IA-QUEST - (Indoor Air Quality Emission Simulation Tool)

Won, D. Y.

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http://irc.nrc-cnrc.gc.ca

IA-QUEST (Indoor Air Quality Emission Simulation Tool)

IRC-ORAL-850

Won, D.

February 13, 2008

National Research Council Canada | Conseil national de recherches Canada
Canada

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IA-QUEST

(Indoor Air QUality Emission Simulation Tool)

D. Won

Feb 13, 2008

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Contents

- **Background for IA-QUEST**
  - Importance of VOCs & Low-Emitting Materials
  - Material Emission Project (1996 – 2000, 2000-2004)

- **IA-QUEST**
  - Major features
  - Application scenarios

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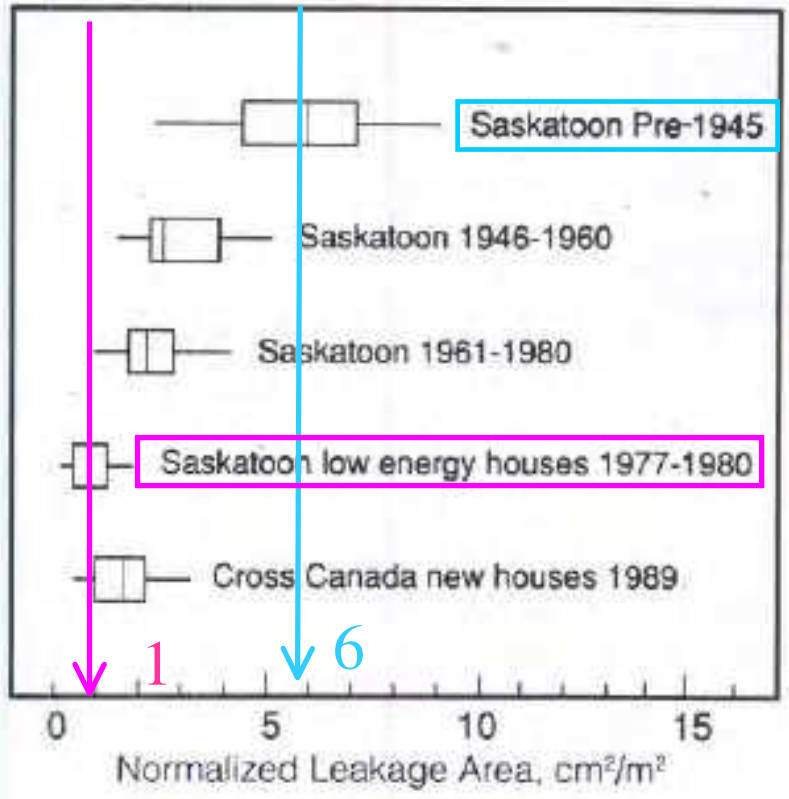
Why do we care about IAQ & VOCs?

- Volatile organic compounds (C & H)
  - **Indoor >> Outdoor (US EPA)**
  - **200-300 VOCs indoors**
  - **Health Effects:** irritants, carcinogens, asthma
  - **No standards for non-industrial s**
- Factors:
  - **Many sources indoors**
  - **Tight houses**



Air tightness survey results (BSI '90)

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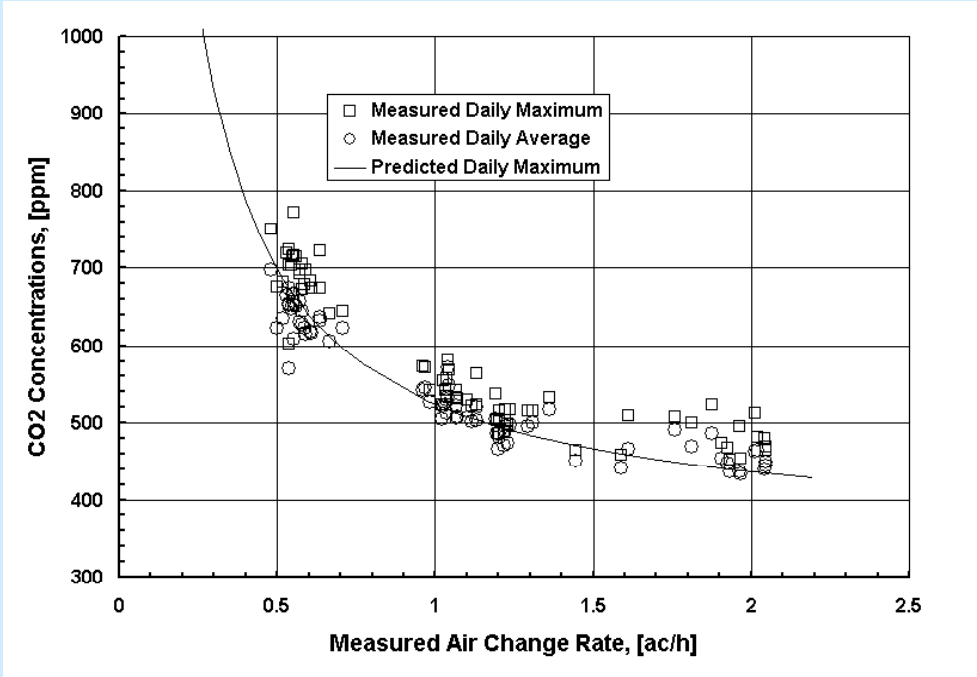
Control Options?

- Ventilation
  - **Open window**
  - **Mechanical ventilation ($$)**
- Air cleaning devices
  - **Energy cost ($$)**
  - **Not efficient**
- Source control
  - **Avoidance**
  - **Selection of low-emitting materials**



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Low-emitting materials (Canada)

- **LEED** (Leadership in Energy and Environmental Design)
  - Low-emitting materials
    - Adhesives and sealants (1 point)
    - Paints and coating (1 point)
    - Carpet (1 point)
    - Composite wood & laminated adhesives (1 point)

- **Labeling Scheme**
  - EcoLogo by Environmental Choice

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Low-emitting materials (USA)

- **LEED**
- **California**
  - Section 01350 specification
  - Recognized by US EPA & others
- **BIFMA Emission Standards**
  (Business & Institutional Furniture Manufacturer's Ass.)
- **Industry Labeling Schemes**
  - Green Label Plus (Carpet & Rug Institute)
  - Indoor Advantage Gold (Scientific Certification Systems)
  - Floorscore (Scientific Certification Systems)
  - GREENGUARD Children & Schools Certification Program (GREENGUARD Environmental Institute)
  - GreenSeal, etc.

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Problem Statement

- **Product labeling is Voluntary**
  - Very limited products are labeled.

- **Lack of Consistency in Product Labeling**
  - Focused on a sector or a national market
  - Specific tests
    - Testing procedures (4 vs 3 & 28 days)
    - Chemicals (TVOC, formaldehyde, ~80 VOCs, ~170 VOCs)
    - Reporting Units
      (Emission factor - $mg/m^2/h$, Indoor concentration - mg/m^3)

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Objectives of Material Emissions Projects (1996-)

- **Baseline data on material emissions with a standardized method**
- **Estimation of impacts on indoor air quality by building materials**
- **Material selections and ventilation strategies**

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Consortium Members

Government partners

- Canada Mortgage and Housing Corporation
- Natural Resources Canada
- Public Works and Government Services Canada
- Health Canada
- Panel of Energy Research & Development

Industry partners

- Canadian Wood Council
- Chemical Manufacturers Association (USA)
- Gypsum Association (USA)
- USG Corporation (USA)

International partners

- Building Center of Japan

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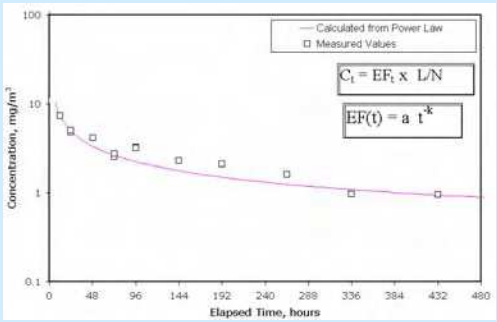
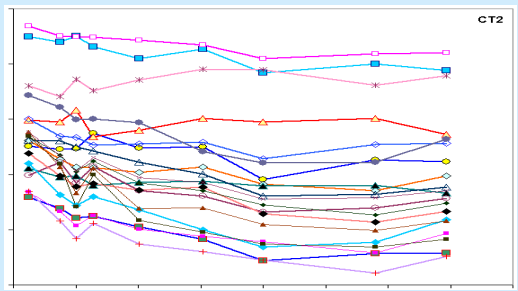
ME project

Building material Specimens (69)

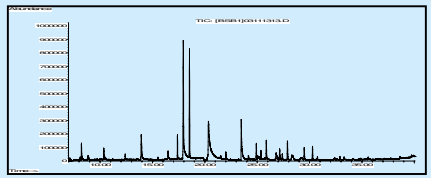
Emissions Tests



Modelling



Data Analysis



Chemical Analysis (90 VOCs)

Decision-making

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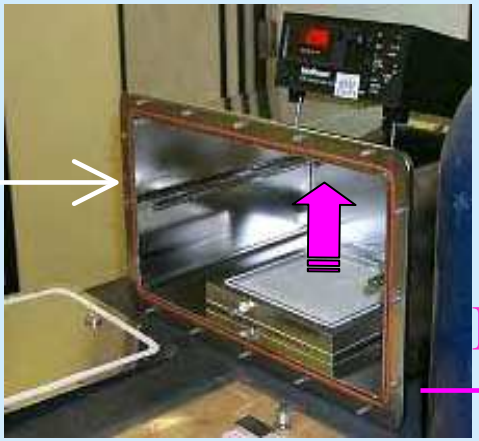
Test Methods: 50-L chamber test

Chamber testing

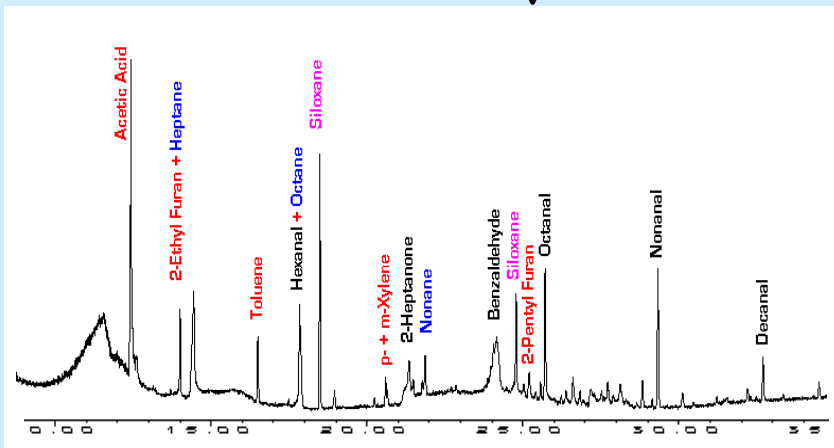
Sampling

Chemical Analysis

Clean air



Exhaust



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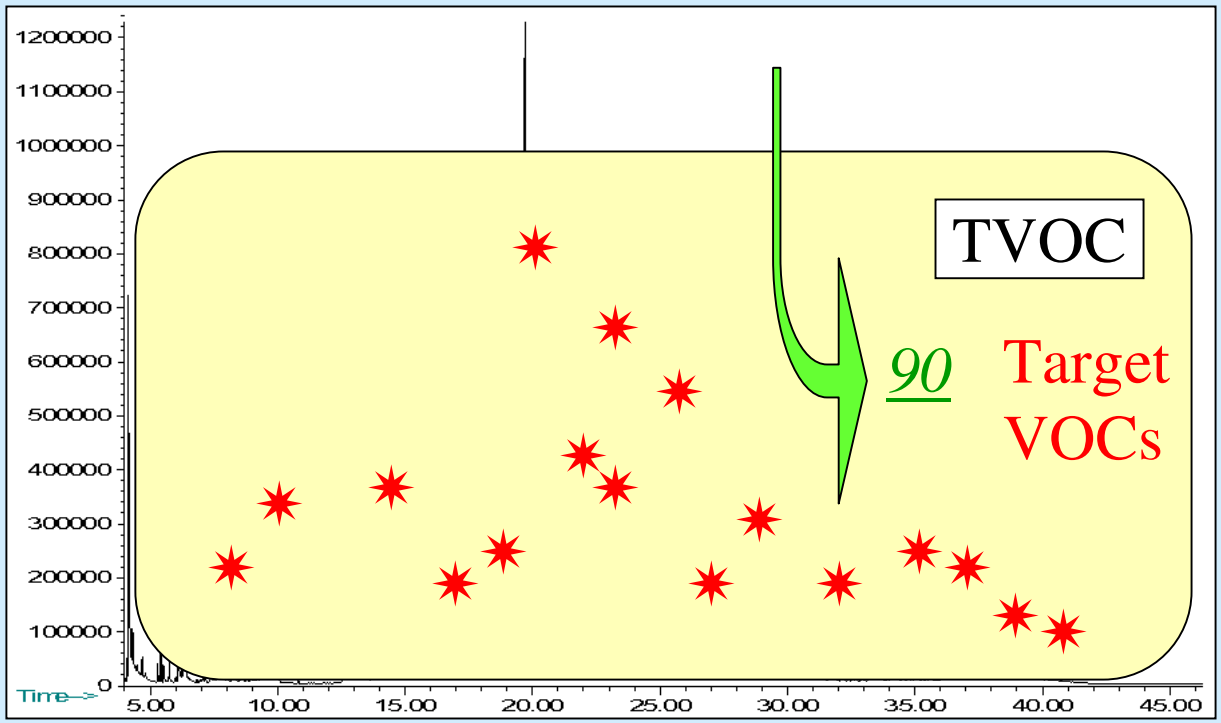
Target VOCs

CMEIAQ-II Advisory Committee:
HC, CMHC, NRCan, PWGSC, Unv.



