

Technology Information Summary

September 2009



Portable Motor Vehicle Cabin Air Purifier

At a Glance

PABILITIES		FIELD CONSIDERATIONS	INFORMATION
Technology Category: <input type="checkbox"/> Detection <input checked="" type="checkbox"/> Decontamination <input type="checkbox"/> Sampling Targets: <input checked="" type="checkbox"/> Biological agents <input checked="" type="checkbox"/> Chemical agents <input checked="" type="checkbox"/> Toxic industrial chemicals <input checked="" type="checkbox"/> Radiological agents <input checked="" type="checkbox"/> Other	Applications: <input type="checkbox"/> Water security <input type="checkbox"/> Building structures <input type="checkbox"/> Building materials <input checked="" type="checkbox"/> Air	<input type="checkbox"/> Weighs <10 lb <input type="checkbox"/> Batteries <input type="checkbox"/> AC current <input type="checkbox"/> Explosive atmosphere operation <input checked="" type="checkbox"/> Novice operator <input type="checkbox"/> Skilled operator <input type="checkbox"/> Audible alarm <input type="checkbox"/> Visible alarm	Information Sources: <input type="checkbox"/> No vendor response <input type="checkbox"/> General info only <input checked="" type="checkbox"/> Vendor-supplied info <input checked="" type="checkbox"/> 3 rd party test data Information Provided: <input checked="" type="checkbox"/> General product <input checked="" type="checkbox"/> Performance <input checked="" type="checkbox"/> Cost

OVERVIEW OF TECHNOLOGY

The Portable Motor Vehicle Cabin Air Purifier is designed to protect people and sensitive equipment in motor vehicles and other indoor enclosures against environmental pollutants and lethal airborne contaminants that may occur from a terrorist attack, including chemical, biological, and radiological agents. The Portable Motor Vehicle Cabin Air Purifier includes a motorized blower, a series of filter media packets, and a HEPA filter, and operates independently from the vehicle's HVAC system. The Portable Motor Vehicle Cabin Air Purifier can be placed on a seat, secured by a seat belt, and plugged into a power outlet in the vehicle. An upholstered cover is available that allows the purifier to function as an armrest/console when placed in the middle of the rear seat. For use by first responders, HazMat vehicle drivers, military personnel in vehicles that have no air purification capability, and the general public.

PERFORMANCE

- ❖ Lowers the concentration levels of carbon monoxide, ozone, nitrogen dioxide, sulfur oxides, lead, and particulate matter enough to meet the National Ambient Air Quality Standards set by the EPA; also targets benzene, a major component of diesel and gasoline engine exhaust.
- ❖ Targeted particulate matter includes all harmful bacteria (such as anthrax), all viruses (such as smallpox, SARS, and all types of influenza), radiation particles from a radiological dispersion device (dirty bomb) or nuclear explosion, sulfates, nitrates, asbestos, lead, mercury, cadmium, diesel soot and toxic volatile organic compounds attached to the particles.
- ❖ Designed to achieve 20 to 30 air exchanges per hour within a vehicle passenger compartment.
- ❖ Failure to replace or recycle saturated HEPA filter and filter media packets can reduce effectiveness.

DEPLOYMENT

- ❖ Operates off vehicle 12 volt DC power; can be adapted to operate off AC outlets in buildings.
- ❖ Weighs about 8.2 kg (18 lb) and measures 25.4 cm x 38.1 cm x 20.3-25.4 cm (10 in. x 15 in. x 8-10 in.); a larger version is 5.1 cm (2 in.) wider and weighs about 9.1 kg (20 lb).

Vendor Information:

Company: Cabin Air Technologies, LLC
 Address: 1132 S.W. 19th Ave. #505
 Portland, Oregon 97205
 Phone: 1-503-295-1151 Fax: 1-503-295-7778
 E-mail: ceo@cabinairtech.com
 Web: <http://www.cabinairtech.com>

Disclaimer: Support for this report has been provided by the U.S. Environmental Protection Agency under Contract No. GS-23F-0011L SIN 871-3. References in this report to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not constitute or imply the endorsement, recommendation, or favor of the U.S. Government.

PRODUCT DESCRIPTION

PRODUCT DESCRIPTION: The Portable Motor Vehicle Cabin Air Purifier is designed to protect people and sensitive equipment in motor vehicles and other indoor enclosures against environmental pollutants and lethal airborne contaminants that may occur from a terrorist attack, including chemical, biological, and radiological agents. The Portable Motor Vehicle Cabin Air Purifier includes a motorized blower, a series of filter media packets, and a HEPA filter, and operates independently from the vehicle's HVAC system. The Portable Motor Vehicle Cabin Air Purifier can be placed on a seat, secured by a seat belt, and plugged into a power outlet in the vehicle. When the speed fans are switched "ON" the purifier will continually recirculate and clean the air until the purifier is switched "OFF." An upholstered cover is available that allows the purifier to function as an armrest/console when placed in the middle of the rear seat.

