Vehicle Interior Air Quality Testing Program
We are the North American market access leader for product safety and our mark is on 23 billion products.
The Definition of Safety is Evolving…So is UL

Complex issues of today have replaced concerns of the past. And the safety landscape of tomorrow is yet to be defined.

• Fire Safety
• Indoor Air Quality
• Performance Testing
• Chemical Regulations
• Transaction Security
• Renewable Energy
• Wireless Testing
UL Automotive Team Service

Sections
1. Electric Vehicle Infrastructure Certification
2. Chemical Emissions Testing
3. Environmental Validations and Transparency
4. Responsible Sourcing Solutions
5. Raw Material Traceability
6. Knowledge Services Research/Consulting
7. Thermoplastics Testing
8. Ongoing Plastics Quality Testing
9. Automotive Functional Safety
10. EMC/Wireless & Global Market Access
11. UL Prospector®
12. Material Compliance Management Systems
13. Online Workplace Safety Training
14. Branded Merchandising

5. Knowledge Services Research/Consulting
6. Thermoplastics Testing
7. Ongoing Plastics Quality Testing
8. Automotive Functional Safety
9. EMC/Wireless & Global Market Access
Chemical Emissions Testing

• Over 25 years of product emissions testing experience
• More than 180 large, intermediate and small chambers worldwide – largest global chemical emissions testing capacity of any company
• Laboratory locations in
  - Atlanta, GA, USA
  - Cologne, Germany
  - Kyoto, Japan
  - Nansha, China
• More than 70,000 products tested across the building products, furnishings, electronics, consumer products, and chemicals sectors
VIAQ Background
## Vehicle Interior Air Quality Awareness

<table>
<thead>
<tr>
<th>Early Research</th>
<th>Purchasing Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2001:</strong></td>
<td><strong>2006:</strong></td>
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<tr>
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</tbody>
</table>
Research Determining Exposure In Cars

- Research studies conducted on used vehicles or vehicles in use (Particulate exposures coming from exterior sources, smoking in vehicles, etc.)

- Few studies exist for measuring Volatile Organic Compounds (VOCs) in new vehicle interiors

- VOCs and other chemicals emitted from interior materials constitute the new car smell

- Chemicals can trigger health effects such as headaches, sore throats, nausea, & drowsiness
Measurements in Vehicles

Comparison of Air Pollution by VOCs Inside the Cabins of New Vehicles (Faber et al, June 2014)

• Total VOC values range from 150 – 14,000 µg/m3 (Avg. ~2,000 µg/m3)

• Studies in new & used vehicles have found between 30 - >200 VOCs

• Individual VOCs vary depending on interior materials

• Concentration of VOCs observed depends on:
  • Vehicle Interior Temperature
  • Interior Trim Materials
  • Age of Vehicle
  • Ventilation
  • Humidity
Vehicle Interior Materials & Components

- Front Seats: Textile, Foam, Adhesive
- Headliner: Textile, Acoustic Insulation
- Rear Seat: Textile, Foam, Adhesive
- Carpet: Textile, Foam, Backing, Fiber
- Door Trim: Textile, Adhesive
- Floor Mats: Textile, Backing, Fiber
- Instrument Panel: Plastic, Upholstery, Trim, Electronics
- Sun Visor: Plastic, Upholstery
- Steering Wheel: Plastic, Upholstery
- Center Console: Plastic, Upholstery
VIAQ Program Development

Phase 1
Material Testing for Development

Phase 2
Component Testing

Phase 3
Predict Cabin Concentration

Phase 4
Material Testing for QC
Classes of VOCs in Vehicle Interiors

- Aliphatic Compounds: 50%
- Cycloalkanes: 10%
- Aromatic Compounds: 10%
- Alcohols/Carbonyls: 10%
- Other: 10%
# Chemicals of Concern