VOC Emission Profile – Building Material

Health-Relevant

IAQ

Analysis

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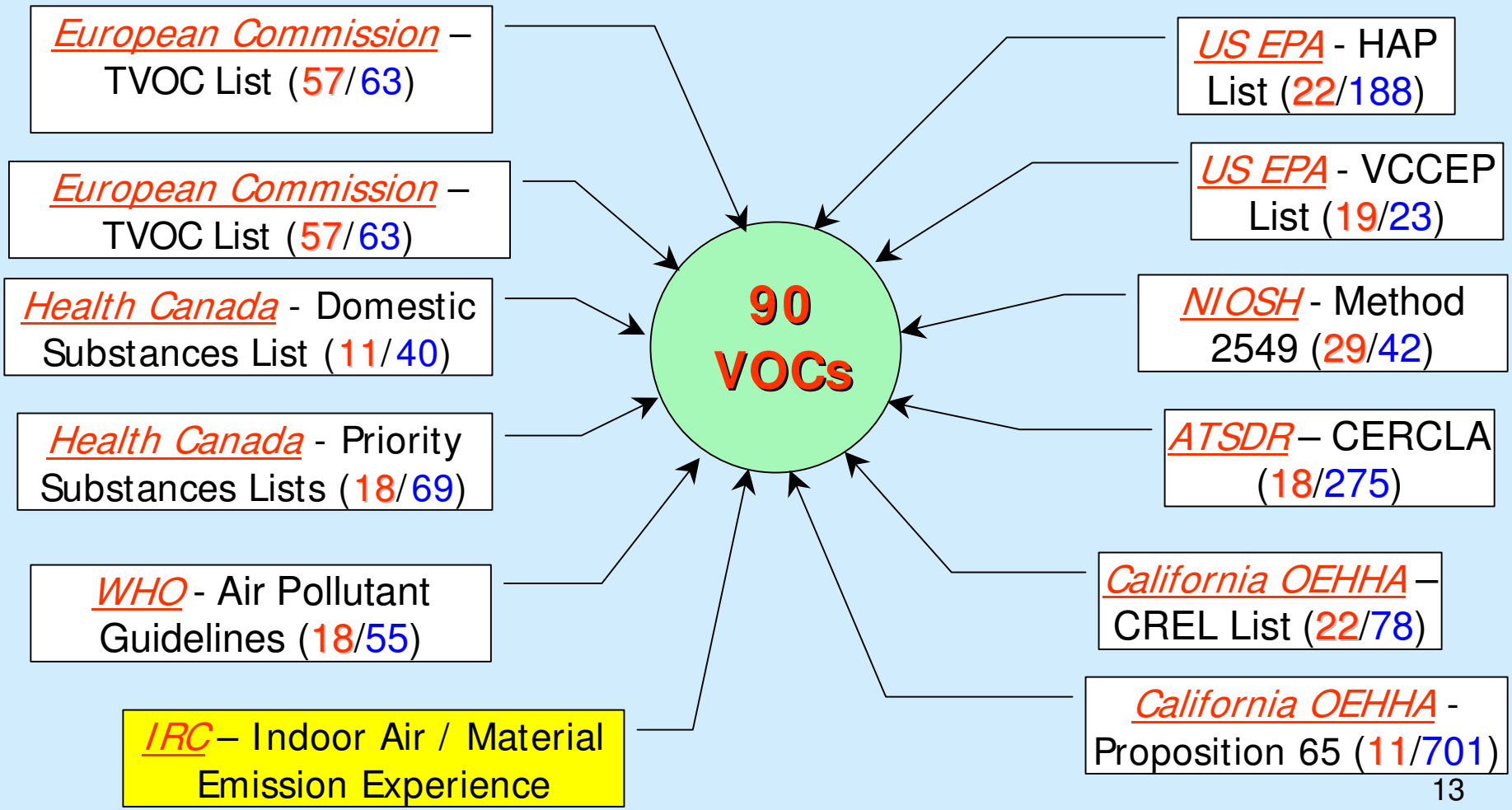
Target VOCs: References



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Software: IA-QUEST

Database

- Emission Data for
  - 90+ VOCs
  - 69 Materials
- Test record
  - Specimens
  - Conditions

Simulation Tool

- single zone model
- prediction of VOC concentrations
- tool for evaluating impact of:
  - material selection choices
  - ventilation schedules and rates

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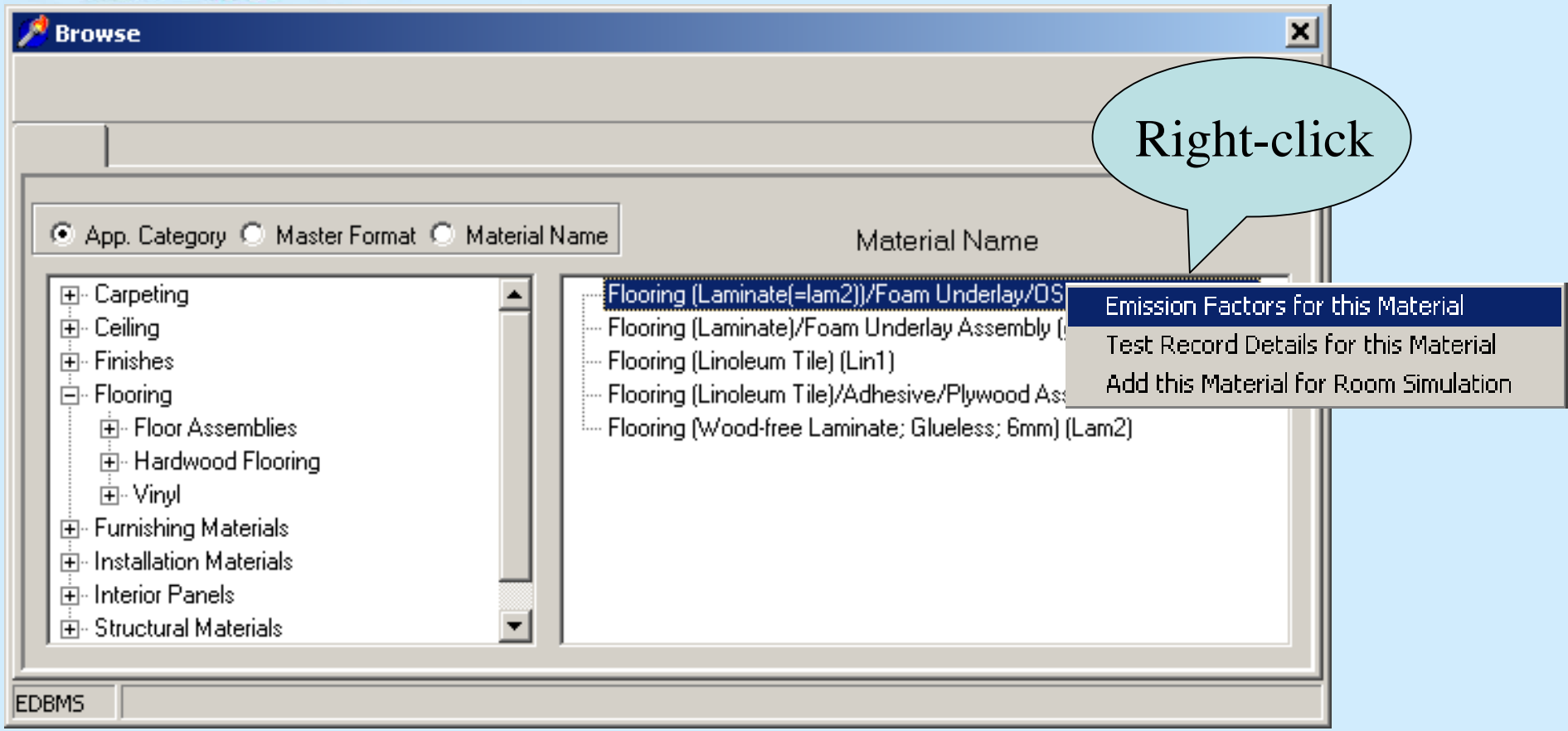
Information (1): Emission Factor



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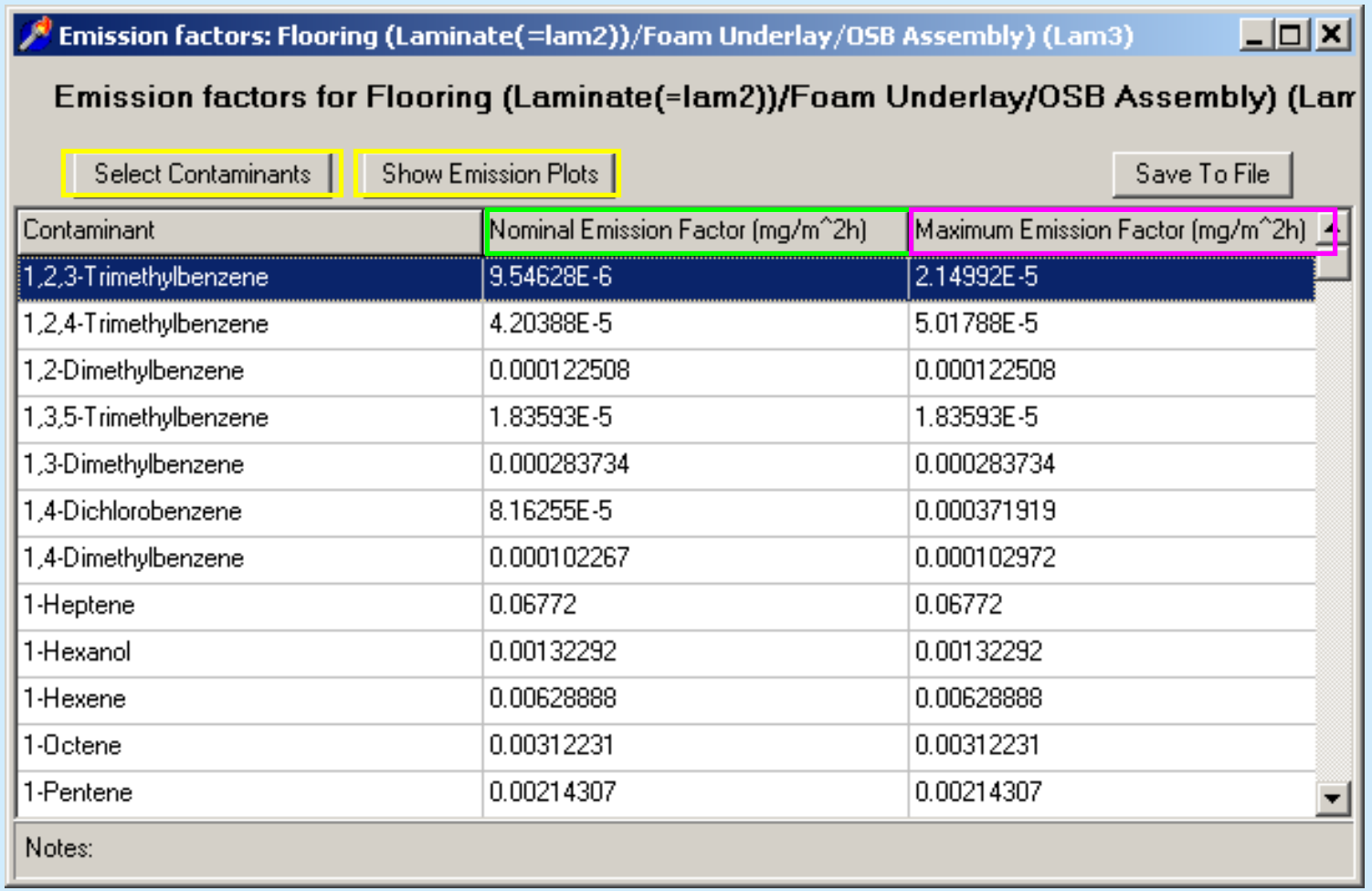
Information (1): Emission Factor (measured)



