Coatings Trends & Technologies SUMMIT

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Water-Based Polyester Polyol Dispersion for VOC-Compliant, Ambient-Cure Polyurethane Floor Coatings:

Testing New Starting Point Formulations and Demonstrating in Real-World Application

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CONTENTS

COIM-USA Coatings & Specialties Overview

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Technical

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COIM Coatings & Specialties products

Polyester resins

- Polyester polyols (100% solids) for urethane resin synthesis
- Specialty polyester polyols for high-solids 2K PU coatings and melamine bake enamels
- Water-reducible polyester polyols
- Water-based polyester polyol dispersions
- Solvent-based polyester polyols
- Bio-derived polyester polyols

Urethane resins

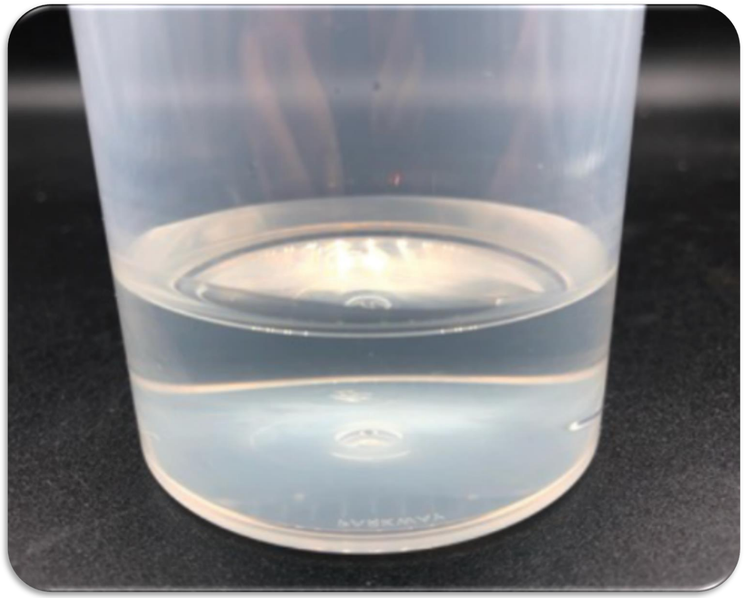
- NCO-functional urethane prepolymer
  - For 1K MCPU and 2K PU (including polyurea-PU hybrids)
  - Low-free isocyanate monomer (MDI, TDI, IPDI, HDI)
  - Conventional (pMDI, MDI)
- Urethane prepolymers for resin synthesis
- Blocked urethane prepolymer for 2K epoxy flexibilization

Novel Water-Based Polyester Polyol Dispersion

Features and uses of the polyester dispersion included in this study*

Key Features

- High solids (64% in water only)
- No co-solvent (including no exempt solvent)
- Surfactant-free
- HAPs-free
- Low odor
- Reactive-amine neutralized (pH ~7.3)
- Low color (APHA <200)
- High-functional (total f = ~2.6)
- Designed for ambient-cure with fast return to service (<24 hr.)
- Coatings and adhesives grade polyester backbone
- Compatible with standard hydrophobic HDI-trimer



Uses

- **Ambient-cure aliphatic water-based 2-component PU thin coatings and adhesives**
- Enabling relatively simple to formulate high performance, ultra low VOC, no odor, easy to use, sustainable coatings

New polyester dispersions in development for bake enamels and other types of coatings and adhesives

Applications and benefits of the polyester dispersion used in this study*

<u>Ambient-cure WB 2K PU applications</u>

- Floor coatings
- Traffic deck coatings
- Concrete coatings
- Direct-to-metal coatings
- Wood coatings

<u>Sustainability benefits</u>

- **VOC compliance in any region (easily formulated to well under 50 g/L)**
- Enables formulating high-solids (50 to 80%) coating systems
- Safe to apply with any coating application method (including spray)
- Low (polyester) odor during application, zero-odor after

New polyester dispersions in development for other applications (e.g. automotive, aerospace, etc.)

