Risk Assessments
Off-Site Workers and Residential

Dr. Cathy Fitzgerald, PE
“Risk assessment data can be like the captured spy: If you torture it long enough, it will tell you anything you want to know.”

William Ruckelshaus – Former EPA Administrator
CARB – 2005
Air Quality and Land Use Handbook

- Freeways and high volume roadways – 500 feet
- Warehouse/distribution centers – 1,000 feet
- Rail yards – 1,000 feet
- Ports – Downwind
- Refineries - Downwind
- Chrome Platers – 1,000 feet
- Dry Cleaners – 300 feet
- Gasoline Stations – 300 feet
CACPOA – 2009
Health Risk Assessments for Proposed Land Use Projects

- Type A Projects – Impact on Emission Source on Surrounding Environment
- Type B Projects – Placing Sensitive Receptors Near Emission Sources
OEHHA GUIDELINES

- Age Sensitivity Factors (ASFs)
- Third trimester to 2 years – ASF of 10
- Age 2 to 16 – ASF of 3
- Lifetime risk – from 70 years to 30 years
- Worker risk – from 40 years to 25 years
- Fraction of time spent at home – 0.73 to 0.85
UPCOMING CHANGES

• EMFAC 2014 – December 2014
• Revision of CalEEMod
• Truck traffic to and from facilities
• Siting residential near freeways
• HARP Revision – Incorporate OEHHA guidance
STEPS IN CONDUCTING AN HRA

- Source Identification
- Source Characterization
- Point, Area, or Volume Source
- Meteorology
- Model Concentrations at Receptors – AERMOD or ISCST3
- Calculate Risk and Compare to Levels of Significance
SIGNIFICANCE THRESHOLDS

**Significance Thresholds**

- Excess Cancer Risk $> 10$ in a million
- Chronic/Acute Hazard Index $> 1.0$
- SCAQMD – Incremental increase in average annual PM$_{2.5}$ concentration of $> 2.5$ ug/m$^3$

**Inappropriate**

- Compare risk as percentage of background from MATES study
- Compare risk to overall probability of cancer – 1 in 3-4 people will get cancer during lifetime
SOURCE CHARACTERIZATION

- Hours of Operation
- Point, Area, Volume Source
- Chemical Usage
- MSDS
- VOC Content
POINT SOURCE

- Emission Rate – gm/sec or lb/hr
- Stack Height
- Stack Diameter
- Stack Exit Velocity
- Stack Gas Temperature

Fueling Area
Spray Booth

PLACEWORKS
Source 2
CarMax Auto Superstore
6100 Auto Center Drive
Buena Park, CA 90621

Monday - Friday: 7:30AM - 6:00PM (service center)

Chemical and Use Rate
Gasoline Dispensing: 15,000 gallons per month
Automotive Refinishing (Spray Booth): 503.7 pounds per year
(SCAQMD 2012 Inspection Report)

- Lot area is based upon Google Earth, Version 6.1.
- 2 oz of 1.86 m and release height of 1 m are based upon California Air Pollution Control Officers Association (CAPCOA) Gasoline Service Station Industrywide Risk Assessment Guidelines (1998).
AREA SOURCE

• Emission Rate – gm/sec/m²
• Long Side of Area
• Short Side of Area
• Release Height
VOLUME SOURCE

- Emission Rate – gm/sec or lb/hr
- Release Height
- Initial Lateral Dimension – Building Length/4.3
- Initial Vertical Dimension – Building Height/2.15
Source 2  
Insurance Collision Centers  
3415 West 2nd Street  

Operation: Automotive Refinishing  
Temporal Profile: 10 6 52 0 0 0

Materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>Wt Fraction</th>
<th>Compound Emissions</th>
<th>MSDS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer</td>
<td>3.0 gal/mo</td>
<td>2.10 VOC lbs/gal</td>
<td></td>
</tr>
<tr>
<td>Basecoat/Reducer</td>
<td>5.0 gal/mo</td>
<td>5.50 VOC lbs/gal</td>
<td></td>
</tr>
<tr>
<td>Clearcoat/Reducer</td>
<td>5.0 gal/mo</td>
<td>2.10 VOC lbs/gal</td>
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</table>