Contaminant	Nominal Emission Factor (mg/m^2h)	Maximum Emission Factor (mg/m^2h)
1,2,3-Trimethylbenzene	9.54628E-6	2.14992E-5
1,2,4-Trimethylbenzene	4.20388E-5	5.01788E-5
1,2-Dimethylbenzene	0.000122508	0.000122508
1,3,5-Trimethylbenzene	1.83593E-5	1.83593E-5
1,3-Dimethylbenzene	0.000283734	0.000283734
1,4-Dichlorobenzene	8.16255E-5	0.000371919
1,4-Dimethylbenzene	0.000102267	0.000102972
1-Heptene	0.06772	0.06772
1-Hexanol	0.00132292	0.00132292
1-Hexene	0.00628888	0.00628888
1-Octene	0.00312231	0.00312231
1-Pentene	0.00214307	0.00214307

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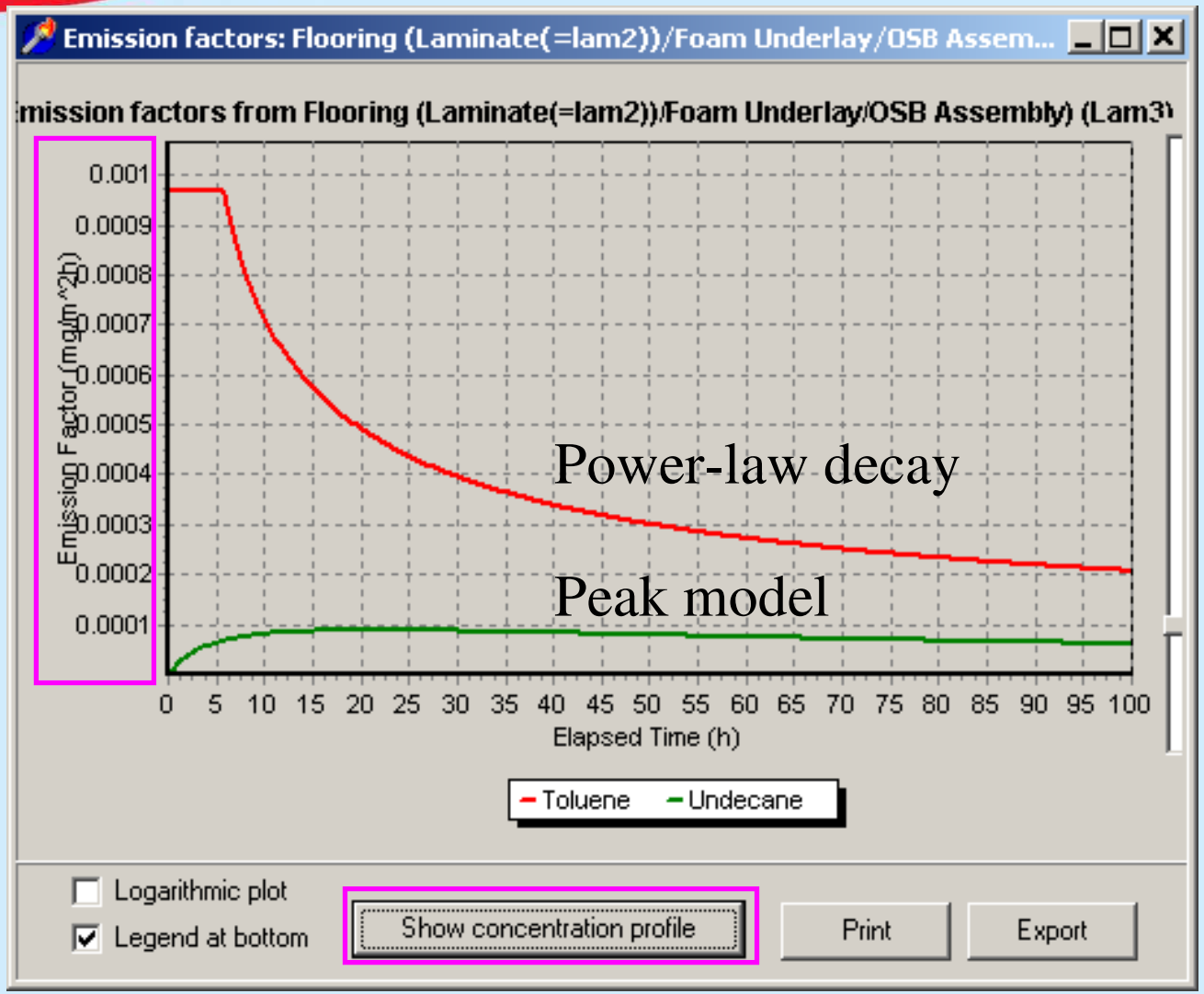
Information (1): Emission Factor (modeled)



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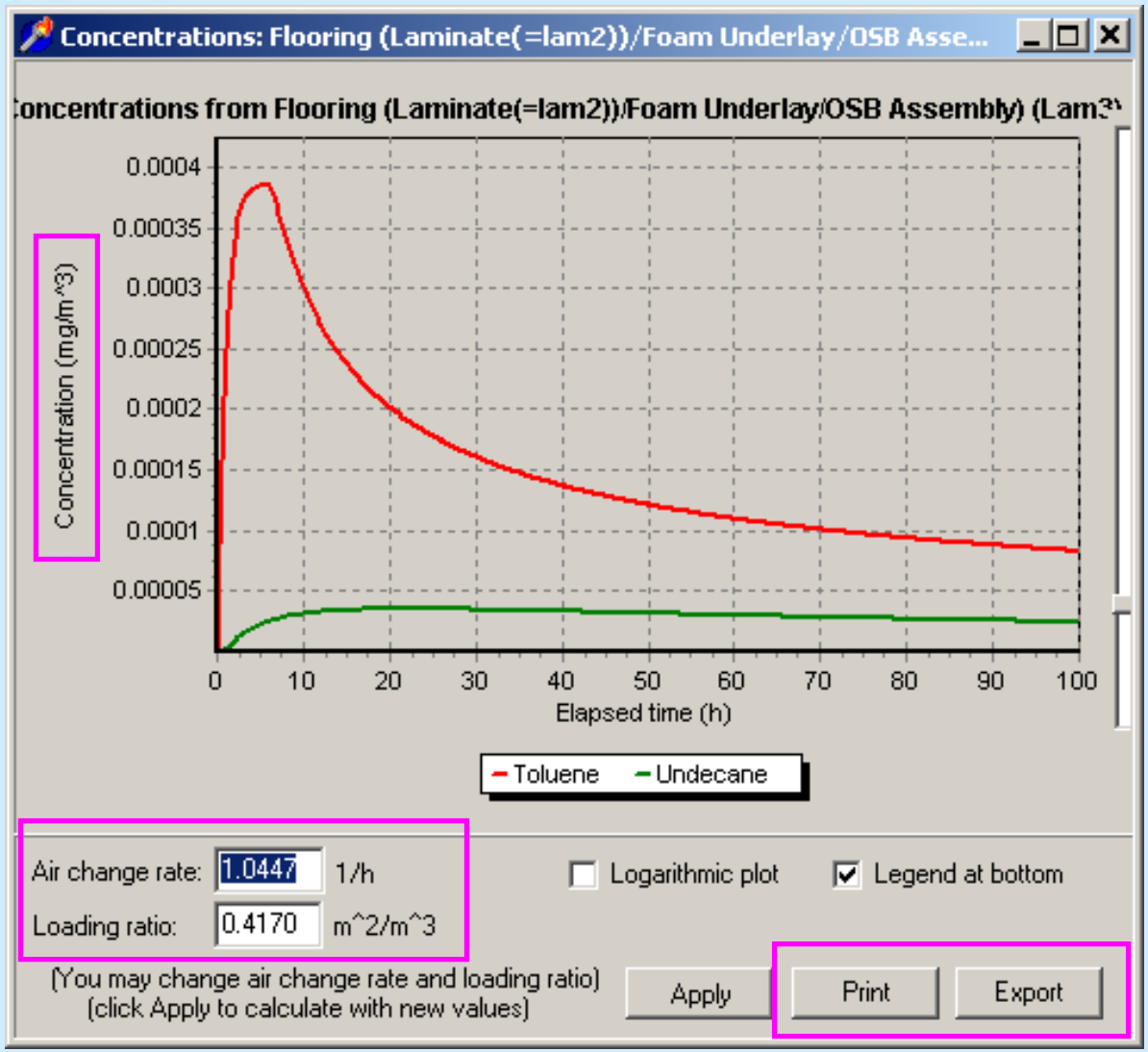
Information (1): Concentration (modeled)



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Information (2): Test Record

Emission Test Record Details: Acoustical Ceiling Tile (Cellulose) (ACT3)

Emission Data for Test : ACT3

Print

Contaminant	Nominal Emission Factor (mg/m^2h)	Maximum Emission Factor (mg/m^2h)
1,2,3-Trimethylbenzene	5.39095E-5	0.000379731
1,2,4-Trimethylbenzene	9.24125E-5	0.000779959
1,2-Dimethylbenzene	2.52401E-5	0.000247815
1,3,5-Trimethylbenzene	4.65021E-5	0.000238733

Test date: 3/8/1998 Test laboratory: Indoor Environment Research Program, IRC/NRC

Product: Acoustical Ceiling Tile (Cellulose) (ACT3)

Product notes: Residential, 12x12", cellulose

Test conditions:

Temperature = 23 °C; Humidity = 50 %; Velocity = .05 m/s;

Turbulence intensity = 1 %; Air change rate = 1 ACH; Loading ratio = 0.72899 m^2/m^3

Test notes: Source: Local retail outlet

Product sample:

Shape/Dimension: 0.212 x 0.212

Surface area = .05 m^2 Thickness = mm Initial mass = g

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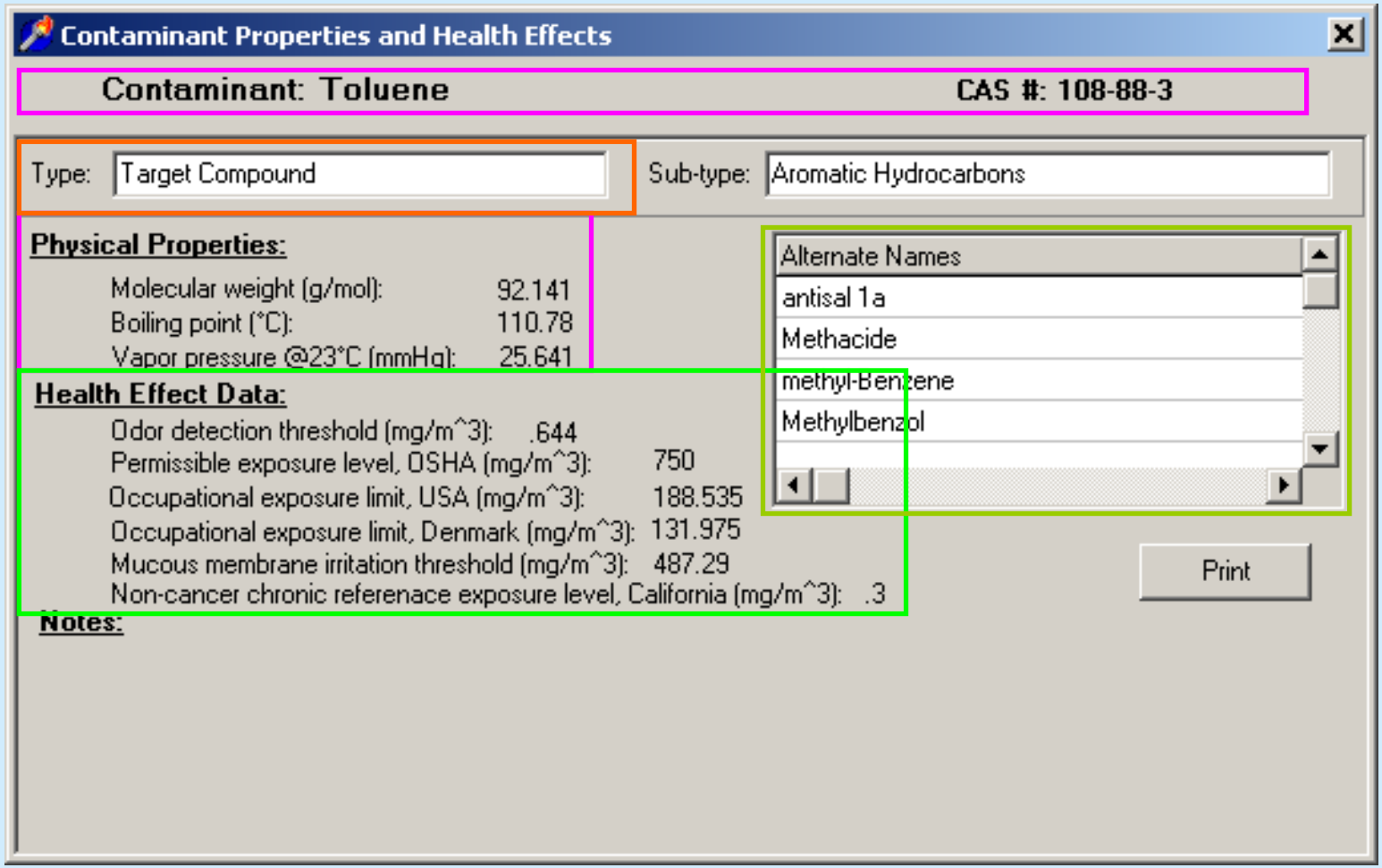
Information (3): Compounds



