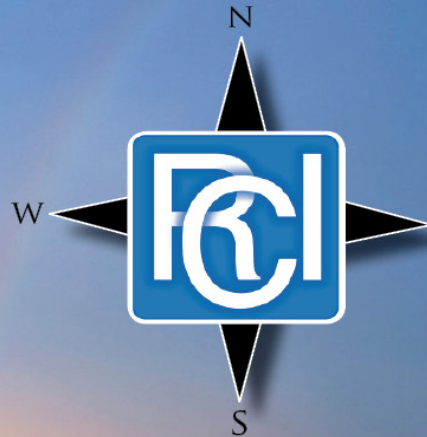
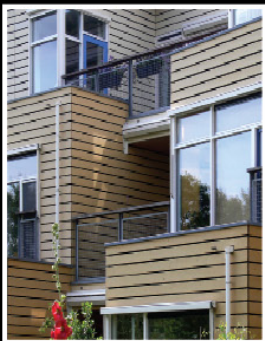
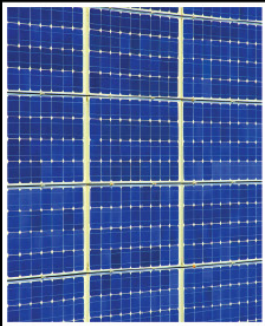


# 25<sup>TH</sup> RCI INTERNATIONAL CONVENTION AND TRADE SHOW



EXPLORING  
the Sustainably  
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ROSEN SHINGLE CREEK RESORT  
ORLANDO, FLORIDA

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# Understanding Volatile Organic Compound Regulations in the Commercial Roofing Industry

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# Introduction

- Regulation of VOC content is becoming wide spread.
- The intent is to reduce smog.
- Regulations are on many construction products, including commercial roofing products.
- VOC content regulations vary from state to state and even within states.
- Many strategies are used to comply.



# Why this is important to us?

- Most regulations concerning the use of adhesives and sealants state:
  - “no person shall use, supply, sell or offer for sale ...”
  - Contractors, Distributors and Manufacturers
- However some states add:
  - **“require the use or specify ...”**
  - **Consultants and Specifiers**



# Disclaimer

- Based on publicly available information and is accurate as of the date it was written.
- Should not be considered legal advice
- Do not act or refrain from acting on the basis of any content without seeking advice from local authorities or a qualified legal professional.



# Examples of VOCs

- Methane
- Formaldehyde
- Fuels
  - Gasoline
  - Diesel
  - Propane
- Benzene
- Solvents
  - Toluene
  - Acetone
  - Xylene
  - MEK
  - Methylene chloride
- Perchloroethylene



# Sources of VOCs

- Emitted as gases from some solids and liquids:
  - Paints, paint strippers and other solvents
  - Wood preservatives
  - Aerosol sprays
  - Cleansers and disinfectants
  - Fuel, gasoline, diesel



# Why Regulate VOCs?

To reduce smog





# Smog ...

- is a huge problem in major urban areas.
- is a brownish haze that pollutes the air.
- makes breathing difficult for many people.
- decreases visibility.
- comprised primarily of ozone.



# Smog and Ozone

- The terms are often interchanged.
- Ozone is the primary component of smog.
- Smog is more than just ozone.
- Smog also consists of other gases and particulate matter.



