

## **ADVANTAGES OF USING DC FANS OVER AC FANS** **IN RADON MITIGATION**

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### **ABSTRACT**

By using a DC based blower fan\* (Figure 1), you will achieve lower costs and better performance in most applications than by utilizing a traditional Inline AC Fan. Some of the advantages are as follows:

- Lower operating cost (45 watts).
- Higher suction (5.5 inches to 6.5 inches W.C.) works on all soil types.
- Use of a DC motor provides a longer life.
- Installation does not require a licensed electrician.
- Slim Profile is easier to install.
- Use of 2" suction & discharge pipes reduces cost and modification requirements.

\* Based upon experimental analysis of the RAM-7 DC Radon Mitigation Fan recently developed by RAM/GAM Engineering.

### **INTRODUCTION**

Traditionally, Radon Mitigation professionals have been using AC based fans to provide sub slab ventilation. While AC motors are capable of moving a great deal of air (assuming unrestricted air-flow), they are generally incapable of providing the initial high suction levels needed (Greater than 2 inches of water at 0 CFM).

Based on our extensive field experience, we have observed that the static pressure in semi to non-permeable soils is very high initially, quite often in excess of 10 inches W.C. (assuming that cracks and gaps are sealed or are far from the suction point). This condition can take in excess of one month before the soil permeability has stabilized to 1 inch W.C. or less (we refer to this as the acclimation period). Furthermore, periods of moderate to heavy rain or moisture can have a dramatic impact on the permeability of the soil. When this occurs, a typical AC fan that provides approximately 2.0 inches of Static Water Pressure will have to go through another acclimation period again (possibly as long as the initial acclimation period). This can cause soil expansion and contraction as well as radon level fluctuations. This fluctuation, particularly with expansive soils can introduce further cracking in the slab thereby decreasing the effectiveness of the mitigation.

Furthermore, during the pre-acclimation period, and if the fans stops for 12 hours or more, the radon levels can reach there equilibrium point (back to original pre-mitigation values). It is important to reduce the acclimation period for these reasons.

## PERFORMANCE

In looking at the performance curves versus various types of AC fans (figure 2), we can see that the suction level is typically 2 to 3 times higher than the standard Inline AC fans. This can allow you to reach the acclimation point 2 to 3 times faster than the standard Inline AC fans, and be able to control the soil expansivity and contraction problems quicker as well. Furthermore, if we look at Figure 3, we can see that 50 CFM of air flow is more than sufficient to mitigate radon in aggregate conditions ranging from compacted non permeable soil to 1 inch diameter pebbles size (> 98 % of all homes).

While one alternative in these cases is a high suction AC Fan (>25 inches W.C.), the cost can be prohibitive (> 5X), along with the power consumption and noise level than that of a standard Inline AC fan. Once you have reached the acclimation period, the CFM performance of a high suction fan is approximately the same as the DC Fan tested by RAM/GAM Engineering.

Using a larger and more powerful moderate suction Inline AC fan, (3 to 4 inches W.C.), you would have approximately 300 to 400 CFM of air movement at 1 inch W.C. . While this may be quite effective in mitigating radon levels, the sheer size, power consumption and noise level of these Inline fans can be quite unappealing to the home owner. In this case, the estimated and observed acclimation period is typically twice as long using this type of fan as when using the DC Blower Fan.

## POWER CONSUMPTION

Most of us only look at the running power consumption of a motor when we explain cost to a home or business owner. While this is generally true, other costs in Power Consumption that can be overlooked, is in heat loss. This heat loss can occur when we have large cracks or gaps that are not sealed (or caused due to soil expansion after the initial sealing is performed). While RAM/GAM Engineering does not recommend this, one solution when not repairing or sealing large cracks and gaps (such as with a finished basement), is to utilize a fan that provides sufficiently high enough airflow, so that you can maintain a minimum static pressure that still brings in fresh air from outside through the soil. This will unfortunately also pull air out of the basement through the cracks, to be ejected outside. As a rough estimate, if you assume that half of the approximate 100 CFM of air flow is coming in through the basement, then the cost of heating 50 CFM of outside air to room temperature during the winter would be about \$125 per year. This is why it is important to ensure that large gaps or cracks are sufficiently sealed or far away from the suction point. And should there be any substantial sized cracks near the suction point, a large enough fan while being able to provide a high enough airflow, would also cost the homeowner substantially more money due to heat loss.