INTENDED USERS: First responders, HazMat vehicle drivers, military personnel in vehicles that have no air purification capability, and the general public.

UTILITY REQUIREMENTS: The Portable Motor Vehicle Cabin Air Purifier's motorized blower can be powered by standard vehicle 12 volt DC power. It also can be adapted to operate off AC outlets in buildings.

DURABILITY/RUGGEDNESS: Portable Motor Vehicle Cabin Air Purifier prototypes have exteriors made of aluminum. When mass produced, the purifiers will likely be made of hard plastic or a composite material. Prototypes have been in operation in vehicles since 2000 without any degradation of the HEPA filter functionality. A Portable Motor Vehicle Cabin Air Purifier in a sports utility vehicle (SUV) remained intact and attached to a seat belt after an accident that caused the vehicle to roll upside down.

APPLICATIONS: The Portable Motor Vehicle Cabin Air Purifier is an independent purifier that does not become part of vehicle air ducts or HVAC systems and is intended to purify air in vehicle cabins or small rooms. Multiple units, or larger units can serve larger rooms or shelters. The purifier design provides flexibility in the type of Filter Media Packets which can be used allowing the filtration media to be tailored to address specific contaminants or requirements.

SOPs, METHODS, USERS MANUALS: A user's manual will be provided.

ACCESSORIES/COMPONENTS: There are no accessories or hardware required to operate the Portable Motor Vehicle Cabin Air Purifier. An upholstered cover is included (generic upholstery included, extra charge to match upholstery to vehicle).

THROUGHPUT OF PRODUCT: The Portable Motor Vehicle Cabin Air Purifier can be secured with a seat belt and plugged into any vehicle by one person in less than a minute. If portability is not required, the purifier can be bolted to the vehicle's floor or in the trunk with ducting to the cabin. When switched "ON," the Portable Motor Vehicle Cabin Air Purifier is designed to achieve approximately 20 to 30 air exchanges per hour within the passenger compartment.

PORTABILITY: The Portable Motor Vehicle Cabin Air Purifier is portable and self contained. It weighs about 8.2 kg (18 lb) and measures 25.4 cm x 38.1 cm x 20.3-25.4 cm (10 in. x 15 in. x 8-10 in.). A larger version of the purifier is 5.1 cm (2 in.) wider and weighs about 9.1 kg (20 lb). The purifier requires no special licensing or other requirements for transport or shipping.

OPERATION/MAINTENANCE: To operate, the Portable Motor Vehicle Cabin Air Purifier should be secured in a vehicle or room and the fan should be switched "ON." The purifier does not need to be calibrated or otherwise monitored during operation. Routine maintenance will include sending either the entire purifier or just the filter media packets to a service center. The HEPA filter typically has a useful life of many years, because the purifier's design includes 6 to 8 layers of pre-filters to protect against early saturation. However, should HEPA filter saturation occur, the air flow through the purifier will stop. If this happens, the HEPA filter should be replaced. The Filter Media Packets will periodically need to be regenerated or replaced as discussed below.

DECONTAMINATION/REUSE: The gas phase filter medium in the Filter Media Packets can be regenerated by heat to thermally desorb the gases that have been adsorbed. Filter Media Packet regeneration should be performed by a company that specializes in regenerating adsorbent media. The frequency for regeneration or replacement will depend on the amount of pollution where the purifier has been used. Where the purifier is being operated to capture only environmental pollutants, servicing once or twice a year should be sufficient. The need for regeneration is often indicated by a noticeable increase in odor that can be smelled by the user. Commercially available badges or sensors for the environmental pollutants could also be used to indicate when environmental pollutants are breaking through the Filter Media Packets. In the event of exposure to chemical, biological, or radiological (CBR) agents, the Filter Media Packets and HEPA filter should be replaced by a designated service center. In that event, the entire purifier can be sealed in a hazardous waste container for shipment to the service center. The purifier's metal exterior and interior grates will not require replacement, but the plastic and metal motorized blower may need to be replaced. Gaskets that seal the filter components in the box will also need replacement after CBR exposure.

TRAINING: No training is necessary. The Portable Motor Vehicle Cabin Air Purifier is a "plug and play" device that requires no monitoring, in contrast with single pass over pressure filtration systems presently used in some military applications.

