Spray Foam Installations with Reduced Occupational Exposure

Phase 1

Dan Nelson, VP R&D - Gaco Western
• It is and shall remain the policy of the Spray Polyurethane Foam Alliance (“SPFA”), and it is the continuing responsibility of every SPFA member company, SPFA meeting or event participant, as well as SPFA staff and leadership to comply in all respects with federal and state antitrust laws. No activity or discussion at any SPFA meeting or other function may be engaged in for the purpose of bringing about any understanding or agreement among members to (1) raise, lower or stabilize prices; (2) regulate production; (3) allocate markets; (4) encourage boycotts; (5) foster unfair or deceptive trade practices; (6) assist in monopolization; or (7) in any way violate or give the appearance of violating federal or state antitrust laws.

• Any concerns or questions regarding the meaning or applicability of this policy, as well as any concerns regarding activities or discussions at SPFA meetings should be promptly brought to the attention of SPFA’s Executive Director and/or its legal counsel.
Overall Project Goals

• 3 Phase Project

• To Collect and Analyze Air Quality Data Which:
  1. Demonstrates the Chemical Exposure Reduction to Sprayers, Helpers and other Contractors During Spray Foam Installations
  2. Collect Supporting Data to Reduce Re-Entry Times
  3. Support Reconsideration of PPE for Other Trades in the Vicinity of the Installation of this Unique System.
The Project

1. **Uniquely Designed Membrane System**
   - Climate Zone Specific
   - Patent Pending

2. **Uniquely Formulated Half Pound Injection Foam**
   - Non-Emissive – as per UL GREENGUARD GOLD® gas-phase testing
   - Self Compressing

3. **Air Quality Measurements During and Following Foam Installation** (Phases 1, 2 and 3)
   - 4,4-MDI, Amine Catalysts, TCPP
   - 3rd Party Collection and Analysis

4. **Professional Data Interpretation and Professional Risk Assessment**
   - Re-Entry Times / PPE
Membranes

Further Magnification

Polypropylene Web

Polyethylene Film®
Specifically Developed New Foam

Class 1, Renewable, Open Cell Foam

- Half Pound Foam with GREengUARD GOLD® Certification for Healthy Building Interiors within the U.S. and is therefore stated by UL to be suitable for use in rooms that house Children and the Elderly
- Based on a Newly Developed Self-Compressing Foam Technology which Reduces the Pressure Exerted on the Surfaces within an Enclosed Cavity – Even When Overfilled
- Only Half Pound Foam System with No OSB (back wall) Voiding when Used as Part of the Entire System
- Field Reports are Validating Actual Yields of 18,000bf
Phase 1
- Actual Building Structures
- Contractor Applied
- No Installed Ventilation During Installation
- Data Collections During Installation
- 3rd Party Collections and Analysis
- Real World Data, Leads to Phase 2

Phase 2
- Data Based on Controlled Conditions
  - Air Exchange Rate of 1 /Hr
- 3rd Party Collections and Analysis
- Data Will Support Changes to Re-Entry Times
New System
Air Quality Research Project

Phase 3
• Statistical Study of Multiple Homes
• Data Will Support Consideration of PPE Changes for Installers and Nearby Contractors
Spray Induced
Occupational Exposure
Cross Sectional Wall Area View

Free Spray

Spray Tip

One Route Toward Worker Exposure

OSB Wall Cavity
Cross Sectional Wall Area View

Most Vapors and Aerosol Droplets Contained!
A Video Introduction to GacoProFill
These photos and video can be stock, but preferably would be taken on site.
Phase 1
Field - Air Sampling
Field Air Sampling Job Details

<table>
<thead>
<tr>
<th></th>
<th>Home #1</th>
<th>Home #2</th>
<th>Cathedral Ceiling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Type</td>
<td>GacoProFilm</td>
<td>Free Spray</td>
<td>GacoProWeb</td>
</tr>
<tr>
<td>Foam Used</td>
<td>GacoProFill</td>
<td>Conventional half-pound</td>
<td>GacoProFill</td>
</tr>
<tr>
<td>Foamed Wall Area</td>
<td>4,978 bd-ft</td>
<td>4,681 bd-ft</td>
<td>16,583 bd-ft</td>
</tr>
<tr>
<td>Wall Type (Wood Studs)</td>
<td>2x6 Vertical, OSB</td>
<td>2x6 Vertical, OSB</td>
<td>12” fill Cathedral Rafters, Lap Metal</td>
</tr>
<tr>
<td>ACH - Air Exchanges/Hour (no fans used)</td>
<td>0.070 upstairs 0.130 downstairs</td>
<td>0.400</td>
<td>0.042</td>
</tr>
</tbody>
</table>

Air Quality Methods Used
- 4,4-MDI – Collected with a dry sampler followed with analysis by LC/MS
- TCPP and amines are collected onto XAD-2, then are analyzed by GC/NPD
Industrial Hygienist – Ready to Start

Helper – Being Outfitted with Air Sampling Equipment
Polyethylene Film

Side by Side Homes

Before Installation

After Installation

Storage Shed

Before Installation

After Installation

Polypropylene Web
TRIMMING = LABOR AND WASTE
No Trimming Gives a 15-20% Yield Increase