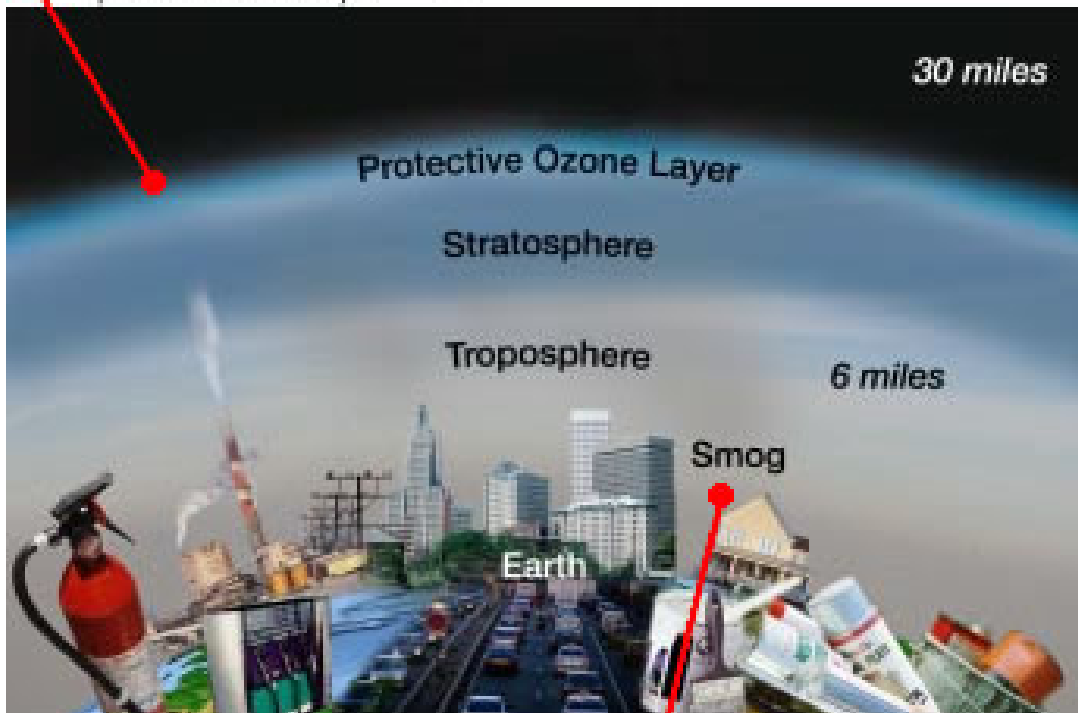
# Confusion on Ozone

Ozone can be *good* or *bad*  
depending on its location.



# Good Up High, Bad Nearby

Too little there...Many popular consumer products like air conditioners and refrigerators involve CFCs or halons during either manufacture or use. Over time, these chemicals damage the earth's protective ozone layer.



Too much here...Cars, trucks, power plants and factories all emit air pollution that forms ground-level ozone, a primary component of smog.



# Ground-Level Ozone Precursors

- EPA establishes standards for six common air pollutants, including ozone.
- EPA tracks the emissions of sources of these pollutants.
- $\text{NO}_x$  and VOC are precursors to ground-level ozone.
- Thus the EPA closely monitors these emissions.



