“FEVE Fluoropolymer Emulsions for Performance Improvement in Architectural Coatings”

Bob Parker, Applications Chemist

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AGC Chemicals
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Outline

- *Overview of "FEVE" resin technology*
- *Introduction of water-based "FEVE" emulsions*
- *Formulations using "FEVE" emulsions as blending resins:*
  1) Semi-Gloss House Paints
     a. White
     b. Dark Red
  2) DTM Industrial Hi-Gloss Coatings
     a. White
     b. Black
     c. Dark Green
     d. Safety Yellow

FEVE Fluoropolymer Resins

- "FEVE" is abbreviation for "Fluoroethylene Vinyl Ether" resins for coatings

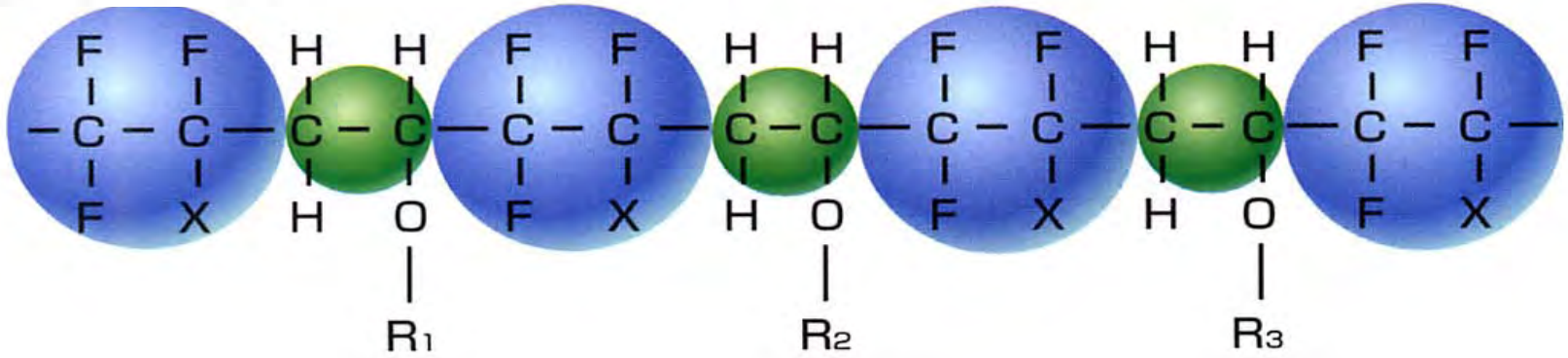
- Known for their high performance properties:
  1) Exceptional resistance to UV degradation
  2) Superior Chemical Resistance
  3) Excellent Thermal Resistance

- Known for their unique formulation properties:
  1) Solvent soluble
  2) Can be cured at ambient temperature with isocyanates
  3) Can achieve high gloss formulations

Fluoroethylene Vinyl Ether (FEVE) Resins

Fluoro Ethylene

Vinyl Ether



FLUORINATED SEGMENTS: Weatherability, durability, chemical resistance

VINYL ETHER SEGMENTS: Gloss, solubility, crosslinking

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Commercial Types of "FEVE" Resins:

1) Solvent soluble resins –

uses organic solvents for viscosity reduction; predominantly cured with isocyanates; available as resin solutions or as 100% solid resins

2) Water-based emulsions –

use vinyl ether macromonomers containing polyoxyethylene (EO) units to create stable emulsions

FEVE Emulsions in Architectural Coatings

FEVE Water-borne Emulsions		
**********	*FE-4300*	*FE-4500*
Solids (Wt.)	50%	50%
pH	7 to 9	7 to 9
Specific Gravity	1.13	1.17
MFT	35°C.	28°C.
Hydroxyl Value	10	13

FEVE Emulsions in Architectural Coatings

White House Paint Formulation Properties	
Solids (Volume)	32%
pH	9.0 to 9.5
TiO_2 Choice	TiPure R-706
PVC	22
Thickeners	both cellulosic and associative
60° Gloss Range	50-65
VOC	150 g/liter

Testing procedure # 1 :

1) Blending of FEVE emulsions and 4 different acrylic emulsions to evaluate stability (3 weeks in 140°F. oven)

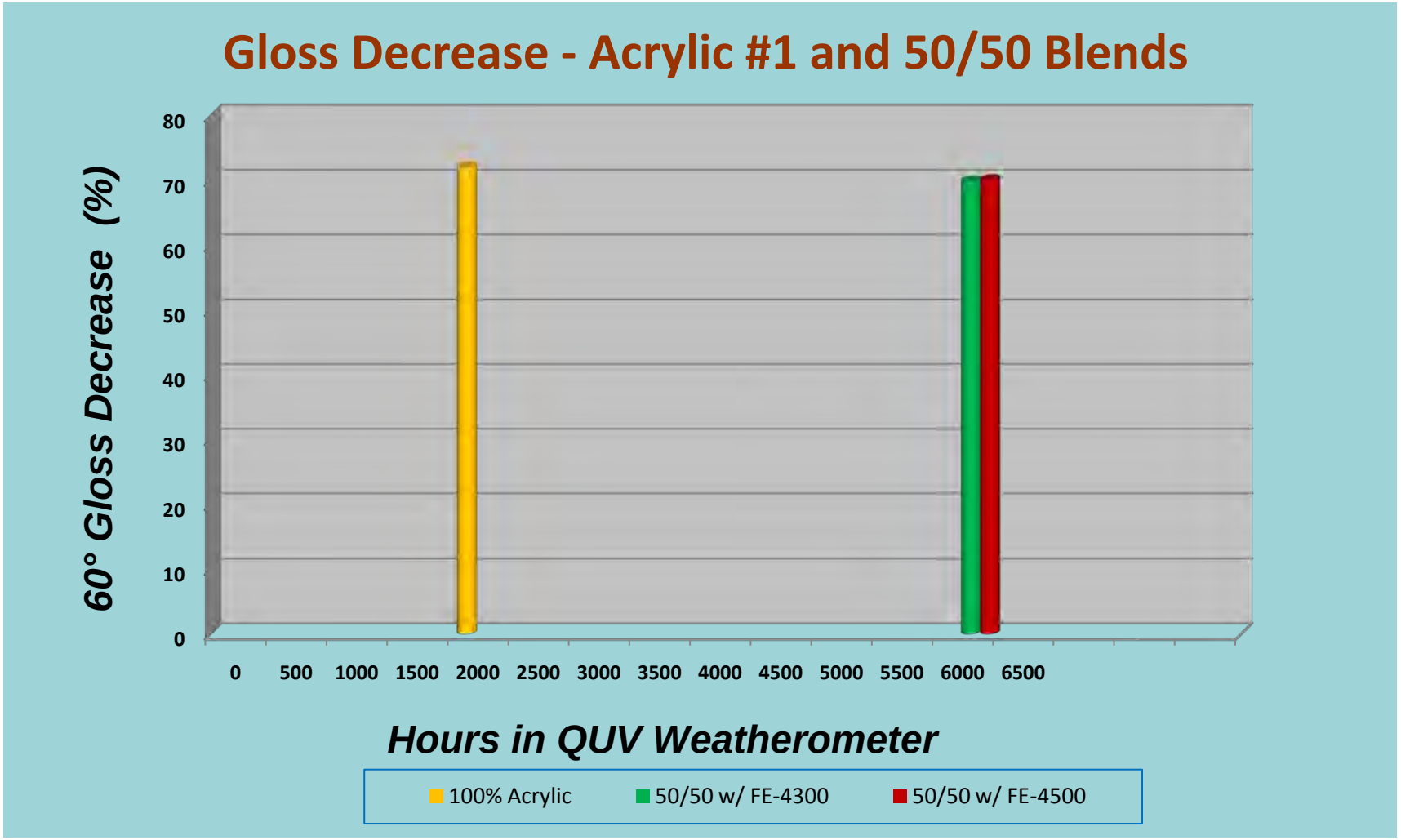
2) Manufacture of 3 *White House Paint* formulations for each acrylic emulsion:
   a. Binder = *100% Acrylic Emulsion*
   b. Binder = *50% Acrylic Emulsion + 50% FE-4300 (FEVE Emulsion)*
   c. Binder = *50% Acrylic Emulsion + 50% FE-4500 (FEVE Emulsion)*

3) Stability testing of all formulations (6 weeks in 120°F. oven)

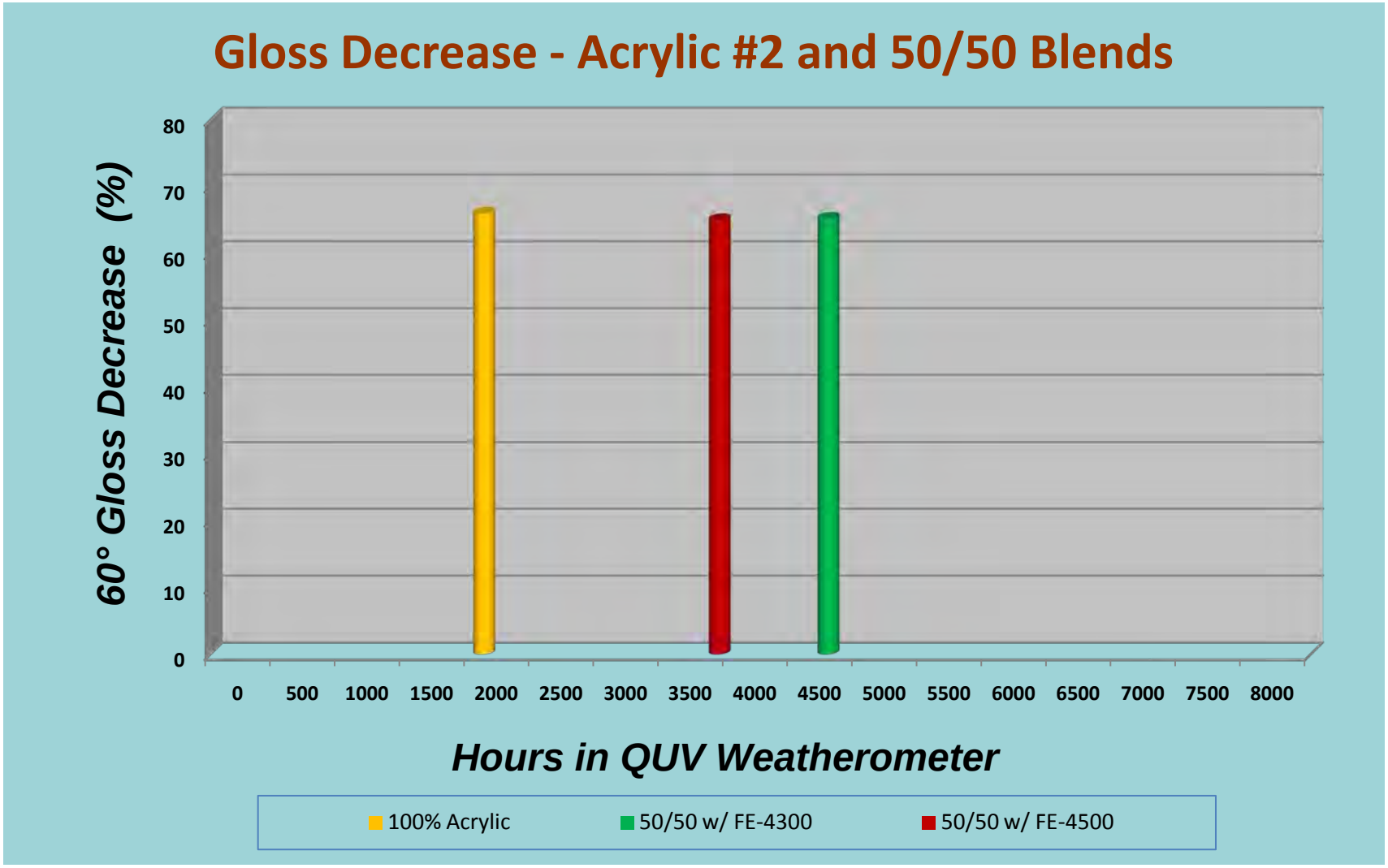
4) Preparation of test panels (primed Al panels coated with 4 wet mils of coating)

5) QUV Weatherometer Exposure (UVA 340 Bulbs used)
   a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50°C.

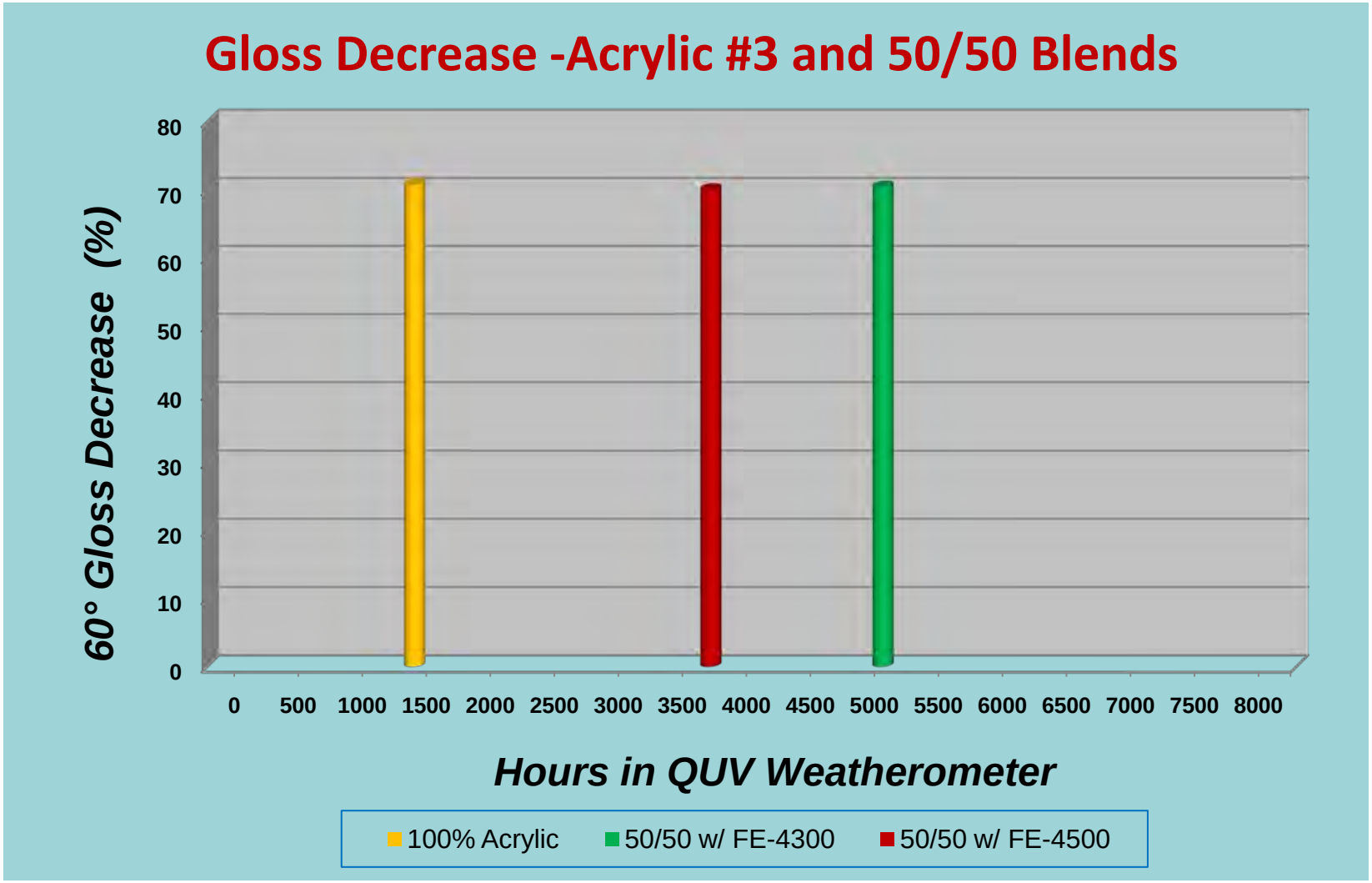
FEVE Emulsions in Architectural Coatings



