T.R.A.C.S. – Total Room Air Cleaning System

ABSTRACT

Self contained air purification system creating approximately 350 cfm of air flow at high speed, designed to remove allergy causing particulate, microorganisms, and odors/chemicals from the air to create a healthy environment. The system utilizes a carbon prefilter for removal of larger particulate and odors/chemicals and gases, three UV lamps for destruction of bacteria, viruses (including Influenza), and molds, an individually certified Hospital Grade HEPA filter (99.99% efficient at .3 microns) for removal of smaller particulate and bacteria, and carbon postfilters for additional odor, chemical, and gas removal..

Air enters from the upper end of the cabinet, travels through the carbon Prefilter pack and past the UV lamps, through the HEPA filter and past the motorized impeller, and finally through the carbon postfilter before it exhausts out of the lower end of the cabinet. In addition to attacking airborne bacteria and viruses, the UV lamps continually bathe the "dirty" side of the HEPA filter (the side of the filter on which the microorganisms are collected) in UV light, thereby deactivating any microorganisms that have been collected and preventing bacteria/mold growth on the HEPA.

The unit is designed for use in homes, commercial offices, or any area having indoor air quality concerns.

CABINET:

Dimensions: 15" x 15" x 22"

Construction: 20 gauge powder-coated steel cabinet with 2" casters and a convenient back panel access to all components. 50 lbs.

Colors: Standard colors are Sandstone, White, and Black.

Air Intake: Air enters TRACS at the upper portion of the cabinet in the front, left, and right sides, effectively taking in air from all areas within the room. By having air enter through the top of the unit, dirty and contaminated air from the normal breathing zone in the room (3-6 feet high) is immediately and efficiently drawn into the cabinet and replaced with clean and disinfected air. Units that have air intake on the bottom can have difficulty drawing in dirty air from upper areas throughout the room because you have to hope that exhaust air will maneuver dirty air to the unit intakes, and this is especially difficult if the unit is placed in close proximity to furniture,. However, by having air intakes at the top of the cabinet, dirty air from the normal breathing zone is

in direct contact and easily exposed to the air intakes, quickly and efficiently pulling airborne contaminants into TRACS. Furthermore, units that pull in air from the bottom can actually suck in and disrupt dust and dirt off of the floor and into the unit, thereby creating a dirty environment around the unit and prematurely causing filter loading.

Air Exhaust: Air is exhausted from TRACS through the lower front, left, and right of the cabinet. Outlets on three sides disperse and distribute clean air to all parts of the room, regardless of unit placement. Air is directed outwards and upwards through so as not to disrupt any dust or particulate on the floor. And unlike some top air discharge designs, the TRACS air exhaust works to corral dirty air back into the unit's intakes and replace it with clean and disinfected air. Air exhaust is critical to the air flow pattern created, and therefore the overall effectiveness of any air cleaner. Many units that exhaust air out of the top tend to scatter and force dirty air away from the cabinet (because the exhaust literally blows airborne contaminants away from the unit), and the air intakes are inefficient at bringing dirty air back to the cabinet. However, the exhaust air in TRACS evenly disperses clean air throughout the room but does not disrupt the efficient contaminant removal by the air intakes. And in doing so, the exhaust of TRACS keeps air 1-4 feet from the ground clean and safe, which is where children (and pets) get their air to breathe. In all, unlike most air cleaners on the market today, the air removal and air supply from the TRACS unit work together in concert to effectively provide "Total Room Air Cleaning".

FILTRATION TECHNOLOGIES:

Carbon Prefilter: A 14x14x1" carbon pack removes larger airborne dust and particulate to keep the HEPA filter and lamps clean and extend their lifespan, but it also contains over 3.5 lbs of blended carbon and zeolite to adsorb odors, chemicals and gases. In addition to removing regular household and office odors (styrene, food and pet odors, mercaptans, aerosols, smoke), a special blend of activated carbon oxidizes and potassium permanganate can be used upon request that removes difficult gaseous pollutants like formaldehyde, ethylene, hydrogen sulfide, ammonia, and more that standard carbon in itself would be inefficient in adsorbing.