# VOC + NO<sub>x</sub> + Sunlight → Ozone

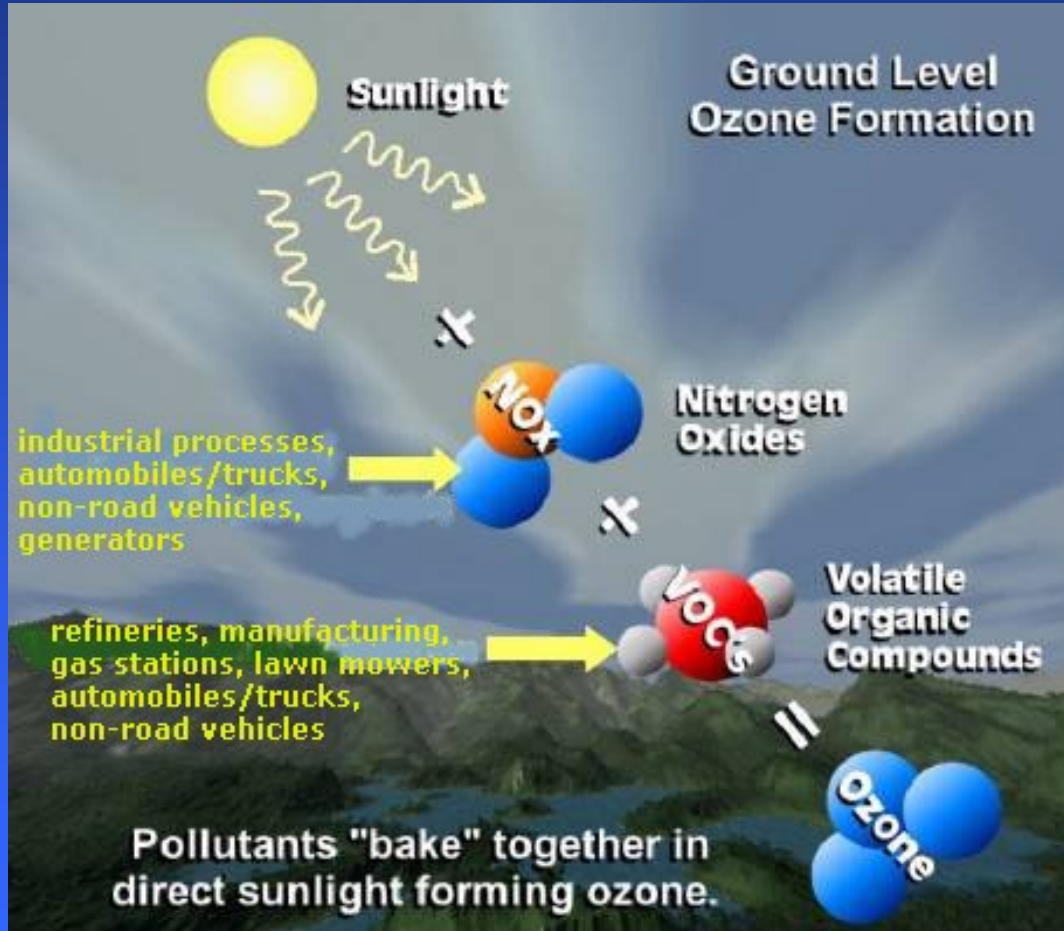
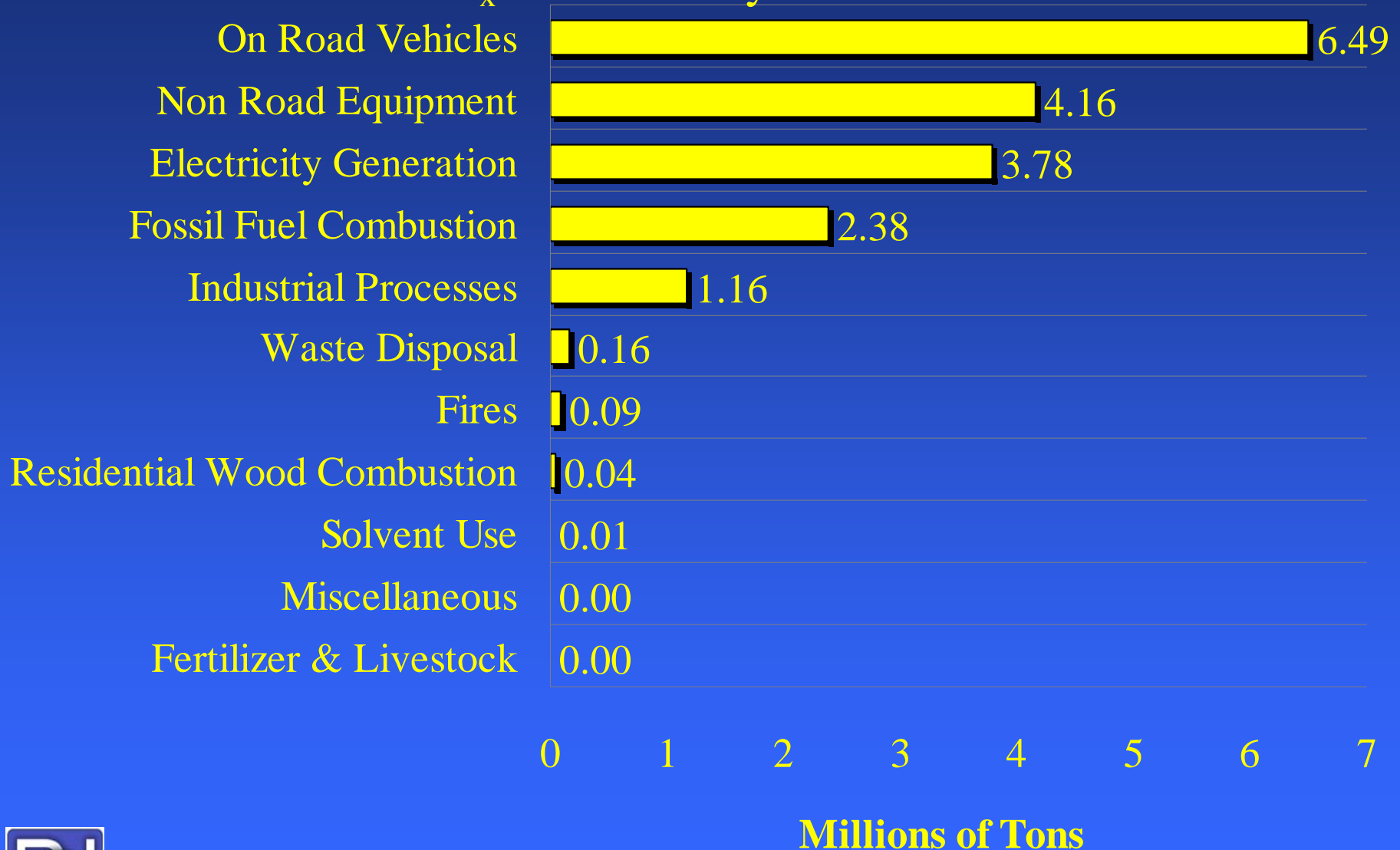