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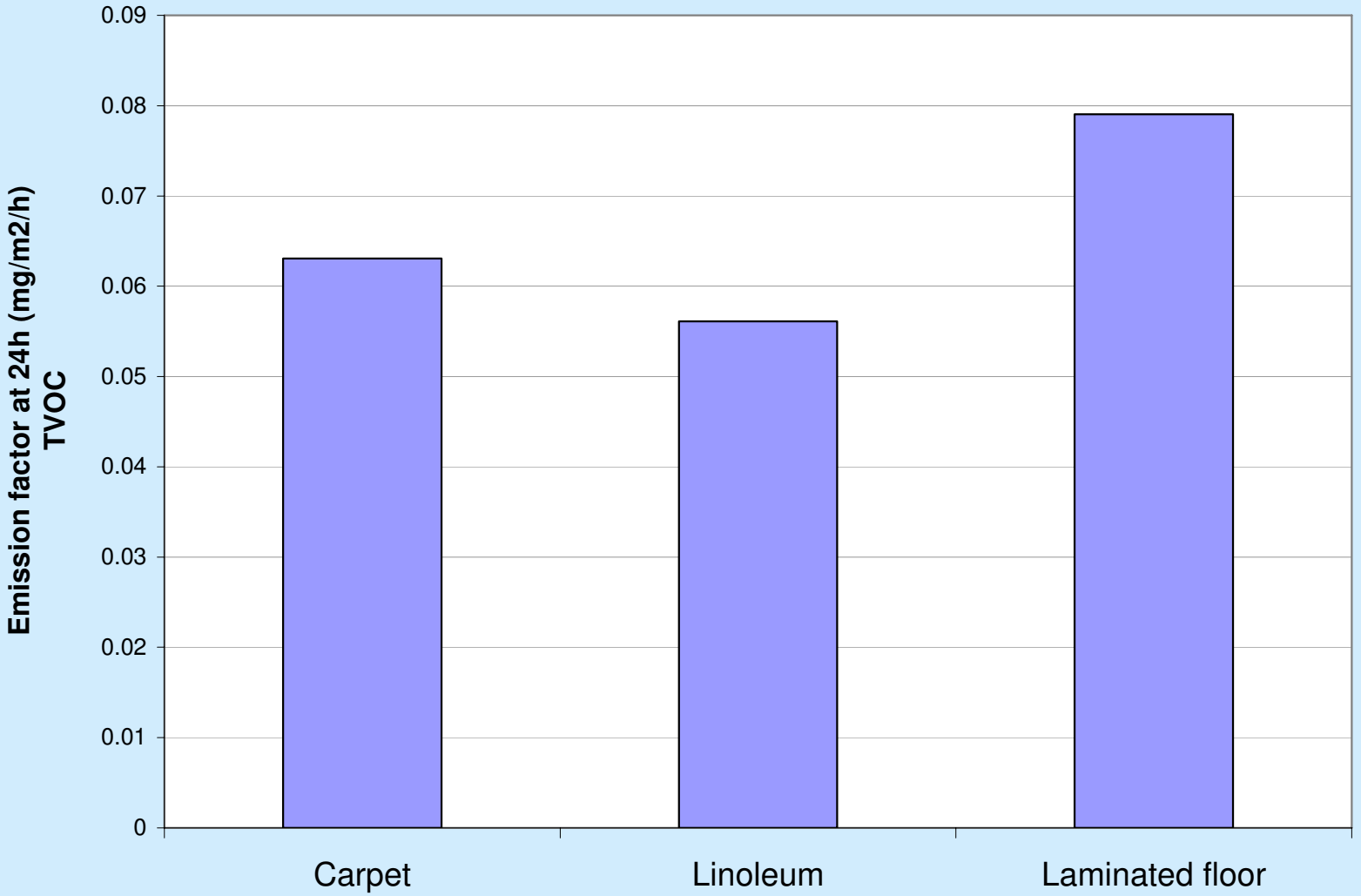
Application #1: Product Comparison

(within floor category)



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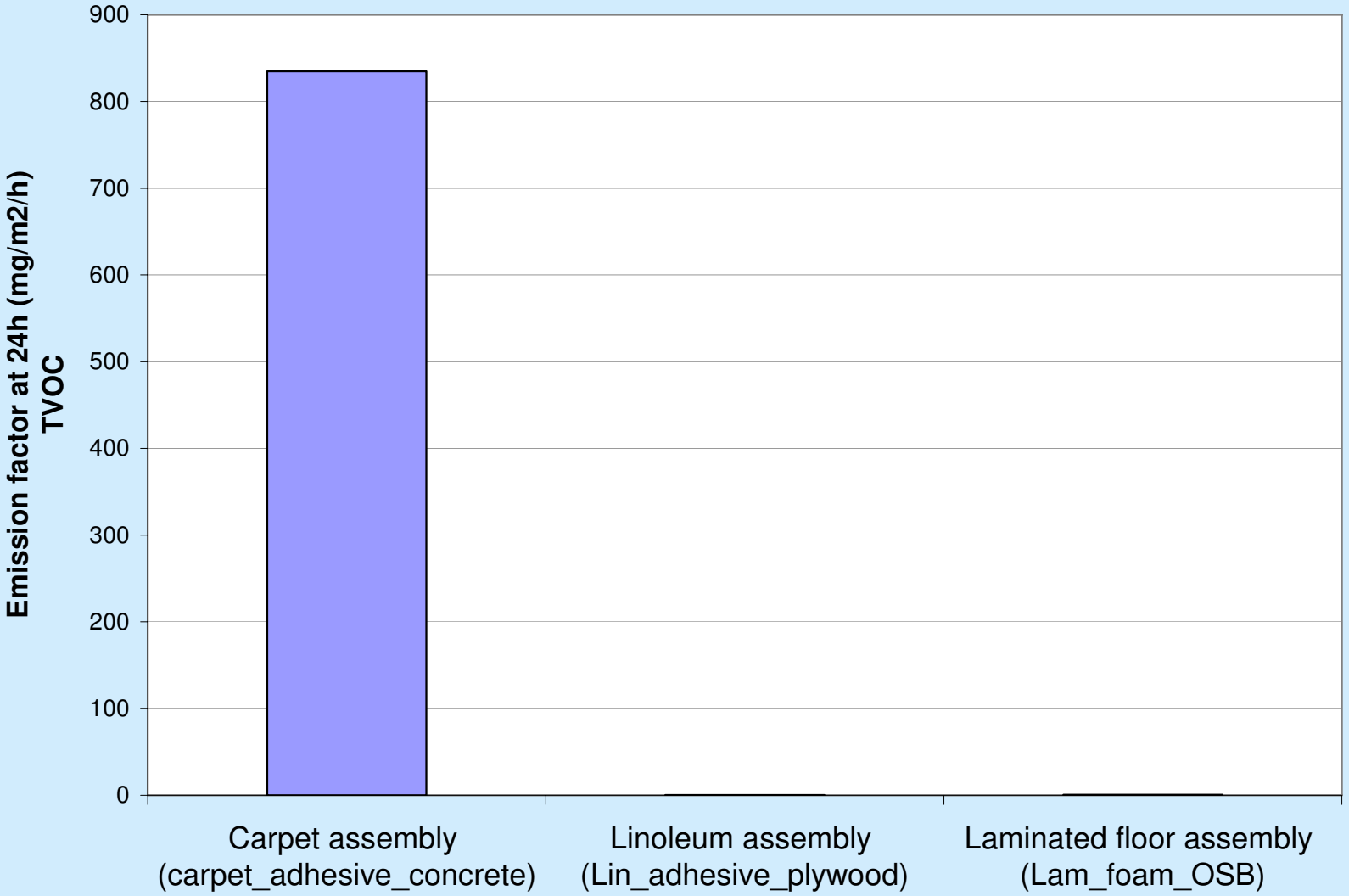
Application #1: Product & application (within floor assemblies)



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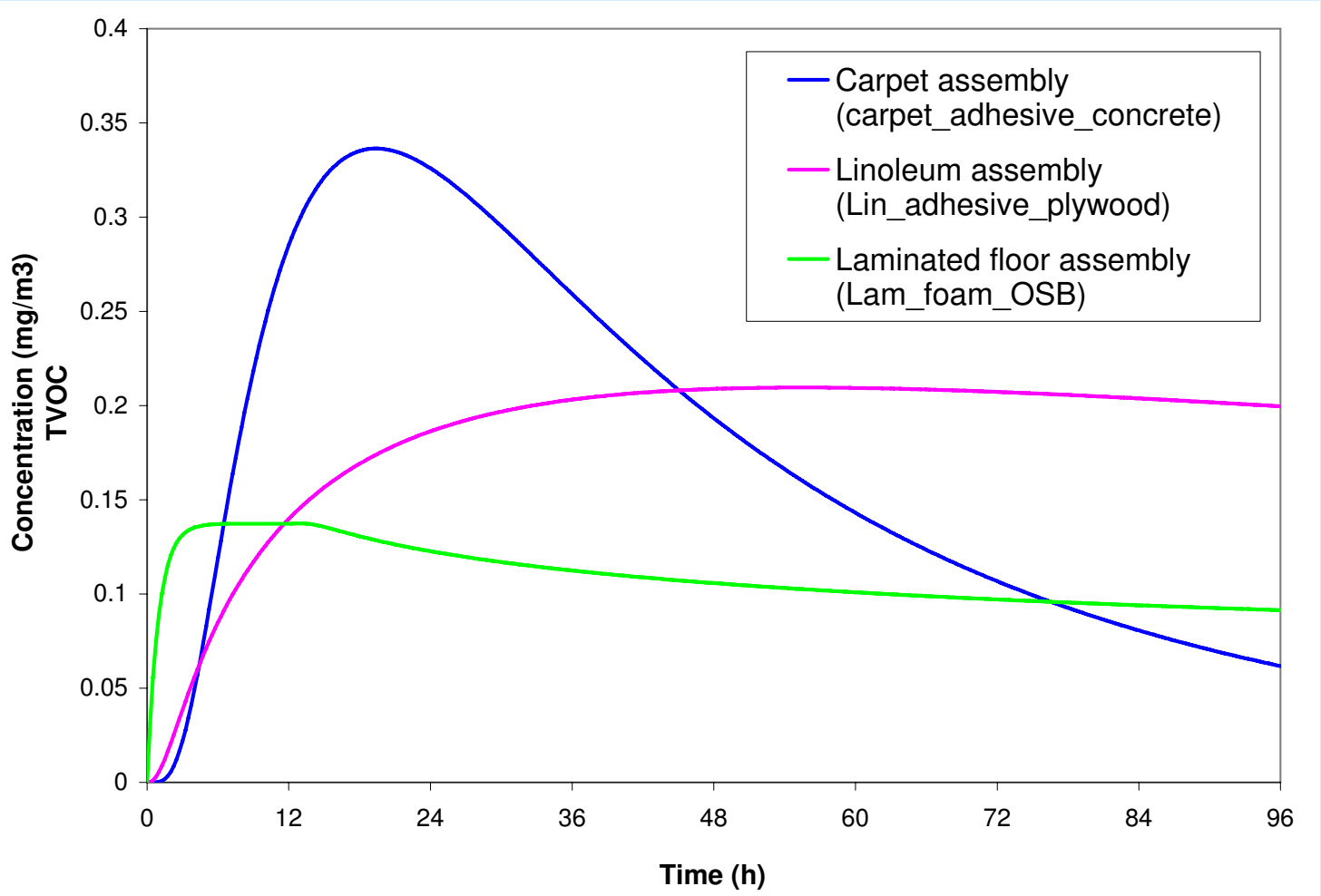
Application #1: Product Comparison
(IAQ - modeled)



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Application #2: Product Selection (Labeling Requirement)

- Scenario:
  - Find a carpet product
  - CRI's Green Label
  - Max Emission Factor: 0.5 mg/m^2/h for TVOC, etc.

