

Restoring Smoke Damaged Textiles - What Does Clean Mean?



Photos courtesy of Sean Scott

Written by Sean Scott, August 27, 2018.

Reprinted with the permission of Sean 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 mix and 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.

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 and/or neutralize every one of the thousands of chemicals that may be created in a fire? If so, how can the consumer be assured the

restoration techniques are effective and the cleaning chemicals themselves are safe?

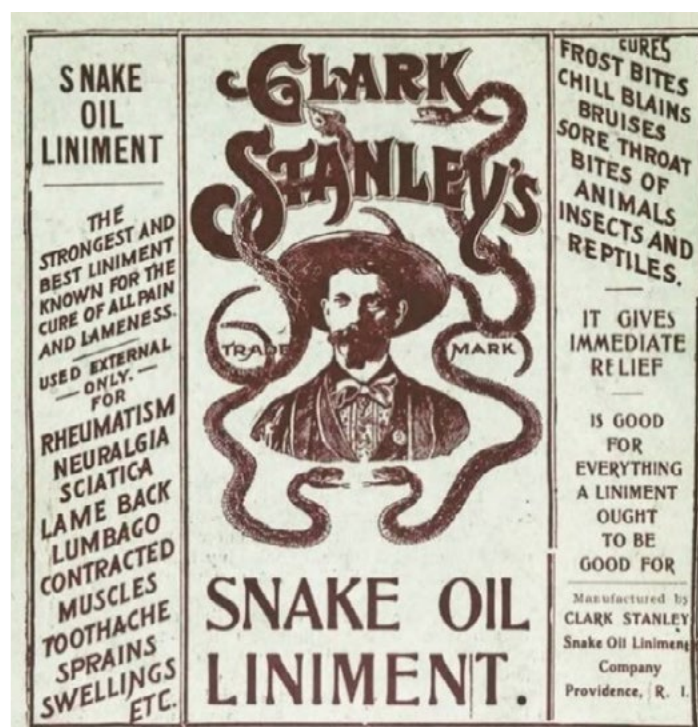
In the restoration industry today, soft goods, clothing, and textiles that are exposed to asbestos, lead dust, sewage, blood-borne pathogens, or mold, are typically considered a total loss. Items damaged with contaminants such as these are typically inventoried, and then discarded. However, in many cases when clothing or soft goods are exposed to highly toxic chemicals, gases, PCB's, and particulates generated by a fire, many of which are far more toxic than asbestos, lead, mold, or other contaminants, a different approach is often taken. Here, 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. But are these methods truly 100% effective in removing all contaminants, VOC's, and particulates or are the proponents of ozone and the manufacturers of cleaning chemicals not telling us something?

Like the snake oil salesmen of the 1800's, proponents of ozone make it sound like it is a miracle elixir that can cure all the ills of smoke damage and remove every particle, chemical, and contaminant. If this is true, then why does the EPA state the following? "There is a large body of written material on ozone and the use of ozone indoors. However, much of this material makes claims or draws conclusions without substantiation and sound science. Often the vendors of ozone generators make statements and distribute material that lead the public to believe that these devices are always safe and effective in controlling indoor air pollution. For almost a century, health professionals have refuted these claims." ¹ The same holds true for many of the chemicals used in the restoration industry, many of which have not been thoroughly researched or studied.

WHAT DO WE KNOW?

Research has barely scratched the surface on identifying the tens of thousands of chemicals that can be created in a structure fire and even less is known on what cleaning agents or methods are truly effective to clean, restore, and/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 or 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 or carcinogenic 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 were to send smoke damaged baby clothes to be treated with ozone and cleaned, is there a possibility that toxic particulates laden with 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 toxic VOC's that may be camouflaged or microscopic particulates that may be embedded in the material.

LESSONS LEARNED FROM THE FIRE SERVICE

Firefighters are exposed to a wide range of toxic chemicals and hazardous substances during firefighting. These contaminant exposures pose significant dangers to firefighters' immediate and long-term health, with an increased risk of cancer topping the list. The contaminants in and on firefighting equipment such as soiled turnout coats and personal protective equipment cross-contaminate everything and everyone they come in contact with. If there is exposure to gases or vapors, liquids, or particles, these substances will get onto clothing and in some cases, certain substances may not come off even during cleaning.

Modern materials, especially synthetics, present an increasingly complex mixture of combustion products, with most of these substances harmful for human exposure, including a number of known carcinogens. There is a long list of substances that include a variety of hazardous compounds such as heavy metals, inorganic chemicals, volatile organic compounds and semi-volatile organic compounds, which are further broken down into categories such as polynuclear aromatic hydrocarbons (PAHs), phthalate-based plasticizers, dioxins, halogenated flame retardants, and particulates.





Examples of Hazardous Substances at Fire Scenes

<p><u>Heavy Metals:</u> Antimony, arsenic, boron, cadmium, chromium, cobalt, mercury, molybdenum, nickel, lead, lithium, selenium, strontium, thallium, thorium, titanium, zinc, etc.</p>	<p><u>Semi-Volatile Organic Compounds:</u> Acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthrene, pyrene, chrysene, acetophenone, di-n-butyl-phthalate, di-n-octyl phthalate, phenol, 2-methylphenol, 4-chloro-3-methylphenol, etc.</p>
<p><u>Hazardous Chemicals:</u> Hydrogen cyanide, sulfur dioxide, nitrogen oxide, ammonia, phosgene, chlorine, sulfuric, hydrochloric, nitric, and other acids and bases, dioxins, furans, PCB's, PAH's, etc.</p>	<p><u>Chemical Mixtures:</u> Gasoline, automotive chemicals, pesticides, herbicides, household cleaning products, swimming pool chemicals, etc.</p>
<p><u>Volatile Organic Compounds:</u> Acrolein, aldehydes, formaldehyde, benzene, methanol, naphthalene, styrene, toluene, etc.</p>	<p><u>Other Substances:</u> Particulate matter, asbestos fibers, chemicals used in the manufacture of illicit drugs, toxic molds, etc.</p>

