Expansion of a Dust Removal System for the BRAE Department Plasma Table

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ABSTRACT

This senior project discusses the expansion of a dust removal system for welding and cutting fumes. A Donaldson Torit Powercore TG8 dust collector is used to collect and process the fumes created during welding and cutting operations that take place in the BioResource and Agricultural Engineering department at Cal Poly San Luis Obispo.

Expansion of the system allows for greatly increased utilization of the TG8 and a cleaner working environment in Lab #6. Testing shows that the system fluently changes between the plasma table and the three hoods in the shop. Each hood is only capable of collecting a smoke column from up to two feet away due to how high up the hoods are.

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INTRODUCTION

When operating a plasma cutter or oxy-acetylene torch gasses, smoke, and airborne particles are produced that enter the surrounding air. These airborne contaminants can be harmful to anyone nearby. The BioResource and Agricultural Engineering (BRAE) department at California Polytechnic State University, San Luis Obispo has a plasma and oxy-acetylene torch cutting table located inside of the Senior Project Laboratory #6. Having the table located inside of the shop results in a need for a ventilation system capable of extracting and filtering the fumes produced by the operation of the table. Welding operations commonly take place often in the laboratory that also produces harmful fumes that should be evacuated or filtered.

To deal with the fumes produced by the cutting table or welding operations the BRAE department purchased a Donaldson Torit Powercore TG8 dust collector. During the Summer 2011 quarter the dust collector was installed in the BRAE Lab #6. To get the dust collector operational a ducting system was constructed to connect the collector to the table. The BRAE department would like to reroute the ducting in a way that allows the dust collector to be used to filter fumes from welding operations taking place in the shop in the workstations adjacent to the cutting table.

Figure 1 shows the Donaldson Torit Powercore TG8 dust collector that was installed in Lab #6 and how it was connected to the cutting table. This configuration works well to extract the fumes from the table but is not able to extract any fumes produced by welding operations taking place in other workstations in the shop. Figure 2 shows the general area where the dust collector could be plumbed to extract welding fumes from.

Figure 1. Original installation of Donaldson Torit Powercore TG8 dust collector in BRAE Lab #6.

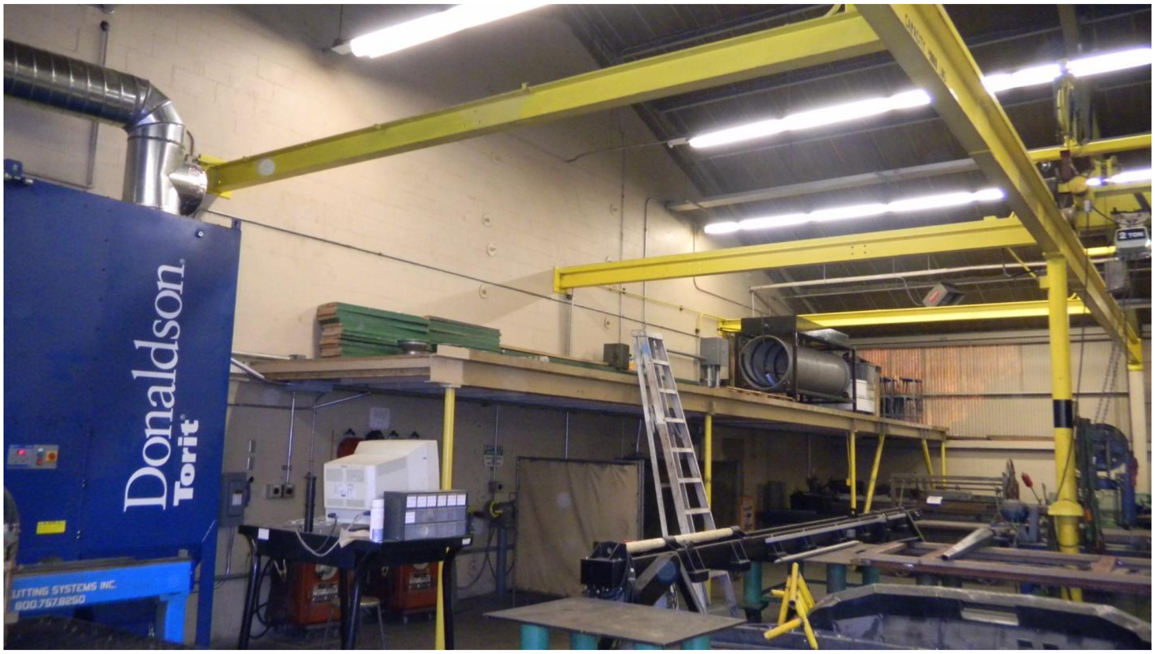


Figure 2. Donaldson Torit Powercore TG8 and surrounding area.

LITERATURE REVIEW

Operating an oxy-acetylene torch, plasma cutter, or welder produces dust and fumes that may be hazardous. The common solution to this problem is to use a dust and fume collection system to extract the harmful vapors from the air before they can be inhaled by operators or bystanders. There is a plasma and oxy-acetylene torch cutting table and multiple welders located in the BioResource and Agricultural Engineering Laboratory #6.

Miller Electric Manufacturing Company, a well known welding and cutting equipment manufacturer describes plasma cutting as such: Plasma looks and behaves like a high temperature gas, but with an important difference; it conducts electricity and cuts any electronically conductive metal. The plasma arch results from electrically heating a gas, typically air, to a very high temperature. This ionizes its atoms and enables them to conduct electricity. A plasma arc torch uses a “swirl ring” that spins the gas around an electrode. The gas is heated in the chamber between the electrode and torch tip, ionizing the gas and creating plasma. This causes the plasma gas to greatly expand in volume and pressure. The small, narrow opening of the torch tip constricts the plasma and accelerates it toward the work piece at very high speeds (20,000ft/s) and temperatures (up to 30,000˚ F). The high-intensity plasma jet melts a very localized area. The force of the jet (or arc) pushes through the work piece and removes the molten metal. (Miller Electric Mfg. Co, 2011)

According to Donaldson, the manufacturer of the dust collector installed, weld fume is made up of 30 to 80 percent submicron-sized particles. That means that most of these particles are respirable (enter the lungs), which makes it critical to have reliable, high performance fume collectors, weld fume extraction and weld smoke filters that collect the fume before it reaches your welder’s breathing zone (Donaldson, 2011a).

The Occupational Safety and Health Administration (OSHA) does not currently regulate welding fumes, however, it does recognize that welding fumes can be harmful. According to OSHA exposure to welding fumes from mild steel is associated with the development of a benign pneumoconiosis, "arc welder's siderosis". This condition is a reversible pneumoconiosis and no associated respiratory signs may be present at the time the pneumoconiosis is discovered. Respiratory impairment has been observed in workers exposed to mild steel welding fumes, but these impairments may be the result of exposure to other toxicants in the working environment, such as crystalline silica. Exposure to welding fumes can result in metal fume fever; this condition resembles influenza and is characterized by fever, chills, headache, nausea, shortness of breath, muscle pain, and a metallic taste in the mouth. The respiratory effects appear to be potentiated by smoking. There is an excess of infertility among welders that led to studies on sperm quality and welding exposures. There appears to be an increased frequency of abnormalities in semen quality associated with duration of exposure. Abnormalities were highest among stainless steel welders. While hypotheses exist, the mechanism of action resulting in infertility is not known. The International Agency for Research on Cancer (IARC) concluded that there is limited evidence in humans for the carcinogenicity of welding fumes and gases. This conclusion was based primarily on a review of 11 cohort studies and 12 case-control studies on lung cancer; only three of these studies (all cohort studies) specifically examined manual metal arc welding of iron, mild steel, or aluminum. Two of the cohort studies found no association between welding fumes and cancer. The remaining cohort studies showed an increased risk for lung cancer, which in some may have been inflated due to selection bias. Ten out of twelve case-control studies showed an association between lung cancer and exposure or employment as a welder. Two of the studies found no risk. IARC's final conclusion was that welding fumes are possibly carcinogenic to humans (OSHA, 1996)

The American Welding Society (AWS) and the American National Standards Institute (ANSI) collaborated to produce ANIZ49.1-2005 Safety in Welding, Cutting, and Allied Processes. In this standard there are many recommendations for creating a safe welding environment. This standard also points out that fumes and gases from welding and cutting cannot be classified simply. The composition and quantity of fumes depend upon the metal being worked, the process and consumables being used, coatings on the work such as paint, galvanizing, or plating, contaminants in the atmosphere such as halogenated hydrocarbon vapors from cleaning and degreasing activities. (ANSI, 2005)

According to LaJean Larsen there are three primary steps to handling dust and fumes: capture, carry, and contain (Larsen, 2008). The two methods of capture are ambient and source. With ambient collection the dust collector draws off of the general shop area. Ambient collectors have three major disadvantages being that they collect the air after it has potentially passed the operators, they only clean a minimal portion of the shop’s air at a time, they are inefficient, and must be run almost constantly. Source collection instead draws fumes from a point source, usually a hood or duct built into the equipment, and ducts carry the fumes to the collector. Compared to ambient, source capture is much more efficient. To use source capture more initial investment must be made to construct a duct system. The relatively fixed ducting can be limiting to the usefulness of a source capture system. The ducting, or carry system, needs to be designed properly to work efficiently. The last element to a good dust collection system is the containment. Air filters are used to catch particles and remove them from the air.

Shown in the Donaldson TG series dust collector brochure in the appendix are the operation conditions for Donaldson’s TG series dust collectors. Figure 3 shows the system performance curve for Donaldson’s TG8 dust collector from this brochure. Static pressure is a measurement of air perpendicular to the duct wall. External static pressure is the measurement of all the resistance in the duct system that the fan has to work against (Brink, 2010). In. wg stands for inch water gauge, which is a measure of the difference between the pressure in the pipe and the pressure of the atmosphere. To calculate this we subtract the pressure at the inlet, inside the ducting, from the pressure in the room or outside of the ducting.

Sizing the ducts for a dust collector is very important to creating an efficient system. If the duct work is too small, higher pressure loss and higher energy due to higher velocity and an increased pressure drop will reduce air volume entering the collection hood, hereby degrading the performance of the dust collector. If the ductwork is too large and the velocity of air is not increased, dirt will not be carried through the ductwork and material will collect inside. If the particle accumulation is too heavy, the ductwork may become heavier than the structure can support and may crash to the floor (Donaldson, 2011b)

$$Q = V \times A \tag{1}$$

To properly size the ducting one should use Equation 1 where Q is ft^3/min, V is the desired velocity in ft/min, and A is the area of the duct in cubic feet (Larsen, 2008). Also according to Larsen, for weld fume applications the transport velocity should be kept at a minimum of 2500 feet per minute to ensure that no suspended particles drop out of the fumes in the duct. It is also important to consider the restrictions created by the ducting which determine the external static pressure. Included in Appendix 3 is important information regarding the determination of friction losses for the duct system in inches of water column. Using the expected friction loss helps determine the airflow generated by the TG8.

PROCEDURES AND METHODS

Design Procedure

Duct Sizing. To be effective at carrying fumes from the shop area into the Donaldson Torit Powercore TG8 dust collector the fumes need to maintain a velocity greater than 2500ft/min. To achieve this speed the ducts need to be stepped up in size after each additional branch connects as fumes travel towards the dust collector. To determine the size needed in each section Equation 1 is used to determine a required duct size based on airflow through the section and the velocity required.

