed to power pneumatic vibrator.
Loctite® 262	Needed to prevent thread loosening from vibration on screws other than those attached to the build plate.



## Assembly

The device has four main sub-assemblies covered above: frame, damping, mounting, and pneumatics. These should be consolidated together before following the next steps to assemble. **The device is to be delivered as a whole, so assembly should only be necessary for future repairs (where all of these steps may not be necessary).**

1. Assemble the complete frame as shown on page 3. This includes sliding the female end of the fasteners in the channels of the extruded aluminum for mating with the male screws.
2. Assemble the damping sub-assembly as shown on page 5. This is then fastened **loosely** to the frame as shown in the full assembly (page 2).
3. Assemble the mounting sub-assembly as shown on page 7 (without the build plate). Fasten this to the damping sub-assembly as shown in the full assembly (page 2).
4. Tighten any loose fasteners, and use Loctite® on all fasteners (except the 6 that raise the buildplate, see "Device Operation" section if you don't know these 6 fasteners).
5. The pneumatics sub-assembly cannot be explained here, because it depends on the available options in the facility the device is used.

## Device Operation

**WARNING:** Do not use this device unless you have been trained, and do not use the device for purposes other than powder recovery. Always use a powered, air-purifying respirator (PAPR) when handling the build plate, part, and powder containers. Always ensure that the sand-blasting cabinet doors are closed and secure prior to operation.

### Directions

1. Inspect the assembly for obvious issues such as: worn springs, backed-out fasteners, damaged metal, and cracked/worn rubber.
2. Open the sand blasting cabinet and slide the build plate and newly printed part upside-down, into the mounting channel (Figure 1).



Figure 1: Build Plate Slid in mounting channel.

3. Align the threaded holes of the build plate with the screw holes above (Figure 2).

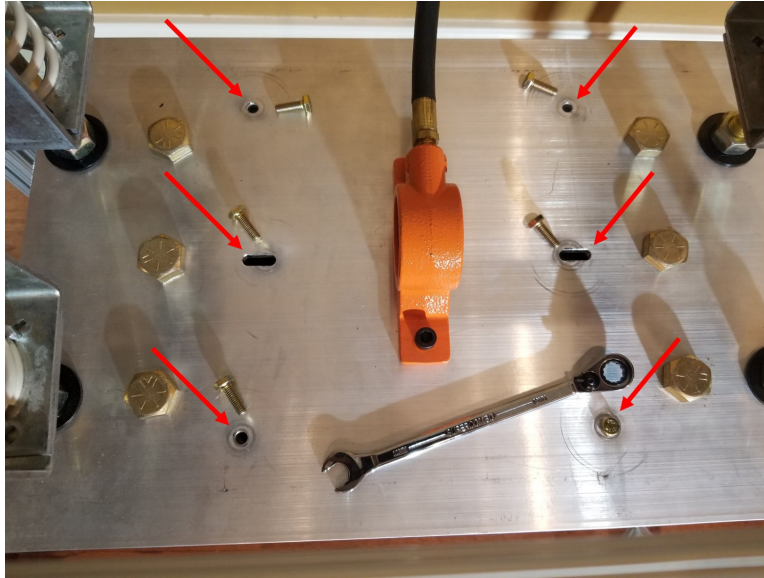


Figure 2: Screw hole locations

4. Fully thread the (6) screws on top of the mounting channel into the build plate, allowing the screws to lift the build plate until it is firmly secured to the top of the channel (Figures 3 and 4).



Figure 3: Screws completely threaded.



Figure 4: Build plate raised in mounting channel.

5. Being sure that the sand blasting cabinet is closed, slowly increase the tool air pressure until the in-line pressure gauge reads the desired pressure (Supplier states 66 lb force and 17,000 vibrations per minute at 80 psi).



Figure 5: In-line pressure for tool.

6. Allow the vibrator to vibrate the part, and feel free to use a compressed air tool concurrently to augment the powder removal process.

