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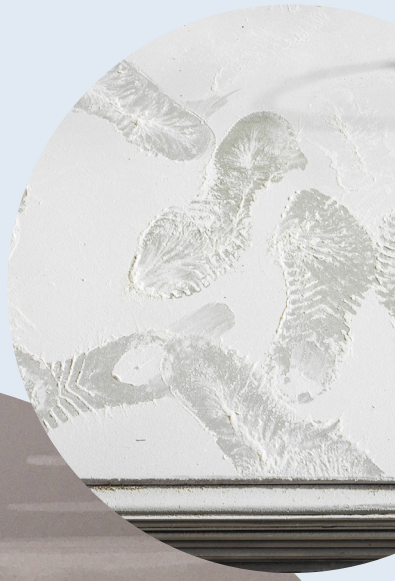

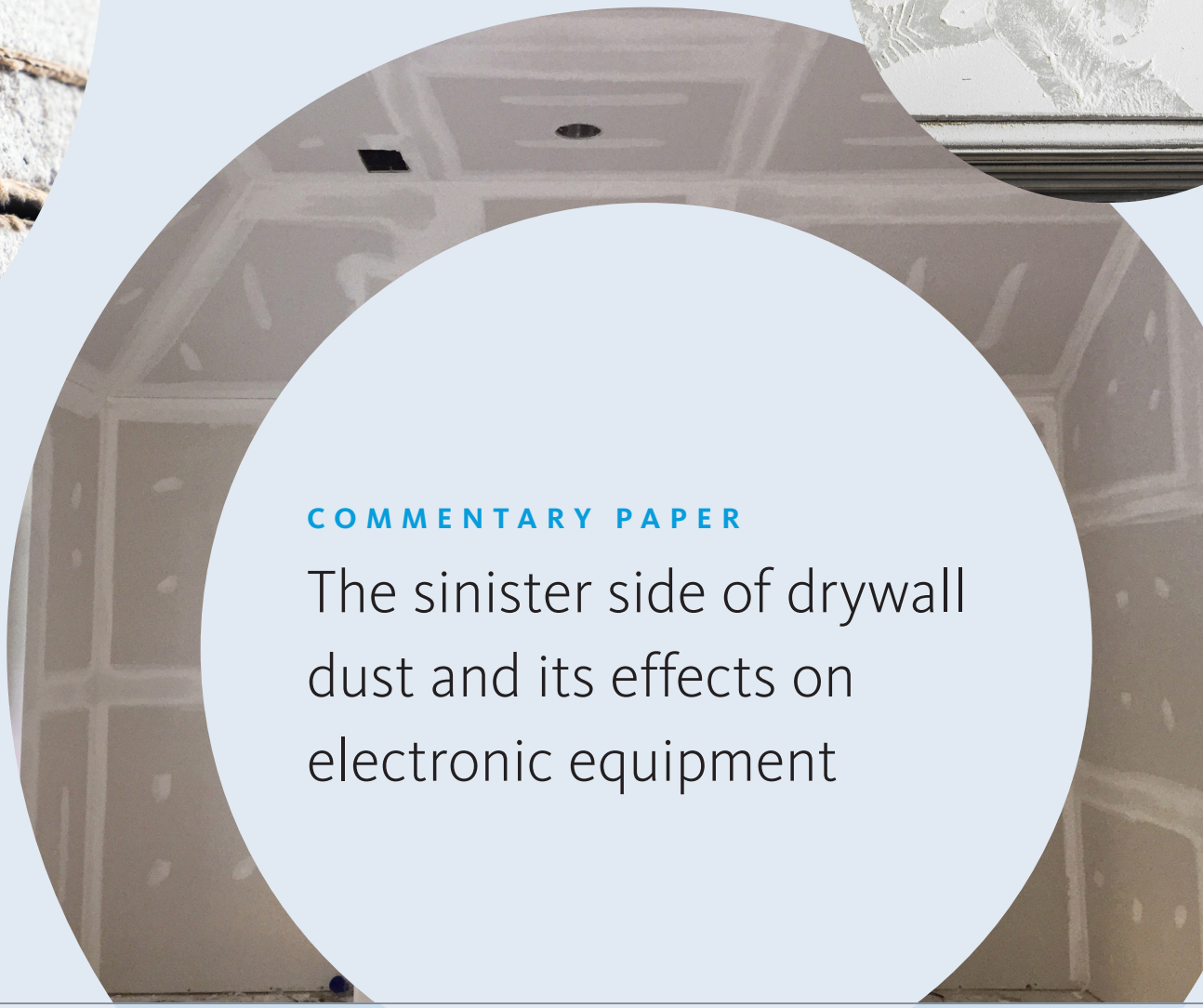

COMMENTARY PAPER

The sinister side of drywall dust and its effects on electronic equipment

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Drywall post loss

Due to its ease of installation, durability, ease of repair and cost effectiveness, drywall has been a staple in American homes for years. In 2005, as a category 5 hurricane battered New Orleans, residential buildings were severely impacted by flooding. One plantation home built two centuries before Hurricane Katrina, now known as The Pitot House Museum, sustained little-to-no damage. How can this be explained? It's simple: building materials matter.

"The Pitot house was built the old way, with plaster walls," says Steve Mouzon, an architect who helped rebuild the city after the hurricane. "When the flood came, the museum moved the furniture upstairs. Afterwards, they simply hosed the walls – no harm done." The other houses weren't built the old way. "All the homes around the Pitot house were lost because they were built with drywall," says Mouzon.

Residential buildings are easily damaged by flooding when compared to commercial structures. Commercial properties are more complex because they house a great deal of immovable equipment, as well as business personal property. "In some cases, the equipment is worth more than the building itself," says Scott Carroll, director of client services at EFI Global.

As an example, to help minimize down time in a flooded hospital setting, restoration crews stage air movers throughout and/or place lay flat ducting to dry the facility. Drywall is torn out as quickly as possible, because with its paper backing, wet drywall is an ideal habitat for mold.

Types of drywall