Duct Routing. Every part of the system was drawn in SolidWorks prior to construction beginning. This allowed the system as a whole to be evaluated and desired dimensions of components to be adjusted to minimize wasted material. Measurements of the plasma table, shop wall, floor, mezzanine, and gantry crane in relation to the TG8 were taken and used in the SolidWorks renderings.

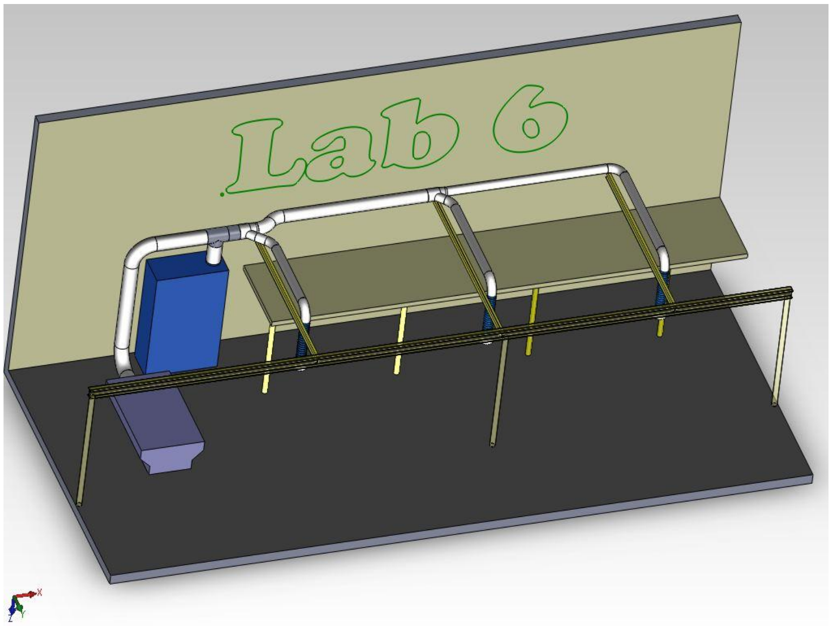


Figure 3. SolidWorks rendering of the system.

It was decided to route the ducting above the three support beams for the crane so that no space under the beams would be lost. This allows a forklift or other equipment to operate under the beams as normal. Each of the three branches of the ducting was routed along one of the beams so that the ducting could be supported by the beam.

Airflow Control. Two blast gates were used to isolate the airflow from either the plasma table or the shop. Pneumatic cylinders open and close the gate using shop air pressure. Two cylinders are used on each valve in order to hold the valve perpendicular and prevent the valve from sticking. A single two position four way valve controls flow to the cylinders. By using this system the operator can select either the plasma table or the shop worksites with the valve and the correct gate will open while the other closes. This eliminates the possibility of having both valves closed and “deadheading” the system. It also simplifies the operation of the valves to a simple flip of the switch.

Figure 4. Rendering of one of the valve assemblies.

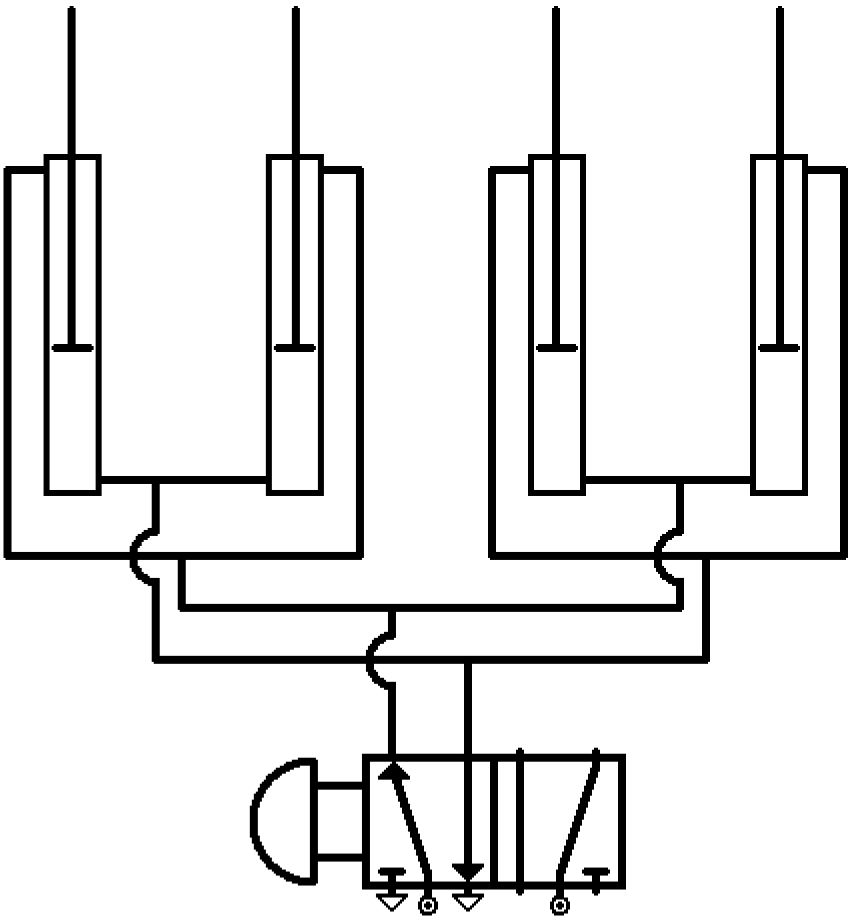
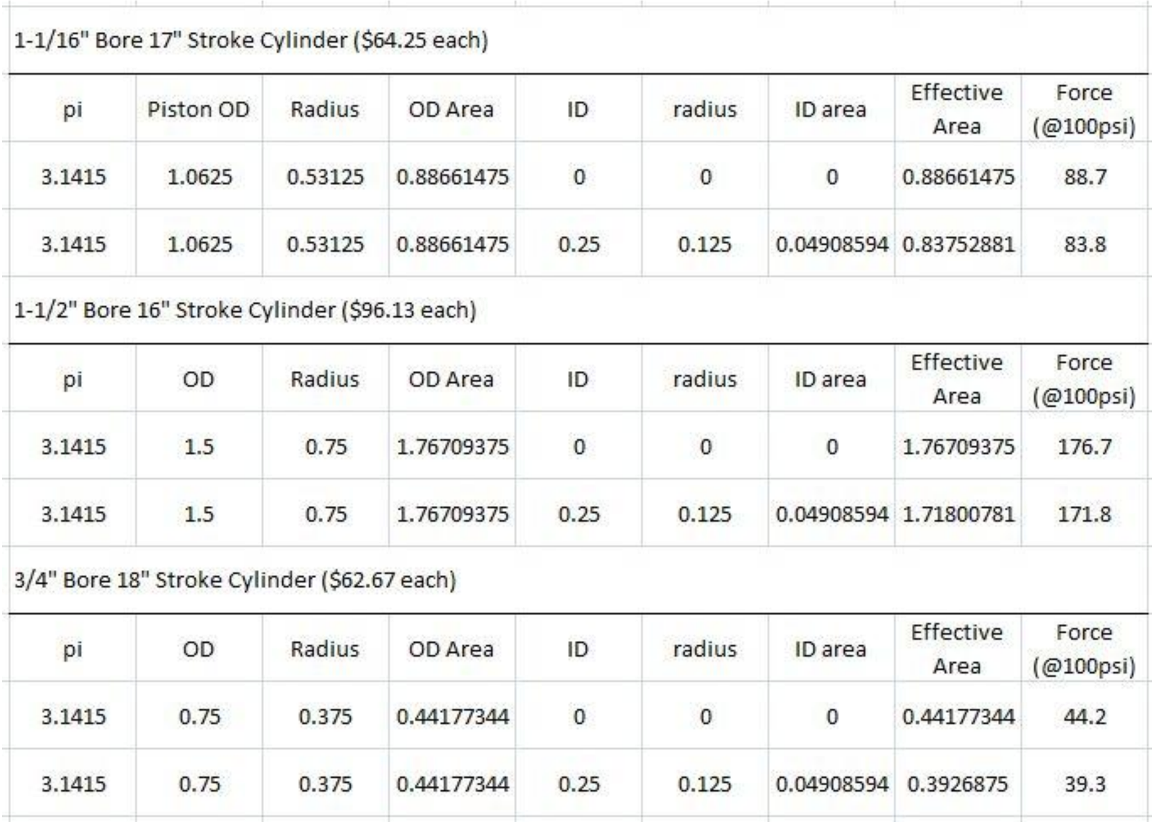


Figure 5. Pneumatic schematic.

The switch used requires 90psi of air pressure or greater to operate correctly, or might be pilot operated. This allows full 120psi of shop air pressure to be used. Three-quarter inch diameter cylinders were used to achieve reasonable force to move the valve without being excessive and possibly damaging the valve. McMaster-Carr had a limited selection of cylinders in stock that offered the minimum sixteen inches of travel that was required to fully cycle to valves. The 18 inch stroke, ¾" bore cylinders provided the least force without needing to be regulated down and were also the cheapest option. Table 1 shows the force calculations for the three best cylinder options.



1-1/16" Bore 17" Stroke Cylinder ($64.25 each)

pi	Piston OD	Radius	OD Area	ID	radius	ID area	Effective Area	Force (@100psi)
3.1415	1.0625	0.53125	0.88661475	0	0	0	0.88661475	88.7
3.1415	1.0625	0.53125	0.88661475	0.25	0.125	0.04908594	0.83752881	83.8

1-1/2" Bore 16" Stroke Cylinder ($96.13 each)

pi	OD	Radius	OD Area	ID	radius	ID area	Effective Area	Force (@100psi)
3.1415	1.5	0.75	1.76709375	0	0	0	1.76709375	176.7
3.1415	1.5	0.75	1.76709375	0.25	0.125	0.04908594	1.71800781	171.8

3/4" Bore 18" Stroke Cylinder ($62.67 each)

pi	OD	Radius	OD Area	ID	radius	ID area	Effective Area	Force (@100psi)
3.1415	0.75	0.375	0.44177344	0	0	0	0.44177344	44.2
3.1415	0.75	0.375	0.44177344	0.25	0.125	0.04908594	0.3926875	39.3

Table 1. Force of pneumatic cylinders.

