

# Nauset Environmental Services, Inc.

an Air Quality Company

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26 January 2013

NES Job #3-1392  
Report No. NES/IAQ-13/1471

June Walsh  
P.O. Box 127  
Truro, MA #####-0127

Re: Mold/moisture inspection + Scope of Work  
for 109 Pinewood Road (Truro)

Dear Ms. Walsh:

Nauset Environmental Services, Inc. (NES) is pleased to submit this letter report on the investigation of mold/moisture conditions at 109 Pinewood Road. Following initial verbal authorization, NES sent William M. Vaughan, PhD, QEP & CIEC to the property on 23 January to inspect your home for residual mold/moisture conditions following report of visible old growth (VMG) by an insurance assessor.

**BACKGROUND:** During a routine inspection, an insurance assessor commented the VMG observed on “the first floor ceilings” and “throughout the attic” in a letter issued by the Underwriting Department of the Massachusetts Property Insurance Underwriting Program (9 January 2013). NES was authorized to carry out a mold/moisture inspection of the house to document mold problem areas and their associated causes. Eventually NES was asked to develop a SOW to address those residual mold/moisture issues needing professional attention.

**EXECUTIVE SUMMARY** The results from this inspection confirmed the presence of isolated visible mold growth (VMG) referred to as **Condition 3 mold contamination** on the first floor and condensation mold growth (CMG) in the grain of the roof sheathing, primarily on the north side to the attic.

On the first floor that was also widespread “ghosting” or shadowing discoloration opined to be due to soot deposits from the kerosene-fired wall-mounted heating system that have settled on cooler surfaces in the house.

A Scope of Work is provided to remediate the mold and soot- impacted materials.

**ON SITE ACTIVITIES** – Dr. Vaughan arrived at 109 Pinewood Road on 23 January about 1:30 pm. June Walsh met Dr. Vaughan at the house and was present during this inspection and reported on events that occurred during the earlier insurance-related inspection.

Dr. Vaughan used a Tramex “Moisture Encounter Plus” non-penetrating moisture meter (MM) to assess the relative dampness of various surfaces to a depth of just over an inch. [This MM is compared to a Tramex “test box” regularly to ensure proper operation.] He used a calibrated Extech Hygro-Thermometer Pen (Model 445580) to measure temperature and relative humidity. Photographs during

P.O. Box 1385  
East Orleans, MA 02643

508/247-9167 [800/931-1151]  
FAX: 508/255-0738

the inspection are found in Attachment A.

**OBSERVATIONS:** Observations at 109 Pinewood Road are provided below. [NOTE: Directions left-right and front-back, are referenced to viewing the house from the street.]

### General

- The outdoor conditions were cold (T=18F) and sunny with light winds.
- There was NO noticeable moldy odor, noted on entering the basement. [Moldy odors come from *currently active* “microbial volatile organic compounds (MVOCs)” that are released from active colonies digesting the organic matter on which they are growing.]
- The house is heated by a single wall-mounted heater (Monitor brand) that is installed in the north wall of the living room and is kerosene-fired (see photo). The electric heating system has been partially removed and, according to Ms. Walsh, is not really used.

### Exterior

- The rear roof was snow-covered with obvious vents for the bathroom shower, the clothes dryer and the stove (see photos). [See further discussion and photos from inside the attic below.]

### Main floor

#### KITCHEN

- There were linear hazy areas on the kitchen ceiling and isolated, obvious areas of VMG near recessed light fixtures (see photos).

#### BATHROOM

- There was isolated, limited VMG around the shower exhaust/light fixture and the light fixture over the sink (see photos).
- The sheet flooring was peeling up next to the tub/shower. Moisture meter readings indicated acceptable dry conditions around the floor and adjacent to the toilet pedestal but elevated moisture near the foot of the tub where it read 28% moisture in wood (MW) (see photo), probably associated with water seeping around the door seal. All other readings were near 15% MW.
- While there is an exhaust fan over the shower, its timer switch does not appear to function to control the exhaust automatically.

#### LIVING ROOM

- There was a linear pattern of hazy discoloration on the ceiling and walls as well as discoloration on the walls where drywall nails were located (see photos). This pattern is identical to that for soot deposition on cooler, less insulated surfaces. Since Ms. Walsh reports NO burning of jar candles and rare use of stick candles during more “formal” dinners in the dining room, the most likely source of the observed hazing/ghosting is soot from the Monitor heater. The ceiling-wall corners and wall-wall corners also exhibit darker hazing/ghosting (see photos) coincident with areas of structural wood and no insulation. [NOTE: Any cooler surface, even small areas like drywall nail head, will have will have less thermal turbulence allowing more particles to settle compared to warmer areas where there is adequate insulation. The soot settling builds up over time until it is visible, as is the case in this house.]
- The open space common with the dining room was dry and comfortable with T=67F and a relative humidity of 25%

### DINING ROOM

- There was also a linear pattern of hazy discoloration on the ceiling of this room, similar to a tick-tack-toe grid (see photo). This pattern also appears to be from soot-related particles.

