



Multifunctional Protective Coatings for Weapon Systems Chemical Agent Resistant Coatings

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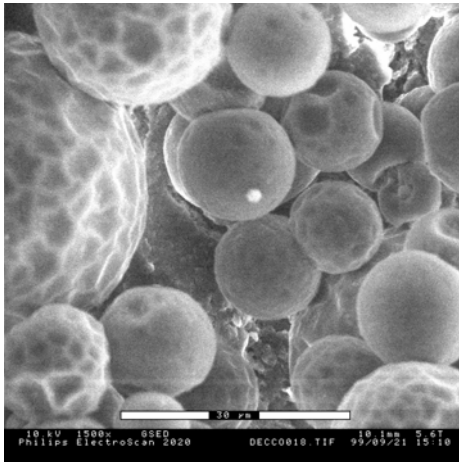
20th March 2006

JSEM

**Lead Research and Development Activity
for Chemical Agent Resistant Coatings**



•Overview



•Formulation



- MIL-DTL-64159
- MIL-DTL-53039



Doctrine

- AR 750-1 Mandates use of CARC on all Tactical Equipment
 - Three Primary Principles



Survivability

Durability

Environmental



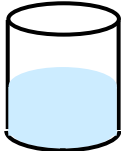
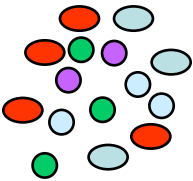
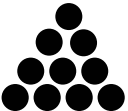
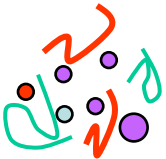

Formulation Objectives

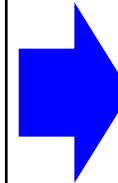
- **Reduce VOCs and Eliminate HAPs**
 - Final goal near zero VOCs and HAPs
 - Minimize hydrocarbon based exempt solvents
- **Enhance current durability**
 - UV stable (4 year minimum with polymer flattened formulas)
- **Sustain Survivability**
 - Resistant to Decontamination solutions (DS2 & STB*)
 - Resistant to chemical warfare agents (nerve and blistering)
 - Minimal detection in the visible and near IR range



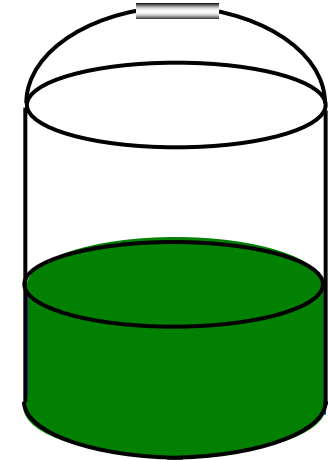
Component vs. Formulated Coating

Individual Coating Components

		Important Factors
Resin		Chemistry, degree of cure, Uniformity, cured resin structure, Impurities, UV absorption
Pigment(s)		UV absorption, surface chemistry, Particle size, crystal form, etc.
Extenders		UV absorption, surface chemistry, size, type, distribution
Additives		UV inhibitors, antioxidants, surfactants, adhesion promoters
Solvents		Film carrier, flow properties, initial intercoat adhesion and compatibility and cure times



TAILORED COATING



- Pigment-resin interactions
- Primer-topcoat interactions
- Application
- Defects and morphology
- Synergy exists! Non-linear relationships between components exist!



Resin Systems

- **Polyureas**: High performance, one component, Hydrocarbon solvent systems
- **Water dispersible**: High performance, Exceptional weathering, Two Component systems Combination of polyurethanes and polyureas