Construction

Ducting. It was originally intended that flow from the table would travel through an elbow and then straight through the tee into the dust collector. Doing this would have allowed the tee to be swiveled so that it connected to lateral ductwork running along the wall. But this would have resulted in the lateral duct to the table being so high up that it would have interfered with the water pipes. In order to clear the water pipes hanging from the ceiling the original tee was re-oriented so that it routed flow from the two adjacent sides down through the perpendicular side and into the dust collector. This required the lateral duct to the plasma table to be raised fourteen inches. To do this a ten-inch vertical section of sixteen-inch diameter tubing was replaced with a 24-inch long section of spiral tubing. The original system had been constructed from spiral tubing so spiral was again used for the modifications to this part to keep it looking aesthetically-pleasing. A section of sixteen inch spiral tube was used to connect the dust collector to the tee. Figure 6 shows the original duct routing and Figure 7 shows the final routing. The red arrows indicate pieces that were removed, the green indicate sections added, and the blue shows the tee that was re-oriented. 7

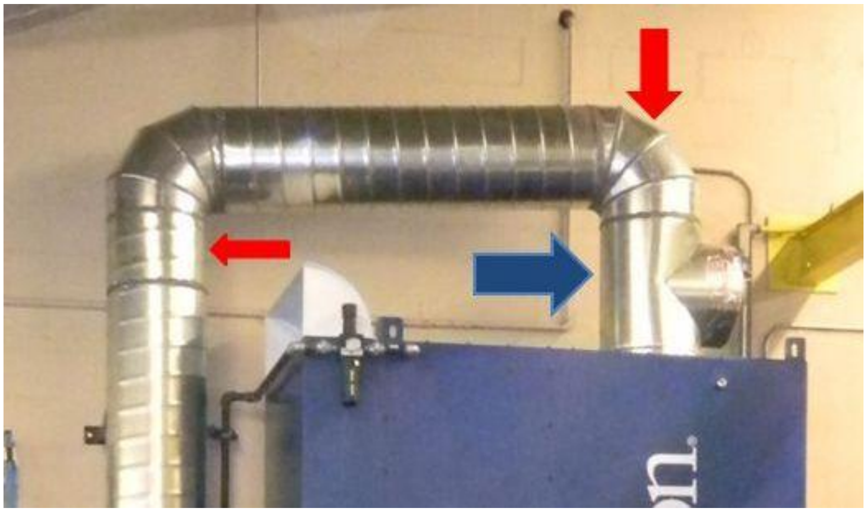


Figure 6. Duct routing to plasma table before project.

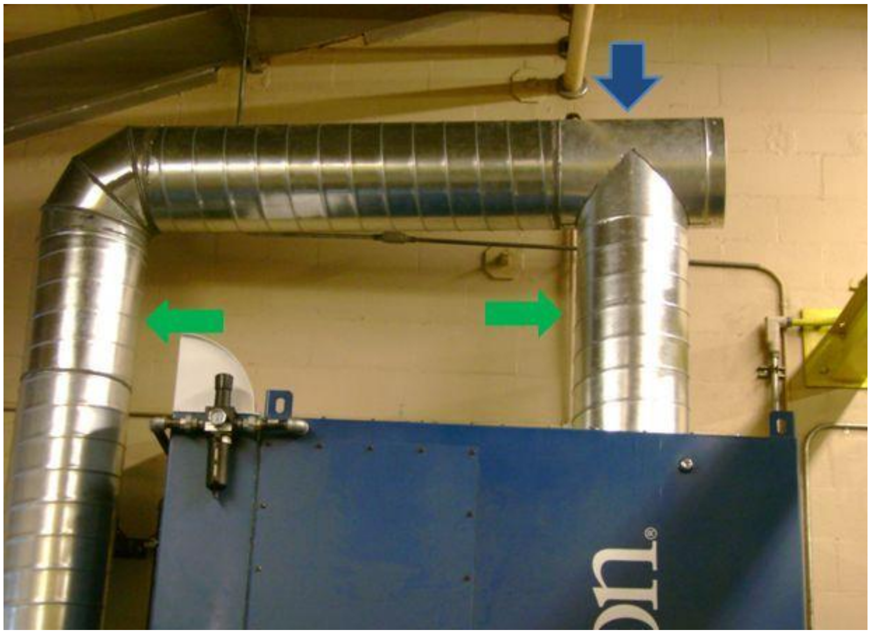


Figure 7. Duct routing to plasma table after project.

Since the tee was no longer free to be rotated, two elbows are to be used to attach to ductwork along the wall. There was not enough room between the tee and the first beam to use two elbows before the connecting to the first wye to allow the first branch to be routed adjacent to the beam. In order to keep the branch adjacent to the beam the first wye was placed before the elbows. Doing this required that the valve for that side be placed between the tee and the wye.

For the remainder of the ducting, spiral tubing was not used because spiral tube only comes in ten foot lengths and therefore much of the ducting would be wasted. Spiral tubing is also more expensive than traditional round tubing which would have added further unnecessary cost. All ductwork is connected with one-inch sheet metal screws and then sealed with a sealant.

The first wye used provides a fourteen-inch inlet in line with the sixteen-inch outlet as well as a ten-inch inlet at a 45˚ angle to the outlet. Each branch consists of ten-inch diameter ducting. Fourteen-inch ducting is used for the middle section. The second wye and ducting is similar to the first except it has two ten-inch inlets and a fourteen inch outlet. From the second wye ten inch ducting is used.

Each branch runs half way between the edge of the mezzanine and the crane before turning down and attaching to a five-foot section of flexible tubing and a collection hood. Each collection hood is equipped with a damper valve to help balance flows.

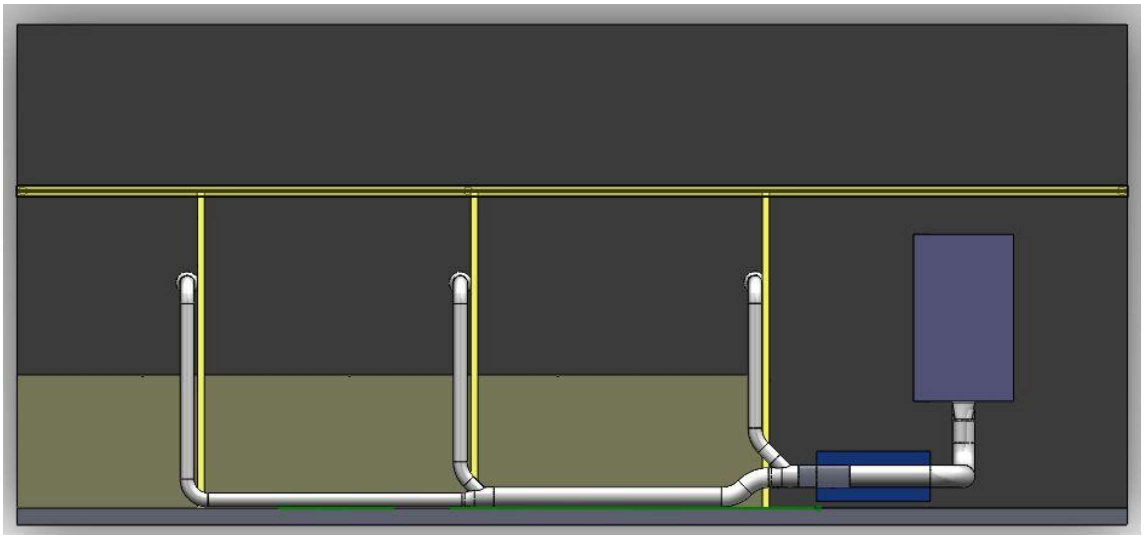


Figure 8. Overhead rendering of duct routing.

Brackets were cut on the plasma table out of 10-gauge sheet metal to support the ducting. Brackets on the branches attach to the beams for support and brackets along the laterals attach to the wall for support. Sheet metal screws secure the ducting to the brackets.

<u>Valves</u>. Sixteen-inch diameter, cast aluminum blast gates were purchased to be used as airflow directional control valves. Blast gates were selected because they provide a positive seal whereas dampers allow significant leakage around the butterfly and would reduce system performance. The cast blast gates used

were relatively inexpensive at $75 each. The only drawback is they have a tendency to stick if the valve is allowed to move off center when opened. To prevent this from occurring two pneumatic cylinders were used on each gate to provide directional stability to the valves and even forces throughout the valve's travel.

To provide a positive stop for the valve that would not damage the valve a frame was constructed around the valve and an adjustable cross member was used it the top of the frame to limit the valves travel. All bolt holes in the gates were drilled out to 1/4-inch to allow for standard 1/4-inch bolts that are stocked by the BRAE Department to be used.

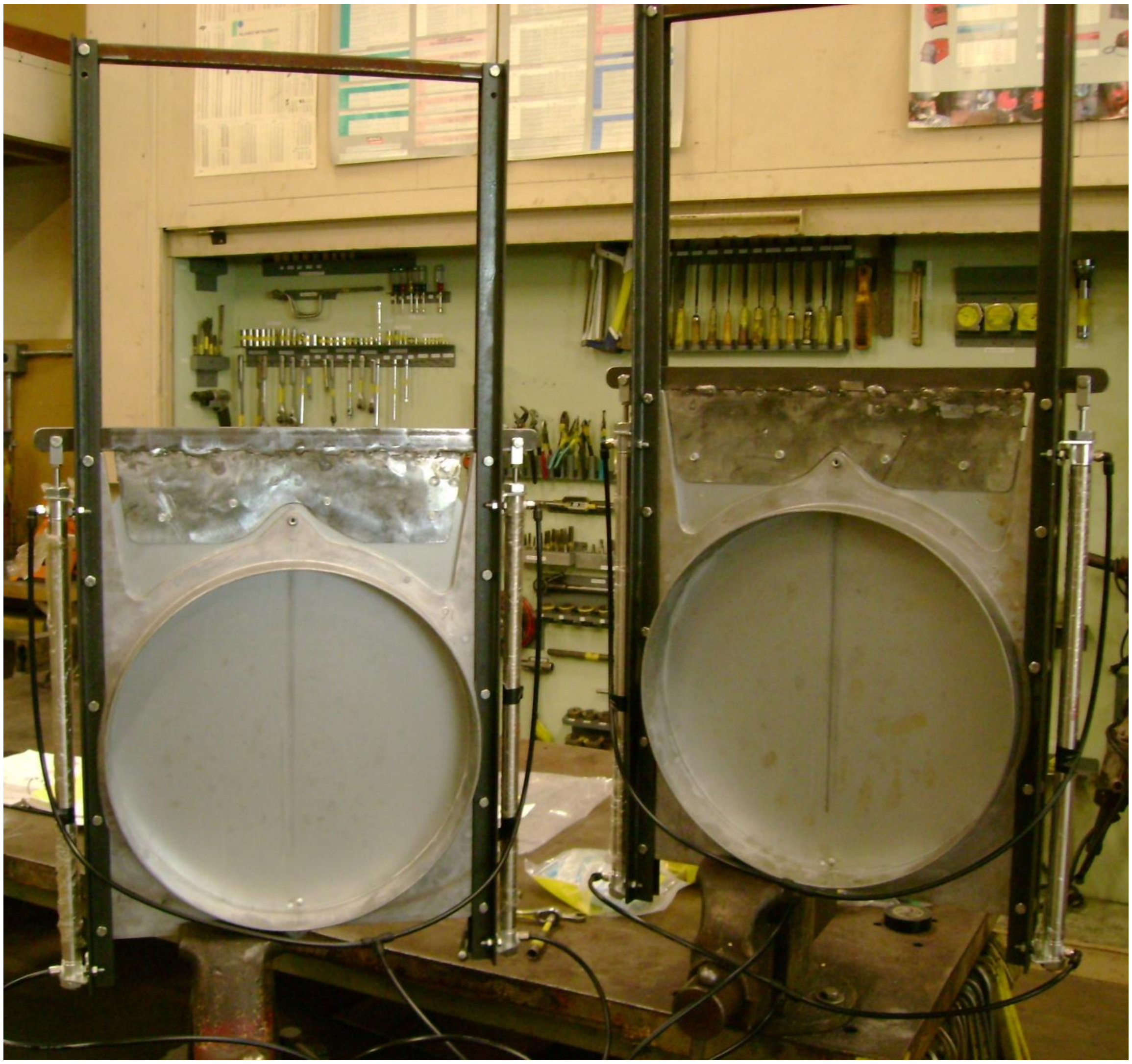


Figure 9. Blast gate valves.