7. Decrease the tool air pressure to the vibrator until it is fully off.
8. Undo the (6) screws to lower the build plate.
9. Being sure that all airborne powder has settled, (with PAPR on) open the blasting cabinet. Remove the build plate and printed part.
10. Removed powder will (mostly) be down the funnel of the sandblaster to be moved into clean, safe, container for reuse.

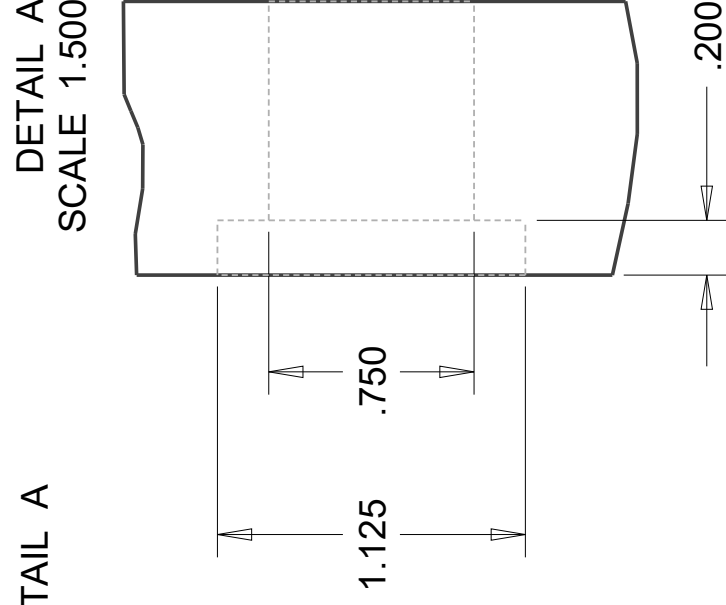
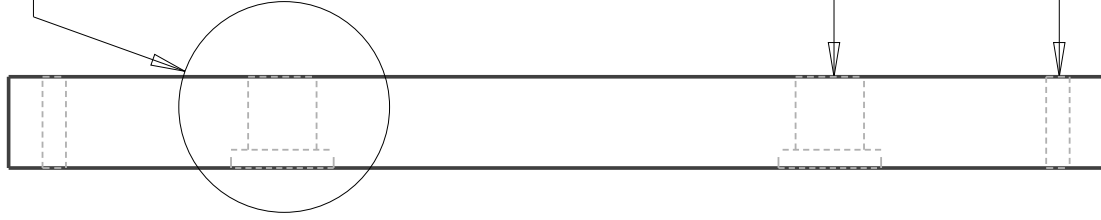
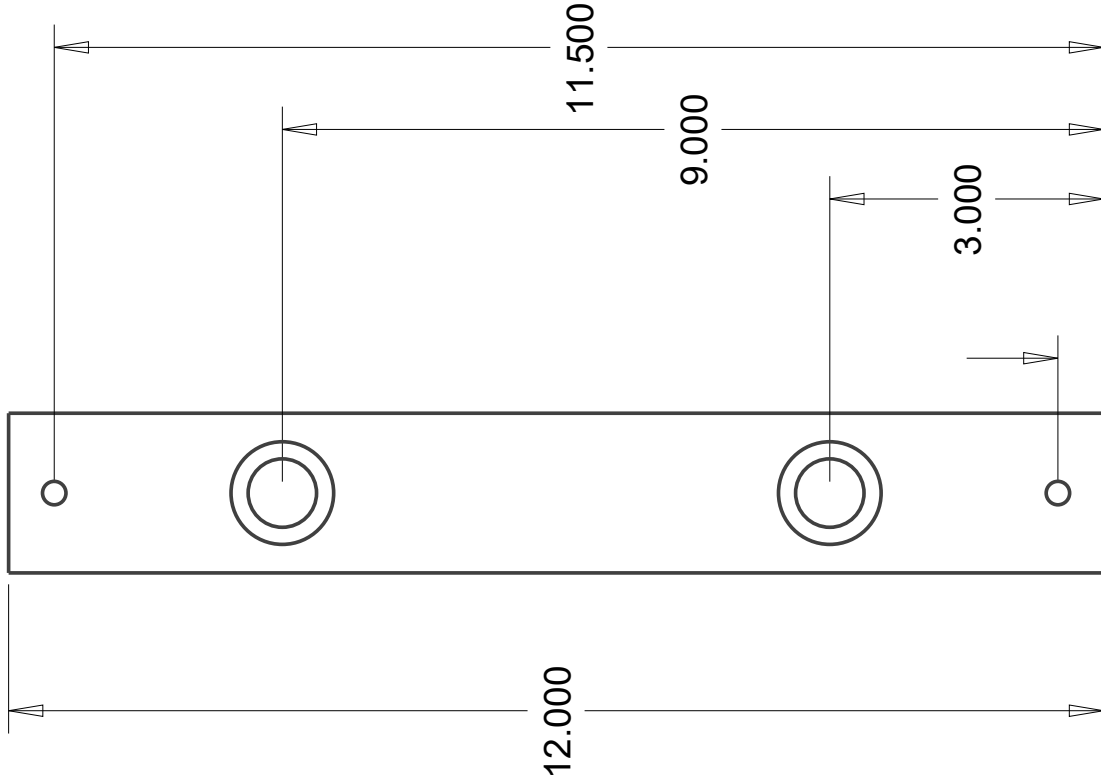
## Troubleshooting and Maintenance