The carbon filters in TRACS were designed for regular replacement, as carbon in any system can quickly become saturated and therefore be ineffective at removing odors, chemicals and gasses. Carbon acts like a sponge,

and once it is saturated it will actually expel trapped fumes and chemicals. Even systems containing more than 10 lbs. of carbon likely need to be changed every four to six months or they can begin out-gassing trapped odors, chemicals, and gases. This can be quite expensive in many air cleaners as the carbon filters can cost in the hundreds of dollars.

Given prefilters in any air cleaner should be changed at least quarterly, PAS combined the prefilter function with the need for fresh activated carbon in the TRACS design; instead of changing just a prefilter pad on a regular basis, a carbon pack that combines particulate and odor removal is changed. The key factor in this design is that the retail price of the TRACS carbon prefilter pack (and postfilter pack) is actually LESS than the cost of standard prefilters/ postfilters in many air cleaners on the market today. Therefore, if changed regularly, (every three months), the odor, chemical, and gas adsorption in TRACS will remain at peak efficiency and effectiveness while still costing much less than larger, more bulky carbon filters. And the cumulative amount of fresh carbon used over the course of a year in TRACS is actually the same or greater than the amount of carbon used in other units.

EVERY TRACS UNIT COMES WITH A TYPICAL YEAR'S SUPPLY (THREE) OF CARBON PREFILTER PACKS

UVGI Lamps: TRACS utilizes three UVGI (Ultraviolet Germicidal Irradiation) lamps contained in a highly reflective UV kill chamber that continually shines on the dirty side of the HEPA filter (this is the side of the HEPA filter that the particulate and biological contaminants are trapped on). UV radiation has been proven to deactivate and destroy microorganisms under certain conditions. Please review the UV Dosages Required for complete destruction of various bacteria, viruses, yeast, molds, etc... in Appendix A. This is important because most viruses are less than .3 microns in size, and HEPA filters are rated 99.97% or 99.99% efficiency at .3 microns. While many viruses smaller than .3 microns can be trapped by HEPA filters, the exact efficiency at particle sizes that small is not documented or guaranteed to be 99+%. However, viruses like Influenza are especially susceptible to UV radiation and TRACS produces enough UV dosage to destroy even some of the most difficult microorganisms on a single pass. UV dosage is a function of the intensity of the UV light, and the amount of time the microorganisms are exposed to that light (referred to as Residence Time). The limitation of most UV systems is that there is rarely is enough UV dosage created to destroy airborne bacteria or viruses, and the lamps are not located in effective areas as they are located at the system's exhaust (after the HEPA).

TRACS was designed to address both of these concerns. First, three lamps are mounted in a highly reflective kill chamber that

amplifies the UV radiation to a level to make it effective against most airborne pathogens. The UV dosage in TRACS is 18,415 microwatt sec/cm^2, allowing it to destroy smaller bacteria and viruses. However, even hospital grade UV systems rarely create enough UV dosage to destroy large airborne molds, spores, and some bacteria because their size requires a very high UV dosage for complete destruction. Fortunately, such microorganisms can be easily trapped by the HEPA filter. However, this can present a problem in non-UV systems and units having the UV located at the exhaust.

While HEPA filters have been the standard for high risk infection control in hospitals and laboratories (because they have been proven to remove airborne microorganisms), they require at least annual replacement due to biological contamination. As microorganisms collect on the HEPA filter over a long period of time, there is a risk of bacteria and mold growth on the HEPA filter as trapped bacteria/mold live, grow, and feed on each other and trapped dust, etc.. (especially in warm and humid environments). This is sometimes called bacteria "grow-through" whereby microorganisms can live and breed on the HEPA media, eventually even eat through the media. This ruins the integrity of the HEPA filter and possibly creates more contamination within the room as the microorganisms/ mold is dispersed by the air cleaner.

