

## Foam remediation

- Diagnosing foam problems
- Selecting the right approach
- The remediation process

### Diagnosing foam problems

IHAA IAQ lab testing – at the site

- Test the site, not the material. Sample lab tests don't tell you the concentrations at the site or what other vapors may be causing health issues associated with the foam.
- Most labs can only test for MDI; you have to know what the proprietary formulations contain to test for more.
- This type of testing would probably cost around \$3,000 (residential).

### Diagnosing foam problems

Odor and harmful out-gassing notes

- We can smell things that most field monitoring systems can't detect (except dogs)
- Testing is expensive, but smelling is cheap
- Heat accelerates outgassing
- Bag/smell tests can verify if an isolation strategy could be effective

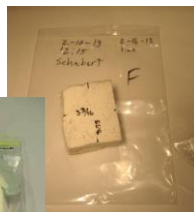
### Diagnosing foam problems

Odor and harmful out-gassing

- Is the problem going away on its own as the foam cures and ventilation changes the air?
  - Bag and heat samples, do smell tests
- Can the problem be solved if the foam is isolated?
  - Isolate test area, bag the area, do smell tests
- Can the problem be solved if the area is ventilated?
  - Bag a test area, ventilate it, do smell tests
  - Identify rate of ventilation that handles rate of odor release

### Diagnosing foam problems

Sample bags – for hot box odor tests



160F Test is designed to match hot roofs

### Diagnosing foam problems

Odor and harmful out-gassing - Does removal solve the problem? Sequence of tests...

1. Remove the foam in a test area, bag the area, do smell tests
2. Remove the foam in a test area, clean and neutralize the surfaces, bag the area, do smell tests
3. Remove the foam in a test area, isolate the test area, bag the area, do smell tests
4. Remove the foam in a test area, clean and neutralize the surfaces, isolate the area, bag the area, do smell tests

## Diagnosing foam problems

Odor and harmful out-gassing - Does removal solve the problem? Sequence of tests...from low-cost to most costly.

5. What happens if you ventilate the test area?
6. What happens if you add ventilation to each of the first four tests?

## Diagnosing foam problems

### Odor test bag areas



1. Just remove the foam
2. Remove and clean
3. Remove and encapsulate
4. Remove, clean, encapsulate



5. Just remove and add local ventilation to the test area
6. Remove and add local ventilation to the other three test areas (numbers 2 – 4)

## Diagnosing foam problems

### Diagnostic conclusions – foam quality

- Classify the foam
  - Class I: Is the foam completely reacted and cured?
  - Class II: Has it been determined that the foam is not completely reacted and cured?
  - Class III: Has the foam been damaged by an external factor such as a fire, flood, or growth of mold or mildew

## Diagnosing foam problems

Industry terms for foam qualities with respect to removal requirements



*Spray Polyurethane Foam: Guidance for the Removal and Disposal of SPF Insulation and Roofing*

Table 1 provides examples for types of SPF removal jobs that may fall into each category. Each removal is unique and an expert onsite makes the determination for the specific removal and remediation steps to follow.

SPF Condition	Description	Examples and causes
Category I	Fully cured SPF	<ul style="list-style-type: none"> <li>Renovation or demolition of building</li> <li>Improper SPF type for application</li> <li>Trimming and cutting (after the cure time recommended by the manufacturer)</li> <li>Poor surface finish or slope (roofing)</li> <li>Mechanically-damaged SPF</li> <li>Re-roofing</li> </ul>
Category II	Partially-cured SPF	<ul style="list-style-type: none"> <li>Cutting and trimming (before the cure time recommended by the manufacturer)</li> <li>Defective SPF (shrinking, cracking, scorched)</li> <li>Improperly mixed or off-ratio</li> </ul>
Category III	Severely damaged SPF	<ul style="list-style-type: none"> <li>Fire</li> <li>Flood</li> <li>Mold and mildew</li> </ul>

See ACC/SFC: Spray Polyurethane Foam: Guidance for the Removal and Disposal of SPF Insulation and Roofing, 2014

## Diagnosing foam problems

Industry terms for foam qualities with respect to removal requirements



**Category I** SPFs are completely reacted and cured. As stated by the EPA, after SPF is applied and cured, it is considered to be relatively inert.<sup>1</sup> Although Category I SPFs may present a respirable dust hazard during removal, these SPFs are considered to be chemically inert and present no chemical hazard for those removing and handling the material. Many SPF manufacturers provide Safety Data Sheets for reacted SPF products.

