Blue Sky Environmental Consulting, Inc.

Protecting the Built Environment ™

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Cabinet Refinishing and the Difficulties in Using Solvent-Based Chemicals in California

By: Patrick Moffett

Example of oil-based kitchen cabinets that have been successfully repaired and refinished

Example of a cabinet waiting to be removed because of water damage to the base frame and the back panel. The goal is to detach the vanity without damaging any of its parts where minimal repair is required.

Example of kitchen cabinet having more than 20% moisture content, where trapped water is under and behind the cabinet. Cabinet box is wood veneer with particleboard. Replacement of the entire cabinet was completed.

Example of removed kitchen cabinets where the countertop is salvageable. Lower “new” cabinet boxes and “original face frame and cabinet doors” must match the 30-year old cabinets.

Example of cabinets that were completely restored, even though only the sink cabinet required refinishing. The initial color stain and finish matching was not acceptable to the adjuster and homeowner.

Example of stain testing different wood veneers.

VOCs in Sealers, Stains, Paint and Finish:

According to EPA, indoor air is three times more toxic than outdoor air, and according to EPA, indoor air pollution is considered one of the top-five hazards to human health. Paints and finishes release low-level toxic emissions. The source of these emissions is a variety of volatile organic compounds (VOCs), which until recently, were essential to the performance of stains, paint and finishes. In many stain, paint and finish supply stores, one will find labeling for low-VOC or no-VOC primers, sealers, stains and paint. It's believed, products having low or no VOC perform as well in terms of sealing, staining, coverage, finish, hardness and durability.

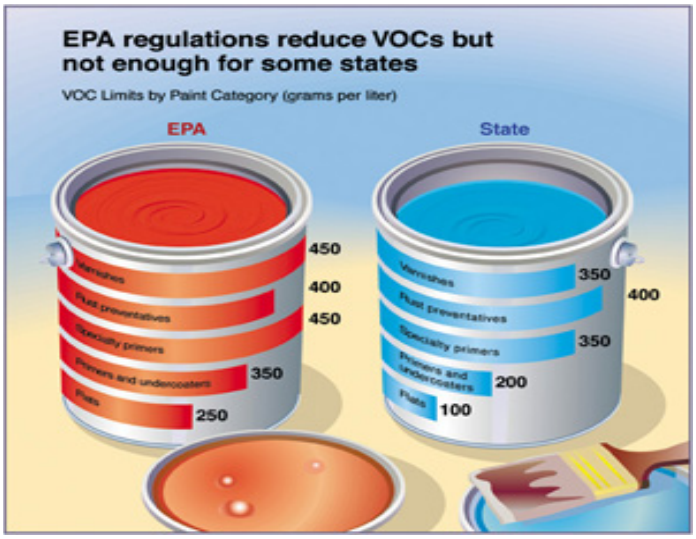
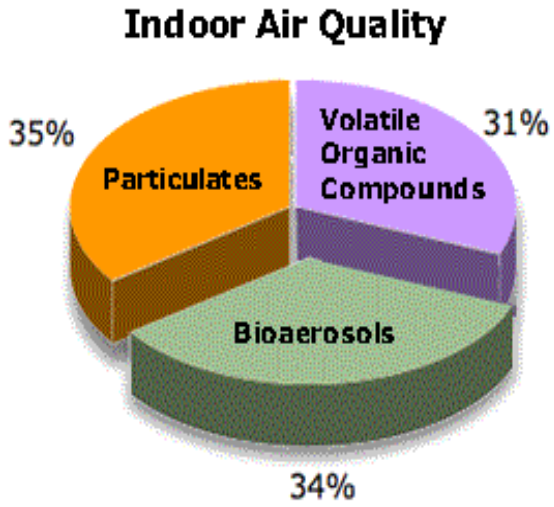


Illustration above by Dick Gage

VOCs are solvents found in paints and coatings, and everything that has been made or formulated by a chemical. Moreover, VOCs have been determined to be a major contributing factor to the formation of ground-level ozone, which has been proven to be a public health concern. To reduce ground-level ozone, the U.S. Clean Air Act regulates or limits manmade emissions of VOCs. Areas of the country that do not meet national standards for ground-level ozone are referred to as "ozone nonattainment areas."

