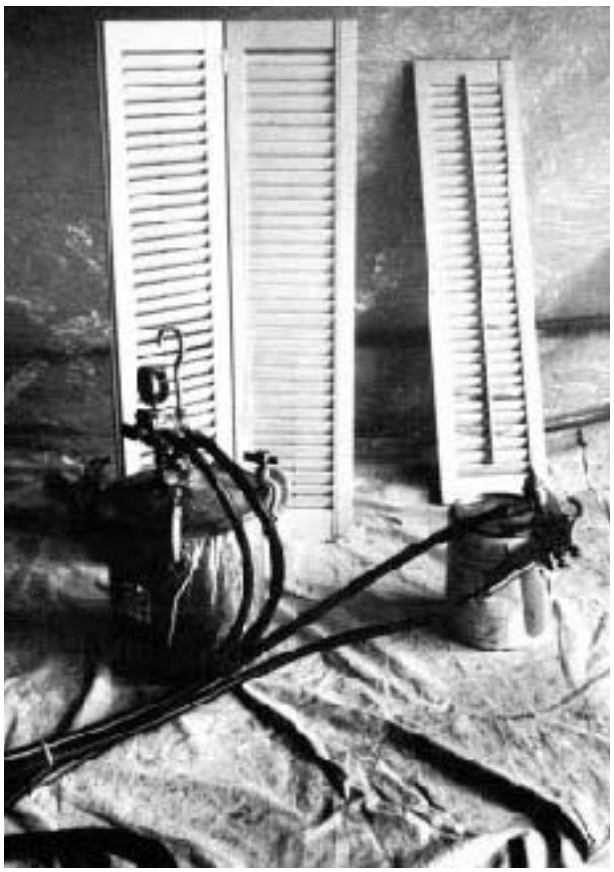

Shutters and similar woodwork would ordinarily get sprayed with several thin undercoats and an oil-based top coat. But low-VOC oil-based enamels are very difficult to spray, and water-based coatings lack the needed durability.

Traditional oil paints mix small amounts of heavy resin with large volumes of solvent. Now paint technologists need to make low-viscosity resins work with little solvent.

BY STEVE SIMMONS

Coping with Low-VOC Paints

With new low-solvent formulations, a quality job takes more time and requires all a contractor's tricks

Many states are either considering — or have already put into place — regulations that limit volatile organic compounds (VOCs). And there is more and more talk about a mandatory national standard. VOCs, in the form of solvents, have long been a basic ingredient in paints and finishes, particularly oil-base products.

Since I work in California, a state that enacted VOC regulations three years ago, I've had a head start on learning to cope with the new regulations and the products they've spawned. It has been neither as disastrous nor as easy as you may have heard. What it has been is confusing and frustrating. Although I do paint somewhat differently than I used to because of the VOC limits, I think the biggest change so far has been the strong element of uncertainty—something that no experienced tradesman or contractor welcomes.

This uncertainty comes from many sources.

- The regulations themselves aren't always clear, and they continue to change.
- As manufacturers scramble to come up with formulations that comply with regulations, the coatings that have been generated aren't consistent either.
- In the face of this, clients want guarantees and black and white answers to questions that are often unanswerable.
- As everyone tries to handle the changes, what passes for factual information from manufacturers, suppliers, and other contractors is often closer to rumor.

What's behind the VOC regulations is the need for cleaner air—something I support. But I've also earned a reputation for high quality work, and to me that has meant using the best oil-base coatings and additives available. Unfortunately, these are the products hardest hit by the regulations (see "States Adopt VOC Limits," next page).

The new, low-VOC formulations of oil-base products don't always allow me to produce the quality I'm used to if I follow the rules. But I'm also not satisfied with many of the water-based products that I could substitute.

Although there is no immediate answer to some of these dilemmas, it's clear that painting contractors and their clients—builders and homeowners—are going to have to be receptive to new materials and methods while insisting on the highest standards they can. For all those contractors who are—or soon will be—facing VOC regulations, I think some of the details of how we've fared here in California will help.

Not Prepared for the Change

During the period between 1978 and 1987, when initial regulations were postponed to give the industry a chance to develop new products, there was little general concern for the issue. The story most of us in the field heard from paint representatives and suppliers was that the regulations were unrealistic, and would make so little impact on the larger problem of air pollution and smog abatement that they might never be enforced.

