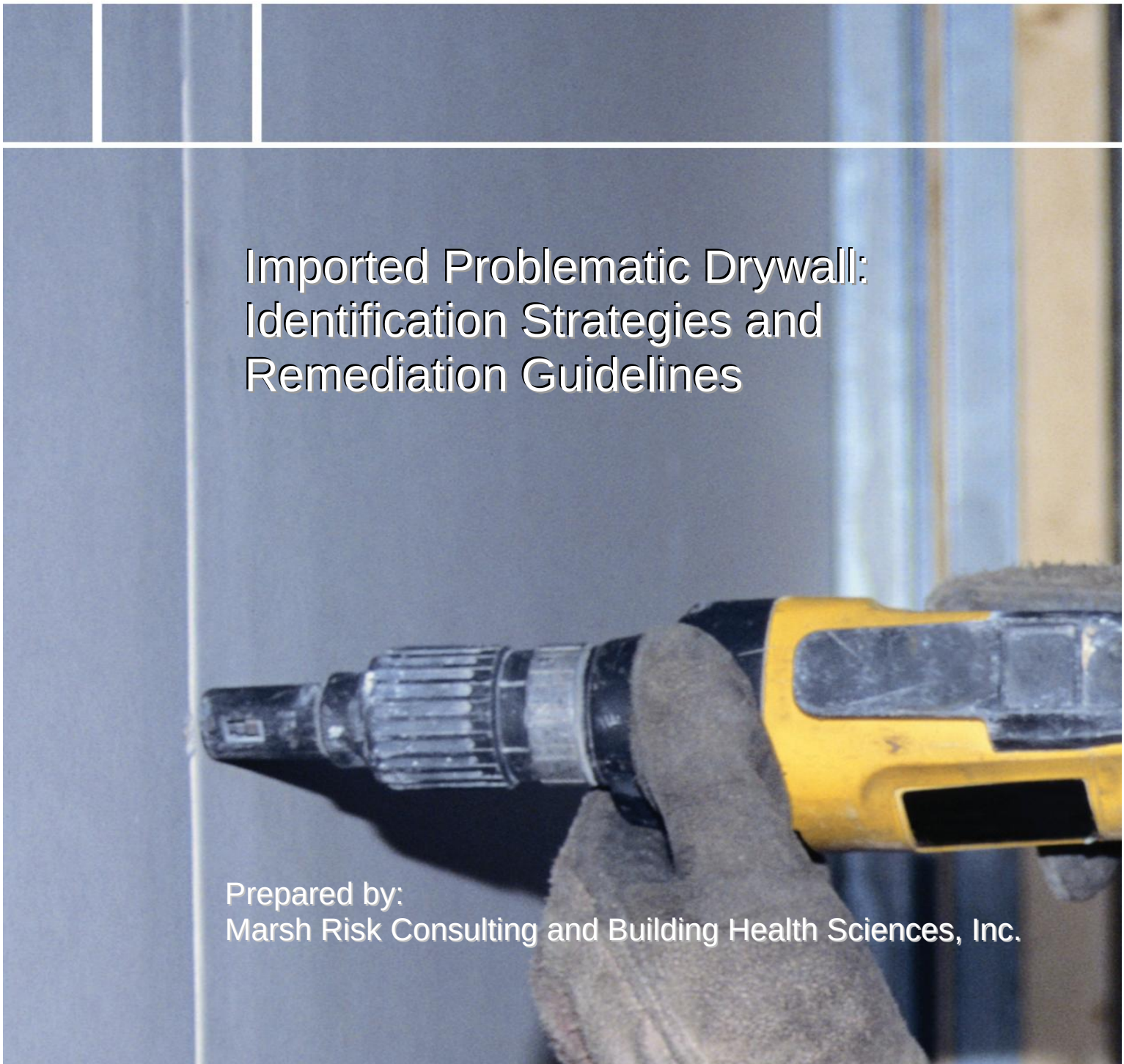
National Association of Home Builders

March 2011

Imported Problematic Drywall: Identification Strategies and Remediation Guidelines



Prepared by:
Marsh Risk Consulting and Building Health Sciences, Inc.

Dear NAHB Member:

On March 4, 2011 NAHB's Chinese Drywall Task Force unveiled the testing and remediation guidelines in this guidance document for association members who have questions about how to detect and remediate problematic drywall. At the time of publication some of the information contained in this document was based on interim guidance from the U.S. Consumer Product Safety Commission (CPSC) and the U.S. Department of Housing and Urban Development (HUD) pending the completion of the CPSC's scientific studies and readers were advised to pay close attention to the results of those studies when they were made available to the public.

On March 18, 2011, the CPSC announced that based on the results of a study conducted on its behalf by Sandia National Laboratories, it was revising its interim guidance issued in April 2010 and, as a result, the CPSC is no longer recommending the removal of all electrical wiring in homes with problem drywall. The CPSC and HUD remediation guidance is still calling for the replacement of fire safety alarm devices (including smoke alarms and carbon monoxide alarms); electrical distribution components (including receptacles, switches, and circuit breakers, but not necessarily electrical wiring); and gas service piping and fire suppression sprinkler systems.

We have now updated the guidance document to reflect, where applicable, this latest information from the CPSC and HUD.

Best Regards,

The NAHB Chinese Drywall Task Force

March 4, 2011

Dear NAHB Member:

As a result of a building boom, as well as the impact on the United States Gulf Coast from the hurricanes of 2004 and 2005, a shortage of drywall caused many in the home-building industry to look for alternative sources of drywall outside of the United States. Although builders have imported suitable drywall from various countries in the past, we now know that some drywall imported from China, mostly between 2004–2008, contains high levels of sulfur and various other airborne compounds, which the product is emitting or off-gassing. Unfortunately, many builders discovered after the fact that this foreign drywall was used in the construction of new homes and remodels. Findings to date have shown a strong association between the presence of problematic drywall and metal corrosion as evidenced by, among other things, blackening of copper electrical wiring and/or air-conditioning evaporator coils.

Predictably, litigation has followed. Most claims involve homes in Florida and Louisiana and to a lesser extent in Alabama, Mississippi, Nevada, North Carolina and Virginia. The majority of the lawsuits have been filed against the drywall manufacturers, although builders, contractors and distributors who handled and installed the materials have been named as well. Some builders also have filed lawsuits against the manufacturers of the drywall.

The U.S. Consumer Product Safety Commission (CPSC) is the lead federal agency investigating the problematic drywall. The U.S. Environmental Protection Agency (EPA), the U.S. Centers for Disease Control and Prevention (CDC) and its subsidiary, the U.S. Agency for Toxic Substances and Disease Registry (ATSDR), are assisting the CPSC. To date the CPSC has had reports about problematic drywall from more than 3,500 residents in 38 states, the District of Columbia and Puerto Rico. State and local authorities also have received similar reports.

To date, the most frequently reported health symptoms associated with the problematic drywall are irritated and itchy eyes and skin, difficulty in breathing, persistent cough, bloody noses, runny noses, recurrent headaches, sinus infection and respiratory tract irritation. No scientific studies or government reports have found that problematic drywall causes long-term or toxic health effects to occupants.

For some time builders, industry groups, consumers and government agencies at the local, state and federal levels have been looking for answers to the following questions:

- How can a homeowner or builder identify if there is problematic drywall in a home?
- How widespread is this problem?
- Is a home with problematic drywall safe?
- What should be done to remediate the problem?

The CPSC has begun to answer some of those questions. In January 2010, the U.S. Department of Housing and Urban Development (HUD) and the CPSC issued the first of

two interim documents. The first document addresses how to identify the presence of metal corrosion, as well as other indicators of problematic drywall in homes. The second, issued in April 2010, was an interim remediation guidance to help homeowners who wanted to begin remediating their homes. In August 2010, the CPSC and HUD published Revision 1 to their Interim Guidance on Identification of Homes with Corrosion from Problem Drywall. While the CPSC will continue to release its scientific studies as they are completed, the commission indicated in July 2010 that the bulk of its scientific investigation is complete. Only long-term corrosion of electrical and fire-safety components continues to be investigated under contracts with other federal laboratories.

Trying to sort through the complex and often conflicting information regarding problematic drywall can be a daunting task. To that end, NAHB retained Marsh Risk Consulting and Building Health Sciences to work with NAHB's Chinese Drywall Task Force to develop a guidance document for NAHB members that is designed to:

- Enable members to determine whether problematic drywall is present in a home.
- Discuss current known information relating to the health risks that a homeowner living in a home with problematic drywall may encounter.
- Outline remediation strategies for homes that may require total remediation.
- Outline remediation strategies for homes that may require partial remediation.
- Outline clearance procedures that may confirm that problematic drywall has been removed from a home.

The guidance set forth in this document, will attempt to provide a remediation strategy that is:

- Safe
- Cost-effective
- Based on proven technologies, materials, means and methods
- Scientifically sound and provides a permanent solution

This document is intended for use on detached, single-family homes, attached multifamily dwellings and homes that have been remodeled or renovated with problematic drywall. This document was not developed or intended for use on commercial properties.

We trust that you will find this document helpful.

Best regards,

Barry Rutenberg
First Vice Chairman

Ray Kothe
Chairman of the Chinese Drywall Task Force of the Board

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1. Qualifications and Disclaimers

This guidance document was prepared for the National Association of Home Builders (NAHB) for the educational and informational use of its members. The document is intended to be read as a whole and not in parts and no section or page should be separated or altered from the main body.

Use of this document offers guidance for identifying and remediating homes with problematic drywall. The information and recommendations contained in this document represent NAHB's considered advice on the subject and are based upon current research results available to NAHB. This document is not intended to set minimum or maximum requirements. The goal is to effectively and efficiently repair the damage being done by the drywall, including eliminating the source of the damage. To achieve this goal, a builder might choose to follow different guidelines that are either not as inclusive as the guidelines in this document or that include additional measures to assure that the home is fully remediated. This document should not be used to determine the effectiveness or the efficiency of a builder's completed or future identification or remediation efforts.

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2. Definitions

The definition section of this guideline was prepared for educational and informational use of the reader. The definitions and terms included in this document are applicable for purposes of this document only. The definitions described below are to be used for this guideline although other definitions and interpretations may be applicable.

1. **Absorption – neutralization:** When the materials used in this process are applied to drywall, they are purported to take up (absorb) the gas emissions the way a sponge takes up water and neutralize the gas, making it inactive, eliminating odor and corrosive qualities.
2. **Airborne Compounds** Substances in the air that can taint or damage other things in the environment. Tests have shown drywall gas emissions cause odor and/or corrosion of metallic items.
3. **Air Corrosivity:** This is the presence of substances or chemicals in the air that are capable of causing corrosion or the eating away of metals and alloys. (See also: corrosion)
4. **Aldehydes:** These chemical compounds are formed when an alcohol combines with an oxygen-carrying compound and replaces one or more hydrogen atoms in the molecule of a hydrocarbon, which is made up of carbon and hydrogen atoms.
5. **Architectural Materials:** Refers to all finishing materials used in a home including, but not limited to, moldings, casing, countertops, backsplashes, stair rails, balusters, newels and fillets, doors, insulation and cabinetry.
6. **Building Systems:** This refers to the mechanical, electrical, plumbing and architectural features of a home that problematic drywall may impact directly (mechanical, plumbing and electrical) or which may be impacted as a consequence (casing, molding, doors, insulation, counters, wall finishes) of remediation to remove the source of the corrosion.
7. **Chamber Testing:** A small room, or container, used to condition specimens for a variety of physical tests in controlled temperature, humidity and atmospheric environments. Test chambers may be set at a certain set of conditions or programmed to cycle through specific sequences of conditions.
8. **Clearance Testing:** Testing used to provide confirmation that all problematic drywall and affected building materials have been removed and that corrosive gases are at usual environmental background levels.
9. **Constituent:** An essential component or element that makes up part of a unit or definable entity.

10. **Consumer Product Safety Commission (CPSC):** The Consumer Product Safety Commission is an independent federal regulatory agency created by Congress in 1972 in the Consumer Product Safety Act. The CPSC's mission is to protect the public from unreasonable risks of injury and death associated with consumer products.
11. **Corrosion:** The eating away and eventual destruction of metals and alloys by chemical attack. Rusting of ordinary iron and steel is the most common form of corrosion.
12. **Corrosion Control:** Proactive actions taken as the result of an assessment or study to control or eliminate an electrolytic or chemical attack to the surface of a material, usually a metallic substance.
13. **Corrosivity:** The ability of a substance or chemical to cause corrosion in metals and alloys.
14. **Endotoxin Test:** Bacteria can injure human tissue by producing poisons or toxins. Endotoxins usually are part of the cell wall of particular types of bacteria. The constituents of various bacterial endotoxins are known, and their presence can be determined by specific laboratory tests.
15. **Federal Interagency Task Force:** A federal task force on problematic drywall comprised of representatives from the U.S. Consumer Product Safety Commission, the Department of Housing and Urban Development, the Environmental Protection Agency and the Centers for Disease Control and Prevention.
16. **High-Efficiency Particulate Absorbing (or, arrestance) filter (HEPA):** A HEPA filter by definition removes at least 99.97% of airborne particles 0.3 micrometers (μm) in diameter.
17. **High-Performance Liquid Chromatography (or, High-Pressure Liquid Chromatography) (HPLC):** A form of column chromatography used frequently in biochemistry and analytical chemistry to separate, identify and quantify compounds based on their idiosyncratic polarities and interactions with the column's stationary phase.
18. **Indoor Air Quality (IAQ):** This refers to the purity of the air in indoor environments.
19. **Inorganic:** A chemical or substance composed of matter that is neither plant nor animal, such as a metal like iron or copper.
20. **In-situ (In Place):** (Latin) Meaning in the original position or place. Here, it refers to leaving the problematic drywall in place after construction while attempting to eliminate or control the gas emissions.
21. **Inspection:** The act of examining or assessing a residence or building to determine whether problematic drywall has been removed.