Maintenance is an important aspect of product ownership, proper maintenance will ensure the product has a long useful life. It must be understood that some components will eventually fail do to the nature of the product. These components include the Rubber, and Spring Components, since they absorb the majority of vibrations which would transfer to the frame of the product. Other components require minor maintenance to ensure they operate normally.

- Rubber - Replace rubber damping material that shows signs of failure, either permanent physical deformation or cracking. This component must be replaced.
- Springs - Component most likely to fail. The springs will have minimal damping and will show permanent physical deformation. This component must be replaced.
- Bolts - Bolts which loosen over time must have Loctite® 262 reapplied to the threads and reattached. The bolts can be reused if they loosen. But if there is damage to threads the bolts must be replaced.
- Air Compressor - Air compressor must be maintained according to the manufacturers instructions.

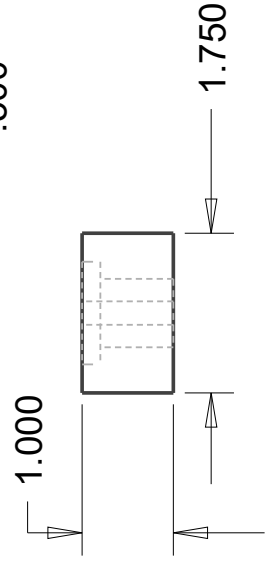
## **Part Drawings**

The images on the following pages are the part drawings for the 3 components that had to be machined. The first drawing is for the Multipurpose Aluminum Bar (8975K626), the second is for the Z-bar (9931T34), and the third and fourth are both for the Multipurpose Aluminum Plate (9246K425).



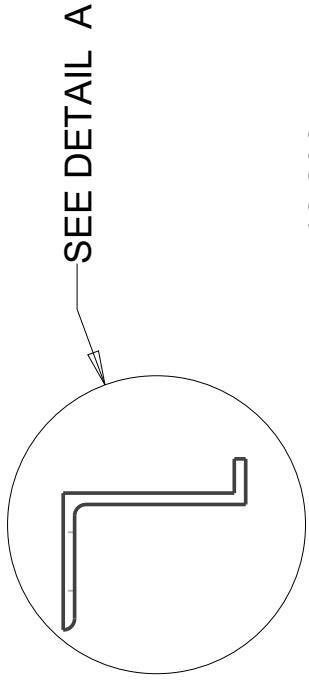
Ø 0.750 THRU ALL  
 L 1.125 ± 0.200  
 IN 2 PLACES