- IA-QUEST function
  - Use "Query"

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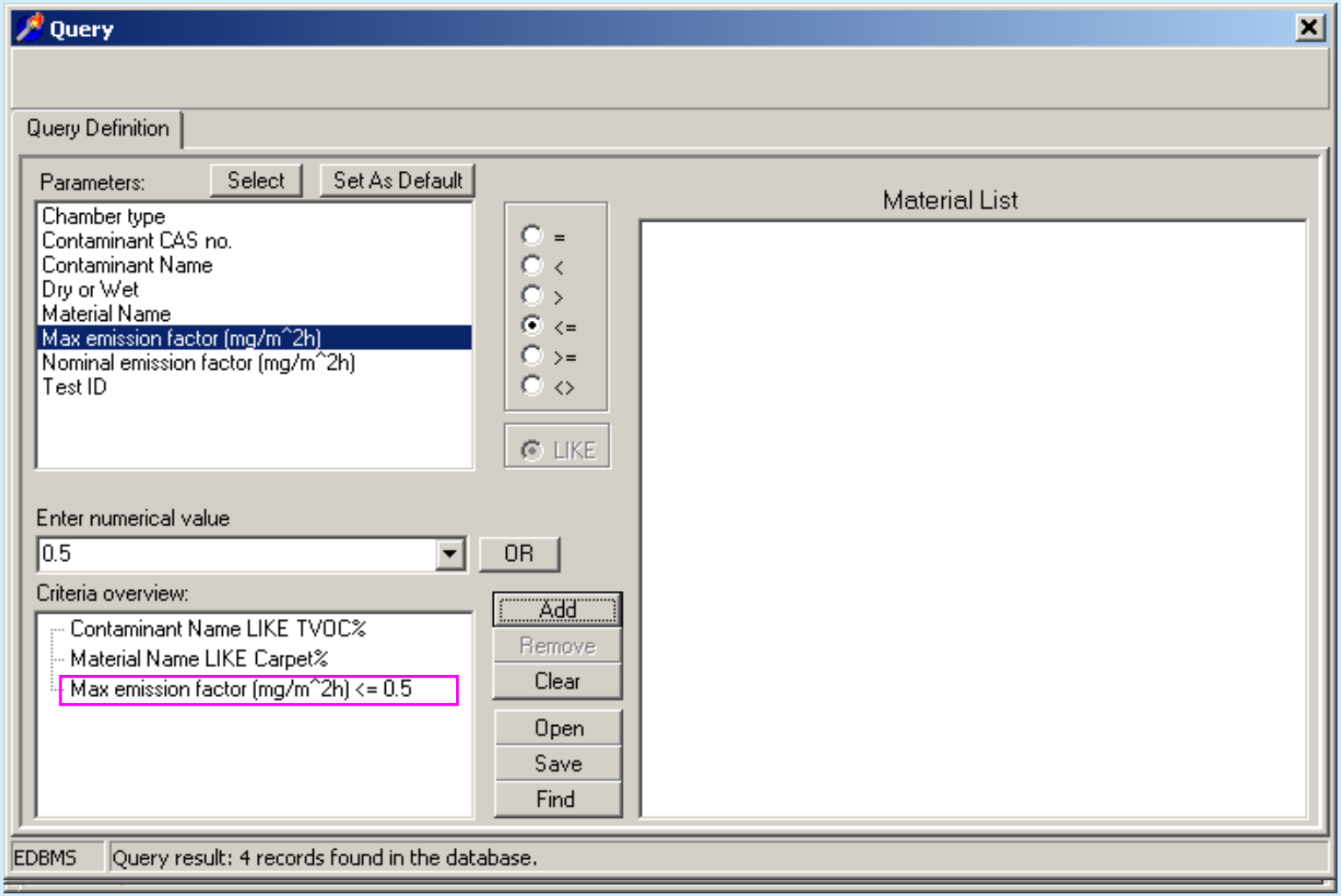
Application #2: Labeling Requirement (Query)



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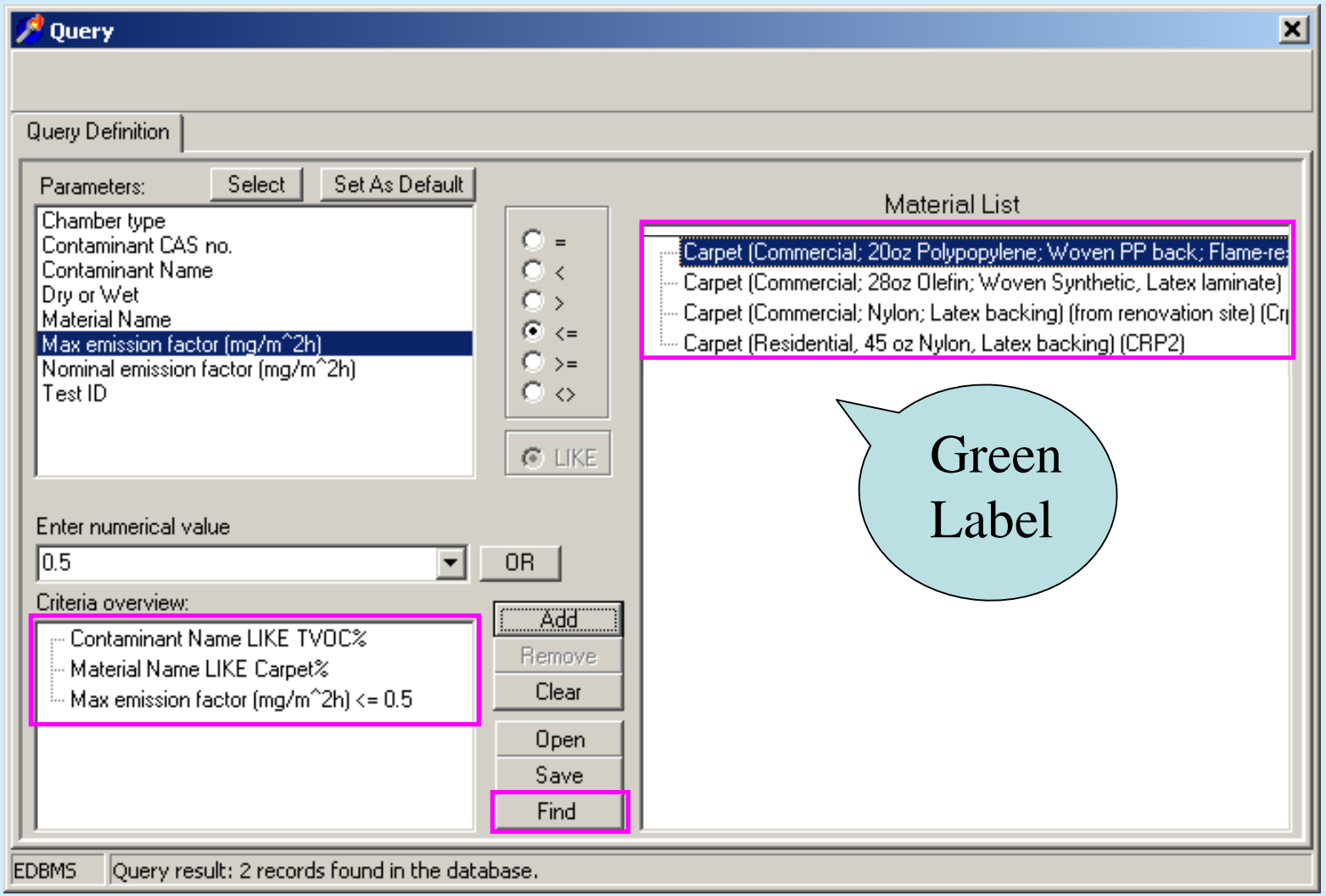
Application #2: Labeling Requirement (Query)



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Application #3: IAQ Meet the Guideline Value?

- Scenario:
  - Carpet in a room (27 m^3, 10 m^2, 0.5 ACH)
  - Can we meet the guideline for the first 10 days?
    - TVOC: ~0.4 mg/m^3 (Japan)
    - Formaldehyde: ~0.015 mg/m^3 (California)

- IAQUEST function
  - Use the “Simulation” capability

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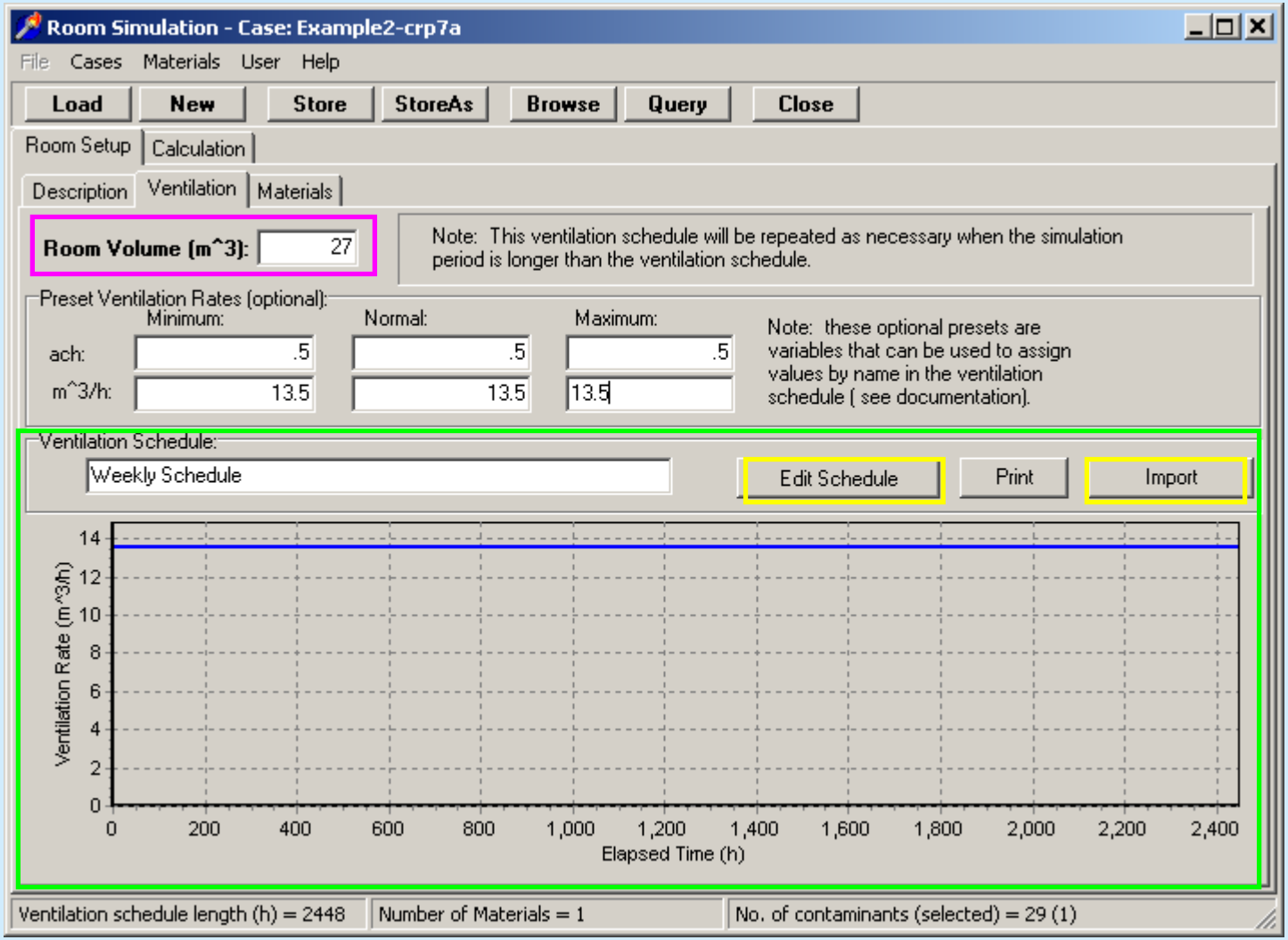
Simulation: Ventilation Data



