July 1, 2013

Jake Hes and Scott Bourdon
University of California, Irvine
EHS
4600 Health Sciences Road
Irvine, CA 92697

Re: Integrated Nanosystems Research Facility (INRF) Fume Hood Assessment – EORM® Project No. 12.1165

Dear Mr. Hes and Mr. Bourdon:

Per University of California, Irvine (UCI)'s request, specifically Jake Hes and Alvin Samata, Environmental and Occupational Risk Management, Inc. (EORM®) conducted an assessment of the fume hoods in the Integrated Nanosystems Research Facility (INRF). The assessment was initiated due to a recent odor issue involving a mixture of hydrofluoric acid (HF) that contained acetic acid. People working in or near the clean room could smell the pungent, vinegar-like odor of acetic acid in the hallway. A separate inspection of the heating, ventilating, and air-conditioning (HVAC) system was conducted by Integral, an Environmental Engineering firm that specializes in industrial ventilation, but it was not within the scope of this assessment. Due to the odor concerns, EORM performed face velocity measurements at the fume hoods to determine if the exhaust air flow rate, in feet per minute (fpm), was adequate and met the Cal/OSHA requirements. In addition, EORM reviewed the chemicals and procedures performed in the fume hoods.

Fume Hood Assessment

Table 1

<table>
<thead>
<tr>
<th>Room #: Fume Hood ID</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
</table>
| W2332: 56542AAZ      | Face Velocity Range: 110-140 fpm  
Process: Resistor Bench | Based on MSDS information provided by UCI and the ventilation flow rate verification performed by EORM it is safe to perform processes in this fume hood according to the clean room procedures and PPE requirements. |
| W2332: TSS#86187     | Face Velocity Range: 40-50 fpm  
Process: Negative Photo Resist | Based on MSDS information and ventilation flow rate verification it is NOT safe to perform processes in this fume hood. Adjust flow settings to an average face velocity of 100 fpm with no point less than 70 fpm. Verify this requirement has been satisfied before performing operations. |
<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>MSDS Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microposit S1813 Photo Resist</td>
<td>Propylene Glycol Monomethyl Ether Acetate (71-76%)</td>
</tr>
<tr>
<td></td>
<td>Mixed Cresol Novolak Resin (10-20%)</td>
</tr>
<tr>
<td></td>
<td>Diazo Photoactive Compound (1-10%)</td>
</tr>
<tr>
<td></td>
<td>Fluoroaliphatic Polymer Esters (0.01-1%)</td>
</tr>
<tr>
<td></td>
<td>Combustible, Irritant</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>30 ppm 8 hr. TWA; 90 ppm 15 min STEL</td>
</tr>
<tr>
<td></td>
<td>NFPA: F2-H2-R0-None</td>
</tr>
<tr>
<td>AZ nLOF 2035 Photoresist</td>
<td>1-Methoxy-2-Propanol Acetate (65%)</td>
</tr>
<tr>
<td></td>
<td>Cresol Novolak Resin (28%)</td>
</tr>
<tr>
<td></td>
<td>Modified Melamine–Formaldehyde Resin (5%)</td>
</tr>
<tr>
<td></td>
<td>Phenolic Polyol (2%)</td>
</tr>
<tr>
<td></td>
<td>Irritant, Flammable</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>50 ppm 8 hr. TWA</td>
</tr>
<tr>
<td></td>
<td>NFPA: F2-H2-R0-None</td>
</tr>
</tbody>
</table>