RAM /GAM firmly believes that any substantial cracks or gaps inside the basement should be sealed, and if there is a reasonable seal between the concrete and the sub slab, then 50 CFM will provide more than ample air movement to continuously keep radon levels low. Should there be no other alternative to leaving a substantial crack or gap near the suction point, then a higher CFM fan, may be the only alternative. Caution should be taken to ensure that Carbon Monoxide and other toxic fumes from the furnace and water heater do not get pulled into the basement due to excessive depressurization in the basement.

### **LOW NOISE**

Acoustics and Vibration of the DC Blower are lower than typical Inline AC Fans due to the use of a blower design as opposed to an Inline fan. Furthermore with the use of 2 inch diameter pipe, the pipes can be run inside of a walls, further reducing the noise level. While the discharge speed is potentially higher when using a smaller diameter pipe, an expansion muffler can drastically reduce exhaust noise should it be needed.

### **SLIM PROFILE**

One of the biggest advantages of utilizing the DC Blower Fan, versus your typical AC Inline Fan, is size. Whereas an AC Inline fan typically requires between 9" and 14" of diameter plus the additional space requirements for the 4.0" diameter pipe at the suction and discharge, the DC blower fan will protrude less than 5 inches from the wall and uses 2.0" diameter PVC pipes for the suction and discharge. Furthermore, the homeowners will love the unobtrusive design.

### **LONGER LIFE**

Another key difference between the AC Inline fans and the DC blower fan is life. While many manufacturers offer warranties from 3 to 5 years on their AC Fans, the risk of failure is still substantial. One of the biggest factors in determining product life, is heat. While an AC fan that deliver 350 CFM and draws 100 watts of power appears to have more than sufficient cooling. A DC Fan that moves only 50 CFM and draws 44 watts will not suffer as many heat related failures when used for radon mitigation (particularly in low permeability soil areas). The reason for this is due to the varying permeability of the soil. Immediately after installation and after rainstorms, the permeability of the soil is very poor. It is not at all unusual to see exhaust flow drop to below 5 CFM until acclimation is achieved. In these instances, having a low power DC fan that has a much higher suction level, will provide a faster recovery period (acclimation) and consequently will provide the necessary airflow for cooling more quickly. A high CFM AC fan during this same period can struggle to reach the acclimation point due to its lower initial suction. As a result, the fan can end up operating for a longer period of time with insufficient airflow to achieve proper cooling. After acclimation, many fans will maintain a typical 1.0" of water suction pressure, which should be sufficient for all types of fans.

DC fans also run more efficiently than their AC counterparts, e.g. they convert more of the energy into motion rather than heat. This allows the bearings to run cooler, thereby increasing bearing life. The fan used by RAM/GAM engineering is also designed to operate at higher temperatures for extended periods of time, unlike the typical Inline AC fans.

### **EASE OF INSTALLATION**

While many of the professional mitigators have become accustomed to the installation requirements of a typical AC Inline fan. There is still a great deal of difficulty in locating appropriate locations to run a 4-inch diameter pipe. To compound this further, a 4-inch diameter hole through walls and joists can substantially impact the integrity of the structure.

AC fans can also require installation by a licensed electrician in most states. While much of this can be left up to a homeowner to do themselves, or for the Radon Mitigator to perform (illegally ???), there is an increased liability in doing so. To do this job legally and properly can require several days and the coordination of efforts from a licensed electrician, a professional mitigator, the homeowner and possibly a city inspector.