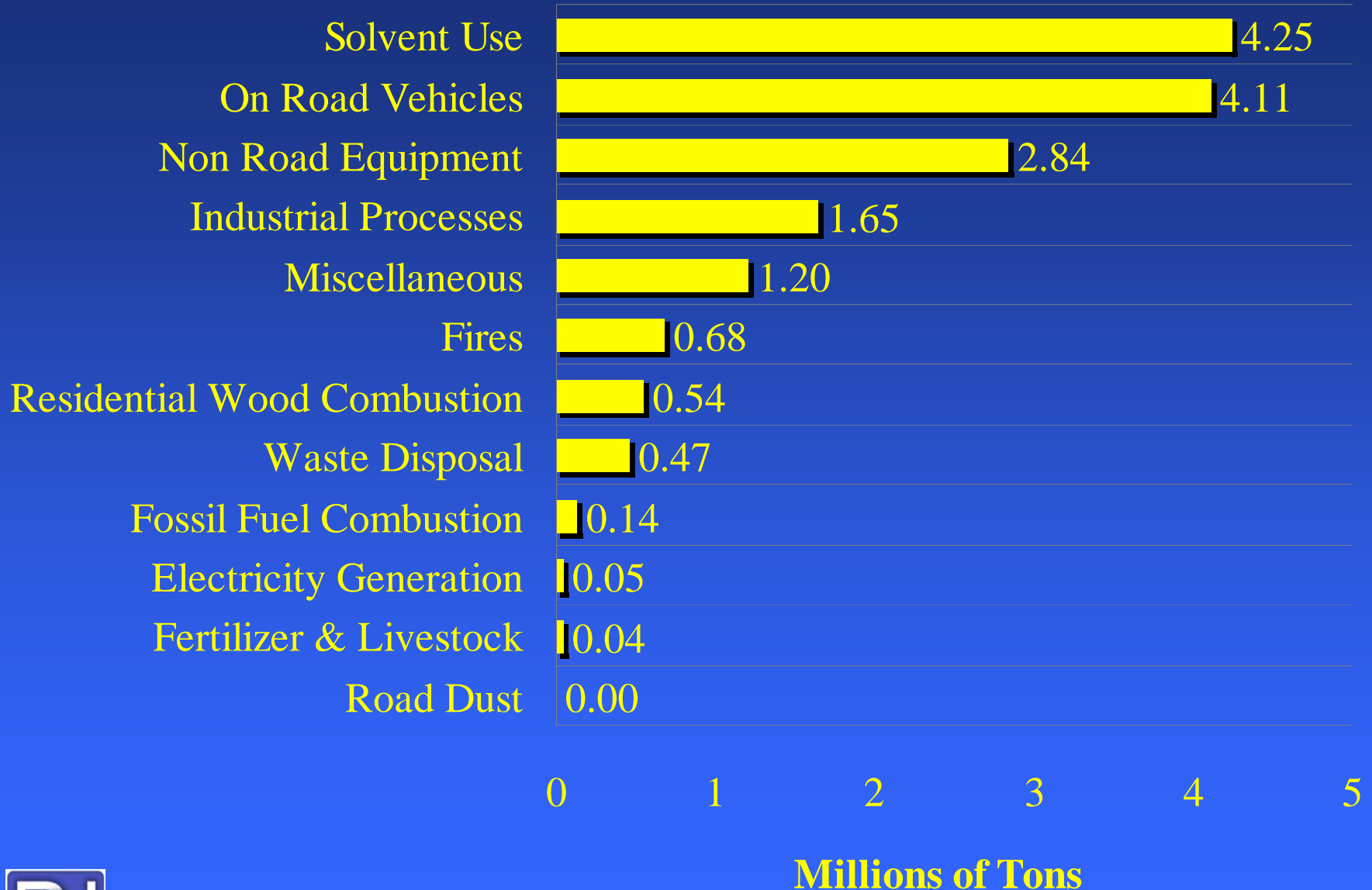
Image Source: Harris County (Texas) Public Health & Environmental Services -

<http://www.hcphe.org/eph/Ozone/OzoneFormationDiagram.jpg>

## National NO<sub>x</sub> Emissions by Source Sector in 2005



# National VOCs Emissions by Source Sector in 2005





# VOC Emissions

- Concerned with photo-reactive VOCs
- Solvents surpassed on-road vehicles as the largest emitting sector in 2005.
- Other sources include:
  - off-road vehicles
  - industrial processes
  - fires



# Beyond Auto Emissions

- Automotive exhaust emissions are the main source of both  $\text{NO}_x$  and VOCs.
- Many controls been applied to auto emissions.
- There still problems with smog.
- Regulators are now looking at other sources of VOCs, such as solvents used in various building and construction products.



