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## **A Study of IAQ in Automobile Cabin Interiors**

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### **Abstract**

Little data exist on pollution levels within interior cabins of automobiles. Yet significant questions have surfaced relative to the potential hazards of the “new car smell” or biological hazards such as mold and animal allergens.

The Greenguard Environmental Institute commissioned a limited study of three automobiles to determine the levels of volatile organic chemicals (VOCs) in the cabin air and two additional automobiles for allergen testing of dust from the upholstery and flooring.

The three automobiles for VOCs represented two new cars, one on the sales lot for two weeks and the other on the sales lot for two months. The third car was a one-year-old vehicle, returned to the dealer because of unacceptable odor. The cars tested for allergens represented cars one year and five years old.

The results of the Greenguard Environmental Institute’s limited study are summarized in the pages that follow.

## Volatile Organic Compounds (Vocs) in New Automotive Interiors

### Summary

**Vocs in Indoor Air.** The health significance of volatile organic compounds or VOCs in indoor environments is an area of on-going debate. There is significant focus on the level of TVOC or total VOC exposure, since this appears to be related to occupant complaints related to “sick building syndrome”. The “cocktail mixture” of hundreds of different VOCs, in combination with other environmental factors, are often the culprit for human complaints such as headache; eye, nose, and throat irritation; asthmatic response; increased respiratory irritation, fatigue, and mental confusion. These VOC mixtures can contain hundreds of individual VOCs, many of which are irritants, odorants, carcinogens, or reproductive hazards. The toxicity of each individual VOC also needs to be considered when evaluating human exposure and control measures.

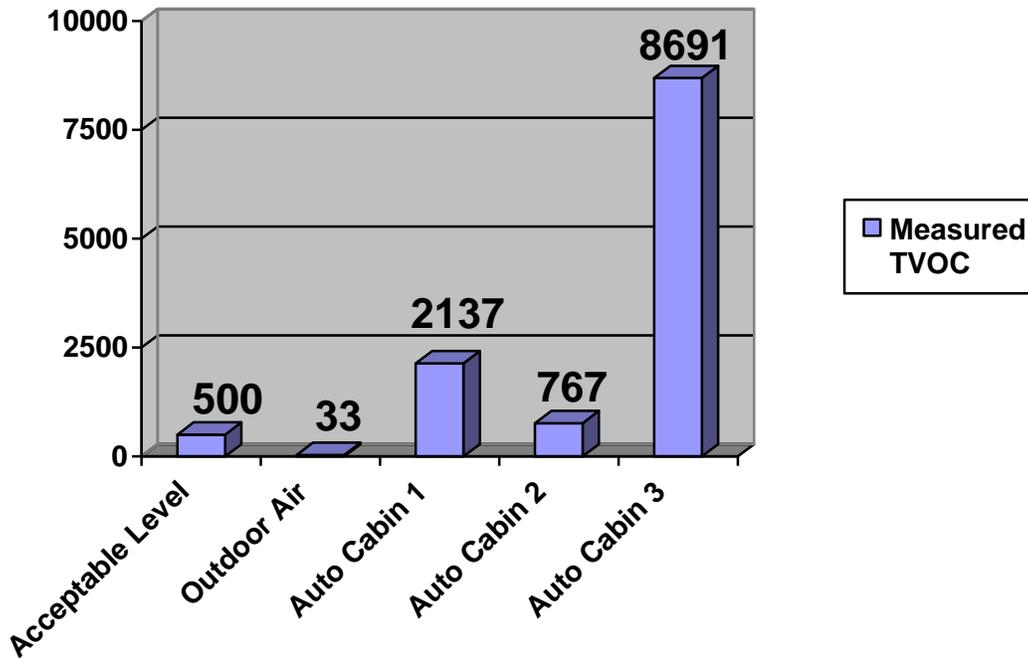
**VOCs in Car Interiors.** There have been numerous studies of the types and levels of VOCs in commercial building, homes, and schools. Data has shown a plethora of VOCs in these environments resulting from construction materials, interior finishes such as paints and coatings; furnishings such as furniture, ceiling tile and carpet; office equipment such as printers and copiers, internal processes such as cleaning systems; and personal care substances. Recent Green /Healthy Building Programs such as the State of Washington and the US Green Building Conference’s LEED Program have established 500 ug/m<sup>3</sup> of total VOCs (TVOC) and 50 parts per billion (PPB) of formaldehyde as acceptable building clearance levels prior to occupancy. Effects to achieve these levels have been effective by using low emitting construction and furnishing materials.