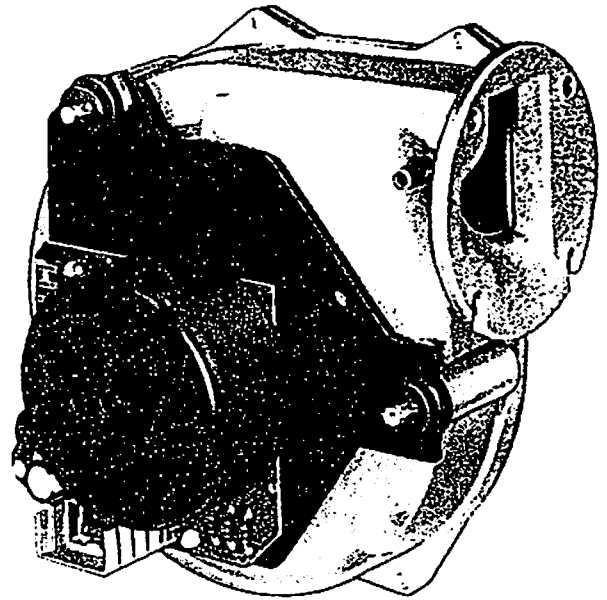
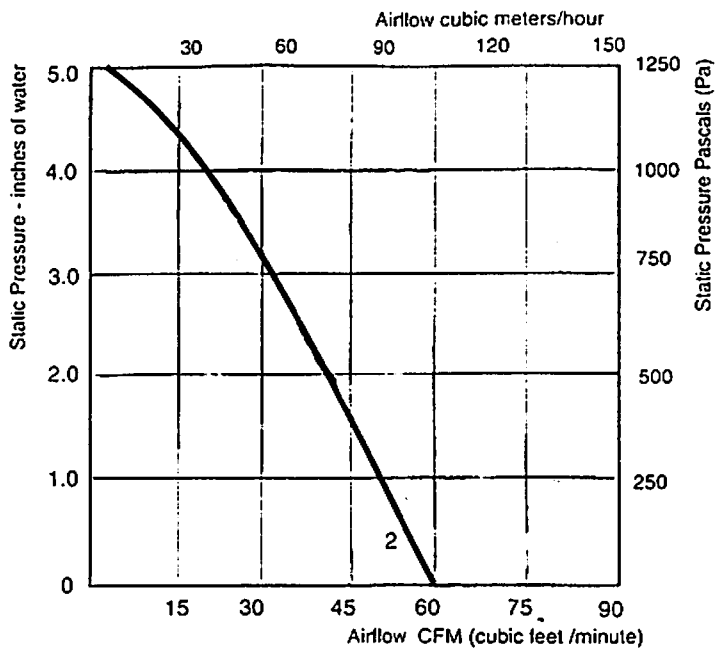
By using a DC Blower fan (24 V DC), you bypass all of these headaches and liabilities in one sweep. This installation and wiring is as simple as plugging in a connector into the fan, and a power supply into an outlet.

### **OVERALL LOWER COST**

If we compare the total cost of an Inline AC FAN installation and a DC Blower Fan Installation, we can readily conclude that using a DC Blower fan is the logical choice. In Table A, we can see a Breakdown of a typical single fan installation.

### **CONCLUSION**

At RAM/GAM Engineering Services, it is our goal to provide you with the leading edge in Radon Mitigation systems and controls. While the majority of our sales are in Inline AC fans, we believe that the use of the DC Blower Fan is the future of Radon Mitigation.

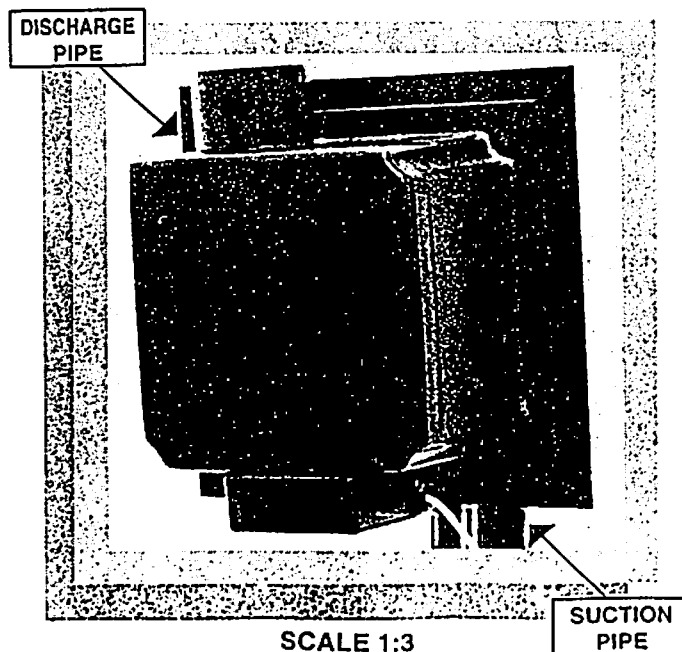


## Radon Gas Blowers 24 VDC Operation

DC Volts	DC Voltage Range	Watts	Type of Bearing	CFM @ 0"	Medium Max °C	Ambient Max° C
24	20 - 28	44	Ball	59	80	70