To connect the valve to the cylinders two pieces of 16-gauge sheet metal were welded to a one inch wide 1/4-inch thick bar that connected to the clevises on the cylinders via 1/4-inch bolts. By constructing this piece from multiple pieces the total fabrication time was reduced as the parts could be easily cut on the shear and band saw as compared to one larger piece cut with an oxyacetylene torch and ground smooth. This assembly is attached to the valve with sheet metal screws. This allows the valve to remain relatively unmodified and adaptable to revised connection pieces.

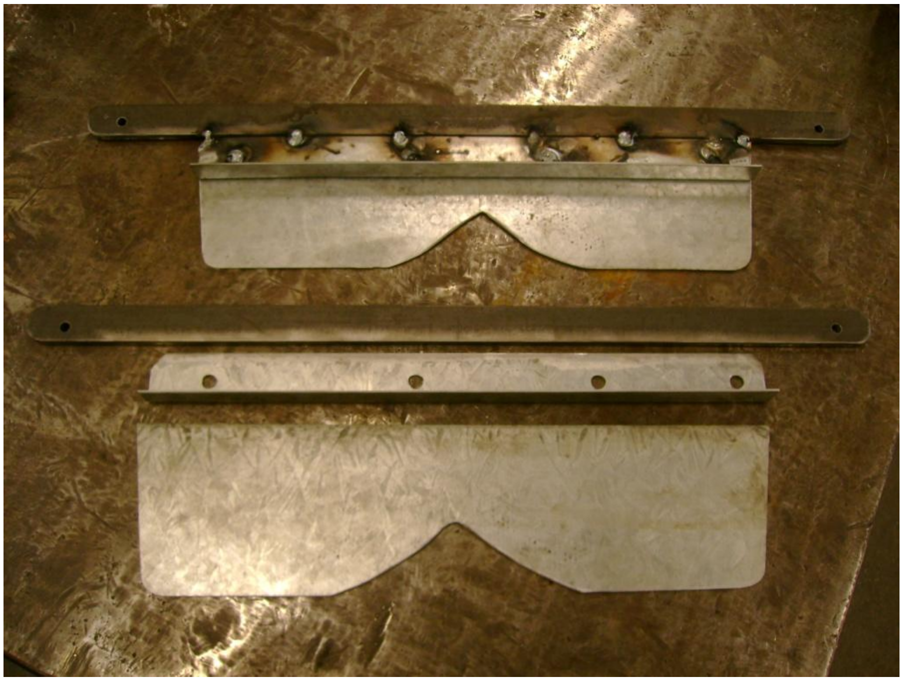


Figure 10. Gate to cylinder connector before and after welding.

Both valves are operated by a single switch that selects either the TG8 to draw from the plasma table or the collection hoods. Since both valves share air supply and return lines, the valve for the plasma table was placed on the tee before the lateral to keep both valves in close proximity to each other and reduce the length of air lines used. Nylon air lines route air between the switch and cylinders. As seen in figure 11, the air lines run through an access port in the top of the TG8, down the side, and along the flexible electrical conduit to the control switch. Mounting clamps attach to existing bolts to hold the air lines in place and keep them from interfering with the TG8's normal operation. The selection switch is mounted in below the TG8's control panel where it is close to the control switches for the TG8 as seen in figure 12.

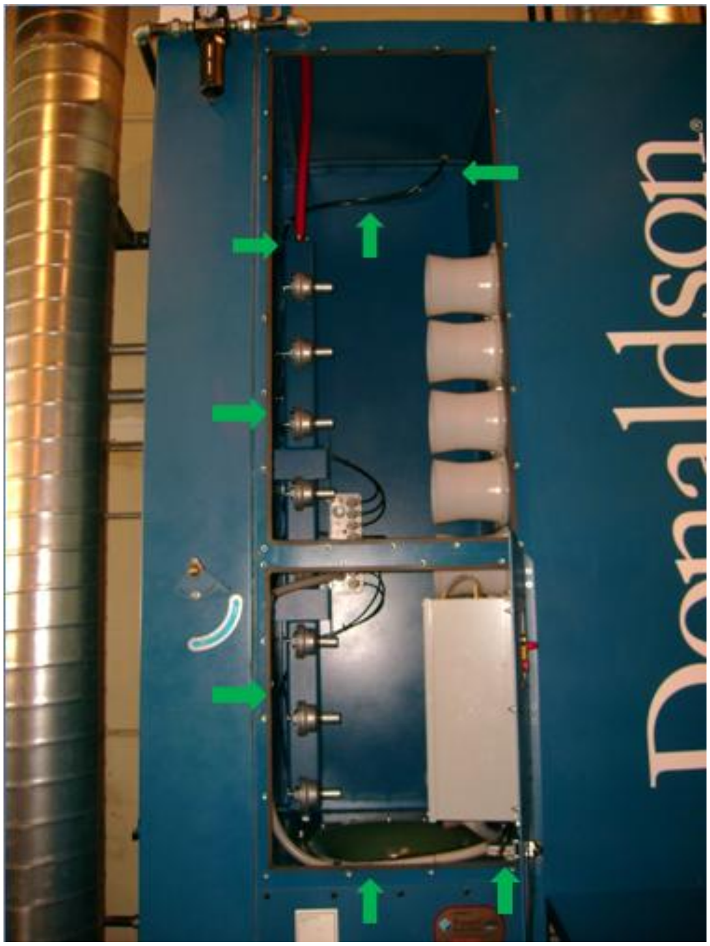


Figure 11. Air line routing inside TG8.

Figure 12. TG8 control panel and air control selection switch.

The valves are supported by their frame that extend down and is bolted to the top of the TG8 using the existing mounting holes for the inlet cover. This takes the weight of the valves and their frame off of the ductwork and reduces damage to the ductwork caused by movement generated by the valves.

Figure 13. Valve supports

Six brackets along the wall and three brackets along each beam, cut from 10-gauge sheet metal with the BRAE Department's plasma table, support the ducting. Brackets along the wall were bolted to the cinderblock wall using two 1/4-inch concrete screws on each bracket. Along the beams four 1/4-inch bolts hold each bracket to the inner web of the beam. To connect the brackets to the ductwork two-inch wide, 1/8-inch thick straps were rolled on a roll bender to form an arc that would cradle the ducting was welded to the brackets. At the three brackets used where the ductwork connected to the flex-tubing an additional arc was bolted to the bracket so that the ducting was captured around its entire circumference for additional stability.

Figure 14. Wall bracket.

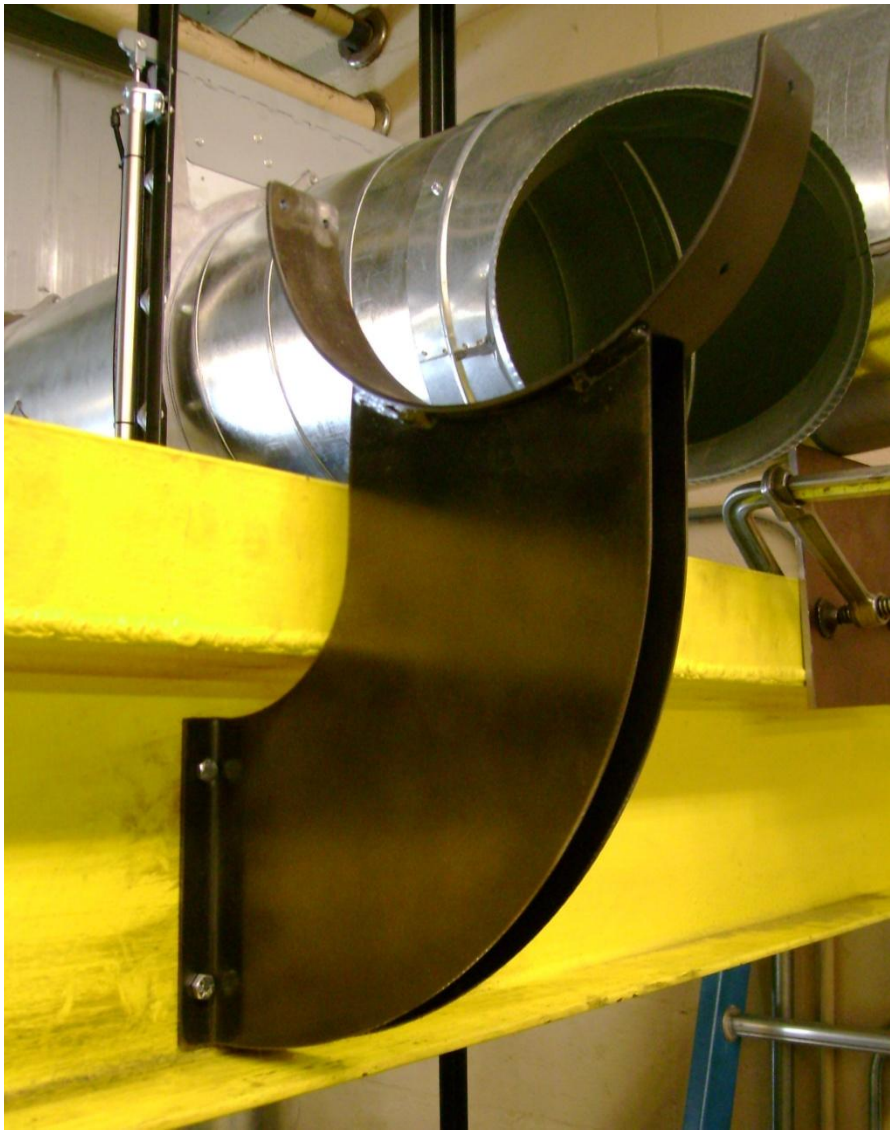


Figure 15. Beam bracket.

Testing

Testing was done by measuring how well the hoods could collect smoke from a an oxy-acetylene torch flame. Using the burning acetylene to create a visible smoke column, the fire was moved outward from the centerline of the hood. Once the hoods failed to effectively capture the smoke column, the distance from the hood centerline was measured. By repeating this test at each hood the capability of each hood or the total system capability could be measured.

Figure 16. Testing.

Results

The results of testing are that the hoods are capable of collecting the smoke column from up to one foot away with all three dampers open. Closing off one other the dampers increased the capability to two feet. Repeated operation of the valves without any incidents shows that the valves operate reliably and do not stick. This makes selection of which system to draw from simple.

The costs of the upgrades to the system totaled $885.25 in materials. Parts for the airflow control system made up the majority of the costs at $497.29. Materials for the ducting only cost $387.96. Factoring in the value of 175 hours of build and design labor at $30 per hour would increase the value of the project to $6,135.25.