**GREENGUARD's Study.** Little data exist on pollution levels within the interior cabins of automobiles, an important indoor environment for today’s consumer. A recent limited review of three automobiles found that TVOC and formaldehyde levels were high and exceeded currently recommended building levels. One car, one year after purchase, showed significantly elevated levels of chemicals. There were over 100 different individual chemicals measured in the cars including many irritants, odorants, and carcinogens. Primary chemicals include 2-ethyl 1-hexanol; trimethylpentanediol monoisobutyrate; phenol; naphthalene; benzenes; and many other alcohols, hydrocarbons; chlorinated chemicals; BHT; and amines. Tables 1-3 all provide for chemicals found in the studies and graphs showing comparison data among the three automobile environments.

**Conclusions.** Results indicate that car interiors can be a significant source of indoor pollution. VOC levels of new cars are significantly higher than recommended levels for today's indoor environment. Sources of these VOCs are the materials inside. A look inside the passenger compartment shows significant presence of plastics, woods, leathers, and textiles, and many of these have been installed with glues and sealants. The materials off-gas and this effect can be exacerbated by heat. The study shows that car designers must give consideration to the materials being used. Low emitting, non-toxic materials are required. To date, low-emitting, non-toxic interiors are not available. Until then, consumers are advised to open the automobile windows and air out their cars for 2 - 6 months.

Table 1

### Summary of Indoor Pollution in New Automobiles



**Acceptable level: 500  $\mu\text{g}/\text{m}^3$ , TVOC (Total Volatile Organic Chemicals)**

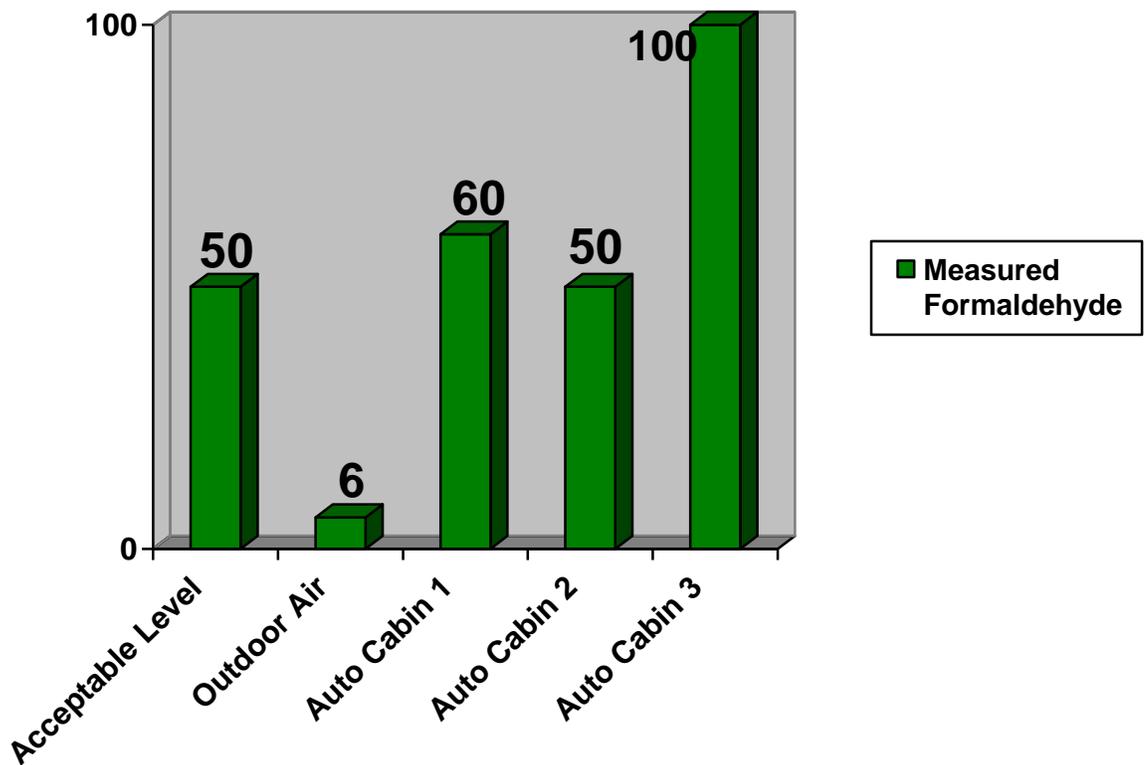
**Automobile Cabin 1: Two weeks on lot**