Ease of use and cost advantage for high performance coatings

Performance benefits

Compatibility with hydrophobic HDI-trimer + polyester backbone + high crosslink density provides:

- Toughness and durability comparable to solvent-based aliphatic PU-polyester
  - Outstanding flexibility and abrasion/scratch resistance
- Chemical resistance (especially to solvents and hydrocarbons)
- Adhesion to a variety of substrates (metal, concrete, plastic, wood)
- High gloss (~90 at 60^{o}) but also matteable
- Ease of use
  - Working time (>1 hour) + dry time (<6 hour) - *can be made faster with catalyst*
  - Recoatable in <12 hours
  - Ability to dial in hardness and performance with wide A:B ratio latitude
  - Can compatibilize certain amounts of modifying resins (e.g. acrylic emulsion, aspartic amines, etc.) to allow for hybrid systems
- Total formulation cost advantage (*don't need water-dispersible HDI-trimer)

Pigmented WB 2K PU-polyester **basecoat**

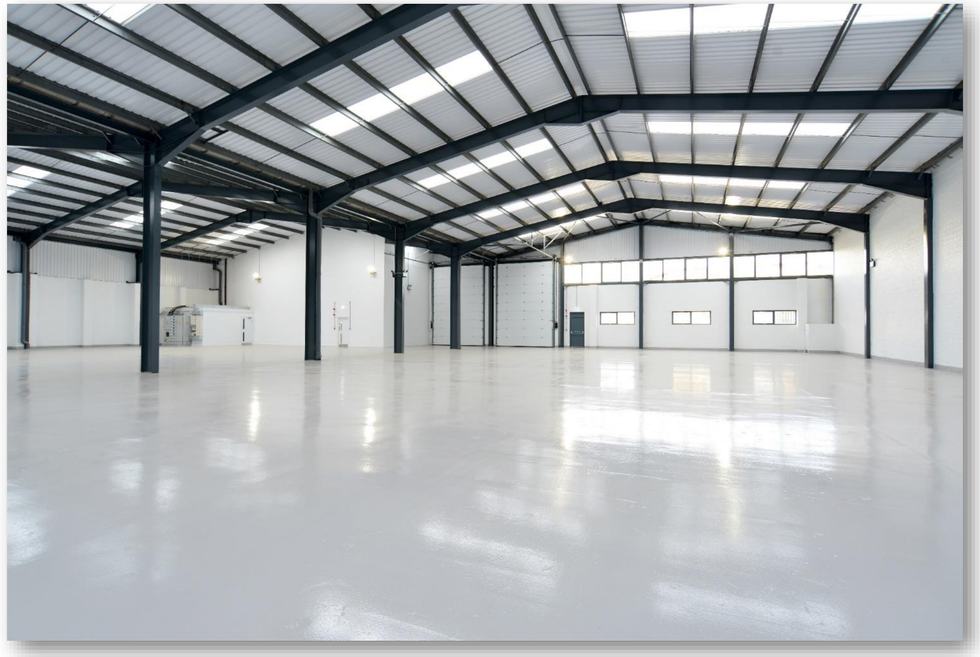
White basecoat formulation

WB 2K PU-Polyester White Basecoat Part A		
Material	**Weight**	**Volume**
POLYESTER POLYOL DISPERSION	28.6	46.8
DI Water	14.6	25.3
Mix on low speed until homogenous		
Defoamer_1 (VOC-free)	0.2	0.3
Defoamer_2 (for conentrates)	0.3	0.5
Rutile TiO2 pigment	54.1	23.4
High speed disperse 20 minutes or until 7.5 Hegman		
Wetting agent	0.6	1.0
Mix on medium speed 10 minutes		
HEUR rheology modifier	1.6	2.6
Mix on medium speed 10 minutes		
Total	100.0	100.0

White Part A + Part B Mixed -- NCO:OH 2.3:1.0		
Material	**Weight**	**Volume**
White Part A	60	50
Hydrophobic HDI-trimer Part B	20	24
Water Reduction	20	26
Total	100	100