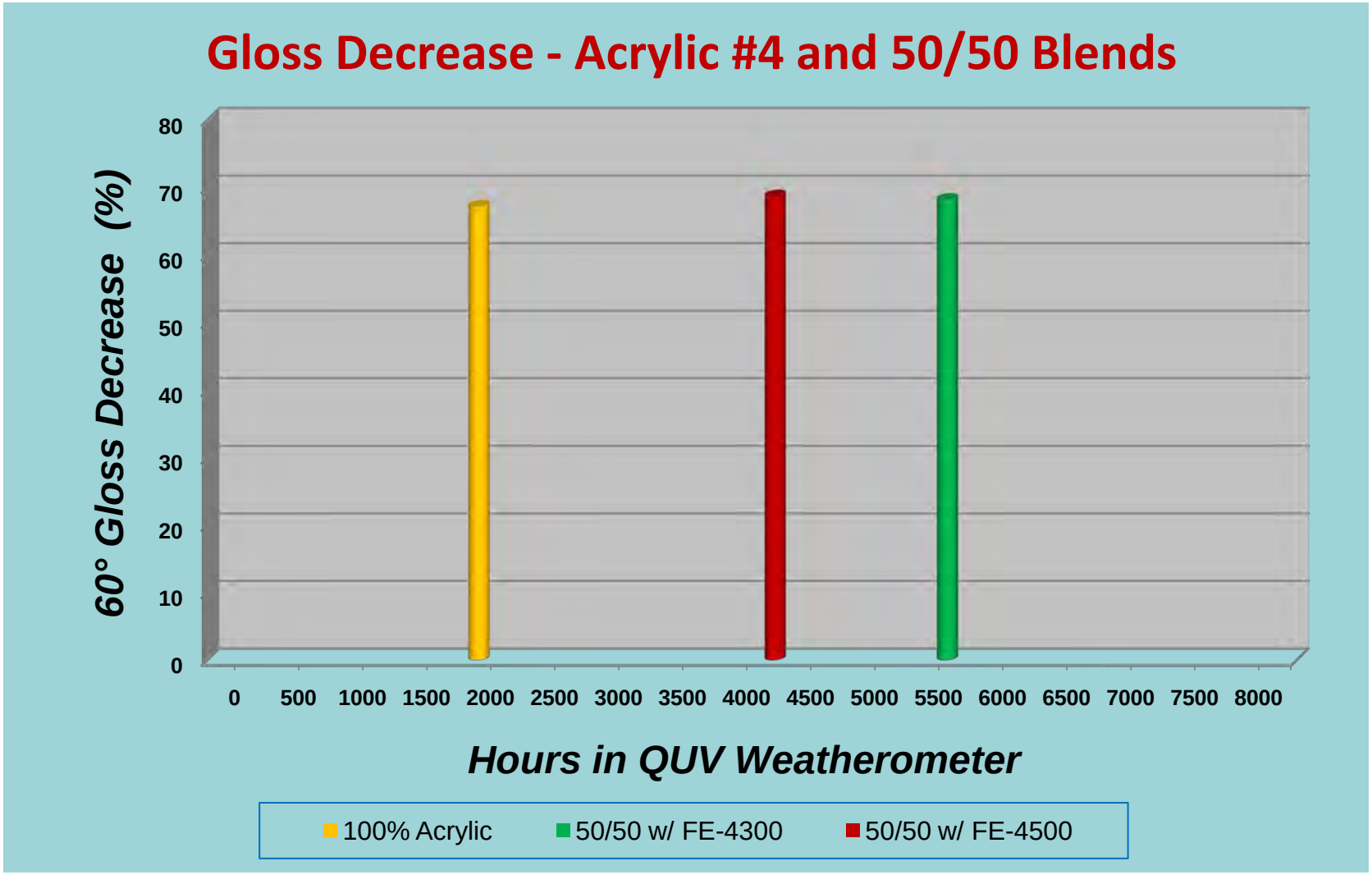
FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings

Red House Paint Formulation Properties	
Solids (Volume)	36%
pH	9.0 to 9.5
Pigment Choice	Organic Red + Phthalo Blue (trace)
PVC	6.5
Thickeners	both cellulosic and associative
60° Gloss Range	50-65
VOC	150 g/liter

Testing procedure # 2 :

1) Choose Acrylic Emulsion #3 as blending resin for Red HP formulation.

2) Manufacture of 6 ***Red House Paint*** formulations:

   a. Binder = *100% Acrylic Emulsion*

   b. Binder = *50% Acrylic Emulsion + 50% FE-4500 (FEVE Emulsion)*

   c. Binder = *60% Acrylic Emulsion + 40% FE-4500 (FEVE Emulsion)*

   d. Binder = *70% Acrylic Emulsion + 30% FE-4500 (FEVE Emulsion)*

   e. Binder = *80% Acrylic Emulsion + 20% FE-4500 (FEVE Emulsion)*

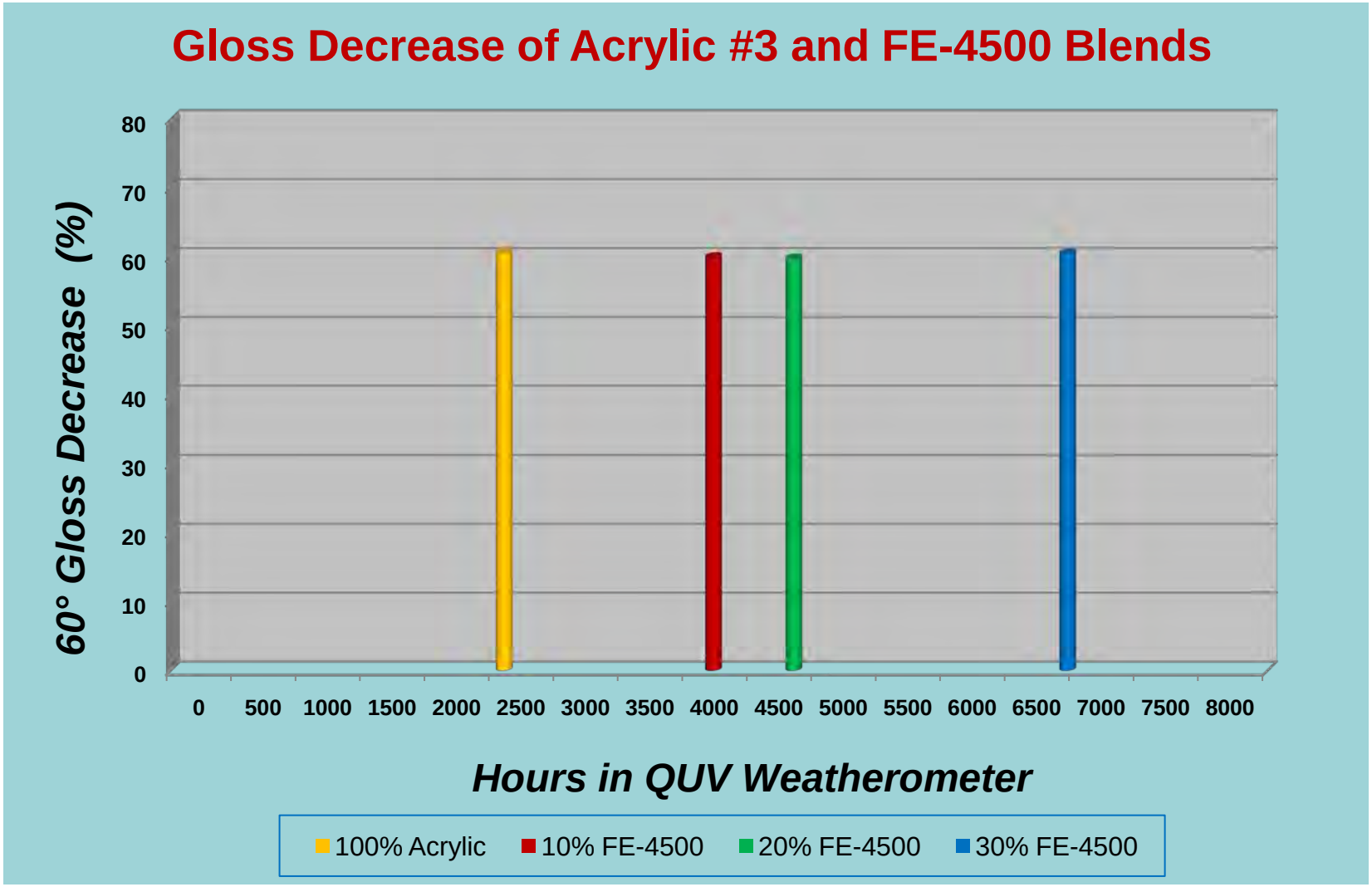
   f. Binder = *90% Acrylic Emulsion + 10% FE-4500 (FEVE Emulsion)*

3) Preparation of test panels (primed Al panels coated with 4 wet mils of coating)

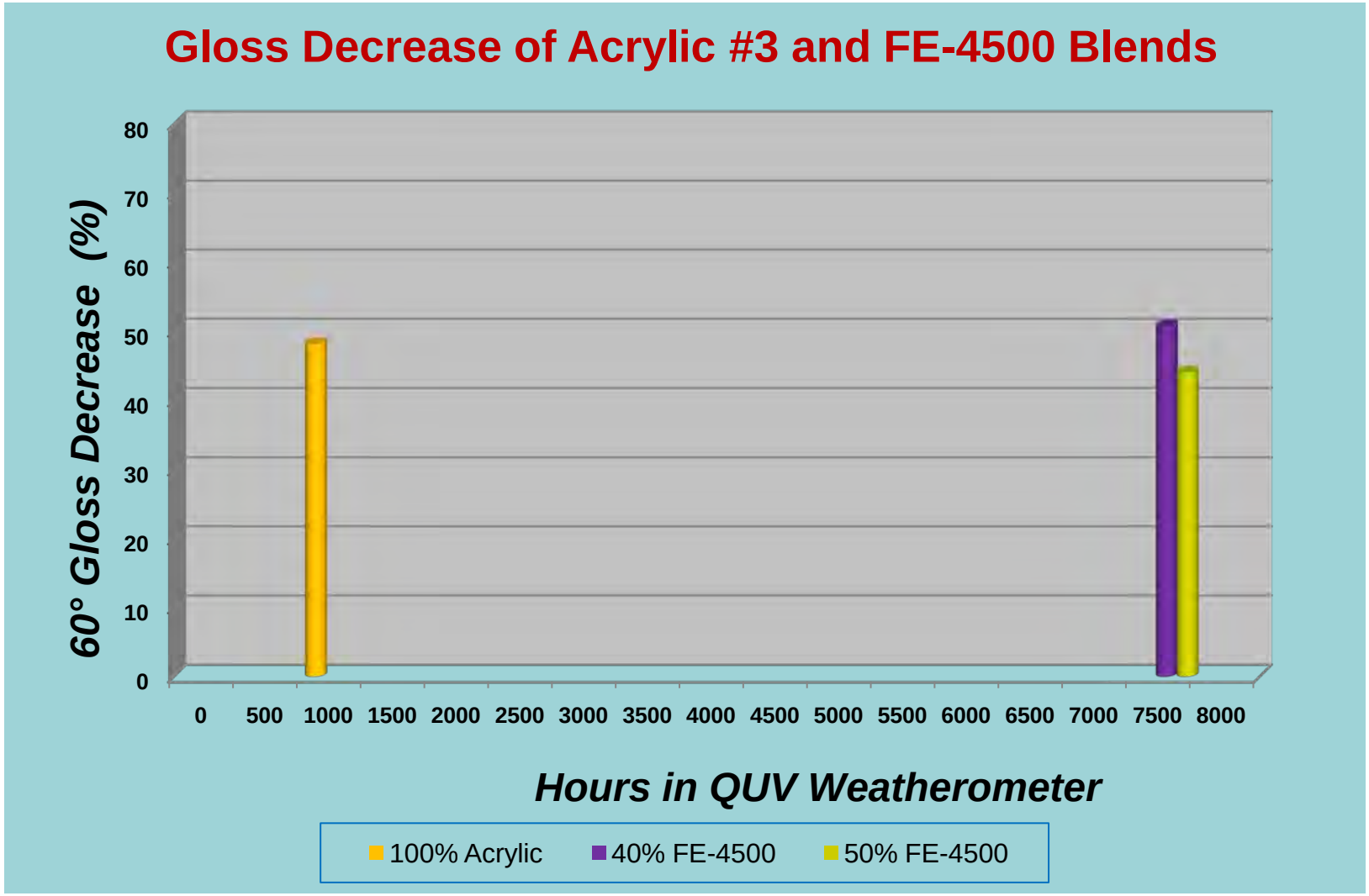
4) QUV Weatherometer Exposure (UVA 340 Bulbs used)

   a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50°C.

FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings

White DTM I/M Paint Formulation Properties	
Solids (Volume)	38%
FEVE Emulsion	FE-4300
pH	9.0 to 9.5
TiO_2 Choice	TiPure R-706
PVC	18
Thickeners	associative-type
60° Gloss Range	60-80
VOC	100 g/liter

Testing procedure # 3 :

1) Choose 3 different acrylic emulsions from 2 manufacturers as blending resins for White DTM I/M Formulation. Blend these acrylic emulsions with the FE emulsions and run oven stability tests.