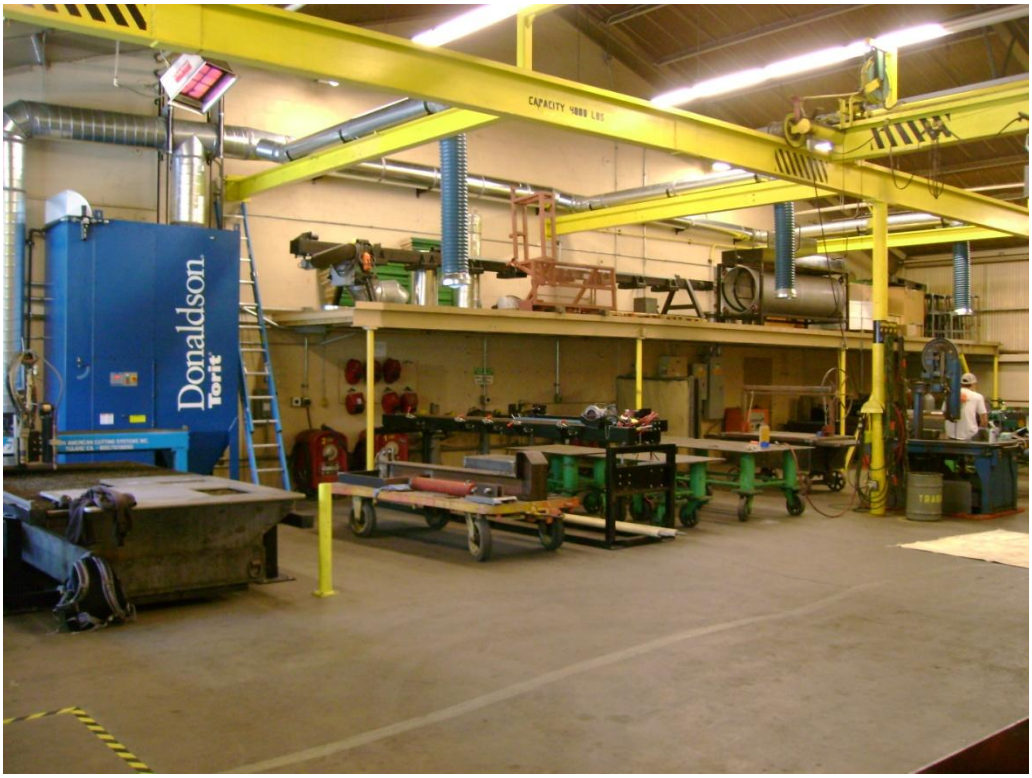


Figure 17. Completed system.

Figure 18. Another view of completed system.

DISCUSSION

The airflow control system used is somewhat complex for what it is doing. Significant time was spent designing and constructing the structure to operate the valves. Also the cylinders and control switch made up a large portion of the total cost for the project since each of the four cylinders cost $62.67. When the system was tested with only one centrally mounted cylinder it experienced problems with the valve slide alignment in the gate and not closing. Using two cylinders on each valve eliminated this problem but at an increased cost. The blast gate manufacturer offered pneumatic operated valves using a redesigned valve that allowed for a single cylinder to operate it, but at an additional $332 and still requiring the purchase of one cylinder it was much cheaper to adapt a standard valve to be pneumatically operated as was done in this project. Even with the increased cost the project final cost was approved by the BRAE department. The finished system works well and is very easy to use.

One of the problems with the testing method is that the torch projects the smoke in the direction that the torch is pointed. This doesn’t accurately represent how the system will be used. The reason this testing method was used is because of how visible the smoke generated was. It is easier to see the thick black column of smoke generated with the torch, whereas the welding fumes the system is designed to collect are light grey and sometimes invisible.

Overall the system works well and is much better than the previous system at removing cutting and welding fumes from the shop and can be considered successful. One limitation of the system is that the collection points are relatively localized. The flexible tubing allows the hoods to be moved a few feet in any direction but there is still a large area of the shop that is not able to be filtered by the dust collector.

RECOMMENDATIONS

If another system were to be designed the only recommended changes would be to consider using spiral tubing throughout the system and to locate the hoods lower to the ground. Spiral tubing costs more but is more visually appealing, has less connection points, and has greater structural integrity. By reducing the number of connection points the potential for leaks in the system is reduced. With a more structural tube the need for support brackets is reduced and assembly is simplified.

The collection hoods on the system would be more effective if they hung lower to the ground. As they are they are well above head level and out of the way. If each hood were dropped another four or five feet with the use of longer flexible tubing the area of coverage for each hood would be increased and the hood could be placed directly adjacent to the fume source.

Also it is worth considering the use of self-cleaning blast gates instead of the standard gates. The self-cleaning gates feature a longer valve that would be less likely to jam when opened by maintaining maximum contact with the valve guide throughout the valves range. By being self-supporting one cylinder mounted along the centerline of the valve could effectively operate the valve. This would eliminate the need for a second pneumatic cylinder and reduce the support frame used. The $43.56 increase in cost compared to a standard valve is more than offset by the lesser cost of only one cylinder and less fittings, line, and metal of the frame used. The drawback to the self-cleaning gate is the increased space required to allow the pneumatic cylinder to be mounted in the centerline of the valve instead of to the sides.

Figure 19. Self-cleaning blast gate.

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APPENDIX A

How Project Meets Requirements for the ASM Major

ASM Project Requirements - The ASM senior project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving.	
Application of agricultural technology	The project will involve the application of mechanical systems and fabrication techniques
Application of business and/or management skills	The project will involve machinery management, cost and productivity analyses, and labor considerations
Quantitative, analytical problem solving	Problem solving will include cost analysis, flow and pressure calculations
Capstone Project Experience - The ASM senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses).	
Incorporates knowledge/skills from earlier coursework	129 Lab skills/safety, 133Engineering Graphics, 142 Machinery Management, 152 SolidWorks, 301 Hydraulic/Mechanical Power Systems, 343/344 Mechanical and Fabrication Systems, 418/419 Ag Systems Management, Physics
ASM Approach - Agricultural Systems Management involves the development of solutions to technological, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving. (insert N/A for any area not applicable to this project)	
Systems approach	The project incorporates economics, engineering, and fabrication
Interdisciplinary features	The project deals with mechanical systems and waste management
Specialized agricultural knowledge	The project applies specialized knowledge in mechanical and fabrications systems

APPENDIX B

Cost Breakdown

Parts

Manufacturer	Part #	Unit Price	Quantity	Total Price
McMaster-Carr				
	5666K25	10.67	15	160.05
	6498K444	62.67	4	250.68
	6498K42	4.08	4	16.32
	6498K33	4.26	8	34.08
	5779K151	2.53	10	25.3
	5112K53	0.3	100	30
	5779K34	4.5	4	18
	2712T44	9.07	1	9.07
	61345K75	83.73	1	83.73
	5779K44	4.5	2	9
	4450K1	1.78	2	3.56
	8876T21	7.36	1	7.36
	90161A544	10.19	1	10.19
			Total Purchase Price =	657.34
Ferguson Enterprises Inc.				
	SHMSP261610	46.98	1	46.98
	SHMTYS241610	21.22	1	21.22
	SHMKD261403	12.08	1	12.08

SHMTYS24141010	16.53	1	16.53
SHM92610	5.96	4	23.84
D8137	3.74	3	11.22
SHM42610	3.72	2	7.44
SHMKD301003	6.51	2	13.02
SHMKD301005	10.64	6	63.84
SHM42614	5.87	2	11.74
		Total Purchase Price =	227.91
		Total Cost of Materials Purchased =	885.25

Labor

	Rate ($/hr)	Hours	Value
Design	30	75	2250
Construction	30	100	3000
		Total Labor Value =	5250
		Total Value of Project =	6135.25

Table 2. Cost breakdown

APPENDIX C

Design Renderings

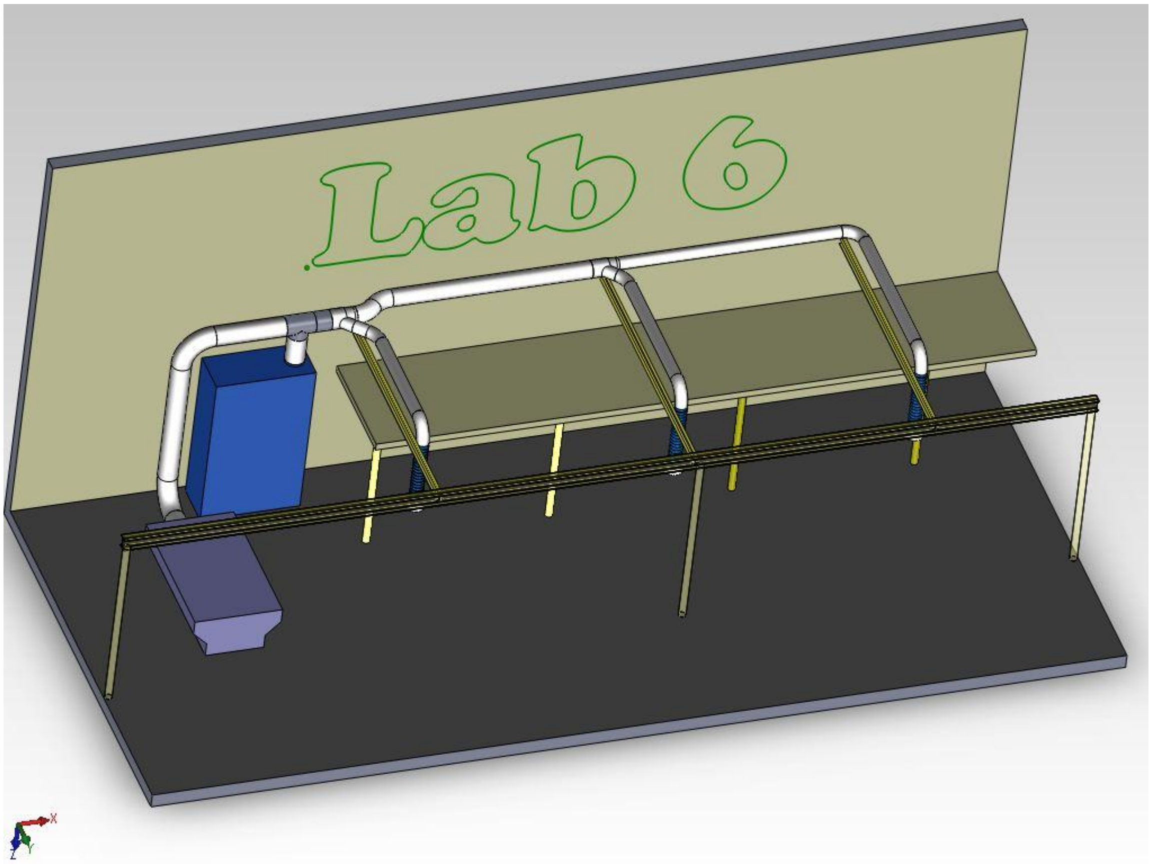


Figure 20. Isometric view of new system.