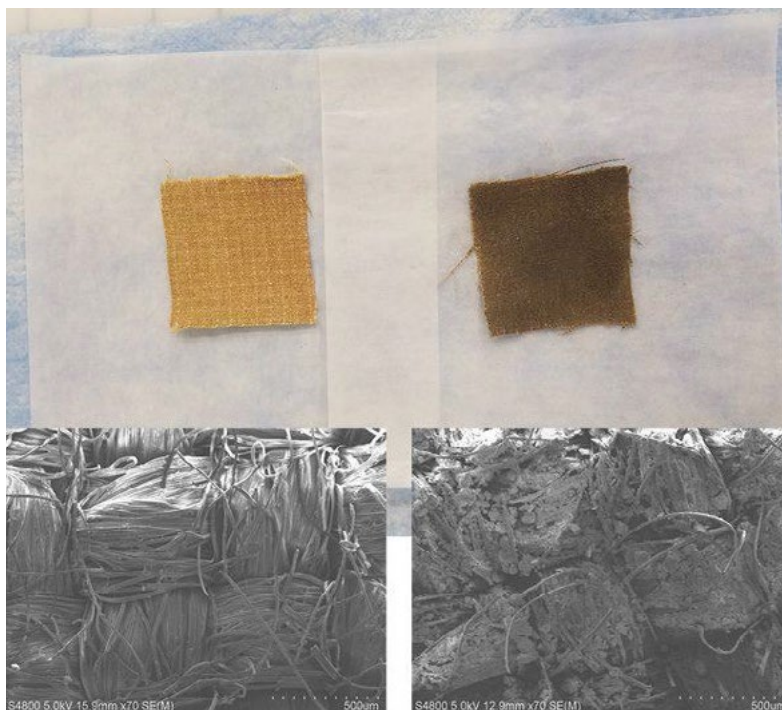
TEXTILE CONTAMINATION AND EXPOSURE

Particulate contamination in a structure fire setting is comprised primarily of the carbon particles from incomplete combustion. These carbon or soot particles adsorb fire gases and hold them in small pores within the particles, making them more dangerous than just the plain carbon. While many particles are visible, many are submicron in size and easily get into any porous surfaces or fabric mesh. Longer exposures produce higher levels of contamination saturation and the extent of contamination depends on the nature of the substances involved.

All contamination seeks to be diluted. This is a principle called chemical mass transfer. The best example is if you took an open container of a volatile chemical (like acetone) and placed it inside a closed room. Over time, the chemical would evaporate and eventually would be equally distributed at the same concentration throughout the room. So, whereas the chemical is initially in a

very concentrated state in the container, it becomes significantly less concentrated and spreads over a broader area over time. This principle also applies to contamination. Clothing and soft goods becomes contaminated by smoke during a fire, picking up fire gases, absorbing liquids, and accumulating particles.

Other forms of the contamination remain tightly bound to the clothing. This occurs as the result of chemicals that have directly permeated or penetrated the materials or were absorbed onto soot particles that remain in and on materials. Chemicals that do not easily evaporate, generally referred to as semi volatile chemicals, are persistent and create longer lasting forms of contamination. Their continued presence in or on fabric items results in a more chronic exposure, either through inhalation or dermal exposure. Many smoke substances are toxic through skin absorption, which can be accelerated by increased temperature and sweating.



The images above are clean and soiled turnout coat fabric swatches side-by-side with electron microscope photographs showing dirt particles embedded in the soiled swatch under extreme magnification. (Photo courtesy of the NIOSH National Personal Protective Technology Laboratory and Health Effects Laboratory Division.)

Fire smoke presents a complicated mixture of toxic chemicals, some of which are persistent and some of which are known carcinogens or acute skin hazards. Many of these chemicals will become entrained within the clothing materials or penetrate the clothing and get onto your skin. While your skin can be a great barrier for many substances, some chemicals more easily permeate and can get into your bloodstream more readily than others. Such chemicals with continued exposure over long periods of time can result in increased risk for a variety of health disorders.

Smoke particles generated by a fire are generally very small, many in the range of a hundredth of a micron in diameter. These particles are present in very high concentrations and, given their size, easily penetrate small pores and openings in clothing. The carbon particles adsorb fire gases created by the decomposition of materials during a fire, leading to a myriad of different chemicals. This adsorption holds onto the particles and the gases that otherwise would dissipate and be diluted in the environment. Added to these attributes are high levels of heat and moisture, which exacerbate the contamination process, especially when there are additional exposures to a variety of melted materials that can deposit on clothing surfaces. The result is a relatively complex set of contaminants that are distributed in different ways throughout the clothing. Moreover, given that every fire has its own DNA, the vast range of conditions leads to varying degrees of contaminants.

ASSESS AND VALIDATE CLEANING EFFECTIVENESS

The missing element in soft good restoration is judging just how effective the cleaning is. We know that washing generally appears to remove soils and that clothing can look closer to its original appearance after being cleaned. In some cases, the clothing smells “clean,” leading us to believe that washing the clothing really works.

Appearance and odor are not enough to assess whether the clothing has been adequately cleaned and, more importantly, decontaminated. While some cleaning processes impart fragrance to the laundered item, these odorants may only mask any scent from a continuing contaminant. The reality is that the smell of “clean” is no odor at all. **The problem with determining whether soft goods are clean is being able to evaluate the clothing scientifically.**

One approach to evaluating clothing for contamination or cleanliness involves getting “samples” from the clothing and then sending those samples to a qualified laboratory for analysis. This requires a certain level of expertise. Sampling methods include using surface wipes, soaking the clothing in small volumes of water with detergent, and physically removing samples for destructive analyses. These techniques can easily be applied anywhere but have to be properly administered to get appropriate results.²

THE USE OF OZONE – FRIEND OR FOE?

Textile restoration companies rely heavily on the use of ozone as one of the key steps in the restoration process. Let’s take a look at the pros and cons of using ozone, starting with one proponent’s opinion: “Ozone is a highly effective natural sterilizer that can inactivate practically any organic contaminant on contact. As it is a highly reactive gas, ozone continually reverts back to its most stable form by releasing one of its atoms to turn back into oxygen (from O₃ to O₂). As the additional oxygen atom breaks free, it will oxidize any organic matter it touches, killing organic contaminants at a cellular level. Essentially, ozone disrupts the cellular structure by rupturing the cell wall – a process referred to as ‘cell lysing’.

By intelligently controlling atmospheric ozone concentration, we are able to safely decontaminate any given area, as the additional oxygen atom in ozone oxidizes and inactivates a broad spectrum of pathogens. Our sanitation process is highly effective for treating the



air and surfaces in any area through the eradication of: Bacteria, Viruses, Odors, Allergens, Mold – Fungus, VOC’s.

The ozone rich atmosphere is sustained for a short period of time, typically one hour, during which time all bacteria and other unwanted elements are destroyed. When the sanitation process is complete, ozone rapidly reverts back into oxygen. This is further accelerated by an ozone deactivation program, so the process can be completed very quickly.