2) Manufacture of 2 ***White DTM I/M Paint*** formulations:

   a. Binder = *100% Acrylic Emulsion*

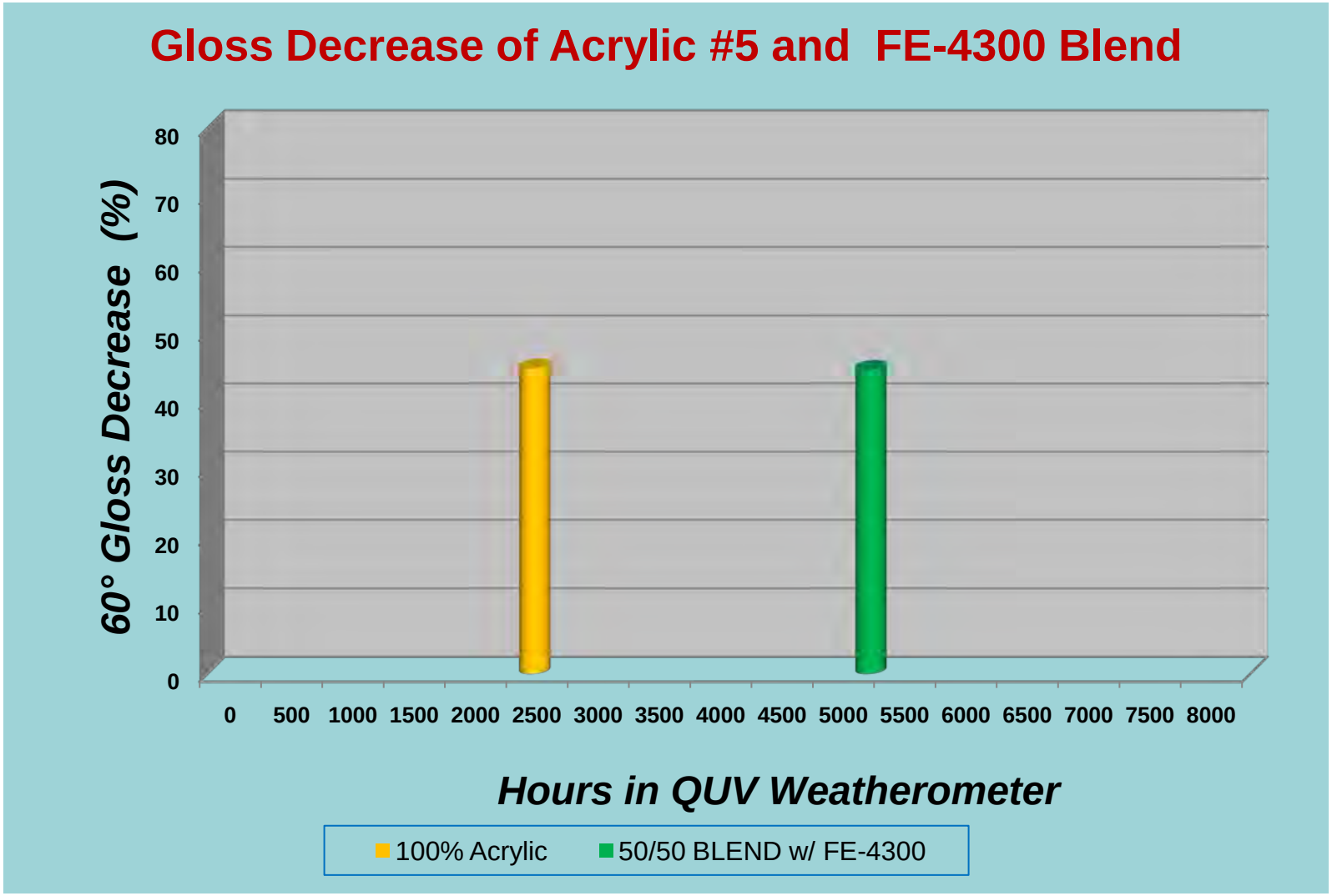
   b. Binder = *50% Acrylic Emulsion + 50% FE-4300 (FEVE Emulsion)*

3) Preparation of test panels (primed Al panels coated with 4 wet mils of coating)

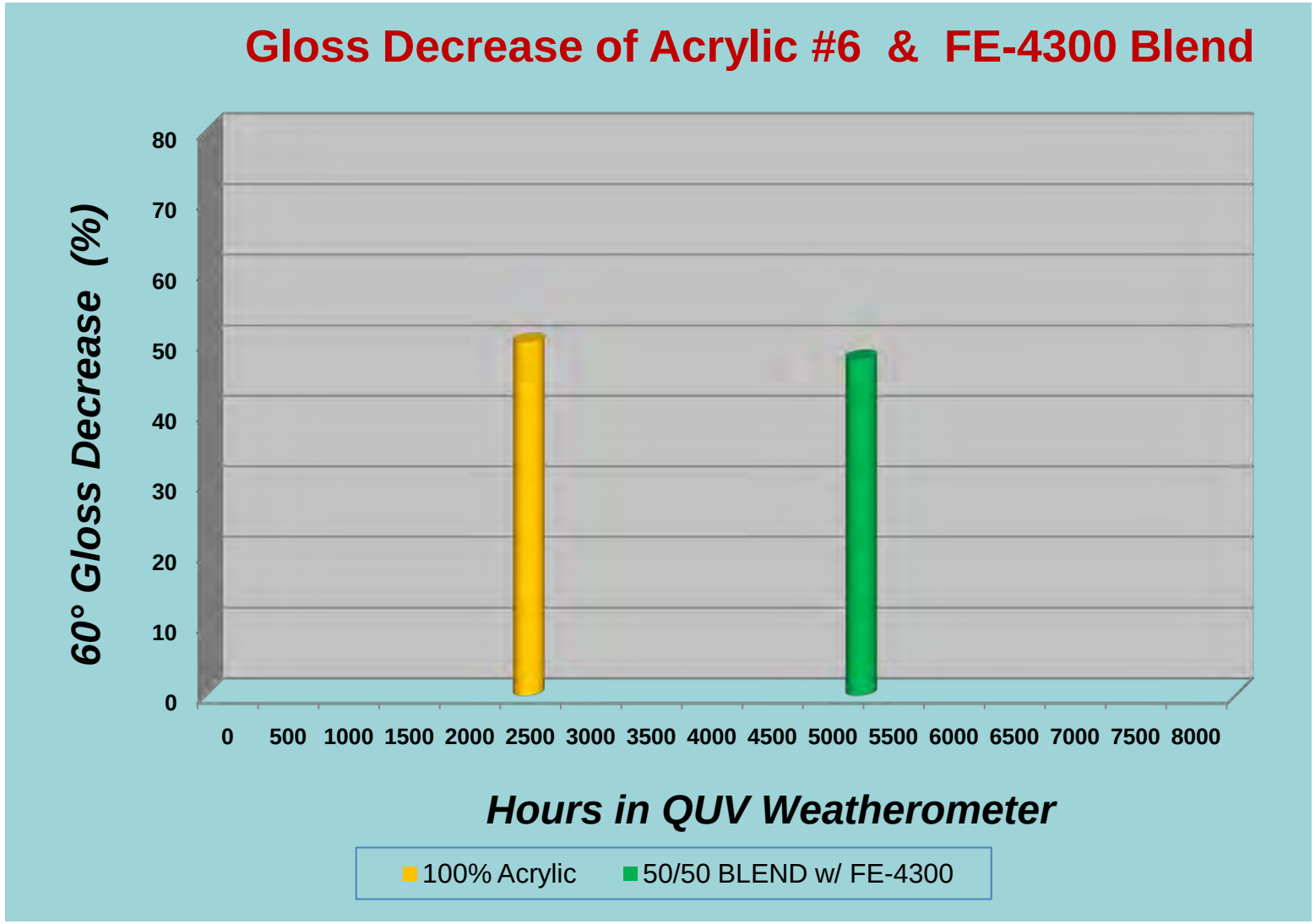
4) QUV Weatherometer Exposure (UVA 340 Bulbs used)

   a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50°C.

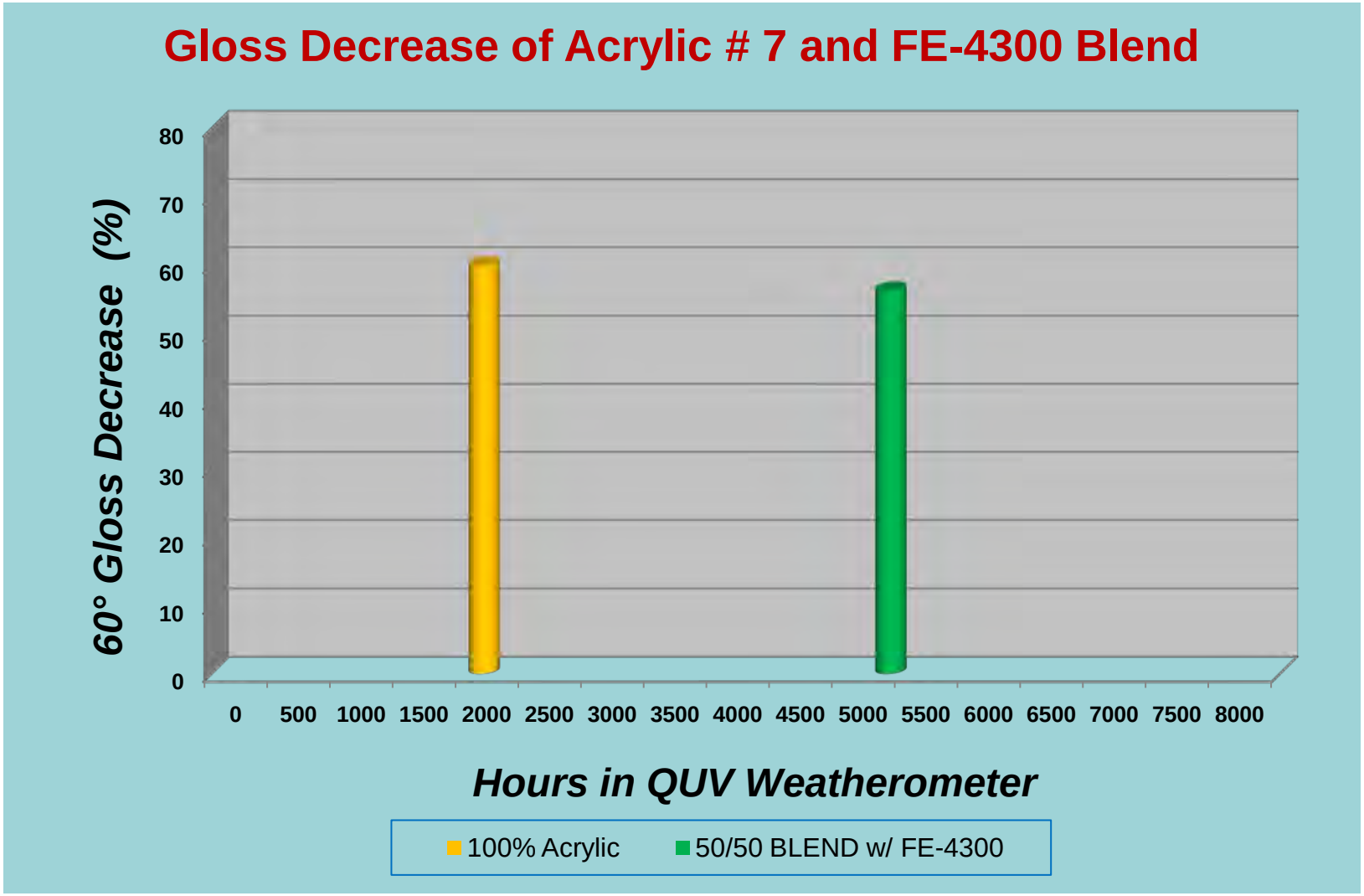
FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings

Black DTM I/M Paint Formulation Properties	
Solids (Volume)	36%
FEVE Emulsions	FE-4300 and FE-4500
pH	9.0 to 9.5
Pigment Choice	Tint-Ayd CW5331 Masstone Black
PVC	2.7
Thickeners	associative-type
60° Gloss Range	60-80
VOC	100 g/liter

Testing procedure # 4 :

1) Choose Acrylic Emulsion # 5 and Acrylic Emulsion # 6 as blending resins for Black DTM I/M Formulation.

2) Manufacture of 3 ***Black DTM I/M Paint*** formulations for each Acrylic:

   a. Binder = *100% Acrylic Emulsion*

   b. Binder = *50% Acrylic Emulsion + 50% FE-4300 (FEVE Emulsion)*

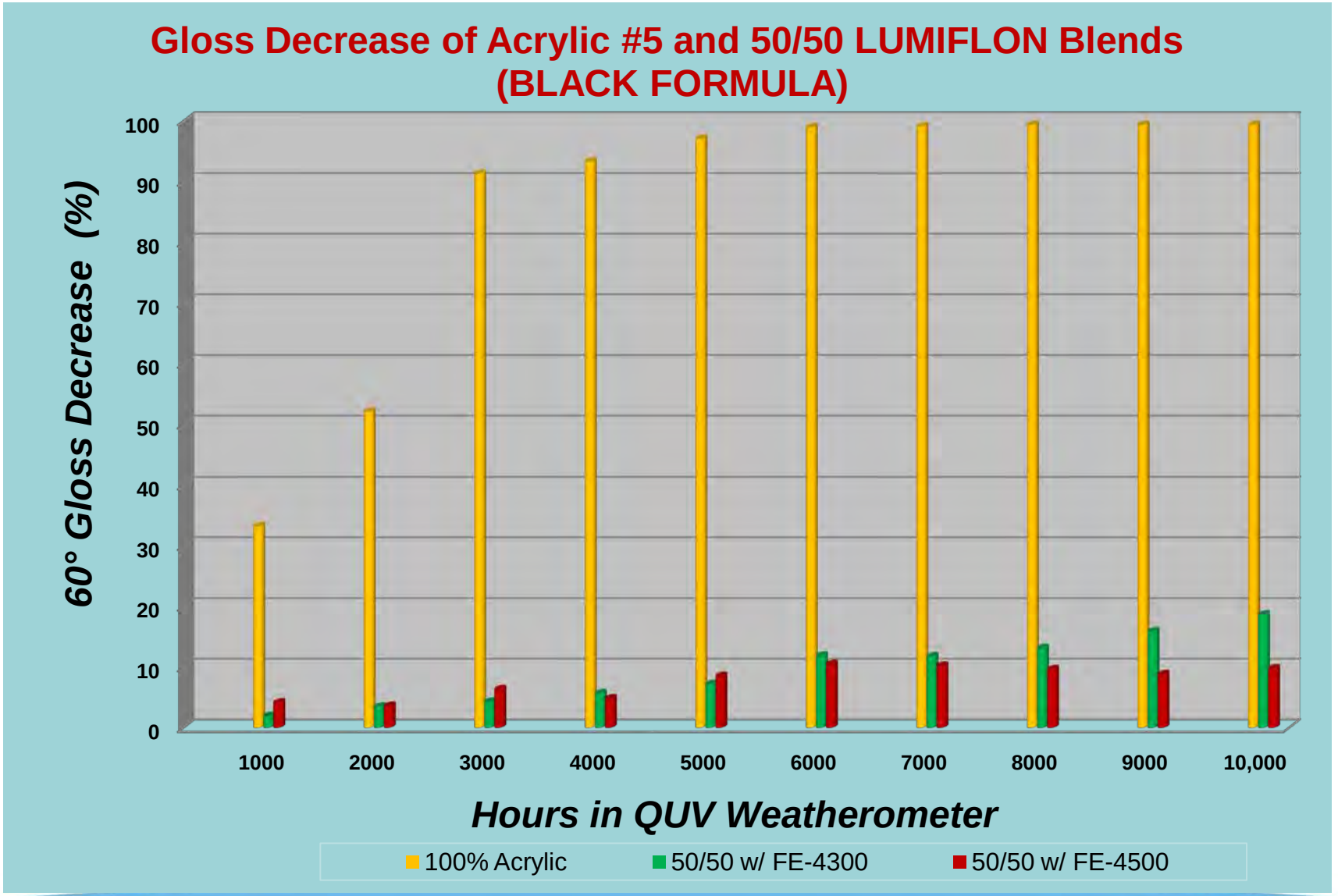
   c. Binder = *50% Acrylic Emulsion + 50% FE-4500 (FEVE Emulsion)*

3) Preparation of test panels (primed Al panels coated with 8 wet mils of coating)