DRILL BIT F (0.257)  
 THRU ALL IN 2 PLACES



UNLESS OTHERWISE SPECIFIED		PART NAME:		PROJECT NAME:		SIZE:	
DIMENSIONS IN INCHES		TOP SUPPORT BAR		SP20 SD-T501		A	
TOLERANCES:		DRAWN BY:		DATE:		MATERIAL:	
X.X ± .0.1		KEVIN RICHTER		02/04/2020		AL-6061	
X.XX ± .0.01		SCALE:		REV:		PART NUMBER:	
X.XXX ± 0.003		0.500		0		SP20-SD-P-003	
ANGLES ± 0.5°		SHEET #:		01 OF 01			





12.000

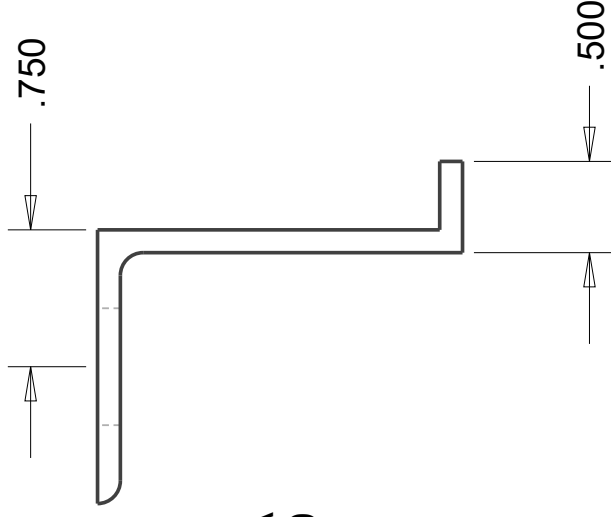
9.000

6.000