The seminars I attended in the early 80's reported ongoing suspensions and reversals in the regulations. Most of what I heard supported the notion that oil-base products would continue to be produced. And besides, we were reassured, by the time the regulations were enforced, new coatings as good or better than the old ones would be in place.

We also knew that industrial maintenance coatings (that contain the full range of low- to high-sheen, oil-base finish coats), fast-dry sealers and primers, varnishes and lacquers, and quart cans of the old formula material would be, at first, exempt from the VOC standard, and therefore available.

Although some of us tested water-base formulations occasionally, we remained convinced that oil-base coatings were superior for a wide range of tasks, including sealing stains, and priming wood, stucco, and skim-coated drywall. They were also ideal for delivering sandable undercoats, and they produced harder, smoother top coats (see "Water-Base Coatings: A Partial Answer," in this article).

Although some of the contractors I know anticipated the March, 1987 deadline by making big purchases of favorite oil-based paints, few of us were prepared for what was coming.

Life Under the Regulations

The first eight months after the VOC regulation took effect in 1987 were frustrating. Some of the paint manufacturers had reformulated a relatively complete line of oil-base coatings; some manufacturers reformulated some products and withdrew others; some other companies simply pulled out of the restricted California markets.

Not only was there a limited number of products on the market, the new formulations were startlingly different. All the interior oil primers and finish coats were much thicker, with awful flow and leveling characteristics, much longer dry times, and much higher gloss retention (with lower sheen paints keeping a high gloss look long after initial drying). Normally, I would thin the material and adjust the other qualities if necessary with additives, but the restric-tions—printed right on the label—ruled this out.

My first experience was eye-opening. I had painted a large bathroom in an estate I was restoring with a low-VOC, low-sheen, oil-based enamel. A week later a plumber who was trimming out the bathroom happened to lean against the wall. The paint was still so malleable that it slid as a sheet into a large wrinkled pile under his pressure. A month later the sheen had still not died down. At that point, I started using napthas, Japan driers, enamel reducers, flowing oils, and gloss modifiers to try to control the thickness, dry time, and gloss of these formulations.

One of the major exceptions to California's complicated regulations is the "quart exemption," which allows the sale of higher-VOC formulations in quart cans, shown here.

Many of the new paints are viscous and slow drying. Yet modifying them with some of the additives above—thinners, driers, and napthas—is prohibited in regulated air-quality districts.

States Adopt VOC Limits

Although California had a headstart in enacting and enforcing VOC regulations, last year saw VOC laws go into effect in four other major urban areas in the country: Phoenix (Maricopa County), Dallas (Dallas and Tarrant Counties), New York City (and Westchester, Rockland, Nassau, and Suffolk counties), and the state of New Jersey. Air quality officials in Wisconsin, Illinois, Indiana, Maryland, Massachusetts, Florida, and other states have regulations pending or under consideration, and there is growing talk of a mandatory national standards.

The acronym, "VOC," that is causing all this change stands for *volatile organic compounds*: "volatile" for solvents that readily evaporate into the air, and "organic" for a class of compounds that contain carbon and hydrogen (better known as *hydrocarbons*).

When these are released into the air during the application of coatings and subsequent drying, they react with other compounds and sunlight to form ozone, the primary component of smog. Architectural coatings are not a significant contributor of ozone by anyone's interpretation—automobile exhaust leads that list—but they are responsible for somewhere between 1.5% and 5% of VOC contributions to the air, depending on who's measuring and where.

Almost all architectural coatings, water-based as well as oil-based, contain VOCs. However, in water-borne coatings they seldom exceed 125 grams per liter (g/l). Most latex flats don't run much more than 50 g/l. But alkyd paints—and primers/sealers, stains, varnishes, and lacquers—perform best when formulated in the 400 to 700 g/l range.

California. VOC regulations were enforced in earnest in the Golden State beginning in 1987 (the original standards, adopted in 1978 were relaxed in order to give industry more time to develop compliant products). The figures shown below reflect a small portion of the second generation standards, known as the Suggested Control Measure for Architectural Coatings adopted by the California Air Resources Board in 1989. Although these standards are currently being challenged in court, the individual air-quality-management districts within the state use them as a guide in setting their own regulations.