22. **Instrumentation, Systems and Automation Society (ISA):** An international, nonprofit, educational organization which promotes the advancement in the theory, design, manufacture and use of sensors, instruments and devices in automation. It also sets standards used in the measurement of corrosive gases capable of damaging such equipment, which is particularly vulnerable to corrosion because of the copper and other metals they contain.
23. **Job-Hazard Analysis (JHA):** A job-hazard analysis is a technique employed by a contractor that evaluates job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools and the work environment.
24. **Migration Patterns:** The pathway of movement from one place to another. Here, it refers to the movement of gas emissions from the problematic drywall throughout the home.
25. **Multi-District Litigation (MDL) 2047:** In the United States MDL refers to multi-district litigation, a special federal legal procedure designed to speed the process of handling complex cases such as air disaster litigation or complex product liability suits. Cases subject to MDL are sent from one court to another for pre-trial proceedings only, after which they are then remanded to the originating court for trial. For problematic drywall the MDL refers to MDL 2047 Chinese-Manufactured Drywall Products Liability Litigation before the Honorable Eldon E. Fallon of the United States District Court for the Eastern District of Louisiana.
26. **Multi-variate Analysis:** Involves observation and analysis of more than one statistical variable at a time. Such an analysis would be used to study the differing effects on the brain of various influences such as lead, cigarette smoke, alcohol, cocaine, aspirin and hydrogen sulfide.
27. **Non-Problematic Drywall:** Any drywall that does not emit gases containing substances at levels capable of causing corrosion or damage to metals and alloys.
28. **Occupational Safety and Health Administration (OSHA):** An agency of the United States Department of Labor. Its mission is to prevent work-related injuries, illnesses, and occupational fatality by issuing and enforcing rules called standards for workplace safety and health.
29. **Off-gassing:** Release of chemicals from various nonmetallic substances under normal conditions of temperature and pressure.
30. **Organic:** A substance that is related to or derived from living organisms. Such a substance contains carbon compounds such as carbon dioxide.
31. **Organosulfides:** The compound formed when sulfur combines chemically with organic or carbon-containing substances, such as carbon di-sulfide.

32. **PEX Plumbing Piping:** A cross-linked polyethylene piping material that is durable under temperature extremes and chemical attack and resists creep deformation, which is why it is used for hot and cold water applications.

33. **Personal Protective Equipment (PPE):** Protective clothing, hard hats, goggles or other garments designed to protect the wearer's body from injury for job-related occupational safety and health purposes.

34. **Problematic Drywall:** Drywall imported from China that emits reduced sulfur compounds resulting in corrosive damage within the home. Also referred to as corrosive drywall.

36. **Qualified Environmental Professional:** A trained professional who will assess the extent of the drywall problem, develop a site-specific work plan and potentially provide oversight during remediation. This individual could be an industrial hygienist, a building scientist or an engineer familiar with residential building systems.

37. **Reliability:** The extent to which a test or measurement gives the same or compatible results in different experiments or trials. That is, the test is repeatable and consistent. Another researcher should be able to perform exactly the same test or experiment with similar equipment under similar conditions and achieve exactly the same results.

38. **Remediator:** The home builder, contractor or other trained professional engaged to perform the work necessary to remove and replace problematic drywall from a home.

39. **Restoration:** The act or process of renewal and refurbishment of the home, which may include rebuilding, replacing or re-installation, as applicable, of removed building systems and materials and appliances damaged by problematic drywall.

40. **Reduced Sulfur Compounds (RSC):** Typically associated with problematic drywall, these include: hydrogen sulfide, carbonyl sulfide, carbon disulfide and sulfur dioxide.

41. **Selective (Partial) Remediation:** The removing or stripping of all drywall products, and removal of any affected building system from a limited portion of a home where the presence of problematic drywall can be isolated, as well as the restoration/rebuilding of that portion of the home, along with restoring/replacing all removed systems and materials. The removing or stripping includes, but is not limited to, cabinetry and joinery, carpeting, HVAC coils and ductwork, plumbing fixtures and piping, electrical distribution components, including receptacles, switches and circuit breakers and fire-suppression sprinkler systems and fire safety alarm devices, including smoke and carbon monoxide alarms and gas service piping from a home.

42. **Source Elimination:** The act or process of expelling or removing a substance that may cause damage. In the context of problematic drywall remediation, this means the removal of all problematic drywall from a home.

43. **Source Reduction:** The act or process of reducing or lessening the amount of a substance that may cause damage. In the context of problematic drywall remediation, this means those steps short of full removal of all problematic drywall from a home.

44. **Sulfides:** Sulfur combines with most metals and non-metals to form sulfides; examples are copper sulfide and hydrogen sulfide.

45. **Tedlar Bags:** Tedlar bags are used to collect samples containing common solvents, hydrocarbons, chlorinated solvents and many other classes of compounds. They also are used to collect low-level sulfur gases, but only if the bag fittings are non-metallic (polypropylene, teflon or nylon). The bags are manufactured from polyvinyl film and are generally considered inert. They can be clear or blackened.

46. **Temporary Superficial Adhesion:** The molecules of the emissions from problematic drywall will attach (adhere) themselves to materials and furnishings in the home in a process known as physisorption. The two materials (emissions and wood) are held together by an attraction between two molecules, each of which has regions of slight positive and negative charge. These positive and negative charges are a transient effect that can occur in any molecule as the random movement of electrons within the molecules may result in a temporary concentration of electrons in one region. In problematic drywall, the natural decay of the emissions, exposure to sunlight or dilution in air will break these bonds and the "temporary" attachment to materials or furnishings in the home will be lost and the emissions eliminated.

47. **The Agency for Toxic Substances and Disease Registry (ATSDR):** A United States federal agency located in Atlanta, Ga., as a division of the Centers for Disease Control and Prevention (CDC) (Title 42 Sub Chapter II Part B §247d-4) and under the Department of Health and Human Services (HHS) (Title 42 Chapter I). It was created by the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 42, Chapter 103).

48. **The National Ambient Air Quality Standards (NAAQS):** Standards established by the United States EPA (Title 42 Chapter 85) under authority of the Clean Air Act (42 U.S.C. 7401 et seq.) that apply to outdoor air throughout the country. Primary standards are designed to protect human health, with an adequate margin of safety, including sensitive populations. NAAQS requires the EPA to set standards on six criteria air contaminants: ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxides and lead.

49. **The National Emissions Standards for Hazardous Air Pollutants (NESHAP):** Emissions set by the United States EPA for an air pollutant not covered by NAAQS that may cause an increase in fatalities or in serious, irreversible or incapacitating illness. The standards for a particular source category require the maximum degree of emission reduction that the EPA determines to be achievable, known as the Maximum Achievable Control Technology (MACT). These standards are authorized by Section 112 of the Clean Air Act and the regulations are published in 40 CFR Parts 61 and 63.

50. **The National Institute for Occupational Safety and Health (NIOSH):** A United States federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control and Prevention (CDC) within the U.S. Department of Health and Human Services. (Title 42 Part 87)

51. **The United States Environmental Protection Agency (EPA):** A federal agency created by Congress in 1970 (Title 42 Chapter 85). The EPA's mission is to protect human health and to safeguard the natural environment, air, water and land upon which life depends. When Congress writes an environmental law, EPA implements the law by writing regulations. Often, EPA sets national standards that states and tribes enforce through their own regulations.

52. **Total (Full) Remediation:** The removing, or stripping of all drywall products and removal of any affected building system and the restoration/rebuilding of the home by restoring/replacing all removed systems and materials. The removing or stripping includes, but is not limited to, cabinetry and joinery, carpeting, HVAC coils and ductwork, plumbing fixtures and piping, electrical distribution components, including receptacles, switches and circuit breakers and fire-suppression sprinkler systems and fire safety alarm devices, including smoke and carbon monoxide alarms and gas service piping from a home.

53. **Transference:** The conveyance or transfer from one material or substance to another. Here, it refers to malodor or corrosive gases moving from the drywall to other elements in the home, such as wood or textiles.

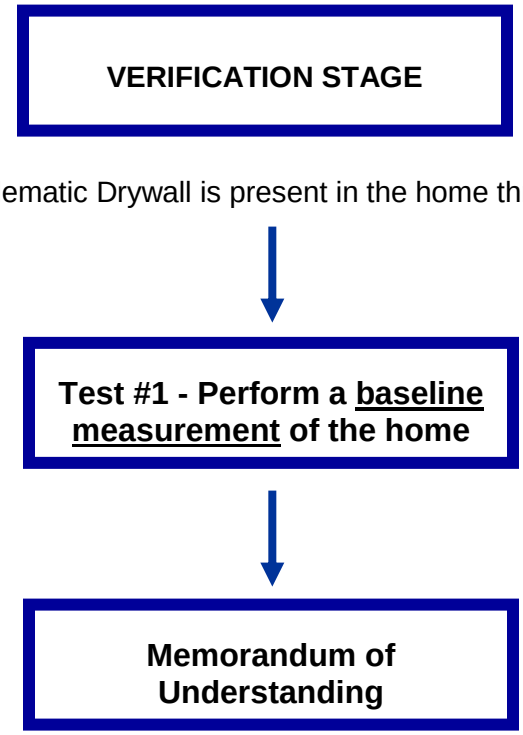
54. **Trigeminal Nerve:** This is the fifth cranial nerve, which arises from the brainstem and divides into three branches that are responsible for sensation in the face and head, as well as the mucous membranes lining the nose, mouth and sinuses beside the nose and the surface of the eyes. It also is involved with movement of the muscles used in chewing food.

55. **Validity:** Defines the strength of the final results of a test or experiment and whether those results accurately describe or measure the item being tested. Validity refers to whether a study is able to scientifically answer the questions it is intended to answer.

56. **Volatile Organic Compounds (VOC):** Organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the earth's atmosphere. Volatile organic compounds are numerous and varied.

57. **X-ray Fluorescence (XRF):** The emission of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombardment with high-energy X-rays or gamma rays. The phenomenon is widely used for elemental analysis and chemical analysis, particularly in the investigation of metals, glass, ceramics and building materials, and for research in geochemistry, forensic science and archaeology.

3. Identification and Remediation Guidance at a Glance



Begin Deconstruction of Structures with Problematic Drywall

Remove appliances, architectural materials, problematic drywall, electrical distribution components, plumbing, fire sprinkler systems, mechanical systems and insulation.

Dispose of Drywall

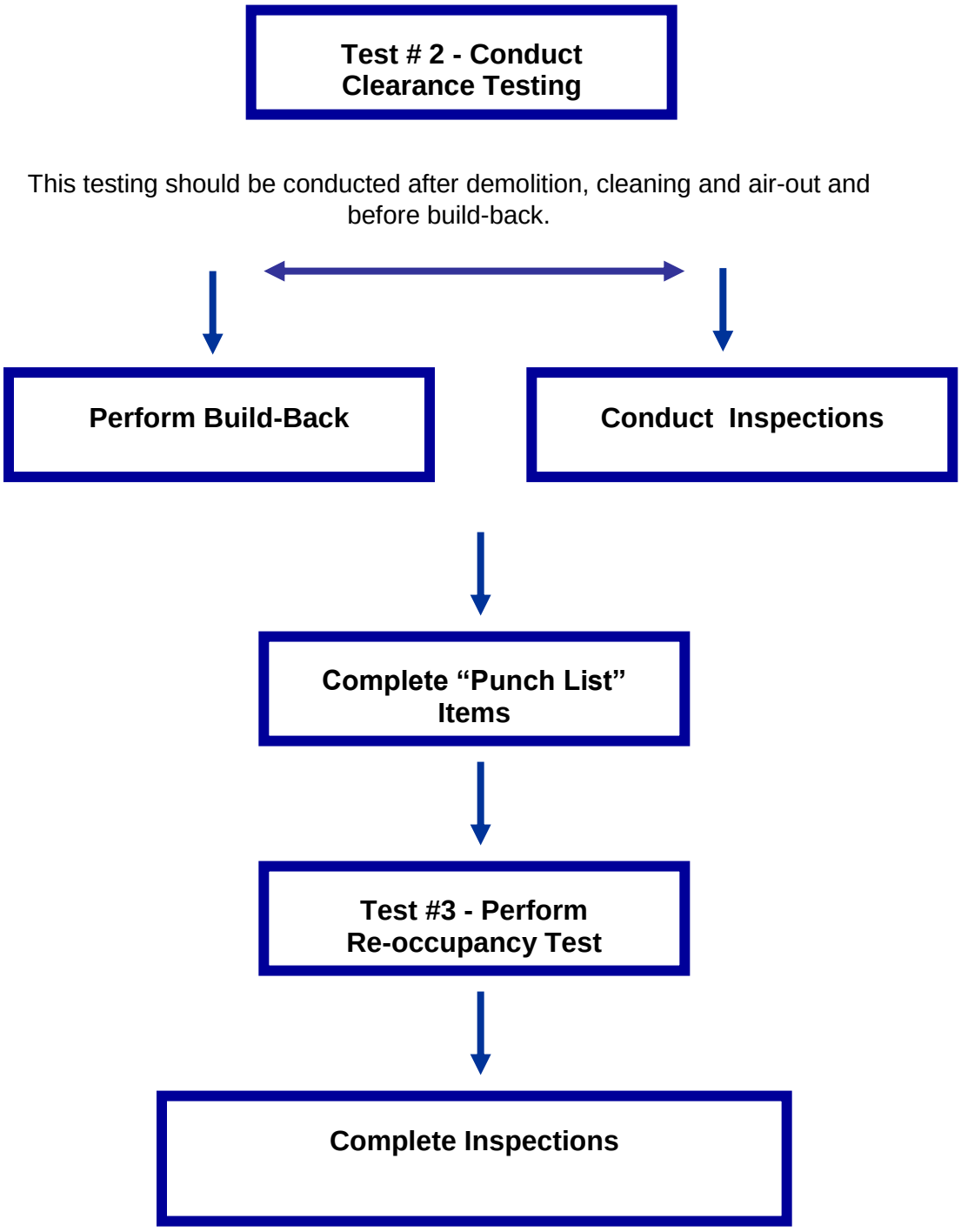
Perform disposal pursuant to local and state disposal requirements.