Advantages of using ozone: *Imagine the possibilities created by safely harnessing the sanitizing power of ozone in gaseous form. As a gas, ozone is at its most effective. Ozone gas can fill areas very quickly, will penetrate into places that are traditionally difficult to reach (including fabrics and upholstery) and will inactivate contaminants on contact. Consider the labor force, time and range*

of chemicals required to disinfect the entirety of a large room and its contents.

By using ozone instead, all of the walls, the doors and door-frames, the windows, the floor, the ceiling, the contents, soft furnishings and even the air can be treated automatically, with no additional chemicals and in a very short timescale.

With traditional sanitizing methods there is a risk of re-contamination as contaminants can potentially be spread around the area on cleaning cloths and implements. This risk is completely negated by using ozone sanitation. As ozone is a gas composed entirely of oxygen, it leaves no chemical residue whatsoever.

At the end of the sanitation process, the only by-product remaining is fresh clean air. When compared to traditional chemical sanitizing agents, ozone would therefore seem the natural choice for any organization looking to reduce the environmental footprint, time and labor requirement of their current sanitation processes.”³

Now, let's take a look at what federal government agencies and science has to say about ozone:

- 1) Ozone can react with air and create nitrogen dioxide if it is improperly generated.⁴ Nitrogen dioxide is corrosive to the skin and the respiratory tract. Inhalation of the gas or the vapor may cause lung oedema. Exposure far above the occupational exposure limit may result in death and the effects may be delayed.⁵
- 2) Ozone reacts with terpenes to create formaldehyde. Terpenes are organic compounds and major components of resin and of turpentine produced by conifer trees (pines, cedars, spruces, redwoods, etc.) Reactions of ozone and terpenes lead to the production of carbonyls such as formaldehyde and acetaldehyde, organic acids, hydrogen peroxide, secondary organic aerosols and hydroxyl (OH) radicals. Produced OH radicals chain-react with volatile organic compounds or carbonyl compounds in indoor environments, resulting in the generation of additional oxidation products. Although a large volume of research related to the production of secondary organic aerosols

has been reported, information about many of the individual secondary products during ozone oxidation of terpenes is limited. Additionally, the mixture of oxidation products appears to have significant irritant properties. Acetaldehyde and formaldehyde were not decomposed by ozone.⁶

- 3) Sulfuric acid can be produced from ozone, water and either elemental sulfur or sulfur dioxide: Ozone reacts with hydrogen sulfide to create sulfur dioxide.⁷ Sulphur Dioxide reacts with humidity and forms sulphuric and sulphurous aerosol acid. It causes breathing difficulty, airways inflammation, psychic alterations, pulmonary edema, heart failure, and circulatory collapse. Sulphur dioxide is also associated with asthma, chronic bronchitis, morbidity and mortality increase in the elderly and infants.⁸
- 4) Formic acid can be produced with the use of ozone. This substance is a medium strong acid that reacts violently with oxidants and is an explosion hazard. It attacks many plastics and metals. It can be absorbed into the body by inhalation of its vapor, through the skin and by ingestion. A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 68 degrees Fahrenheit. The substance is very corrosive to the eyes, the skin and the respiratory tract and is corrosive on ingestion. Inhalation of the vapor may cause lung oedema. The substance may cause effects on the energy metabolism, resulting in acidosis.⁹

Some manufacturers and advocates for ozone claim that ozone will render almost every chemical contaminant harmless by producing a chemical reaction whose only by-products are carbon dioxide, oxygen and water. This is misleading.

- First, a review of scientific research shows that, for many of the chemicals commonly found in indoor environments, the reaction process with ozone may take months or years (Boeniger, 1995). For all practical purposes, ozone does not react at all with such chemicals. And contrary to specific claims by some vendors, ozone generators are not effective in removing carbon monoxide (Salls, 1927; Shaughnessy et al., 1994) or formaldehyde (Esswein and Boeniger, 1994).

- Second, for many of the chemicals with which ozone does readily react, the reaction can form a variety of harmful or irritating by-products (Weschler et al., 1992a, 1992b, 1996; Zhang and Lioy, 1994). For example, in a laboratory experiment that mixed ozone with chemicals from new carpet, ozone reduced many of these chemicals, including those which can produce new carpet odor. However, in the process, the reaction produced a variety of aldehydes, and the total concentration of organic chemicals in the air increased rather than decreased after the introduction of ozone (Weschler, et. al., 1992b). In addition to aldehydes, ozone may also increase indoor concentrations of formic acid (Zhang and Lioy, 1994), both of which can irritate the lungs if produced in sufficient amounts. Some of the potential by-products produced by ozone's reactions with other chemicals are themselves very reactive and capable of producing irritating and corrosive by-products (Weschler and Shields, 1996, 1997a, 1997b). Given the complexity of the chemical reactions that occur, additional research is needed to more completely understand the complex interactions of indoor chemicals in the presence of ozone.
 - Third, ozone does not remove particles (e.g., dust and pollen) from the air, including the particles that cause most allergies. However, some ozone generators are manufactured with an "ion generator" or "ionizer" in the same unit. An ionizer is a device that disperses negatively (and/or positively) charged ions into the air. These ions attach to particles in the air giving them a negative (or positive) charge so that the particles may attach to nearby surfaces such as walls or furniture or attach to one another and settle out of the air. In recent experiments, ionizers were found to be less effective in removing particles of dust, tobacco smoke, pollen or fungal spores than either high efficiency particle filters (HEPA) or electrostatic precipitators. (Shaughnessy et al., 1994; Pierce, et al., 1996).
 - In an experiment designed to produce formaldehyde concentrations representative of an embalming studio, where formaldehyde is the main odor producer, ozone showed no effect in reducing formaldehyde concentration (Esswein and Boeniger, 1994). Ozone is not considered useful for odor removal in building ventilation systems (ASHRAE, 1989).
 - While there are few scientific studies to support the claim that ozone effectively removes odors, it is plausible that some odorous chemicals will react with ozone. For example, in some experiments, ozone appeared to react readily with certain chemicals, including some chemicals that contribute to the smell of new carpet (Weschler, 1992b; Zhang and Lioy, 1994). Ozone is also believed to react with acrolein, one of the many odorous and irritating chemicals found in secondhand tobacco smoke (US EPA, 1995).
 - Some data suggest that low levels of ozone may reduce airborne concentrations and inhibit the growth of some biological organisms while ozone is present, but ozone concentrations would have to be 5 - 10 times higher than public health standards allow before the ozone could decontaminate the air sufficiently to prevent survival and regeneration of the organisms once the ozone is removed (Dyas, et al., 1983; Foarde et al., 1997).
 - Even at high concentrations, ozone may have no effect on biological contaminants embedded in porous material such as duct lining or ceiling tiles (Foarde et al, 1997). Even with high levels of ozone, contaminants embedded in porous material may not be affected at all.¹⁰
- 5) Ozone reacts with water vapor and creates hydrogen peroxide. Reactions studied produced H₂O₂ and a significant increase in the yields of H₂O₂ was observed when water vapor was present. The 'water effect' is the result of a direct reaction of water vapor with the Criegee biradical (the main intermediate in reactions of ozone with alkenes).¹¹
 - 6) Although it resembles oxygen in many respects, ozone is much more reactive; hence, it is an extremely powerful oxidizing agent, particularly useful in converting olefins into aldehydes, ketones, or carboxylic acids.¹²
 - 7) Ozone creates Methyl Bromide (Bromomethane). Biproducts of ozonation that have been identified include formaldehyde and other aldehydes, carboxylic acids, hydrogen peroxide, bromate, bromomethanes, brominated acetic acids, brominated acetonitriles and ketones.¹³