White basecoat formulation characteristics

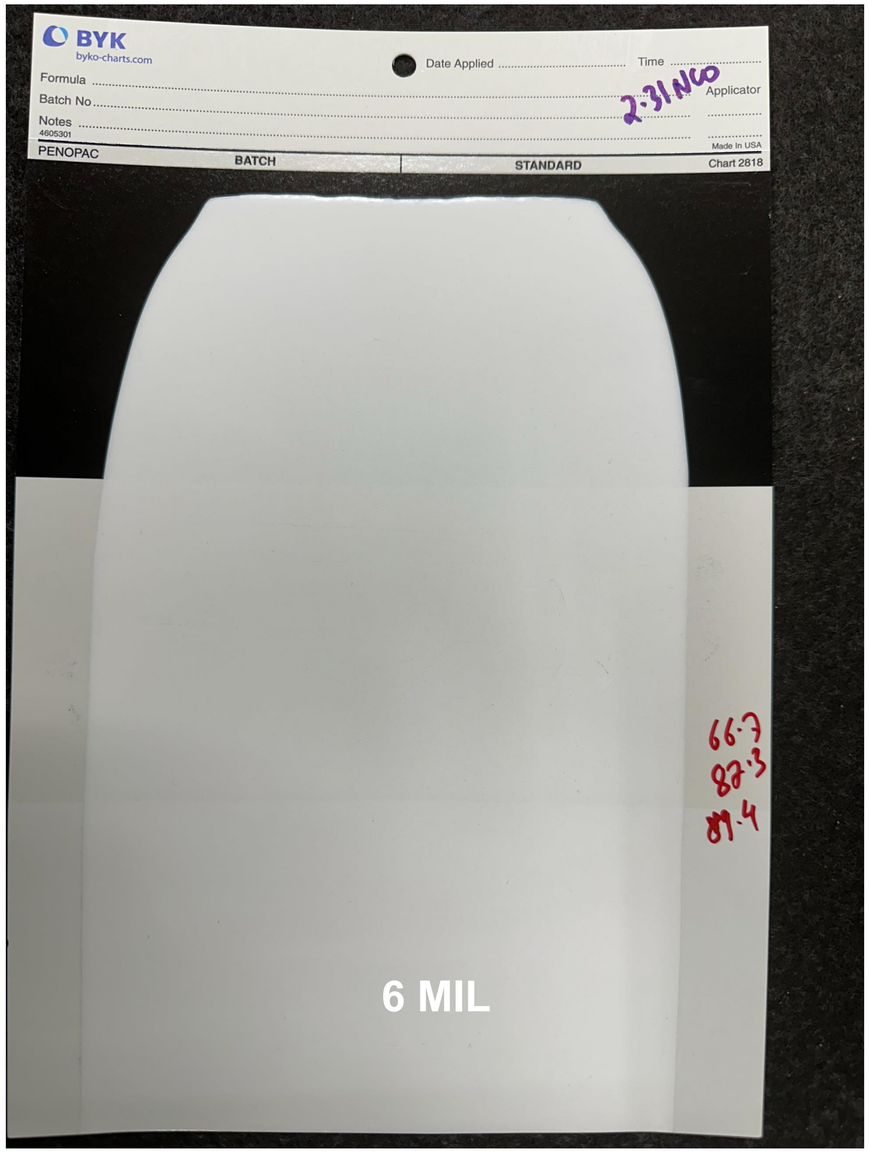
Formula Properties	Part A	Applied (A+B+H2O Reduction)
Theoretical density (lb/gal)	14.5	11.6
Weight solids (%)	74.0	65.0
Volume solids (%)	56.1	51.0
Viscosity (cP)	885	180
P/B ratio		1.05
Calculated coating VOC (g/L)		6.1