### MASTER BEDROOM

- There was also a linear pattern of hazy discoloration on the ceiling of this room (see photo). This pattern also appears to be from soot-related particles.

### WOOD-PANELED ROOM

- There was also a linear pattern of hazy discoloration on the ceiling of this room, but lighter than the living room and dining rooms that were closer to the Monitor heater (see photo). This also appears to be from soot-related particles.

### Attic

- There was obvious dark discoloration in the sheathing on the north side of the attic but little discoloration in the south side sheathing that has been in place since the roof was replaced in 1995 (see photos). The dark discoloration on the north side DID NOT RUB OFF under finger pressure, indicating it was in the grain of the plywood and not readily released to the air where spores might be inhaled, essential for exposure resulting in allergic reactions. Since the ‘new’ south side sheathing is not impacted while some of the south sheathing has discoloration, that pattern on select sheets indicates older mold growth, probably related to the replaced, deteriorated roofing that dampened the sheathing by oozing water, NOT recent conditions in the last 17 years.

These observations in the attic are very common on the Cape when there has been limited ventilation in the past so that warm, moist air that enters the attic space in the winter from the living space below condenses on the underside of the cold sheathing on the north side. The formation of this damp layer on the underside of the plywood activates growth of the mold spores that have settled there over the years or, more likely, accumulated from storage conditions between the plywood mill, lumber yard and job site, also referred to as “lumberyard mold.”

The generally more north-facing side of an attic roof often has these areas of darker staining from mold growth. Being colder for longer periods of time each day there is more condensation on those surfaces. The resulting condensation mold growth involves micro fungi that are mostly in the grain of the plywood where the limited layer of water provides enough moisture to support digestion of glues, binders, etc. Hence these in-grain growth areas are much less likely to be releasing spores to the air than would come from surface growth. It is the inhalation of mold spores in the air that leads to exposure to allergens and irritating structural elements from mold colonies. The density of the resulting staining increases over the years of cyclic wetting/growth periods between dry/dormant periods.

[Since the observation is of dark gray to black mold growth many people assume that it must be “THE toxic black mold” widely mentioned in the media in recent years. That mold is *Stachybotrys chartarum* and has been associated with alarming anecdotes about impact on neural function. Whatever the scientific findings on health impacts eventually turn out to be, the dark growth in attics is almost certainly NOT “THE toxic black mold,” for several reasons:

- *Stachybotrys* has a high requirement for water, not just periodic dampness, before it will establish a colony where its spores would accumulate in a slimy mass. Attics have no such high amounts of liquid water to promote their colonies.
- *Stachybotrys* prefers paper, not wood, as a diet, ideally from drywall that has been soaked for an extended time.

Hence, despite the color of the mold growth, it is NOT cause for alarm. As a matter of fact mold colonies develop different colors depending on their genetics and diet. Many common molds indeed develop dark colonies.]

This growth by micro fungi also does not deteriorate the strength of the sheathing. It takes much more moisture oozing through porous shingles and tar paper to support those wood-eating macro fungi. In that case there would probably be stained streaks running down many rafters as well as discoloration of sheathing immediately adjacent rafters.

Usually the south-facing side of the roof is relatively clear of mold, since it is warmed and dried by the winter sun, preventing heavier condensation that would readily support mold growth.

It is the health effect of molds that is the prime concern from an indoor environmental perspective. There are several factors that greatly reduce the health risk issues associated with light mold growth on/in attic sheathing:

- There is little likelihood of high concentrations of spores leaving the grain of the plywood as evidenced by not having fluffy growth on the surface that could be affected by wind currents and not being able to change the surface by rubbing. Hence any mold spores present in the air will be at relatively low concentration and mostly reflect what is blowing in the gables and eaves on the wind.
- The attic is not an area of frequent occupancy by the residents, so there is little chance of inhaling the spores. Dose describes the exposure to any environmental contaminant and dose is determined by multiplying concentration of the irritant times the duration of the exposure. Under the existing conditions the dose of mold spores delivered to the residents is minimal.
- In addition, since warm air rises, the air from the living space, it is moving up through gaps into the attic around penetrations and delivering the moisture to the attic as evidenced by the growth in the first place. The air movement is NOT primarily from the attic down (except under rare high wind transients).
- AND the relatively few spores released into the attic air will tend to move up and out through vents, not move down through penetrations against the prevailing flow to enter into the living space.