Perform Cleaning

The home should be swept, HEPA vacuumed and all interior surface areas wiped down to remove dust and/or debris.

Perform Air-Out

Open the windows in the home and allow the home to air out for a minimum of 14 days.


Test # 2 - Conduct Clearance Testing
This testing should be conducted after demolition, cleaning and air-out and before build-back.
Perform Build-Back
Conduct Inspections
Complete “Punch List” Items
Test #3 - Perform Re-occupancy Test
Complete Inspections

4. Scientific Facts - Problematic Drywall

A. Overview

This section of the guideline was developed to assist members of the National Association of Home Builders to understand what problematic drywall is and whether problematic drywall is present in a home. It is important to understand the scientific facts behind problematic drywall in order to develop a home inspection or screening procedure that can detect the presence of problematic drywall and will be cost effective and easy to deploy. The scientific concepts related to problematic drywall include:

- The construction of gypsum board.
- The source of contamination for problematic drywall.
- The chemistry of problematic drywall.
- Airborne compounds produced as a result of problematic drywall.
- Corrosion damage resulting from problematic drywall.

After the scientific facts are explained, the next section of the document will outline:

- How to perform a visual home inspection on a home that may contain problematic drywall.
- A testing strategy to assist the builder in determining whether various airborne compounds that are produced from problematic drywall are present in the home.
- The health effects for homeowners who may be living in homes with problematic drywall.
- In-situ [in-place] remediation techniques.

B. Scientific Concepts

i. The Construction of Gypsum Board

Drywall or gypsum board is the name applied to a family of panel-type products consisting of a noncombustible core, primarily of gypsum, with a paper surfacing on the face, back and long edges. Gypsum board also is known as drywall, wallboard, sheetrock, gib board or plasterboard.

A gypsum board panel is made of a paper liner wrapped around an inner core made primarily from gypsum plaster, a form of calcium sulfate. Raw gypsum is either mined or obtained from flue-gas desulfurization. Gypsum plaster is mixed with fiber (typically paper and/or fiberglass), plasticizer, foaming agent, finely ground gypsum crystal and various additives that increase mildew resistance, moisture resistance and fire resistance. The gypsum board is then formed by sandwiching a core of wet gypsum between two sheets of heavy paper or fiberglass mats. When the core sets and is dried in a large drying chamber, the sandwich becomes rigid and strong enough for use as a building material.

By code, all gypsum board used in the United States must meet requirements of ASTM C1396, Standard Specification for Gypsum Board.[1] These specifications and standards address the physical properties of drywall. With the exception of guidelines on banning the use of some unsuitable types of synthetic gypsum, such as phosphogypsum, there are presently no standards which address the chemical composition of drywall.[1] However to maintain industry-wide quality-assurance standards, all members of the Gypsum Association subscribe to an ongoing third-party, in-plant product inspection and labeling service. The Gypsum Association is a not-for-profit trade association that promotes the use of gypsum while advancing the development, growth and general welfare of the gypsum industry in the United States and Canada.

ii. The Source of Contamination for Problematic Drywall

Gypsum, which is approved for use as a food additive, is not considered a toxic or hazardous material. Naturally occurring impurities in gypsum are a potential source of drywall contamination. These impurities can include mineral salts, carbon-containing materials (e.g., oil shale) and elemental sulfur.[2]

Some of the drywall imported into the United States is alleged to have been made from gypsum that contains high levels of impurities. Impurities at levels high enough to result in the manufacture of corrosion-causing drywall are believed to have been found in China. Some of this drywall was shipped to the

United States. Raw gypsum, apparently from China, was reported to have a detectable sulfur-like odor. This odor became even more noticeable after the raw gypsum was processed into drywall, a procedure that involves grinding and burning.[2]

Several other unsubstantiated theories have been presented regarding the origin and nature of drywall contamination responsible for corrosion and/or health effects. Those theories include:

- Gypsum was mixed with fly ash (no evidence).[2]
- Gypsum was manufactured from phosphogypsum, a by-product of phosphate mining, and radioactive (tests ruled this out).[3]
- Gypsum contained asbestos (tests were negative).[4, 5,]
- Gypsum contained bacteria (no evidence).[6]
- Drywall odor is produced by additives, pesticides or fungicides (no evidence).[2]

Recent reports have suggested that similar sulfide contamination also is produced by some American-made drywall. Test data comparing American and Chinese drywall do not support this theory.[7] However, drywall made from recycled waste that included problematic Chinese drywall is a potential source of contamination.

Research has been conducted by the United States government and others to define the chemical constituents that differentiate problematic from non-problematic drywall. Results reveal, while most constituents are similar, elemental sulfur is much more concentrated in problematic drywall.[8] One other constituent—strontium—also has been evaluated by several research efforts.[9,10] Additional work completed by the CPSC and its contractor, Environmental Health & Engineering (EH&E), was published in its report of May 28, 2010.[11] As a result of this additional work, sulfur content is now accepted by both CPSC and HUD as "the marker most directly correlated with the reports of problem drywall in a home."[12] In general, any detection of elemental sulfur indicates a potential for corrosive emissions. In its Revision 1 to the Interim Guidance-Identification of Homes with Corrosion from Problem Drywall (August 27, 2010),[13] the Consumer Product Safety Commission and HUD stated: "The Task Force now believes that the best and preferred practice for identifying the presence of Chinese drywall in a home does not include the use of strontium as one of the corroborative factors…its use may lead to false-positive results."[12] The Task Force did point out that "it is important to note that the screening for strontium with specially calibrated X-ray fluorescence analyzers may still be a cost-effective and efficient manner in which to *preliminarily* identify areas of a

home possibly affected by problem drywall for further testing such as elemental sulfur in those areas."[12] Current research has revealed that strontium levels varied in both domestic and imported drywall among the various brands of drywall imported from China.[14]

iii. Chemistry of Problematic Drywall

Although various theories have been proposed, the chemistry of problematic drywall has yet to be resolved. Knauf-Tianjin (KPT), a manufacturer and importer of problematic drywall, had scientists at the Fraunhofer Institute for Building Physics in Valley, Germany, conduct research. Their published research results suggested that a reaction involving elemental sulfur, carbon-containing material, heat and water resulted in formation of various sulfides responsible for causing odor and corrosion.[2] Theories that suggested either carbon monoxide or bacteria play a significant role in the production of sulfur gas-containing emissions from problematic drywall have not been supported by research results.[15,16,6]

In order to understand how problematic drywall emissions occur [emission dynamics] experiments were performed that compared initial emissions with those at later times, and estimated the duration of off-gassing. With respect to problematic drywall, both corrosivity and odor should be tracked to determine how emissions vary by ambient temperature, relative humidity, season, weather changes and time of day.

One investigator reported that problematic drywall emissions increased tenfold when temperature was raised from 75 degrees to 100 degrees Fahrenheit.[9] Others report similar increases with rising relative humidity.[17]

Other factors that may be evaluated when investigating problematic drywall emissions include:

- Variance between sites within a home.
- The impacts of construction.
- Ventilation.
- HVAC operation.
- How emissions are affected by other environmental factors.
- Migration patterns (air pathways).
- Quantity and location of problematic drywall in a home.

iv. Airborne Compounds Produced as a Result of Problematic Drywall

Limited, preliminary testing by Fraunhofer Institute scientists found the following compounds were higher in air during laboratory testing of problematic versus non-problematic drywall:

- **Organosulfides**
  - methanathiol
  - propanethiol
  - (ethylthio) propane
  - butyl ethyl sulfide
  - 2 methyl 3 furanthiol
  - diisopropyl disulfide
  - isobutyl isopropyl disulfide
  - diethylthiophene
  - ethyl isopentyl disulfide

- **Other trace volatile organic compounds**
  - 2,3 butanedion
  - 3 methylbutanal
  - 1-hexen-3-one
  - Hexanal
  - 2 acety 1 pyrroline
  - 1 octen 3 one
  - Octanal
  - z-2-nonenal[2]

Investigators generally agree that organosulfides are a key component of problematic drywall emissions.[2,15,18,19] Hydrogen sulfide and carbon disulfide have been detected in some testing, but were not significant in the limited work reported by Fraunhofer.[2] The CPSC reported that, in multi-variate analyses, hydrogen sulfide concentration in the indoor air was associated with both copper and silver corrosion.[18] It should also be noted, however, that the characteristic, rotten-egg odor of hydrogen sulfide is not noticeable in problematic drywall homes. Rather, corrosive drywall odor appears more consistent with a mixture of organosulfides. Because problematic drywall emissions are a complex and unstable mixture, specific sulfides and other VOCs can be expected to vary among samples. Significantly, all of the individual problematic drywall emissions are in the very low range (a few parts per billion)[2,18] and highly reactive, disappearing quickly. For both of these reasons, they are extremely difficult to detect, particularly when sampling is performed in a large area such as inside a home.

v. Corrosion Damage Resulting From Problematic Drywall

Black tarnishing is consistently observed on exposed copper in homes containing problematic drywall. Black tarnishing is primarily found on electrical and mechanical components. Other metals such as brass, chrome and silver may also be affected. Black tarnishing is generally caused by a metal surface reacting with sulfide compounds and moisture. These conditions are rarely observed in newer homes containing non-problematic drywall, except in cases where a “rotten egg” odor is present from sulfur water (potable or irrigation) or sewer gas.

Air-conditioning systems have failed in homes containing problematic drywall where corrosive air is in contact with the air-conditioner evaporator coils under moist conditions. Corroded coils have leaked refrigerant, causing the system to malfunction and stop cooling. Visible blackening of the air-conditioning coils is typical and easy to identify.

The prevalence of other corrosion damage is subject to debate. There have been some reports of electronic devices, such as refrigerators and microwave ovens, being affected. There also is concern that smoke and carbon monoxide detectors may be compromised.[20] As a result of the CPSC-directed investigative efforts, Remediation Guidance was published in March 2011. This guidance addressed life-safety issues and directed that, as part of the remediation, all electrical distribution components, including receptacles, switches and circuit breakers be removed along with gas service piping and fire suppression sprinkler systems, and safety alarm devices, including smoke and carbon monoxide alarms exposed to problematic drywall.[21] The CPSC is no longer recommending necessarily the removal of all electrical wiring in the home.

Some investigators state that the corrosion is superficial and can simply be wiped off.[22] Others state that electrical and mechanical components in areas with any sign of tarnishing should be replaced as a precaution because corrosion may be progressive, even after emissions have been controlled.[16] As a precaution, many problematic drywall remediation projects simply replace all mechanical and electrical systems and appliances. These projects have generally not included an assessment to identify which electrical and mechanical components can be reused safely.

IDENTIFICATION STRATEGIES

5. How to Perform a Visual Home Inspection on a Home That May Contain Problematic Drywall

A. Current Guidelines

The federal government,[23] the state of Florida,[24] ASTM (draft),[25] the Florida State Task Force for Chinese Drywall Removal[26] and the Multi-District Litigation (MDL)[27] have each issued guidelines for home inspections to identify whether problematic drywall is present in a home. These guidelines can be summarized as follows:

- All of these guidelines include visual inspection of metal surfaces to locate black tarnishing, particularly copper wiring, plumbing and air-conditioning coils.
- None of these guidelines uses tarnishing patterns or construction history to estimate the location of problematic drywall panels in homes with mixed drywall.
- Two of these guidelines prescribe follow-up laboratory analytical testing to confirm that tarnishing is sulfide corrosion.[23,24]
- Two of these guidelines document electrical/mechanical failures.[26,24]
- All of these guidelines suggest collecting drywall samples for evidentiary purposes and testing to determine chemical composition of the drywall.
- Three of these guidelines mention odor, but do not include a procedure for identifying it.[24,26,27]
- All of these guidelines suggest documentation of drywall labels, but do not classify them by corrosivity.
- All of these guidelines focus on drywall purchased after 2001, but none uses construction history to help locate problematic panels in mixed drywall homes.
- None of these guidelines references air testing or exposure assessment.
- None of the guidelines specify observations needed to design a remediation project.

A new procedure for home inspection, along with specific criteria for decision-making, has been developed that takes into consideration our review of evaluative efforts, including the above guidelines, field experience, practicality and ease of use, as well as cost.

B. Home-Screening Procedure

To conduct an investigation of a home and to determine if the home contains problematic drywall, the following should be considered:

1. Ask Some Initial Background Questions That Include:
   - When did the construction begin?
   - When was the drywall installed?
   - What is the basis for suspecting problematic drywall is in this home?
   - Summarize construction records or related information suggesting the origin of drywall and where it was used in the home.
   - Describe HVAC systems and associated zones.
   - List potential sources of odor, corrosivity and excess moisture.
   - Are there any health concerns that coincide with time spent in the home?
   - When and where have sulfur-type odors been detected?
   - Where has black tarnishing been observed and is it suspected of causing HVAC and other system failures?