# Beyond Auto Emissions

- Since 1998, EPA has regulated the VOC of many products, including:
  - automobile refinish coatings
  - consumer products
  - architectural coatings
  - aerosol coatings
  - portable fuel containers
  - household cleaners
  - personal care products
- However adhesives and sealants are not regulated by the EPA.



# Clean Air Act Amendments (CCA)

- EPA, states and cities must implement programs to reduce emissions of ozone precursors from sources such as:
  - cars
  - fuels
  - industrial facilities
  - power plants
  - consumer/commercial products



# Clean Air Act Amendments

- EPA established the National Ambient Air Quality Standards (NAAQS).
- EPA can sanction areas of the country that do not meet NAAQS.
- These areas are designated as *nonattainment* areas.



# Nonattainment Areas

- Must submit State Implementation Plans (SIPs)
- SIPs may propose stringent regulations, such as limiting VOC content of various products.
- One target of these regulations can be adhesives and sealants.

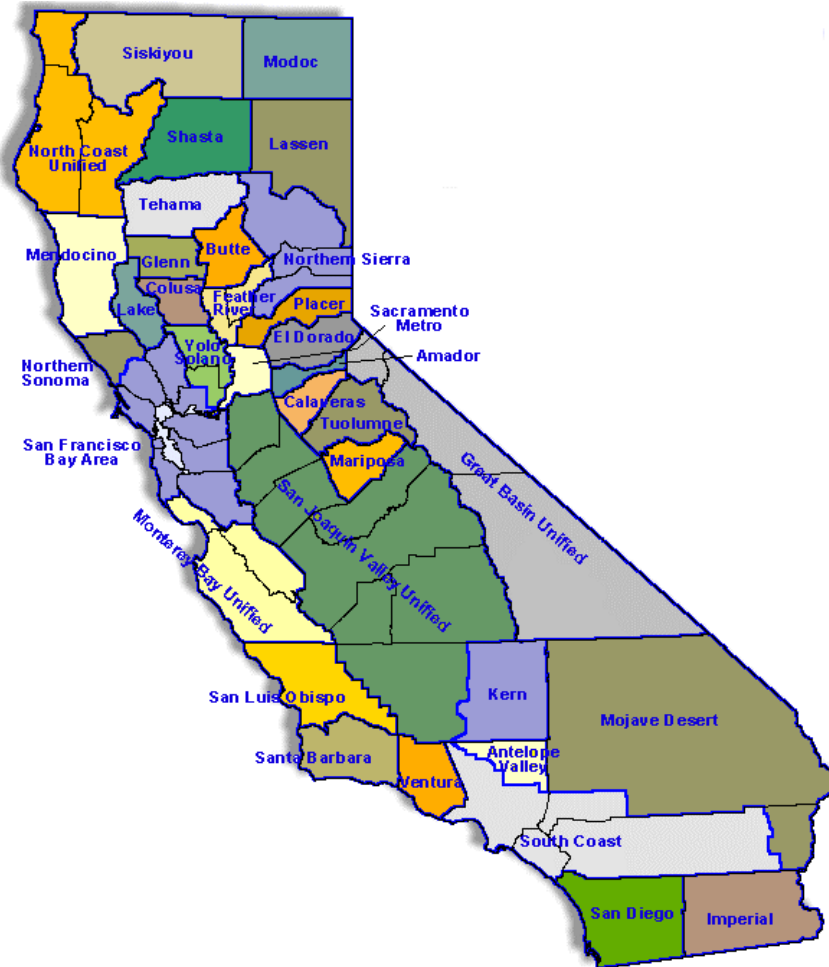


# California's Air Districts

- California began regulating VOCs and other pollutants before the CAA.
- California has 35 air quality districts.
- First regulations on adhesives and sealants were adopted by the South Coast Air Quality Management District (SCAQMD).



# California's Air Districts





# SCAQMD

- SCAQMD includes the Los Angeles area.
- Adopted Rule 1168 in 1989.
- This was the first VOC content regulation on adhesives and sealants.
- Many types of adhesive and sealants are covered by this rule.



# SCAQMD Rule 1168

- Single-ply roof membrane adhesives and sealants are regulated.
- VOC content limits are
  - 250 g/L for adhesives
  - 450 g/L for sealants
- Measurements exclude water and other *exempt compounds*.