(For a broader discussion of mold in attics see Chapter 8 in Jeff and Connie May's book The Mold Survival Guide for Your Home and Your Health that is Attachment B to this report.)

[While the above discussion deals with the health-related issues from the mold that has grown, one must address the sources of moisture that have led to the condensation in the first place in order to reduce that flow of warm moist air up from the living space. These gaps include any penetrations of the ceiling for light or fan fixtures or air ducts. Possibly the largest gap is the perimeter of the attic stairway/hatch itself.]

Attic (continued)

- The vents from the shower, dryer and kitchen were all attached to their respective exterior structures (see photos).
- The insulation was pulled back from the installation of each on the recessed lights in the kitchen, near the bathroom exhaust fan as well as the sink light fixture (see photos). This situation would allow those ceilings to cool considerably during winter months leading to dew point condensation in the living space where there are moisture sources from human respiration, cooking and showers. Hence the VMG observed on the first floor is readily associated with these areas of failed insulation, not any pervasive problem with the house.
- The short insulation bats were not perfectly butted together (see photos) and were lifted up in some areas. The location of these small gaps between the insulation bats would reduce the insulation effect and result in cooler ceiling surfaces. The gaps coincide with the middle of the ceilings along both sides of the house but are most evident along the north side, affecting the living room, dining room and master bedroom. These cooler surfaces would allow preferential settling of soot particles and increased hazing/ghosting over time.
- While there is an apparent ridge vent in the attic (probably installed in 1995 when the roof was replaced), it is not supported by adequate soffit venting for two reasons – small button vents along the soffits (observed from outside) that are easily painted over and insulation bats pushed to the roof sheathing (see photos) further blocking adequate replacement air flow to support the ridge vent. Despite these defects, the two gable vents appear to provide considerable ventilation.

**SUMMARY & DISCUSSION:**

With concern for “cleaning” mold-impacted areas where VMG has been observed, it is important to understand the following terms:

- **MOLD CONTAMINATION** -The terms Condition 2 and 3 used describe mold contamination are part of the August 2008 American National Standards Institute/Institute for Inspection Cleaning and Restoration Certification (ANSI/IICRC) S520-2008, “Standard and Reference Guide for Professional Mold Remediation.” **Condition 2** involves evidence of settled spores from a contaminated area, a condition documented to some extent by “disturbed” air samples. **Condition 3** refers to “actual mold growth and associated spores ... active or inactive, visible or hidden.”

The observations in this house point to two separate conditions leading to two different impacts on the *interior* surfaces.

1. There are areas in the attic near ceiling penetrations for an exhaust fan and several recessed light fixtures where the insulation was initially pulled back and never returned to its proper functioning position. The resulting spot defects in insulating the ceiling has led to winter “cold spots” that have brought the local ceiling surface temperatures below the dew point temperature of the occupied space where occupants, cooking and showering are adding moisture to the air. The resulting limited areas of condensation have stimulated the digestive enzymes in mold spores that are present sufficient to digest organic matter present and develop localized colonies perceived as VMG, Condition 3 contamination.

2. There are broader areas of reduced insulation in the attic aligned with the edges of installed short batts, as opposed to continuous rolls of insulation used in recent decades, where cooler ceilings are the result. There are also areas where these batts are lifted up slightly, also allowing areas of the ceilings to be cooler in linear patterns where soot deposits can accumulate gradually over the years resulting in the evident hazing/ghosting patterns.

To reduce the recurrence of patterns of VMG in the occupied space, the insulation needs to be reinstalled properly around each fixture.

To reduce the recurrence of patterns of soot hazing/ghosting:

- The source of the soot, probably the Monitor, needs to be located and sealed.
- The insulation needs to be properly adjusted or repositioned all over the attic.

The pattern of CMG *on the north side of the attic* is common on the Cape in north-facing roofs, as discussed in detail above, and not posing a health concern to occupants since:

- The mold growth is in the grain of the plywood and not readily releasing spores to the air, the main exposure route to induce allergies.
- Air moves up from the warm living space on the main floor into the attic and only rarely down, except in brief periods of strong winds.

Hence the north side discoloration is primarily cosmetic and does not call for health-related removal. [IF there is a desire to remove the discoloration at some point, it will be more cost effective to replace all the sheathing the next time the roofing is replaced.]

A Scope of Work is presented below to address limited mold remediation of the few areas of **Condition 3** contamination and to clean the soot deposits throughout the main floor.