The hazard summary from the EPA states that methyl bromide is used as a fumigant and pesticide. Exposure typically occurs during fumigation activities. Methyl bromide is highly toxic. Studies in humans indicate that the lung may be severely injured by the acute (short-term) inhalation of methyl bromide. Acute and chronic (long-term) inhalation of methyl bromide can lead to neurological effects in humans.

Studies in humans indicate that the lung may be most severely injured by the acute inhalation exposure of methyl bromide. Breathing high concentrations of methyl bromide may cause pulmonary edema, impairing respiratory function. Acute exposure by inhalation of methyl bromide frequently leads to neurological effects in humans. Symptoms of acute exposure in humans include headaches, dizziness, fainting, apathy, weakness, confusion, speech impairment, visual effects, numbness, twitching, and tremors; in severe cases paralysis and convulsions are possible. Acute exposure may produce delayed effects. Symptoms may improve without treatment in less serious cases. Methyl bromide is irritating to the eyes, skin, and mucous membranes of the upper respiratory tract. Dermal exposure to methyl bromide can cause itching, redness, and blisters in humans. Kidney damage has been observed in humans who have inhaled high levels of methyl bromide. Inhalation of methyl bromide may cause the liver to become swollen and tender, but no significant injury to the liver has been observed in humans. Injury to the heart has been observed in mice and rats exposed to high concentrations of methyl bromide by inhalation. Tests involving acute exposure of rats and mice have demonstrated methyl bromide to have high acute toxicity from inhalation and oral exposure.

Data from an occupational study suggest that mild functional neurological impairment may result in humans chronically exposed to methyl bromide by inhalation exposure, but this is not conclusive due to concurrent exposure to other chemicals and inadequate

quantitation of exposure levels and durations. Neurological effects, including lethargy, forelimb twitching, tremors, and paralysis, have also been observed in animal studies. Certain types of fabrics and clothing components can be damaged or destroyed by ozone use.¹⁴

8) Health experts warn that it is important to control conditions to ensure that no person or pet becomes exposed to high levels of ozone. Ozone also masks the odor of some pollutants by impairing a person's sense of smell.¹⁵

9) Beware of Ozone-generating Indoor "Air Purifiers". Manufacturers sometimes inappropriately refer to ozone as "activated oxygen," "super oxygenated" or "energized oxygen," implying that ozone is a healthy kind of oxygen. Because ozone reacts with some other molecules, manufacturers claim that the ozone produced by these devices can purify the air and remove airborne particles, chemicals, mold, viruses, bacteria, and odors. However, ozone is not effective at cleaning the air except at extremely high, unsafe ozone levels, and then it is only partially effective. Persons especially vulnerable include children and those who suffer from asthma or other respiratory diseases, including the elderly.

Ozone can also damage materials such as rubber, fabrics, plastics and other indoor furnishings. Ozone can react with existing chemicals in the air to create other toxic pollutants, most notably formaldehyde and ultrafine particles. Evidence shows that ozone concentrations below the health standards are not effective in removing many odor-causing chemicals. **Ozone is also known to deaden one's sense of smell.** Not only does this disguise rather than eliminate odors, it can also have the dangerous effect of decreasing a person's ability to detect high ozone levels. For more information on the health effects of ozone, visit <http://www.arb.ca.gov/research/aaqs/caaqs/ozone/ozone.htm>.¹⁶

MY OWN EXPERIMENT RESULTS – A MAJOR CAUSE FOR CONCERN

Recently, I conducted an experiment where I sent a couple articles of smoke damaged clothing to a leading textile restoration company to have them cleaned and deodorized. The articles were a pair of toddler's purple polka dot pajamas and an infant's red onesie. Both articles 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.



This is the location where the sample clothes were taken.

The following pages show photos of the actual experiment clothes before the cleaning:









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

Here are what the clothes looked like after the cleaning and deodorization process:









Although the articles looked clean and smelled like what you might expect as a “clean” smell, I wanted to find out scientifically if the methods used to restore the clothes might tell a different story. So, I submitted the articles to a forensic laboratory that specializes in testing for chemicals and fire VOC's, to see if the combination of ozone and the cleaning processes truly restored the clothes or if there were any VOC's or chemical residues left behind that might be of concern.

About a week later, I received the analysis report from the lab and my suspicions were confirmed. Chemicals had been discovered in the fabrics that were byproducts of combustion attributed to the fire, some of which 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 that were 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

A layperson would assume that a nationally recognized restoration company that touts themselves as experts in textile odor cleaning and restoration, would use methods that would not only be effective, but safe once the processes were completed. In addition, you would also think that a piece of clothing that went through such a vigorous cleaning process would most certainly not have any hazardous chemical residues. However, a wide range of chemicals were discovered and here are some of the health risks of exposure to the chemicals that were found in my experiment:

Lab Report: Primary and Secondary Fire Indicators

O Cresol

<https://cameochemicals.noaa.gov/chemical/3014>

This chemical is rated as a very toxic compound and a strong dermal irritant that frequently causes dermatitis. Serious or fatal poisoning may result if large areas of skin are wet with o-cresol, and the substance is not removed immediately. Ingestion of even a small amount may cause paralysis and coma. It is corrosive to body tissues, with toxicity similar to phenol. Exposure can cause irritation to eyes, skin, and mucous membrane. Central nervous system effects include confusion, depression, respiratory failure; dyspnea (breathing difficulty), irregular rapid respiration, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage.