2. Conduct an Odor Evaluation:
   - Prior to inspection, windows and doors should be closed, fans, air cleaners and fragrance generators turned off and odor-producing activities discontinued.
   - Upon first entry, note whether a sulfur-type odor is detectable (none? not sure? slight? strong?) and where it is most noticeable.
   - Simultaneous opinions about the presence and location of the odor by more than one individual are better for identification.

3. Conduct a Visual Inspection:
   - Note any black tarnishing on exposed metal surfaces (e.g., piping, appliances, mirrors, fixtures, contents).
   - Access AC coils and note any black tarnishing.
   - Remove electrical outlet and light covers and note any black tarnishing on copper ground wires.
   - Also check inside light fixtures and breaker boxes.

4. Label Identification:
   - Check for labels behind exposed drywall panels (e.g., unfinished areas, attic floor, chases/plenums).
   - Labels that say “China” or have Chinese lettering, or no marks at all may or may not be problematic but can be indicative of imported drywall that may warrant further investigation.

- Document labels for comparison to lists suggesting which drywall may be problematic.

5. General Inspection:
   - Note any other sources of corrosion or odor such as recycled, sulfur-containing water for irrigation or landscape features, sulfur-containing drinking water or sewer-gas odors.
   - Note any conditions suggesting past or current water damage in the home that may suggest another source impacting building materials such as drywall.

6. Classifications:
   - No Indications of Problematic Drywall Problem
     Drywall installed prior to 2002 or no observed black tarnishing or detectable problematic drywall-type odor, under closed warm conditions
   - Problematic Drywall Throughout
     Black tarnishing observed in most electrical outlets and AC units
   - Localized Problematic Drywall
     Black tarnishing limited to specific areas

7. Information From the Inspection Screening Can Be Used to Help Determine:
   - Locations of problematic drywall (additional sampling and laboratory analysis may be necessary)
   - Electrical and mechanical components requiring replacement
   - Relative significance of exposure
   - Appropriate response actions

6. Testing Strategies to Assist a Remediator in Determining Whether Problematic Drywall Is Present in a Home

Testing for various airborne compounds can supplement visual inspection. Measuring the amount of air corrosivity in the air that is above normal background appears to be the most practical and reliable method for determining whether problematic drywall is in a home. The CPSC used this method in its indoor testing of 51 homes. Air-corrosivity testing also can be used to perform clearance and verification to confirm that remediation has successfully removed excessive airborne compounds. Other methods for testing the presence of specific airborne compounds have proven difficult and expensive because of the precision required, the need for specialized collection techniques and the low levels to be assessed. A detailed discussion of currently available commercial test methods is contained in Appendix A.

A. Hiring Professionals to Assist With Testing Drywall

As a first step in performing air-corrosivity testing to identify whether problematic drywall is present in a home, the remediator should consider hiring an independent qualified environmental professional, industrial hygienist or building scientist who can assist the remediator in testing for problematic drywall. This individual will assess the extent of the drywall problem, develop a site-specific work plan and develop a testing program to be applied throughout the remediation. The qualifications of the individual performing the assessment and designing the test strategy should have, at a minimum, a relevant science or engineering degree and two years of full-time supervised experience. (These qualifications are based on recommendations by the American Industrial Hygiene Association.)

The qualified environmental professional may choose to work with a competent individual who is on site and who will be trained by the professional in the air corrosivity testing methodology. Once the qualified environmental professional has designed the site-specific testing strategy, the chosen on-site individual will assist in the placement and collection of samples for sample analysis. This individual could be, for example, the builder or construction supervisor.

B. Current Testing Strategies for Problematic Drywall

When a qualified independent professional is testing the air to determine the presence of various airborne compounds, three measurements are taken at various points in time.

The first measurement is a **baseline measurement,** taken after the home screening/inspection procedure has concluded a home may have problematic drywall. Since a baseline measurement is the first measurement taken, it must be performed prior to the removal of any personal contents and any remediation activity including removal of any drywall. Subsequent samples will be compared to this initial reading.

The second measurement is a **clearance measurement** and is taken after the problematic drywall has been removed, cleaning and air-out has been performed but before the build-back has occurred. This measurement will assist in determining whether the remediation activities completed at this point have removed drywall associated various airborne compounds from the home.

The third measurement is a **re-occupancy measurement** and is performed prior to the homeowner moving back into the home after build-back is completed. This measurement verifies the elimination of drywall associated with various airborne compounds that have been removed from the home.

The relative criteria for interpreting the data results can be placed into three general categories. These categories represent the amount of various airborne compounds present in a home, or in an addition, and are categorized as mild, moderate and severe. Test results that fall in the moderate or severe ranges indicate various airborne compounds are still present in the home. Mild readings indicate various airborne compounds may be in the home, attributable to typical background levels. Background levels of various airborne compounds can be present in homes depending upon environmental factors. These environmental factors can include whether a home is located close to a swamp or in the middle of the desert. Additional factors that can affect background levels include the use of cleaning products in the home such as bleach.

C. Measuring Air Corrosivity: Metal Coupons or Probes

Air corrosivity can be measured using a simple metal strip called a probe, or a coupon.[28,29] Based on cost, ease of use and time saved, a metal probe is recommended. The probe is left at the home site for a predetermined number of days. It is then collected and read by a qualified professional using a corrosion

rate instrument. This device and the interpretation of the results require expertise and training.

There are some things that can interfere with accurate measurements. These include sulfur-containing water and sewer gas. Other causes of corrosion such as bleach might also affect the accuracy of the reading. The metal strip will only detect current corrosivity. Neither past nor future emissions can be determined, including those increased by elevated temperature or humidity.

Below is a discussion of some different methodologies based on air-corrosivity testing:

1. CPSC Air-Corrosivity Methodology

In its indoor air testing of 51 homes, the CPSC used metal coupons that were left in the homes for fourteen days and then sent to a laboratory for analysis. The CPSC found distinct differences in the corrosion rates of the ground wires in complaint homes (homes with problematic drywall), as compared to noncomplaint homes (homes without problematic drywall). Various airborne compound levels in the air of noncomplaint homes were in the mild range. In contrast, levels in complaint homes were in the moderate-to-severe range. (See Appendix A for more detailed explanation.)

Advantages:

- Easily placed and left undisturbed in the home.
- Ease of handling (coupon has a plastic case with the metal wires inside.

Disadvantages:

- Manufacturer recommends leaving in place two to four weeks.
- Coupons are expensive.
- Laboratory analysis takes weeks (up to four) and is expensive.
- The scale used to determine whether the coupon indicates the presence of problem drywall has not been validated for use in the setting of a home or building. The only scale in use is the CPSC's observations as describe in its 51-home study.[11]

2. BHS Air-Corrosivity Methodology

NAHB is aware of at least one methodology that has refined air-corrosivity testing expressly for homes with problematic drywall. Building Health Sciences located in Rockville, MD, measures air corrosivity with a copper metal probe and the use of a specially designed meter (dosimeter) that can read the probe results instantaneously at the test site. The criteria for interpreting the probe results have also been refined for use in homes or buildings.

Advantages:

- Easily placed and left undisturbed in the home.
- Remains in place three days.
- Can be read with dosimeter at the home, or can be mailed to the qualified environmental professional for reading.
- Reading and interpretation is immediate.
- Probes are inexpensive and can be reused; they can be mailed to the location for placement by the trained, on-site individual.
- The scale used to determine whether there is problem drywall in the home has been tested and developed specifically for use in the setting of a home or building.

Disadvantages:

- Proper handling of the probe requires training by the qualified environmental professional.
- Dosimeter is expensive.

3. Other Air-Corrosivity Methodologies

There are other methods of measuring air corrosivity that are being used in the field. All of these have in common the use of a copper metal strip. They differ in the source supplying the strip, the standardization of the strip and in the laboratory method of interpreting what the strip shows.

Disadvantages:

- Each of these methods is unique to the group using it.
- Each method, as well as the laboratory interpretation of the results, has not undergone scientific testing for reliability and validity.

D. Probe Test Methodology

As stated previously, based on cost, ease of use and time saved, the metal probe method is recommended. The probe is left at the site for a predetermined number of days and is then collected and read by the qualified independent professional using a meter.

1) Number and Placement of Metal Probes

An experienced professional should select the number of probes to be used and their proper placement in the home. This individual will need to know construction information collected in the Home Screening Procedure.

2) Timing of Probe Placement

The metal probe should be placed using the following sequence:

a. Prior to the start of any work in the residence, before the removal of any personal items and before any remediation activity:
   - **Baseline Sample** – This is an indoor control sample to be used for future reference; to assess and document the condition of the home and the level of various airborne compounds. Subsequent samples will be compared to this initial baseline reading.

b. Post remediation and air-out (before build-back) and prior to restoration:
   - **Clearance Sample** – This indicates the absence or presence of various airborne compounds to evaluate whether the remediation activities taken have been adequate to eliminate drywall-related corrosive gases.

c. Prior to move-in:
   - **Re-Occupancy Sample** – This verifies the elimination of drywall associated corrosive gases.

d. Optional Sample:
   - **Outside Sample** – An additional sample taken outside would be required at each of the stages noted above if there are sewer gas or sulfide odors present outdoors, such as from recycled sulfur-containing water for irrigation and landscaping water features.

3) Probe Reading

As already noted, a qualified independent professional at the testing site can read the probe by using the meter. Alternatively, an on-site individual can be instructed in the proper handling of the probe, which can then be placed in a mailer and returned to the trained professional who will, using the meter, determine the result remotely.

4) Probe Results: After remediation and air-out “clearance,” prior to restoration

The results discussed below are provided for the general information of the remediator who is involved in remediating problematic drywall. This discussion is intended to clarify the test process, but is not a detailed explanation of every possible result and its implications.

Any remediation effort should be directed by a trained environmental professional who is familiar with the science of problematic drywall and various airborne compound emissions, as well as with proper remediation/restoration techniques and clearance testing strategies. Research is under way to refine the criteria used in corrosivity testing and probe interpretation. Corrosivity is emerging as a practical and extremely reliable indicator of removal of contamination from the affected home, but at present requires the expertise of the trained professional for interpretation.

As the CPSC found in its research, remediation is incomplete if the probe shows various airborne compounds are present at levels greater than expected background levels; that is, in the moderate or severe [high] range. Such a reading means various airborne compounds are still present and build-back cannot begin. Additional work is needed prior to repeating the clearance test. The qualified independent professional may need to provide further guidance.

7. Health Effects for Homeowners Who May Be Living in Homes With Problematic Drywall

A. Background

The concept that the indoor environment can, at times, be associated with adverse health effects is well-accepted. Indoor air-quality complaints commonly include reports of allergic and irritative symptoms related to the eyes, nose and throat.[30,31] Studies have revealed that emissions associated with building materials, furnishings, carpets and equipment such as appliances, computers and printers affect the indoor environment by producing odors and vapors.[32,33,34] The kinds of complaints or symptoms reported and attributed to the indoor environment, such as headaches, malaise, and fatigue, are often nonspecific in nature and could have many other causes, including, for example, stress. In many instances, finding the precise cause of the symptom may take extensive clinical and environmental evaluation, which is not practical.

B. Biological and Toxicological Plausibility

Odors themselves, particularly strong and/or unpleasant odors, can significantly increase the likelihood that an individual will experience discomfort.[33] In fact, odors themselves can produce adverse health symptoms. Schiffman and Williams [34,35] identified three possible mechanisms by which malodors can impact occupants. The first is irritation; that is, irritation causes the symptoms, rather than the odor. The odor does not cause the symptoms; it acts as the marker of the exposure. This mechanism could arise from more than one chemical substance, each of which is below the concentration causing irritation, but the additive effect of all of the chemicals exceeds the threshold for irritation.[36,37]

Various airborne compounds from problematic drywall consist of a variety of sulfur compounds, both inorganic and organic. Some of these have an odor and some are corrosive. Of these, some are mucous membrane irritants capable of causing symptoms at certain levels. Effects of inhaled irritants include “immediate burning or stinging sensation in the eyes, nose, or throat. ”These effects can produce varying levels of pain or discomfort. The irritants interact with nerve endings of the trigeminal nerve located in the cornea [of the eye], nose, tongue, oral cavity and upper respiratory tract.”[37,38] Different odorants, such as sulfide gases and aldehydes, can stimulate the same nerve endings.[37,38]

The second proposed mechanism is that adverse health symptoms can arise from the presence of odors despite the odorant being below the irritant threshold. While the mechanism by which health complaints develop in the absence of irritation is not known, there are several examples in the literature of communities in which health complaints were associated with low levels of hydrogen sulfide or odors from a waste site.[39,40,41,42,43,44,45,46,47] In some instances, the authors concluded that the perception that the odor or the source of the odor posed a health hazard was responsible for the development of the symptoms.

The odorant may not, of course, be the only source of a various airborne compound or irritant present in the environment. Thus, the third mechanism suggests there could be other co-pollutants which arise from the odor-active material or from other sources within the same indoor environment: VOCs and formaldehyde from wood products or other building materials, nitrogen dioxide from gas stoves [48,49] or outdoor various airborne compounds which enter the home, such as ozone or various airborne compounds from vehicles or equipment. In this mechanism, the odor merely causes the occupant to focus on the indoor environment and the discomfort, while contributing little to the actual symptoms caused by other substances in the same location.