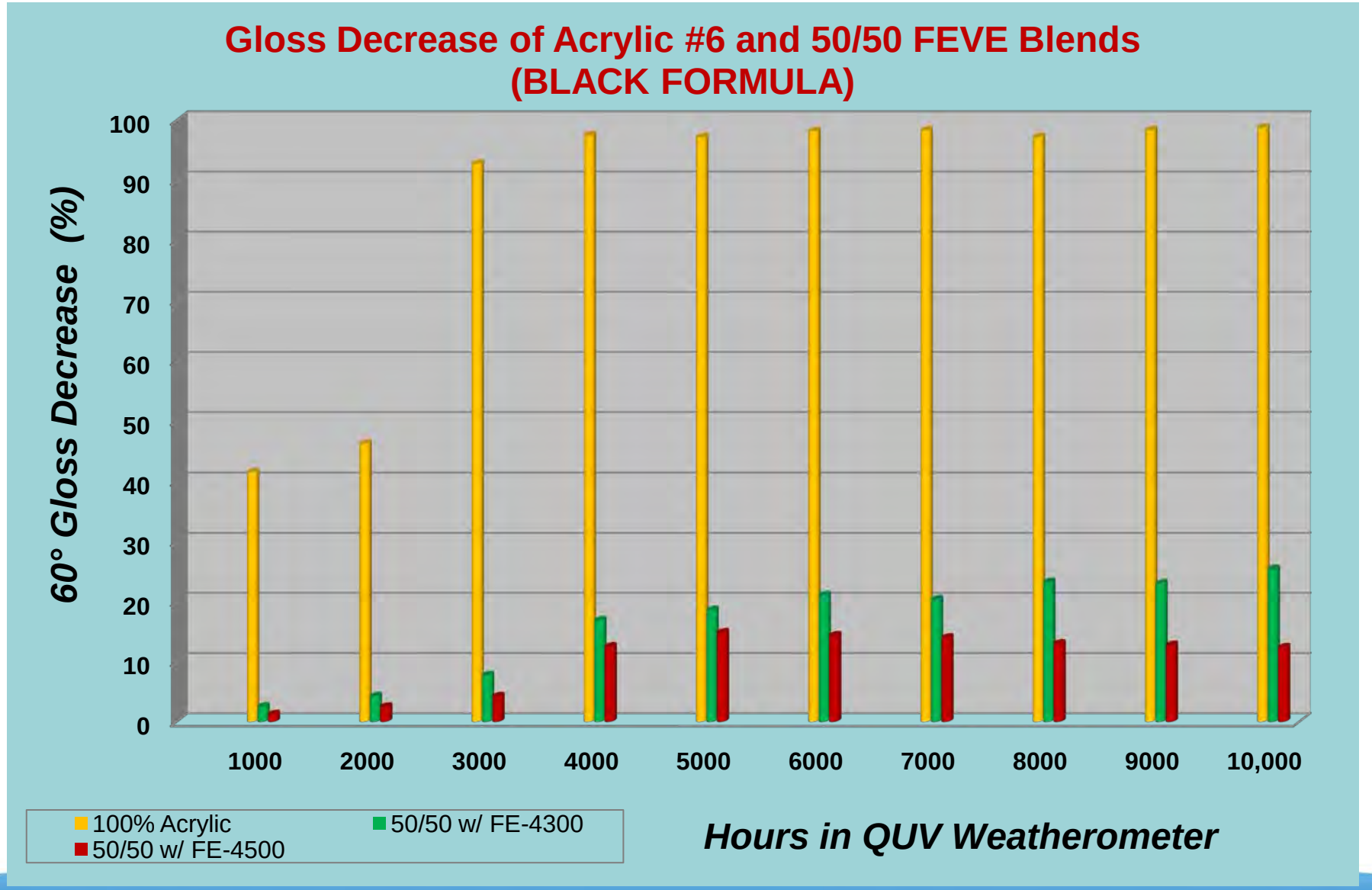
4) QUV Weatherometer Exposure (UVA 340 Bulbs used)

   a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50° C.

FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



Testing procedure # 5 :

1) Choose Acrylic Emulsion # 5 and Acrylic Emulsion # 6 as blending resins for Black DTM I/M Formulation.

2) Manufacture of 3 ***Black DTM I/M Paint*** formulations for each Acrylic:

   a. Binder = *100% Acrylic Emulsion*

   b. Binder = *80% Acrylic Emulsion + 20% FE-4300 (FEVE Emulsion)*

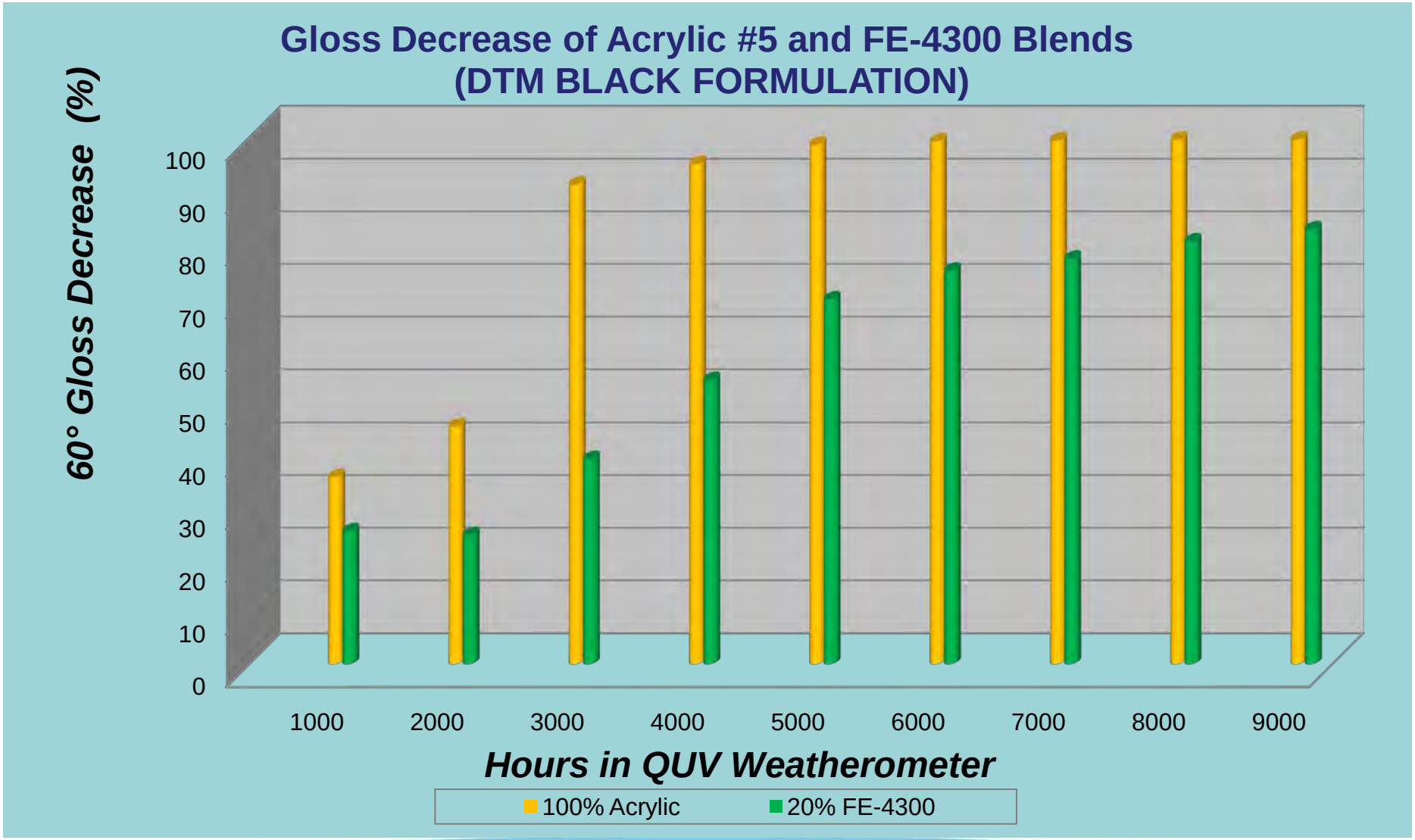
   c. Binder = *80% Acrylic Emulsion + 20% FE-4500 (FEVE Emulsion)*

3) Preparation of test panels (primed Al panels coated with 8 wet mils of coating)

4) QUV Weatherometer Exposure (UVA 340 Bulbs used)

   a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50° C.

FEVE Emulsions in Architectural Coatings



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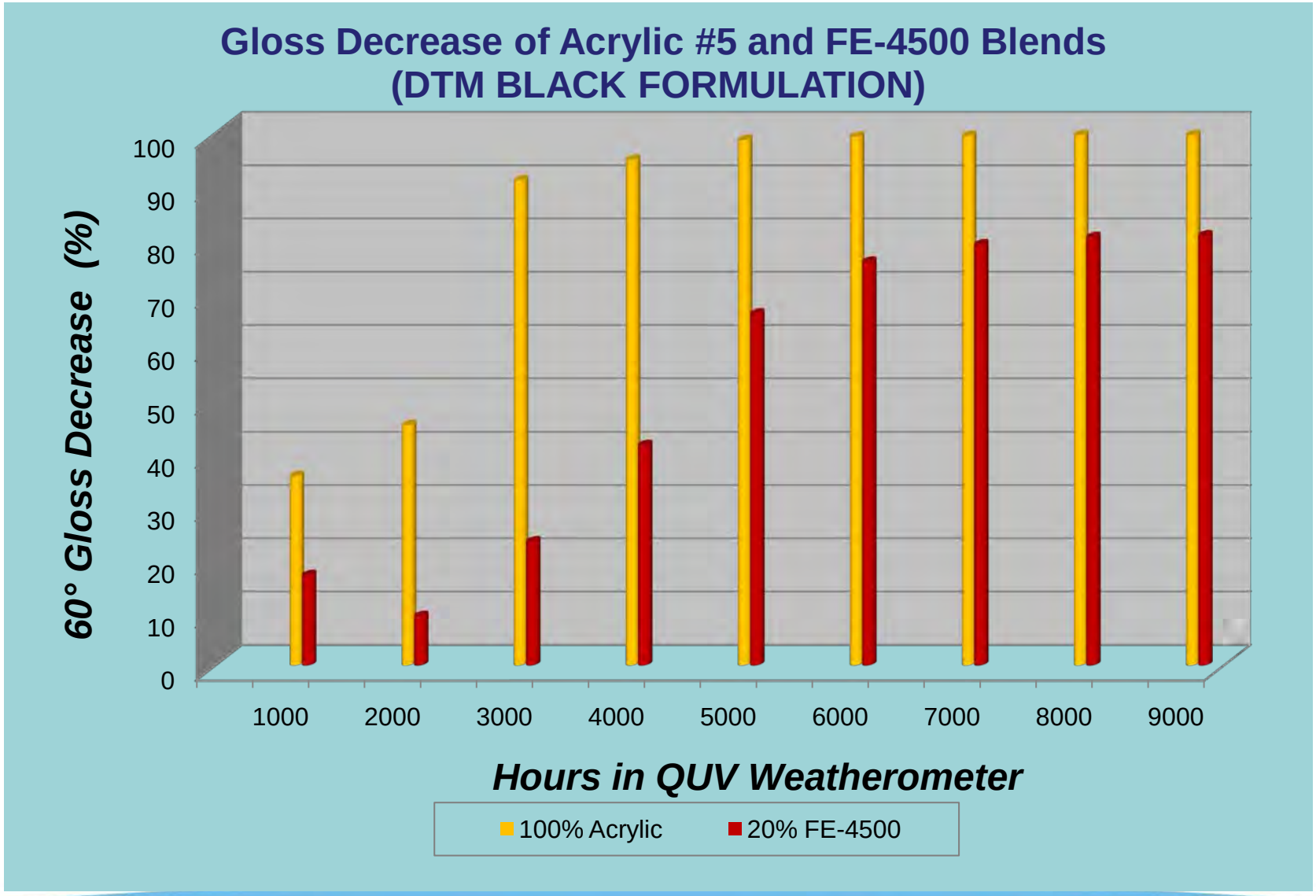