Emissions: Average Monthly

<table>
<thead>
<tr>
<th>Material</th>
<th>Wt Fraction</th>
<th>Compound Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer</td>
<td>6.30 lbs/mo</td>
<td></td>
</tr>
<tr>
<td>Basecoat/Reducer</td>
<td>27.50 lbs/mo</td>
<td></td>
</tr>
<tr>
<td>Clearcoat/Reducer</td>
<td>10.50 lbs/mo</td>
<td></td>
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</table>

Total 44.300 lbs/mo  
0.172 lbs/hr

Speciation:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Wt Fraction</th>
<th>Compound Emissions</th>
<th>Adjusted Wt Fraction</th>
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</thead>
<tbody>
<tr>
<td>Primer Butyl Alcohol</td>
<td>0.23</td>
<td>1.4490</td>
<td>0.0327</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>0.001</td>
<td>0.0063</td>
<td>0.0001</td>
</tr>
<tr>
<td>Methyl Isobutyl Ketone</td>
<td>0.04</td>
<td>0.2520</td>
<td>0.0057</td>
</tr>
<tr>
<td>Toluene</td>
<td>0.10</td>
<td>0.6300</td>
<td>0.0142</td>
</tr>
<tr>
<td>Other (NOS)</td>
<td>0.63</td>
<td>3.9827</td>
<td>0.0895</td>
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<tr>
<td>Basecoat/Reducer Ethylbenzene</td>
<td>0.05</td>
<td>1.375</td>
<td>0.0310</td>
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<tr>
<td>n-Hexane</td>
<td>0.01</td>
<td>0.275</td>
<td>0.0062</td>
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<tr>
<td>Toluene</td>
<td>0.19</td>
<td>5.225</td>
<td>0.1179</td>
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<tr>
<td>1,2,4-Trimethylbenzene</td>
<td>0.01</td>
<td>0.275</td>
<td>0.0062</td>
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<tr>
<td>Other (NOS)</td>
<td>0.74</td>
<td>20.350</td>
<td>0.4594</td>
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<tr>
<td>Clearcoat/Reducer Methyl Isobutyl Ketone</td>
<td>0.02</td>
<td>0.210</td>
<td>0.0047</td>
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<tr>
<td>Toluene</td>
<td>0.10</td>
<td>1.050</td>
<td>0.0237</td>
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<tr>
<td>Xylene</td>
<td>0.07</td>
<td>0.735</td>
<td>0.0166</td>
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<tr>
<td>Other (NOS)</td>
<td>0.81</td>
<td>8.505</td>
<td>0.1920</td>
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</table>

Total 44.300  1.000
**CALCULATE PM2.5 EMISSION RATES**

**Source 2**  
Insurance Collision Centers  
3415 West 2nd Street

Operation: Automotive Refinishing

<table>
<thead>
<tr>
<th>Temporal Profile</th>
<th>10</th>
<th>6</th>
<th>52</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

**Spray Booth Specifications:**

- Transfer Efficiency: 0.65
- Control Efficiency: 0.90

**Particulate Matter Emissions:**

<table>
<thead>
<tr>
<th>Product</th>
<th>Use Rate (gal/mo)</th>
<th>Density (lbs/gal)</th>
<th>Solids Fraction</th>
<th>PM EF (lbs/mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer</td>
<td>3.0</td>
<td>8.30</td>
<td>0.24</td>
<td>0.209</td>
</tr>
<tr>
<td>Basecoat/Reducer</td>
<td>5.0</td>
<td>7.28</td>
<td>0.15</td>
<td>0.191</td>
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<tr>
<td>Clearcoat/Reducer</td>
<td>5.0</td>
<td>8.17</td>
<td>0.45</td>
<td>0.643</td>
</tr>
</tbody>
</table>