However, by having the UV lamps located before and continually bathing the dirty side of the HEPA filter, the bacteria and mold collected are destroyed and deactivated over time. This is because an "infinite" residence time is produced, as the trapped bacteria/mold is exposed to the UV light as long as the unit remains on. In all, the UV in TRACS not only destroys airborne bacteria and disease, but it also continually radiates on the dirty side of the HEPA filter to extend HEPA filter life and ensure the destruction of larger more difficult microorganisms.

HEPA filter: TRACS utilizes a 14" x 14" x 3 5/8" individually certified HEPA filter with 80 square feet of media for dust, dander, mold, allergen, and particulate removal at hospital grade efficiency. Unlike many commercial/residential HEPA filters that utilize HEPA media but whose finished filters are not tested, the HEPA filter used in TRACS is individually tested to ensure the filter's efficiency of 99.99% efficient at .3 microns. In some commercial/residential units the media will be 99.97% efficient at .3 microns but the media is not gasketed and sealed within the filter frame to prevent air bypass around the media. As such, the filter itself may not be 99.97% efficient at .3 microns even though the media is.

Carbon Postfilters: Three 14 x 4 x ¾ " carbon pads cover each exhaust area on the TRACS unit to remove potential latent odors from the air and/or unit interior, and to buffer noise from the fan motor. These are permanently installed in the system, so they never need to be replaced.

UNIQUE ATTRIBUTES:

Airflow Pattern: The key to any air cleaner is the airflow pattern that it creates. A device can utilize the best air cleaning technology in the world, but if the dirty air is not drawn into the unit from throughout the room and replaced with clean disinfected air, then the device's overall effectiveness and efficiency is limited. The airflow pattern created by TRACS is designed to produce an excellent mixing factor and clean all parts of the room. Furniture and other room masses that can be disastrous to other unit's ability to collect dirty air have limited effects on the airflow created by TRACS. This is due to the location and design of the unit's intake area, the velocity of the air traveling out of the unit, and the location and design of the air exhaust vents.

With TRACS, dirty air is drawn in through the top of the unit through intake vents. This allows for the most efficient removal of contaminated air from the normal breathing zone (3-6 feet high), as the dirty air has easy and direct access to the unit's air intake. Air then passes through the five stages of filtration before being exhausted out of the lower portion of the unit. The exhaust air is directed outwards and upwards by the exhaust vents molded into the cabinet, effectively distributing air throughout all corners and within all levels in the room (please see picture below). The velocity of the air being exhausted is high enough to effectively move large volumes of air long distances, ensuring total room air cleaning.

The airflow pattern created by TRACS is better than other air cleaners that may have the air intake on the lower portion of the cabinet and the exhaust on the top. If a small air cleaner is located on the floor (underneath the normal breathing zone), top exhaust can suspend dirty air 4-6 feet in the air without cleaning it. This occurs as the exhaust continually pushes dirty air upwards and away from the unit, scattering but keeping dirty air 4-8 feet from the floor and away from the air cleaner. Furthermore, dirty air that is suspended in the breathing zone cannot easily be cleaned if the air intakes are next to the floor, especially if the unit is placed next to furniture so that a portion of the intake panel is blocked from direct access to the air. TRACS, on the other hand, works to actively collect, consolidate and remove air directly from the breathing zone. TRACS does not wait and hope that exhaust air will maneuver dirty air back to the unit. Instead, the air intake system of TRACS aggressively takes dirty air out of the normal breathing zone (virtually "vacuuming" contamination out of the air) and cleans and

disinfects it for redistribution into the room. In doing so, the exhaust of TRACS also maintains clean air in the lower levels of the room (1'-4' from the floor), keeping that air level safe and clean for children and pets.

Furthermore, TRACS draws in and exhausts air out of three sides of the unit (front, and both sides). Therefore, the airflow pattern described above not only occurs in the area directly in front of the unit, but also on each side. Please see the drawing below showing the ceiling view. In all, with this design TRACS can effectively clean all corners of a room, and all levels of air within the room.

