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School Floor Coverings: Effects on Children's Well-Being and Learning

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Floor Covering Issues

- How do floor coverings affect indoor air quality?
- How do floor coverings affect safety and the learning environment?

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Indoor Air Quality in Schools

- Sources of IAQ problems include:
  - HVAC contamination - a frequent source of indoor air quality problems
  - Microbiological contaminants - usually originate outdoors
  - Water damage
  - Inadequate maintenance
  - Localized sources

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School IAQ depends on Many Factors

- Outdoor air quality - gases, particles, bacteria, fungi
- HVAC design, operation and maintenance - air handling units, filters, ducts.
- Building materials - woods, caulking, adhesives, mineral wools
- People - odors, clothing, bioeffluents
- Activities – cooking, labs., correction fluids, cleaning and maintenance practices, pest control
- Technology - photocopiers, computers, laser printers
- Finishes - paints, varnishes, wall coverings
- Furnishings - furniture, draperies, floor coverings

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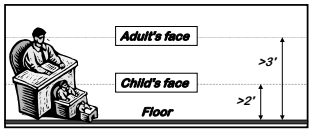
IAQ and Respiratory Effects

- Research studies repeatedly have shown that people respond to what is in the air in their breathing zone, not what is trapped in surface materials.



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Floor Covering Issues

- **Source**
  How are floor coverings a source of some air pollutants?
- **Sink**
  How are floor coverings a reservoir for some air pollutants?
- **Safe**
  How are floor coverings an effective trap for some air pollutants?

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Indoor Air Pollutants

- *Volatile Organic Compounds (VOCs)*
  - *Paints*
  - *Materials*
  - *Adhesives*
  - *Cleaning*
  - *Equipment*
- *Biologicals*
  - *Bacteria, Endotoxin*
  - *Fungi, Mycotoxins*
  - *Allergens (Cockroaches, Dust mites, Dogs, Cats)*

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New Carpet Emissions

- *New carpet can emit a number of volatile organic compounds (VOCs) when first exposed to the air.*
- *Emissions will vary with the type of carpet.*

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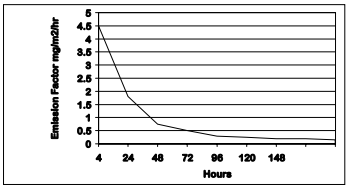
TVOC Emissions for New Carpet

When exposed to air, VOC emissions will decay rapidly.



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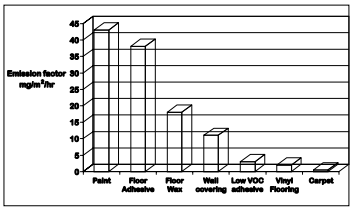
TVOC Emission Factors of Some Indoor Materials



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New VCT Emissions

- *New VCT can emit a number of volatile organic compounds (VOCs) when first exposed to the air.*
- *Emissions will vary with the type of VCT and adhesive.*

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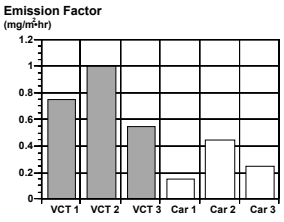
Installed VCT and Carpet

(Black, 1995)



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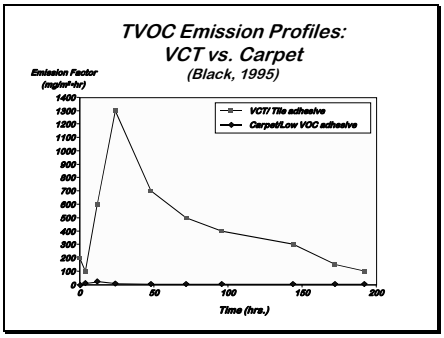

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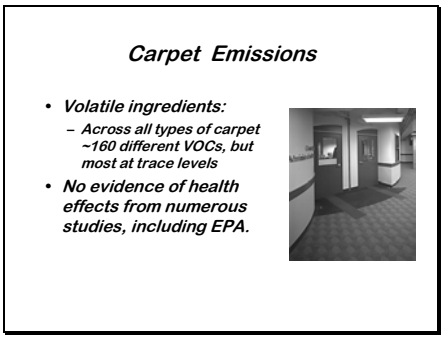