<sup>1</sup>[http://www.epa.gov/dfe/projects/spf/exposure\\_potential.html](http://www.epa.gov/dfe/projects/spf/exposure_potential.html)

## Diagnosing foam problems

Industry terms for foam qualities with respect to removal requirements



**Category II** SPFs are those that have been determined not to have completely reacted and cured. Incompletely reacted SPF could be due to factors such as improperly mixed and off-ratio application. SPF that has not been allowed to cure for the amount of time recommended by the manufacturer would generally be included in Category II SPFs. Category II SPFs may not be chemically inert and could present a chemical hazard for those removing and handling the material.

See ACC/SFC: Spray Polyurethane Foam: Guidance for the Removal and Disposal of SPF Insulation and Roofing, 2014

### Diagnosing foam problems



Industry terms for foam qualities with respect to removal requirements

Category III SPFs are Category I SPF (fully reacted SPF) that have been damaged by an external factor such as a fire, flood, or growth of mold or mildew.

NOTE 1: It is beyond the scope of this document to determine the condition and the category of the SPF. Determining the precise condition of a SPF is often product-dependent and may require examination or testing by a representative from the SPF manufacturer or expert consultants.

See ACC/SFC: Spray Polyurethane Foam: Guidance for the Removal and Disposal of SPF Insulation and Roofing, 2014

### Diagnosing foam problems

#### Diagnostic conclusions – foam quality

- Identify the foam remediation needs
  - Class I: The foam does not require remediation, however, the installation may need repairs to achieve the intended performance
  - Class II: Requires remediation – type/method to be determined
  - Class III: Requires remediation – remove and replace

### Diagnosing foam problems

Can the foam application be repaired (Class I or Class II)?

- Good quality (Class I) or foam of marginal or mixed quality (Class II) – depends how fully the chemicals are reacted and cured?
  - Examples: Good foam delaminated from the substrate, substrate was wet, all but the first layer is good foam.
- Can non-quality functional defects (Class I) be repaired with other materials
  - Example: Thermal shock material can be salvaged if on ratio, over-thick pass material can be salvaged if not scorched or out-gassing.

### Diagnosing foam problems

Can the application be repaired?

- If yes, how do you know if a problem will re-occur?
  - Treat it as if it will
  - This usually applies to dimensional stability foam problems
  - Relieve stresses before remediating
  - Remove damaged or contaminated bonding surfaces before making repairs
- If no, are there alternative solutions that cost less than removal?

### Diagnosing foam problems

Should the application be isolated instead of repaired?

- Due to impossible or extremely difficult access
- Because the cost of repairs is too high
- If so, which methods are effective?
  - Coatings and barriers
  - Local ventilation
  - General ventilation

### Diagnosing foam problems

- Does the foam need to be removed?
  - Are there un-reacted (Class II) chemicals?
  - Is the material still out-gassing?
- If there are no un-reacted chemicals:
  - Is the foam dimensionally stable and/or can it be stabilized?
  - Is the bond likely to break over time?
  - Can the defects be repaired?

Some foam installations are of good quality, but Owners decide to remove it anyway



### Diagnosing foam problems

Has the foam really failed?

- If no, ... move on to other solutions
- If yes, ... proceed to remediation

### The remediation process

Selecting the right remediation approach based on:

- Risk assessments
  - Health problems trump all
  - Sometimes health risks dictate removal
- If health is not at risk, a cost-benefit analysis of the remediation options available
  - Function and performance follow health risks

### The remediation process

There are three basic remediation approaches

- Repair and stabilize
- Isolate
- Remove and replace
- Combinations of these (is this a fourth type?)