$\varnothing$  11/16  $\nabla$  THRU ALL IN 3 PLACES

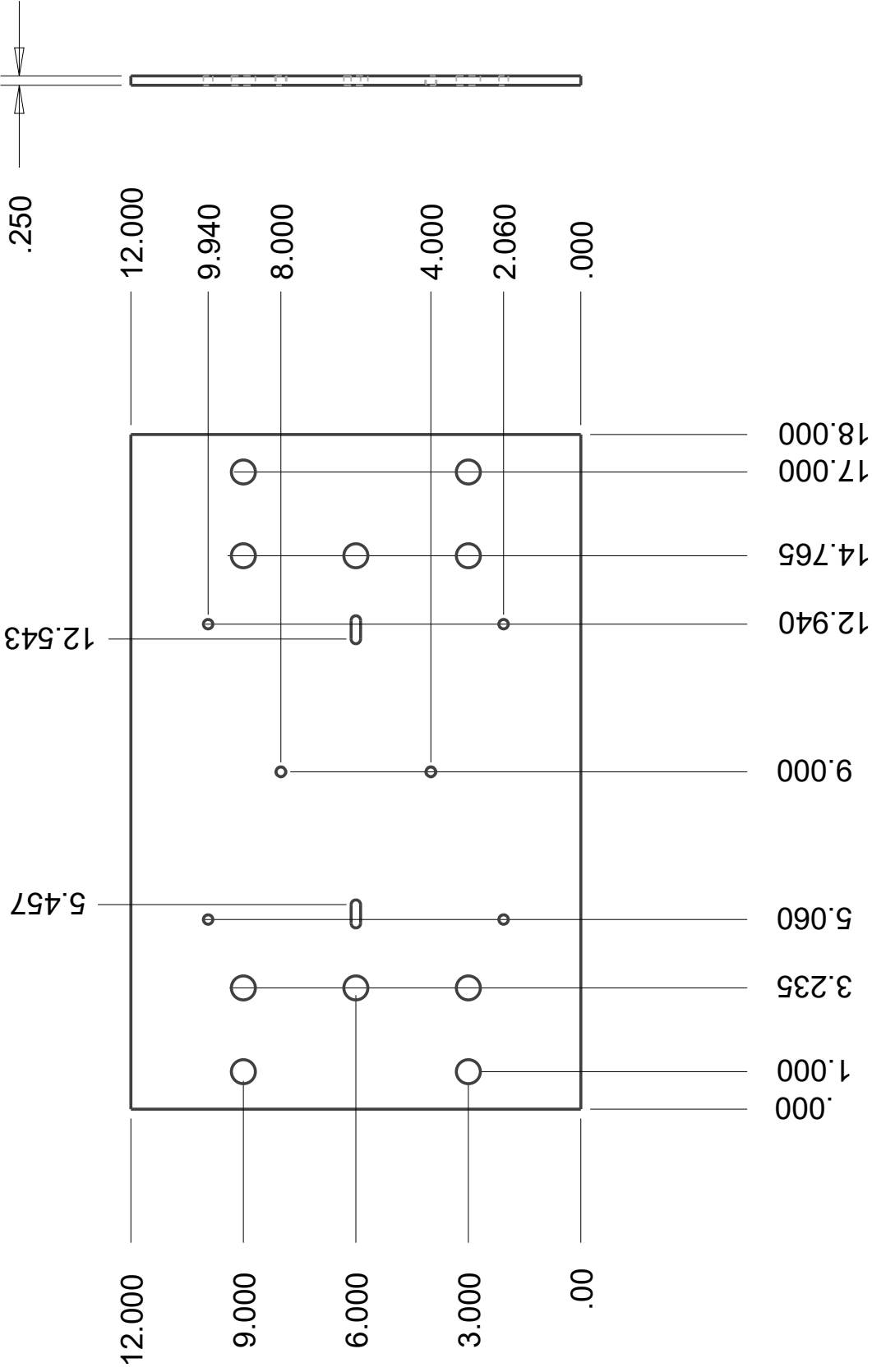
3.000

.000



DETAIL A  
SCALE 1.000

UNLESS OTHERWISE SPECIFIED	PART NAME:	PROJECT NAME:	SIZE:
DIMENSIONS IN INCHES	BUILDPLATE SLOT	SP20 SD - T501	A
TOLERANCES:	DRAWN BY:	DATE:	MATERIAL:
X.X ± .0.1	KEVIN RICHTER	02/04/2020	AL-2024
X.XX ± .0.01	SCALE:	REV:	PART NUMBER:
X.XXX ± .0.003	0.500	0	SP20-SD-P-001
ANGLES ± 0.5°	SHEET #:	01 OF 01	