When careful chamber testing was performed by German researchers at the Fraunhofer Institute of Building Physics,[2] odor-active sulfur compounds of marked intensity were found in a sample of drywall from one Chinese mine.[2] These compounds contribute to the perceived sulfur odor present in some problematic drywall-affected homes. Corrosive effects may or may not accompany the odor produced by odor-active sulfur compounds, since the corrosive sulfide compounds are not identical to those producing odor.[2,9,16]

Finally, if an occupant is aware that problematic drywall is present in the home and sees obvious blackened corrosion of the air-conditioner coils, this could induce fear that a health hazard is present and bias his or her perception that health symptom(s) being experienced are associated with the home. For example, eye or upper respiratory tract irritation in the occupant might be attributed to the problematic drywall, rather than to the actual cause. In the CPSC study, in those homes where malodor was not present, health complaints were not reported to the CPSC.[18]

C. Occupant Complaints: The CPSC Complaint Database

As of September 2010, over 3,500 consumer complaints have been reported to the CPSC from 38 states, the District of Columbia and Puerto Rico.[50] It is possible that this number may not reflect the full impact of the problem since not all affected consumers are aware of, and some are unwilling to report, the presence of Chinese drywall in their home.

Complaints related to the presence of problematic drywall include odors produced by various airborne compounds from the drywall, corrosion of metal items in the home involving elements of the electrical and mechanical systems and short-term adverse health complaints. The odors have been characterized as having a “rotten egg” smell, or an odor similar to a struck match. Not all of the homes reporting corrosion, however, had odors. The CPSC database of complaints as well as those from occupants from the study homes commonly included upper airway, nose, throat, and skin irritation. Odors themselves, particularly strong or unpleasant ones, induce symptom reporting, as discussed earlier.

Sulfides are known irritants at certain levels.[49,51] The concentrations of individual sulfide compounds in problematic drywall emissions are, when measured, generally below known irritant levels. Additive or synergistic effects of these compounds could explain the reported irritant effects in sensitive individuals.[18]

The irritant effects of sulfides are the result of their effect on the mucous membranes, the moist tissue that lines the eyelids and external surface of the eyes, as well as the upper respiratory tract. The latter includes the nose, sinuses, the mouth, palate, throat and upper airways.[49,51] In the eyes, burning, itching and tearing can occur, as well as blurred vision. Visual effects result from changes in the tear layer. If the eyes have a deficient tear layer, as occurs in an aging-related problem such as dry eyes, the irritant effects can be magnified, producing more intense symptoms.

Complaints in the nose can include non-allergic rhinitis (runny nose) and nasal congestion. With irritation and swelling of the nasal mucous membranes, the sinus ostia (openings) which drain into the nose can become narrowed or obstructed, leading to symptoms of sinus blockage with congestion and possibly headache. In the throat, irritation can produce a cough, hoarseness and discomfort with swallowing. Upper airway irritation is also associated with a cough, a feeling of chest congestion and the sensation of difficulty taking a deep breath. If an individual has asthma and hyper-reactive airways, a

concomitant of that condition, airway irritation can lead to spasm and potentially to an asthma attack.

No studies in the medical literature were found relating adverse health effects at low concentrations to the types of corrosive species identified during testing performed by federal and state agencies in the homes containing problematic drywall. As noted, however sulfides found in various airborne compound drywall emissions have been documented to affect the eyes and the respiratory tract at some concentrations.[49,51]

Most of the individual components of the reactive various airborne compounds produced by problematic drywall have not been studied individually for acute or chronic effects. However, as a class, sulfides are irritants and their measured levels in the drywall emissions are far below acutely toxic levels. They also are highly reactive and short-lived. They are not stored in the body, nor do they accumulate over time. Those compounds that have been studied in occupational exposures occurring over a period of years require much higher concentrations to show any chronic effects.[36,52,53,54] As a class, sulfides have not been found to cause cancer.[55]

The characteristics of sulfides—their reactivity, short-life and lack of accumulation in the body—mean that, once an individual leaves the residence containing problematic drywall, his or her exposure ends. Therefore, complete remission of any health complaints conceivably related to the drywall emissions can be anticipated.

8. Evaluation of Remediation Without Removal of the Drywall (*In-Situ* Remediation)

Information available from a number of firms offering methods for treating the effects of problematic drywall in a home was evaluated. The advertised benefit that i*n-situ* or in-place remediation offers to remediators is that they may avoid the cost and disruption associated with remediation methods that require relocation of the homeowner and removal of the drywall. These methods as well as advantages, disadvantages and verification are discussed below. NAHB concludes, with one exception of biochemical treatment, that none of these methods have been shown to be an adequate, long-term remedy for odor and the damaging effects of airborne emissions from problematic drywall. None of the in-place methods directly addresses the corroded electrical, plumbing/piping and mechanical systems.

Judge Fallon, who is presiding over the multi-district litigation concerning problematic drywall, has decided, with rare exception, that no form of remediation will be acceptable to the Court unless complete removal of all problematic drywall is performed.[56] Likewise, the CPSC recommends total removal of all possible problem drywall.

A. Chemical Gas Treatment

This approach involves release of chlorine dioxide gas in the home to inactivate the emission source. Although proven successful in controlling certain bacteria and hydrogen sulfide in oil and gas production, this method has not proven to be effective against a long-term source of emissions such as problematic drywall. The process of releasing chlorine dioxide gas has been applied to problematic drywall homes by commercial contractors who have circulated chlorine dioxide for several hours.[57] In some cases, homes were enclosed in a tent with the contents removed; in other cases, tenting was not performed and the contents left inside during treatment.

Advantages:

- Less time required than removal
- Lower cost

Disadvantages:

- While chlorine dioxide may react with airborne and surface sulfides, sulfide-producing material inside problematic drywall may not be inactivated.
- Can be damaging to material and contents.
- Does not address corroded electrical and mechanical systems.
- May create potentially harmful by-products.

Verification:

- To date there have only been anecdotal claims that problematic drywall emissions are resolved (no test data provided).
- Manufacturer-furnished validation chamber test shows inadequate performance with only a 20% reduction in hydrogen sulfide emissions.[58]

B. Absorption-Neutralization Process

These processes involve the application of proprietary coatings to the exposed drywall surfaces and ceilings. One method of application includes the drilling of holes in the drywall to inject the product under pressure into the wall cavities such that it coats the unexposed drywall surfaces and other building materials within the cavity. The vendors claim their coatings absorb and neutralize the problematic drywall emissions and seal the emitting surfaces.[59, 60, 61, 62]

Advantages:

- Less time required than removal
- Less expensive

Disadvantages:

- Inability to coat all cavity surfaces
- Does not address corroded electrical and mechanical systems
- Does not address residual odors on contents
- May leave potentially harmful residues

Verification:

- Anecdotal claims of successful control are presented without conclusive data.
- In one instance home test data[59] are based on methods lacking sensitivity to detect organosulfides.
- Manufacturer-furnished validation chamber testing is based on a piece of problematic drywall[59] fully coated in controlled conditions. These test circumstances may not be replicated when the product is sprayed into wall cavities between the wall framing and insulation in a residence.

C. Air Treatment – Handling

Two methods have been proposed for treating indoor air quality. One method is mechanical air scrubbing and the other indoor-air moisture reduction. These methods address only the problematic drywall airborne emissions with no attempt to treat the problematic drywall itself.

i) Air Scrubbing

A number of firms provide air-filtration systems to process the air and "reduce odor and corrosion." One firm that has placed its equipment in several test homes markets a proprietary filtration system for installation in the home's air-handling unit(s) that is reported to remove sulfide contaminants from the air.[63] Another firm provides a stand-alone air scrubber separate and apart from the home's HVAC system(s). The indoor air circulates through these air-scrubber devices, alters the chemical structure of various airborne compounds and renders them inactive. It discharges noncorrosive air.

Advantages:

- No relocation of occupants
- Lower cost than removal
- Immediate and temporary relief

Disadvantages:

- Source remains in place and continues emitting sulfides.
- Ongoing utility cost
- No protection during power outage.
- Does not address corroded electrical and mechanical systems.
- Ongoing costs to replace the filter media

Verification:

- Did not test for sulfides.[63]

ii) Moisture Reduction

Since sulfide emissions from problematic drywall appear to increase with moisture, reducing relative humidity, moisture sources or drying wet materials may be beneficial. Experimentation is required to determine whether this approach can achieve acceptable indoor air quality with respect to health, corrosion control and odor. Mechanical introduction of outside air and associated increased pressure in the residence could deliver drier air to wall cavities. This may also require adding dehumidification capacity to the home. Other actions to control condensation, leaks and wicking also would reduce the availability of moisture, which contributes to the generation of sulfide emissions from problematic drywall.

Emission reductions, which might be achieved from moisture control, could potentially be sufficient to improve air quality in homes with less severe problematic drywall problems or could provide temporary relief pending more

comprehensive remediation. Moisture control as a means of reducing problematic drywall emissions was attempted unsuccessfully in a pilot project performed in Louisiana and Florida by KPT (Knauf Tianjin), the results of which were presented in the multi-district litigation in the Southern District of Louisiana in February 2010.[27]

Advantages

- Pressurization from increased dry air to the wall cavities would reduce the rate of emissions.
- Increased fresh air would dilute various airborne compounds from problematic drywall.

Disadvantages

- Adding outside air and reducing summer humidity in Gulf Coast homes will require a larger-capacity air-conditioning unit.
- Problematic drywall emissions continue.
- Does not address corroded electrical and mechanical systems.
- Requires perpetual maintenance and increased energy costs. There is no performance data available.

D. Corrosion Resistance

Some components of electrical and mechanical systems damaged by problematic drywall emissions have been replaced with corrosion-resistant materials. For example, aluminum or coated air-conditioning coils have been installed. This can help prevent further corrosion, but does not address on-going emission of sulfides, odor, potential health effects or corrosion to electrical systems.

E. Biochemical Treatment

The product used to provide this form of *in-situ* treatment for problem drywall is a combination of substances formulated to neutralize the compounds produced by problem drywall, as well as VOCs (volatile organic compounds) from building materials. It is available in several different forms: foam, spray, liquid, fog and aerosol. All of these are water-based and nontoxic. The product is applied in foam form to the posterior side of the drywall and the wall cavity via holes drilled in the drywall. It also is applied to the front side, in a spray form. The occupied spaces of the home are then fogged with the same product.[64] Replacement of the air-handling unit is included as part of the treatment program. In addition to *in-situ* treatment, there are several different protocols offered. For example, if

complete tear-out is desired, the product can then be used for shell decontamination.

Advantages:

- *In situ* requires less time than removal.
- Lower cost.
- 10-year warranty against recurrence of odor and/or corrosion.
- Water-based, nontoxic formulation

Disadvantages:

- Treatment itself does not address corroded electrical and mechanical systems.
- Does not address residual odors on contents.

Verification:

- Bulk and air-corrosivity testing are used to monitor removal of airborne compounds.
- Current testing of one year post-treatment has shown no corrosion [or, odor]; results verified by neutral observer.

REMEDIATION GUIDELINES

9. Overview of Problematic Drywall

A. General Principles

Based on the data provided in the CPSC studies,[18,53,20,65] reports from private testing agencies and the experience of multiple home builders who have undertaken the remediation of several hundred homes, NAHB sought to establish guidelines that can be followed by those who remediate homes that contain problematic drywall. The goal of remediation is not only to eliminate the effects of problematic drywall but also to repair or replace the mechanical, electrical, plumbing and architectural materials in homes that have suffered consequential damage due to the presence of problematic drywall. The result is to restore the structure to a condition as though the problematic drywall had never been installed. A review of the collective body of research suggests a viable remediation strategy should be:

- Safe
- Cost-effective
- Based on proven technology, materials, means, and methods
- Scientifically sound, permanent
- Customized to each residence

In developing these guidelines, NAHB concluded that the following two categories of remediation methodologies met all of the evaluation criteria:

- Total
- Selective

This section of the document addresses in detail total removal and replacement of all drywall and all impacted building materials. Additionally, selective removal is acceptable under certain limited conditions.

This guideline is intended for use on detached single-family homes, attached multi-family dwellings and homes that have been remodeled or renovated with problematic drywall. This guideline was not developed or is intended for use on commercial properties.

This guideline serves to provide a cost-effective means to restore the physical condition of the structure and is not intended to include any resulting financial impact problematic drywall may have had on the home or the homeowner.

B. Qualifications for Problematic Drywall Remediation

Before undertaking a remediation program, the remediator shall be in possession of a valid license where applicable, and have appropriate insurance. It would be wise for the remediator to name the homeowner as an additional insured on the insurance policy during the period of remediation. Currently, there is no state in the United States that requires a special license or certification for remediating problematic drywall separate from a general contractor license.

C. Safety

The remediator is responsible to follow all applicable laws and standards including the requirements of the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) for providing a safe work place and providing appropriate personal protective equipment (PPE) for employees.

It is suggested that personnel involved in problematic drywall remediation activities should wear Level D personal protective equipment (PPE). Level D PPE includes pants, long-sleeve shirt, safety boots or shoes, safety glasses or goggles and a hard hat. At the present time, problematic drywall has not been classified as a hazardous material. However, ventilation of the structure is needed to avoid any adverse effects from exposure to problematic drywall emissions. The wearing of “moon suits” and use of respirators are not currently required.

When performing remediation work for problematic drywall, the use of a dust mask is deemed sufficient to avoid inhalation of dust and other construction debris. When dry-sanding drywall, a dust mask is to be worn. There are two basic types of dust masks that may be used: the white, gauze particulate mask used for dust, or the canister-type mask that has replaceable filters. The wearing of a NIOSH/MSHS-approved respirator equipped with a particulate cartridge that is properly fitted and is in good condition is required when exposed to dust that is above exposure limits. A respiratory program that meets OSHA’s 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant use of a respirator. [66,67,68]

Currently, critical barrier and decontamination areas are not required by state or federal government agencies.