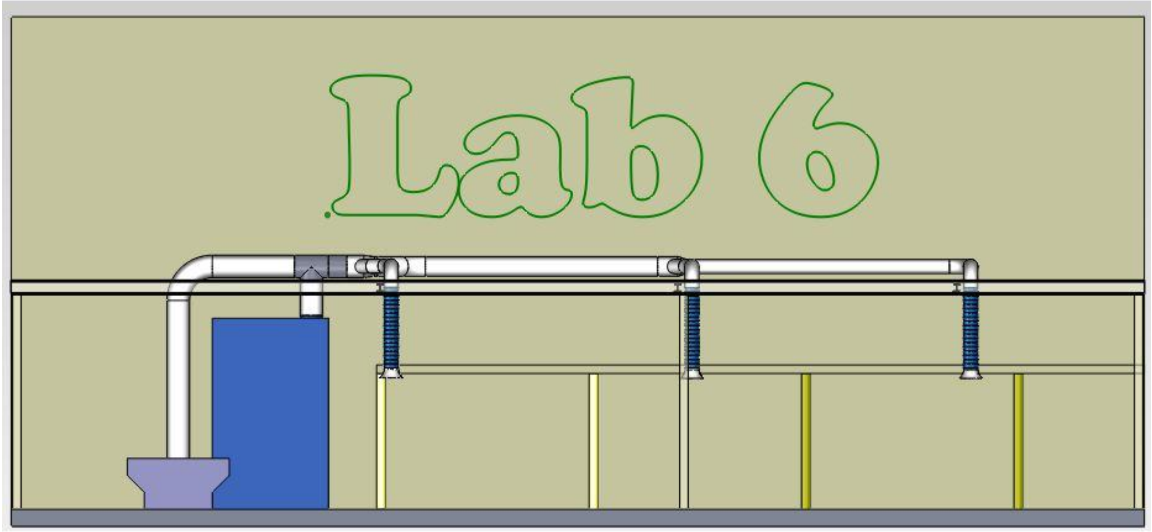


Figure 21. Frontal view.

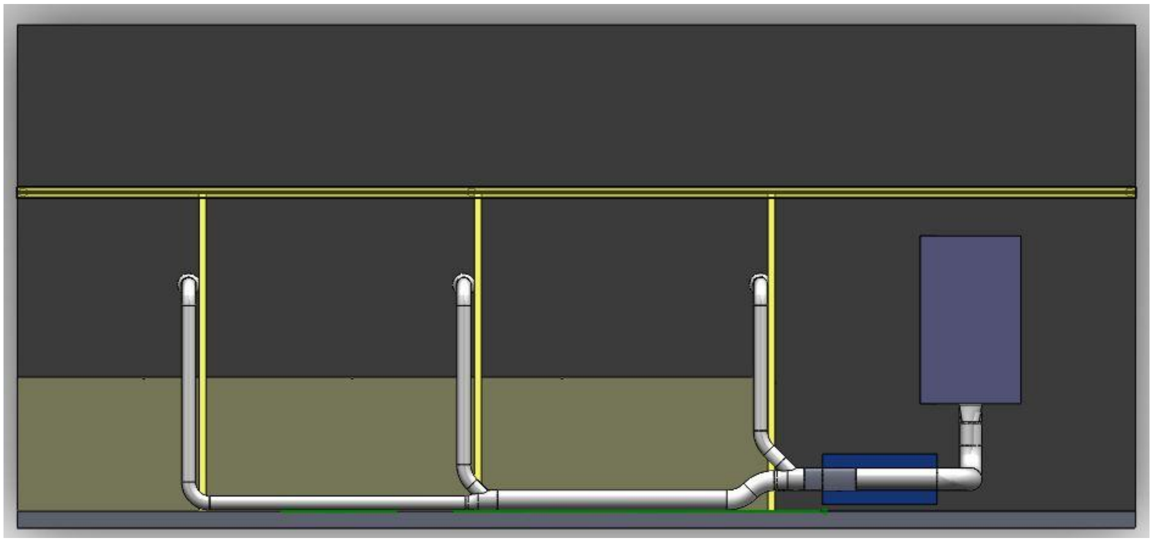


Figure 22. Top view.

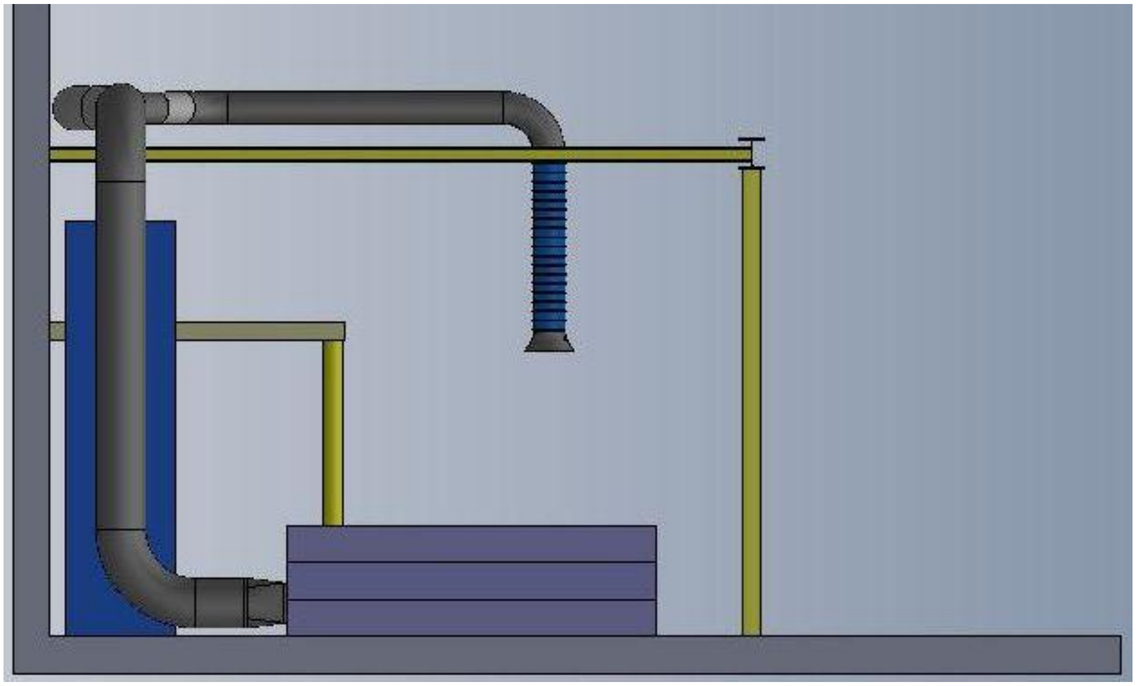


Figure 23. Right side view

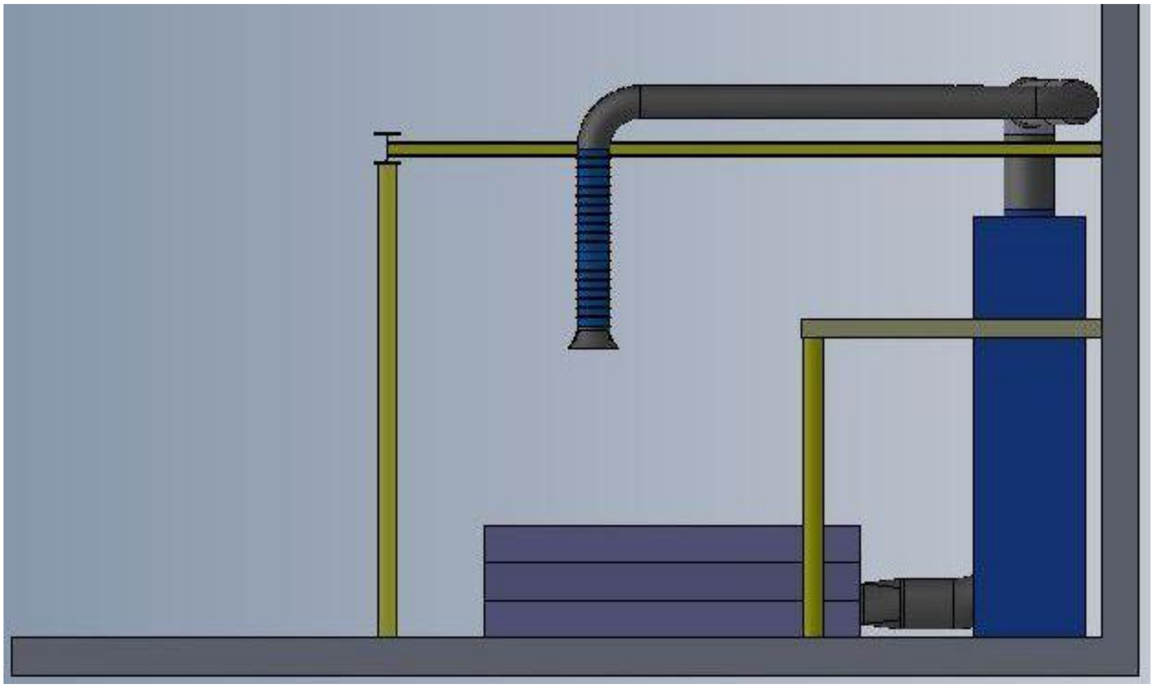


Figure 24. Left side view.

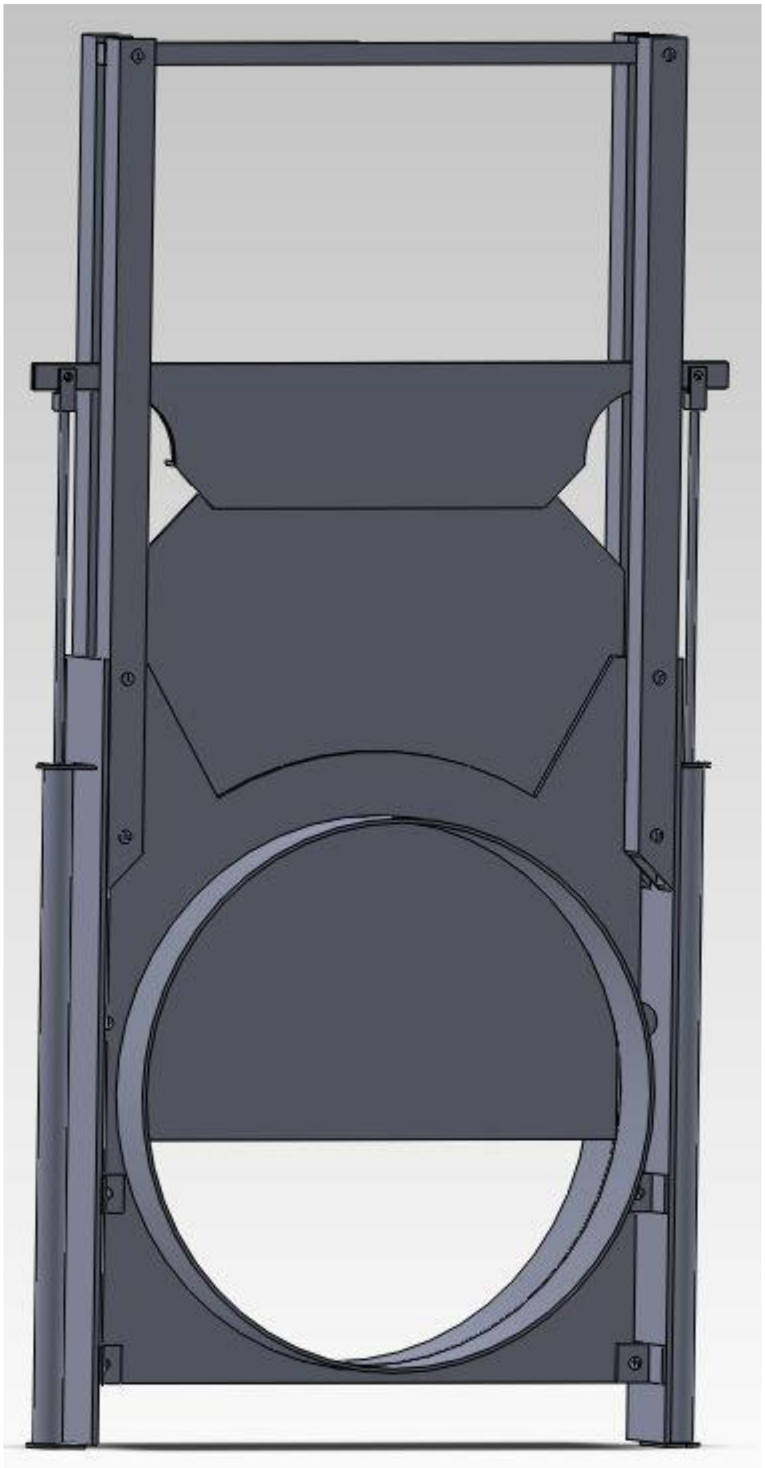


Figure 25. Valve.