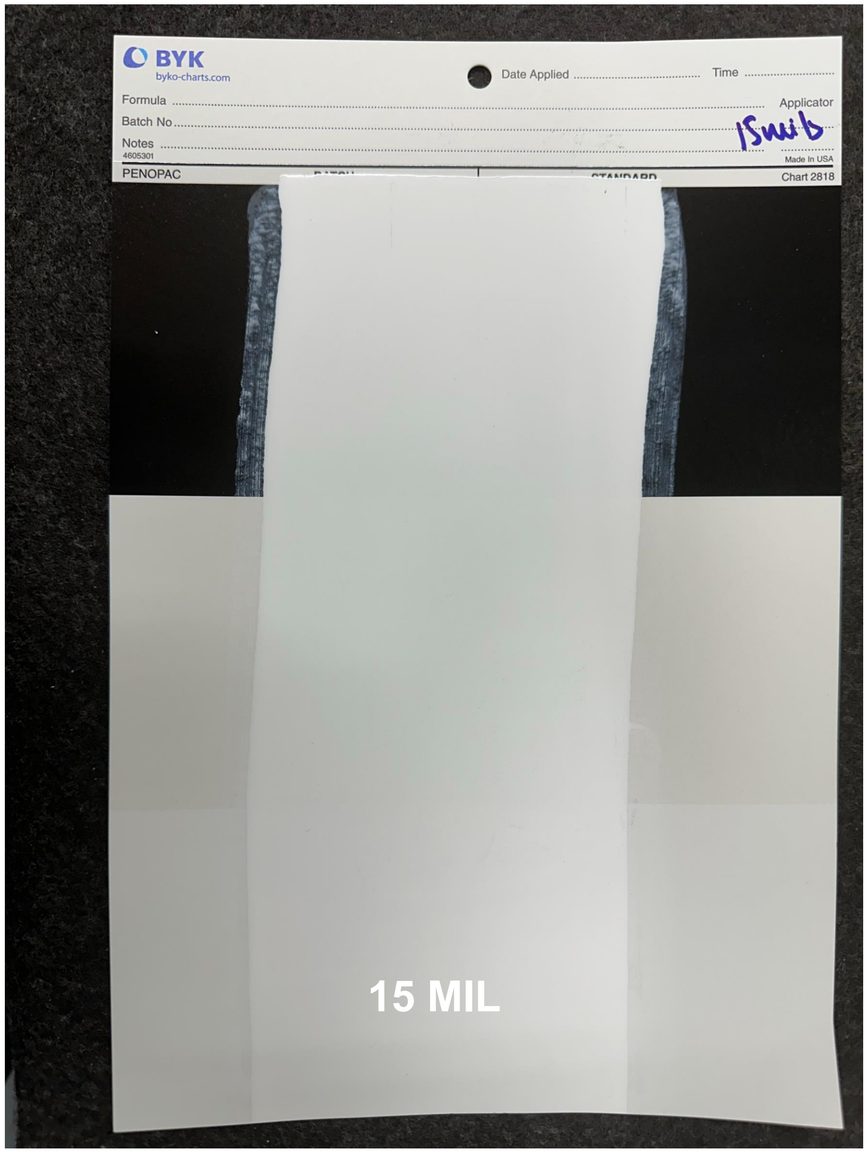


White basecoat performance results

WB 2K PU-Polyester White Basecoat		
Substrate	Q-panel and Leneta paper	
Cure	7 days ambient	
Film Properties	**6 mil WFT**	**15 mil WFT**
Dry film thickness (mil)	3.1	7.6
Gloss 20° / 60° / 85°	70 / 89 / 91	68 / 90 / 90
Pencil hardness	2H	H
Konig hardness (4°)	128	66
Impact direct & reverse @160 in-lb	PASS	PASS
Cross cut adhesion	4B	TBD
Taber abrasion (mg lost/1000 cycles)	91	TBD

White basecoat performance results – 6 vs 15 mil WFT





White basecoat performance results

WB 2K PU-Polyester White Basecoat		
Substrate	Q-panel	
Cure	7 days ambient	
Chemical Resistance	**6 mil WFT**	**15 mil WFT**
MEK Double-Rubs (100 passes)	No Effect	No Effect
Skydrol LD-10	No Effect	No Effect
95% Ethanol	No Effect	No Effect
Motor Oil	No Effect	No Effect
Anti-Freeze	No Effect	No Effect
Washer Fluid	No Effect	No Effect

Clear WB 2K PU-polyester **topcoat**

Clear topcoat formulation

WB 2K PU-Polyester Clear Topcoat Part A		
Material	**Weight**	**Volume**
POLYESTER POLYOL DISPERSION	59.8	58.8
DI Water	30.5	31.8
Mix on low speed until homogenous		
Defoamer_1 (VOC-free)	0.4	0.4
Wetting agent	1.3	1.3
AMP (amino alcohol)	0.3	0.3
Zinc-amine complex	0.7	0.6
Mix on medium speed 10 minutes		
UV Absorber	3.8	3.4
Add above slowly while mixing on high speed 5 minutes		
HEUR rheology modifier	3.3	3.3
Mix on medium speed 10 minutes		
Total	100.0	100.0

Clear Part A + Part B Mixed -- NCO:OH 3.0:1.0		
Material	**Weight**	**Volume**
Clear Part A	50	52
Hydrophobic HDI-trimer Part B	50	48
Total	100	100

Clear topcoat formulation characteristics

Formula Properties	Part A	Applied (A+B)
Theoretical density (lb/gal)	8.7	9.2
Weight solids (%)	46.0	73.0
Volume solids (%)	44.0	70.0
Viscosity (cP)	504	7,800
Calculated coating VOC (g/L)		10.9