TECHNICAL SUPPORT: Routine maintenance and technical service is provided by Cabin Air Technologies, LLC, or their designated service centers. Cabin Air Technologies, LLC can be contacted by phone 1-503-295-1151, fax 1-503-295-7778, or via their website, <http://www.cabinairtech.com>.

Portable Motor Vehicle Cabin Air Purifier

HEALTH/SAFETY -- PERSONNEL HAZARDS: The Portable Motor Vehicle Cabin Air Purifier does not create any health hazards. The power plug that attaches to a power outlet is fused to prevent electrical problems. In the event of exposure to a CBR attack, the filter media within the air purifier will need to be recycled or replaced.

HEALTH/SAFETY -- ENVIRONMENTAL HAZARDS: The HEPA filters and Filter Media Packets will occasionally need to be replaced. As noted above, the Filter Media Packets can be regenerated unless they are exposed to CBR agents, in which case they should be replaced. The frequency of Filter Media Packet and HEPA filter replacement/regeneration depends on the exposure to environmental, industrial, or terrorist related contaminants. In most circumstances, Cabin Air Technologies, LLC estimates that recycling/replacing the filter media will occur once or twice a year.

HEALTH/SAFETY -- PUBLIC HEALTH HAZARDS: None.

PERFORMANCE SUMMARY

DETECTION LIMITS/EFFECTIVENESS: The Portable Motor Vehicle Cabin Air Purifier is designed to lower concentrations of carbon monoxide, ozone, nitrogen dioxide, sulfur oxides, lead, and particulate matter enough to meet the National Ambient Air Quality Standards set by the EPA. These health standards are set at a concentration level for each pollutant above which there is risk to human health. These standards were self-imposed by Cabin Air Technologies, LLC to provide a goal for testing and verifying performance. In addition, the purifier is designed to reduce benzene, a plentiful contaminant from gasoline and diesel exhaust, to levels that meet the ambient air standard in Holland.

The table below compares the targeted health standard with levels measured inside traveling vehicles in 10 studies without the Portable Motor Vehicle Cabin Air Purifier in use, and levels measured inside traveling vehicles when the Portable Motor Vehicle Cabin Air Purifier was operating. These results show effective reduction of all the targeted pollutants to meet the prescribed health standards. Targeting the major environmental pollutants requires the use of filter media that are also effective against CBR agents.

Health Standards for Major Pollutants vs. Levels Found in the Passenger Cabins of Traveling Cars

Pollutant	Ave. Time	Government Ambient Air Health Standards			10 In-Car Studies Without Purifier		Typical Performance With Purifier	
		Holland	US EPA	California	Peak	Mean Range	Test Site	Mean
Benzene	Annual	10 µg/m ³ (3 ppb)			766 µg/m ³ (240 ppb)	8 - 380 µg/m ³ 5 - 240 ppb	Los Angeles	2.3 µg/m ³ (0.72 ppb)
Carbon Monoxide	1 h		35 ppm (40,000 µg/m ³)	20 ppm (23,000 µg/m ³)	100 ppm	3 - 46 ppm	Bangkok	11.9 ppm
	8 h		9 ppm (10,000 µg/m ³)					
Ozone	1 h		120 ppb	90 ppb	350 ppb	10 - 177 ppb	Los Angeles	2 ppb
	8 h		75 ppb	70 ppb			Bangkok	<25 ppb
Nitrogen Dioxide	Annual		100 µg/m ³ (52 ppb)					
	1 h			(180 ppb)			Los Angeles	<100 ppb
					290 ppb	20 - 140 ppb	Portland	<100 ppb
Sulfur Dioxide	3 h		500 ppb				Portland	<320 ppb
	24 h		365 µg/m ³ (140 ppb)		400 ppb	<320-400 ppb	Los Angeles	<320 ppb
Lead	3 mo		1.5 µg/m ³		3.1 µg/m ³	2--1.3 µg/m ³	Los Angeles	<1.0 µg/m ³
							Portland	<0.65 µg/m ³
Particulate Matter*								
PM-10	24 h		150 µg/m ³	50 µg/m ³	1044 µg/m ³	20--370 µg/m ³	Los Angeles	9.14 µg/m ³
							Bangkok	37.4 µg/m ³
PM-2.5	24 h		35 µg/m ³		382 µg/m ³	29--220 µg/m ³	Los Angeles	1.2 µg/m ³
	Annual		15 µg/m ³				Bangkok	20.3 µg/m ³

*Particulate matter (PM-10 and PM-2.5) Includes all harmful biological agents such as anthrax, smallpox, SARS, all types of influenza, and ricin. In addition it includes radiation particles from a dirty bomb or nuclear explosion, sulfates, nitrates, asbestos, lead, mercury, cadmium, fungi, diesel soot, and toxic volatile organic compounds attached to the particles.