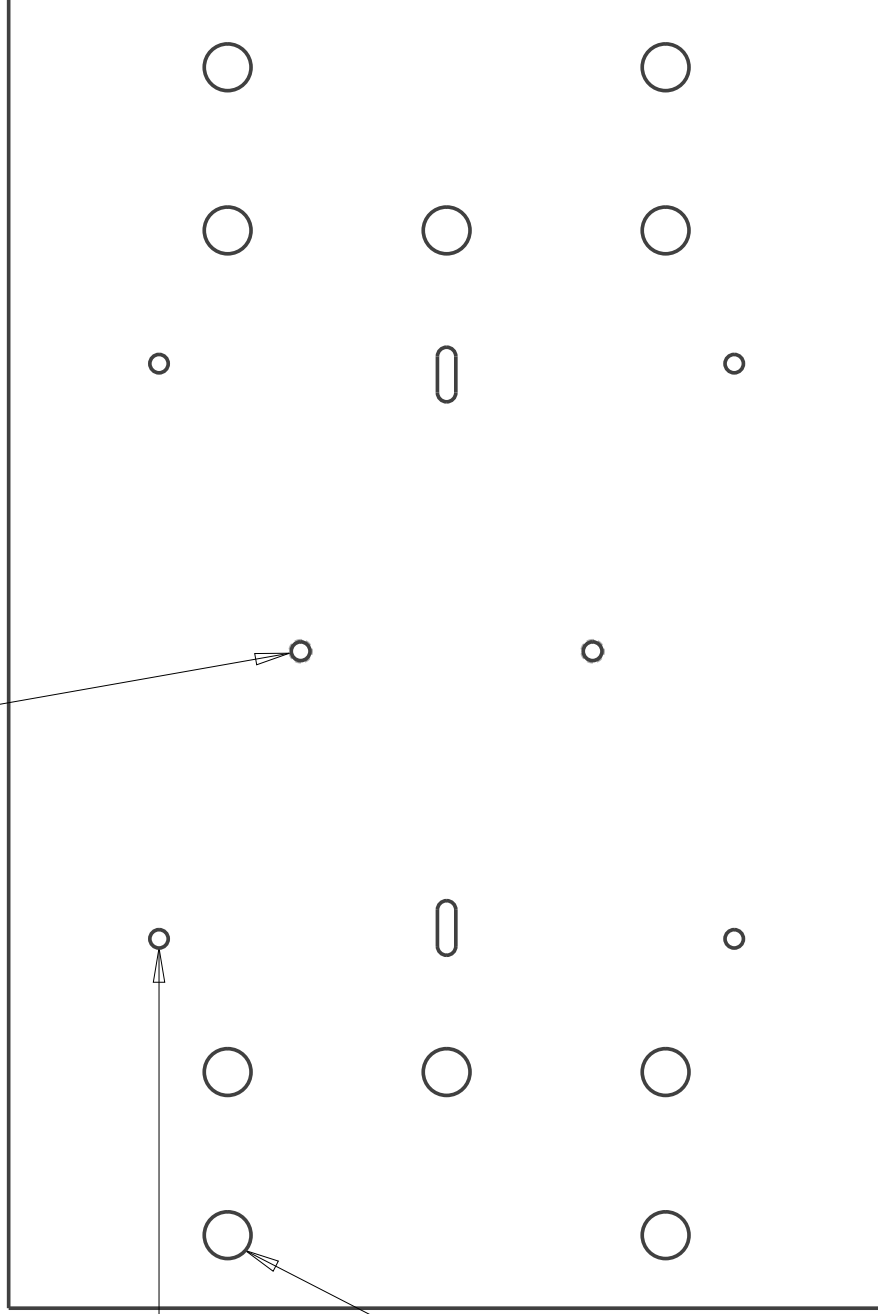


UNLESS OTHERWISE SPECIFIED		PART NAME:		PROJECT NAME:		SIZE:	
DIMENSIONS IN INCHES		SUPPORT PLATE		SP20 SD-T501		A	
TOLERANCES:		DRAWN BY:		DATE:		MATERIAL:	
X.X ± 0.1		KEVIN RICHTER		02/04/2020		AL-6061	
X.XX ± 0.01		SCALE:		REV:		PART NUMBER:	
X.XXX ± 0.003		0.250		0		SP20-SD-P-002	
ANGLES ± 0.5°		SHEET #:		01 OF 02			

5/16-18 THREAD THRU ALL  
IN TWO PLACES

DRILL BIT F  
(0.257) THRU ALL  
IN SIX PLACES

Ø 11/16 THRU ALL  
IN TEN PLACES



UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES TOLERANCES: X.X ± .0.1 X.XX ± .0.01 X.XXX ± 0.003 ANGLES ± 0.5°	PART NAME:		PROJECT NAME:		SIZE:
	SUPPORT PLATE		SP20 SD-T501		A
	DRAWN BY:		DATE:	MATERIAL:	
	KEVIN RICHTER		02/04/2020	AL-6061	
SCALE:	REV:	SHEET #:	PART NUMBER:		
0.400	0	02 OF 02	SP20-SD-P-002		