- *The A+B viscosity is too high for floor coating application in the field;*
- *This formulation would need to be reduced further with 10 to 20 pbw water after mixing parts A and B*
- *This is demonstrated in the real-world garage floor example described in the next section*

Clear topcoat performance results

WB 2K PU-Polyester Clear Topcoat	
Substrate	Q-panel and Leneta paper
Cure	7 days ambient
Film Properties	**6 mil WFT**
Dry film thickness (mil)	4.3
Gloss 20° / 60° / 85°	86 / 93 / 98
Pencil hardness	6H+
Konig hardness (4°)	208
Impact direct & reverse @160 in-lb	PASS
Cross cut adhesion	5B
Taber abrasion (mg lost/1000 cycles)	20

WB 2K PU-Polyester Clear Topcoat	
Substrate	Q-panel
Cure	7 days ambient
Chemical Resistance	**6 mil WFT**
MEK Double-Rubs (100 passes)	No Effect
Skydrol LD-10	No Effect
95% Ethanol	No Effect
Motor Oil	No Effect
Anti-Freeze	No Effect
Washer Fluid	No Effect

Suggested floor coating system

1. Primer* (optional)

2. White/gray/color basecoat
   - DFT = 3 to 8 mil
   - A/B (by weight) = 3:1

3. Flake (optional)

4. 1st clear topcoat (for sealing)
   - DFT = 3 mil
   - A/B = 2:1

5. 2nd clear topcoat (for durability)
   - DFT = 3 mil
   - A/B = 1:1

If a primer is needed, and depending on the substrate and ambient conditions, options include:
- *Epoxy*
- *MCPU (typically aromatic)*
- *PUD*

Typically, with this polyester resin, a primer is not needed for adhesion

Real-world DIY garage floor coating demonstration

DIY garage floor coating restoration plan

1. Prep floor (i.e. clean and mask baseboards)
2. Gray basecoat
3. Flake broadcast
4. 1st clear topcoat (for sealing)
5. 2nd clear topcoat (for durability)

DIY

- This was our first floor coating job (zero experience)
- Paint cans were pre-packaged at the desired A:B ratios
- Very light sweet polyester smell during mixing and application
- No odor during drying, nor after completion
- A+B mix working time ~1 hour (we were done using each mix within 45 min.)
- Coverage = 300 to 400 ft^2 per gallon paint kit
- Used nap roller on extension pole
- Took care to apply each layer as thin as we could
- Dry in <4 hours even though it was quite humid

Application process and equipment

Day 1
- Washed & swept floor (did not sand)
- Masked baseboards

Day 2
- Re-swept floor (morning)
- Applied gray basecoat (afternoon)
- Immediate flake broadcast while gray paint still wet

Day 3
- Swept floor of debris and loose flakes (morning)
- Applied 1st clearcoat (~12 hours after basecoat applied)
- Applied 2nd clearcoat (~8 hours after 1st clearcoat applied)

Day 4
- Fully dry and tack-free

Day 6
- Fully cured and could be parked on

Paint mixing procedure

1. Lightly mix Part A (pigmented only, not necessary for clear)
2. Pour Part B (100% solids hydrophobic HDI-trimer) into Part A can
3. Drill mix for about 1 minute
4. Pour some of the mix back into the Part B can, swirl around, and then pour back into Part A can
5. Drill mix for about 1 minute
6. Reduce by adding tap water – 0 to 20% (i.e. 0 to 20 oz of H_2O)
   - *Reduce less for vertical surfaces; pigmented; high ambient humidity; and porous substrates*
   - *Reduce more for horizontal surfaces; clearcoats; low ambient humidity; and smooth substrates*
7. Drill mix carefully for about 1 minutes (paint may splash due to viscosity reduction)
8. Continue to occasionally mix A+B lightly during first 30 minutes of application (pigmented only, not necessary for clear)
9. Apply entire mix, the quicker the better, but must be within 1 hour
10. Unused mix will cure into a foam that can be discarded in the trash (do NOT use only part of kit and then try to save for use later)
    - *Note that if one combines A+B kits together to increase size of mix there can be a significant reduction in working time due to the mass effect on reaction exotherm*
    - *Larger mixes would require a different Part A formulation (e.g. with lower catalyst level) to have equal working time*
    - *Coating mix can be pressure sprayed but pot life will be shorter*