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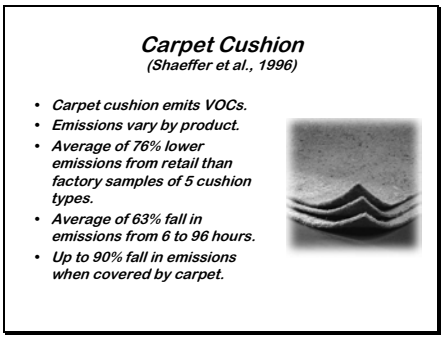

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VOC Pollutants

(Washington + Florida AQS Studies)

- *VCT and sheet vinyl floor coverings emit more VOCs into the air than carpet*
- *Adhesives are the strongest emitters of VOCs in flooring systems*
- *Low VOC emitting adhesives can substantially reduce overall emissions*

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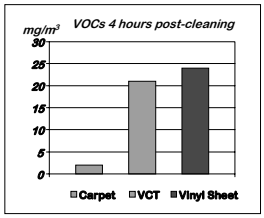
Floor Cleaning and VOCs

(Black 1995)

- *Cleaning systems for hard surface flooring can contribute substantial amounts of VOCs into the air*
- *Carpet cleaning (hot water extraction) emits very low to no VOCs*



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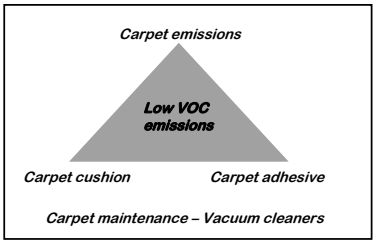
Carpet System Emissions



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CRI Testing Initiatives

- Carpet emissions testing.
- Carpet cushion emissions testing.
- Carpet adhesive emissions testing.
- Vacuum cleaner testing.

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CRI IAQ Carpet Testing Program

- The CRI Indoor Air Quality Testing and Labeling Program pioneered voluntary product emissions testing.
- CRI program tests mill samples for:
  - TVOCs 0.6 mg/m²•hr
  - Styrene 0.4 mg/m²•hr
  - 4-PC 0.1 mg/m²•hr
  - Formaldehyde 0.05 mg/m²•hr
- Emissions criteria developed in conjunction with the Environmental Protection Agency.

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CRI Carpet Cushion Testing

- Carpet cushion testing program:
  - TVOCs 1.0 mg/m²•hr
  - Formaldehyde 0.05 mg/m²•hr
  - 4-PC 0.05 mg/m²•hr
  - BHT 0.3 mg/m²•hr
- Carpet Cushion Council also undertakes emissions testing.

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CRI Carpet Adhesive Testing

- Carpet adhesive testing program:
  - TVOCs 10.0 mg/m²•hr
  - Formaldehyde 0.05 mg/m²•hr
  - 2-ethyl-1-hexanol 3.0 mg/m²•hr

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CRI Vacuum Cleaner Testing Program

- Soil removal
- Dust containment
- Carpet appearance retention

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Carpet as a Source?

- Carpet is not a source of formaldehyde.
- Carpet does not emit VOCs at levels even remotely close to a threshold of concern.
- 4-PC emissions, if present, are low and not toxic.
- Most VOCs are offgassed within the first 96 hours after airing.
- Most carpets emit only trace amounts of a limited number of VOCs (look for the IAQ label).

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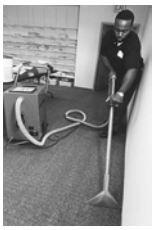
Floor Coverings as a Sink ?