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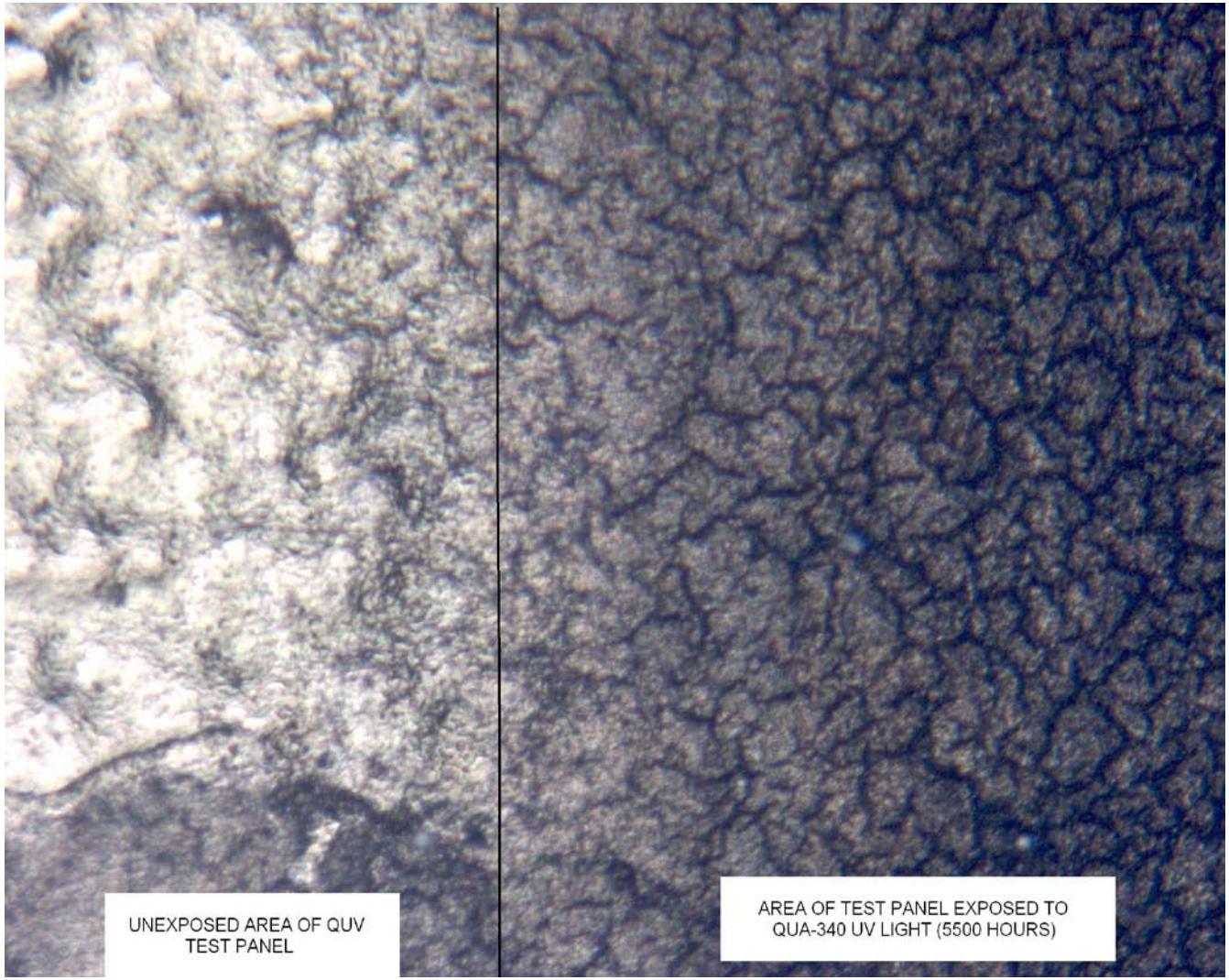
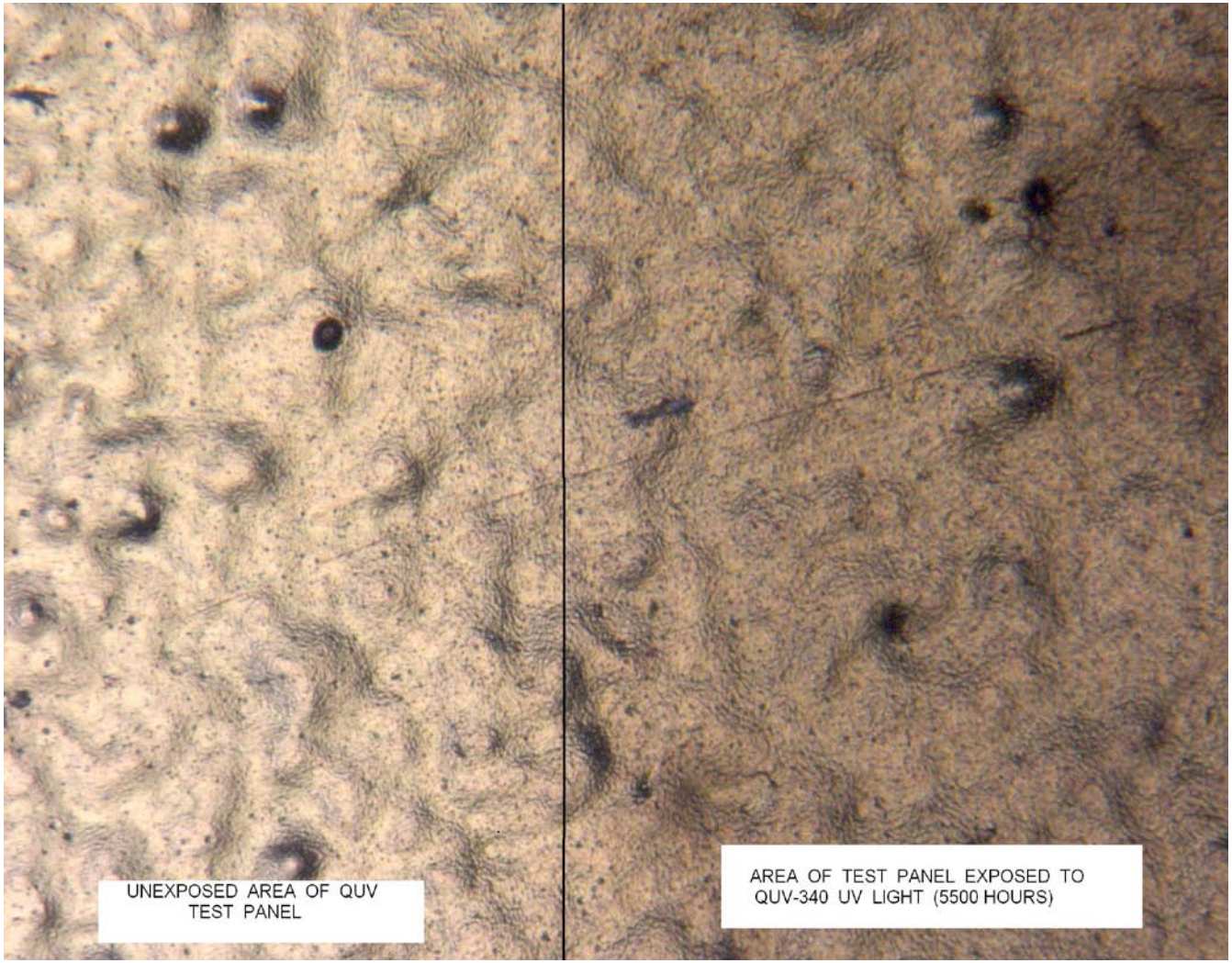


Test Formulation:

100% Acrylic Emulsion #5 as total binder

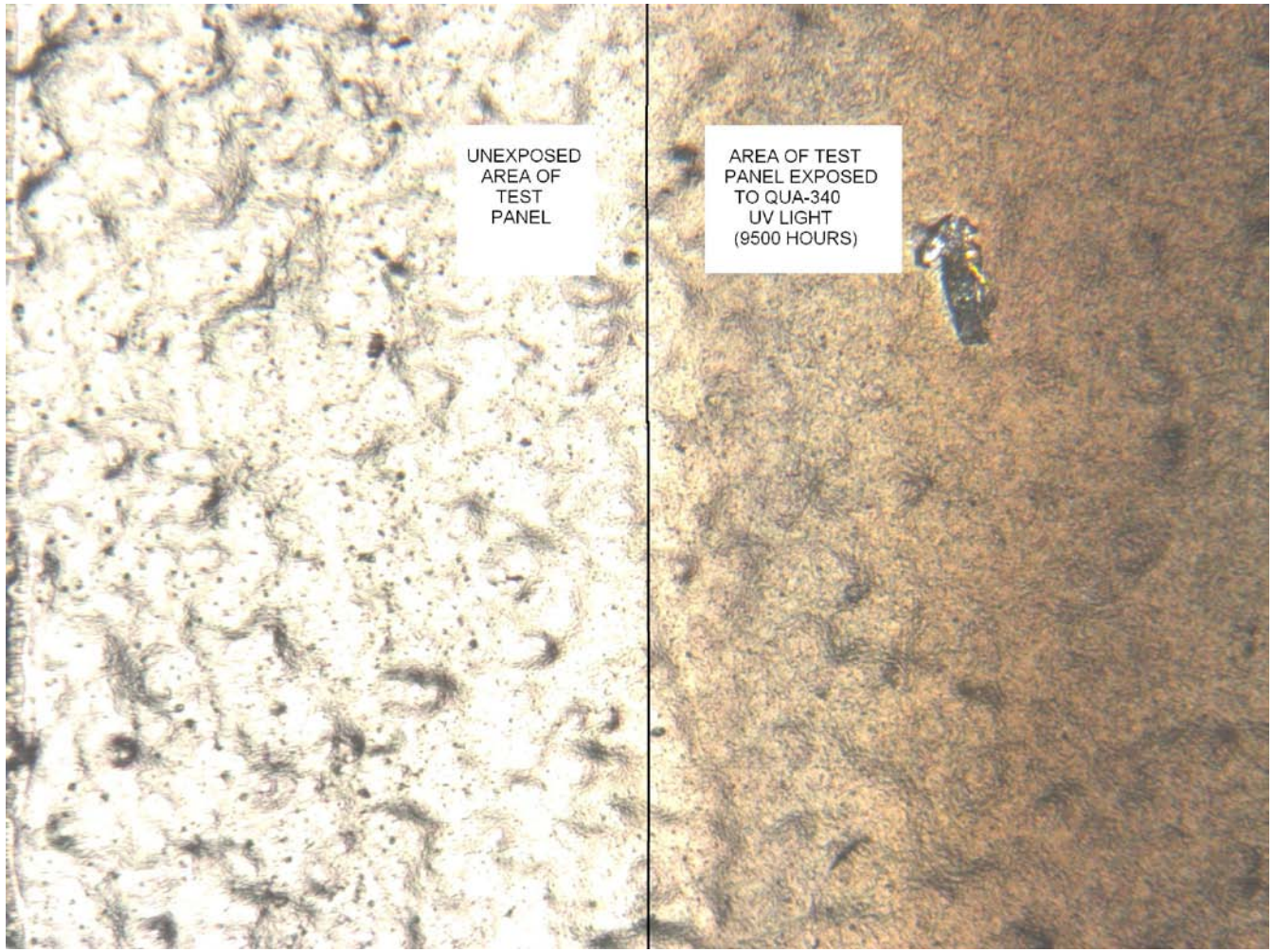
FEVE Emulsions in Architectural Coatings



Test Formulation:

80% Acrylic emulsion #5 and 20% FE-4300 FEVE Emulsion as total binder

FEVE Emulsions in Architectural Coatings



Test Formulation:

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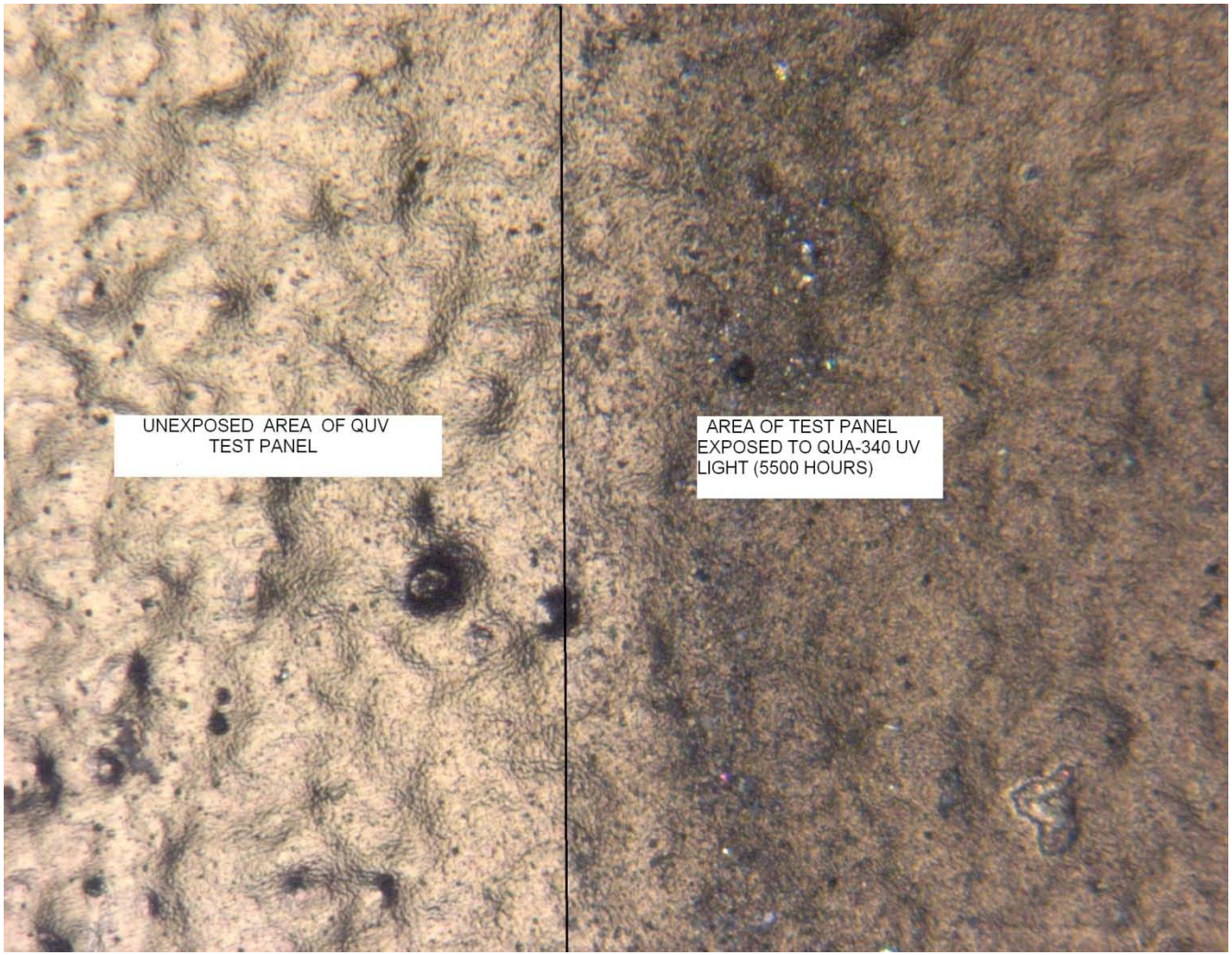
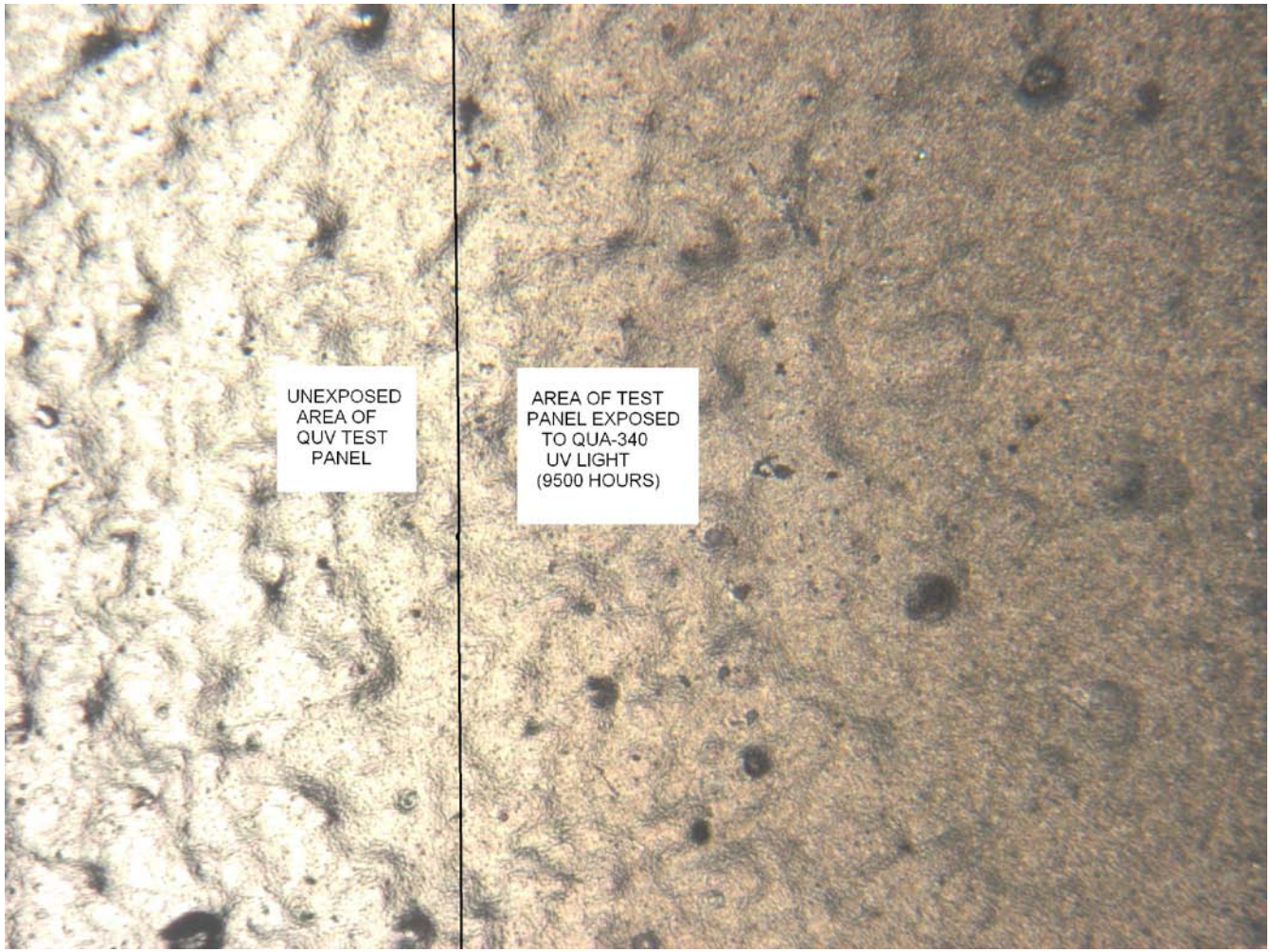