Drywall consists of two paperboards that sandwich gypsum, a soft sulfate mineral composed of calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$). The kind of paper used, chemical composition and thickness determine the drywall type. The paper covering can be gray, green, purple, brown, blue, or white – while the internal gypsum board is an off-white color. The types of drywall include:

Regular drywall
Perhaps the most common type of drywall that is used in both residential and commercial ceilings and walls.

Moisture resistant drywall
Often referred to as green or purple board because of the paper color surrounding the drywall, moisture-resistant drywall is made with a thicker paper backing and coated with wax for extra moisture resistance. This type of drywall is used in kitchens, laundry rooms and bathrooms.

Plasterboard
Referred to as blue board, plasterboard is used as a base for plaster applications. The face paper is absorptive – allowing better adhesion of the plaster finish coat to the drywall.

Soundproof drywall
As the name suggests, soundproof drywall is designed with added wood fiber, gypsum and polymers to increase the sound transmission class (STC) above that of regular drywall.

Fire-resistant drywall
Specialized fire-resistant drywall contains fiberglass, which slows the progress of fire and does not burn as fast as regular drywall. This type of drywall is used around equipment that could cause a fire. In a residential setting, that would include the basement, or walling around a furnace and garage.

VOC-absorbing drywall
The Environmental Protection Agency (EPA) describes volatile organic compounds (VOCs) as compounds that have a high vapor pressure and low water solubility. VOCs are emitted as gases from certain solids and liquids. Examples include paints, cleaning supplies, and building materials. VOC absorbing drywall captures VOCs and traps them inside the drywall, making them inert.