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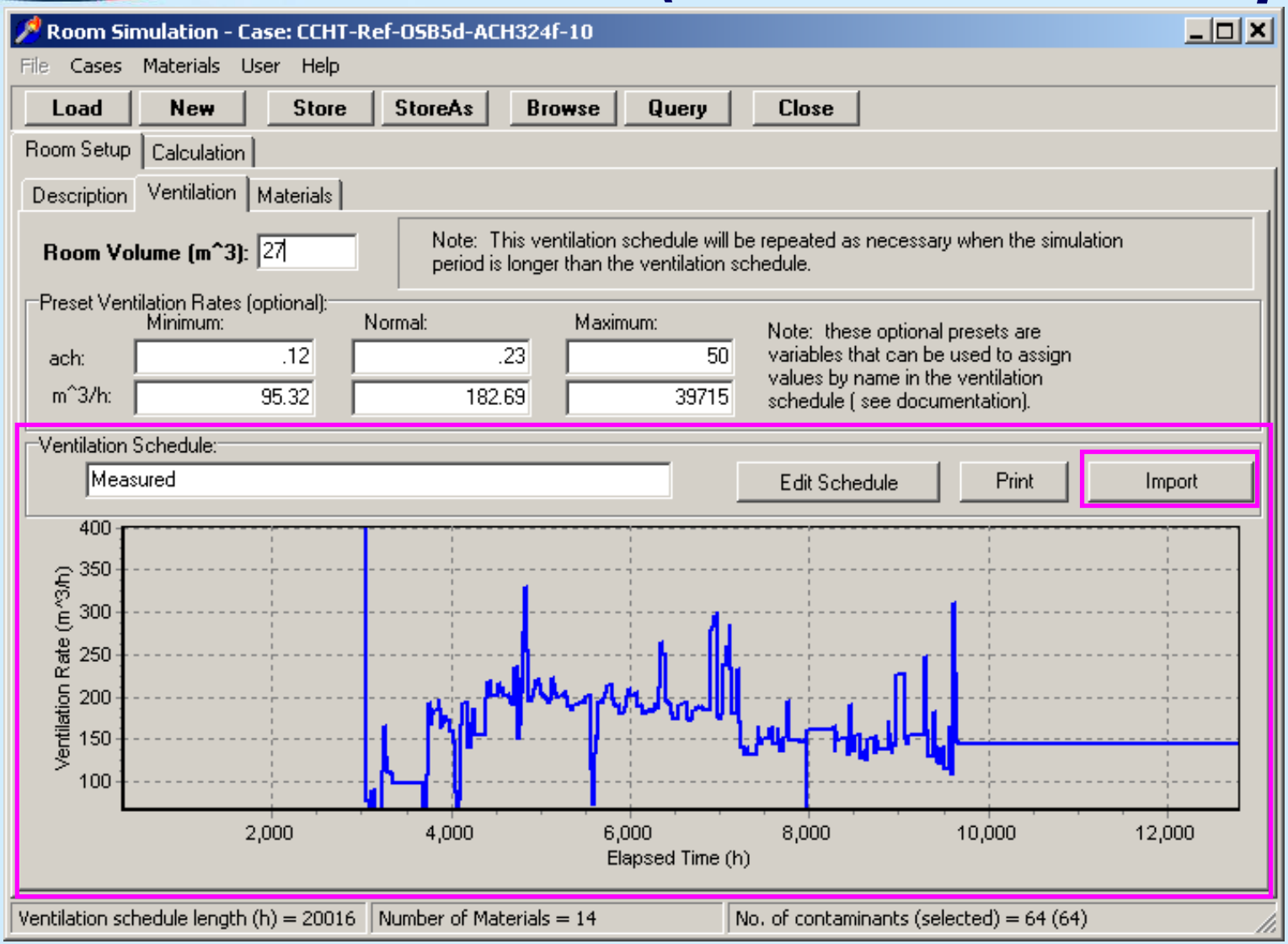
Simulation: Ventilation (measured & complex)



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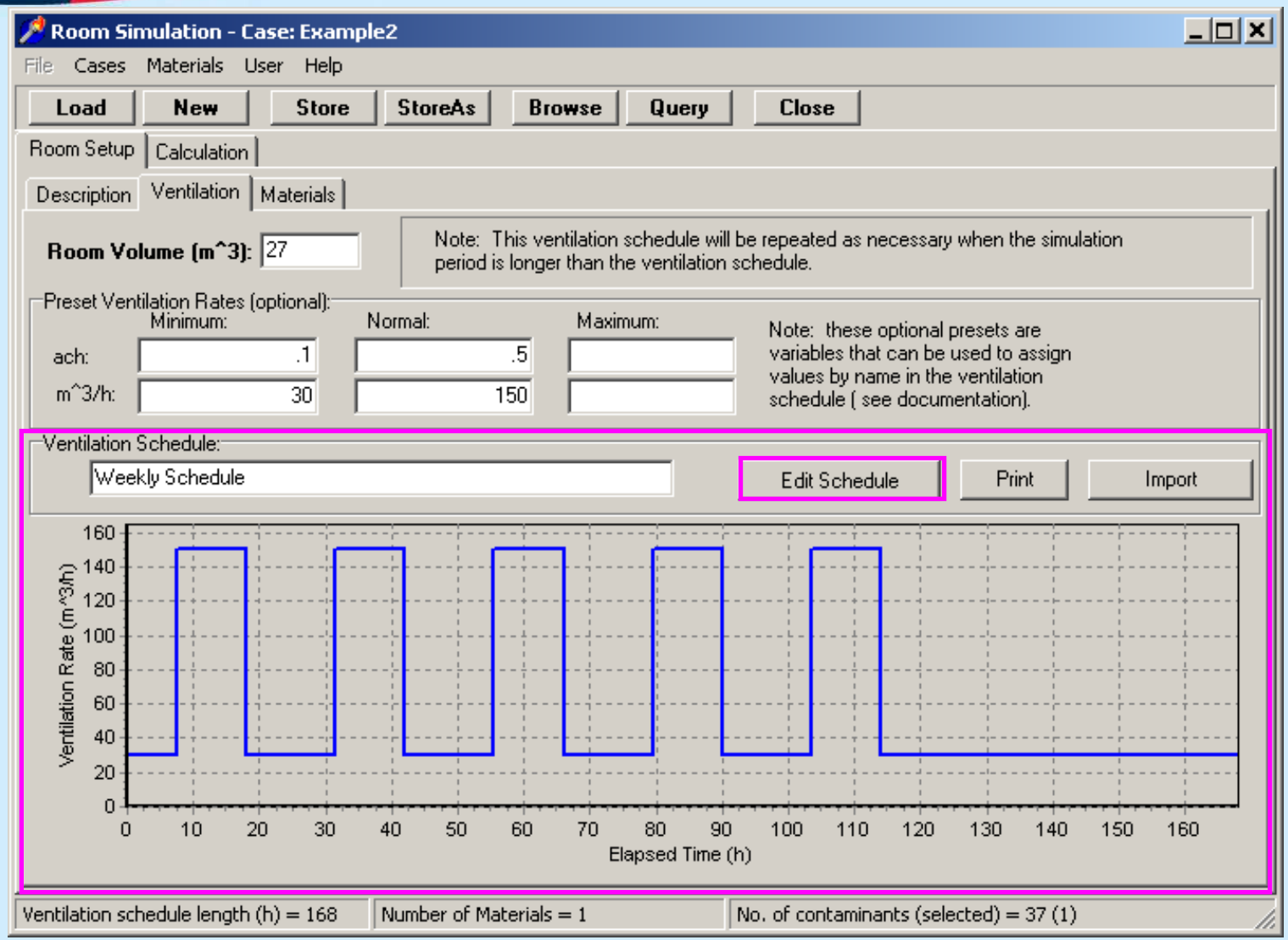
Simulation: Ventilation (weekly)



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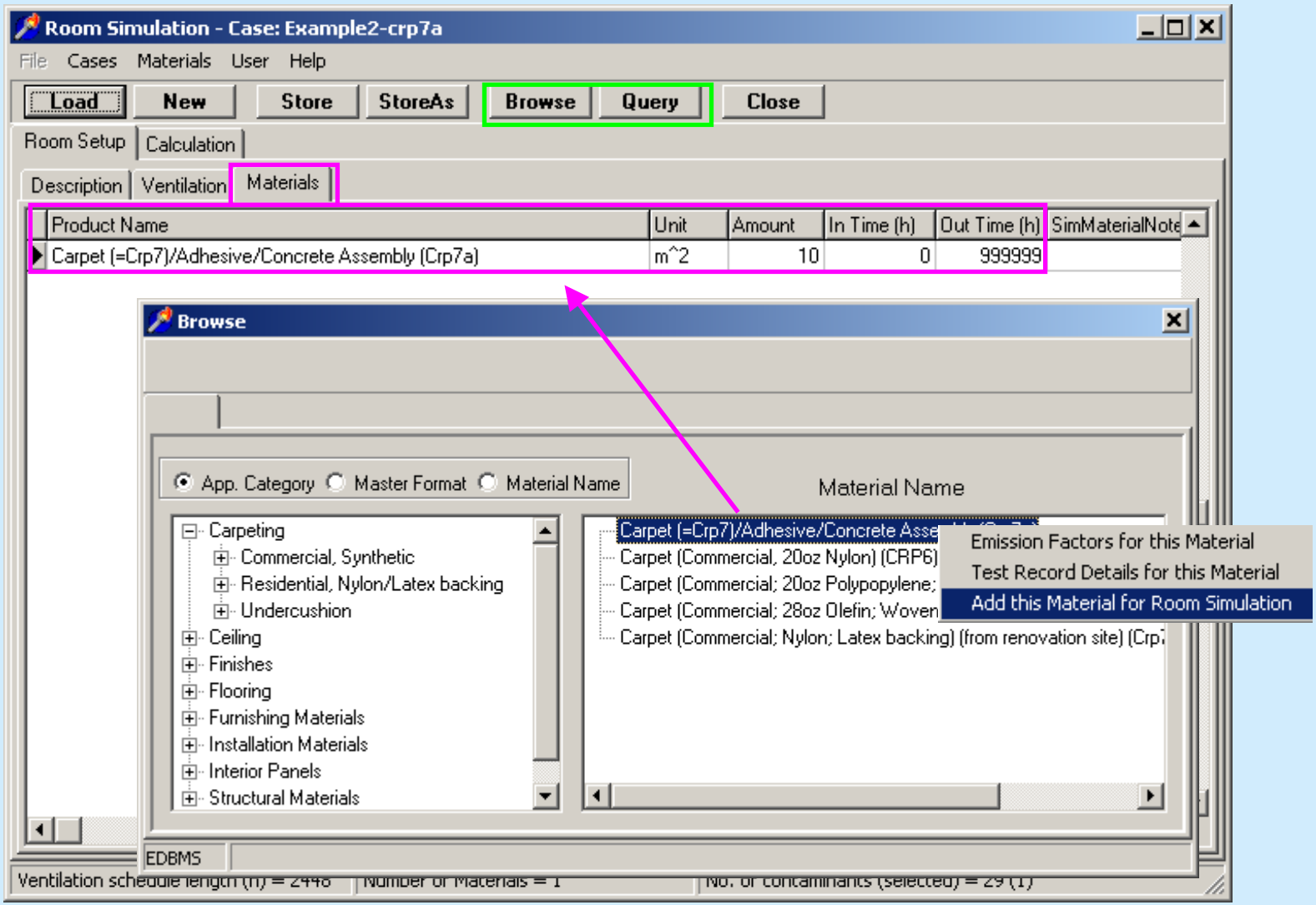
Simulation: Materials



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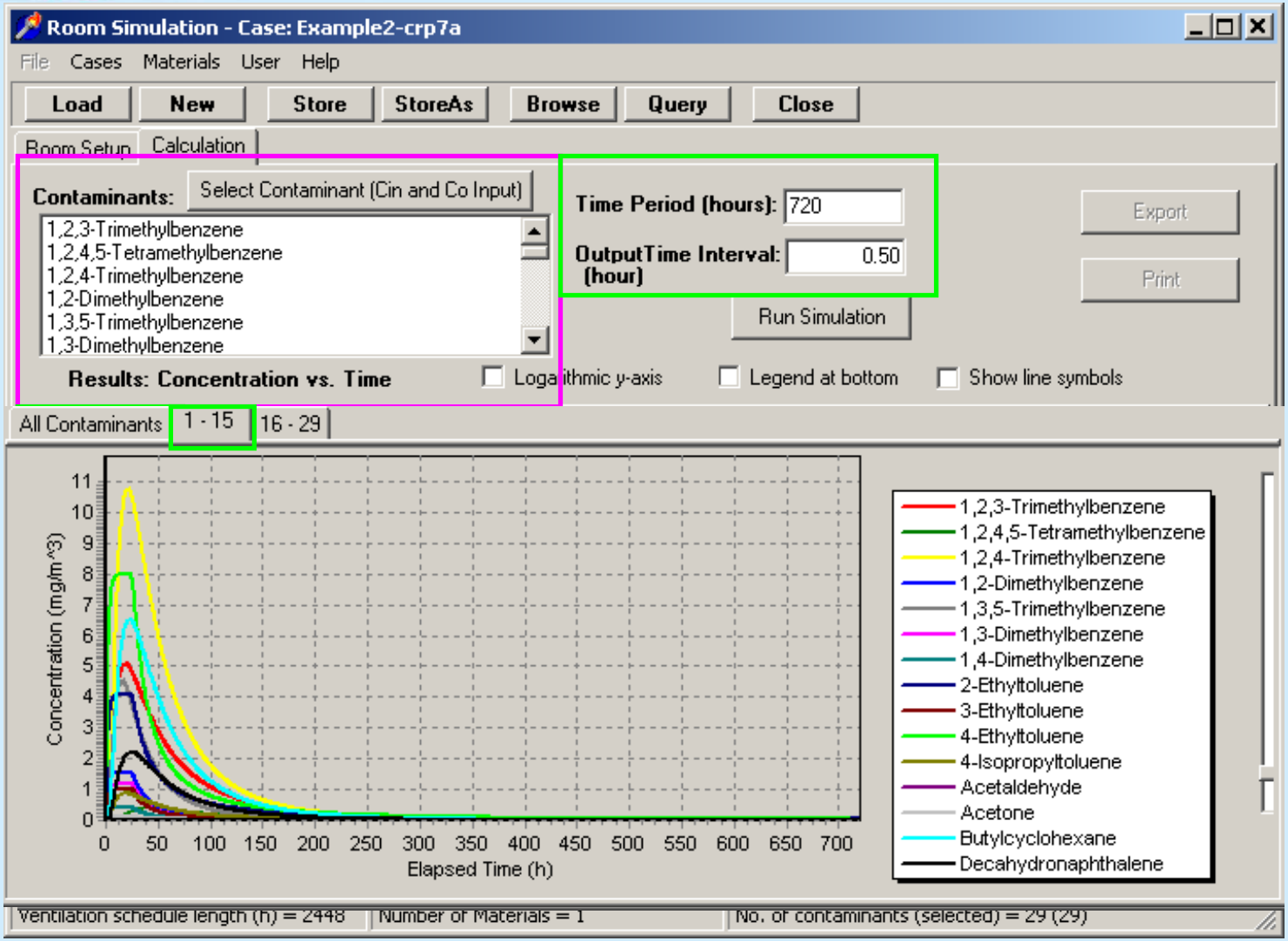
Simulation: Calculation Results