All flat *and* non-flat coatings:	* 250 g/l
Except:	
Primers, sealers, & undercoaters:	** 350 g/l
Industrial maintenance coatings:	420 g/l 340 g/l by 1992
Stains:	
(opaque & semi-transparent)	350 g/l
Wood preservatives:	
(opaque, semi-transparent, & clear)	350 g/l
Clear sanding sealers:	550 g/l 350 g/l by 1992
Varnish:	350 g/l
Shellac:	
(pigmented)	550 g/l
(clear)	730 g/l
Lacquer:	*** 680 g/l

* Most districts still allow higher-VOC, non-flat formulations to be sold in quarts and aerosol cans.
** Several major districts that have allowed higher-VOC, quick-dry primers may be dropping the exemption in 1991.
*** Several major districts may require 350 g/l in 1992.

Other areas with VOC regulations. New York's standards took effect July 1, 1989, followed by New Jersey's In January, 1990. Both were based on regulations in effect in California in 1987. The regulated limits are shown below. Containers that hold *less* than a quart (31 ounces) are exempt.

Flat coatings:	250 g/l
Non-flat coatings:	380 g/l
Except:	
Primers, sealers, & undercoaters:	
(standard)	350 g/l
(quick-dry)	500 g/l
Industrial maintenance coatings:	450 g/l
Stains:	
(opaque)	350 g/l
(semi-transparent)	550 g/l
Wood preservatives:	
(opaque, semi-transparent, & clear)	550 g/l
Varnish:	450 g/l
Shellac:	
(pigmented)	550 g/l
(clear)	730 g/l
Lacquer:	680 g/l

Water-Based Coatings: A Partial Answer

Although it's not really discussed much, there's an unstated notion for many of us in the trade that the best painters use oil-base paint. Part of this may be that alkyd paints are an outgrowth of the original lead paints, which were formulated on site and are still unmatched in look and performance. Or maybe it's that oil-base paints create a clear distinction between professionals and latex-using amateurs.

There are some other reasons too. One is price. Although latex paints can be very inexpensive, the really top quality water-based paints cost much more than their oil-base equivalents. (Most clients don't understand the difference between latex at $10 a gallon and water emulsion paints at $30-$35 a gallon.)

Still another reason why professionals use oil-base products may be that water-based coatings are still evolving, and painters just don't have the experience with many of the new formulations.

Although I have to admit to some of these prejudices, I have been trying more water-based coatings. What I've found is that water-based products generally require more time for a top quality finish. If good painting practices (thorough prep, thoughtful product selection, and careful application) are important in oil-base work—and they are—then they are doubly important with the water-based coatings. But even when I spend the time, the resulting finishes aren't always comparable in the aesthetics or the protection they afford. And water-based finishes are typically much more difficult to recoat.

Exterior applications. Water-based exterior coatings can be very temperamental depending on conditions: the moisture content of the wood, the surface prep, air temperature, surface temperature, amount of direct sun, amount of oxidation on metal, etc. Having to have the right day in terms of weather conditions may be fine for a homeowner, but it can kill a contractor's scheduling.

Although I do use some water-based primers for second coats, in general they don't seal out redwood and cedar tannins on siding as well, nor do they seem to inhibit rust like oil-base paints. They can also raise the grain of wood. This goes for water-based stains as well.

Most of the water-based, exterior clear finishes I've dealt with have to be applied in two coats at up to six months apart. Given clients' penchant for procrastinating and the fact that I have to charge for multi-story set-up costs for each coat, the second coat seldom gets applied. Another drawback here is that many of these finishes can't be sprayed with an airless or even a Hudson sprayer; they must be brushed and rolled.

Interior applications. Where an oil-base enamel can be cleaned, etched, spot-primed, and recoated quickly, water-based enamels take a lot more preparation time if they are to be recoated with the same material because of the poorer penetration and adhesion of water-based products.

Because they aren't really sandable, the cleaning has to be done flawlessly. Even then, I prime the entire surface with an oil-based, quick-dry primer before recoating. I have been asked to bid a lot of repaint work lately where the last guy didn't do this. Some of these jobs have only been a few weeks old.