### The remediation process

Repair and stabilize



### The remediation process

Repair and stabilize



## The remediation process

### Repair and stabilize

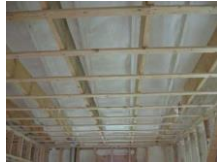


## The remediation process

### Repair and stabilize

- Repairs can include isolation or remove and replace strategies in limited areas.
  - Closed-cell foam shrinkage in limited areas due to slightly off-ratio events
    - Drum run-out events
    - Heating system events
    - Mixer restriction
    - Brain failure
  - Localized delamination due to substrate compatibility

### Short-term off-ratio event = limited remediation



### Short-term off-ratio event



Drum run-out event



## What are the causes of foam problems?

### A roof "repair and stabilize" project



Photo DSCN1993.jpeg

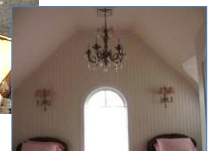


Photo DSCN2003.jpeg

Pictures of cracks along rafters in the House attics. The one on the right has been temporarily stuffed with batt insulation until the remediation work begins.

## The remediation process

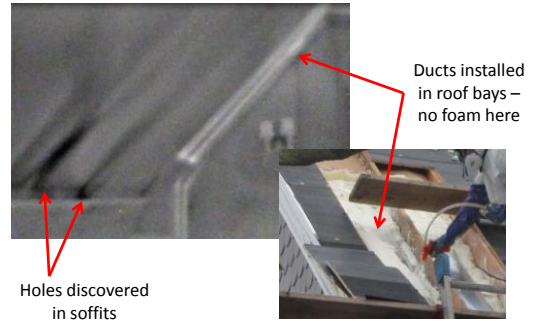
### A roof "repair and stabilize" project



### The remediation process



### The remediation process



### North side soffit areas



Holes in framing and missing foam sealant discovered in soffits

0.54 CFM50 / sf before air sealing

0.19 CFM50 / sf after air sealing

### The remediation process

#### Isolation alone

- Clean/prepare the foam as required for the encapsulation product/method
- Encapsulate the foam and/or residue
- Ventilation (short and long term) can be a means of isolating vapors from the occupied space. It may dilute the vapors to a safe level, but this is not an isolation strategy – either strategy requires equipment and uses energy

### The remediation process

#### Isolation alone

- Encapsulate the foam and/or residue with barriers or coatings that will limit vapor release to the degree that it can be removed by the normal ventilation
  - When buying vapor barrier coatings (paints), most distributors, and some manufacturers, don't know if the material is a vapor barrier or what its perm rating is. Target >1.0 as a maximum perm rate. You will have to monitor outgassing to verify that this is enough.
  - Must be compatible with the foam and the substrate
  - BIN and other shellac-based products are not vapor barriers – they all withdrew this claim

### The remediation process

#### Remove and replace (Category I SPFs - if no un-reacted chemicals are present)

- Mechanically remove the material - avoid damage to mechanical systems (there are chemical removers)
- Disposal
- Perform adhesion tests on the substrate before installing new foam of good quality to verify that the substrate does not have any residue that will affect bonding

See ACC/SFC: Spray Polyurethane Foam: Guidance for the Removal and Disposal of SPF Insulation and Roofing



### Mixing and matching products

Changing over on the fly can involve at least 40#, or 20 cu. Ft., of finished product. Both products are contaminated during the change over.



### Infrared locates off-ratio material



### Shower inside of the wall



### Adhesion test required?



### Pattern analysis discovers off-ratio material



### The remediation process

Remove and replace (Category II SPF's - if un-reacted chemicals are present)

- Mechanically remove the material - avoid damage to mechanical systems (there are chemical removers)
- Clean the surfaces?
- Neutralize the substrate material?
- Isolate the substrate (coatings, barriers, short-term or permanent ventilation)?
- Disposal

See ACC/SFC: Spray Polyurethane Foam: Guidance for the Removal and Disposal of SPF Insulation and Roofing

## The remediation process - removal

Mechanically  
remove the material  
- avoid damage to  
mechanical systems

Tools of the removal  
trade



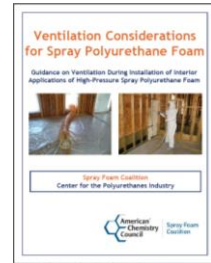
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## The most important tools are:

If there are Class II materials, use the SFC protocols for isolating and ventilating during a spray foam installation

- Signage
- Enclosure systems
- Blowers and fans
- AQ monitoring system

Ventilation Considerations for Spray Polyurethane Foam, 2013, ACC/Center for the Polyurethanes Industry