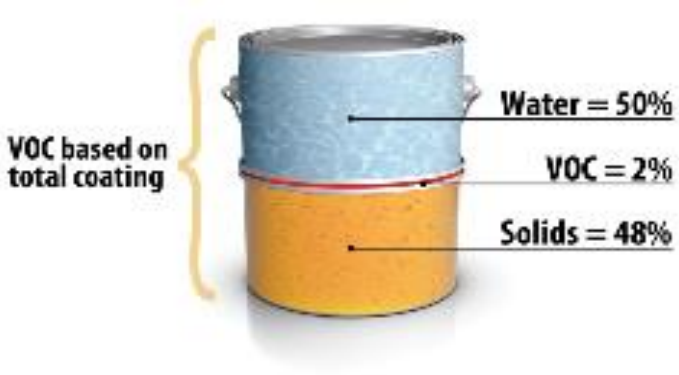
Under the Clean Air Act, these areas generally are required to reduce VOC emissions within their boundaries (not including vehicle emissions) by 3 percent each year until the national standard is met. ("*Summary of State and Federal VOC Limitations for Institutional and Consumer Products*." ISSA, 2015) The VOC limitations issued by these various authorities is constantly evolving. On an ever-increasing basis, more and more states like California are issuing VOC limitations, while states with existing limitations are expanding the reaches of their regulations as well as issuing more aggressive restrictions for existing product categories.



California AQMD Rule 1136 "Wood Product Coatings;" and SCAQMD Rule 1113 for VOCs

The purpose of California Air Quality Management District (AQMD) Rule 1136 is to reduce volatile organic compounds (VOC) emissions from the application of coatings or strippers to, and surface preparation of, any wood products, including furniture, cabinets, shutters, frames and toys. Rule 1136 states: a person or facility shall not apply any coating to a wood product which has a VOC content, including any VOC-containing material added to the original coating supplied by the manufacturer, which exceeds state limits. Besides paints and coatings, EPA cites all kinds of products in our home and business that release VOCs, including but not limited to: carpet, upholstery, wallpaper, pesticides, cleaning supplies, to office equipment such as copiers, printers, correction fluid and permanent markers. Even roofing materials that are heated by the sun can release VOCs, where through vapor pressure, gases can be forced back into the building.

South Coast Air Quality Management District (SCAQMD) is the air pollution control agency for Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties. SCAQMD is the smoggiest region of the U.S.



SCAQMD develops plans and regulations designed to improve air quality by reducing VOC emissions. These plans are then submitted for approval to the EPA and CARB to ensure compliance with their respective Clean Air Acts.

Just relying on a sealer, stain, paint or finish's Material Safety Data Sheet (MSDS); now known as a Safety Data Sheet (SDS), it will not provide you with VOC information other than it meets "low-VOC" or "no VOC" requirements set by EPA. You will want to read further and find out if the product meets California Rule 1136; and if you are in southern California, does the product comply with SCAQMD Rule 1113. If they don't, you could be in violation of state or region regulations that can result in fines or a lawsuit.

LEED 09 BD&C Building Design and Construction (NC,CS) 7/2014 LEED 09 ID & C Interior Design & Construction (CI) TABLE 1. IEQc4.2 Applicable VOC Limits 10/1/2013 Indoor Environmental Quality Credit Category 4.2, Paints and Coatings (updated 01/29/16)		
TABLE 1. IEQc4.2 Applicable VOC Limits 10/1/2013 Product Type	Referenced Standard‡	VOC Limit (g/L minus water)
Interior Flat Coating	Green Seal GS-11, 1993	50
Interior Non-Flat Coating	Green Seal GS-11, 1993	150
Anti-Corrosive/ Anti-Rust Paint	Green Seal GC-03, 2nd Edition, 1997	250
Clear Wood Finish: Lacquer	SCAQMD Rule 1113, 2004	550
Clear Wood Finish: Sanding Sealer	SCAQMD Rule 1113, 2004	350
Clear Wood Finish: Varnish	SCAQMD Rule 1113, 2004	350
Clear Brushing Lacquer	SCAQMD Rule 1113, 2004	680
Floor Coatings	SCAQMD Rule 1113, 2004	100
Primers, Sealers and Undercoaters	SCAQMD Rule 1113, 2004	200
Shellac: Clear	SCAQMD Rule 1113, 2004	730
Shellac: Pigmented	SCAQMD Rule 1113, 2004	550
Stain	SCAQMD Rule 1113, 2004	250
Japans/ Faux Finishing Coatings	SCAQMD Rule 1113, 2004	350
Pigmented Lacquer	SCAQMD Rule 1113, 2004	550
Waterproofing Sealers	SCAQMD Rule 1113, 2004	250
Wood Preservatives	SCAQMD Rule 1113, 2004	350
Low-Solids Coatings	SCAQMD Rule 1113, 2004	120

^ Note: VOC levels for Low-Solids Coatings are measured in grams of VOC per liter of material, including water. IEQ Credit 4.2: Per USGBC:• Clear wood finishes, floor coatings, stains, primer, sealers and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings.