Although water-based enamels have gotten much better over time, I still find that coverage can be a problem in the darker tones, and flow and leveling just aren't what I'm used to with oil-based enamels. Even with additives to improve the flow I find the water-based products don't level as well, resulting in brush marks. Lap time on larger areas can also be a problem. The only way around these disadvantages is to spray, but that's not always practical.

Despite their reputation for a quick dry, latex enamels don't cure all that fast. So, if I paint a door in the morning and conditions aren't perfect, shutting the door late in the afternoon may pull the film right off.

I also see some serious drawbacks with water-based varnishes. Although some guys "goop" (wood fill) a floor, sand it, and then coat it with a water-based varnish, you get a better job if you fill *after* you seal it initially so that sanding and vacuuming the original surface doesn't pop some of the fills out. However, you can't "sandwich" your fill in between water-based coats because the oil-based putty will cloud the finish coat.

The good news. In some cases, I have replaced the oil-based products I used to use with water-based ones. For instance, I now use exterior, water-based primer as a second prime coat over wood and stucco. I also use more exterior, water-based enamel because it has better color retention, gloss retention, and flexibility. I also use water-based porch and deck paints rather than oil-based varieties.

I'm very hopeful about the development of new resins. Just in the past few years, there have been real advances in the dry and cure times, flow and leveling, and sandability of emulsified oils, water-thinned solubilized oils, and water-based epoxies.—*S.S.*

Paint manufacturers mix pigments and resins and thin with solvents in huge vats like the one above. However, in low-VOC oil paints, solvents are replaced in part with solids, yielding heavy and thick formulations.

My second experience wasn't much better. I put a less-experienced brushman on a whole wall of windows full of muntins with the newly formulated, oil-based interior enamel. The result was a dry film more than twice the usual thickness. I spent 1½ days sanding it back down; however, I had to wait almost four days for this one coat to dry before I could even sand it. I'm now very careful about who I put on the brushwork.

During this period, I tried several companies' oil-base primers, sealers, and finish enamels thinking it might make a difference, but found I needed to add back the reduced volatiles in all of them to make the coatings practical to apply (particularly if I were spraying). The cost of most of these oil-base products remained relatively level, however, except for a steep rise in the price of quarts.

Continuing Problems

Although the initial reformulations were the worst, most of these problems—especially prolonged drying and curing times, and high gloss retention—remain a part of low-VOC formulas (see "Oil-base Coatings: Pushing the Limits," last page). However, as new combinations of resins have been put to work, the viscosity problem has gotten better in the enamels in the past few months.

Oil-base interior stains still suffer from the lack of solvents—they're gummy, take much longer to dry, and never really seem to penetrate the wood.

The new undercoaters have another problem. In addition to taking much longer to dry, they release such strong vapors that I have been using fast-dry, oil-based primers instead. (These types of primers are still exempt in the old formulations where I paint.) Although they also release a lot of volatiles at first, the odor stops more quickly and I get a faster, more predictable dry time. A lot of other contractors have found this same approach on their own.

Unfortunately, less thoughtful painters are using these quick-dry primers outside to condense job times. The brittleness of these coatings isn't appropriate for exterior work where film flexibility is so important. I've seen quite a few paint failures because of this.

Still another problem I have with the new formulations is rapid yellowing. The light-colored undercoats I use under transparent glazes in my specialty finishes, and the light-colored, oil-based enamels were yellowing before I finished the job. This problem is even more

Industrial maintenance coatings, like the alkyd enamel above, are exempt from the 250-grams-per-liter VOC limit. Essentially the same formulas that sold prior to regulation, they are restricted to non-residential use.

noticeable in the clear coats, varnishes, and lacquers. I actually have to adjust overglazes and colors in delicate finishes I plan to clear coat afterwards to compensate for this problem.

Also, the whites and tint bases of some oil-base products are a little grayer due to the higher resin content and increased use of pigment extenders. This means some of the subtle pastels are difficult to obtain. Most of the ultra-deep colors are no longer available either.

One "alternative" to these headaches is to switch to batching quarts of the exempted material or to use the industrial maintenance coatings, which are either old versions of the newly formulated materials or heartier and faster drying versions of them. Neither of these choices is sanctioned by the regulations, but a lot of painting contractors haven't been dissuaded from using coatings that are still available.