## Cause – Off-ratio foam

A floor “remove and replace” project



## Data collection

The first attempt



## Off ratio - fluctuations

- Layers of A-rich, good quality, and B-rich foam



## Off ratio - fluctuations

The second attempt

Layers of A-rich, good quality, and B-rich foam





## Off ratio - fluctuations



## The remediation process - removal



Removal was required as this was a Type II problem



## Off ratio - fluctuations

Layers of A-rich, good quality, and B-rich foam



## The remediation process - removal



Class II materials,  
but outside



Flat bar and a  
hammer worked the  
best



## The remediation process - removal

Three days for two men – approx. 120 sq.  
ft. No wires cut, one water leak found



After removal



After replacement



Cause – Off-ratio foam

Basement and  
attic “removal”  
project



The remediation process - removal

Removal was required as  
this was a Type II problem



The remediation process - removal

Site protection



The remediation process - removal

Air quality management



### The remediation process - removal

#### Personal protection



### The remediation process - removal

#### Difficult access



### The remediation process - removal

#### In progress



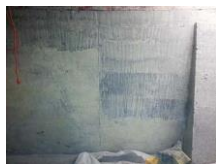
### The remediation process - removal

#### The results



### The remediation process - removal

#### The results



### The remediation process - removal

#### Disposal



### Remediation testimony

"Yes it was incredibly difficult to get the foam out (and the *unreacted* foam chemicals that have leached into the wood is impossible to remove). The remediation crew was here for more than six weeks on and off. A huge time commitment. When they were done, Annie and I put in at least one hundred additional man hours continuing and finishing off the removal, just brutal.

After we do the repainting, we still have the heat exchange ventilator to install and finally, we need to insulate, once again."

### The remediation process – removal

- Clearly, mechanical removal methods are difficult for large volumes of foam, but necessary to preserve mechanical systems.

### The remediation process – removal next steps

- Cleaning works for residue in some cases, but coatings, barriers, and short-term ventilation may be required to restore safe air quality given the complexity of the substrates involved.
- Neutralizing agents can work for some chemicals - See the product's MSDS/GHS for cleanup of chemical spills.

### The remediation process

#### Two ventilation strategies

- General ventilation – whole house exhaust vent, centralized HRV system, etc.
- Local ventilation – depressurize attics, crawlspaces, structural cavities to the outdoors. Similar to a radon remediation system.

### Diagnosing foam problems



How can you add local ventilation to this project? Think radon remediation.

1. Make sure the bays are all connected
2. Sheath the underside of the floor joists
3. Depressurize the floor cavity with a small-flow Fantec fan through the rim joist to the outside

### The remediation process

#### What are the replacement options?

- New, good quality foam
- Alternative comparable performance systems (is this always possible, reasonably?)
  1. Stone foundations?
  2. Attic slopes with small framing?
  3. Is rigid foam board cut-and-fit an alternative?
  4. Are higher cost alternatives the responsibility of the party who is at fault?



### Recommendations

General guidelines for making remediation decisions

- Determine the cause of the problem before implementing a remediation strategy
- If this is not a health issue, only target the original function and performance goals in the remediation unless upgrades are authorized
- Plan the remediation work so it will be a durable (life of the building) solution

### Recommendations

General guidelines for the remediation work

- Perform the appropriate IAQ management and personal protection during remediation, including CAZ management
- Require a rigorous quality assurance program for all three types of remediation
- Require full documentation of the conditions & processing (repairs, removal/replacement)

### Recommendations

If there are Class II materials, use LEED protocols for ductwork and protection of adjoining spaces



What's wrong with this picture?

### Recommendations

Guidelines for after the remediation work

- Follow and verify CAZ safety requirements
- Implement full-time, low-level exhaust and/or HRV ventilation as appropriate to meet minimum ventilation standards
- When possible, require long-term monitoring (IAQ, Blower door performance, fuel use, comfort)

### Quiz questions:

- Do all projects with foam problems require the foam to be removed and replaced?
- Do all symptoms of foam problems indicate processing and installation defects?
- Does all problem foam have to be replaced with the same type/brand of foam?
- Is it possible to ensure that foam that is cracking will not shrink again after the work is remediated?
- Can the substrate be a source of air quality concerns even after problem foam has been removed?
- Do all foam problems require the same level of personal and site protection?
- Does air quality testing work for foam installations?