Total: 1.044 lbs/mo  

4.05E-03 lbs/hr
AERMOD MODEL

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Source Group</th>
<th>Rank</th>
<th>Peak</th>
<th>X (m)</th>
<th>Y (m)</th>
<th>ZELEV (m)</th>
<th>ZFLAG (m)</th>
<th>ZHILL (m)</th>
<th>Peak Date, Start Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNUAL</td>
<td>Group 2A</td>
<td>0.03365</td>
<td>407217.84</td>
<td>3748507.75</td>
<td>21.50</td>
<td>0.00</td>
<td>21.50</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Source Group</th>
<th>Rank</th>
<th>Peak</th>
<th>X (m)</th>
<th>Y (m)</th>
<th>ZELEV (m)</th>
<th>ZFLAG (m)</th>
<th>ZHILL (m)</th>
<th>Peak Date, Start Hour</th>
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<tbody>
<tr>
<td>ANNUAL</td>
<td>Group 2B</td>
<td>0.03203</td>
<td>407217.84</td>
<td>3748507.75</td>
<td>21.50</td>
<td>0.00</td>
<td>21.50</td>
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</tbody>
</table>
EXPOSURE PARAMETERS

RESIDENT

- 24 hours/day
- 7 days/week
- 350 days/year
- 70 year duration
- DBR – 302 l/kg-day
- 30 years
- Fraction of time at home
- ASFs for children

OFF-SITE WORKER

- 8-12 hours/day
- 5 days/week
- 245-250 days/year
- 40 year duration
- DBR – 149 l/kg-day
- 25 years
## Risk Calculations - Resident

### Concentration from AERMOD

### Table 1

<table>
<thead>
<tr>
<th>Source Number</th>
<th>Source</th>
<th>Mass LOD (μg/m³)</th>
<th>Weight Fraction</th>
<th>Concentrants</th>
<th>Carcinogenic Risk</th>
<th>Noncarcinogenic Hazards</th>
<th>Toxicological Endpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CarMax (residue dispersion) (spray booth)</td>
<td>3.2E-02 1.0E-03</td>
<td>1.0E-01</td>
<td>Benzene</td>
<td>2.9E-05 1.0E-01 9.1E-08 1.7E-08 6.0E-04 1.7E-02 5.6E-06 5.6E-06</td>
<td>5.6E-06</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.3E-04 1.0E-01</td>
<td>1.0E-01</td>
<td>Benzene</td>
<td>2.9E-05 1.0E-01 7.1E-09 1.3E-08 6.0E-04 1.7E-02 4.5E-07 4.5E-07</td>
<td>4.5E-07</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0E-01 1.0E-01</td>
<td>1.0E-01</td>
<td>Formaldehyde</td>
<td>6.0E-06 2.1E-02 1.3E-10 4.1E-12 9.0E-06 2.6E-03 4.5E-07 4.5E-07</td>
<td>4.5E-07</td>
<td></td>
</tr>
</tbody>
</table>

### Key to Toxicological Endpoints

- RESP: Respiratory System
- CNS/PNS: Central/Peripheral Nervous System
- CV/B: Cardiovascular/Blood System
- IMMUN: Immune System
- KIDN: Kidney
- REPRO: Reproductive System
- EYES: Eye irritation and/or other effects

### Hazard Indices

- Exposure Parameters
- Risk Value

**Exposure Factors used to calculate dose**

- Resp: Respiratory System
- CNS/PNS: Central/Peripheral Nervous System
- CV/B: Cardiovascular/Blood System
- IMMUN: Immune System
- KIDN: Kidney
- REPRO: Reproductive System
- EYES: Eye irritation and/or other effects

**Risk Calculation**

### 70-Year Resident Exposure Scenario

### Risk Value

- 1.0E-08
- 2.2E-06
- 6.1E-06
- 6.1E-06
- 0.0E+00
- 0.0E+00
- 0.0E+00
- 6.1E-06
- 4.5E-07

### Total

- 1.0E-08
- 2.2E-06
- 6.1E-06
- 6.1E-06
- 0.0E+00
- 0.0E+00
- 0.0E+00
- 6.1E-06
- 4.5E-07
## Table 2
**Carcinogenic Risks and Noncancer Hazards**