Guaiacol

<http://datasheets.scbt.com/sc-205337.pdf>

If guaiacol is absorbed, profuse sweating, thirst, nausea, vomiting, diarrhea, cyanosis, restlessness, stupor, low blood pressure, gasping, abdominal pain, anemia, convulsions, coma and lung swelling can happen followed by pneumonia. Some phenol derivatives may produce mild to severe eye irritation with redness, pain and blurred vision. Permanent eye injury may occur; recovery may also be complete or partial. The material may cause moderate inflammation of the skin either following direct contact or after a delay of some time. Skin contact with the material may damage the health of the individual; systemic effects may result following absorption. Phenol and its derivatives can cause severe skin irritation if contact is maintained and can be absorbed to the skin affecting the cardiovascular and central nervous system. Entry into the blood-stream through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. There is some evidence to suggest that the material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. If phenols are absorbed via the lungs, systemic effects may occur affecting the cardiovascular and nervous systems. Inhalation can result in profuse perspiration, nausea, vomiting, diarrhea, cyanosis, stupor, falling blood pressure, hyperventilation, abdominal pain, anemia, convulsions, coma, and inflammation of the lung.

Acenaphthylene

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+2661>

Acenaphthylene is a polycyclic aromatic hydrocarbon (PAH). They are ubiquitous environmental contaminants formed from combustion products of fossil fuels, cigarette smoking and in grilled or smoked foods. They are reported to alter trophoblast proliferation in the placenta, in addition to disturbing its endocrine functions, which may be able to increase the risk of preterm delivery in pregnant women.

Acrolein

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+177>

Acrolein is a biocide currently registered as an herbicide to control aquatic weeds, as a burrow fumigant to control rodents, and as a microbiocide to eliminate slime-forming microbes in oil drilling operations, pulp and paper mills, and in industrial cooling towers. It is an intermediate for synthetic glycerol, polyurethane and polyester resins, methionine, and pharmaceuticals. In World War I, it was used as a tear gas under the name Papite. Potential symptoms of overexposure are irritation of eyes, skin and mucous membranes; decreased pulmonary function; delayed pulmonary edema; chronic respiratory disease. Intense lacrimation and nasal irritation ordinarily give adequate warning of inhalation, but exposed patients should be observed for 24 hours for a slowly developing pulmonary edema. Acrolein is ciliastatic and capable of causing direct tissue damage similar to that reported for formaldehyde. Acrolein has a relatively short half-life and exerts its greatest effects on the upper and lower respiratory tract. Acrolein is also a weak sensitizer and may elicit asthma-type reactions.

Acetonitrile

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+42>

Acetonitrile is a liquid with an ether like odor. It is a volatile, highly polar solvent used in many different industrial applications including use for the hydrocarbon extraction processes, especially for butadiene; intermediate; catalyst; separation of fatty acids from vegetable oils; and manufacturing of synthetic pharmaceuticals. It is also the starting material for many types of nitrogen-containing compounds. It can be metabolized to produce hydrogen cyanide, which is the source of the observed toxic effects. Symptoms and signs of acute acetonitrile intoxication include chest pain, tightness in the chest, nausea, emesis, tachycardia, hypotension, short and shallow respiration, headache, restlessness and seizures. The systemic effects appear to be attributable to the conversion of acetonitrile to cyanide. Blood cyanide and thiocyanate levels are elevated during acute intoxication. Fatalities after exposure to acetonitrile in the workplace and fatal cases of a child ingesting an acetonitrile containing cosmetic have been reported. Elevated tissue cyanide concentrations were found in postmortem examination of these cases. Acetonitrile is readily absorbed from the gastrointestinal tract, through the skin and the lungs. All three routes of exposure have been reported to lead to systemic effects.

2,4 Dimethylphenol

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+42532,4->

Dimethylphenol appears to be a topical cocarcinogen, but its role as a primary cancer-producing agent is uncertain.

Naphthalene

<https://www.atsdr.cdc.gov/phs/phs.asp?id=238&tid=43>

Hospitals have reported many cases of hemolytic anemia in children, including newborns and infants, who were in close contact with clothing or blankets stored in naphthalene mothballs. Newborns or infants are thought to be especially susceptible to this effect on the blood, because their bodies are less able to get rid of naphthalene than adults.

Acute exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and, in infants, neurological damage. Symptoms of acute exposure include headache, nausea, vomiting, diarrhea, malaise, confusion, anemia, jaundice, convulsions, and coma. Cataracts

have been reported in humans acutely exposed to naphthalene by inhalation and ingestion.

Chronic exposure of workers to naphthalene has been reported to cause cataracts and retinal hemorrhage. For more information on the health risks of Naphthalene exposure visit: <https://www.epa.gov/sites/production/files/2016-09/documents/naphthalene.pdf>

Methylbiphenyl

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+6162>

Biphenyl is an irritant of the eyes, nose, throat, mucous membranes and respiratory tract. Biphenyl is a powerful lung irritant by inhalation. Repeated dermal contact can result in sensitization dermatitis. Eye exposure produces redness and pain. Effects reported after acute exposure include cough, headache, flaccid paralysis, anorexia, nausea, vomiting or diarrhea, bronchitis, insomnia, depression, memory loss, facial paralysis, vertigo, numbness and aching of the extremities and fatigue. Acute and chronic exposure result in central and peripheral nerve damage and severe liver injury. Chronic exposure produces symptoms of fatigue, headaches, tremor, insomnia, sensory impairment and mood changes.

Suspected of damaging fertility or the unborn.

<https://pubchem.ncbi.nlm.nih.gov/compound/2-Cyano-4-methylbiphenyl#section=Safety-and-Hazards>

Lab Report: Quantitative and Semiquantitative Results

The following chemicals were discovered that may be attributed to cleaning chemicals, reactions with ozone, or other factors:

Phenol

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+113>

Phenol is toxic and some individuals may be hypersensitive with lethality or serious effects at very low exposures. Rapid absorption and severe systemic toxicity can occur after any route of exposure including skin. Death and severe toxicity are usually due to effects on the central nervous system, heart, blood vessels, lung, and kidneys. However, toxic manifestations may vary somewhat with the route. Observed effects from acute exposure may include: shock, delirium, coma, pulmonary distress, phenolic breath, scanty dark urine, and death. Protracted or chronic exposure usually results in major damage to the liver, kidneys and eyes. Pigmentary changes of the skin have been noted. Consumption of water contaminated with phenol resulted in diarrhea, mouth sores, burning of the mouth, and dark urine. Phenol is highly caustic to tissues. Skin exposure results in pain, then numbness, blanching, severe burns, and eschar formation. Ingestion leads to burning of throat and severe gastrointestinal inflammation. Inhalation can result in pulmonary irritation and edema.