Finally, please review the table in Appendix B showing the air changes per hour that TRACS can achieve in various room sizes. The unit is designed to create approximately 350 cfm of airflow on high speed.

Position of UV Lamps: The UV lamps in TRACS are located before and radiating on the dirty side of the HEPA filter (the side on which the particles and microorganisms are trapped). Large mold spores, bacteria and other microorganisms that virtually all UV systems cannot destroy on a single pass because of their large size (it would require a UV dosage in the hundreds of thousands of microwatt seconds/cm^2 to destroy many molds) are easily trapped by HEPA filtration. However, many such trapped molds and bacteria can live and breed on the HEPA filter, and can eventually compromise the integrity and eat through the filter over time. As a result, many HEPA-only air cleaners should have their HEPA filters changed at least on a yearly basis (or sooner) to maintain filter efficiency. With TRACS, however, because the UV lamps continually bathe the dirty side of the HEPA filter, the HEPA can last much longer, as all trapped microorganisms are destroyed over time because they are exposed to almost an infinite UV dosage (because the residence time is unlimited as long as the unit is running). NO OTHER RESIDENTIAL/COMMERCIAL AIR CLEANER ON THE MARKET TODAY HAS UV LAMPS INSTALLED IN THE SAME POSITION AS TRACS.

HEPA Sealed in the Cabinet: The HEPA filter in TRACS is gasketed and sealed within the cabinet with a locking mechanism that forcefully prevents air from bypassing the high efficiency filtration. Given high velocity air will choose the path of least resistance, if the HEPA filter is not adequately sealed and gasketed within the cabinet, dirty air will completely bypass this primary

means of filtration and be exhausted back into the environment. However, easily accessed thumb screws in the HEPA filter rail compress the HEPA's gasketing to the HEPA shelf. This, along with the filter rails creates an effective seal within the TRACS cabinet to ensure maximum unit efficiency and prevent dirty air bypass.

Unit Testing/Efficiency: Because of the quality of the HEPA filter and the fact that it is secured within the cabinet to prevent air bypass. TRACS performs at HEPA efficiency (99.9+% at .3 microns) Therefore, each TRACS unit is tested with a particle counter and the unit efficiency is documented and noted on a Certificate of Performance, which is included with each unit shipped.

Safety Interlock: TRACS is equipped with a safety interlock that shuts the unit's power off when the back panel is removed for filter and lamp maintenance. This safety feature looks to prevent direct contact with electrical components, an engaged blower, or direct exposure to illuminated UV lamps.

Low Maintenance Costs Please review the section above outlining the design and function of the carbon prefilter pack. To review, when changed regularly the cumulative annual amount of "fresh" carbon will equal or exceed that of most other residential/commercial units. But because the carbon pack also acts as the prefilter, (and they are priced as standard prefilters despite their significant carbon content), annual maintenance costs are considerably cheaper than units having prefilters/postfilters and separate carbon filters. Furthermore, PAS acknowledges that in order to keep an air cleaner running at peak performance, regular replacement of filters and lamps must occur. Therefore, all replacement parts used in TRACS are priced well below market value (and much less than competitor's units) to encourage regular maintenance and optimize unit efficiency and effectiveness.

All wiring covered UV radiation can have harmful effect on some wiring and other components over time, making them brittle, discolored, and potential electrical hazards. However, all internal wiring and the electrical ballasts are completely shielded from UV radiation by metal compartments within the cabinet, ensuring safe long-term operation.