- *Floor coverings and biologicals (fungi, cockroaches, dust mites etc.)?*
- *Floor covering maintenance?*
  - *Vacuuming*
  - *Cleaning methods*



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Fungi

- *Health problems can be caused by spores, parts of the fungal body, and fungal metabolites (mycotoxins).*
- *Fungi need moisture and food for growth.*

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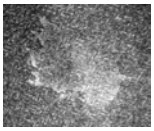
Fungi



- *Fungi can grow on and under persistently wet carpet*

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Fungi

- *Fungi can grow on and under persistently wet VCT floors.*

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Floor Surface Biologicals

(Black, 1995)

Fungi/Plate

	March	*April*
Carpet	*7*	*31*
Ceramic Tile	*10*	*18*
VCT	*-*	*48*

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Microbial Growth Requirements

- *Fungi and bacteria do not feed and grow on carpet fibers or on VCT.*
- *Fungi do not grow on flooring and building materials when the RH is below 80%* (Korpi et al., 1998).
- *Regular cleaning and drying maintains flooring integrity.*

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House Dust Mites

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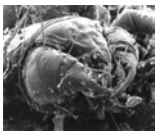
House Dust Mites

- People shed ~50 million skin scales/day (~1 Kg/year).
- Mites feeds on fungus + dead skin scales.
- Mites cannot feed at humidity <70% and die at humidity <50%.
- Mite fecal pellets <20μm.
- About 15 million Americans are allergic to dust mites, mainly feces.
- 30-40% of asthmatic children are sensitized to dust mites.



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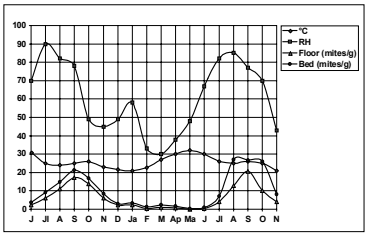
Mites: Seasonal Changes (India)

(Tilak and Jogdand, 1989)



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Mites in Florida

(Fernandez-Caldas et al., 1990)

- *Surveyed 40 homes in Tampa, FL.*
- *Mites present in 88% dust samples.*
- *Mite allergen in carpet dust not airborne.*
- *Mattresses averaged more than twice the mites/g dust found in carpet dust.*

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Dust Mites

- *Dust mites most common in mattresses and bedding (~1,000,000 per mattress).*
- *Dust mites present in upholstered chairs.*
- *Dust mites in carpet can easily be managed.*
- *Mites are killed by UV, liquid nitrogen, dilute tannic acid, acaracides (benzyl benzoate).*

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Carpet and Mites

- *Most research on mites is in Europe, where different types of carpet are used.*
- *Most US research has measured mites in carpet dust not mite allergen in the air.*
- *Synthetic and wool carpet can have similar counts of mites in carpet dust, but airborne allergen levels are only high with wool carpet.*
- *Synthetic carpet better traps and holds dust, and airborne mite allergen levels are comparable to a hard floor.*

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Dust Mites and Asthma

- *Dust mite allergen sensitization effects on asthma occur within the first 3 years and probably within the first 12 months of life.*
- *Sensitization requires exposure to high mite allergen levels for prolonged periods.*
- *Sensitization often occurs in conjunction with exposure to other allergens - cat, dog, cockroach.*
- *Mattresses, not carpets, pose the most significant risk for mite allergen exposure.*

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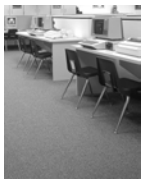
Floor Dust in Schools

(Dybendal et al., 1989)

- *Floor dust samples tested from classrooms in 12 schools.*
- *No differences qualitatively or quantitatively between floor dust from carpet or linoleum.*
- *Mite allergen levels highest in air over smooth floors.*
- *School environment typically has low levels and is protective against mite allergen.*



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Pet Allergens

(Dybendal and Elsayed, 1992)

- *About 100 millions domestic animal pets in USA (56 million cats).*
- *Cat allergen (feline domesticus I - Fel d I) produced by sublingual salivary glands and hair root sebaceous glands.*
- *Fel d I can contaminate a room in 30 minutes and be detected at least 20 months after pet is removal.*
- *Cat allergen is very prevalent in school floor dust, and is introduced on clothing.*