Test Formulation:

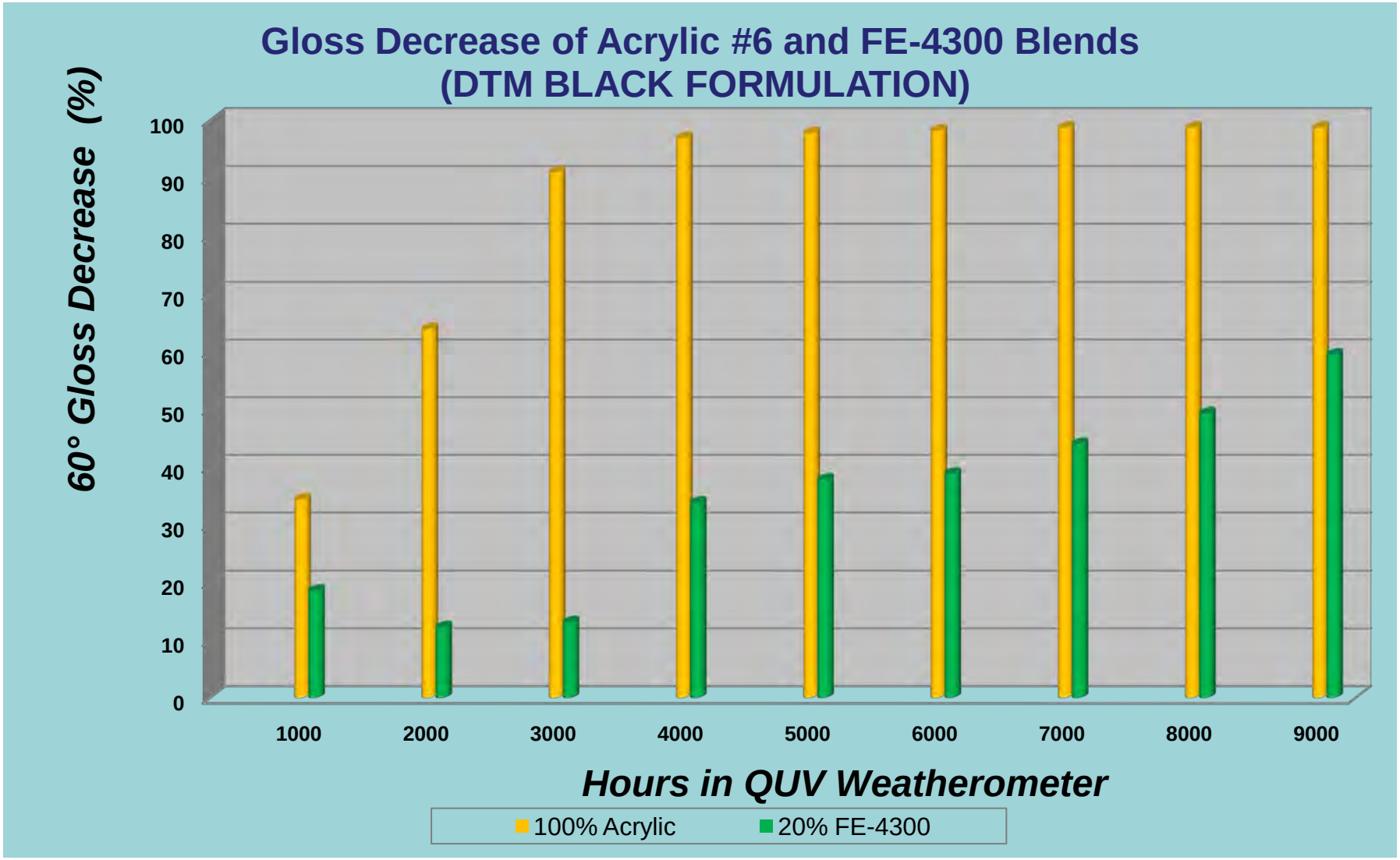
80% Acrylic emulsion #5 and 20% FE-4500 FEVE Emulsion as total binder

FEVE Emulsions in Architectural Coatings

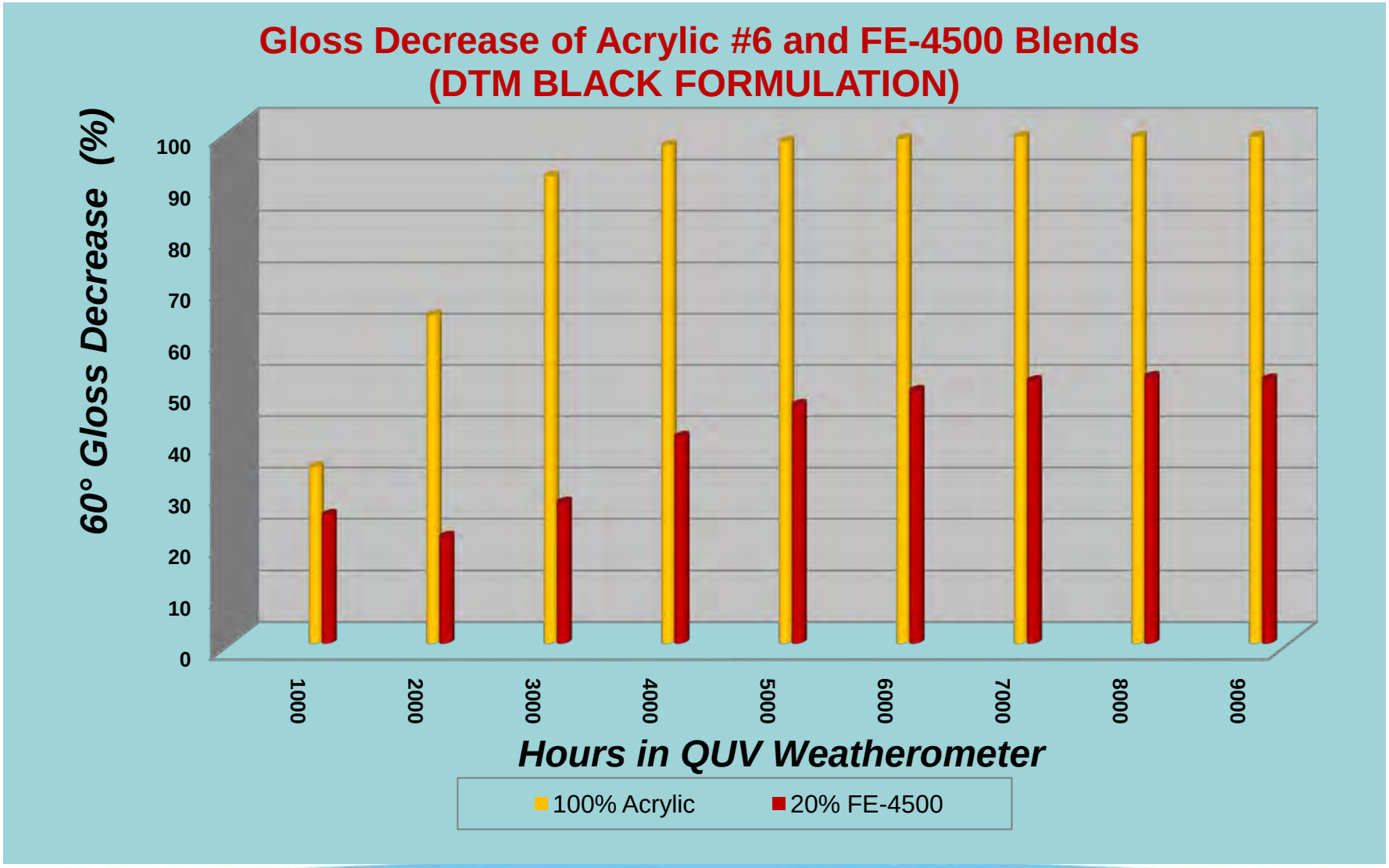


Test Formulation:
80% Acrylic emulsion #5 and 20% FE-4500 FEVE Emulsion as total binder

FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



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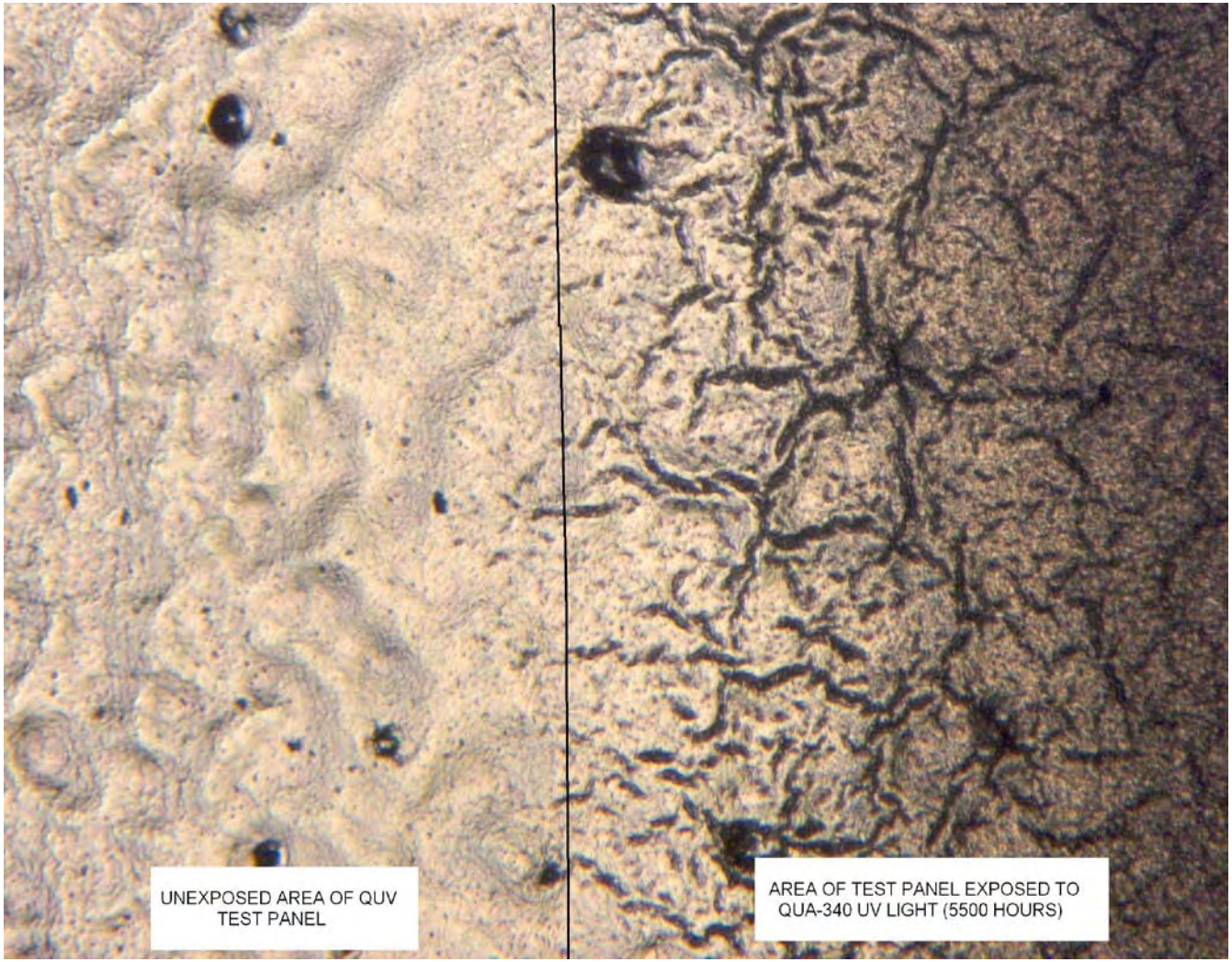
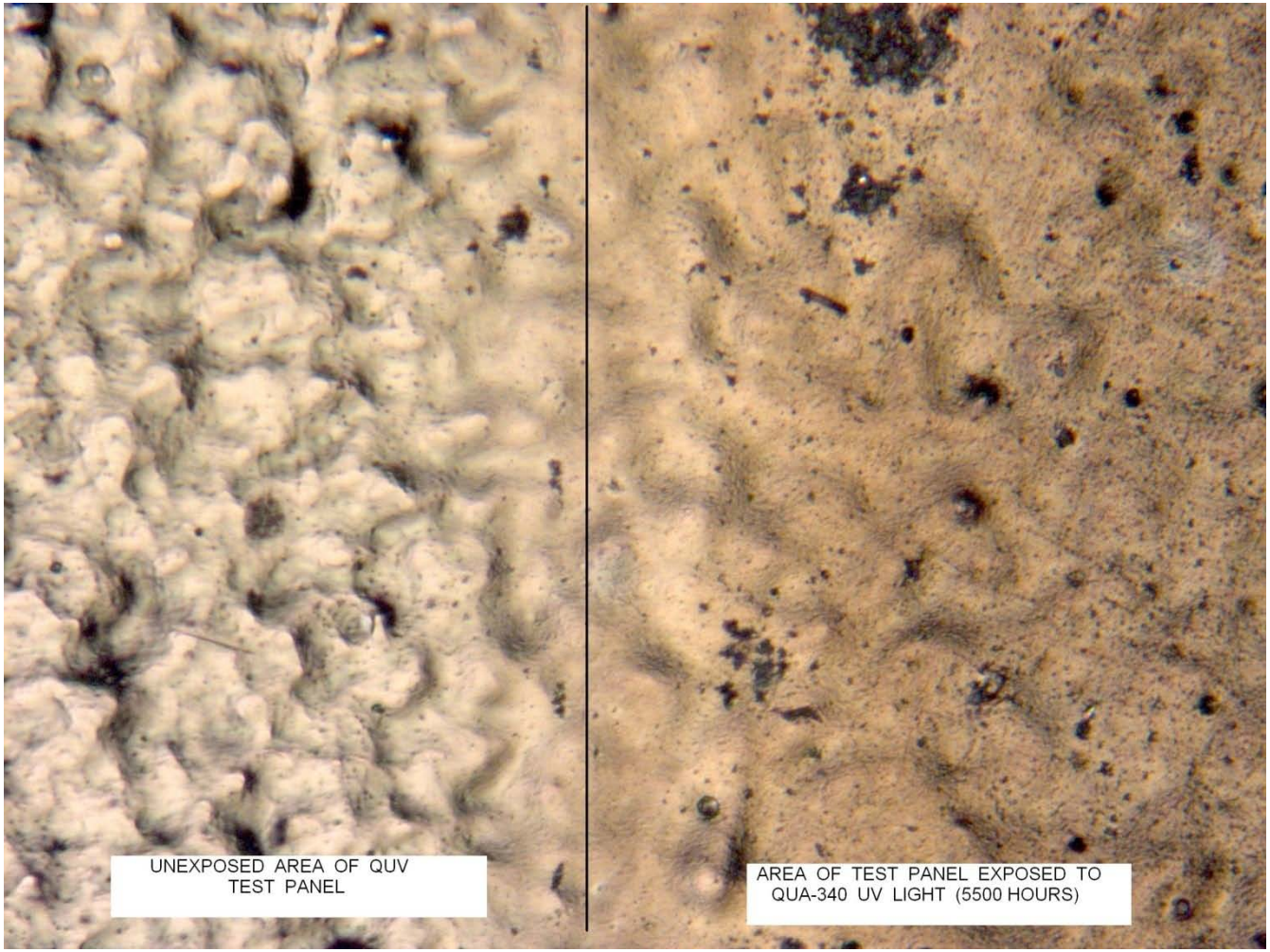