# SCAQMD Rule 1168

- Can be considered a *model rule*.
  - Other jurisdictions have used it as a starting point for their regulations.
  - LEED refers to it.



# Other California Districts

- Another 11 air districts adopted regulations similar to SCAQMD.
- 23 remaining districts do not have rules on sealants and adhesives at this time.



# Air Districts with Adhesive or Sealant Regulations



# California Rules

- All of the 12 districts with rules have a VOC content limit of 250 g/L on adhesives.
- Sealants:
  - Some regulate, some do not
  - If they do, then the limit is 450 g/L
- Some exempt small containers
- Some do not exempt tertiary butyl acetate



# Tertiary Butyl Acetate (TBAc)

- EPA revised the definition of VOC to exclude TBAc in 2004.
- Basis for the revision:
  - TBAc is “negligibly reactive”
  - Using TBAc as a substitute solvent “will help decrease ground-level ozone formation.”



# Tertiary Butyl Acetate (TBAC)

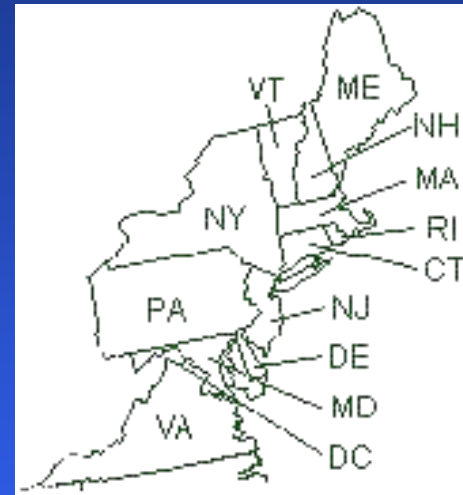
- TBAC is a very good replacement solvent for some solvents commonly used in adhesives.
- However, SCAQMD and 8 other districts do not exempt TBAC from VOC content calculations.
- Thus adhesives compliant in one district may be noncompliant in the next.





# Ozone Transport Commission

- The OTC is a group of 12 states in the Northeast and the District of Columbia.
- Regional approach was taken because air pollutants travel long distances.



# OTC's Duties

- Advises the EPA on ozone transport issues in the region.
- Develops and implements solutions to ground-level ozone problems.
  - Creates *model rules*



# Model Rules

- OTC develops model rules for its members.
- Members may opt to promulgate the rule “as is” or may modify it.
- Or, they may opt to do nothing.
- Many have been developed, including
  - Portable Fuel Containers
  - Architectural, Industrial and Maintenance Coatings
  - Adhesives and Sealants



# Model Rule for Adhesives and Sealants

- Largely based on SCAQMD Rule 1168
  - Single-ply roofing adhesives – 250 g/L
  - Single-ply roofing sealants – 450 g/L
- Definition of exempt compounds was left to the individual states.
  - States usually already have this defined.



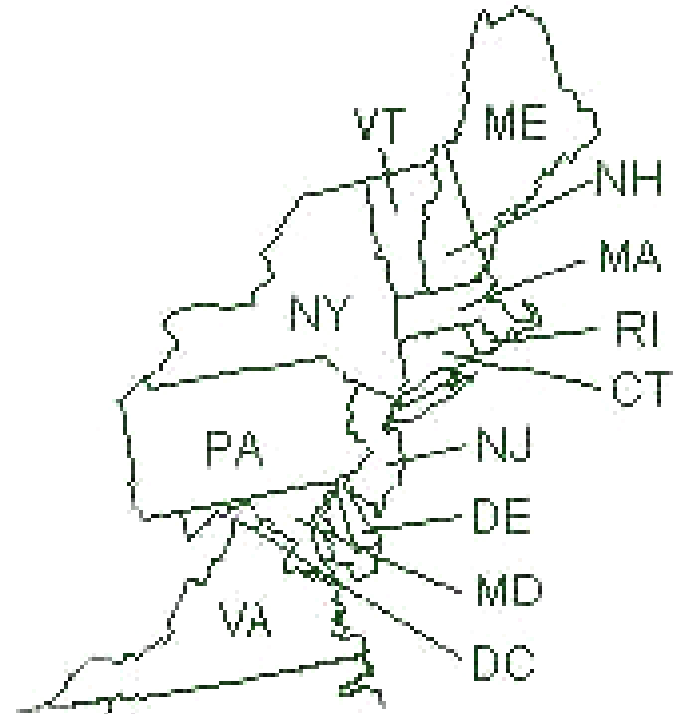
# Rule 1168 in OTC States

- To comply with Rule 1168 in California, manufacturers relied on *water-based* adhesive technology.
- Worked fine in the warm California climate.
- The weather in the OTC states is much different than California.