NEW FEATURES

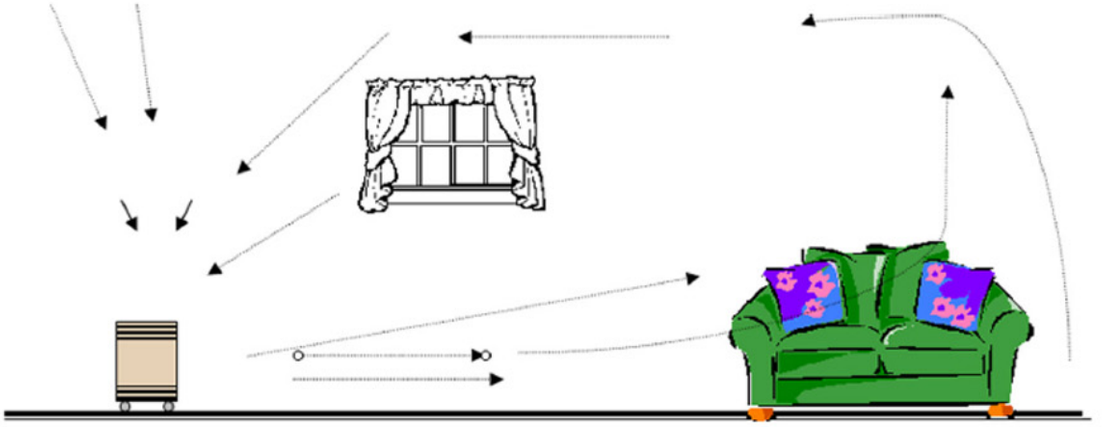
Ease of maintenance: **All** filters and UV lamps are easily accessed and replaced by simply removing the back panel and sliding/ pulling the parts out. ***NO TOOLS ARE REQUIRED FOR REPLACEMENT OF FILTERS AND LAMPS.*** Four nylon knurl screws need only be taken out to remove the back panel, and the unit can remain upright in normal operating position for all maintenance procedures.

Full Variable Speed: TRACS utilizes a full variable speed control, so it can be set on a virtually any speed up to 350 cfm. This allows the customer to balance air flow against any air noise that is suitable for their taste.

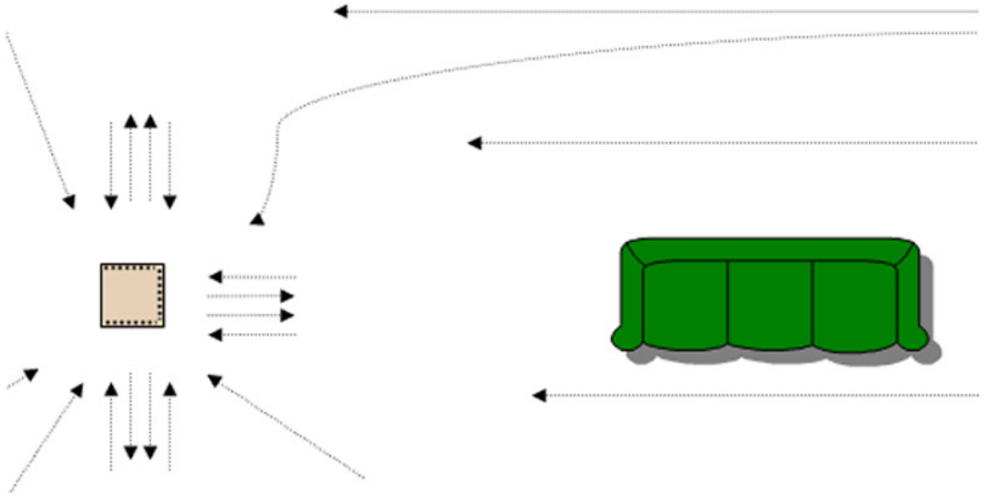
UV On/Off Switch: TRACS employs a separate switch that will turn the UV lamps on or off separately from the motor. This allows consumers to turn off the UV lamps when running the unit if energy consumption is a concern, and if bacteria/mold destruction is not a problem at the time. PAS recommends that prior to changing filters (especially the HEPA), the UV lamps should be turned on without the motor/blower in order to destroy any microorganisms that may be trapped on the filters. Given the HEPA will trap molds and bacteria as long as the motor is running, it is conceivable that live bacteria and mold could be trapped on the HEPA even after the unit is shut off but the motor winding down. Furthermore, larger molds that require higher UV dosages may not be fully destroyed if collected on the filter shortly before the unit/motor is shut off. These live microorganisms could become airborne if disrupted when changing the filters, creating a health risk. However, with the ability to keep the UV lamps on without the motor running for a short period of time, all latent bacteria and molds on the HEPA should be deactivated. Therefore, with TRACS, consumers are ensured that the HEPA filters are free from contamination before they are replaced, creating a much safer environment when maintaining your air cleaner.