Table 1.0 – Example of Continental Building Products drywall ingredients

Component	Chemical Abstracts Service (CAS) number	Percent (by weight)	Incompatible materials
Gypsum (Calcium Sulfate)	7778-18-9	70 - 90%	Incompatible with diazomethane, aluminum and phosphorus
Calcium Carbonate	1317-65-3	60 - 65%	Incompatible with acids, aluminum, ammonium salts, fluorine and magnesium. When heated to decomposition it emits an acid smoke and irritating vapors
Cellulose	9004-34-6	0 - 10%	Cellulose is combustible. Incompatible with strong oxidizing agents
Crystalline Silica (as Quartz)	14808-60-7	0 - 2%	Increased risk of fire and explosion on contact with: oxidizing agents (e.g. peroxides). Not corrosive to metals
Vermiculite	1318-00-9	0 - 10%	Hydrofluoric acid
Potassium Sulfate	7778-80-5	0 - 5%	Strong oxidizing agents, aluminum, magnesium, sodium, calcium
Starch	9005-25-8	0 - 5%	Strong oxidizing agents
Fiberglass	65997-17-3	0 - 5%	None known
Mica	12001-26-2	2 - 3%	Acids. Avoid temperatures above 450 deg F (230 deg C), potential violent decomposition may occur. Thermal decomposition in the presence of air may yield carbon monoxide, carbon dioxide, phenolics, acids, aldehydes, ketones and other unidentified toxic and/or irritating compounds
Paraffin Wax	8002-74-2	0 - 2%	Strong oxidizing agents
Boric Acid	10043-35-3	0 - 1%	Boric Acid reacts as a weak acid that may cause corrosion on base metals. Reaction with strong reducing agents such as metal hydrides or alkali metals will generate hydrogen gas that could create an explosive hazard. Avoid contact with strong reducing agents

Composition of drywall

In the United States, there are seven manufacturers of drywall: US Gypsum (USG), CertainTeed Gypsum, Georgia-Pacific, American Gypsum, Lafarge North America, PABCO and National Gypsum. Drywall is also known as gypsum wallboard, plasterboard and sheetrock. While each manufacturer has their secret sauce, most drywall is manufactured with similar ingredients.

Table 1.0 exhibits composition/information on ingredients for multiple types of drywall manufactured by Continental Building Products (CBP). Most manufacturers do not have a list of eleven ingredients within their drywall. The table is shown because CBP published the most comprehensive safety data sheet (SDS) available. Table 1.0 was modified to include incompatibility of specific ingredients with other materials/chemicals.

To simplify the review of drywall ingredients and their potential effects on equipment, a few examples of regular drywall SDS compositions are provided.

Chemical name	CAS number	Weight %
Calcium Sulfate	10101-41-4	95 - 100
Cellulose (paper fiber)	9004-34-6	1 - 5
Silica Fume	69012-64-2	0.5 - 1.2
AirRenew Extreme Impact product only:		
Fiberglass Mat	65997-17-3	1 - 2

Table 2.0 – CertainTeed composition/information on ingredients

Component	CAS number	Weight %
Calcium Sulfate Dihydrate (Gypsum)	10101-41-4	> 85%
Crystalline Silica (Quartz)	14808-60-7	< 5%
Cellulose (Paper Fiber)	9004-34-6	< 10%
Proprietary Additives	N/A	< 1%

Table 3.0 – National Gypsum composition/information on ingredients

Name	Product identifier	%	GHS ingredient classification
Gypsum (Ca(SO4).2H20)	CAS no. 13397-24-5	90 - 99	Not classified
Limestone	CAS no. 1317-65-3	< 10	Not classified
Quartz	CAS no. 14808-60-7	< 2	Carc. 1A, H350 STOT SE 3, H335 STOT RE 1, H372

Table 4.0 – Lafarge composition/information on ingredients

As can be seen in tables 2.0 - 4.0, calcium sulfate dihydrate (gypsum), calcium carbonate (limestone), cellulose (paper fiber) and crystalline silica (quartz) are the ingredients with the highest weight percentages. Gypsum, by far the largest ingredient, is not compatible with aluminum. Aluminum and its alloys are widely used in the production of electronic and microelectronic components such as capacitors. Among all metal core printed circuit boards (PCBs), aluminum PCBs are the most used.