### 40-Year Worker Exposure Scenario

<table>
<thead>
<tr>
<th>Source Number</th>
<th>Source</th>
<th>Mass GLA (µg/m³)</th>
<th>Weight Fraction</th>
<th>Contaminant</th>
<th>Carcinogenic Risk</th>
<th>Risk Value</th>
<th>Hazard Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CanMan (canister sampling)</td>
<td>4.50E-05 1.00E-05 6.7E-04 1.02E-05</td>
<td></td>
<td>Benzene</td>
<td>2.9E-01 1.0E-01</td>
<td>3.2E-00</td>
<td>7.1E-02 7.1E-02</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.9E-09 3.1E-06</td>
<td>8.1E-06 8.1E-06</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
- **Key to Toxicological Endpoints**
  - **RESP**: Respiratory System
  - **CNS/PNS**: Central Nervous System
  - **CV/B':**: Cardiovascular/Peripheral Nervous System
  - **IMMUN**: Immune System
  - **KIDN**: Kidney
  - **REPRO**: Reproductive System
  - **EYES**: Eye irritation and/or other effects

- **Hazard Indices**
  - **RISK**: Risk Value
  - **REL**: Relative Risk
  - **RED**: Excess Relative Dose

- **Concentration from AERMOD**

- **Exposure Parameters**

- **Risk Value**

- **Hazard Indices**
CANCER BURDEN

- If Risk is > 1 in a million
- Define Zone of Impact (ZOI)
- Population within ZOI
- Calculate Cancer Burden – Population x Risk Value
- Threshold of Significance - cancer burden >0.5
SCAQMD RISK CALCULATOR

TIER 2 RISK ASSESSMENT FLOWCHART

1. Estimate Emission Rate
2. Determine Release Type
   - Point Source?
   - Volume Source?
3. Determine Release Height
   - Point Source: Height of stack
   - Volume Source: Height of Building and Floor Area
4. Determine Operating Schedule
   - ≤ 12 hours / day?
   - > 12 hours / day?
5. Identify Receptor & Distance
   - Residential
   - Worker
6. Identify Dispersion Factor (X/Q)
   - From Tables 2A, 3A, 4A, or 5A
7. Identify Meteorological Correction Factor (MET)
   - From Tables 2B, 3B, 4B, or 5B
8. Select Annual Concentration Adjustment Factor (AFann)
   - From Table 2C or 3C
9. Identify Cancer Potency (CP)
   - From Table 8A
10. Identify Multipathway Factor (MP/rw)
    - From Table 8A
11. Select Daily Breathing Rate (DBR)
    - From Table 9A
12. Select Exposure Value Factor (EVF)
    - From Table 9B
13. Calculate MICR (See Figure 3C)
    \[ MICR = CP \times Q\text{tons} \times X/Q \times AF\text{ann} \times MET \times DBR \times EVF \times 10^6 \times MP \]
TIER 2 SCREENING RISK ASSESSMENT REPORT

A/N: __________________________   Application deemed complete date: 12/07/12
Fac: __________________________

2. Tier 2 Data

<table>
<thead>
<tr>
<th>MET Factor</th>
<th>1.00</th>
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<tbody>
<tr>
<td>4 hr</td>
<td>0.89</td>
</tr>
<tr>
<td>6 or 7 hrs</td>
<td>0.73</td>
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</table>

Dispersion Factors table:

<table>
<thead>
<tr>
<th></th>
<th>For Chronic X/Q</th>
<th>For Acute X/Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dilution Factors (ug/ml)/(tons/yr)