**Comments addressed to 9 January 2013 letter received by Ms. Walsh** from the Massachusetts Property Insurance Underwriting Association stating that the property is “uninsurable:”

- ◆ The “mold and mildew growth ... (on) the 1<sup>st</sup> floor ceilings” is localized, has been identified as related to areas of inadequate attic insulation and can be simply cleaned as indicated in the SOW below.
- ◆ The “mold and mildew growth throughout the attic” is thoroughly discussed above and is a result of cooler surfaces on the north side of the roof that does not receive warming from the sun, is in the grain of the wood not readily releasing spores to the air to create a health concern, not compromising the strength of the sheathing and is mainly cosmetic.
- ◆ The improper venting mentioned is inaccurate as show in photographic evidence.

It is the professional opinion of this inspector, William M. Vaughan, PhD, QEP, CIEC, that none of the conditions highlighted makes the house uninsurable.

## **RECOMMENDATIONS (Scope of Work):**

### **MOISTURE**

Since there are no conditions of excess moisture associated with leaks or water releases, the localized excess condensation on ceiling surfaces needs to be reduced by correcting the flawed insulation installation in the attic. In addition:

- BE SURE THAT ANY GAPS AROUND CEILING FIXTURES ARE SEALED to reduce air movement into the attic, possible using expanding foam, tape, or caulk.
- Ensure that exhaust hoses from appliances to roof vents are tightly secured with proper sized tie-wrap cables or hose clamps to prevent exhausting moist air into the attic.

The excess moisture in the bathroom can be corrected by installing a new exhaust fan with more power that is controlled by a functional timer switch.

The flow of warm, moist air from the occupied space into the attic can be reduced by installing adhesive foam of proper thickness around the gap at the pull-down stairs using sticky foam taped such as one of the Frost King products.

## MOLD

There are only a few isolated patches of VMG on main floor ceilings. They can be cleaned by:

- Using a HEPA-filtered vacuum to clean each small area.
- Wiping each impacted area with moldicide or a bleach solution no stronger than 5% (1/4 cup of bleach in a quart of water).
- Repaint following the soot cleaning addressed below.

## SOOT

The soot deposits observed across the main floor can be cleaned by a professional cleaning service familiar with the techniques for cleaning following oil furnace puff-backs or failed heat-exchangers, particularly:

- Wipe all smooth surfaces – walls ceilings – with chemical sponges designed for such cleaning of oily films
- Clean all surfaces with a strong detergent
- Repaint all painted surfaces
- Contents are less susceptible to soot deposits since there is no thermal differential that encourages visible deposits. If selected contents are identified as soot-impacted, cleaning should be evaluated as compared to disposal.

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To avoid problems with mold in the future, be attentive to any and all water intrusion or condensation issues, taking general advice from The Mold Survival Guide for Your Home and for Your Health by Jeff and Connie May (2004). In particular:

- Turn off the water to the washing machine ANY TIME you leave for several days since rubber hose failure can occur in any season and cause massive water damage! **Better still**, treat the water valve as if it were a “switch” and turn off the water after each washing.
- If there are allergic or sensitized individuals living in the building, use a HEPA filter-equipped vacuum for routine cleaning to capture spores and irritants.

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The above discussion and recommendations are related to the information you provided and the conditions visually observable at the time of NES’s site visit on 23 January and are thus limited to these

activities and timeframe. Future events and changes in the condition and operation of the building may well alter the conditions for biological activity/growth, especially moisture. Such changes will alter the relative significance of these recommendations and the effectiveness of their implementation. Thus the impact of such changes and cannot be considered part of the scope of this report/work.

I trust the above information is sufficient for your current needs. Please call us with any questions or to clarify points.

Very truly yours,



William M. Vaughan, PhD, QEP, CIEC  
President, Senior Scientist



QEP=Qualified Environmental Professional (since 1994)  
CIEC=Council-certified Indoor Environment Consultant (#0608032)

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## Attachment A

### Select Photographs Taken During the Inspection





109 Pinewood Road



Vents from the bathroom area – large = shower & small = dryer



Kitchen vent



Viewing to east (left) side of kitchen where there is localized VMG near light fixture and linear haze/ghosting



Viewing to west (right) side of kitchen where there is localized VMG near light fixture and linear haze/ghosting



Monitor wall-mounted heater in living room





Hazing/ghosting on living room ceiling (see attic discussion & photos as well)



Hazing/ghosting along front wall and right corner of living room



Drywall nails evident over front door



Drywall nails and ceiling corners showing hazing/ghosting on front wall



Grid pattern of hazing/ghosting in dining room



Hazing/ghosting in master bedroom



Hazing/ghosting in right rear paneled room



Excess moisture (28% MW) in bathroom floor near foot of tub/shower





VMG around shower exhaust fan



Clear 17-year old sheathing on south (rear) sheathing as opposed to darkened north side sheathing





Dryer and shower vents attached properly but without tie-wrap on drying vert.