10. Documentation and Sampling

Documentation and sampling during all stages of remediation can be used for the following purposes:

- Preserving evidence to demonstrate to the homeowner what was done during the remediation process.
- Preserving evidence for litigation.
- Preserving evidence for insurance claims.
- Preserving evidence for the Consumer Product Safety Commission.

Every property that may be remediated has its own set of facts and circumstances to make that property “unique.” It is important that the remediator understand which areas listed above apply to the home being remediated and take steps to appropriately document and sample every step of the remediation. Proper and complete documentation of all remediation activities is an ongoing process and is recommended at all stages of repair. The documentation is intended to provide a record of the condition of the home prior to remediation, the condition of the home during remediation, samples of mechanical, electrical, plumbing and architectural materials removed from the home during remediation, video and photographic record of clearance, if the parties so desire, and a final record of the home following remediation and return of the homeowner to the home.

It is recommended that prior to the start of remediation, the remediator:

- Prepare a complete inventory, including a written, video and photographic record of the condition of the home, the furnishings, decorations and personal effects. This record also will confirm the location of all personal effects and their condition prior to moving and storage.
- Take measurements for wall decorations, photographs and pictures to assure they are returned to their original location. In addition, the remediator shall take samples of all painted walls and walls with special finishes to assure they are replicated in the reconstruction process.
- Ensure the photographic and video record is retained with the drywall and other product samples.

The remediator should consider preserving samples of mechanical, electrical, plumbing and architectural materials removed from the home. In addition to the drywall samples, the remediator may choose to collect the following:

- One smoke alarm from each floor.
- Two electrical switches or receptacles from each room.
- All HVAC coils.
- Samples of copper pipe from different locations in the home.
- Samples of copper wire cut or removed from the home.
- Samples of any plumbing fixtures or door hardware that show evidence of corrosion.
- Samples of light fixtures that show evidence of corrosion.
- Each sample may be bagged in a clear plastic bag and sealed. The bag may be labeled and can include the following information:
  - Date and time the sample was taken.
  - Location of sample.
  - Description of the sample.
  - Name of person who took the sample.
  - Sequential log number for the sample.

11. Developing a Plan and Putting It in Writing

A. Remediation Plan

The remediation plan should address the scope of the remediation, the means and methods to be used, who is going to perform the work and the testing strategies and/or third parties that will be involved to validate that the remediation has been successfully performed. At a minimum, the remediation plan should address each of the following:

- Scope of work and memorandum of understanding
- Safety
- Documentation
- Qualifications
- Temporary relocation of homeowner
- Preparation
- Deconstruction
- Disposal
- Cleaning
- Clearance
- Build-back
- Inspection
- Return of the homeowner

Each of the steps in the remediation plan are addressed in detail below. It is important that the remediator preparing the plan disseminates the plan to everyone involved and assures that everyone is fully aware of what is planned and how the work will be performed. Accordingly, once the plan has been developed, the remediator should review the plan, seek third-party review and then implement it. During the course of the work, the remediator should revisit the plan and incorporate any necessary adjustments to the plan.

B. Scope of Work and Memorandum of Understanding

Communication is critical and plays a very important role in remediation. It is recommended that the remediator at the beginning of the remediation process develop a scope of work that should be written into a Memorandum of Understanding to be submitted and discussed with the home owner. The Memorandum of Understanding should outline the work and responsibilities of the remediator and the responsibilities of the homeowner. The Memorandum of Understanding should include the step-by-step remediation process commencing with the relocation of the homeowner into temporary living accommodations and the packing and storage/moving of the homeowner's furnishings and personal effects.

The Memorandum of Understanding may address who is responsible for the following:

- The remediator's license number(s).
- A certificate of insurance naming the homeowner as an additional insured during the period of the remediation.
- Any terms and conditions the remediator requires, including but not limited to releases and/or indemnification.
- Contact information for the remediator: address, phone, fax, and email.
- Information regarding the temporary accommodations, including but not limited to the address of the temporary accommodation, utilities to be provided and the party that will assume the cost of the relocation.
- Protection of the property being remediated, such as landscaping, pools, spas, etc.
- Documentation in writing/visual (pictures, video etc.) that will be made of the condition of the home and furnishings prior to relocation. This will allow the remediator to return the furnishings to their original location prior to remediation.
- A description of the mechanical, electrical, plumbing and architectural materials to be removed.

- A description of the mechanical, electrical, plumbing and architectural materials that will remain.
- A special section may be added to address any unique features of the property.
- The plan for the refurbishment, warranty or replacement of any impacted appliances.
- The cleaning and air-out process.
- The reconstruction process broken down by discipline describing what mechanical, electrical, plumbing and architectural materials will be replaced with new materials and what will be replaced with existing materials.
- For any upgrade, provision of an agreement which outlines the homeowner's responsibility for the cost of the upgrade(s).
- A timetable provided by the remediator that approximates the duration of the remediation including dates for inspections and clearance, (including clearing of punch-list items and any warranty), a homeowner walk-through and relocation back to the home.
- Payment of all mortgages, taxes and homeowner association dues or assessments.
- Payment, if not assumed by the homebuilder, for utilities.
- Special conditions, such as the responsibility of homeowners in Florida to install hurricane shutters in the event of a hurricane warning.
- A release or description of any paperwork that the homeowner will be required to sign when the remediation is completed.
- Leasing suitable, equivalent housing during the period of remediation.
- Paying for all utilities at the new temporary location.
- Maintaining landscaping at the home during remediation.
- Maintaining and protecting pools/spas.
- Packing, moving and/or storage of the homeowner's personal effects.
- Upon completion of remediation, returning personal effects, unpacking and replacing personal effects to the original location.
- Paying the mortgage on the property.
- Paying the taxes on the property.
- Maintaining homeowner's insurance on the property, subject to the conditions of the remediator's insurance.
- Paying any homeowners' association fees.

The remediator should discuss with its attorney whether and what form of a release should be included in the Memorandum of Understanding, and what documents, such as a release (if not included in the Memorandum of Understanding) or acknowledgement of satisfactory completion of the work, the homeowner will be required to sign upon completion of the remediation. The remediator should carefully consider, with the advice of counsel, the effect of

such documentation on insurance coverage for the remediator's costs of identifying and remediating the problematic drywall and on the builder's subsequent liability for any future problems.

12. Preparing for Deconstruction

A. General Principles

Deconstruction of structures with problematic drywall involves taking a home apart selectively while carefully preserving valuable elements for re-use. Deconstruction includes the removal of all problematic drywall and all building materials affected by the problematic drywall. The means and methods and order in which the work is performed are left to the discretion of the remediator. The work must be performed in accordance with all applicable building codes.

The remediator is required to obtain all permits and schedule all required building inspections. In a number of locations, building departments are uncertain about the procedures for remediating problematic drywall. In some instances, the building department has required a new set of signed and sealed drawings before a permit would be issued. Exceptions to building permits may be necessary to maintain power to the home and to provide for irrigation of landscaping and operation of pool/spa pumps and filters during remediation. Permit fees may vary from venue to venue.

Pursuant to Section 6B of this guideline and prior to the relocation and removal of personal items, a baseline test must be performed before removal of any problematic drywall. Subsequent tests will be compared to this baseline measurement.

B. Relocation and Removal of Personal Items

Due to the scope of the work associated with the remediation of problematic drywall, all occupants and all personal belongings must be removed and relocated to temporary housing or stored during the remediation period. Upon completion of the remediation and receipt of a Certificate of Occupancy/Certificate of Completion, the occupants and their belongings can be returned to the residence. Details relating to the terms and conditions of the relocation and removal of the occupants and their personal effects may differ from location to location. This is a matter to be resolved directly between the occupant and the remediator and documented in the Memorandum of Understanding. For materials such as clothing, bedding, wood and upholstered furnishings, there may be some temporary superficial adhesion which can

cause an odor. Removal from the source (the home) and dilution with fresh air has been determined to be most effective in eliminating any residual adhesion (permanent odor). The homeowner may at their discretion take additional steps to clean or launder personal effects and furnishings.

C. Preparation and Protection

Currently, the erection of critical barrier and decontamination areas is not required during remediation. Prior to commencement of remediation it is recommended that the remediator take appropriate steps to protect the following items.

Flooring

As it pertains to all wood, ceramic tile, stone flooring, or other types of flooring, the remediator should document any damage for normal wear and tear that currently exists on the floor. A good protection system for flooring consists of three parts: a moisture barrier to protect the floor from spills, soft padding to protect the floor and a hard layer to protect the padding and moisture barrier during the remediation process. The following is an example of a typical flooring-protection system:

- Clean the floor thoroughly and lay the moisture barrier over the flooring. A moisture barrier of 4 to 6-millimeter-thick polyethylene sheeting, Tyvex or similar material should be laid down directly over the flooring and secured at the perimeter of the room.
- Lay a protective padding over the moisture barrier, which may consist of ½-inch re-bond carpet padding, roofing felt or similar material.
- Cover the padding with either ¼-inch masonite, ¼-inch Luan plywood or similar material and cut to fit to the shape of the room. Tape all seams with duct tape.

Other

Each home that is remediated is unique. Therefore, it is recommended that the remediator protect the following items to avoid damage during deconstruction.

- Driveways, walkways and landscaping
- Stair railings
- Tub and shower enclosures
- Windows

D. Cabinetry, Doors and Hardware

In homes with problematic drywall, removal and reuse of various building materials such as cabinetry, doors and hardware is acceptable. However, in certain instances the cost to remove, transport and store these materials exceeds the cost of new materials. The reuse of these materials may be a business decision individual remediators will make with the homeowner based on the cost and time for remediation. The remediator may document all materials that will be removed and reused. Materials that will be reused shall be preserved.

E. Appliances

All appliances, including without limitation, washers, dryers, dishwashers, stoves, ovens, refrigerators, trash compactors, disposals, intercom systems, and microwave ovens are to be removed prior to remediation. The appliances may be reused subject to inspection and approval of the manufacturers' authorized representative. If the electrical contacts in the appliances reveal any signs of corrosion, the appliance should be replaced. Likewise if the coils in the refrigerator show signs of corrosion, the refrigerator should be replaced.

F. Architectural Materials

Most architectural materials can be removed, stored and reused. However, the decision to reuse these materials is more often an economic one based on the cost of preservation during deconstruction and storage versus the cost of new materials.

- Cabinetry, bathroom vanities and counter tops are to be removed, cleaned stored and can be reinstalled in the home during reconstruction.
- Doors and door hardware can be removed and reused during reconstruction. However, if there is any sign of corrosion on the hardware it should be replaced.
- Wood trim, casing and molding can be removed and reused. However, experience has shown that these materials may be damaged or lost during deconstruction, and there is little economic justification to salvage the wood trim.
- Carpet and carpet padding should be removed and discarded.
- Floor finishes such as ceramic tile, marble, stone, linoleum, wood and sheet goods can remain and are to be properly protected during remediation to prevent damage. There is a possibility wood flooring may be damaged during remediation due to the lack of air conditioning and humidity control.

After restoration of the drywall and removal of the floor protection, the remediator shall determine whether there has been any damage to the wood floor that would necessitate its removal and replacement.

- Cement board, (Durock, HardieBacker, WonderBoard and EasyBoard), can remain. Removal is only required if it is necessary to access plumbing for replacement.
- Gyp-Crete used as a subflooring material can remain.

G. Elevators

Background:

Elevators are a very common feature in low-rise condominiums and apartments. In recent years there has been an increase in the use of elevators in private homes. Typically, elevators in condominiums and apartments of 6 floors or fewer are hydraulic, while elevators in private homes use traction. The potential impact of problematic drywall on devices such as elevators and other special systems that might be installed in condominiums, apartments and some homes are discussed below. These include but are not limited to the following items.

- Elevators
- Fire alarms, pull boxes, strobes and horns
- TV Security Systems

Elevators:

Condominiums and Apartment Buildings

Elevator shafts in condominium and apartment buildings are typically constructed of concrete and concrete block, with some drywall surrounding the exterior doors. The drywall framing will comply with code requirements for firewalls, making it very unlikely that any problematic drywall was used in this application. The operating equipment also is located in an equipment room, usually in the basement or other room somewhat remote from the living areas. The equipment rooms are always constructed with fire-rated walls. In addition, the shafts are vented. As a result of elevator movement, there is a significantly greater flow of fresh air in the shafts than in the residences. Thus, if problematic drywall is present in the building, the construction and isolation of elevator shafts and equipment rooms provides some protection and reduces the risks of corrosion and odor.

Elevators in condominiums and apartments are regulated devices and subject to annual inspection. Typically, they are maintained on a regular schedule with a service agreement with the manufacturer's authorized service company. In any condominium or apartment building where problematic drywall is present, the service company should be called to conduct a thorough examination of all control and signal wiring, control systems, door-closure electronic eyes, power wiring, lighting and ventilation systems. Any of these items showing any evidence of corrosion should be replaced. If no corrosion is noted, the service company should conduct full load and functional tests and certify the elevators for operation. The state or local permitting authority should be advised of the reason for the inspection and testing and invited to attend and witness the testing. The condominium or apartment manager should request a new elevator operating permit. The elevator service company should be directed to include the inspection of signal-wiring and control systems for any sign of corrosion, loss of signal or fault as part of its regular preventative maintenance service.

