

Claims[®]

COVERING THE BUSINESS OF LOSS

November
2018

Volume 66 . Number 11
PropertyCasualty360.com

An **ALM** Publication



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from the November 2018
issue of *Claims* magazine

The National Underwriter Company



HOW CLEAN IS 'CLEAN'?

By Sean M. Scott

During a structure fire, toxic smoke, volatile organic compounds (VOCs), and particulate matter are generated from the vast array of building materials, contents and household products that combust. These chemicals interact with each other to create a vast array of carcinogens, poisonous gasses, acids and other toxins that can cause acute and chronic illnesses, cancer and even death. Some are so toxic that the EPA has designated them as having a zero level of permissible exposure limit (PEL).

Clothing, textiles and other types of soft goods often act like VOC sponges and are highly susceptible to smoke saturation, retention and contamination during and after a fire, which prompts the question: Can clothing and other types of soft goods damaged by smoke really be completely decontaminated and restored? Can ozone, laundry detergents, and dry-cleaning chemicals remove or neutralize every one of the thousands of chemicals

that may be created in a fire? If so, how can we assure consumers that the restoration techniques are effective and the cleaning chemicals themselves are safe?

In the restoration industry today, soft goods, clothing and textiles exposed to asbestos, lead dust, sewage, blood-borne pathogens or mold, are typically considered a total loss. Items damaged with these contaminants are typically inventoried and discarded. However, when clothing or soft goods are exposed to highly toxic chemicals, gases, PCBs and particulates generated by a fire, a different approach should be taken.

The theory is that soft goods and fabrics can be completely sanitized and deodorized by placing them in an ozone chamber for a couple days, using commercial grade laundry detergents, dry cleaning and other cleaning methods. Are these methods truly 100% effective in removing all contaminants? Or are there other dangers from ozone and the cleaning chemicals?

What do we know?

Research has been inadequate in identifying the tens of thousands of chemicals created in a structure fire, and even less is known about which cleaning agents or methods are truly effective to clean, restore or decontaminate smoke-damaged soft goods. So, how do we know for sure when items contaminated by smoke and sent to be cleaned aren't contaminated when they are returned to be used or worn? If toxic chemicals and particulates generated by a fire are known to be human health hazards through inhalation or absorption through the skin, then restoration and cleaning companies should have some method to scientifically verify that the restoration was truly successful, right?

If you send smoke-damaged baby clothes to be treated with ozone and cleaned, is there a possibility that toxic particulates and harmful chemicals could be trapped in the fabric? If so, could these toxic particulates be absorbed

by a baby's skin and cause a reaction, sickness, disease or worse? The answer is a resounding yes!

Most restoration practitioners rely on physical appearance and the sense of smell to determine whether something is clean or not. However, the real dangers lie in what you can't see or smell. Although an item may appear clean and have a fragrance that some identify as clean, the real dangers are camouflaged toxic VOCs or microscopic particulates that may be embedded in the material.

Experiments cause major concerns

Recently, I sent several articles of smoke-damaged clothing to a leading textile restoration company to be cleaned

Here is what the clothes looked like before the cleaning and deodorization process.



and deodorized. The articles were a pair of toddler's purple polka dot pajamas and an infant's red onesie. Both had been in a house fire where a ground floor bedroom was completely gutted and the remainder of the home had moderate to heavy smoke damage throughout. Both articles were taken from a room that was furthest away from the fire source and both had a very pungent smoke odor.

Prior to accepting the clothes for cleaning, the textile restoration company assured me that they could completely deodorize and clean them. They placed the articles in an ozone chamber for 48 hours and laundered them. A few days later, I received the clothes back and they looked like new and had a pleasant smelling detergent fragrance.

Although the articles looked and smelled clean, I wanted to determine scientifically if the methods used to restore the clothes might tell a different story. I submitted the articles to a forensic laboratory that specializes in testing for chemicals and fire VOCs to see if the combination of ozone and the cleaning processes truly restored the clothes, or if there were any residues left behind.