Applications of aluminum PCBs may include:

- Computer graphics cards, motherboards, hard drives and mobile phones.
- Electrocardiogram (ECG) machines, magnetic resonance imaging (MRI), X-ray and computer tomography (CT) equipment, blood pressure machines and incubators.
- Medium and high-powered LED lighting circuits.
- Audio equipment such as power amplifiers, office automation, and communication equipment.

Chinese drywall

At the height of the United States housing boom in 2007, building materials were in short supply due, in part, to several hurricanes that devastated Florida (2004-2005) and the damage caused by Hurricane Katrina. Hundreds of millions of pounds of Chinese drywall were imported into the U.S. during that time. American construction companies used the Chinese-made drywall because it was abundant and cheap. Homeowners in the southeastern United States complained of corroding copper and a rotten egg odor emanating from copper surfaces that turned black and exhibited a powdery ash type substance.

Lab comparisons of Chinese and American-made drywall showed significantly higher levels of pyrite in the Chinese material. Pyrite has a chemical composition of iron disulfide (FeS2) and is the most common sulfide mineral. There was speculation that the pyrite oxidation resulted in off-gassing of volatile chemicals and sulfurous gases. This predominantly happened during periods of high heat and humidity. That is why most cases were noted in southern states. Heating, ventilation and air conditioning (HVAC) coils were affected, as well as copper pipes and electrical wiring.

While Chinese drywall is not the focus of this commentary, the effects of drywall contamination cannot be thoroughly discussed without acknowledging that this situation happened, as claims are still being reviewed to this day.

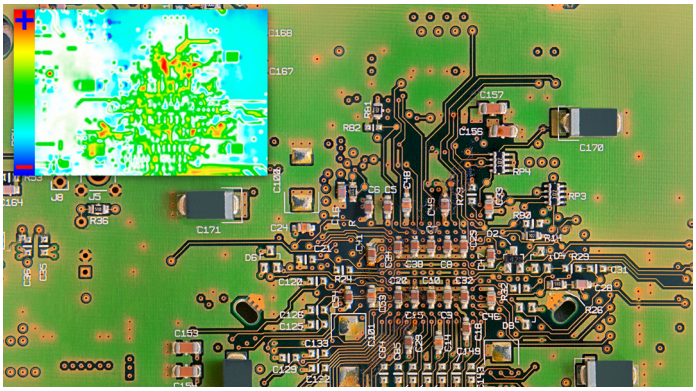
Effects of drywall dust on electronic assemblies

The American Chemical Society published a study in 2020 titled, “Influence of calcium scaling on corrosion behavior of steel and aluminum alloys”. The study results showed that the presence of calcium carbonate and calcium sulfate (a calcium salt) as a scaling environment, increased the corrosion rate for aluminum alloys and carbon steel. The study also showed that the same environments did not affect the corrosion behavior of stainless steel.

An analysis of gypsum published by Janalta Interactive revealed that, "gypsum/gypsum mortar attacks zinc and iron (steel) very strongly when combined with humidity. Aluminum materials and lead in general are not likely to be attacked by the more neutrally reacting gypsum building materials. In aluminum that is free of copper, moist gypsum promotes a limited pitting corrosion." Pitting corrosion is a localized form of corrosion by which cavities or holes are produced in the material. Once pitted, the material is permanently damaged. "Aluminum alloying that contains copper has the potential to corrode quite intensively in wet gypsum."

While the presence of aluminum as a common PCB substrate has been established, how many other metals exist on a circuit board? According to the Multidisciplinary Digital Publishing Institute (MDPI), PCBs consist of approximately 26% metal, made up mainly of copper, lead, aluminum, iron, zinc, tin, as well as other heavy metals such as cadmium and nickel. As noted, zinc and iron are susceptible to a corrosive attack in the presence of gypsum/ gypsum mortar and humidity. Considering typical water usage when extinguishing a fire, or recovery activities following a flood, elevated humidity is a common concern.