Kitchen ceiling VMG under fixture where insulation had not been replaced



Kitchen ceiling VMG under fixture where insulation had not been replaced [Note are in foreground where insulation had been lifted up over a piece of wood, reducing the insulation of the ceiling and leading to an area of hazing/ghosting



Area near bathroom exhaust fan showing large uninsulated surface (compare to earlier view of VMG)



Insulation on north side of attic where there is an evident dip in the insulation where batts are not fully butted together, leading to cooler, linear surfaces in the ceiling below

Attachment B

Chapter 8 on Attic mold excerpted from

The Mold Survival Guide for Your Home and Your Health

by Jeff and Connie May



*The* **MOLD**  
**SURVIVAL**  
**GUIDE** FOR YOUR  
**HOME**  
AND FOR YOUR **HEALTH**

**JEFFREY C. MAY**  
**CONNIE L. MAY**

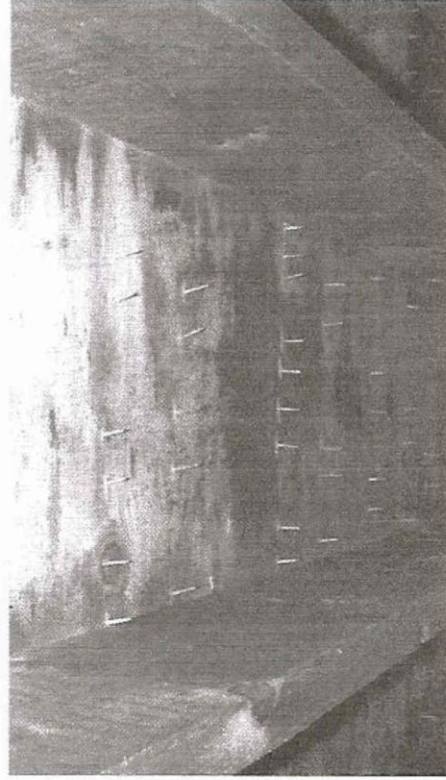
*With a contribution by*

John J. Ouellette, M.D., and Charles E. Reed, M.D.

The Johns Hopkins University Press  
Baltimore & London

tre me cases you will see water dripping from the roof-shingle nails that penetrate the sheathing, which in turn will be completely blackened and even delaminated from moisture and mold. If you look down directly onto the floor beneath the nail tips, you may see stains where the drops fell.

In a cold climate, inadequate ventilation of the attic space may lead to excess humidity as moist air from the warmer rooms below infiltrates into the cooler attic around plumbing pipes, the attic hatch, or even recessed lighting fixtures. The moisture in the air then condenses on surfaces that are below the dew point. Sometimes homeowners think their houses have attic ventilation, because roof vents have been installed, yet I have seen time and time again that while the external component of the vent was properly installed, the required opening in the wood roof sheathing or soffit trim was never cut. This can be true at the ridge vent (at the peak of the roof) and at



Black mildew on attic sheathing. The nails (protruding through the sheathing between the two rafters) are what hold the roof shingles onto the sheathing. This north-facing slope of a gable roof is covered with black microfungi (not *Stachybotrys* mold). The black growth gets denser toward the overhang (at the bottom of the picture) where it is colder. The white ovals at the nail penetrations indicate a lack of mold growth; the zinc that leaches from the galvanized nails into the wood is toxic to mold.

## Chapter 8

# THE SPACES WE DON'T LIVE IN

You relax in your living room chair, you sit at the kitchen table, you read in bed at night. Your home is your kingdom, and you think you are sovereign. Well, not quite. There are other realms in the house where Nature writes the rules, and in these unconditioned spaces, spores lie waiting to usurp your control of what may be the largest investment of your life.

### Attics

Many people call me because they are worried about visible mold growth in their attics. The black growth on attic sheathing and rafters consists primarily of species of *Cladosporium*, *Alternaria*, or other genera of microfungi, but rarely, if ever, the potentially toxic *Stachybotrys* mold, because attics are not consistently wet (that is, the wood does not usually have water activity above 90 percent) and thus are not usually damp enough to sustain this kind of mold.

It is common to find black mold on the attic sheathing of a gable roof (one shaped like an inverted V), especially toward the lower edges above or near the overhang, or even along one of the gable end walls. Very often the north-facing roof slope is most severely affected, because it receives little sun during the day and doesn't warm up enough to accelerate evaporation and drying out. In ex-



soffit vents (at the overhang). If you hire roofers to install ventilation, make sure they cut the openings in the wood before they install ridge and soffit strip vents. (Rectangular soffit vents are fine, but don't bother with small circular vents, which do not allow for adequate airflow.) Also make sure they install a roof vent that works.