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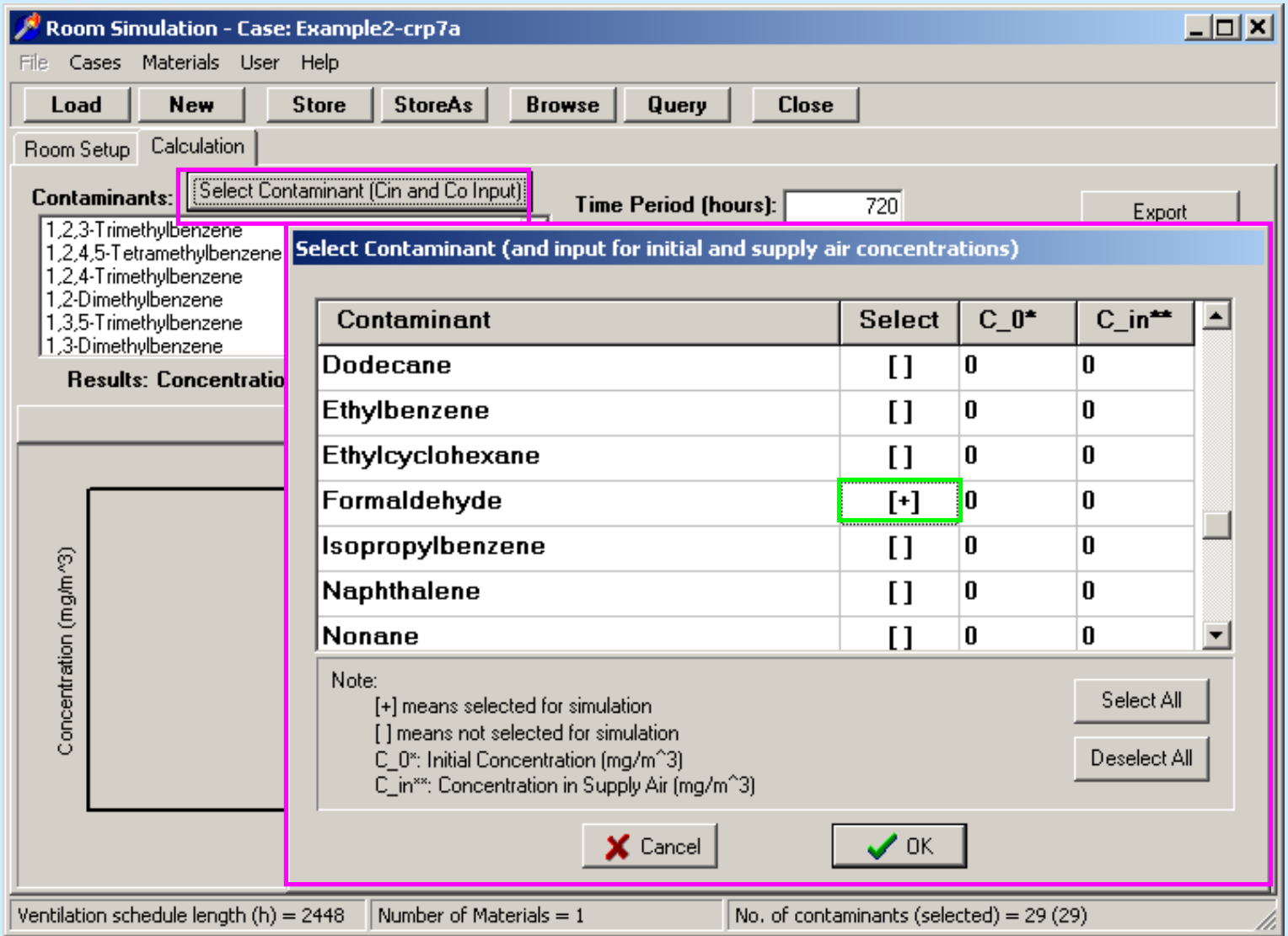
Simulation: Calculation Results



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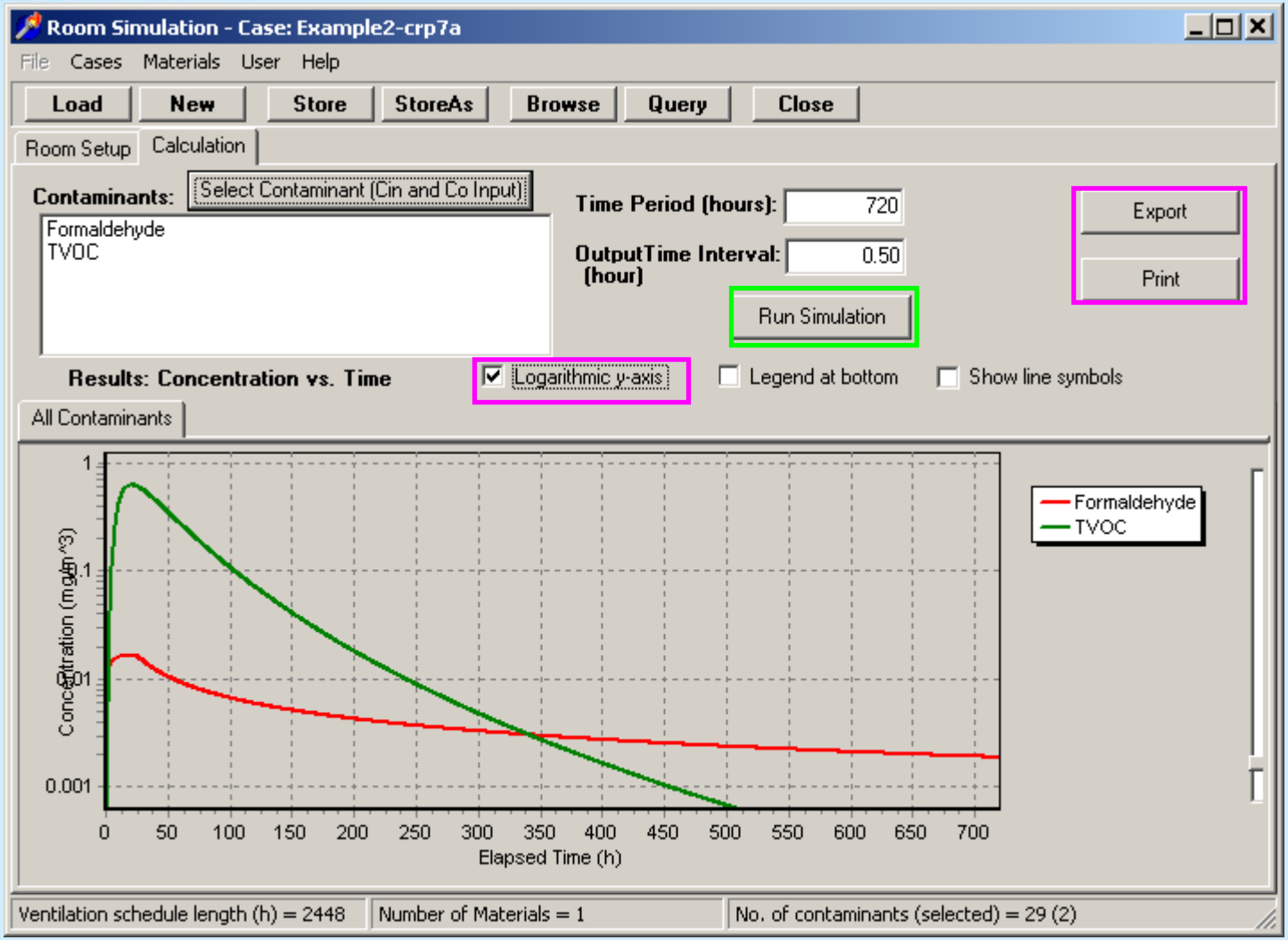
Simulation: Calculation Results



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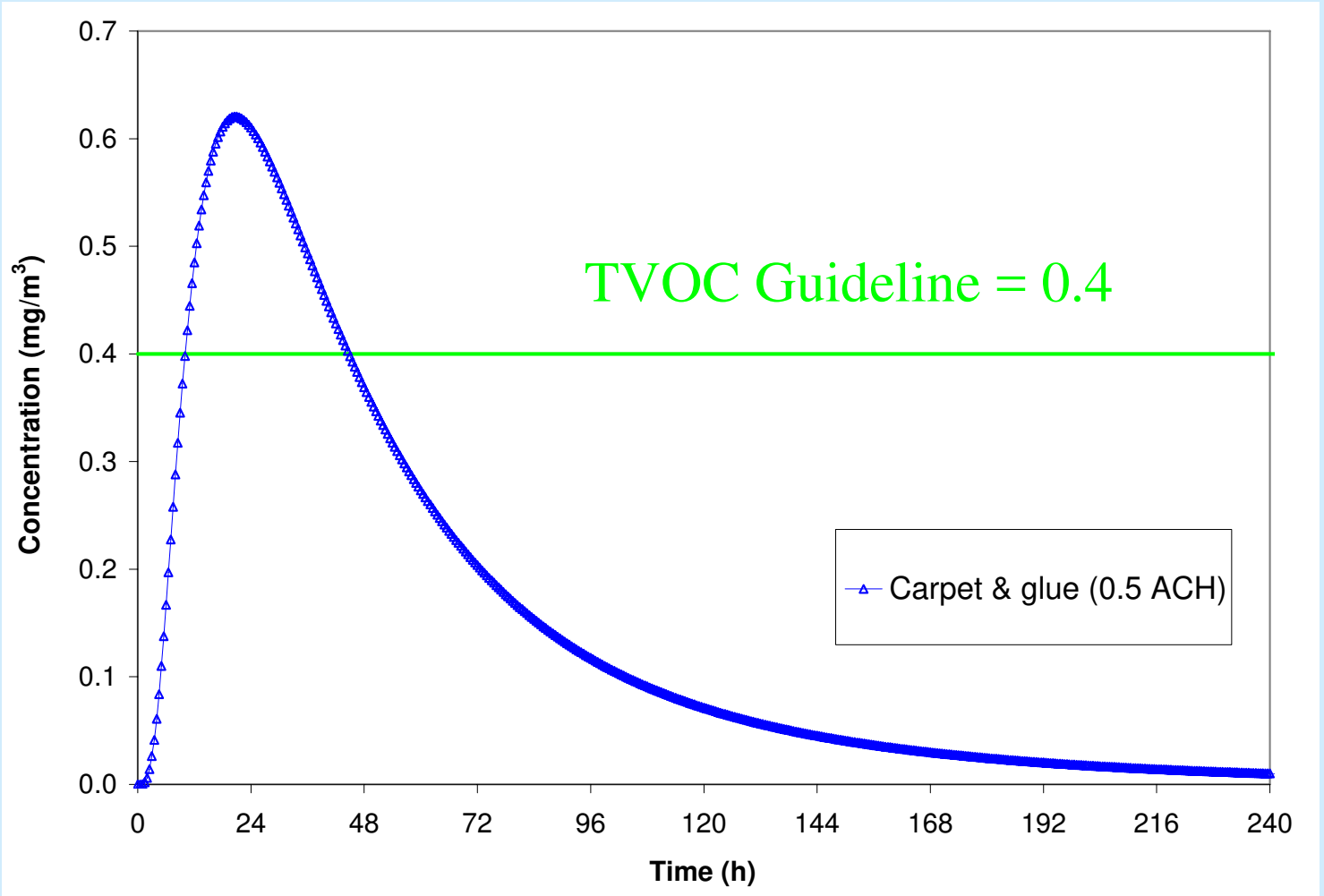
Application #3: IAQ Guideline Values (carpet & glue)