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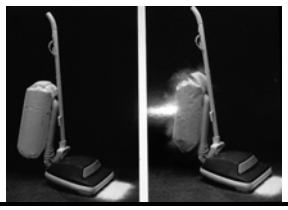
Floor Dust Removal

- *Effectiveness of vacuums is now tested.*
- *Use of high-efficiency cleaners (cleaning bags – 3-layer microfiltration) is important.*



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Managing Biocontaminants

(Washington + Florida AQS Studies)

- *Floor surface biologicals are similar to airborne biologicals for carpet and hard surfaces.*
- *Airborne biologicals track outdoor air.*
- *Replacing carpet does not reduce indoor airborne biologicals.*
- *Dust mite allergen in carpet dust is not found in the air without considerable mechanical disturbance; airborne levels are short-lived.*
- *Contaminants in carpet can be removed with simple maintenance.*

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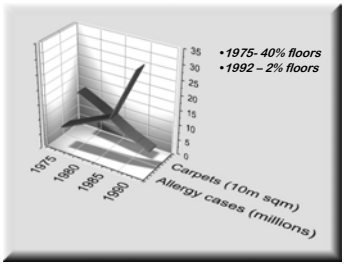
Carpet and Asthma in Sweden

(Shishoo and Böjesson, 1996)



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Allergy and Asthma

(Jaakkola et al.*, 1999)*

- *251 healthy infants and toddlers compared to 251 diagnosed with asthma.*
- *Children with PVC flooring in nurseries, bedrooms and other rooms had an 89% higher risk of asthma than those in PVC-free homes.*

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Emissions from Computers

(Ostman, 2000)

- *When new, plastic computer monitors can emit triphenyl phosphate, an allergenic chemical that is widely used as a flame retardant, and concentrations are significant in the breathing zone, especially with new computers.*

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Childhood Asthma Risks

(Ball et al., 2000)

- *Exposure of young children to other children at day care protects against the development of asthma later in childhood.*

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Childhood asthma risks

- *Asthma risks in infancy and childhood :*
  - *Gender (males vs. females)*
  - *Maternal asthma*
  - *Maternal smoking*
  - *Atopy - Hay fever, eczema*
  - *Ethnicity (Caucasian, African American)*
  - *Early respiratory infection (RSV)*
- *Sensitizers:*
  - *Molds and fungi*
  - *Allergens – cockroaches, cats, dogs, dust mites*
  - *High fat diet*
  - *Inactivity*
  - *PVC and plasticizers*
  - *Acetaminophen, antibiotics*
  - *Air pollutants (e.g. NO_2, O_3)*

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Asthma Protection

- *Infants are protected from asthma by:*
  - *No maternal smoking*
  - *Breast feeding*
  - *Larger family size*
  - *Early exposure to other children*
  - *Early respiratory illnesses (not RSV)*
  - *Farming lifestyle*

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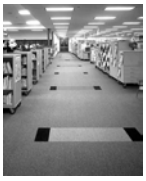
Effects of Floor Coverings

- *Indoor air quality*
- *Safety (slips, trips, falls)*
- *Comfort (sitting surface)*
- *Cleaning and maintenance*
- *Appearance - color, softness, texture, comfort, quality.*
- *Acoustics - ambient, impact noises (School Sound Level Study, 1986)*



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Environmental Benefits

- *Carpet traps dust for periodic removal.*
- *Carpet is recyclable.*
- *Carpet can be cost competitive to install, and less costly to maintain than other surfaces.*

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Educational Benefits

- *Carpet is a safe surface –*
  - *less frequent and less serious trips and falls (less force) on carpet.*
  - *no slips on carpet.*

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Educational Benefits

- *Carpet improves thermal conditions (insulation) and acoustic conditions (impact noise, reverberation time) in classrooms and schools.*

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Conclusion

- *Carpet can be a cost effective and beneficial floor surface for schools.*

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If you select carpet as a floor covering…

Look for "green" and keep it clean!

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Thank you…
Questions?

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Cornell Ergonomics Web

http://ergo.human.cornell.edu