Even with the best attic ventilation, you can still have a serious mold problem if too much moisture enters the attic from the house. For example, bathroom and dryer exhausts vented into the attic can lead to condensation, particularly in the winter. If mold is growing in your attic in just a few of the rafter bays above the bathroom or laundry area, you most likely need to vent the bathroom or dryer exhaust to the outside (and check for leaks in exhaust hoses). If there is mildew growing on most of the attic sheathing and the attic is well ventilated, you must find and eliminate the sources of moisture. Attic ventilation is important, but controlling the leakage of house moisture into the attic is *more* important.

If you live in a warm climate and air-condition your home, and the AC system and/or ducts are located in the attic, moisture from humid *outdoor* air, used to ventilate the attic, may also condense on the outside of the system's components, such as the condensate trap or lines, or the "suction line" to the AC coil, if they are below the dew point of the attic air. (Very often these are frustrating problems, because condensation is intermittent and occurs only on very humid days.) Uninsulated AC ducts (or those that leak cold air) are particularly problematic. In climates where air conditioning is used during much of the year, the roof sheathing is too hot for condensation to take place during the day. At night, however, if the sky is clear and the temperature outside is low enough, the roof (particularly the north-facing slope) may cool to below the dew point.

As discussed earlier in the book, an unbalanced heating or cooling system can also create attic condensation. I investigated one home in New York State in which the interior side of the gable-end sheathing behind the attic wall insulation and the exterior edges of the attic roof sheathing were black from microfungi growth. It was winter, and outside there were icicles hanging from the vinyl siding

at many levels on all four sides of the building. For some reason the homeowner had removed the duct for the hot-air system's only return, located in the hallway on the first floor. He had left the duct opening at the furnace, however, so all the air entering the system was coming from the very damp basement.

Since no air was being returned from the habitable rooms, the air pressure was higher in these locations than in either the attic or the wall cavities. This resulted in exfiltration to the attic and wall cavities from the habitable rooms, and moisture condensed in the attic, as well as on the sheathing behind the vinyl siding, where it froze in the winter. There was so much moisture in the walls that eventually they would have been decayed by macrofungi. Luckily this was the first winter this condition had existed. The remedy was to reinstall the return duct (and, of course, to clean up the mold and dehumidify the basement).

Check your attic periodically for mold growth. Treating attic mold with bleach isn't really effective, because the wood surfaces are porous and rough, and it's impossible to kill all of the growth. Where the mold is superficial (microfungi), there is no structural damage to the sheathing and rafters, and the growth is in the low part of one or two rafter bays, you should HEPA-vacuum the surfaces and then paint the affected wood with an alcohol-based primer, which will generally kill most of the spores and seal them into a paint film. (Consider hiring a professional to do this, because alcohol-based primers have flammable and toxic fumes, and great caution must be exercised during application. Follow all manufacturer's precautions.) Keep in mind that just painting over mold does not cure the underlying moisture problem, which *must* still be solved.

In many cases I find that one entire side of the attic is black with mold growth, but the sheathing is intact and the rafters are not damaged. In such cases a professional remediation can, under containment conditions (see part 3), clean the surfaces by soda-blasting or Dry Ice-blasting them (using baking soda or Dry Ice instead of sand, which is too abrasive). Then the wood can be sealed.

Attic sheathing in newer homes can be made of plywood or OSB





(oriented strand board, discussed in chapter 1). If, because of moisture and mold growth, plywood sheathing is delaminated and weakened, or OSB sheathing is swollen or damaged, the affected sheathing must be replaced. Of course, this means removing and replacing roof shingles. Any rafters that are significantly decayed from macro-fungal growth (most often due to leaks) may have to be repaired or replaced as well. Occasionally the entire roof structure has to be removed and rebuilt, though in some cases I think this work has been done because people overestimated the significance of the damage or because rebuilding was less expensive than professional remediation.

Remember that attic mold growth is most often due to genera of microfungi (*Cladosporium*, *Stemphylium*, and *Ulocladium*, all black, or *Penicillium*, which may appear to be white). These fungi usually only affect wood surfaces, whereas macrofungi destroy wood's structural integrity. If you have mold in your attic, consult an ASHI (American Society of Home Inspectors) member, an experienced roofer, or a structural engineer for a second opinion before hiring a remediator or tearing the house apart.

More often than not, mold on attic sheathing is not much of a spore exposure issue in habitable spaces below. Mold of any type in an unfinished attic may still, however, be a problem for those who are sensitized, if the mold emits an odor or is disturbed (sometimes people using unfinished attics as storage space disturb the growth, or AC return ducts suck in moldy attic air through leaks and gaps). And in finished attic spaces, microfungi can grow on carpeting or on walls that have been dampened by roof leaks or flashing leaks around chimney or plumbing vent pipes; mold in such spaces can be just as problematic as mold in any other habitable room.