Making Adjustments

Although most experienced painting contractors have found ways to make the new products work, the greatest impact has been on time and its management.

To begin with, I'm testing more because I'm less confident of the newest formulation. It also takes more time to apply the low-VOC formulations. One to two brush strokes is what it typically takes to level an interior oil-based enamel; with the new formulations it can take six to ten strokes to bring the wet coating thickness down to what it should be. It also means going back to the batch bucket more often because the material "skins over" faster.

The biggest problem is longer and less predictable dry times, which are vital to know. Slow-drying floor varnish is an obvious example of something that could shut down a job for days. And with the multiple coats required in high quality paint work, it can be very difficult to make up a schedule that accommodates drying times and job sequences without breaking up the day unproductively. This is going to increase somebody's costs—either the contractor's or the homeowner's.

Trying to avoid some of these problems can lower the quality of the work. For instance, I am more reluctant to do that extra spot priming for a flawless finish because of the scheduling hassles it will cost me with the new products' longer drying time.

For this reason, and to make up for the time I will lose waiting for high-solids enamel top coats to dry, I use quick-dry primers on inside work. Yet you don't get the best *build* (smooth layering that hides grain and tiny imperfections) with them, nor do they cover or sand as well.

I also find myself skipping one of the two prime coats I put down on new work for a very smooth finish. With one primer coat, I then use less porous, quicker drying fills like Bondo (instead of spackle) since I'm no longer "sandwiching" my fills and caulks between two primer coats.

The last area where I've adjusted is in dealing with clients. I have to warn them about longer gloss retention and quicker color fading because these qualities of the paint are evident over time. Longer cure times come up when I ask them not to shut a newly painted door for several days or put books on a shelf for two weeks. Beyond that, I have found I'm only planting doubts in their minds if I discuss the changing formulations further. But I have also narrowed my clientele somewhat to people who are willing to pay for high quality work. This way I'll be compensated—and hassled less—for the extra time that's required with the new materials.

Looking to the Future

Recently adopted regulations in my area will require further reformulation of industrial maintenance coatings, quick-dry primers, varnishes, and lacquers at much lower VOC levels in the next several years. I suspect this will effectively eliminate these products—and the interim strategies I've been using.

Since I don't want to violate the intent of the law, let alone be prosecuted for violating the letter of it, I'll be turning more frequently to the water-based generation of coatings. I expect to continue using some exterior oil-based primers and trim paint, and interior undercoats and finish coats, but I'll try to supplement these standards with new materials as they improve.

It seems clear that increased preparation times and the high price tag on high-end, water-based coatings will increase the price of our work. And that means educating the homeowner and business owner. They will ultimately be paying for the increases.

Although it's frustrating to have to give up the "tried and true," and relearn what products and methods work well, I'm not advocating going back. Painters have to keep painting. We are in a transition period that will require us to use all our skills and learn some new tricks, but it's one we'll get through. ■

Steve Simmons is a painting contractor in El Sobrante, Calif.

Oil-Based Coatings: Pushing the Limits

by Brad S. Kisner

The business of making paint has changed a lot in the past few years in California due to air quality regulations. As a small manufacturer of high-quality, oil-based architectural and industrial paint (where the regulations hit the hardest), we've had to completely reformulate many of our coatings to make them comply with the general ceiling of 250 g/l (grams per liter) of VOCs.

We've been able to adjust our formulas to accommodate some of the regulations with little loss of performance. But in too many cases, our "solution" is a far cry from the original product in terms of leveling characteristics, flow, dry time, gloss, color retention, and durability.