Benzene

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+35>

Benzene is used in manufacturing detergents, pesticides, plastics and resins, synthetic rubber, aviation fuel, pharmaceuticals, dye, explosives, PCB gasoline, flavors and perfumes, paints and coatings, nylon intermediates, photographic chemicals, etc. People who breathe in high levels of benzene may develop drowsiness, dizziness, rapid or irregular heartbeat, headaches, tremors, confusion, unconsciousness, and death. Benzene causes cancer and is genotoxic in humans.

Isopropanol

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+116>

Toxic effects of isopropanol include central nervous depression, liver, kidney, cardiovascular depression and brain damage. It can cause drowsiness, ataxia, stupor, coma and respiratory depression, irritation of mucous membranes and eyes, gastritis, gastric hemorrhage, vomiting, pancreatitis, cold clammy skin, hypothermia, miosis, tachycardia, slow and noisy respiration.

Toluene

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+131>

Toluene is a component of gasoline, paints, inks, lacquers, paint thinners, adhesives, fingernail polish, cleaning agents, and rubber. Toluene is used to produce benzene, trinitrotoluene, nylon, plastics, and polyurethanes. It is also used in production of drugs of abuse. Toluene is a favorite of solvent abusers, who intentionally inhale high concentrations to achieve a euphoric effect.

Ethylbenzene

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+84>

Human exposure to ethylbenzene occurs mainly by inhalation. Ethylbenzene has low acute and chronic toxicity for humans. It is toxic to the central nervous system and is an irritant of mucous membranes and the eyes.

Decanal

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+288>

<https://cameochemicals.noaa.gov/chemical/8495>

Decanal, also known as decaldehyde is an aldehyde. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. The use of ozone can increase byproducts including acetone, nonanal, decanal, 4-oxopentanal (4-OPA), 6-methyl-5-hepten-2-one (6-MHO), formic acid, and acetic acid.

1,4 Dioxane

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+288> • <https://cameochemicals.noaa.gov/chemical/8495>

Short-term inhalation exposure to 1,4-dioxane may cause irritation of the eyes, nose, throat, and lungs. Symptoms of acute exposure include coughing, drowsiness, vertigo, headache, nausea, vomiting, stomach pains, coma, and death. There is a report of a fatal case of acute poisoning by inhalation that led to hepatic and renal lesions, and demyelination and edema of the brain. Workplace exposures to high concentrations of 1,4-dioxane have resulted in death. The deaths occurred 5-8 days after the initial symptoms of illness.

Trichloroethene

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+133>

Overexposure to trichloroethylene may cause headache, vertigo, visual disturbance, fatigue, giddiness, tremors, somnolence, nausea and vomiting, irritation of eyes and skin, dermatitis, cardiac arrhythmias, paresthesia, liver injury. Death has occurred at very high concentrations (10,000 ppm) and was associated with cardiac arrhythmia and massive liver damage. TCE exposure is associated with an increased risk of kidney cancer. Liver cancer incidence was elevated in most of the Tier I cancer incidence studies. TCE is carcinogenic to humans. Based on sufficient epidemiological evidence for cancer of the kidney, with strong mechanistic support from studies in experimental animals and exposed humans. The epidemiological data also identified limited evidence for an association with liver cancer and non-Hodgkin lymphoma.

Ethyl Acetate

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+83>

Ethyl acetate is an effective poison for use in insect collecting as its vapors are a respiratory tract irritant whose vapors can kill the insect quickly without destroying it, leaving it intact for study. Short-term exposure to high levels of ethyl acetate results first in irritation of the eyes, nose and throat, followed by headache, nausea, vomiting, sleepiness, and unconsciousness. High concentrations can cause central nervous system depression and congestion of the liver and kidneys. Chronic poisoning has been described as producing anemia, leucocytosis (transient increase in the white blood cell count), and cloudy swelling, and fatty degeneration.

Nonanal

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+7229>

Nonanal is not registered for use in the U.S., but approved pesticide uses may change periodically and so federal, state and local authorities must be consulted for currently approved uses. It is used in the perfume industry and as a flavoring agent. Ozone exposure resulted in a significant early increase in nonanal in the airway epithelial lining fluid of humans. Nonanal produced in vitro by ozonation of liposomes induced hemolysis of human red blood cells, and combination of nonanal and hydrogen peroxide was significantly more hemolytic than nonanal alone.

Hydrocarbons

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+7092>

<https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+632>

Mixtures of polycyclic aromatic hydrocarbons (PAHs) are carcinogenic in humans. The evidence in humans comes primarily from occupational studies of workers exposed to mixtures containing PAHs as a result of their involvement in such processes as coke production, roofing, oil refining, or coal gasification (e.g., coal tar, roofing tar, soot, coke oven emissions, soot, crude oil). Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lung and skin following inhalation and dermal exposure, respectively. Some ingestion of PAHs is likely because of swallowing of particles containing PAHs subsequent to mucociliary clearance of these particulates from the lung.

Hydrocarbons are a diverse group of organic compounds that are made up of primarily carbon and hydrogen atoms. Hydrocarbons are derived from petroleum, coal tar and natural gas, as well as from plants and animals. They may be classified as aliphatic (including the paraffins, olefins, acyclic terpenes, and acetylenes) and cyclic (including the alicyclics, aromatics and cyclic terpenes). Examples range from gasoline to essential oils to solvents. They are used as fuels and solvents and are found in many household and commercial products. Low viscosity, highly volatile hydrocarbons (eg, kerosene, gasoline, liquid furniture polish) are chiefly aspiration hazards. Pulmonary damage, transient CNS depression or excitement, and secondary effects of hypoxia, infection, pneumatocele formation, and chronic lung dysfunction can occur. Cardiac complications are rare. These hydrocarbons are poorly absorbed from the gastrointestinal tract and do not cause appreciable systemic toxicity by this route unless aspiration has occurred.

So, What Does Clean Mean?

Now after reading all the health effects of exposure to these chemicals, would you let your child wear clothes that had these chemicals in the fabric? I would venture to guess, probably not. Then you have to ask yourself this; if you wouldn't let a young child wear them, then at what age would you feel comfortable letting someone in your family or even you yourself wear clothes that were contaminated with these chemicals?

If you look up the definition of the word "clean", it reads: "free from dirt or pollution; unsoiled; unstained, free from foreign or extraneous matter; pure. What you don't see is any mention of scent. Scents are added to almost everything we use from cosmetics and personal care products to candles, cleaning products, hand soaps, laundry products and air fresheners. Somewhere along the line, "clean" has lost some of its meaning and has now become a scent when in fact the act of cleaning laundry or anything else is done to remove both soil and offensive odors. So, how is "clean" supposed to smell? Simply put, clean laundry should smell like the absence of offensive odors. For most consumers, clean can also smell like your favorite detergent or fabric softener or any scent that reminds you of clean. This may be the smell of chlorine bleach or pine-scented disinfectant or some other scent.