NO TRIMMING
LESS LABOR
NO MESS
NO DUST EXPOSURE
Overspray on Face Shields

FreeSpray

FreeSpray - Helper

GPFilm

GPFilm - Helper

Peeloff #1

Peeloff #2

Peeloff #5

Peeloff #6

1mm

Poly Web
Occupational Foam Chemical Exposure Limits:

- **BDMAEE** Amine - ACGIH TLV-TWA 0.05ppm
  (continuous 8 hr time-weighted average exposure value)

- **TCPP** – none

- **4,4-MDI** – OSHA Permissible 0.020ppm
  (ceiling value)

- **4,4-MDI** – ACGIH TLV-TWA 0.005ppm
  (continuous 8 hr time-weighted average exposure value)
Air Measurement

A. Conventional Free Spray
   1. Sprayer
   2. Helper

B. GacoProFilm
   3. Sprayer
   4. Helper

C. GacoProWeb
   5. Sprayer
   6. Helper

Chemical Targets:
1. 4,4-MDI,
2. TCPP,
3. Amines
The Results
COMPARATIVE RESULTS

Air Quality Analysis Data (ppm)

KEY:
GPF = GacoProFill Foam
Web = GacoProWeb Membrane
Sprayer = Installer
Film = GacoProFilm Membrane
Conv = Conventional Spray-Foam

BDMAEE - ACGIH TLY - TWA
4,4-MDI – OSHA Ceiling

TOTAL Amines | 4,4-MDI | TCPP
### Specific Results – Amines*

<table>
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<tr>
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<th>ProFill Reduction vs Conventional Foam Spray</th>
<th>Helper</th>
<th>ProFill Reduction vs Conventional Foam Spray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Free Spray**</td>
<td>0.41 ppm</td>
<td></td>
<td>0.06 ppm</td>
<td></td>
</tr>
<tr>
<td>Conventional Free Spray***</td>
<td>0.14 ppm</td>
<td></td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>GacoProFilm</td>
<td>ND</td>
<td>-100%</td>
<td>ND</td>
<td>100%</td>
</tr>
<tr>
<td>GacoProWeb</td>
<td>ND</td>
<td>-100%</td>
<td>ND</td>
<td>100%</td>
</tr>
</tbody>
</table>

ND = Below Detection Limits

* One amine catalyst used in the conventional foam was proprietary and therefore was not included in the air sampling study.

** Reactive Amine

*** BDMAEE

BDMAEE Amine - ACGIH TLV-TWA - 0.05ppm - (continuous 8 hr time-weighted average exposure value)
Specific Results - TCPP

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<tbody>
<tr>
<td>Conventional Free Spray</td>
<td>0.070 ppm</td>
<td></td>
<td>0.030 ppm</td>
<td></td>
</tr>
<tr>
<td>GacoProFilm</td>
<td>0.011 ppm</td>
<td>-84%</td>
<td>0.015 ppm</td>
<td>-50%</td>
</tr>
<tr>
<td>GacoProWeb</td>
<td>0.013 ppm</td>
<td>-81%</td>
<td>0.005 ppm</td>
<td>-83%</td>
</tr>
</tbody>
</table>

There are no exposure limits established for TCPP
## Specific Results – 4,4-MDI

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</thead>
<tbody>
<tr>
<td>Conventional Free Spray</td>
<td>0.3000 ppm</td>
<td></td>
<td>0.0300 ppm</td>
<td></td>
</tr>
<tr>
<td>GacoProFilm</td>
<td>0.0076 ppm</td>
<td>-97%</td>
<td>0.0008 ppm</td>
<td>-73%</td>
</tr>
<tr>
<td>GacoProWeb</td>
<td>0.0010 ppm</td>
<td>-99%</td>
<td>0.0003 ppm</td>
<td>-99%</td>
</tr>
</tbody>
</table>

OSHA Permissible – 0.020ppm – (ceiling value),
ACGIH TLV-TWA – 0.005ppm – (continuous 8 hr time weighted average)
Conclusions

• This field-study demonstrates that the GacoProFill system dramatically reduces occupational chemical levels in the vicinity of the foam installation.

• Resulting occupational exposure amine levels were below detection capabilities

• GacoProFill occupational exposure 4,4-MDI levels were below OSHA permissible, even during the foam installation process. In 3 of 4 cases it was also below the ACGIH-TLY-TWA for 8hr exposure.

• This data suggests that alternative and available open cell installation methods exist that create a safer worker environment for the installation of polyurethane foam – especially regarding potential isocyanate exposure.
Next Steps – Phases 2 and 3

• We Have Now Completed a Similar Study in a Controlled Climate Chamber
  • 1ACH – as a worst case scenario
  • Measured air quality for 48 hrs after foam installation
  • Determine Re-Entry Time Reduction Potential

• We Now Plan to Repeat a Similar Study in Multiple Home Installations
  • Include replicates for statistical significance
  • Determine PPE Reduction Potential based on Professional Risk Analysis
Acknowledgements

• Rick Wood – Industrial Hygiene Consultant
  • Project Organization
  • Air Measurements
  • Analysis Oversight

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  • Guidance
  • Support

• Mark Fortney – Building Science Manager, Gaco Western
  • Project Management
  • Oversight
  • Sprayer Helper 😊

• Various Additional Members of the Gaco Western Spray-Foam Sales and Technical Teams
Thank You!