APPENDIX D

Sections of Donaldson TG8 Brochure

Donaldson.
Torit®

TORIT® POWERCORE® DUST COLLECTORS
TG SERIES

PowerCore®
Smaller, Smarter Collectors.™

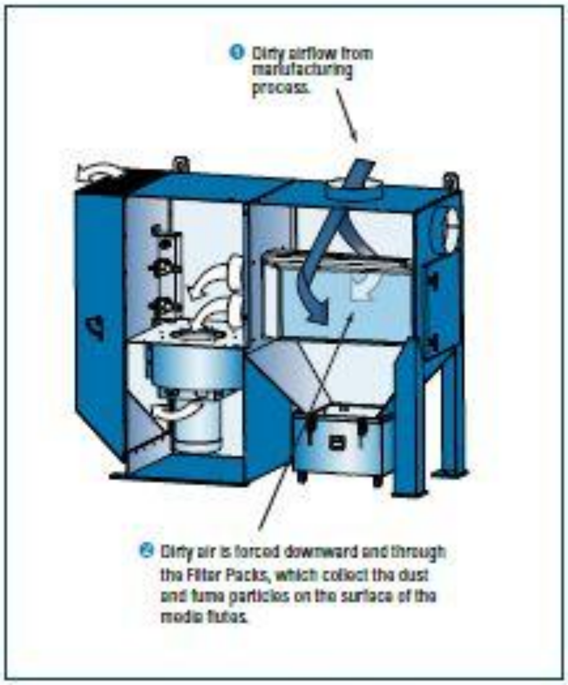
2010
Plant Engineering
PRODUCT
of the YEAR.
Silver Award

Donaldson.com/ToritPowerCore

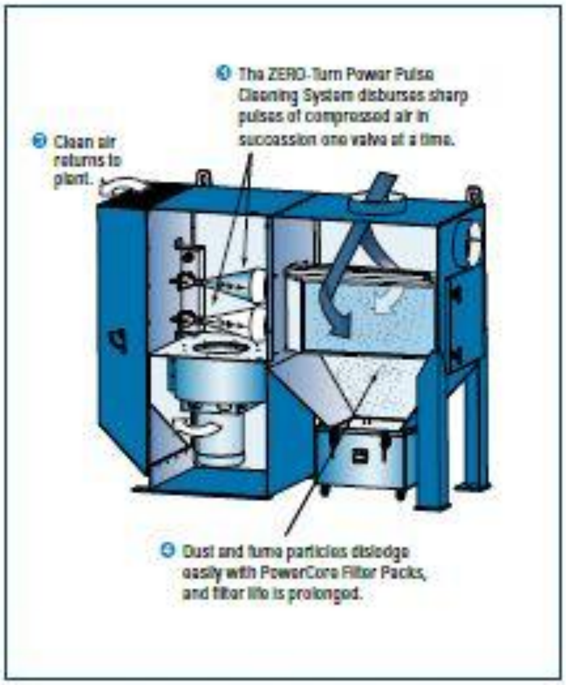
TORIT® POWERCORE® **TG SERIES**

OPERATING ADVANTAGES & CONDITIONS

HOW THE TG SERIES WORKS



Normal Operation



Filter Cleaning Operation

ADDRESSING SAFETY CONCEPTS

Donaldson® Torit® manufactures and partners with recognized experts to provide solutions for critical processes where harmful particulate must be controlled.

Torit PowerCore TG collectors offer:

- Reinforced Housing Construction
- Low-Inlet Drop-Out Box
- Inline Spark Cooler
- Composite-Style Explosion Relief Panels
- Fire Suppression
- Explosion Suppression
- Heat Sensors
- Alarm Strobes

OPERATING ADVANTAGES & CONDITIONS

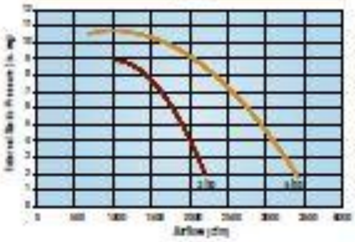
OPERATING CONDITIONS FOR TG COLLECTORS

TG Models	TG2	TG4	TG6	TG8	TG12
Horsepower	5 (3)	7.5 (5,10)	10 (15)	15 (20)	20 (30)
Sound Level db(A)	71-74 dB(A) depending on HP. Peak pulse noise is 92.7 dB(A)				
External Static Pressure	See system performance curves				
Housing Construction	3/16 - 12 gauge steel compliant with IBC2006				
STD Housing Rating	-12"	-12"	-15"	-15"	-15"
Reinforced Housing Rating	.15 bar	.15 bar	.2 bar	.32 bar	.16 bar
Seismic Spectral Acceleration	$S_S = 1.5$ $S_1 = 0.6$				
Wind Load Rating (mph)	90				
Compressed Air Required (psig)	90-100				
Operating Temperature	150°F				
Control Voltage	120 VAC -or- 24 VDC				
Valves/Controls	60 Hz				

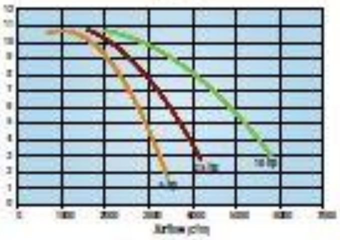
SYSTEM CURVES

Unlike other technologies that require upgrades for more demanding applications, each TG footprint comes standard with a unique high performance power pack. The system performance graphs below show the fan performance with clean filters. The curve indicates available external static pressure to the unit.

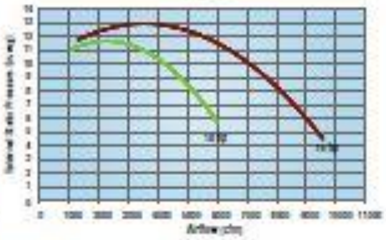
TG2



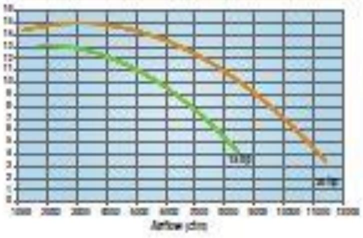
TG4



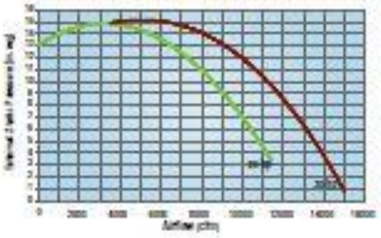
TG6



TG8

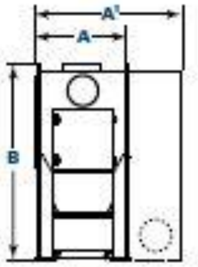


TG12

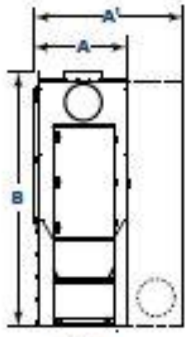


DIMENSIONS & SPECIFICATIONS

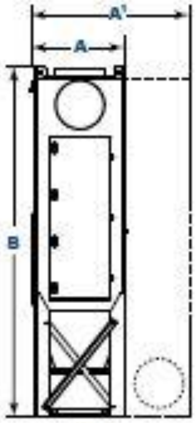
MODELS TG2 THROUGH TG12



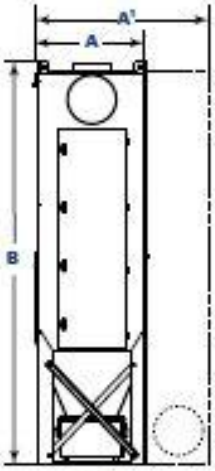
TG2
Front View



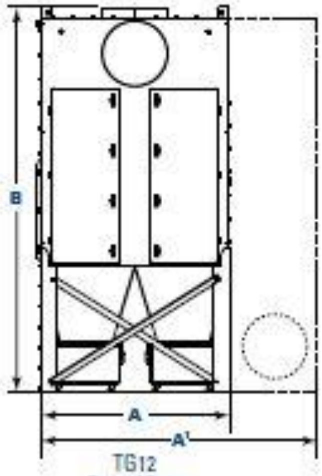
TG4
Front View



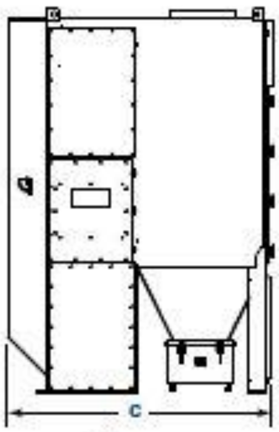
TG6
Front View



TG8
Front View



TG12
Front View



TG2, 4, 6, 8, 12
Side View

Model	Nominal Airflow Range* (cfm)	No. of Filter Packs	PowerCore Filter Area (ft²)	No. of Valves	Shipping Weight			Dimensions (inches)			
					Std Housing (lbs)	R Housing (lbs)	Low-Inlet Box (lbs)	A	A'**	B	C
TG2	960 - 3200	2	294	2	1100	1150	1700	30.8	47.1	66.6	83.2
TG4	1920 - 5500	4	588	4	1600	1650	2025	31.0	47.1	86.1	82.1
TG6	2880 - 8640	6	882	6	2250	2350	2800	31.2	51.6	117.2	82.1
TG8	3840 - 11,520	8	1176	8	2900	3400	3300	36.8	59.1	135.0	82.2
TG12	5760 - 13,440	12	1764	12	4120	4600	4700	59.7	85.6	120.3	83.2