Drywall dust presents another challenge for electronic assemblies, beyond its ability to cause deterioration of certain metals in the right environment. Drywall and environmental dust act as insulators, which can cause overheating. While insulation in a residence is critical to prevent heat from escaping, the opposite is true for sensitive electronic circuitry. PCBs that generate heat require cooling. Most cooling applications call for air movement across the boards to dissipate the heat. Circuitries that operate at elevated temperatures experience failures and a diminished life expectancy.



Lastly, when facility recovery activities take place at a loss site, technicians at times tear out or clear more than just drywall. This may include ceiling tile debris, carpeting, floor adhesives, wooden cabinets, furnishing and environmental contamination. With or without drywall in the mix, those added extra contaminants present danger to circuitry, as a result of conductive particulate that can cause electrical short circuiting.

Qualitative testing methods

In an effort to prevent secondary damage – damage that would occur if recovery specialists were not cognizant of all aspects of the loss site – a thorough remediation plan has to be established at the onset. Such a plan requires qualitative information, to identify areas within a facility that were impacted as a result of the loss event, versus normal environmental or production by-product contaminants that were pre-existing. According to the American Industrial Hygiene Association (AIHA), "It is essential to match the sampling method and media with the corresponding analysis, to maintain the integrity of particles and residue of interest and support the scope of the investigation".

Tape lifts

A technique that preserves the relative position, density, size and shape of all particles on the original surface, as well as the population per unit area, is called a tape lift. This technique is preferred for evaluating char, ash, soot and other signature particles via optical microscopy. ASTM E1216-21 is one of many industry-accepted tape lift sampling methods. This method allows for a proper analysis of the in situ depositional soot patterns that differentiate anthropogenic background – environmental change caused or influenced by people, either directly or indirectly – from a fire event.

Wipe samples

Wipe samples measure ionic contaminants such as bromides, chlorides, nitrates, sulfates and sodium, among others. The samples are analyzed with an ion chromatograph, an instrument that measures concentrations of ionic species by separating charged particles from a liquid, using the SW9056A water extraction test method for anions, and a modified ASTM D6919 water extraction method for cations. Wipe samples ascertain the levels of potentially corrosive particles that settled on a surface.

Wipe samples should be used when the alteration of microscopic particle properties, depositional patterns or composition, does not adversely impact the quality of the resultant data.

Bresle method

Bresle equivalent testing is used to measure electrical surface conductivity of contaminants, by following ISO 8502 parts 6 and 9. The measured increase in conductivity establishes the concentration of soluble salts. What does this mean and why is it important? Loss-related contaminants can include chlorides from consumed materials containing polyvinyl chloride (PVC), nitrates from burned plastics and carpeting, as well as sulfates from consumed cardboard, wood and paper products.

While the meter displays both the conductivity and the surface salt concentration, the type of ionic particles present (chlorides, nitrates, sulfates) remain unknown. Obtaining a conductivity reading is important because it helps experts estimate the risk of electrical failures in a specific area, if equipment is powered on before loss related contaminants are professionally removed. Presence of elevated soluble salts signals degradation likelihood of susceptible surfaces.

Soluble salt profiler

Soluble salt profilers (SSPs) are also designed to measure surface conductivity and establish the concentration of soluble salts. They do so by employing a different technology, although tests comparing the two have shown that the SSPs provide an equivalence to the Bresle test in accordance with ISO 8502 part 9.

Equipment recovery options

It's wishful thinking to assume that on every loss that requires quantitative sampling, the sampling will take place before facility restoration activities begin. Experts that perform this type of testing are, at times, engaged several days or even weeks after the loss occurs, while facility restoration often starts the same day. As a result, it is important to understand what equipment remediation options could be employed, depending on site conditions.