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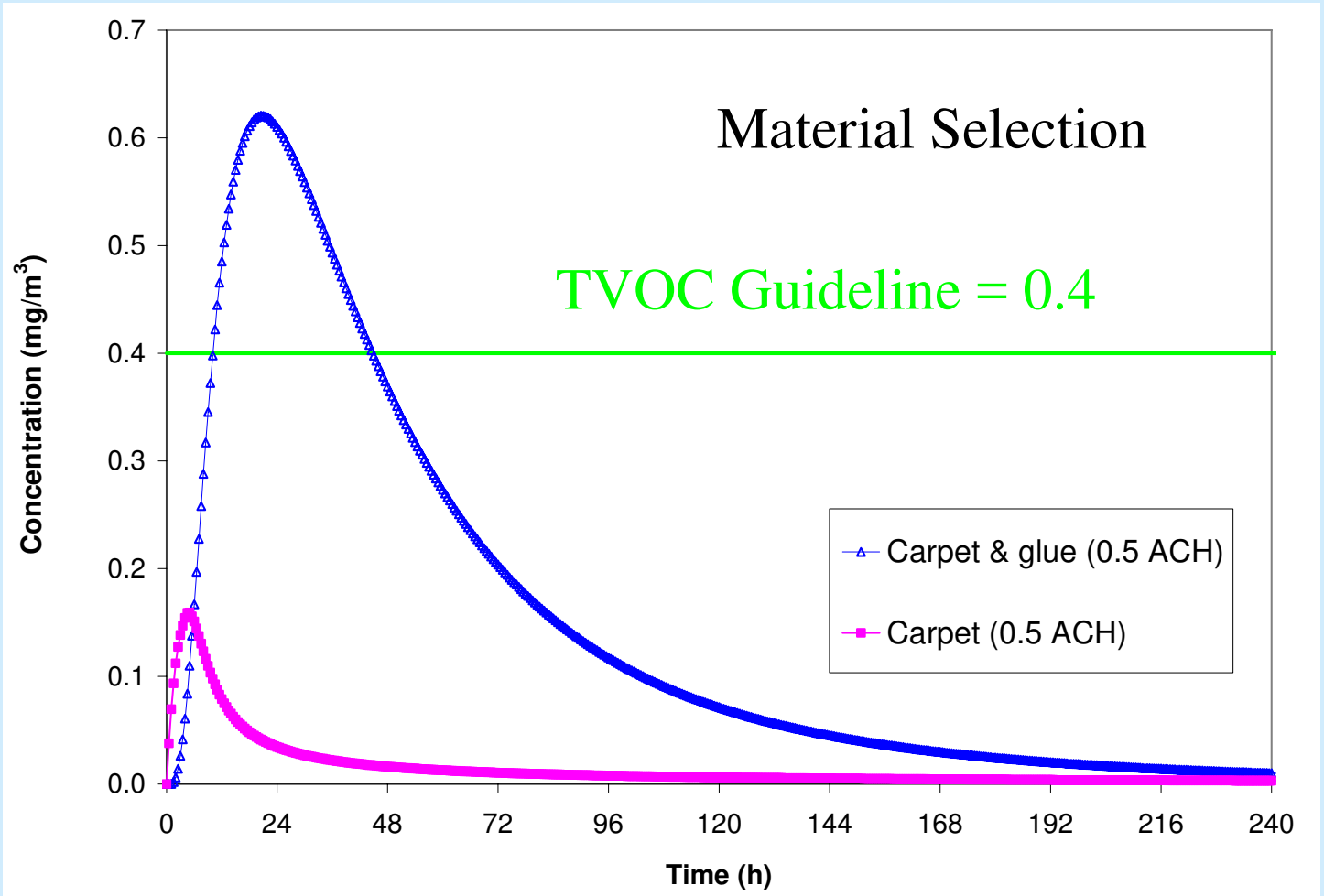
Application #3: IAQ Guideline Values (No glue)



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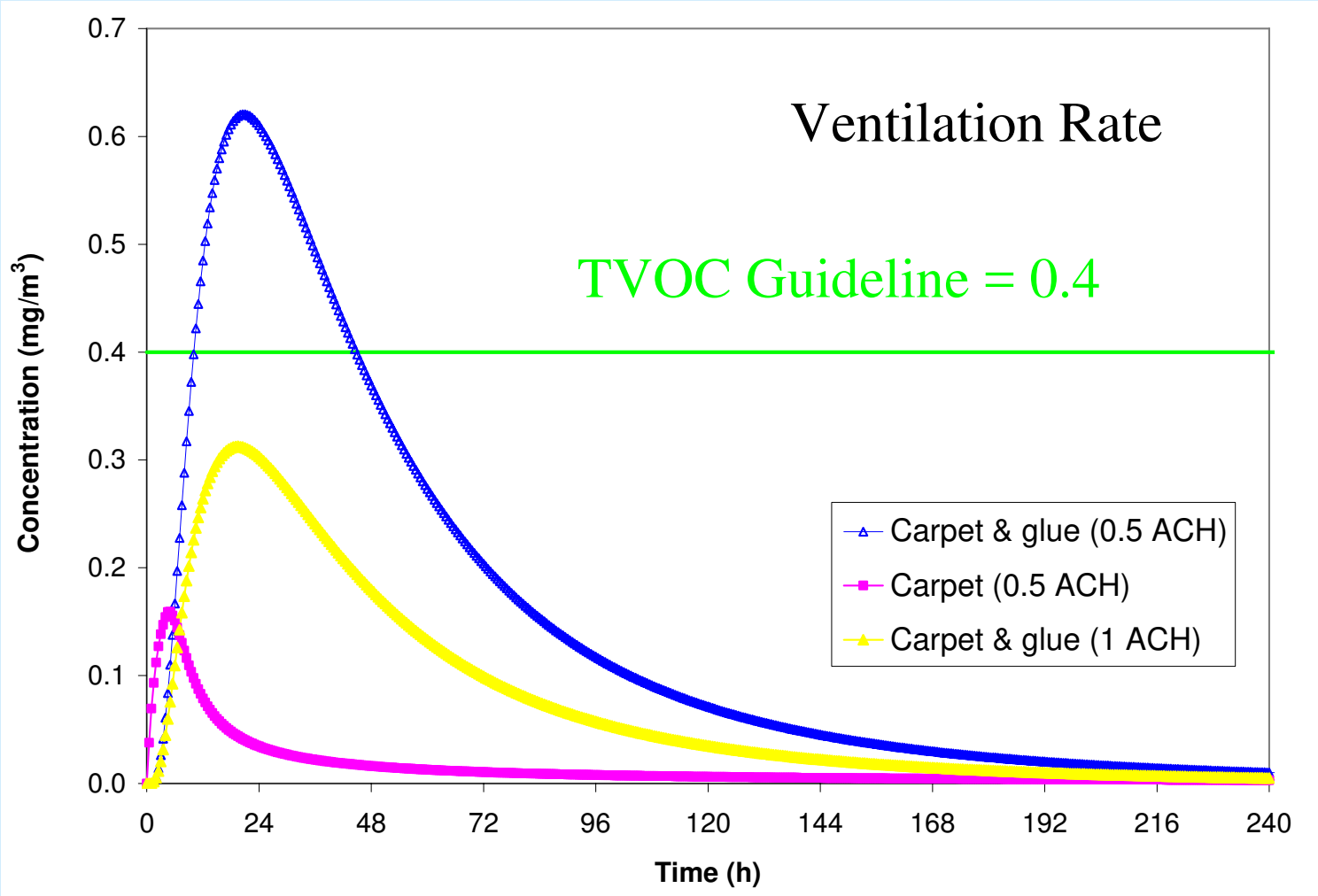
Application #3: IAQ Guideline Values (0.5 → 1 ACH)



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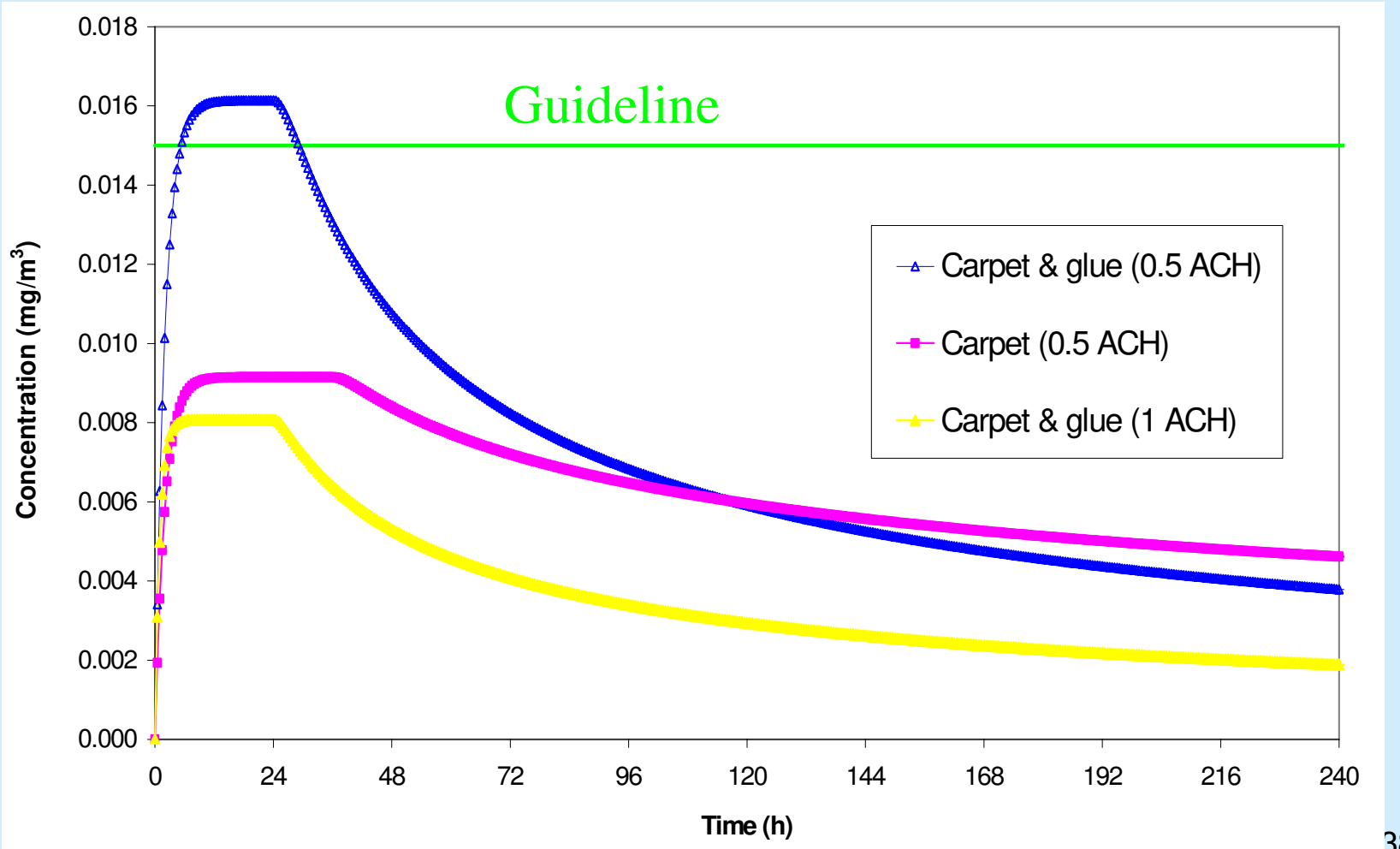
Application #3: IAQ Guideline Values (Formaldehyde)



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Limitations:

- Comprehensive, but Limited Database

  - 69 materials? (genetic description)
  - 90 VOCs? (semi-VOCs: plasticizers & flame retardants?)
  - Formaldehyde data (not measured for all)

  - Remedies: collaborations with testing companies

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Summary

- **1st tool to manage VOCs indoors**
- **69 bldg materials**
- **90 target compounds, developed by federal partners**
- **Database for emission factors**
- **Simulation of indoor air quality (concentrations)**
  - Building materials
  - Ventilation rates
  - Chemicals

- **2nd version is planned (inputs are appreciated!)**