**Automobile Cabin 2: Two months on lot**

**Automobile Cabin 3: 1 year old, Consumer Complaint**

Table 2

## Summary of Indoor Pollution in New Automobiles



**Acceptable level: 50 ppb Formaldehyde (HCHO)**

**Automobile Cabin 1: Two weeks on lot**

**Automobile Cabin 2: Two months on lot**

**Automobile Cabin 3: 1 year old, Consumer Complaint**

Table 3

*Most Prevalent VOCs Found in Cars*

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Ethylhexanol  
Dichloroethyl ethyl ether  
Dodecanol  
Methenamine  
Nonanol  
Trimethylpentanediol monoiosobutyrate  
BHT  
Methyl pyrrolidinone  
Acetic acid  
Acetonitrile  
Ethyl toluene  
Benzene  
Chlorobenzene  
Butoxyethanol  
Dichloroethane  
Phenol  
Trimethylpentanediol diisobutyrate  
Caprolactam  
Triethylamine  
Undecane  
Trimethyl benzene  
Formaldehyde  
Acetaldehyde  
Benzaldehyde  
Dodecane  
Naphthalene

## Mold and Allergens in Automobiles

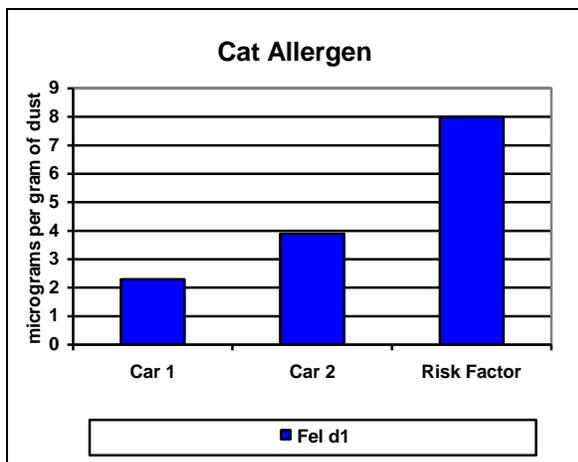
### Summary

**Allergens in Indoor Air.** Allergic and asthmatic reactions are common health problems associated with indoor air quality. Asthma affects over 30 million Americans, and allergies affect more than 20% of the population. Allergens of concern include chemicals, dust and microbiological allergens from dust mites, cats, dogs, cockroaches, rodents, and molds.