USE LOWEST NAP ROLLER COVER (1/4" MAX)

Garage floor coating application process video

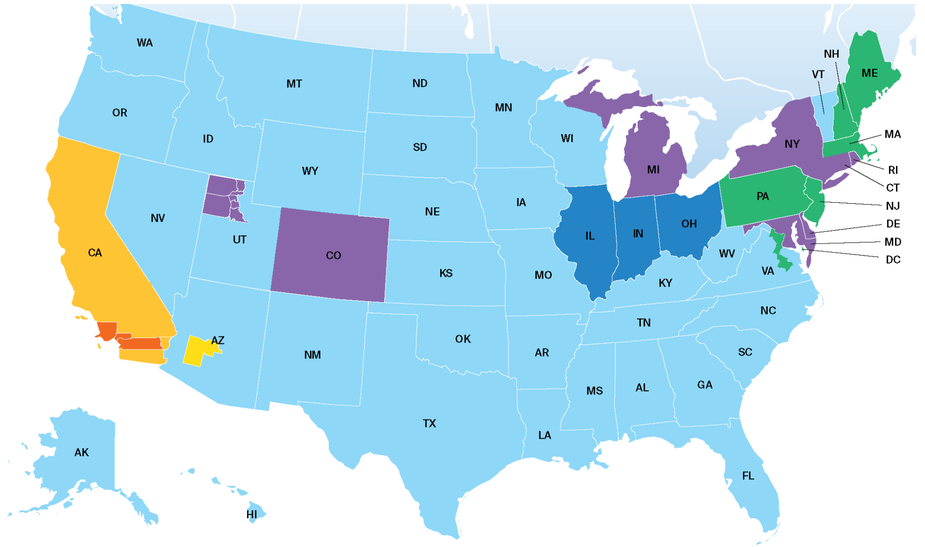
Garage floor coating finished results video

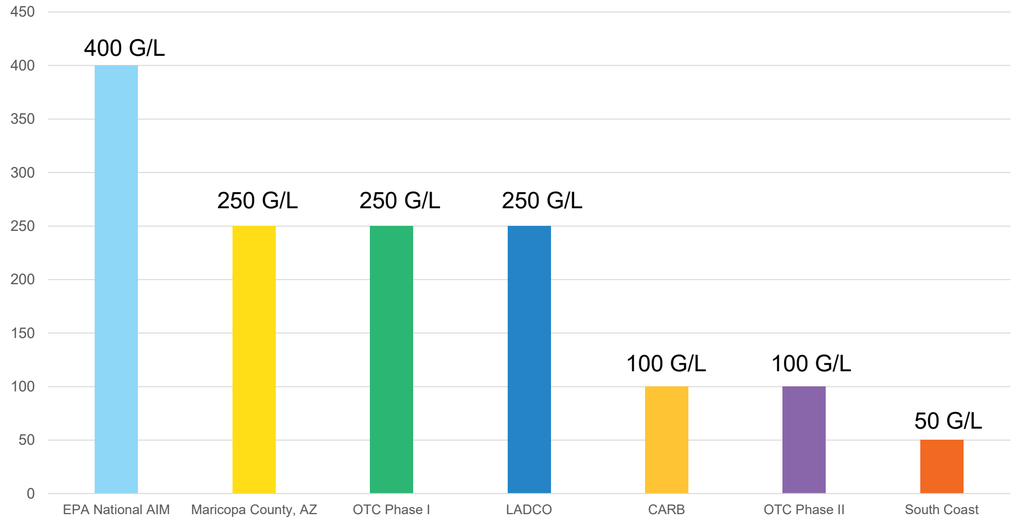
Before and After

VOC compliance anywhere in the United States

- This garage was in TX
- *But even if it was in Los Angeles, CA it would have easily complied with the 50 g/L VOC limit*
  - *Without using any exempt solvents*
  - *With toughness and durability at the level of solvent-based PU-polyester*

FLOOR COATING VOC LIMITS





Conclusions

- The new water-based polyester polyol dispersion can be formulated into various pigmented and clear high-performance VOC-compliant, no-odor, ambient-cure, 2K PU floor coatings.
- An effective use of this novel technology in floor coatings is to combine a fully opaque pigmented basecoat, topcoated with one or more layers of highly durable clearcoat.
- This use was successfully demonstrated in a real-world garage floor coating restoration example.

THANK YOU