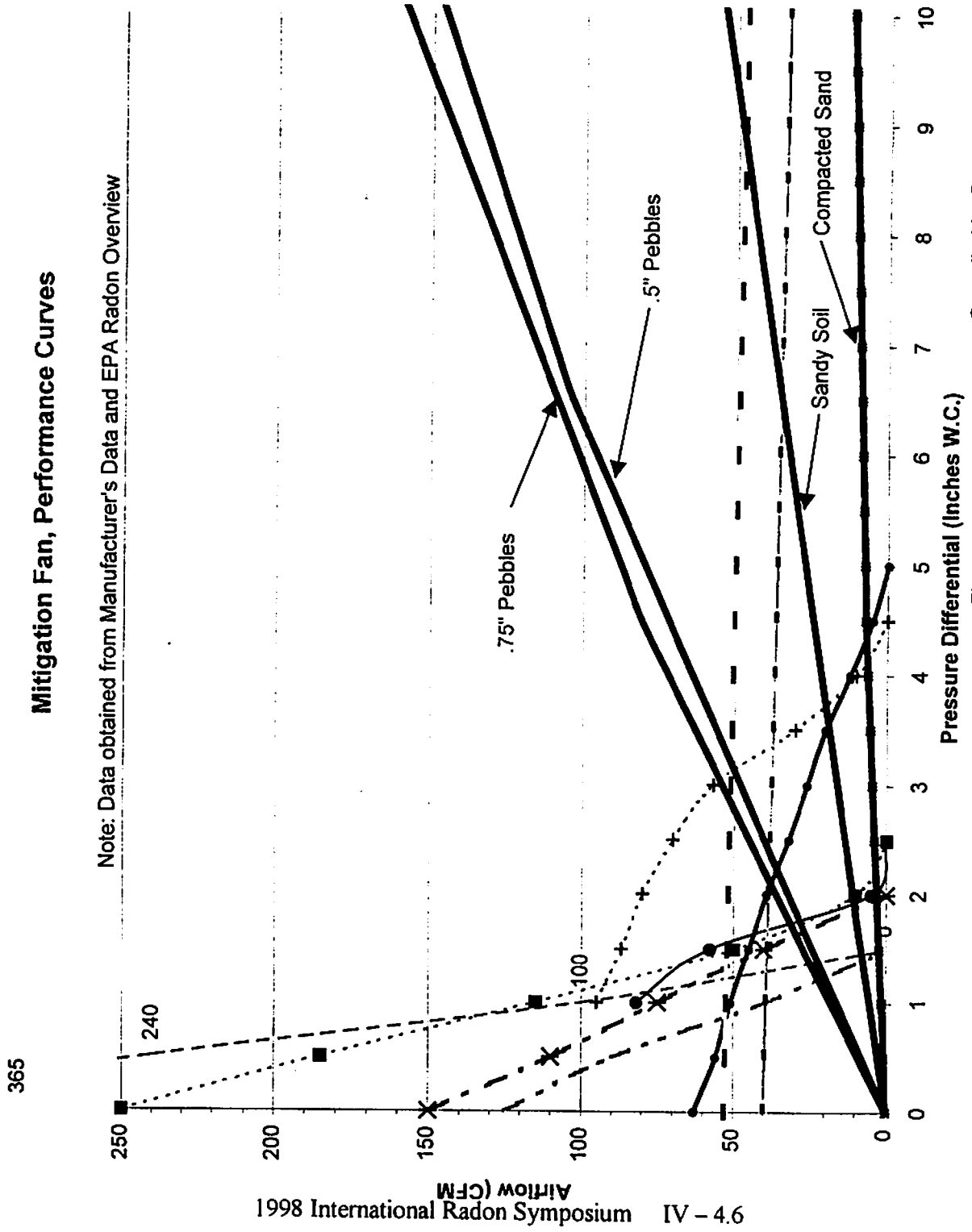
**RAM 7-DC**

**Figure 1**



# Mitigation Fan, Performance Curves

Note: Data obtained from Manufacturer's Data and EPA Radon Overview

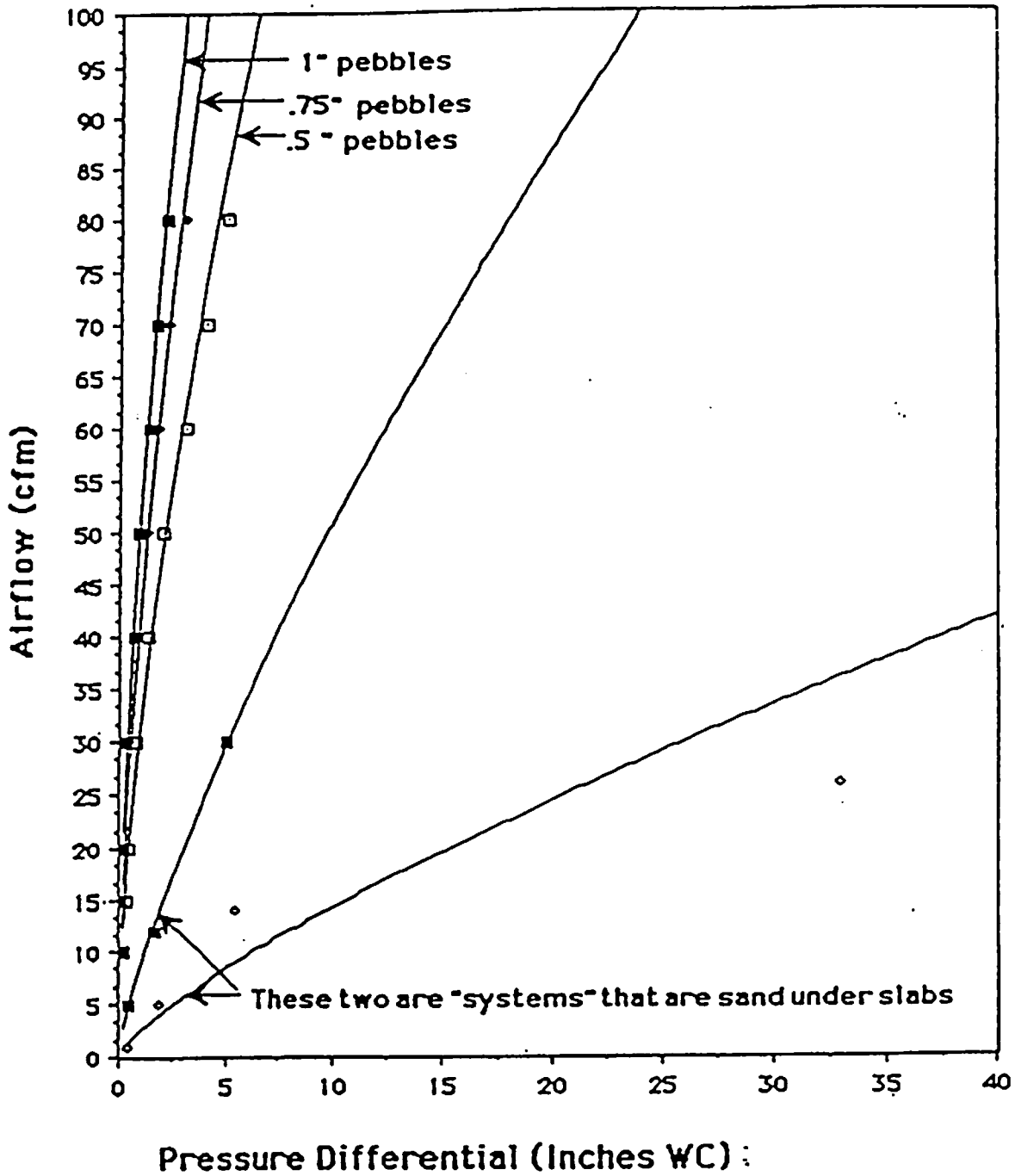


Compiled by RAM/GAM Engineering

Figure 2

# "SYSTEM" CURVES FOR DIFFERENT AGGREGATES

These three systems are pebbles in a 1' x 1' x 10' bed



SOURCE: Camroden Associates

### Figure 3

1998 International Radon Symposium IV-4.7

Material & Labor Costs	Price		
	RAM - 7	Typical	Typical
	DC Blower Fan	Inline AC Fan	High Suction Inline Fan
Sch. 40 Plastic Pipe (40 ft)	\$12.00	\$40.00	\$40.00
Sch. 40 Plastic Elbows (6)	\$3.00	\$18.00	\$18.00
Rubber Couplings (2)	\$5.00	\$13.00	\$13.00
Labor @ 25\$ per Hour	\$50.00	\$100.00	\$100.00
Electrical Components	\$0.00	\$15.00	\$15.00
Electrician	\$0.00	\$100.00	\$100.00
Sub Total	\$70.00	\$286.00	\$286.00
Fan	\$ 225 - \$ 250	\$ 80 - \$ 350	\$ 400 - \$ 800
Total Cost	\$ 295 - \$ 320	\$ 366 - \$ 636	\$ 686 - \$ 1086

Note: Above figures show only the differential costs between DC Blower and AC Inline Fans. Costs of Suction Hole(s), Sealant Material, Plastic Sheets, Suction Hole requirements, etc., are the same and have been omitted for clarity. Cost of DC power supply is included in RAM -7 Fan Price.

**TABLE 1**