<table>
<thead>
<tr>
<th>Item</th>
<th>IARC</th>
<th>Effect on Human Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>1</td>
<td>Eye, nose, and throat irritation. High levels may cause coughing, wheezing, chest pains, and bronchitis. Lung and nasopharyngeal cancer.</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>B2</td>
<td>Irritation of the eyes, skin, and respiratory tract. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may also occur.</td>
</tr>
<tr>
<td>Benzene</td>
<td>1</td>
<td>Causes skin and eye irritation, is extremely dangerous when inhaled, and in serious cases, causes leukemia and increases the occurrence rate of lymph cancer and blood cancer.</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>2B</td>
<td>Affects internal organs, lungs, central nervous system.</td>
</tr>
<tr>
<td>Styrene</td>
<td>2B</td>
<td>Stimulates eyes, skin, nose, respiratory system, causes sleepiness or unconsciousness.</td>
</tr>
<tr>
<td>Toluene</td>
<td>3</td>
<td>Stimulates central nervous system, causing nausea, and abnormalities in stomach and nerve system</td>
</tr>
<tr>
<td>Xylene</td>
<td>3</td>
<td>Causes nerve stimulation, skin infection, cornea damage and so on, damages kidney and reproductive functions</td>
</tr>
</tbody>
</table>

**Group 1** Carcinogenic to humans  
**Group 2A** Probably carcinogenic to humans  
**Group 2B** Possibly carcinogenic to humans  
**Group 3** Not classifiable as to its carcinogenicity to humans
Global Requirements
Global History of VIAQ Testing

- 1970:
  - Germany
  - VW (1978)
  - Car cabin air quality study

- 1980:
  - Germany
  - (1981)
  - VOCs Report

- 1990:
  - TOYOTA
  - (1991)
  - VOC study

- 2005:
  - Korea
  - (2005)
  - VOC study

- 2007:
  - China
  - (2007)
  - VOC

- 2012:
  - China
  - (2012)
  - Guideline

- 2012:
  - ISO
  - Standard
  - (2012)

- 1998, 2003:
  - CARB
  - VOCs Report

- 2005:
  - JAMA
  - (2005)
  - VOC

- 2010:
  - Korea
  - Guideline

- 2007:
  - Germany
  - DIN (2007)
  - ISO standard

- 2007:
  - Proposal
  - No. 98

- 2007:
  - Korea
  - Guideline

- 2012:
  - Proposal
  - Guideline
Global VIAQ Requirements

- HJ/T 400-07 December 2007 "Determination of Volatile Organic Compounds and Carbonyl Compounds in Cabins of Vehicles"
- GB/T 27630-2011 01 March 2012 “Guideline for air quality assessment of Passenger car”
- Japanese Automobile Manufacturers Association Guideline “Voluntary Approach to Vehicle Cabin VOC Reduction”
- JASO Z 125 “Road vehicles - Interior - Measurement methods of diffused volatile organic compounds (VOC)”
Different Approaches for Each Region

USA OEMs
OEM methods
Materials Test

EU OEMs
OEM, ISO, and VDA methods
Component Test (Chamber)
Materials Test

Asian OEMs
OEM and JAMA methods
Component Test (Bag)
Materials Test
ISO Standards

UL testing follows ISO 12219 framework with sufficient flexibility to meet regional and specific OEM requirements

ISO 12219-1:2012 -- Whole vehicle test chamber
ISO 12219-2:2012-- Bag method
ISO 12219-3:2012-- Micro-scale chamber method
ISO 12219-4:2012-- Small chamber method
OEM Standards

Many OEMs have adapted the material and component test standards to meet their individual needs or capabilities.

**Chamber Testing**
- BMW GS 97014-3
- VW PV 3942
- Renault D49 3027, 3085

**Bag Testing**
- Nissan NES M0402
- Toyota TSM 0508G
- Honda DWG 0094Z
- Mazda MES CF 080 B
- Hyundai-Kia MS300-55

**Formaldehyde Flask Method**
- VW PV 3925
- Volvo VCS 1027, 2739
- Renault D40 3004
- GM GMW15635

**Headspace**
- VW PV 3341
- Volvo VCA 1027, 2749

**Direct Thermal Desorption**
- Daimler PB VWL 709
- Renault D42 3109
- GM GMW15634