<table>
<thead>
<tr>
<th>Receptor</th>
<th>X/Q</th>
<th>X/Qmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1.445</td>
<td>83.35</td>
</tr>
<tr>
<td>Commercial</td>
<td>8.756</td>
<td>462.84</td>
</tr>
</tbody>
</table>

Adjustment and Intake Factors

<table>
<thead>
<tr>
<th></th>
<th>AFans</th>
<th>DBR</th>
<th>EVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1</td>
<td>302</td>
<td>0.96</td>
</tr>
<tr>
<td>Worker</td>
<td>1</td>
<td>149</td>
<td>0.38</td>
</tr>
</tbody>
</table>

3. Rule 1401 Compound Data

<table>
<thead>
<tr>
<th>Code</th>
<th>Compound</th>
<th>R1 - uncontrolled (lbs/hr)</th>
<th>R2 - controlled (lbs/hr)</th>
<th>CP</th>
<th>MP MICR Resident</th>
<th>MP MIRC Worker</th>
<th>MP Chronic Resident</th>
<th>MP Chronic Worker</th>
<th>REL Chronic</th>
<th>REL Acute</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Benzene (including benzene from gasoline)</td>
<td>8.40E-05</td>
<td>8.40E-05</td>
<td>1.00E-01</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>60</td>
<td>1300</td>
</tr>
<tr>
<td>T3</td>
<td>Toluene (methyl benzene)</td>
<td>8.40E-05</td>
<td>8.40E-05</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>300</td>
<td>37000</td>
</tr>
<tr>
<td>X1</td>
<td>Xylenes (isomers and mixtures)</td>
<td>1.35E-05</td>
<td>1.35E-05</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>700</td>
<td>22000</td>
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<tr>
<td>E4</td>
<td>Ethyl benzene</td>
<td>8.10E-07</td>
<td>8.10E-07</td>
<td>8.70E-03</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2000</td>
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</table>
### 5a. MICR

\[
\text{MICR} = \frac{CP \times Q \times (X/Q) \times AFann \times MET \times DBR \times EVF \times 1E-6 \times MP}{(\text{ton/yr})} 
\]

<table>
<thead>
<tr>
<th>Compound</th>
<th>Residential</th>
<th>Commercial</th>
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</thead>
<tbody>
<tr>
<td>Benzene (including benzene from gasoline)</td>
<td>1.54E-08</td>
<td>1.82E-08</td>
</tr>
<tr>
<td>Toluene (methyl benzene)</td>
<td></td>
<td></td>
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<tr>
<td>Xylenes (isomers and mixtures)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>1.29E-11</td>
<td>1.53E-11</td>
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</table>

#### 5b. Cancer Burden

<table>
<thead>
<tr>
<th>Cancer Burden</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>X/Q for one-in-a-million:</td>
<td></td>
</tr>
<tr>
<td>Distance (meter):</td>
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</tr>
<tr>
<td>Area (km²):</td>
<td></td>
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<tr>
<td>Population:</td>
<td></td>
</tr>
<tr>
<td>Cancer Burden:</td>
<td></td>
</tr>
</tbody>
</table>
### 6. Hazard Index

HIA = \[\frac{Q(\text{lb/hr}) \times (X/Q)_{\text{max}} \times AF}{\text{Acute REL}}\]

HIC = \[\frac{Q(\text{ton/yr}) \times (X/Q) \times MET \times MP}{\text{Chronic REL}}\]

<table>
<thead>
<tr>
<th>Target Organs</th>
<th>Acute</th>
<th>Chronic</th>
<th>Acute Pass/Fail</th>
<th>Chronic Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alimentary system (liver) - AL</td>
<td></td>
<td>1.55E-08</td>
<td>Pass</td>
<td>Pass</td>
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<tr>
<td>Bones and teeth - BN</td>
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<td></td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Cardiovascular system - CV</td>
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<td></td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Developmental - DEV</td>
<td>3.10E-05</td>
<td>6.43E-05</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Endocrine system - END</td>
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<td>1.55E-08</td>
<td>Pass</td>
<td>Pass</td>
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CONTACT INFORMATION

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