Based on MSDS information provided by UCI and the ventilation flow rate verification performed by EORM it is safe to perform processes in this fume hood according to the clean room procedures and PPE requirements.
<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>MSDS Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AZ Developer 1:1</strong></td>
<td>Sodium Metasilicate (1%)</td>
</tr>
<tr>
<td></td>
<td>Irritant</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>NFPA: F0-H2-R0-None</td>
</tr>
<tr>
<td><strong>PMGI 101 Developer</strong></td>
<td>Tetraethyl Ammonium Hydroxide (5%)</td>
</tr>
<tr>
<td></td>
<td>Irritant</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>SCAQMD Rule 443.1 VOC’s: 0</td>
</tr>
<tr>
<td></td>
<td>NFPA: F0-H2-R0-None</td>
</tr>
<tr>
<td><strong>PG Remover</strong></td>
<td>N-Methyl Pyrrolidinone (99%)</td>
</tr>
<tr>
<td></td>
<td>SCAQMD Rule 443.1 VOC’s: 1,026 g/L</td>
</tr>
<tr>
<td></td>
<td>Not Established 8 hr. TWA</td>
</tr>
<tr>
<td><strong>SU-8 2000 Series Resist</strong></td>
<td>Epoxy Resin (3-75%)</td>
</tr>
<tr>
<td></td>
<td>Cyclopentanone (23-96%)</td>
</tr>
<tr>
<td></td>
<td>Hexafluoroantimonate Salt (0.3-5%)</td>
</tr>
<tr>
<td></td>
<td>Propylene Carbonate (0.3-5%)</td>
</tr>
<tr>
<td></td>
<td>Triarylsulfonium Salt (0.3-5%)</td>
</tr>
<tr>
<td></td>
<td>Irritant</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>VOC’s (% by wt.): 20-98% (285-960 g/L)</td>
</tr>
<tr>
<td></td>
<td>NFPA: F3-H2-R0-None</td>
</tr>
<tr>
<td><strong>SU-8 3000 Series Resist</strong></td>
<td>Cyclopentanone (20-60%)</td>
</tr>
<tr>
<td></td>
<td>Mixed Triarylsulfonium/Hexafluoroantimonate Salt (1-5%)</td>
</tr>
<tr>
<td></td>
<td>Propylene Carbonate (1-5%)</td>
</tr>
<tr>
<td></td>
<td>Epoxy Resin (35-80%)</td>
</tr>
<tr>
<td></td>
<td>Formaldehyde Polymer (1-30%)</td>
</tr>
<tr>
<td></td>
<td>Cycloaliphatic Epoxy Resin (1-30%)</td>
</tr>
<tr>
<td></td>
<td>Proprietary (&lt;8%)</td>
</tr>
<tr>
<td></td>
<td>Irritant, Toxic, Flammable</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>VOC’s (% by wt.): 22-52% (288-538 g/L)</td>
</tr>
<tr>
<td></td>
<td>NFPA: F3-H2-R0-None</td>
</tr>
<tr>
<td><strong>G Thinner</strong></td>
<td>Cyclopentanone (80-90%)</td>
</tr>
<tr>
<td></td>
<td>Propylene Glycol Monomethyl Ether (10-20%)</td>
</tr>
<tr>
<td></td>
<td>100 ppm 8 hr. TLV; 150 ppm 15 min STEL (ACGIH)</td>
</tr>
<tr>
<td></td>
<td>Irritant, Toxic, Flammable</td>
</tr>
<tr>
<td></td>
<td>Not a Carcinogen (OSHA)</td>
</tr>
<tr>
<td></td>
<td>SCAQMD Rule 443.1 VOC’s: 950 g/L</td>
</tr>
<tr>
<td></td>
<td>NFPA: F3-H2-R0-None</td>
</tr>
<tr>
<td>Chemical Name</td>
<td>MSDS Information</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| MF-319 Developer                    | Tetramethyl Ammonium Hydroxide (2.2%)  
Not a Carcinogen (OSHA)  
NFPA: F0-H3-R0-None |
| Microposit S1808 Photoresist        | Propylene Glycol Monomethyl Ether Acetate (75-80%)  
Mixed Cresol Novolak Resin (10-20%)  
Diazoo Photoactive Compound (1-10%)  
Fluoroaliphatic Polymer Esters (0.01-1%)  
Combustible, Irritant  
Not a Carcinogen (OSHA)  
30 ppm 8 hr. TWA; 90 ppm 15 min STEL (Manufacturer)  
5 ppm 8 hr. TWA (OSHA)  
NFPA: F2-H2-R0-None |
| AZ 300 MIF Developer                | Tetramethyl Ammonium Hydroxide (0-2%)  
Irritant  
Not a Carcinogen (OSHA)  
NFPA: F0-H2-R0-None |
| Microposit S1805 Photo Resist       | Propylene Glycol Monomethyl Ether Acetate (81-86%)  
Mixed Cresol Novolak Resin (10-20%)  
Diazoo Photoactive Compound (1-10%)  
Fluoroaliphatic Polymer Esters (.01-1%)  
Combustible, Irritant  
Not a Carcinogen (OSHA)  
30 ppm 8 hr. TWA; 90 ppm 15 min STEL (Manufacturer)  
5 ppm 8 hr. TWA (OSHA)  
NFPA: F2-H2-R0-None |
| Microposit SC 1827 Positive Photo Resist | Propylene Glycol Monomethyl Ether Acetate (65-76%)  
Mixed Cresol Novolak Resin (10-30%)  
Diazoo Photoactive Compound (1-10%)  
Fluoroaliphatic Polymer Esters (.01-1%)  
Combustible, Irritant  
Not a Carcinogen (OSHA)  
30 ppm 8 hr. TWA; 90 ppm 15 min STEL (Manufacturer)  
5 ppm 8 hr. TWA (OSHA)  
NFPA: F2-H2-R0-None |

**Conclusions**

No significant issues were noted during the visual fume hood inspection that would contribute to the source of odor reported in the clean room.
The fume hood face velocity data from the INRF clean room were indicative of normal fume hood conditions. Only one fume hood was below the required velocity for carcinogens and other hazardous chemicals. According to the clean room manager, this hood has a dampener that can be opened to obtain a higher face velocity.

Review of the chemicals used in these fume hoods did not present any information that was unusual or extraordinary.

**Recommendations**

Based on the results of sampling and observations described in this report, EORM recommends the following best management practices:

- Communicate the results of this survey to affected/concerned employees.
- Ensure that fume hoods have an average face velocity of 100 fpm, with no reading lower than 70 fpm, before performing procedures.
- Reinstitute the use of fume hoods in INRF for approved clean room procedures based on Table 1 of the report.
- In the event of more odors, perform an Industrial Hygiene survey to determine if TWA or STEL values are being exceeded. Odor levels may be below Cal/OSHA TWA or STEL values, but still cause nuisance odors.
- Continue to review new chemicals and procedures with lab management to ensure that ventilation and PPE requirements are being met.

Please call EORM at (949) 420-0662 with any questions you may have regarding this report.

Regards,

**Michael Palazzola**

Reviewed by:

**Steve Riedman**

Michael Palazzola
Consultant Specialist

Steve Riedman, CIH
Senior Consultant

Attachments
Attachment 1

INFR Facility Map
Attachment 2

Fume Hood Photos
Figure 1: Photo Resist Application

Figure 2: Photo Resist Application

Figure 3: Solvent List