Unit Aesthetics The front corners are now rounded for a better appearance, and to prevent injury on sharp corners. The shape of TRACS, especially the flat top with the rounded front corners, along with the quiet operation allow for discreet operation within any room. If desired, objects like doilies, plants, magazines, and pictures can be placed on the top of the cabinet to help it blend into the surroundings.

AIR FLOW PATTERN



AIR FLOW PATTERN – CEILING VIEW



APPENDIX A

UV dosage required for complete destruction of various microorganisms

Dosage in micro-watt sec/cm^2

MOLDS	
ASPERGILLUS AMSTELODAMI	77,000
ASPERGILLUS FLAVUS	99,000
ASPWERGILLUS GLAUCUS	88,000
ASPERGILLUS NIGER (BREAD MOLD)	330,000
MUCOR RACEMOSUS	35,200
OOSPORA LACTIS	11,000
PENICILLIUM CHRYSOGENUM	56,000
PENICILLIUM DIGITATUM	88,000
PENICILLIUM EXPANSUM	22,000
RHIZOPUS NIGRICANS (CHEESE MOLD)	220,000
BACTERIA	
BACILLUS ANTRACIS SPORES	46,200
BACILLUS SUBTILIS SPORES	22,000
CLOSTRIDIUM TETANI	23,100
CORYNEBACTERIUM DIPPTHERIAE	6,500
DYSENTERY BACILLI	4,200

ESCERICHIA COLI	6,600
LEGIONELLA PNEUMOPHILA (LEGIONNAIRES DISEASE)	2,760
INFECTIOUS JAUNDICE	6,000
MYCOBATERIUM TUBERCULOSIS	10,000
RHODOSPIRILLUM RUBRUM	6,100
SALMONELLA ENTERITIDIS	10,000
SALMONELLA TYPHOSA (TYPHOID FEVER)	26,400
SALMONELLA	6,160
SHIGELLA DYSENTERIAE-DYSENTERY	3,400
STAPHLYLOCOCCUS AUERUS	6,600
STREPTOCOCCUS PYROGENES	4,200
STREPTOCOCCUS SALIVARIUS	4,200
VIRUSES	
INFECTIOUS HEPATITIS	8,000
INFLUENZA	3,400
YEASTS	
SACCHAROMYCES CEREISIAE	13,200
SACCHAROMYCES ELLIPSOIDEUS	13,200

APPENDIX B

Square feet of room* Air changes per hour created**		
100 ft^2 26 ACH		
150 ft^2 18 ACH	200 ft^2 13 ACH	250 ft^2 11 ACH
300 ft^2 9 ACH	350 ft^2 8 ACH	400 ft^2 7 ACH
450 ft^2 6 ACH	500 ft^2 5 ACH	600 ft^2 4 ACH
700 ft^2 4 ACH	800 ft^2 3 ACH	900 ft^2 3 ACH
1,000 ft^2 3 ACH	1,250 ft^2 2 ACH	1,500 ft^2 2 ACH

* 8’ ceilings assumed

** Air Changes Per Hour: Term used to measure room airflow (ventilation) rates. ACH is a measure of the rate (time) it takes to clean/remove all of the air in the room, and replace it with clean/fresh air. For example, if 9 ACH are created in a room, then all of the air in

the room will be cleaned 9 times per hour. Industry standards recommend a minimum of 3 ACH to achieve a satisfactory reduction in indoor air contamination.

*** 350 cfm used to make calculations.