* Based on clean filters.
** Width includes optional Low-Inlet Box

APPENDIX E

Standard friction loss in standard ducts

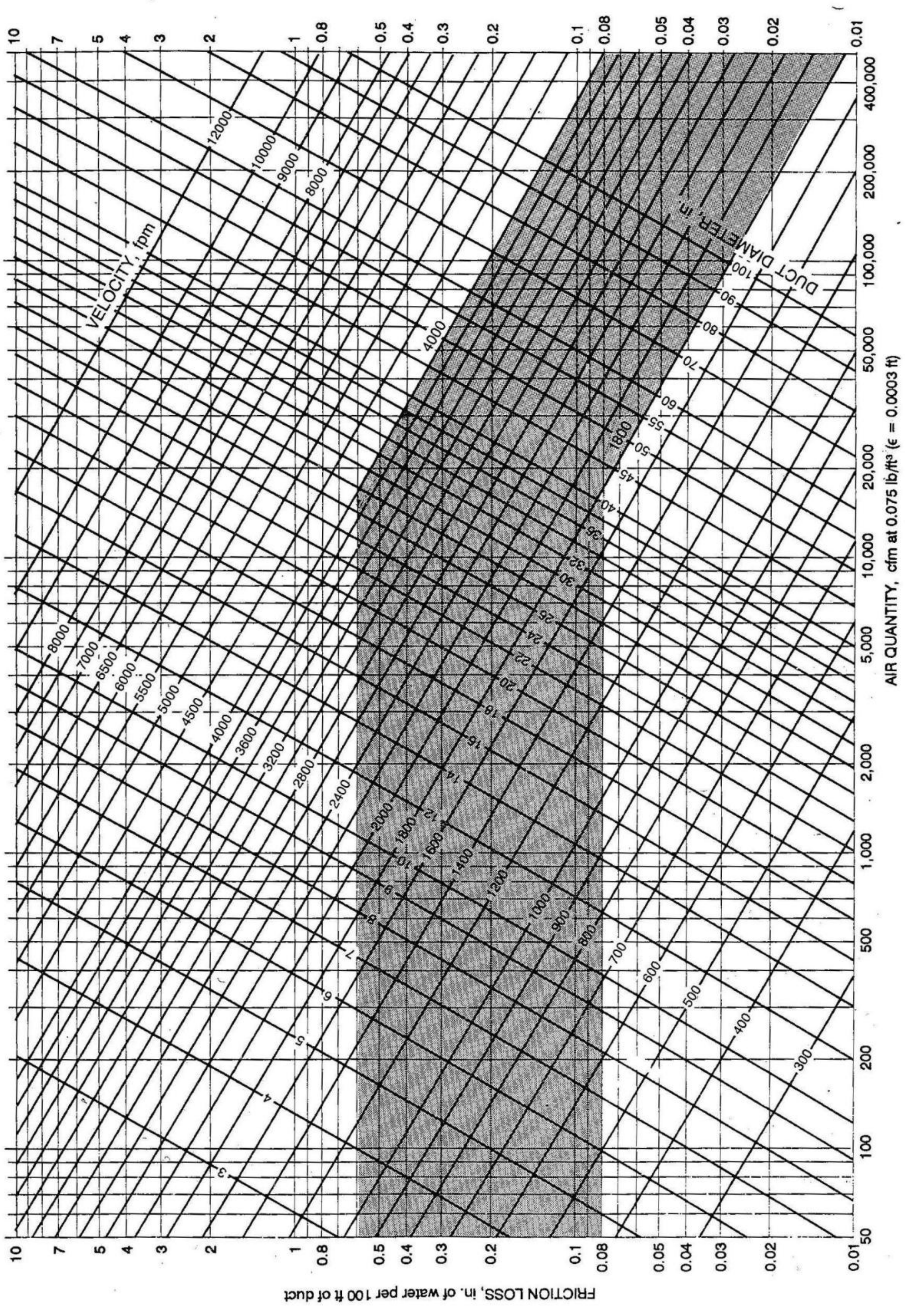


Figure 26. Standard friction losses in standard ducts. (Lindeburg, 2001)

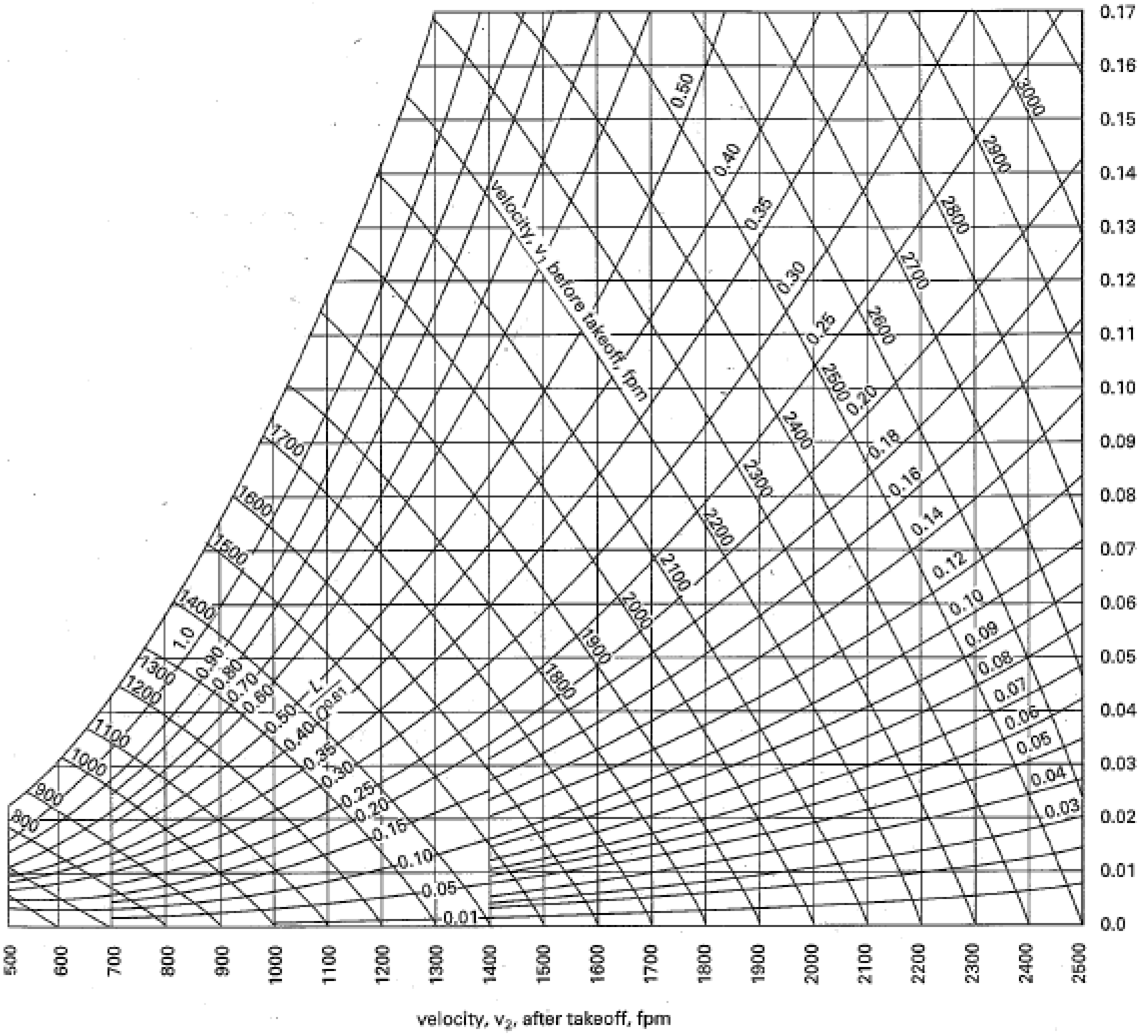


Figure 27. Static regain chart (r=0.75). (Lindeburg, 2001)

APPENDIX F

Performance data for double-acting cylinders

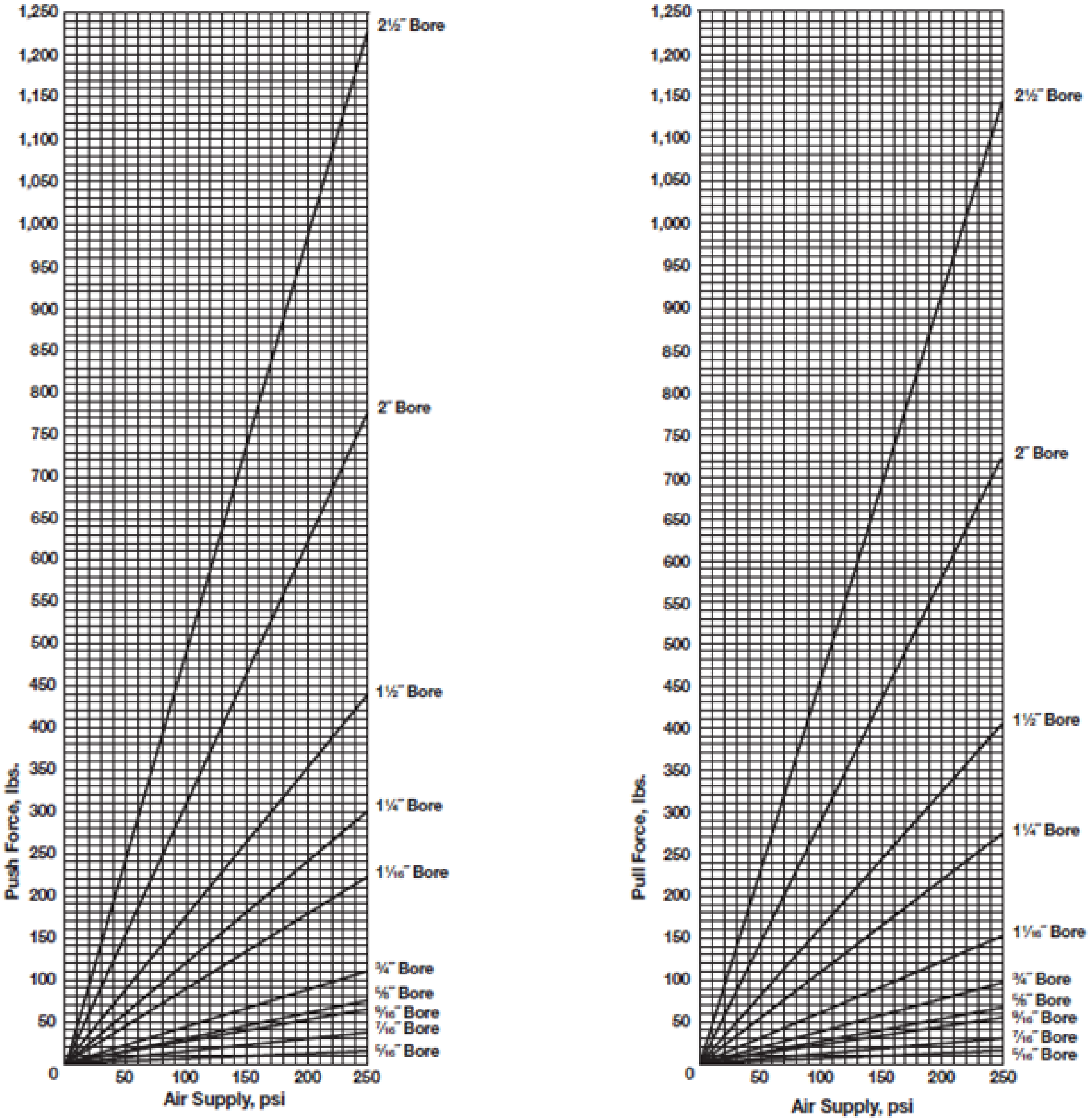


Figure 28. Performance data for double-acting cylinders. (McMaster-Carr, 2010)