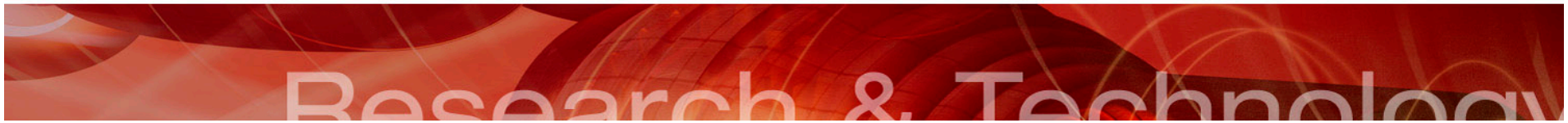

Heat-Resistant UV-Curable Clearcoat for Aircraft Exterior Use

Rick Baird
April 30, 2012

Heat-Resistant UV-Curable Clearcoat for Aircraft Exterior Use

Drivers—Why a heat-resistant UV clearcoat?

- **Present paints show discoloration** ***in areas subjected to high heat (~300F) in service***
- **Heat-resistant clearcoat** ***would act as barrier to oxygen, moisture, retard degradation process***
- **Need very fast cure** ***of clearcoat to minimize flow time hit***
- **UV cure** ***delivers best cure time; thermally-curable paints too slow***
- **Small areas affected—*facilitates implementing a cure process with off-the-shelf equipment***

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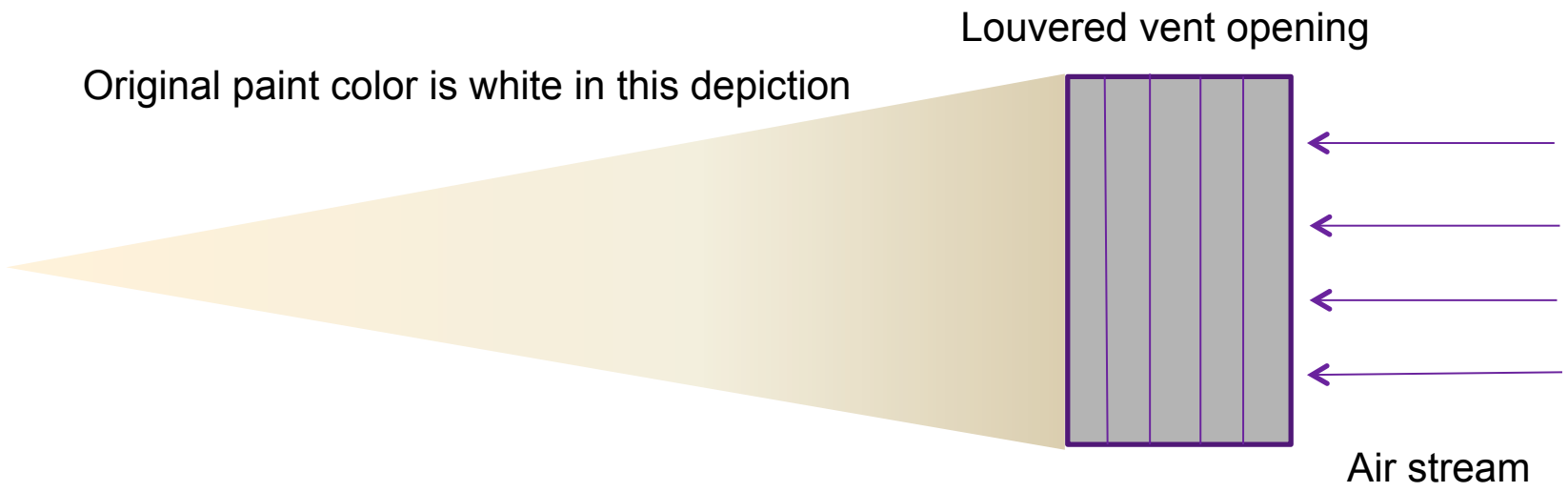
Typical discoloration pattern (shown to relative scale)



Affected area < 10 sq ft

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UV Cure—Advantages:

- **Curing takes seconds*—overall cure depends on how quickly surface can be scanned with UV lamps. Best thermal cure = hours.***
- **Paint achieves full cure *during UV exposure—no wait after UV exposure to fly***
- ***Reduced hazardous emissions—NEAR-ZERO VOCs!***

UV Cure—Limitations:

- **Capital investment for cure system *required—BUT small affected area enables use of off-the-shelf portable systems***
- **No commercial airplane *in-service data—new technology***

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Basic Requirements:

- **Clear formula with superior heat resistance** ***with acceptable batch-to-batch uniformity that meets Boeing exterior decorative spec***
- **Spray properties** ***close to thermally-cured paint (OK to heat paint)***
- **Cure process** ***that minimizes equipment complexity, accomplishes surface and through cure and meets safety requirements; also provides for overspray cure***
- **Cost-competitive process—*e.g. flow time advantages must offset capital costs***

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Technical Issues:

- **Clear formula:**
  - *Ability to adhere strongly to underlying thermally-cured color coat w/ minimal surface prep*
  - *Retain clarity and resist yellowing to preserve color appearance of underlying coat*
  - *The good news: No pigment chromophores to interfere with cure*

- **Sprayability and leveling power:**
  - *Need ability to apply to vertical or horizontal surface*
  - *Need thick film build (~0.002") in single pass*
  - *Require strong leveling for appearance, BUT resist sag for 20 min or longer*
  - *No VOCs to evaporate so may need heating to achieve these properties*

- **Paint-shop-compatible cure process:**
  - *Require explosion-proof (Class-I, Div-1) compliance*
  - *Single-bulb UV-A cure preferable (simplest, safest, most economical)*
  - *May need nitrogen to purge system, exclude O2 for good surface cure*
  - *Require overspray to cure with little or no UV exposure—dual mechanism?*

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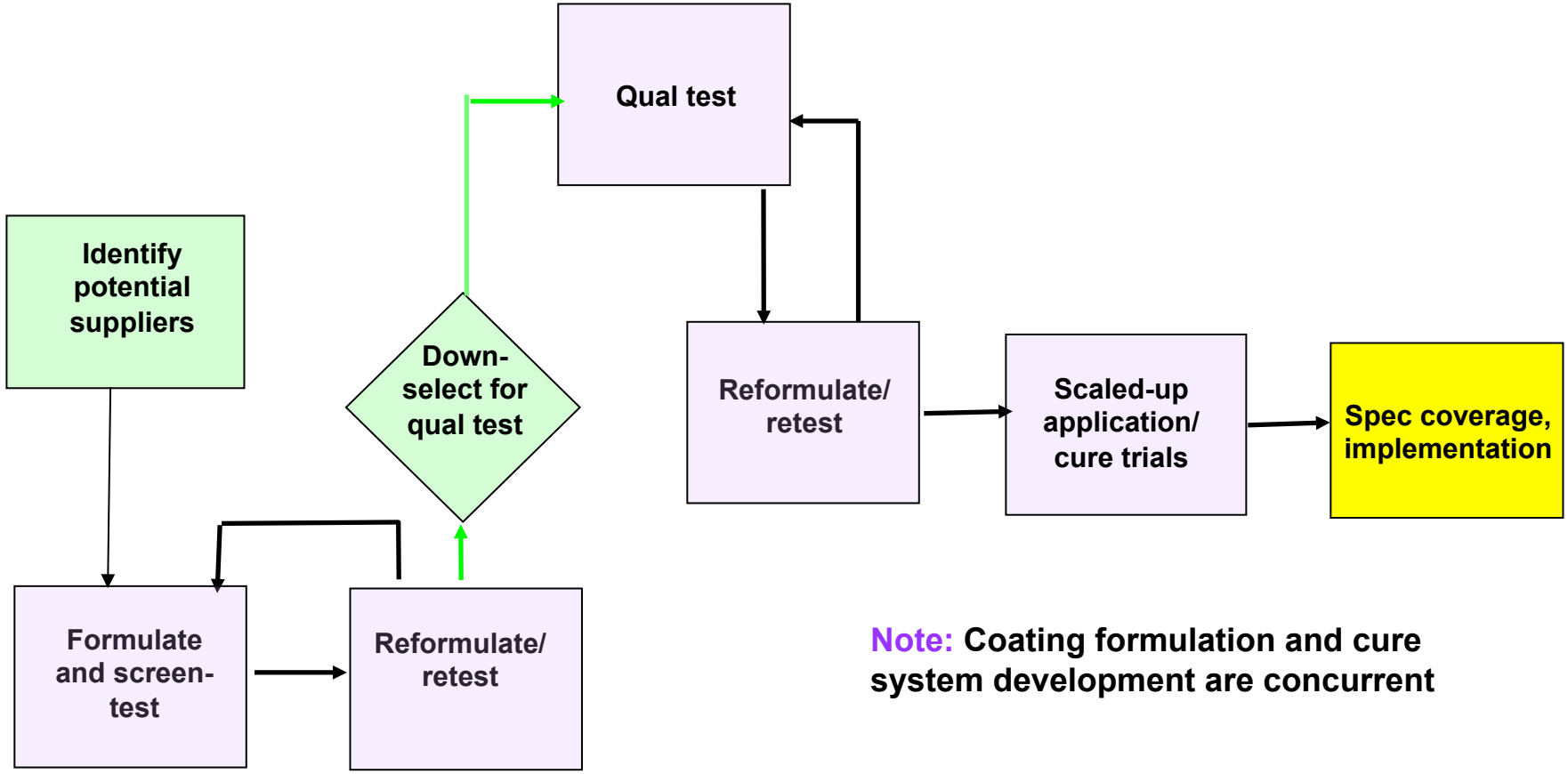
Approach:



Note: **Coating formulation and cure system development are concurrent**

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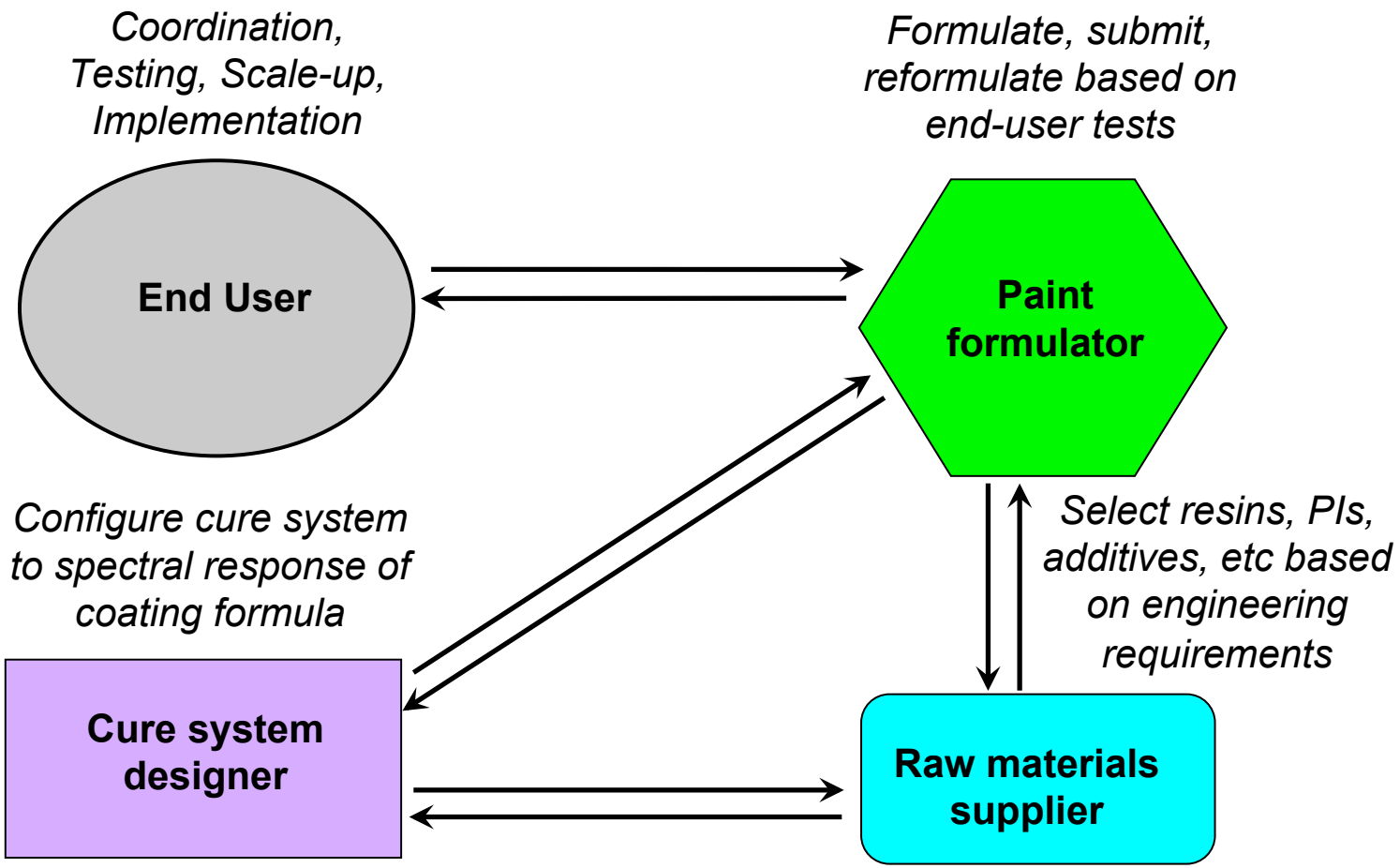
Supplier Collaboration—a Multidisciplinary Approach



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Screen test results—latest formulations:

Property	A	B
Spray temp		
"Hang" time		
Cure dosage		
Cure intensity		
Overspray cure (tack-free)		In work
60 deg Gloss		
Pencil-scratch hardness*		
Leveling		
Fluid resistance—MEK, IPA, 100 rubs		
Fluid resistance—Skydrol, 30 days*		
Scribe adhesion (tape-pull)*		
Droplet jet test*		
Impact resistance (Gardner)*		
Thermal shock*		
Weatherometer (500 kJ) deltaE**		
Weatherometer delta gloss**		

*** Values over abraded undercoat. **Weatherometer per SAE J1960 protocol**

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Next Steps:

- **Screen-test submissions—*subset of full qual-test battery***
- **Qual-test *submissions that pass screen tests***
- **Test off-the-shelf *cure systems for suitability***
- **Adapt cure system *as needed to meet safety, productivity requirements***
- **"Test-tube" *application/cure trials (simulated ducts, etc)***
- **Production *trials/implementation—identify interested airlines, gain experience with process in production environment***

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Questions?