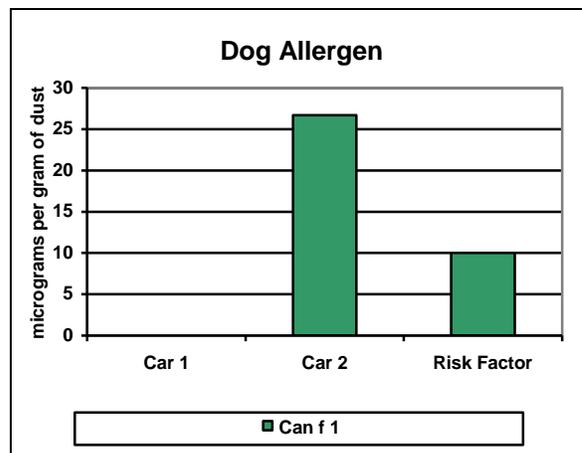
**Allergens in Car Interiors.** Numerous studies have measured allergens and mold, primarily in schools and homes. Little data have been collected from transportation (such as cars) to understand potential exposure effects on occupants.

**GREENGUARD's Study.** A recent limited study of allergens was conducted in two automobiles, a one-year-old unused vehicle, and a five-year-old used vehicle. Data showed the presence of dog and cat allergens and numerous molds in extractable dust from the seating and flooring of the cars. In one car, dog allergen was significantly elevated and would be expected to be a health concern to sensitive individuals. Molds were numerous in both cars, indicating a potential concern for allergic reaction. An allergenic mold, *Aureobasidium*, was predominant in one car at unusual levels, and overall mold levels were higher than those in a typical home. Allergen results including the list of measured molds and photographs of cultured molds are included.

**Conclusion.** Limited data indicate that seating and flooring in cars can harbor allergens and molds, which may result in allergic reactions among occupants. Proper cleaning and maintenance are key steps to reducing mold and allergen exposure.



Fel d 1: allergen 1 from Felis domesticus (cat)



Can f 1: allergen 1 from Canis familiaris (dog)

#### Molds Found

Cladosporium sp. A (39)

yeast (23)

Aureobasidium sp. (20)

Epicoccum sp. (13)

Alternaria sp. (6)

Bipolaris sp. (4)

non-sporulating fungi (floccose) (2)

non-sporulating fungi (hyaline) (2)

Penicillium sp. A (2)

Penicillium sp. B (2)

Penicillium sp. C (2)

Arthrinium sp. (1)

Aspergillus fumigatus (1)

Aspergillus japonicus (1)

Aspergillus niger (1)

Cladosporium sp. B (1)

Curvularia sp. (1)

Drechslera sp. (1)

Fusarium sp. (1)

Mucor sp. (1)

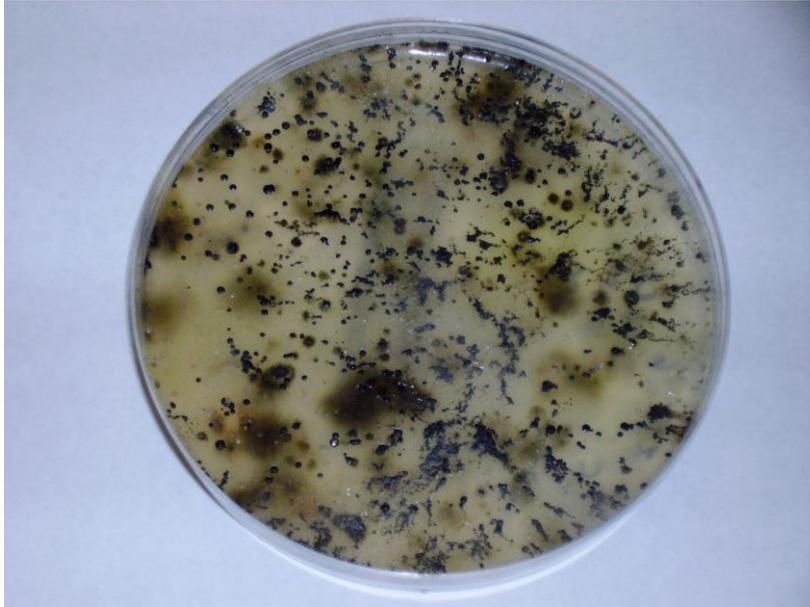
non-sporulating fungi (chlamydo spores) (1)

non-sporulating fungi (pigmented) (1)

Phoma sp. (1)

## Mold in Car Interior

3m



4d