Paint Strippers:

Most paint stripping chemicals are considered toxic. They work by melting the finish, underlying paint or stain, and base, leaving raw wood. The active ingredient in many paint strippers is methylene chloride; a potential carcinogen. One of the more environmentally friendly replacement of methylene chloride in paint strippers is an active ingredient of N-Methylpyrrolidone (NMP), an organic solvent. NMP chemically changes the finish, paint and primer, softening it for easier removal. However, NMP still causes health concerns as a potential human reproductive hazard.

Primers, Sealers, Stains, Paint and Top-Coat Finishes:

Primers, sealers, stains, and paint off gas (release of solvents in the air) during the life of the product. Once applied, solvents off-gas, where they release large amounts of VOCs over a matter of a few days to a week. As the product cures, VOCs become less, to where they are not noticeable to most humans. Yet, VOCs in the microgram (*u*g) are detectible through scientific instruments; they still may be a respiratory irritant to a health concern for some chemically sensitive individuals.

Both latex and oils paints contain solvents. With most oils, the primary solvent is paint thinner - thus the strong odor and the relatively high VOC levels (typically in the 250 - 400 gpl [grams per liter] range). The maximum allowable VOC content should be lower than 150 gpl says, Sheri Steber with Timer Pro Coatings.

Most latex paints also contain solvents, though far less than oils - the VOCs in latex paint come primarily from these solvents. Everything being equal, the lower the VOCs in a coating, the fewer solvents and the lower the emissions (there are exceptions because there are solvents that can be used that do not count toward VOCs but these are rarely used in interior coatings.)

As with paint, stains can also contain high levels of biocides, fungicides, and VOCs, which potentially pose health problems to building occupants. To combat high-levels of VOCs, cabinet manufacturers and refinishers are using water-based stains and sealants without biocides and added dryers, and products made with beeswax and carnauba wax. Some acrylic urethanes are manufactured without the addition of biocides, which may be acceptable for individuals who are chemically sensitive.

Situations which May Cause Cabinets to be Refinished and Refinishing Difficulties:

Picture above by Meaghan Thomas

Several reasons why cabinets require refinishing – cabinets are old, scratched, require repair; there are missing parts.

Another reason – cabinets are damaged because of an event, such as smoke, fire and water. After a fire, determining damage requires a close inspection finishes that are smoke impacted or heat damaged. Only through surface test cleaning can a restorer or cabinet specialist determine what the cabinet assembly and its parts looked like before the loss.

In a flooding situation where water caused swelling and damage to cabinets and finishes, the restorer or cabinet specialist determines the salvageability and restorability of each box, face, doors, drawers, trim, slides and glides.

Matching base coat sealers, primers or an oil penetrating stains and dyes that were applied 10, 30 or 100-years ago, requires testing of salvageable wood and finishes. Some cabinets may be stain and finish tested without removing them, while other cabinets including face frame (doors, drawers and trim) may require removal to a cabinet shop. In either case, where sanding, stripping or the reapplication of a sealer is required, it must be done under dust-control and well ventilated conditions.

Note: When cabinet finishes and countertops are older than 1978, they “must” be tested for lead “before” disturbing the finish or counter.

Matching the finish of cabinets can be challenging, for example: the stain color and finish of non-damaged cabinets will change (age) over time. The finish tends to yellow or take on a hew that is not as bright as it was years before. This aging process is referred to as the cabinet’s “patina” produced by oxidation (chemical change) of the finish over a period of time. Removing the patina can change the appearance of the cabinet. Adding patina is an art, which seldom is successful; match color, finish and hue. When cabinet doors, drawers and frame are made with new wood, the new wood may not be from the same solid wood, ply or veneer wood species. The wood’s species, locality of growth and porosity/density can cause the best cabinet wood to look different over time.