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# Rule 1168 in OTC States

- Water-based adhesives do not work well in cold weather, below 40 °F.
- This would severely limit the roofing season in OTC states.



# Compromise

- The EPDM Roofing Association (ERA) made OTC states aware of the consequences on the roofing industry.
- In response, several states are phasing in the rules over 3 years.
- The VOC content limits would apply only during the summer months.





# Phased In Approach

- Most states have agreed to effective dates of
  - May 1 – September 30 in 2010 and 2011
  - Maine does not start until May 1, 2011.
- On January 1, 2012 the rules become fully effective.
- This provides manufacturers with time to develop new technologies that will work in the colder environment.



# Not in Effect Yet

- At the time of writing, the following OTC members have not promulgated rules:
  - District of Columbia
  - Massachusetts
  - New Hampshire
  - New York
  - Pennsylvania
  - Vermont



# Summary of OTC Rules

Jurisdiction	Status	VOC Content Limit		Phase In Periods			
		Adhesives	Sealants	2009	2010	2011	2012
Connecticut	Effective 10/3/2008	250	450	June 1 – Aug 31	May 1 - Sept 30	May 1 - Sept 30	After Jan 1
Delaware	Effective 5/1/2009	250	450	June 1 – Aug 31	May 1 - Sept 30	May 1 - Sept 30	After Jan 1
District of Columbia	Under Consideration						
Maine	Effective 1/1/2011	250	450	N/A	N/A	May 1 - Sept 30	After Jan 1
Maryland	Effective 1/1/2009	250	450	May 15 - Sept 15	May 1 - Sept 30	May 1 - Sept 30	After Jan 1
Massachusetts	Nothing has been adopted						
New Hampshire	No action yet						
New Jersey	Effective 1/1/2009	250	450	June – Aug	May - Sept	May - Sept	After Jan 1
New York	Under Consideration						
Pennsylvania	Proposed	250	450				
Rhode island	Effective 7/1/2009	250	450	July 1 - Aug 31	May 1 - Sept 30	May 1 - Sept 30	After Jan 1
Vermont	Nothing has been adopted						
Virginia	Proposed	250	450	N/A	May 1 - Sept 30	May 1 - Sept 30	After Jan 1



# Compliance Strategies

- Solvents are needed to dissolve polymers to make the adhesive or solvent.
- Solvents that are VOCs must be:
  - Reduced or eliminated, and
  - Replaced with exempt solvents.
- However, many polymer systems require complete reformulation.
  - Simple replacement does not work.



# Exempt Solvents

- Non photo-reactive VOCs may be exempt
  - methylene chloride
  - methyl chloroform
  - acetone
  - p-Chlorobenzotrifluoride (PCBTF)
    - Common name: Oxsol
  - TBAc
    - Exempt per EPA, but not SCAQMD et al.



# Exempt Solvents

- Reduce the VOC content
- Consequences
  - Reformulation
  - Longer drying times
  - Shorter working time
  - Odor
  - Higher cost



# Water-Based Options

- Some polymer systems are water soluble.
- Zero or very low VOC content



# Water-Based Options

- Shortcomings for outdoor applications:
  - Water freezes at 32 °F
  - May be irreparably damaged if allowed to freeze
  - Must be stored above 60 °F.
  - At cool temperatures
    - Long drying times
    - Difficult to apply





# Other Options

- Some adhesives and sealants do not use solvents.
- They are 100% solids.
- Polyurethanes
- Epoxies



# Bonding Adhesives

- Used extensively in commercial roofing
- Largest volume product affected by VOC content regulations.
- Critical to fully-adhered, single-ply systems
  - Failure could be catastrophic
  - Performance cannot be compromised to ensure the safety of the building's inhabitants during severe weather.



# Contact Adhesives

- Most common bonding adhesives use *contact adhesive* technology.
- Require two side application
- Must dry before surfaces are mated
- Strong initial and long-term bonds
- High shear resistance



# Polymer Matrix

- Determines final properties of the adhesive
- Requirements:
  - Excellent strength
  - Flexibility
  - Durability
  - Fire resistance
  - Flexible at low temperatures (as low as -40 °F)
  - Stable at high temperatures (up to 200 °F)



# Solvent System

- Determines the application characteristics:
  - Viscosity
  - Spreadability
  - Sprayability
  - Drying properties
    - Ideally, drying time = application time
    - Excessive drying time = loss of productivity