Ways of limiting VOCs. Although paint technology has come a long way this century, there is no magic formula for dramatically reducing VOCs without affecting the application and dry film characteristics of the coating. We have four approaches currently available to us which can be used singly or in combination. Each has its drawbacks:

- *Removing solvents and adding resins and extender pigments, creating a "high in solids" formulation*. Many of the new oil-base formulations have coverage rates up in the 600- to 700-square-feet per gallon range (as opposed to the long-time industry standard of 300- to 400-square-feet per gallon) because of the greatly increased solids in each can. It's very difficult to apply the new formulations as prescribed because they are so thick and heavy, and thinning is prohibited by the regulations. Not surprisingly, most of the failures in this group are associated with applying too much material per square foot.
- *Replacing resins with ones that require less solvent*. When you remove as much as half the solvent in a formula, low-viscosity resins are required to keep the flow and leveling characteristics of the paint tolerable. The molecules of these resins are smaller and don't build the long chains that heavier resins do, so they help "loosen up" the paint. (It's a little like using grains of rice instead of long strands of spaghetti.) However, it's the long molecular chains that give dry paint film its durability and longevity.
- *Using exempt solvents such as 1-1-1 trichloroethane in place of the solvents previously used*. Industrial formulations commonly use 1-1-1, but it is used sparingly in architectural coatings because it's very expensive. And there's concern within the industry that it will lose its exemption if overused. Most other exempt solvents contain chlorofluorcarbons (CFCs).
- *Creating new, equivalent, water-borne coatings to replace solvent-borne products*. Despite their ease of use, these products don't always measure up to their solvent-based cousins. A May, 1989 *Consumer Reports* article summarized it by saying that solvent-borne nonflats are "still the choice where a tough, water resistant coating is needed…Most people prefer to use latex wherever possible…But the world of glossy paints is still a tough arena for latex to compete in."

Product Changes

There are five categories of architectural coatings—all of them oil-based—that are adversely affected by the strict California VOC limits. Some of these coatings have already been affected, and others will be in the next several years as regulations tighten even further:

Clear wood finishes. These coatings include lacquers, sanding sealers, and varnishes (including polyurethane).

Lacquers are formulated with nitrocellulose or synthetic resins to dry quickly (and therefore dust-free) without chemical reaction, so their VOC levels are very high. The current limit of 680 g/l works well, however, some air quality districts here in California want to set a limit of only 350 g/l for the future. This will essentially eliminate lacquers as we know them for on-site use.

Sanding sealers, currently being formulated at 550 g/l, may be limited to just 350 g/l by 1992 in many districts. This would bring them down to the same VOC level as varnish, giving them many of the same application problems.

Varnishes dry by chemical reaction, but require more solvents than the current 350 g/l VOC limit allows to be workable. High solids formulas—sometimes referred to as "high build"—are difficult to apply and when laid down too thick will wrinkle drastically. If applied in a thin enough coat, their durability is nearly as good as the previous formulations, but drying takes much longer.

Waterborne "varnishes" are becoming much more available, but they carry a hefty price tag and aren't always as durable as they need to be.

Non-flat enamels. Painting contractors are used to having a creamy, brushable enamel that flows out to a smooth, hard, and durable gloss or semi-gloss finish.

But having to cut VOC levels by almost half required complete redevelopment—enamels that were approximately 50% solids and 50% solvents have increased to well over 70% solids. The resulting product, with its slow-drying, draggy resins, is difficult to spray or brush. Yellowing and low exterior durability are also commonplace. So are lowered "open times" that allow the paint to skin over—the result of adding more dryers in an effort to speed up drying and cure times.

Stains. Oil-base stains have been hard hit by current regulations because their original makeup was almost 80% solvent. With a VOC ceiling of 350 g/l, paint chemists have had to substitute low-viscosity oils for much of the solvent. These big oil molecules get hung up on the surface of wood rather than penetrating it, which leaves a gummy film and reflective areas known as "shiners."

Quick-dry primers. These primers dry quickly because of the amount and volatility of the solvents used to make them. They allow a painter to apply both prime and finish coats in a single day, a real advantage when scheduling is tight. Although these primers have been given an exempt status in many districts, they were not included in the suggested control measure, and we will lose them here in our home district in 1991.

Industrial maintenance coatings. These high-performance non-flats are formulated for industrial, commercial, or institutional situations where there's continual exposure to moisture, chemicals, temperatures in excess of 250°F, and heavy abrasion. They are no longer approved for residential use.

These coatings are currently acceptable with a VOC level of 420 g/l. However, in 1992 the suggested control measure calls for a new limit of 340 g/l, which will require the use of an exempt solvent such as 1-1-1 trichloroethane. This formulation will work, although it will be a good deal more expensive and not made for brushing.

Brad S. Kisner is responsible for architectural sales at Triangle Coatings in San Leandro, Calif.