Private Residences

Elevators in private homes, unlike condominiums and apartments, are not subject to annual inspection nor are they typically covered under a service agreement. In addition, their method of construction does not afford the same level of isolation or protection. In the event that problematic drywall is present in a home with an elevator the following procedure should be followed. Before any wholesale removal and replacement of power and signal-control cabling is performed, the elevator should be inspected by a manufacturer's representative to determine if there is any visible damage/corrosion to wire and cable or electronic circuit boards. Complete functional tests should be conducted to determine that there is no deterioration in service and functionality. Any components that are deemed to be damaged should be removed and replaced.

Fire Alarms, Pull Boxes, Strobes and Horns**:**

These devices will usually only be found in condominiums and apartments, not in private homes. Modern systems are typically controlled with a computer, thus each device in the system must be examined. Because these systems are monitored, any faults are reported and the cause of the fault is recorded. If it cannot be reset remotely, a service call will be made.

If problematic drywall is present in a condominium or apartment, the service company monitoring and/or maintaining the system, or other certified party, should be called to conduct a thorough examination of all wiring, terminations, and devices to determine if there is any evidence of corrosion or damage. If no damage, corrosion or other fault is identified, the examining party should recertify the system. These devices are regulated. Thus, during the inspection and testing, an inspector from the local fire marshall's office should be invited to

attend. Any components or devices that are damaged should be removed and replaced.

TV Security Systems:

While TV security systems are more often associated with condominiums and apartment buildings, they are increasingly being used in more expensive custom homes.

Cameras are usually mounted on the exterior and are sealed from the weather. There is little likelihood of damage to the cameras themselves if problematic drywall is in the home, condominium or apartment building. Damage is more likely to be associated with the monitoring and recording equipment housed somewhere in the interior of the building. The manufacturer's representative should be contacted and requested to perform a complete system inspection in the event problematic drywall is present. A component that appears to be damaged or corroded should be repaired or replaced. If no damage or corrosion is evident, the system monitoring/servicing company should be directed to expand its regular preventative maintenance service. This should include inspection of all signal wiring and recording systems for any sign of corrosion, loss of signal or fault.

H. Garage Door Openers/Door Bells

Garage door openers may be reused; however, the safety reversing sensors and wiring should be replaced. If doorbell systems are impacted by problematic drywall, they also should be replaced.

I. Life-Safety Devices

All life-safety devices such as smoke, fire, carbon monoxide and security alarms are to be removed and replaced.

J. Fire Sprinkler Systems/Gas Service Piping

Remove and replace all fire suppression sprinkler systems and gas service piping.

K. Electrical Materials

On March 18, 2011 the U.S. Consumer Product Safety Commission and the U.S. Department of Housing and Urban Development issued Remediation Guidance for Homes with Corrosion from Problem Drywall.[21] This remediation guidance calls for the replacement of all:

- Possible problem drywall
- Fire safety alarm devices (including smoke alarms and carbon monoxide alarms)
- Electrical distribution components (including receptacles, switches, and circuit breakers, but not necessarily wiring)
- Gas service piping and fire suppression sprinkler systems

The CPSC is no longer recommending necessarily the removal of all electrical wiring in the home. This decision is based upon the results of recent scientific studies on the effects of corrosive environments on electrical wires. Removal or cleaning of the exposed ends of the wiring to reveal a clean/uncorroded surface is recommended.

NAHB recommends that remediators follow the CPSC and HUD guidance referred to above. All electrical lighting and wiring must be in compliance with all local, state and federal electrical and building codes.

L. Plumbing

It is recommended that all copper tubing, copper pipe and fittings be replaced. The copper fittings in PEX piping shall be replaced. However, brass fittings can remain. Carbon-steel piping and PVC piping are unaffected by problematic drywall so these pipes can remain in place during deconstruction.

Plumbing fixtures, sinks, tubs and commodes can be reused. Sinks and commodes shall be removed during deconstruction. Tubs may remain and shall be protected during deconstruction and reconstruction. Plumbing fixtures and hardware can be reused if they do not show any evidence of corrosion.

M. Mechanical Systems

Mechanical systems refer to heating, ventilating and air-conditioning systems (HVAC) and the associated ductwork and controls. Removal of HVAC systems and ductwork will include:

- Remove and replace the coils in all air-handling units. During remediation, the air-handling unit is to be removed and stored. There may, however, be little economic justification to replace only the coils versus a complete unit.
- Ductwork: All ductwork, flexible ductwork and sheet metal shall be removed during remediation. Metal duct that is not internally insulated can be cleaned and reused. Metal duct that is internally insulated does not have to be replaced. Flexible duct that has a polyethylene core and an exterior heavy-

duty polyethylene vapor barrier with a permeance of .1 or less can be cleaned and reused. In the event the external vapor barrier is damaged or the splices have not been prepared in accordance with the Air Diffusion Council Standards for flexible duct installation, the flexible duct should be discarded and replaced. Flexible ductwork that does not have an external vapor barrier with a minimal permeance of .1 is to be replaced.

- Replace all low-voltage signal wire to the HVAC controls. The mechanical subcontractor should inspect the HVAC controls and if the controls show signs of corrosion they should be replaced.

N. Insulation

All blown-in and batt insulation is to be removed and replaced. Closed-cell foam insulation can be left in place, unless it has to be removed to gain access to another affected building material.

13. Removal of Problematic Drywall From a Home (Deconstruction)

Removal of problematic drywall from a home may be accomplished in two ways: total (full) remediation or selective (partial) remediation.

Total remediation is defined as the removing, or stripping of all drywall products and removal of any affected building system and the restoration/rebuilding of the home by restoring/replacing all removed systems and materials. The removing or stripping includes, but is not limited to, cabinetry and joinery, carpeting, HVAC coils and ductwork, plumbing fixtures and piping, electrical distribution components, including receptacles, switches and circuit breakers and fire-suppression sprinkler systems and fire safety alarm devices, including smoke and carbon monoxide alarms and gas service piping from a home.

Selective remediation is defined as the removing or stripping of all drywall products, and removal of any affected building system from a limited portion of a home where the presence of problematic drywall can be isolated, as well as the restoration/rebuilding of that portion of the home, along with restoring/replacing all removed systems and materials. The removing or stripping includes, but is not limited to, cabinetry and joinery, carpeting, HVAC coils and ductwork, plumbing fixtures and piping, electrical distribution components, including receptacles, switches and circuit breakers and fire-suppression sprinkler systems and fire safety alarm devices, including smoke and carbon monoxide alarms and gas service piping from a home.

If the home was built between 2001 and 2008 and it has been confirmed that problematic drywall is present throughout the entire home, total remediation is the only viable option even if the home contains some non-problematic drywall.

When considering whether to conduct full or selective remediation, the following should be evaluated:

- The cost and time required to identify the problematic drywall.
- The cost and time to complete selective removal and replacement versus the efficiency and cost of total removal of the problematic drywall.
- Building systems must be properly remediated. Therefore, selective remediation of problematic drywall must allow access for building system remediation.

A. Total Removal

Total removal of problematic drywall is required of drywall in walls and ceilings. All problematic drywall must be removed. Once the drywall is removed, the balance of the building systems may be removed.

B. Selective Removal

Selective removal would be a viable option only where the remediator can, with certainty, identify specific areas or rooms in the home that contain problematic drywall. The two most likely situations for remediating only problematic drywall are first, where the problematic drywall is limited to a remodel or a room addition in an older home which otherwise does not contain problematic drywall; The second is in multiplex units where the remediator can verify that problematic drywall was not used in the firewalls between the units. The remediator will have to verify that there are no affected building systems behind these firewalls.

Where problematic drywall is isolated to a room or an addition, all drywall on the ceiling and walls in the remodeled or added rooms shall be removed. The remediator must verify they have removed all problematic drywall up to the limits of the remodel. Remediation of mechanical, electrical, plumbing and architectural materials, and cleaning and reconstruction within the limits of the remodel shall be conducted as set forth above. The remediator must verify that the HVAC system has not been affected, nor have any other materials in the balance of the home been affected. If they have, they must be removed and replaced as outlined above.

In a multi-family property where the remediator can verify that the firewalls were constructed with non-problematic drywall, but the balance of the home contains problematic drywall, the home should be remediated as if it were a total removal, with the exception that the drywall in the firewall can remain. This is conditioned on the remediator being able to verify there are no affected building materials within the firewalls that will require remediation.

C. Disposal

The remediator must comply with all local and state disposal requirements for disposal of construction debris, including drywall. As an example, the state of Florida has determined that remediators may dispose of problematic drywall at a construction and debris disposal site.

Remediators will typically utilize a hauling service to dispose of construction debris. The remediator shall include in any agreement with the hauling service the requirement to certify the hauling service is disposing of the construction debris in an appropriate waste/landfill site. The remediator shall require that the problematic drywall is being disposed, and not being recycled.

14. Cleaning

The cleaning process is critical for the successful implementation of this remediation guideline. **If not conducted properly, the remediator may fail the clearance testing that follows the cleaning process and not be permitted to conduct build-back in a timely manner. The following steps should be conducted with specificity and, if needed, conducted more than once:**

- Following removal of all drywall and all impacted building materials the home should be thoroughly swept.
- After sweeping, the home should be vacuumed with HEPA filters to collect all gross particulate matter.
- After the HEPA vacuum cleaning, use large volume fans and HEPA filters to create negative air pressure in the home.
- Following the HEPA process, use compressed air to “blow down” all surface areas in the home to remove particulate matter and continue to “blow down” the home until the air is “visibly” clear.
- Following a thorough cleaning and vacuuming to remove all dust, dirt and drywall materials, all interior surface areas including wall-framing members, ceiling joists and bottom cord of trusses should be wiped down with a moist cloth. The cloth can be wetted with a mild detergent. Solutions such as Oxine, OdoBan or RemedialConC® can be used.

15. Air Out of the Home

Following the cleaning process, open the windows in the home and allow the home to air out for a minimum of 14 days. There is no published science that supports the duration of the air-out period; only experience indicates air exposure will eliminate residual transient deposits of reduced sulfur compounds.

16. Clearance

Pursuant to Section 6B of this guideline, a clearance test measurement is taken after the problematic drywall has been removed, cleaning and air-out have been performed but build-back has not yet occurred.

Clearance testing is defined as a procedure that provides confirmation that all problematic drywall and affected building materials have been removed and that various airborne compounds are at usual environmental background levels.

The clearance process is the culmination of multiple steps taken during the remediation process to verify the adequacy of the quality-control procedures used during the remediation process. Additionally, the clearance process will provide confirmation of the removal of all problematic drywall and affected building materials and that HEPA clean-down and air-out have occurred.

Clearance testing is a vital process because it supports the conclusion that the problematic drywall as well as the corrosive gases affiliated with this drywall have been removed from the home. If the test measurements reveal that corrosive gases from problematic drywall are still present in a home, then additional cleaning and air-out must be performed prior to build-back.

17. Build-Back, Restoration and Finishes

At this point in the remediation process, the clearance testing has been performed and the results have revealed that the corrosive gases from problematic drywall are at or below background levels, which will allow the remediator to begin the building-back and restoration process. With the exception of those items salvaged from the home, the remediator shall use new materials. The means and methods and order in which the work is performed are at the discretion of the remediator.

18. Inspection

Prior to the inspection process, which may take place with the homeowner, a re-occupancy test must be performed. This measurement is a tool for the remediator and

for the homeowner that will verify problematic drywall has been removed from the home and the home has been remediated.

During the inspection process, the remediator may choose to walk through the home with the homeowner and review the Memorandum of Understanding in its entirety to assure the homeowner that the remediation process has been completed pursuant to their agreement.

19. Conclusion

The problems faced by the building industry due to the importation of problematic drywall offer no simple or inexpensive solutions. However, experience indicates that effective identification, testing and remediation strategies can limit exposure and vulnerabilities and ultimately provide a solution for the homeowner and for the building industry.

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21. Appendix

Warning – The sample forms that follow are merely provided for educational purposes to illustrate the principles discussed in this guidance document. Readers should work with their attorney to prepare documents that meet their particular needs.

APPENDIX A

Appendix A - Testing Methodologies – Critique of Current Methods

Currently available testing methods have been evaluated for the NAHB. The discussion which follows addresses the kinds of testing that can be performed, their reliability, advantages/limitations, ease of use and accuracy.

A. Establishing Valid Test Methods and Criteria

Problematic drywall emissions are a new environmental issue with no standardized test methods or criteria for identifying problematic drywall and interpreting data. While government agencies have suggested some air and bulk tests as potentially applicable, all have significant limitations and none have been validated. Meanwhile, commercial laboratories have begun offering a multitude of tests, which also lack validation and present significant questions as to relevance and interpretation. Both the Florida Attorney General[69] and the Federal Trade Commission[70] have issued alerts to homeowners and builders regarding companies offering testing and remediation services because many have not been scientifically validated to be effective.

B. Material Sampling Procedures and Criteria

Several methods are available to test drywall to determine if it is imported and/or problematic. The CPSC/HUD Interim Guidance suggests the presence of higher levels of strontium and elemental sulfur are indicators the drywall has been imported from China, and the presence of elemental sulfur is an indicator of problematic drywall.[23] For a test method to be acceptable for testing individual drywall samples, the test results must consistently and accurately differentiate between drywall that is problematic and drywall that is not problematic. The federal action level for presuming drywall is problematic is a strontium level of at least 1,200 ppm (parts per million) and a level of at least 10 ppm for elemental sulfur.[23]

When conducting laboratory analysis to confirm the presence of problematic drywall, it is acceptable to test individual drywall samples. If selective remediation is being considered, however, such sampling is impractical to locate problematic drywall panels in a home that may contain multiple types of drywall. BHS considers such methods to be costly, destructive and time-consuming.