# Solvent-Based Bonding Adhesives

- Polymer matrix is usually polychloroprene rubber (PCR).
  - Such as DuPont's Neoprene
  - Excellent properties
    - Strength
    - Flexibility
    - Temperature stability
    - Fire resistance



# Polychloroprene Rubber

- PCR is difficult to dissolve
- Solvent system usually consists of:
  - Xylene
  - Toluene
  - Combination of the two
  - Both are VOCs



# Low VOC Solvent Systems

- To comply with VOC content regulations
  - Xylene and toluene must be replaced with exempt solvents, such as:
    - Acetone
    - Oxsol
    - TBAc





# Acetone

- Acetone can only be used at low levels.
  - Low flash point of 1.4 °F
  - As acetone evaporates water may condense on the surface of the adhesive.
  - Referred to as *blushing*
  - May cause poor bonding and blistering



# Oxsol

- Is being used in some low VOC adhesives.
- Dry times are considerably longer
- Strong odor
- May cause swelling of EPDM
  - Solvent blisters
  - Reducing adhesion
- Relatively scarce (China) and expensive



# TBAc

- Also used in some low VOC adhesives.
- Dry time similar to VOC adhesives
- Cost
  - Substantially more than VOC solvents
  - Less than Oxsol
- VOC exemption
  - EPA – Yes
  - SCAQMD et al. - No



# Oxsol and TBAc

- TBAc has some favorable points to Oxsol:
  - Dry time
  - No swelling of EPDM
  - Lower cost
- However, TBAc is not exempt from VOC content calculations in all jurisdictions.



# Water-Based Adhesives

- Have been available for single-ply roofing for many years.
- Acrylic latex technology is typically used.
- Acrylics provide:
  - Heat resistance
  - Flexibility
  - Strength



# Water-Based Adhesives

- Main limitation is temperature.
  - Must not be allowed to freeze
  - Usually stored above 60 °F
  - Ambient temperature must be 40 °F and rising
  - Must be above 40 °F for 48 hours after application for full curing
- May limit the roofing season in some areas to less than 6 months.



# Water-Based Costs

- Water is a very inexpensive solvent.
- Water-based adhesives may be 1½ - 2 times more expensive than VOC adhesives.
- Some expense is offset by increased coverage rates.



# Drying Time

- Highly dependent on ambient conditions:
  - Temperature
  - Humidity
  - Wind speed
  - Cloud cover
- Coverage rate also affects drying time.
- Water-based adhesives are more sensitive to these conditions than solvent-based systems.





# Polyurethane Adhesives

- Are usually VOC free and are 100% solids.
- Largest use is for adhering insulation.
- For adhering single-ply membranes:
  - Fleece-backed membranes are usually required.
  - Polyurethane adhesives typically do not bond well directly to single-ply membranes.
- This area has potential for growth.



# Adhesive Primers

- Used to prepare some surfaces to receive an adhesive or adhesive tape
- Usually included under “Adhesives” category.
- Sometimes given its own category
- VOC content limit of 250 g/L



# Primers

- Similar approach as solvent-based adhesives
- Primers may have solids content as low as 5%, remainder being solvents.
- Polymer matrix may include:
  - Butyl-based polymers
  - Tackifying resins
  - Curatives



# Low VOC Primers

- Oxsol is a good replacement solvent.
- Longer dry times are required.
- Swelling of EPDM may occur.
  - Excessive application must be avoided.
  - Primers are usually applied in very thin layers.



# Sealants

- Defined as material used to fill, seal or waterproof gaps or joints; i.e. Caulks
- Small volume of sealant on a typical roof
- VOC content limit is 450 g/L.
- Most sealants have relatively high solids.
- Nearly all roofing sealants meet the requirements.



# What lies ahead?

- January 6, 2010 - EPA proposed strengthening national ambient air quality standards for ground-level ozone.
- EPA is looking at reducing the standard from the current 0.075 ppm to 0.060 to 0.070 ppm.
- More nonattainment areas.
- More regionalized approaches, such as the OTC.
- More regulations!



# Advocacy

- The roofing community supports the efforts to improve air quality.
- However, we are also committed to providing safe, durable and affordable systems.
- We must be diligent to ensure that these standards are not compromised by over-regulating products.
- We must express our concerns to rulemaking bodies.



# Conclusions

- Specifiers and contractors must be aware of current and proposed regulations.
  - Especially phased-in or seasonal rules
- To comply, communications are needed between:
  - Rulemaking bodies
  - Manufacturers
  - Code agencies
  - Consultants and Specifiers
  - Contractors
  - Building owners





Thank You



# Questions