Scientists in product research and development have zeroed in on scent clues to teach consumers the "smell of clean". Scented cleaning and laundry products tell consumers that their efforts have been productive. If your laundry and home smell a certain way, then they are clean.

So why are heavy scents so common in laundry detergents? You might think it's just because people like nice smells. But the truth is, traditional detergent companies use scents to cover up the odor in your laundry.

They can't actually clean out the stink, so they add fragrance. As the problem persists, you need more and more fragrance. And they deliver, knowing that if they went fragrance-free, you would smell what's really hiding in your clothes. The fresh laundry smell they provide is tricking you into thinking the product works.¹⁷

INDOOR AIR QUALITY: Scented Products Emit a Bouquet of VOCs

A survey of selected scented consumer goods showed the products emitted more than 100 volatile organic compounds (VOCs), including some that are classified as toxic or hazardous by federal laws. Even products advertised as "green," "natural," or "organic" emitted as many hazardous chemicals as standard ones.

Anne Steinemann, a professor of civil and environmental engineering and public affairs at the University of Washington, Seattle, and colleagues used gas chromatography-mass spectrometry to analyze VOCs given off by the products. They tested 25 air fresheners, laundry detergents, fabric softeners, dryer sheets, disinfectants, dish detergents, all-purpose cleaners, soaps, hand sanitizers, lotions, deodorants, and shampoos.

A single fragrance in a product can contain a mixture of hundreds of chemicals, some of which (e.g., limonene, a citrus scent) react with ozone in ambient air to form dangerous secondary pollutants, including formaldehyde. The researchers detected 133 different VOCs. Most commonly detected were limonene, α - and β -pinene (pine scents), and ethanol and acetone (often used as carriers for fragrance chemicals).

Steinemann found the average number of VOCs emitted was 17. Each product emitted 1–8 toxic or hazardous chemicals, and close to half (44%) generated at least 1 of 24 carcinogenic hazardous air pollutants, such as acetaldehyde, 1,4-dioxane, formaldehyde, or methylene chloride. These hazardous air pollutants have no safe exposure level, according to the U.S. Environmental Protection Agency. Of the 133 VOCs detected, only ethanol was listed on any label (for 2 products), and only ethanol and 2-butoxyethanol were listed on any Material Safety Data Sheet (for 5 products and 1 product, respectively).

The Consumer Product Safety Commission, which regulates cleaning supplies, air fresheners, and laundry products, currently does not require manufacturers to disclose any ingredients on the label, including fragrances in these products. The same is true for fragrances in personal care items, which are overseen by the Food and Drug Administration. The Household Product Labeling

Act, currently under review in the U.S. Senate, would require manufacturers to label consumer products with all ingredients, including fragrance mixtures. "Disclosing all ingredients could be a first step to understanding potential toxicity and health effects," says Steinemann.

Although the authors did not seek to assess whether use of any of the products studied would be associated with any risk, Steinemann says she receives hundreds of letters, phone calls, and e-mails from people who report a variety of respiratory, dermatological, and neurological problems they attribute to scented products: "Children have seizures after exposure to dryer sheets, and adults pass out around air fresheners," she says.

Claudia Miller, an allergist and immunologist at the University of Texas Health Science Center at San Antonio says "The best smell is no smell,"¹⁸

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, for example, 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. These windows of vulnerability have no equivalent in adult life.

Children have more time than adults to develop chronic diseases. Many diseases triggered by toxic chemicals, such as cancer and neurodegenerative diseases, are now understood to evolve through multistage, multiyear processes that may be initiated by exposures in infancy. This insight has catalyzed new research to identify how early environmental influences may affect health in childhood and across the human lifespan.

Evidence is strong and continuing to accumulate that toxic chemicals are important causes of disease and dysfunction in children. This recognition first arose in studies of lead and mercury. In recent years, as research strategies in environmental pediatrics have become more refined, the pace of scientific discovery has quickened and a series of new associations has been discovered.

Examples include the following: Prenatal exposure to PCBs is associated with reduction in children's intelligence. Baby boys exposed in the womb to phthalates, a chemical compound found in plastics, cosmetics, and many common household products appear to be at increased risk of behavioral abnormalities that resemble attention deficit hyperactivity disorder. Prenatal exposure to bisphenol A, a synthetic chemical used to manufacture polycarbonate plastics, is linked to behavioral abnormalities in girls. Prenatal exposure to brominated flame retardants is linked to cognitive impairments, and prenatal exposures to arsenic and manganese is associated with neurodevelopmental impairment.

The credible possibility exists that among the hundreds of untested chemicals currently in wide commercial use, there are synthetic chemicals whose toxicity to early childhood development has not yet been discovered.¹⁹

CONCLUSIONS

I am not a scientist, chemical engineer, or expert in microbiology, toxicology, or chemistry. I am a fire restoration contractor that has spent his life in the construction and restoration industry and simply wanted to verify some of the claims and methods accepted in the industry today. I asked the one question few have been willing to ask – do the cleaning methods used today to clean smoke damaged textiles and soft goods really work? The information and discoveries contained in this paper provide compelling evidence that restoration companies, insurance adjusters, and consumers alike should carefully consider. Given my findings, I suggest before cleaning an entire home full of smoke damaged textiles, have a couple sample articles cleaned and then analyzed by an independent laboratory to see if the cleaning and deodorization process works. If the sample articles come back truly clean, then the cleaning processes are effective and the customer can rest assured that his or her clothes have been properly restored. However, if the clothes come back contaminated with hazardous chemical residues or VOC's, then you may need to reevaluate the cleaning methods altogether.

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 whatever 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.

Consider this; when homes or buildings are contaminated with asbestos, lead, mold, sewage, or other hazardous contaminants, a testing laboratory will typically test the surfaces, areas, rooms, and/or air after the cleanup is completed to certify that the restoration and cleaning processes were successful in removing the contaminants. This is commonly known as a final clearance test. Textiles, especially clothing exposed to fire or smoke related contaminants should without question also be tested in like manner to insure they are safe to use or wear.

Without having textiles tested after a cleaning, could expose people to a wide range of chemical exposures and health risks and the restoration vendor or contractor to considerable liability.

For more information on this topic or to find out where you can have textiles tested for contaminants, contact Sean Scott at Sean@TheRedGuideToRecovery.com or call 858-453-6767.