About a week later, the analysis report from the lab confirmed my suspicions.



Toxic chemicals that were byproducts of combustion attributed to the fire were found in the fabrics, and some were odorless. In addition, there were chemicals that may have come from the cleaning solutions, detergents or the chemical reactions caused by exposure to ozone.

Here is the actual list of chemicals discovered in the clothing, many of which are known to be extremely toxic to human health from either inhalation or contact with the skin:

Fire-related VOC's and other chemicals found in the fabric

- O-Cresol
- Methylbiphenyl
- Biphenyl
- 2-Methylnaphthalene
- 2-Methoxyphenol
- C9-C11 Hydrocarbon
- Ethanol
- Ethylbenzene
- 4-Ethyl-2-M
- C10-C12 Hydrocarbon
- Acetone
- 1,2,4-Trimethylbenzene
- Ethoxyphenol
- C11-C13 Hydrocarbon
- Ethyl acetate
- Benzaldehyde
- Acenaphthylene
- C12-C14 Hydrocarbon
- Chloroform
- Nonanal
- Acrolein
- C14-C16 Hydrocarbon
- 1,4 Dioxane
- Decanal
- Acetonitrile
- Styrene
- Toluene
- Hexadecane (C 16)
- Furfural
- Isopropanol
- Acetic acid
- Guaiacol
- Salicylaldehyde
- Benzene
- Heptanal
- Octanol
- 2,4-Dimethylphenol

- Trichloroethene
- M,p-Xylene
- Tetrachloroethene
- Naphthalene
- Methyl methacrylate
- O-Xylene
- Phenol

Children's vulnerability to toxic chemicals

Children's early developmental processes are easily disrupted. Rapid, complex and highly choreographed development takes place in prenatal life and in the first years after birth, continuing more slowly throughout childhood into puberty. In the brain, billions of cells must form, move to their assigned positions, and establish trillions of precise interconnections. Likewise, development of the reproductive organs is guided by a complex and precisely timed sequence of chemical messages and is shaped by maternal and fetal hormones.

Recent research in pediatrics and developmental toxicology has elaborated the concept of "windows of vulnerability." These are critical periods in early development when exposures to even minute doses of toxic chemicals, levels that would have no adverse effect on an adult, can disrupt organ formation and cause lifelong functional impairments.

If, for example, cells in an infant's brain are injured by lead or a toxic chemical, the consequences can include developmental disabilities in childhood and possibly increased risk of neurological degeneration, such as Parkinson's disease, in adult life. If inappropriate hormonal signals are sent to the developing reproductive organs by a synthetic chemical endocrine disruptor, such as certain chemicals commonly found in household products, plastics, and cosmetics (phthalates), and on clothing (flame retardants), lifelong reproductive impairment may ensue.

Children have more time than adults to develop chronic diseases. Many diseases triggered by toxic chemicals, such as cancer and neurodegenerative diseases, are



Here is what the clothes looked like after the cleaning and deodorization process.

known to evolve through multi-stage, multi-year processes that may be initiated by exposures in infancy.

Given these findings, I suggest before cleaning an entire house full of smoke-damaged clothes or textiles, that several sample articles be test cleaned and then analyzed by an independent laboratory to see if the cleaning and deodorization process works. If the sample articles come back free of toxic residues or VOCs, then the cleaning processes are effective, and the customers can rest assured that their soft goods have been properly restored. However, if the items come back contaminated, then cleaning methods may need to be re-evaluated.

What is 'clean'?

So, what does 'clean' mean in terms of restoring someone's clothes or soft goods to a pre-loss condition? Is it even possible with today's techniques? If the end result of using ozone and cleaning chemicals that were used in my experiment leaves similar residues of toxic chemicals, then most smoke-damaged textiles may simply have to be considered a total loss.

Just like structures contaminated with asbestos, lead, mold, sewage or other



hazardous contaminants undergo clearance testing to confirm their successful removal, textiles, especially clothing exposed to fire or smoke-related contaminants should undergo similar testing to ensure they are safe to use or wear. 🍷

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