DECONTAMINATION TECHNOLOGIES: The Portable Motor Vehicle Cabin Air Purifier decontaminates the air, it does not decontaminate surfaces.

INTERFERENCES: Failure to replace or recycle saturated HEPA filter and Filter Media Packets can reduce effectiveness.

COST INFORMATION

Category	Item	Cost
Accessories/Components	Portable Motor Vehicle Cabin Air Purifier: sedans, small SUVs, and small truck passenger cabins	\$ 798
	Portable Motor Vehicle Cabin Air Purifier: large SUVs, vans, and large truck passenger cabins	\$ 1100
	Upholstered cover to match vehicle upholstery (<i>Note: a generic upholstered cover is included in the purchase price, only matching upholstery is extra</i>)	\$ 69
Consumables	Filter Media Packets:	
	--Standard desiccant/adsorbent packet	\$ 52
	--Standard coal-based activated carbon	\$ 48
	--Standard coconut shell activated carbon	\$ 52
	--Standard carbon monoxide catalyst	\$ 86
--Military prescribed chemisorbent carbon	\$ 149	
	<i>These above prices are expected to be lower when mass production is under way.</i>	
	HEPA Filter	\$ 69
Maintenance	Annual or biannual servicing of the Portable Motor Vehicle Cabin Air Purifier	\$ 100 + shipping
	Recycle or replace filter media packets	Prices shown above
Warranties	One year warranty on parts and labor, excluding exposure to lethal CBR agents from a terrorist event.	
Technical Service	Service contracts not available.	

REFERENCES AND ADDITIONAL INFORMATION

JOURNAL REFERENCES/PRESENTATIONS:

Lindsay, Marie D., and Lovell, William S., "Portable Motor Vehicle Cabin Air Purifier," presented at the American Filtration and Separation Society Meeting, Galveston, Texas, April 10-11, 2002. http://www.cabinairtech.com/AFS_Paper_20020410.pdf.

Presentation to Department of Defense review and evaluation of Cabin Air Technologies, LLC, submission for Advanced Technology Showcase, Irvine, CA, held October 29, 2002. http://www.cabinairtech.com/CAT_DOD_Presentation_20021029.ppt.

INDEPENDENT EVALUATIONS/REVIEWS: Independent laboratory testing has been accomplished as follows:

Performance Analytical, Inc. (now known as Columbia Analytical Services, Inc.) Laboratory Report, dated Sept. 27, 2000, for gas chromatography/mass spectrometry analysis of benzene and other volatile organic compounds, from three air samples taken in stainless steel Summa Canisters in a traveling vehicle in Los Angeles. Available upon request.

Dr. Robert O'Brien, President of VOC Technologies, retired Professor of Chemistry, Portland State University, Portland, OR, tested a Cabin Air Purifier prototype for gasoline exhaust gases and other volatile organic compounds using a gas chromatograph/mass spectrometer. His letter dated November 15, 2006, states the results: "We found that a wide range of gasoline constituents (volatile organic compounds or VOCs) including benzene and other aromatic hydrocarbons were >90% removed from a 1 cubic meter chamber within a few minutes of cleaner operation." Available upon request.

U.S. Army Edgewood Chemical Biological Center conducted a test of the Portable Motor Vehicle Cabin Air Purifier (see <http://www.cabinairtech.com/product/performance/index.html> for information on the test results).

The Cabin Air Technologies, LLC website (<http://www.cabinairtech.com/product/patent/index.html>) gives the patent numbers and issue dates from the six countries that have granted patents on this technology to date. U.S. Patent number 6,773,477 includes drawings and narrative that provide detailed descriptions of the various components that make up the Portable Motor Vehicle Cabin Air Purifier.

LIST OF PROJECTS/CLIENT REFERENCES: Four generations of prototypes have been tested and used in vehicles owned and rented by principals in Cabin Air Technologies, LLC. Production runs of the Portable Motor Vehicle Cabin Air Purifier have not been manufactured or marketed; prototypes are available.

FOR FURTHER INFORMATION ABOUT THIS REPORT AND EPA'S TECHNOLOGY TESTING AND EVALUATION PROGRAM (TTEP), CONTACT:
 Shannon Serre
 U.S. EPA ORD/NHSRC
 (919) 541-3817
serre.shannon@epa.gov
<http://www.epa.gov/nhsrc/ttep.html>