Test Formulation:

100% Acrylic Emulsion #6 as total binder

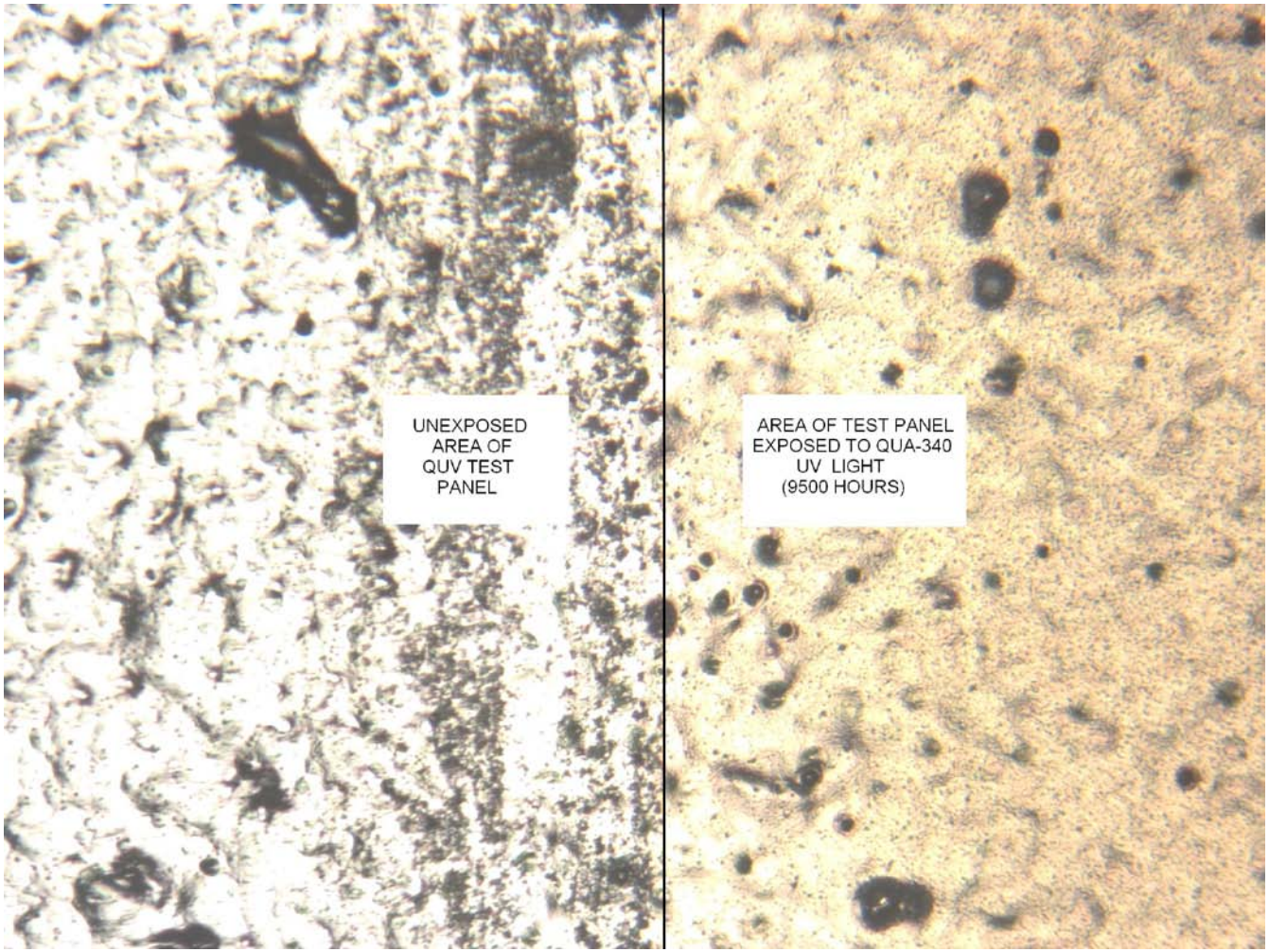
FEVE Emulsions in Architectural Coatings



Test Formulation:

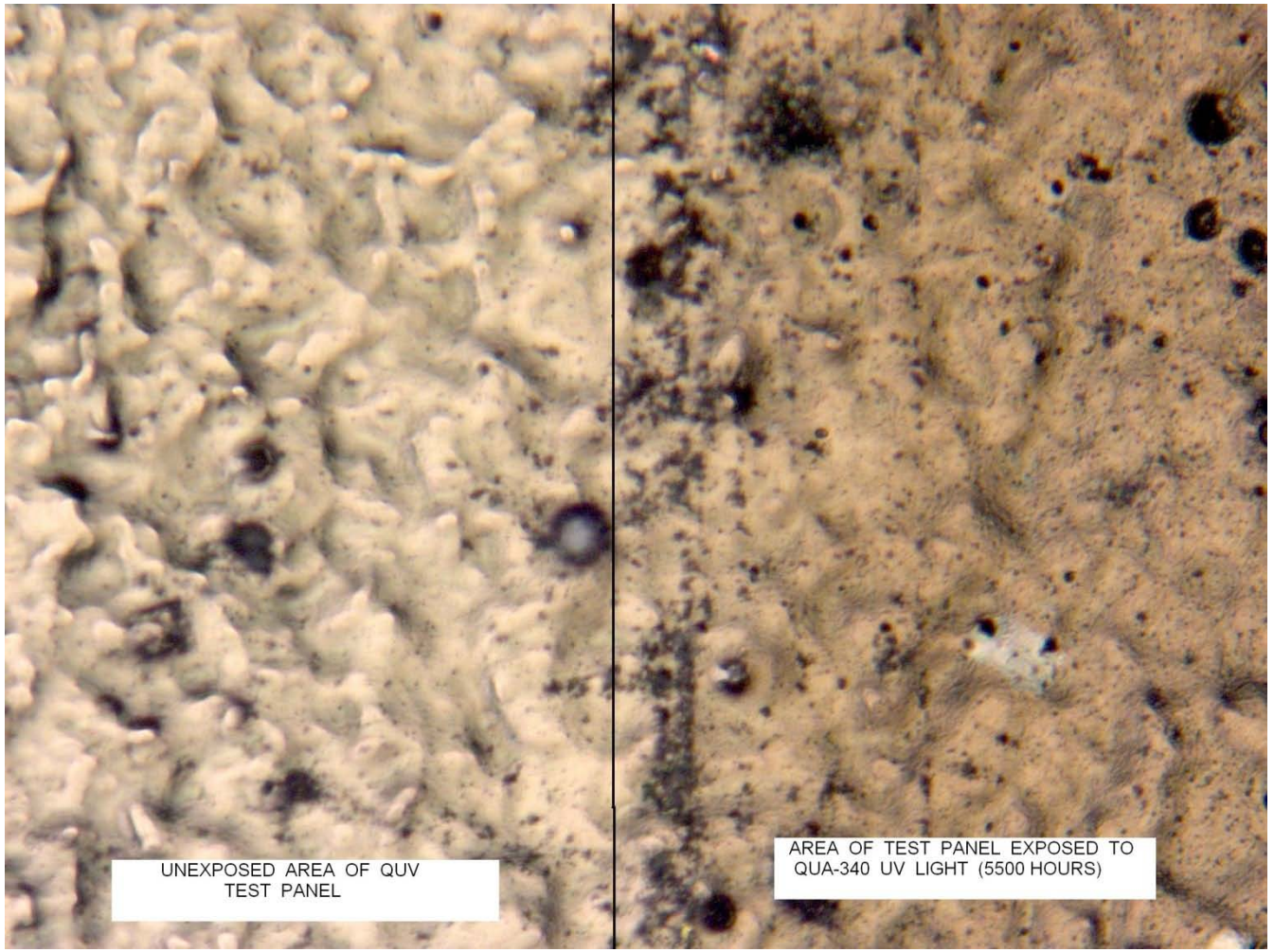
80% Acrylic emulsion #6 and 20% FE-4300 FEVE Emulsion as total binder

FEVE Emulsions in Architectural Coatings



Test Formulation:
80% Acrylic emulsion #6 and 20% FE-4300 FEVE Emulsion as total binder

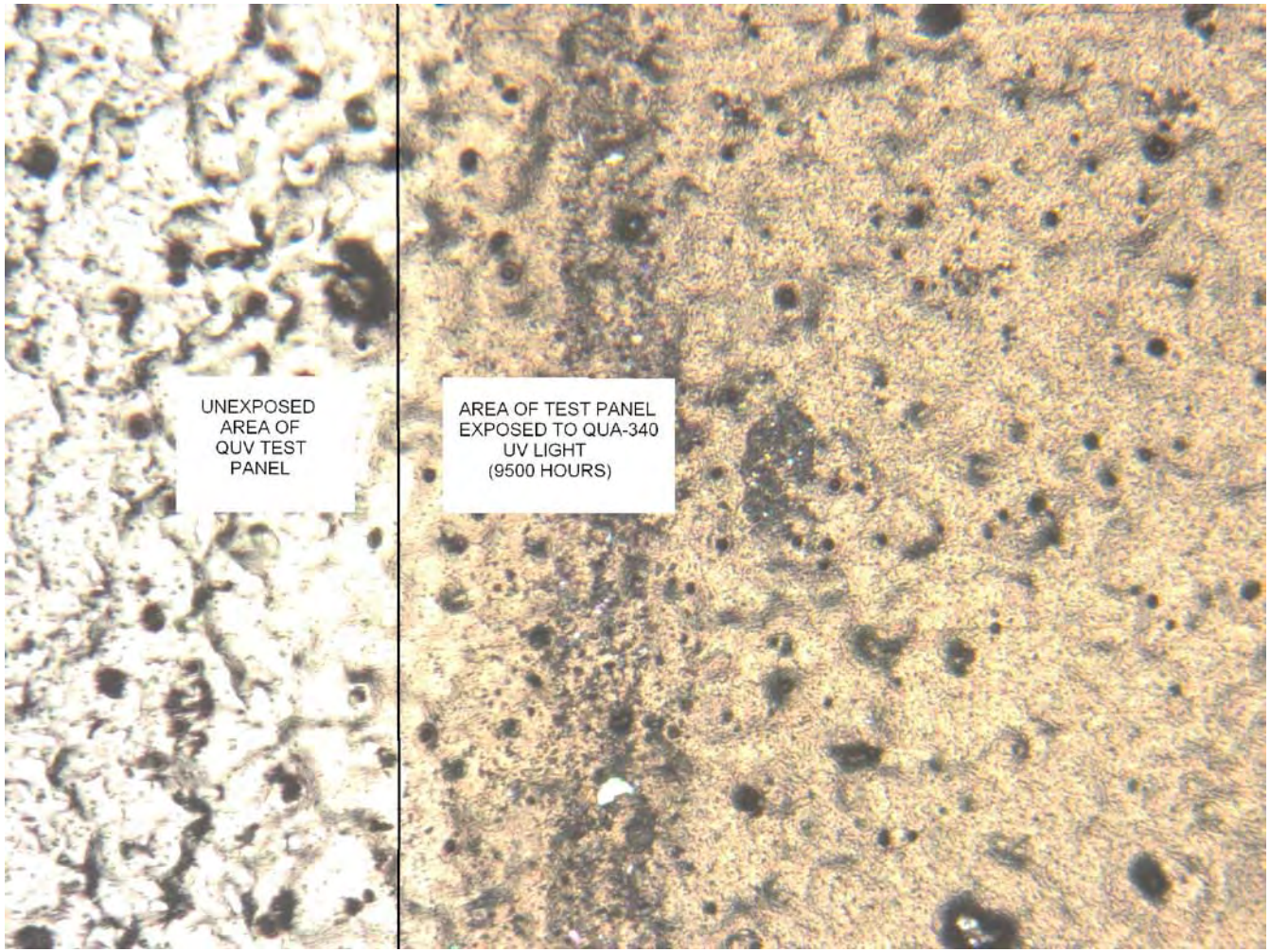
FEVE Emulsions in Architectural Coatings



Test Formulation:

80% Acrylic emulsion #6 and 20% FE-4500 FEVE Emulsion as total binder

FEVE Emulsions in Architectural Coatings



Test Formulation:

80% Acrylic emulsion #6 and 20% FE-4500 FEVE Emulsion as total binder

FEVE Emulsions in Architectural Coatings

Dark Green DTM I/M Paint Formulation Properties	
Solids (Volume)	32.7%
FEVE Emulsions	FE-4300, FE-4500, and FE4400
pH	9.0 to 9.5
Pigment Choice	TiO_2 Colorant (Evonik 896 line) Phthalo Green Colorant (896 line) Tint-Ayd CW5317 (Elementis)
PVC	8.7
Thickeners	associative-type
60° Gloss Range	60-80
VOC	150 g/liter

FEVE Emulsions in Architectural Coatings

FEVE Water-borne Emulsions	
**********	*FE-4400*
Solids (Wt.)	50%
pH	7 to 9
Specific Gravity	1.13
MFT	55°C.
Hydroxyl Value	49

Testing procedure # 6 :

1) Choose Acrylic Emulsion # 5 as blending resin for Dark Green DTM I/M Formulations