#### *An Attic Odor*

One couple moved into a newly constructed home after they'd had a serious mold problem in the house they were renting, and they began to notice that they could occasionally smell the attic air in the upstairs rooms. They found out that the air ducts between the sec-

ond floor and the attic had many unintended openings. In fact, in some spots where lighting fixtures, supply grilles, or bathroom vents were located, they could see through from the attic into the rooms below. Their daughter was mold sensitized, and they were worried that any mold spores in the attic might be carried in airflows to the rooms below.

Since the house was new, the attic was probably not very moldy. Still, allergens do collect with dust in attics, whether ventilated or not. For this reason it's a good idea to minimize the amount of attic air that enters the habitable areas below.

In another home that had a mouse infestation in the exposed insulation in the attic floor, the new owner could sometimes smell a peculiar odor in the unfinished attic. I encouraged him to hire professionals to eliminate (under containment) the old exposed attic insulation, some of which was no doubt contaminated with mold as well as rodent litter, and then to thoroughly clean out the attic, HEPA-vacuum the floor structure (in this case, the floor joists and the back of the ceiling below), have the entire floor structure sprayed (to seal it), and reinsulate, being careful not to leave any soffit openings to the exterior through which rodents or bats could enter.

#### The Roof

I was asked by a management company to investigate whether there might be a connection between the owner's respiratory problems and leaks associated with the fireplace chimney (a wood-framed enclosure for a metal flue pipe). The leakage had been going on for over a year, and there were stains near the chimney on the ceiling of the second-floor bedroom (including the closet) and around the fireplace in the living room on the level below.

Apparently the wood-framed "faux" chimney had been leaking water from the cap flashing (which covered the "chimney" at the top). The metal should have been convex, but instead it was concave, so rainwater collected around the pipe at the center, rather than running off to the edges of the flashing. Over the years the pud-





dle of water rusted the metal, and moisture leaked down around the flue pipe. There was mold on the closet drywall and in the closet carpet where mold-eating mites foraged. The flashing as well as the moldy carpeting and drywall had to be replaced.

One family moved into a new home and found a serious leak above one of the finished rooms on the top floor, directly under the roof. Part of a wall, some carpeting, and a section of the floor had been damaged. They fixed the roof and dried the carpet, but they were still worried about the possibility of a hidden mold problem, so they e-mailed me for advice.

I thought there was a good chance of microbial growth in the carpet, and possibly the pad and even the subfloor beneath, if these had been wet several times and had remained wet for a few days. Wearing a NIOSH N95 mask and operating a room fan on exhaust, someone in the family or someone they hired (if people in the family had mold sensitivities) could carefully peel back the carpet and pad to see if they had been saturated, or if there was any staining to indicate the extent of the leak and any subsequent mold or bacterial growth. I warned them to be careful not to stir up any dust. If there was significant staining or visible mold growth, I recommended that they hire an investigator to evaluate the situation, and probably have professionals eliminate and replace any moldy carpeting and pad, as well as any plywood subfloor that had significant decay or delamination. (Always use containment when very moldy materials are disturbed in a habitable space; see part 3.) If the plywood seemed intact and was just stained, and there was no odor, then it could be sealed with alcohol-based primer before being recarpeted. Finally, if the family was considering keeping the carpet, I suggested that they HEPA-vacuum up a sample of carpet dust and send it to a lab for microbial analysis before making any final decisions.

Some home inspectors walk on the roof to observe the conditions of the shingles and the chimney. I recall one inspector telling me that the last time he did this (the very last), he was moving along cautiously when suddenly the shingles and sheathing gave way with a loud crunch. He ended up with the lower half of his body dangling

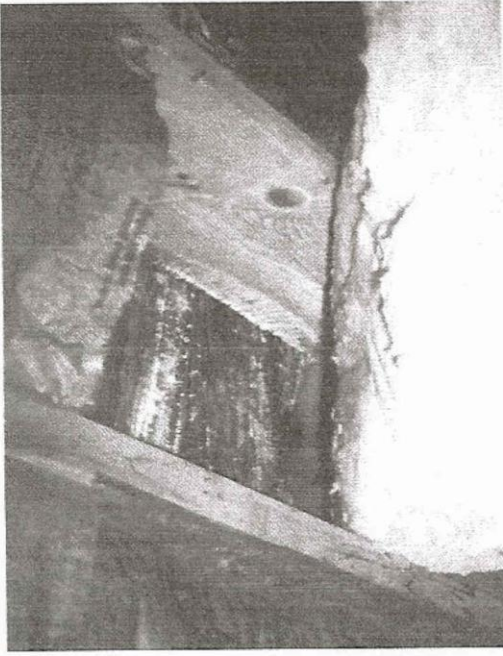
into the attic between the rafters. When those roof shingles were first installed, roofers were perfectly safe walking across the surface of the plywood sheathing and installing shingles with nails driven into the wood. What had weakened the roof since the installation? Most likely there had been a long-term roof leak, allowing severe macro-fungal decay.