SOURCES

- 1) *Ozone Generators that are Sold as Air Cleaners* <https://www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners>
- 2) *How Clean Is Clean? A Fire Service Transformation for Addressing PPE Contamination Control* <http://www.fireengineering.com/articles/print/volume-171/issue-1/supplement/how-clean-is-clean-a-fire-service-transformation-for-addressing-ppe-contamination-control.html>
- 3) <http://www.odorkillerpro.com/how-ozone-cleaning-works/> 4) <https://www.ncbi.nlm.nih.gov/books/NBK430751/> 5) Centers for Disease Control <https://www.cdc.gov/niosh/ipcsneng/neng0930.html> 6) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996213/>
- 7) <https://en.wikipedia.org/wiki/Ozone>
- 8) Centers for Disease Control <https://www.atsdr.cdc.gov/phs/phs.asp?id=251&tid=46>
- 9) Centers for Disease Control <https://www.cdc.gov/niosh/ipcsneng/neng0485.html>
- 10) Environmental Protection Agency <https://www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners>
- 11) <http://www.nature.com/articles/346256a0> and https://envronozone.com/science/ozone_science.htm
- 12) <https://www.britannica.com/science/ozone>
- 13) World Health Organization http://www.who.int/water_sanitation_health/dwq/S04.pdf
- 14) Environmental Protection Agency <https://www.epa.gov/sites/production/files/2016-09/documents/methyl-bromide.pdf>
- 15) New South Wales Australia - Ministry of Health <http://www.health.nsw.gov.au/environment/factsheets/Pages/ozone-generators.aspx>
- 16) https://www.arb.ca.gov/research/indoor/ozone_gen_fact_sheet-a.pdf
- 17) <https://hexperformance.com/dont-know-fresh-laundry-smell/>
- 18) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3018511/>
- 19) *Children's Vulnerability To Toxic Chemicals: A Challenge And Opportunity To Strengthen Health And Environmental Policy* <https://www.healthaffairs.org/doi/full/10.1377/hlthaff.2011.0151>

DISCLAIMER:

This paper is distributed as a public service for informational purposes only. While reasonable efforts were made to ensure the completeness and accuracy of its contents when published, no warranties or guarantees are made with respect to the completeness or accuracy of the information and opinions stated herein. The information and opinions stated herein may not be applicable to or suitable for every individual or situation, and constitute the opinions of the Author. Neither the Author nor Abbotts Cleanup & Restoration, shall be responsible to any user of the information for any injury, loss or damage of any kind or nature whatsoever that may be sustained as a consequence of the use and application of any information or opinions presented. In no event shall the Author nor Abbotts Cleanup & Restoration, be liable for any action taken or not taken by any person in reliance, directly or indirectly, upon the information and opinions provided herein. This publication is provided with the understanding that the Author, is not engaged in rendering legal advice and no legal opinions are provided by the Author. If legal or other professional advice or expert assistance is required, the services of a competent professional should be obtained.

All persons and entities using the information and opinions provided herein do so at their own risk and they hereby waive any and all claims against the Author and Abbotts Cleanup & Restoration,. Such waiver includes any and all claims arising in contract or tort, and all forms of equitable relief and damages including without limitation compensatory, general, special, and consequential damages.

Without limiting any other disclaimer provided herein, under no circumstances shall the Author be liable for any injury, loss, or damage of any kind or nature whatsoever. Information in this newsletter relates to a subject that changes periodically due to changes in the industry practices, science, and technology. All users of this paper acknowledge this disclaimer and agree to the limitations of liability stated above. Do not use this information if you do not agree with this disclaimer and its limitations of liability as reasonable. If any portion of this disclaimer is found to be unenforceable under applicable law, the remainder of the disclaimer will remain enforceable.

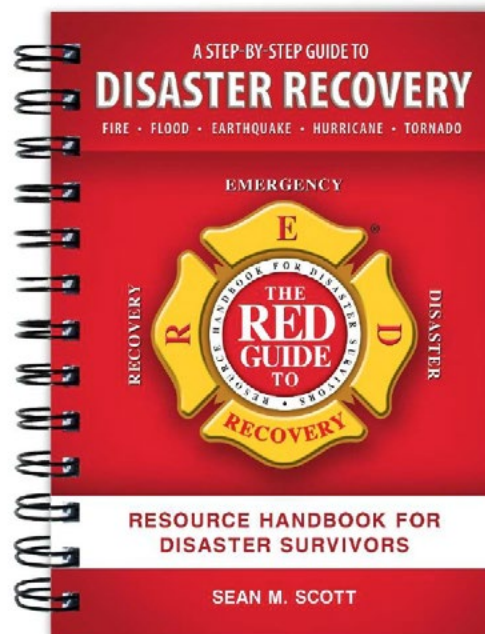
ABOUT SEAN SCOTT:

Mr. Scott is a licensed general contractor in the State of California who has spent over 39 years in the construction and restoration industry. As a second-generation restoration contractor, he has been involved with literally thousands of property damage claims of all types and sizes, ranging from commercial and residential floods, high-rise fires, smoke claims, mold contaminations, subsidence and earthquake claims, explosions, vehicular collisions, and many other types of property damaging incidents. Throughout his career, Sean has worked with all the major insurance carriers that underwrite residential and commercial policies and has worked directly with claims adjusters, independent adjusters, third party administrators, public adjusters, and attorneys. Sean is also the author of two books, ***The Red Guide to Recovery - Resource Handbook for Disaster Survivors*** and ***Secrets of the Insurance Game*** and the co-author of ***The Native Family Disaster Preparedness Handbook***.

Sean has devoted his life assisting individuals and families rebuild their homes, businesses, and lives and has witnessed first-hand the physical, emotional, and financial challenges people face once the first responders leave the scene. Since 2009, Sean's award-winning book ***The Red Guide to Recovery*** has been adopted by fire departments, emergency management agencies, and relief organizations across the U.S.

Sean now uses his time and expertise to help people navigate the recovery process, speak on recovery and restoration topics, and consult with those in the restoration industry who need guidance to be more successful. He also provides expert witness testimony, estimating services on property damage claims, insurance claim appraisal services, construction defect investigation, and training.

For more information on disaster recovery, **The Red Guide to Recovery – Resource Handbook for Disaster Survivors** and **Secrets of The Insurance Game** both provide a wealth of insight and useful information. Visit www.TheRedGuideToRecovery.com for details on the content of these books and other disaster preparedness and recovery resources.



For more information, contact:

Sean Scott

Office: 858-453-6767

Cell: 858-349-2262

Email: Sean@TheRedGuideToRecovery.com

www.TheRedGuideToRecovery.com