2) Manufacture of 4 formulations:

a. Binder = *100% Acrylic Emulsion*

b. Binder = *80% Acrylic Emulsion + 20% FE-4300 (FEVE Emulsion)*

c. Binder = *80% Acrylic Emulsion + 20% FE-4500 (FEVE Emulsion)*

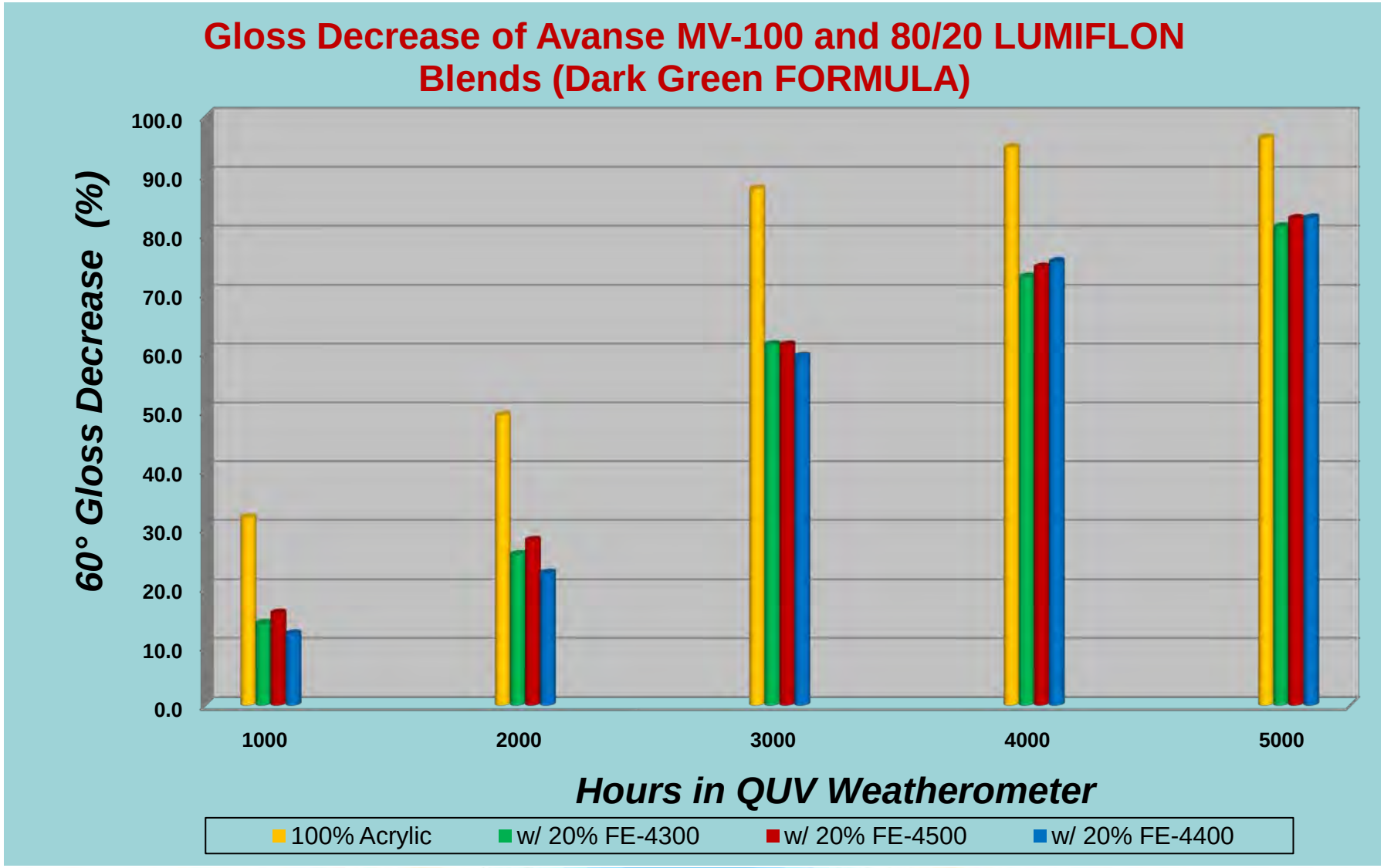
d. Binder = *80% Acrylic Emulsion + 20% FE-4400 (FEVE Emulsion)*

3) Preparation of test panels (primed Al panels coated with 8 wet mils of coating)

4) QUV Weatherometer Exposure (UVA 340 Bulbs used)

a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50° C.

FEVE Emulsions in Architectural Coatings



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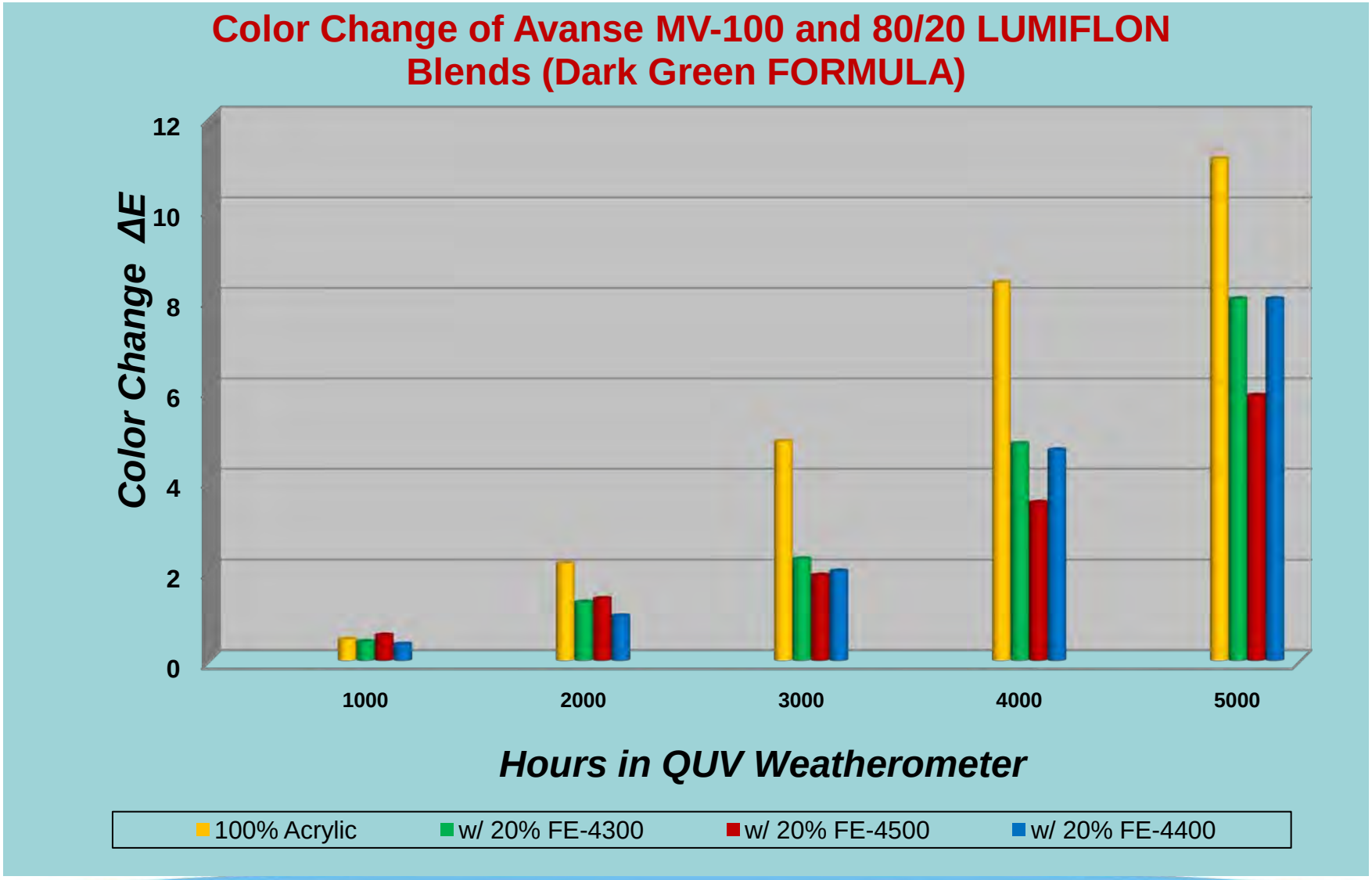


Testing procedure # 7 :

1) Choose Acrylic Emulsion # 5 as blending resin for Safety Yellow DTM I/M Formulations

2) Manufacture of 3 formulations:

a. Binder = *100% Acrylic Emulsion*

b. Binder = *80% Acrylic Emulsion + 20% FE-4300 (FEVE Emulsion)*

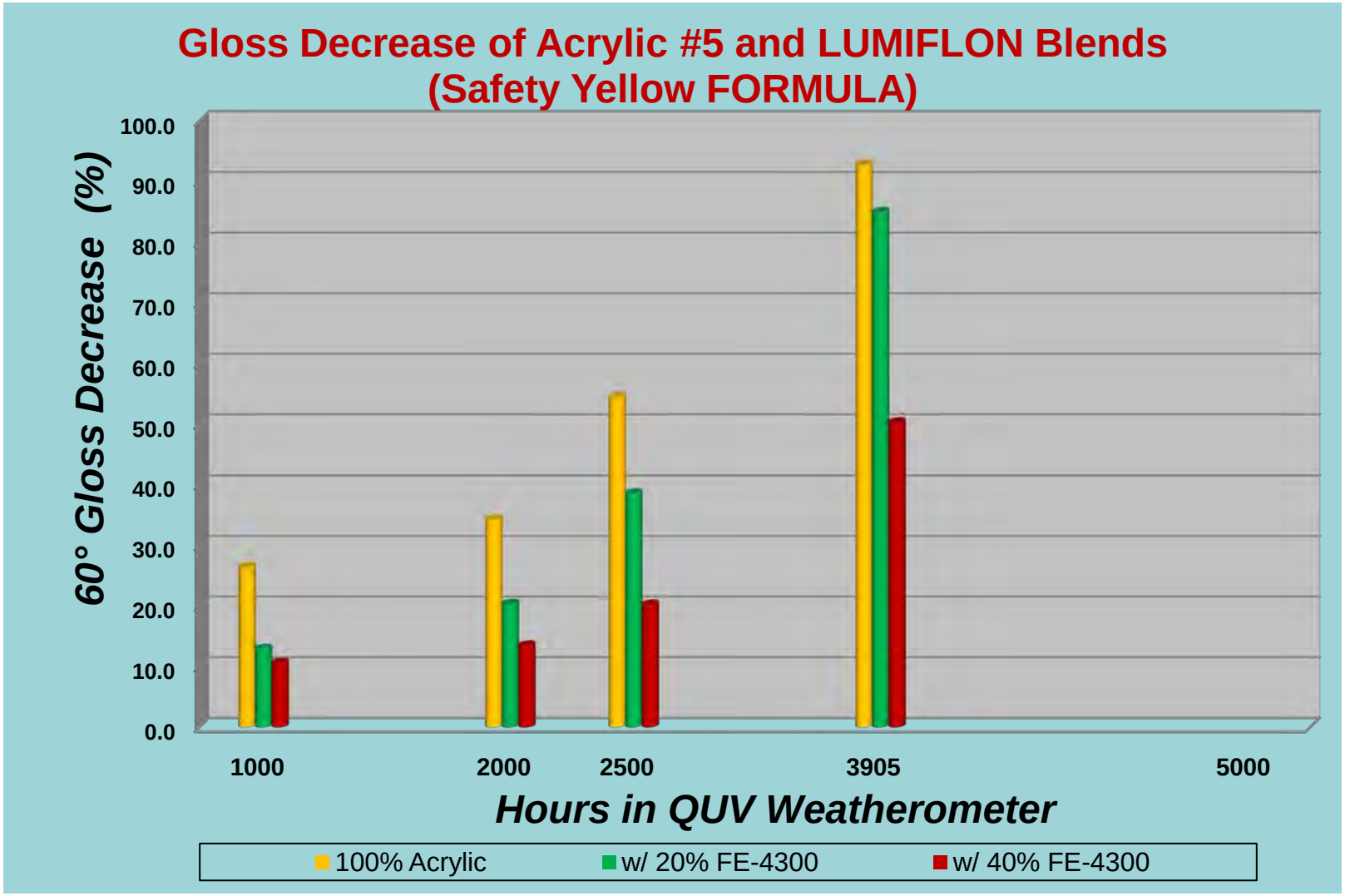
c. Binder = *60% Acrylic Emulsion + 40% FE-4300 (FEVE Emulsion)*

3) Preparation of test panels (primed Al panels coated with 8 wet mils of coating)

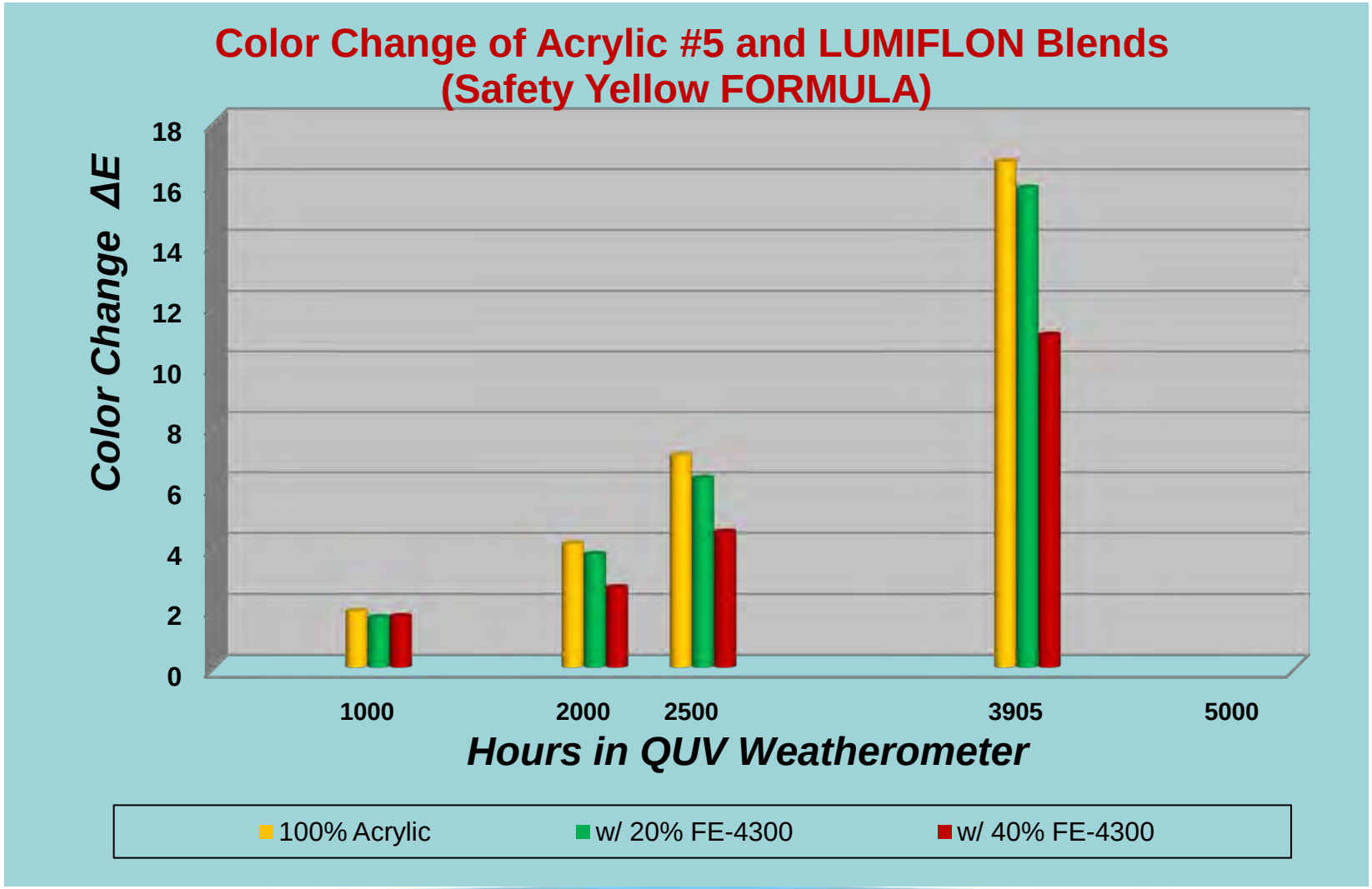
4) QUV Weatherometer Exposure (UVA 340 Bulbs used)

a. Test Cycle = 8 hours UV light @ 60°C. + 4 hours condensation @ 50° C.

FEVE Emulsions in Architectural Coatings



FEVE Emulsions in Architectural Coatings



Conclusion:

Inclusion of FEVE emulsions in architectural coating formulations can increase gloss retention, color retention, and the overall durability of the dry film. These characteristics will prolong the aesthetic properties and the protection properties of these coatings, thereby increasing the time frame between recoats.