Power off equipment

Equipment in commercial settings tends to be powered on continuously. Post loss, equipment should be powered off by qualified personnel. Doing so prevents contaminants from being drawn into control cabinets or computer equipment, that utilize fans to introduce air into those assemblies for cooling purposes.

Poly sheeting

Plastic tarps should be employed to cover equipment that was powered off.

Containment

There are circumstances that prevent equipment from being powered off. In those cases, containment should be built to prevent contamination from further exposing the equipment. Equipment that is powered on should not be covered. Doing so may cause it to overheat.

Preservation

Countless materials are used to build equipment. Some can withstand exposure to corrosive contaminants, while others quickly deteriorate. Equipment decontamination specialists utilize rust inhibiting lubricants to protect vulnerable metals. The most recognized rust inhibitor is WD-40, that can be found in large quantities at industrial supply and home improvement stores.

Oil based rust inhibitors are not applied on printed circuit boards. Vapor phase corrosion inhibiting technologies are designed to safeguard electronics. These technologies form a protective molecular barrier on the surfaces with which they come in contact.

Decontamination

For over forty years, professional equipment decontamination has been successfully employed on sensitive electronic assemblies – ranging from manufacturing controllers to data center servers and medical equipment. The cleaning techniques mirror those utilized in the printed circuit board industry.

There is one exception that is not well understood in the post-loss equipment decontamination industry. Ultrasonic cleaners, similar to those utilized to clean jewelry although far larger, should not be utilized to clean electronic assemblies. Unless electronic components were designed to withstand high-frequency sounds waves – transmitted through a bath containing a cleaning solution – and the ensuing cavitation attack, those components could fracture. Ultrasonic cleaners are better suited for hard non-absorbent materials such as rigid metal parts, tooling, dental and surgical instruments and firearms.

The right experts at the right time

Property losses involve structures and/or equipment. Regardless of what caused the loss, there is no reason for a secondary loss to ensue. Other than drywall that may collapse during the loss, drywall dust is typically generated during recovery activities. Being mindful of drywall dust migration and the adverse effects on equipment, is paramount.

Experts must understand the different test methodologies. Some testing techniques provide no value if there is a need to know where the combustion by-product migrated too. Others do not quantify how corrosive the settled contaminants are. It is also important to understand which decontamination methods are appropriate for the affected equipment.

Retaining the right experts to establish a scope, determine reserves, work with original equipment manufacturers (OEMs) and oversee the recovery, will minimize down time. This, in turn, translates to claim settlements whereby the insured appreciates the proposed indemnity, and the adjuster can move on to helping another business recover.

About EFI Global

EFI Global, part of Sedgwick, is a well-established brand with an excellent reputation in the Americas, Africa, Asia-Pacific and Europe as a market leader in environmental consulting, engineering failure analysis and origin-and-cause investigations. Each year, EFI Global completes more than 45,000 projects worldwide for a wide range of clients, such as commercial, industrial, institutional, insurance, government, risk managers, public and private entities. EFI Global is one of the world's most respected emergency response firms, capable of providing practical solutions to the most complex problems. Our multidisciplinary team of first responders, project managers, engineers, geologists and scientists are selected for their technical proficiency and in-depth industry knowledge to aid clients in resolving technical problems. For more, see **efiglobal.com**.

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Get in touch with an expert

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Tracey is a senior managing principal for the large complex loss practice for EFI Global, specializing in environmental consulting. She has over 25 years' experience supporting environmental, health and safety projects. Technical specialization includes forensic assessments associated with damages to determine scope and repair, and includes numerous projects involving building materials and reactive Chinese drywall. Tracey's experience also includes performance of environmental risk assessment and toxicological services for corrective action and expert testimony, as well as the performance of workplace industrial hygiene assessments and food and product contamination assessments. For additional information, contact **Tracey.Dodd@efiglobal.com**.

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