Staining and Blending:

Pictures above are from "Wood Magazine," showing a stain chart wheel that matches different stains to different wood species. When applying a stain on raw wood for the first time, the stain absorbs into pores where the grain of wood takes in or repels stain, this is primarily based on wood hardness of the soft wood and heart wood. If the stain is not applied properly, it can look blotchy and unattractive. For this reason, sealers are traditionally applied before staining, where after drying, the oil-based or water-based sealer allows a more even coat of stain to be applied and absorbed into pores.

Oil-based Primers and Finish vs. Water-based Latex Primers and Finish Challenges:

Depending on the finish, and its stain and primer/sealer, the cabinet may or may not be easily restorable. The rule of thumb, oil-based chemicals should not be applied over latex paint because paint may peel, because, water and oil don't mix. Yet, oil-based "painted" cabinetry can be stripped and sanded to remove most oil-based finish, or lightly sanded to allow the application of water-based latex paint. A primer is required before applying a water-based latex paint over oil.

However, when cabinets are "stain-grade," and they have an oil-base stain and finish, where a water-based latex stain and finish is to be applied, this is not recommended, without taking the cabinet back down to raw wood. Refinishing issues include but are not limited to: 1) cabinets made in a factory where the finish is baked on, making refinishing difficult to impossible; 2) cabinets having a wood veneer must be carefully stripped of finish and sanded, stained and refinished; 3) cabinets requiring only staining and finish, a water-base "stain" and finish may not color match the wood species of non-affected cabinets the same; the water-base "finish" may look different, diffusing and refracting ambient and illuminating light, creating high and low spots (phong value; index of refraction [IOR]), unless all cabinets are refinished equally to a default stain and finish value.

Once the wood takes on its desired color, a finish can be applied, usually a liquid, paste, or gel. There are two basic types of wood finish: those that form a film or coating; and those that penetrate the wood surface. Film finishes, which cure hard and can be built up in layers, include varnish, shellac, lacquer, water- and latex-based semitransparent stains, and solid-color stains. Penetrating finishes are oil-based and don't cure to a hard film. These include oil finishes, such as Tung and linseed oil, and oil-based stains. (Green Seal Report, February 2005)

Wood finishes can include several components:

1. Pigments or dyes are used in wood stains to add color and hide flaws.
2. Resin is the natural or synthetic film-forming component of these finishes. (Resins are also called binders, especially when used in stains or paints, because they hold – or bind – the pigment to the wood surface.) Resins include acrylics, vinyl, alkyds, cellulosic, epoxies, polyurethanes, and oils. The type of resin determines the finish's hardness, flexibility, and resistance to stains, solvents, and water.
3. Solvents and/or thinners are used to maintain the finish in liquid form. Solvents are needed to dissolve resins. Thinners are used to reduce viscosity (thickness) of the liquid. Some finishes contain both solvents and thinners. Solvent-based coatings typically use organic solvents such as alcohols, ketones, glycol ethers, petroleum distillates (mineral spirits, toluene, xylenes, and naphtha), and turpentine. The solvent in a waterborne coating is usually a glycol ether, and water is used as a thinner.
4. Various additives are used, in smaller amounts, to adjust drying time, prevent fungus and mildew growth, act as thickeners, etc. For centuries, varnish (a catch-all term for clear wood finishes) was made from resins collected from natural products such as tree saps or insect secretions and mixed with linseed or other natural oils. To create the final product, the mixture was thinned with turpentine. More recently, synthetic resins derived from coal tar and petroleum began to replace the natural resins, and petroleum distillates became the most commonly used solvents. The petroleum-based products in the synthetic resins helped increase durability. But, beginning in the 1970s, increased concerns over the impact of certain chemicals on human health and the environment accelerated a trend toward the development of high-solids (lower-VOC) finishes and water-based products. A resurgence in the use of pure oils and shellacs containing natural ingredients marks another recent trend in wood finishes.
    a. Varnishes. Technically, all resin and-solvent mixes are varnishes. Shellac is a spirit varnish—it uses distilled spirits (denatured alcohol) as a solvent, while spar varnish uses a drying-type vegetable oil (typically Tung oil) combined with phenolic resin. In today's common usage, "varnish" means a mix of drying oil and a natural or artificial resin that is cooked (often with an inert-metal catalyst) to make a clear finish that is typically used indoors. Varnish, which cures by chemical reaction (polymerization), is known for good resistance to heat, solvents, and water. Alkyd and polyurethane varnishes, however, may

contain high VOCs. Water-based varnishes using polyurethane or acrylic polymers have been developed that emit lower VOCs.