Commercial test methods now being offered to test drywall include:

- Measurement for elemental sulfur and strontium using a hand-held XRF device in the field. Continued research is expanding XRF capabilities and reliability, but the updated XRF system has not yet been released to the public. This equipment now has the ability to test for sixteen elements with a "library" containing the characteristic signature and corrosive capability for some 32 different types of drywall, both domestic and imported. The library will be programmed into the device. XRF, however, is not accurate in all situations. Currently, to confirm whether the drywall is problematic requires independent confirmation from a laboratory.[10] XRF is expensive and the number of qualified practitioners is limited. Since the device is so expensive, it can be rented with a trained professional to use it.
- Use of FT-IR spectroscopy to look for a characteristic problematic drywall footprint.[71] FT-IR is expensive and the number of qualified practitioners is limited.
- Laboratory analysis of drywall for elemental sulfur by GC/MS or HPLC (accurate but expensive and time consuming). The result is applicable to only one small piece of drywall.[23]
- Chamber testing of a piece of drywall for reduced sulfur. This method is expensive, time-consuming and lacks criteria.[19,72,73,74]
- Black tarnishing of copper placed in a container with a piece of drywall (qualitative only).[74]
- An endotoxin test for bacteria (bacteria have not been proven causal).[74,6]
- A proprietary test for physical properties and organic content (not validated).[22]

C. Current Air Sampling Procedures and Criteria

Air-quality monitoring for problematic drywall emissions may be conducted to:

- determine whether problematic drywall is present
- evaluate occupant exposure
- prioritize remediation
- design a remedial strategy
- verify remediation.

Air sampling is generally not a good method for confirming the presence of problematic drywall. Moreover, it is unsuitable for locating specific sheets or locations of problematic drywall.

A specific Guideline should be established for any method under consideration. Such a Guideline would include standard monitoring conditions, sampling strategy, sample collection and analytical procedure. Thereafter, the Guideline must be validated; that is, verifying that it actually does what it purports to do, and showing that it does so reliably. Are its results consistent and repeatable? For use by field practitioners, such a Guideline ideally should be simple, quick, and inexpensive.

Potential interference must also be taken into account, such as how other indoor contaminants affect the test results. Where there is sufficient information, air-quality standards can be set to protect against health effects or damage. Where sufficient information is lacking, as is the case with problematic drywall, relative criteria may be set to differentiate various airborne compounds from normal background, based on a representative database.

With respect to air-quality monitoring, specific chemical tests have been proposed for field practitioners (e.g., hydrogen sulfide by CPSC) or are offered commercially (e.g., VOC analysis). Problematic drywall emissions represent a complex and variable mixture of airborne compounds: Each constituent is reactive, unstable and present at a very low concentration. These limitations make chemical testing under field conditions impractical and resulting data inconclusive. While some researchers have been able to detect various airborne compound concentrations unique to problematic drywall, this has been possible only through the use of extremely expensive and sophisticated techniques.

Despite the limitation of chemical air sampling, the CPSC initially suggested this be considered for use in evaluating problematic drywall homes. The CPSC reported the only parameter that was higher in problematic drywall homes was hydrogen sulfide. This was based on a statistical comparison of the average dosimeter reading in 51 homes over a two-week period.[75]

A review of that data however, shows the range of readings in problematic drywall complaint homes was virtually identical to both those in non-complaint homes and outside air (between about 0.2 to 3 parts per billion),[18] making it impossible to classify a home based on hydrogen sulfide measurement. Nevertheless, some consultants are now testing homes with hydrogen sulfide meters and these results should be considered inconclusive.

Other investigators recommend collecting air samples to be analyzed in the laboratory for various sulfides.[76] The lowest concentration these methods are able to detect are higher than the expected levels of individual sulfide compounds likely to be present, i.e., approximately one part per billion.

Questions have also been raised concerning the standard practice of collecting such samples with Tedlar bags since sulfides stick to their inside surface[77] and, unless the bags are opaque, they are degraded by exposure to light.[78] While other sampling media are claimed to preserve air samples better for sulfide analysis,[77] efficacy apparently has not been established at the low parts-per-billion level.

Some investigators collect air samples with sorbent tubes for laboratory organics analysis: total or individual VOCs (volatile organic compounds).[9,19,63] Since all indoor environments have widely varying total VOC levels made up of a great diversity of individual compounds at the ppb level, such testing cannot distinguish problematic drywall emissions. The CPSC indoor air study report described extensive VOC determinations, but concluded there were no findings unique to problematic drywall homes.[75]

Finally, problematic drywall inspectors also offer a proprietary “home test kit”[79] and trained dogs.[80] Neither method has been validated.

D. Measuring Air Corrosivity to Determine if Problematic Drywall Exists in a Home

Air corrosivity can be measured on a simple copper probe (also called a coupon), which is left at a site for several days and then measured for either corrosion gain or metal loss.[28,29] Potentially interfering sources of sulfides would have to be taken into account (e.g., sulfur water or sewer gas). Non-sulfide sources of corrosion such as bleach might also interfere. Using a coupon to measure air corrosivity only detects current corrosivity and would not account for past or future emissions, including those accelerated by increased temperature or humidity.

The ISA (Instrumentation, Systems, and Automation Society) has developed classes to designate rates of corrosion in Angstroms per thirty days, on a log scale. ISA classes include Mild, Moderate, Severe, which are delineated in the standard ISA-71.04-1985, Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.[81]

Using copper coupons and the ISA classification of corrosion rates, the CPSC reported distinct differences in ground wire-corrosion rates between complaint and non-complaint homes.[18] Air reactivity of non-complaint homes and outside air were all in the Mild range (about 20-100 Angstroms per thirty days), while levels in problematic drywall complaint homes ranged from Moderate (approximately 300 A/30 days) to Severe (approximately 2000 A/30 days).[18] These data suggest measuring the corrosivity of air may provide a practical method to assess and track air quality in problematic drywall homes.

E. Odor

Since odor related to imported problematic drywall has been disturbing to homeowners, its eradication is essential as part of a successful remediation guideline. Under some conditions, many, but not all, problematic drywall homes have a characteristic sulfur-type odor. This odor results from a mixture of organo-sulfide compounds which are “odor-active”.[2] Odor, however, does not track consistently with the corrosivity of problematic drywall, since the compounds producing each of the effects overlap, but are not identical.

Problematic drywall odor is variable and subjective. Therefore, it is not possible to use it as a reliable indicator of the presence of problematic drywall. Once all of the drywall responsible for producing the malodor is removed—that is, once the source of the odor is removed—any remaining odor-active sulfur compounds will dissipate with time and sufficient airing-out.

APPENDIX B

Appendix B – Clearance Inspection Report

Home Owner's Name: _____ Date: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Remediator's Name: _____

Street Address: _____

City: _____ State: _____ Zip Code _____

Work Commenced on: _____ Completed By: _____

VERIFICATION OF THE PRESENCE OF PROBLEMATIC DRYWALL: (Method used, samples taken, or tests performed, attach copies of all test results.)

_____

_____

_____

QUALITY CONTROL TESTS AND INSPECTIONS: (Identify all QC tests and inspections required in the protocol and attach copies of all inspection reports.)

_____

_____

_____

BUILDING DEPARTMENT PERMITS AND INSPECTIONS:
Attach copies of all permits and the results of all Building Department inspections.

_____

_____

_____

OTHER AGENGIES HAVING JURISDICION OVER THE WORK

Identify below any other agencies having jurisdiction over the work: (Attach copies of any reports, tests or inspections conducted by such agency)

_____

_____

_____

PHOTOGRAPHIC RECORD: (Attach copies of photographs which validate removal, cleaning and final condition of the home.)

Removal: _____

Date Pictures Taken: _____ Picture Taken by Whom: _____

Clean and Air Out: _____

Date Pictures Taken: _____ Picture Taken by Whom: _____

Final Completion:

Date Pictures Taken: _____ Picture Taken by Whom: _____

THIRD PARTY TESTING AGENCY: (Attach copies of all tests)

Name of Testing Agency: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Test Performed: _____

Test Date: Test Report Date: _____

PUNCH LIST

Attach copy of any punch list with each item signed off to indicate completion

_____

REMEDIATOR'S CERTIFICATION

This is to certify the subject home, located at _____

has been remediated in accordance with the Memorandum of Understanding (MOU)

dated _____and the attached remediation procedure and that all problematic drywall has been removed, all affected building materials have been removed, the home has been cleaned and aired, and rebuilt with new materials or the reuse of original materials which have been cleaned and approved for reuse.

By signing this document I, _____

on behalf of: _____

certify that the home is free of all problematic drywall and the affects thereof.

Signature: _____

Title: _____

Date: _____

HOMEOWNER'S ACCEPTANCE

This is to certify acceptance all remediation work due to problematic drywall on the subject home, located at _____
has been completed in accordance with the Memorandum of Understanding dated _____ to my full satisfaction and that all documentation required in the Memorandum of Understanding, the remediation protocol and this Clearance & Acceptance have been provided.

Signature: _____

Date: _____

Notary: _____

Name: _____

Date: _____

My License Expires on: _____

APPENDIX C

Appendix C - Chronology

The following chronology provides a broad timeline of a number of the more prominent events that have taken place in the history of the problematic drywall issue. This chronology serves only to provide a perspective on the events which help to frame this issue and is neither all inclusive nor does it attempt to include all events which some may find salient to the issue.

Date	Event
June 1, 2008	Florida Department of Health central office, Division of Environmental Health, in Tallahassee, receives first call about sulfur odors and carbon disulfide related to drywall from a homeowner.
Oct. 2, 2008	Florida Department of Health and Environ International met to review Environ's investigation of sulfur compound emissions from certain imported gypsum board and related health considerations.
Nov. 4, 2008	Florida Department of Health made initial contact with the Consumer Product Safety Commission (CPSC).
Dec. 1, 2008	CPSC first began to receive drywall-related complaints from consumers. Media interest surrounding imported corrosive drywall increases.
Dec. 28, 2008	Environ presented its report of the air sampling done on 79 homes.
Feb. 1, 2009	Freitag, Mayer and Breuer publish paper on the identification of odor-active organic sulfur compounds in gypsum products.
March 20, 2009	Florida Department of Health releases Unified Engineering Inc. analysis of five drywall samples.
March 30, 2009	Senators Nelson and Landrieu introduce S 739, To require the Consumer Product Safety Commission to study drywall imported from China in 2004 through 2007, and for other purposes.
March 30, 2009	Senators Nelson and Landrieu introduce Senate Resolution 91 Calling on the Consumer Product Safety Commission, the Secretary of the Treasury, and the Secretary of Housing and Urban Development to take action on issues relating to drywall imported from China.
April 2, 2009	Congressman Wexler introduces HR 1977, To require the Consumer Product Safety Commission to study drywall imported from China in 2004 through 2007, and for other purposes.
April 14, 2009	CPSC hosted a joint meeting with EPA, CDC/ATSDR to coordinate a federal action plan to address potential health hazards that may be attributable to problematic drywall.
May 1, 2009	Chinese Embassy letter states that drywall exported to the US is safe.
May 19, 2009	Environmental Protection Agency test report for the Agency for Toxic Substances and Disease Registry.

May 21, 2009	Senate Committee on Commerce, Science and Transportation Hearing on Health and Product Safety Issues Associated with Imported Drywall.
June 1, 2009	Centers for Disease Control present initial health guidance.
June 1, 2009	CPSC enters into contract with Environmental Health and Engineering (EHE) for in-home indoor air sampling on approximately 51 homes.
June 9, 2009	CPSC enters into contract with Lawrence Berkeley National Laboratory (LBNL) to conduct chamber studies.
June 15 and 16, 2009	Chinese experts join CPSC staff on inspections of homes in Florida and Louisiana.
June 15, 2009	The U.S. District Court for the Eastern District of Louisiana received the Transfer Order, MDL-2047 from the MDL Panel.
June 22, 2009	CPSC sent initial fourteen samples to EPA /ERT to commence analysis.
Aug. 10, 2009	Consumer Product Safety Commission establishes that problematic drywall is not radioactive.
Nov. 5 and 6, 2009	Tampa Technical Symposium.
Nov. 23, 2009	CPSC issues 51-home air-sampling report, preliminary fire-safety corrosion study, and preliminary electrical component study.
Dec. 18, 2009	Florida Department of Health updates its definition of drywall associated with corrosion in residences and assessment guidelines.
Dec. 22, 2009	HUD Press Release "How to Assist Homeowners Facing Problem Drywall"
Jan. 1, 2010	Interim Guidance from Consumer Product Safety Commission (CPSC) and Housing and Urban Development (HUD).
Jan. 28, 2010	CPSC and HUD issue Guidance on identifying problem drywall in homes.
February 1, 2010	CPSC Investigation of Imported Drywall Status Update.
March 1, 2010	CPSC staff preliminary evaluation of drywall chamber test results.
March 1, 2010	CPSC Alert to Fire Safety Professionals.
March 26, 2010	CPSC released Microbiological Assessment of Chinese Drywall.
May 28, 2010	CPSC released “Identification of Problematic Drywall Source Markers and Detection Methods
July, 2010	CPSC issued “Status Update: Investigation of Imported Drywall
Aug. 27, 2010	CPSC and HUD issued “Summary of Revision 1 to The Interim Guidance on Identification of Homes with Corrosion from Problem Drywall” and “Interim Guidance – Identification of Homes with Corrosion from Problem Drywall – Revision 1”
January 31, 2011	CPSC issues release that the CDC review finds no link between problem drywall and 11 reported deaths
March 18, 2011	CPSC and HUD Remediation Guidance For Homes With Corrosion From Problem Drywall 03-18-2011. Bethesda, MD, U.S. Consumer Product Safety Commission