I saw such decay during one of my home inspections, but fortunately I was in the attic when I encountered it, rather than on the roof, which happened to be flat. The attic was large because the house was huge, over eleven thousand square feet. I became suspicious when I noticed plastic sheets spread out on the attic floor and a mop with a bucket in one corner. At one location the tarpaper vapor barrier at the bottom of the fiberglass insulation batts between the roof joists was stained. I pulled down a section of the insulation, and water poured out; the roof sheathing was so rotted that the mycelia of macrofungi were in the wood. In this case the moisture originated from a leak around a poorly installed rooftop air-conditioning unit; the tarpaper prevented the moisture from evaporating. It's lucky that no AC technician ever took a step on that section of the roof while servicing the unit, because the person might have ended up in the attic.

One man e-mailed me because his roof had leaked in several spots for years before he repaired the problem. He had hoped any mold present would eventually die, since the moisture source had been eliminated. He lived near the ocean, and when the wind blew from the water, he sometimes found it hard to breathe in the rooms on the upper level of his house. Could mold growth caused by the roof leak be the culprit?

Given that the roof had leaked for a year or more before being repaired, I was pretty sure mold had grown in the unfinished attic, and even if the mold was dead, it could still remain allergenic. If the attic was ventilated, the force of the wind could stir up any moldy attic dust, which could then find its way through pipe openings and other gaps into the habitable spaces of the man's house. It's also possible that there were other sources of mold. Wind-blown rain can cause





Rotted sheathing in a flat roof. The dark plywood sheathing between the lighter-colored rafters has been damaged by wood-decaying fungi. Water poured out of the fiberglass as the insulation was lowered, and the white semicircular threadlike pattern above the knot in the rafter is probably the mycelia of macrofungi that were starting to destroy the wood structure because of the saturated conditions.

mold growth underneath the siding, for example, and even in the wall cavities of homes located near the ocean. (If the air pressure is greater in the wall cavities than in the house, mold spores can be carried indoors by infiltrating air.) I suggested that the man have an ASHI home inspector determine the extent of the problem and make recommendations for repairs.

If a roof has to be replaced, minimize the chances for exposing the sheathing to the weather. (In older houses, where planks rather than plywood or OSB were used for sheathing, rain will enter the attic through the gaps between the exposed planks.) Be aware of weather reports and know what steps need to be taken to protect the site during reroofing. If the weather is threatening, be sure the contractor comes prepared with tarps to cover the exposed roof areas. (Many roofers don't strip the entire roof at one time, so there is only

a small area to protect.) If insulation is soaked by a sudden storm, it should be removed and new insulation should be installed after any damp construction materials have dried out.

When roof shingles are replaced, the pounding on the sheathing can release wood debris into the attic. Stored goods and insulation will then become covered with dust. If there is mold on the sheathing in the attic and you are concerned about mold exposure, cover stored goods with plastic sheets before the roofers start (but don't lay the plastic over recessed light fixtures in the attic floor, because this could start a fire). Isolate the attic as much as possible from the rest of the house. If there is no attic floor, be careful where you step, lest you end up in the room below. Whoever cleans up afterward should wear a NIOSH N95 mask and should HEPA-vacuum the dust on the floor or on other solid surfaces. (If new roofing has already been installed on moldy sheathing, then exposed, soiled fibrous attic insulation may have to be replaced.)

### Garages

If you are not overcome by the odor of gasoline in a garage, you may be sickened by the stench of garbage from the trash barrels or the musty smell of the mold growing in a damp corner. People tend to be careless about conditions in their garages, because they think of them as outdoor spaces. Roof leaks are ignored, and moldy leaves are allowed to blow in and accumulate.

I recently visited some friends I hadn't seen in many years. As I pulled into the driveway of their immaculately maintained ten-year-old home, I noticed a streak of green moss and a long, damp-looking vertical stain on the brick veneer at the interior corner, where the two-story house met the single-story garage that projected out from the front of the house. It appeared that the garage roof had a leak.

I unloaded my suitcase from the car trunk and walked through the garage, where I could see patches of black mold on the inside drywall, mirroring the outside water stain. After I took my suitcase to the second-floor guest room, I looked out the window and discovered that my room was just above the garage roof area where I sus-