b. Shellacs. In its pure form, shellac is a natural resin secreted by the lac insect, found mostly in India and Thailand. Shellac cures as its solvent, alcohol, evaporates. Although it creates a brilliant shine, shellac's uses are limited because of its susceptibility to damage from liquids and heat. Shellac is useful for touch-ups because it bonds well to most other finishes. Shellac is also used as a sealer and under-coat with lacquer or varnish and polyurethane. It may not be compatible as a sealer under certain polyurethanes, though, because of the natural wax it contains.
c. Lacquers. Lacquer is a clear finish best suited for accenting wood grain. It dries fast and is very durable. The most common type, nitrocellulose lacquer, uses a binder made from a natural polymer, cellulose, which is derived from wood or cotton. Lacquer thinner is a blend of solvents, which may include ketones and esters, alcohols, and fast-evaporating hydrocarbons such as toluene or xylene. Like shellac, lacquer cures by evaporation. Without a clear protective coating, it is easily scratched and susceptible to water damage. Another drawback to lacquer is its typically high solvent content.
d. Natural oils. Linseed and tung oils are penetrating finishes that cure by absorbing oxygen from the air, a process that strengthens the finish. Linseed oil is extracted from flax seeds. Boiled linseed oil used in wood finishing has been mixed with chemical additives to hasten the drying time. Tung oil is derived from the nuts of trees that are native to Asia. These oils are durable, water-resistant, and easy to apply but require several coats and are slow-drying. Natural oils that have been heat-treated to increase gloss and hardness and reduce curing time are called polymerized oils.
e. Water-based. Water-based finishes are made up of droplets of solvent-based finish, usually acrylic or polyurethane, and a solvent, usually a glycol ether, with water functioning as a thinner. Water-based finishes cure by coalescing: the droplets of finish move closer together and interlock as the water evaporates. Water-based finishes offer minimal solvent fumes, easy cleanup, and good scuff resistance, but they may raise the wood grain and offer only moderate resistance to water, heat, and solvents. (Green Seal Report, February 2005)

Summary:

1. In California, we are not allowed to use certain sealers, stains and finishes that do not comply with VOC regulations. Restorers and refinishers are mandated to use only low or no VOC chemicals. Often, these chemicals are water-based, where they may not have the same solids and volatile compounds that allowed the replacement or restored cabinet to have the same life-long durability and beauty as new cabinets.
2. Many cabinets can be successfully matched to their original condition, but this requires an expert in cabinet staining and finishing.

3. By repairing, refinishing or restoring one cabinet, where the goal is to match it with other cabinets, and there is a color or finish difference, it may be necessary to refurbish all cabinets.
4. One sometimes forgets, by installing new replacement cabinets that are expected to match existing cabinet finishes, the new cabinet's finish may not match the patina of older cabinets. Failing to blend in sealers, stains and finish can result in restoring or replacing cabinets.
5. When older wood-stained cabinets have an oil-based stain and finish, where new or refinished cabinets have water-based latex stain and finish, natural and incandescent light can sometimes pick up a light difference. Sometimes, this is due to a diffraction of light as our eyes see both the stain and finish under certain lighting conditions.
6. When the restorer recognizes there will likely be a color match or finish difference, they are expected to bring these issues up to their customer.
7. In an insurance claim, the restorer is expected to advise the adjuster of a color match or finish issue, while providing the customer and adjuster with problem solving options including – restaining, refinishing or replacement.

About the Author:

Patrick Moffett is an IICRC instructor who teaches fire and water damage restoration courses across the U.S., Canada, Europe and Australia. Patrick's 30 years of experience in mitigating thousands of fire and water damage losses, they required the assessment of: wood finishes, built-in cabinets, kitchen and bathroom cabinets, moldings, trim, flooring and building framing. Patrick is an AIHA registered industrial hygienist and a licensed general contractor. Patrick is the owner of Blue Sky Environmental Consulting, Inc., in southern California His contact information is: Email PatMoffett@att.net; Office (714) 379-1096; Cell/Text (714) 928-4008.

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