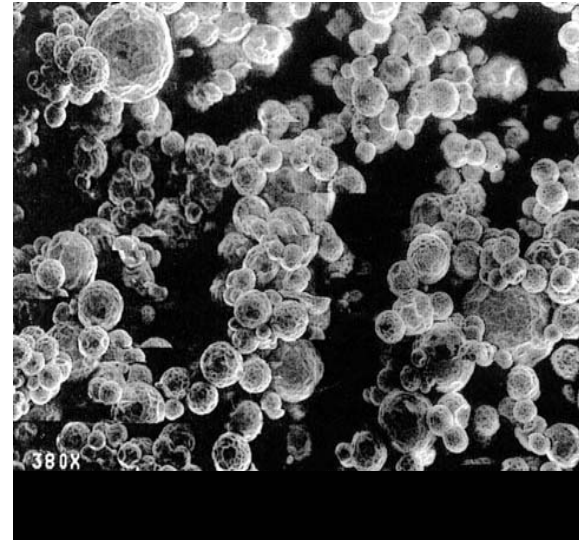
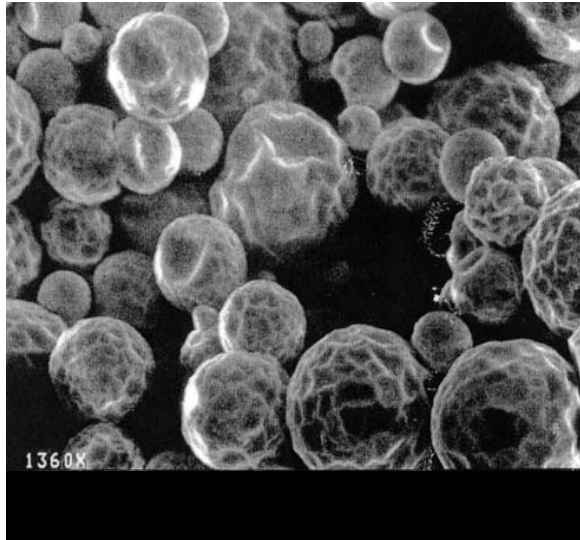


PIGMENTATION for CARC

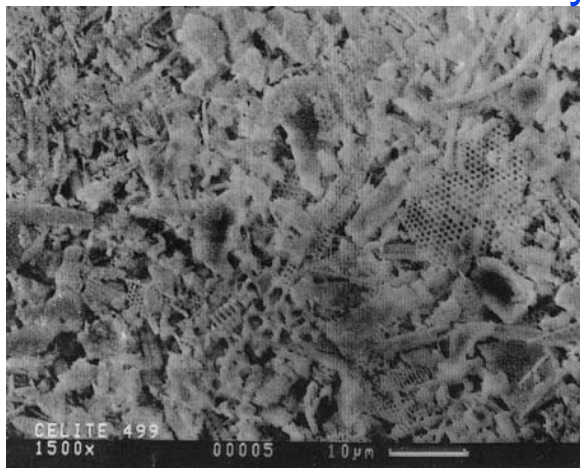
- Control surface roughness to minimize reflectivity in the visual and IR regions**
- Inert inorganics used for prime pigments**
- Mimics chlorophyll reflectance curve for 383 Green**
- Use of polymeric flattening agents**



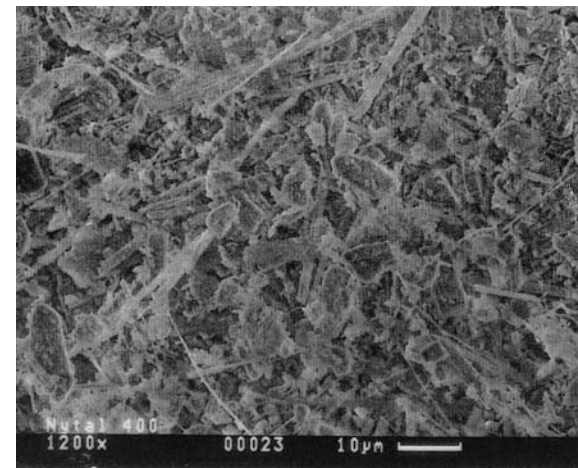
SILICEOUS VS. POLYMERIC



Polymeric beads



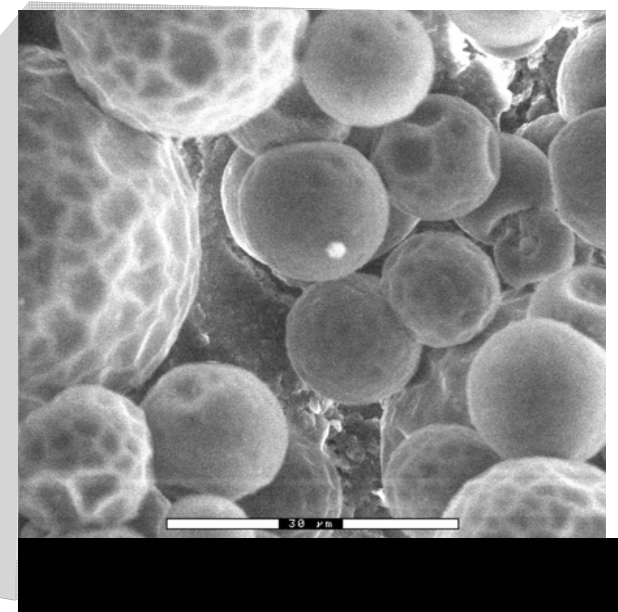
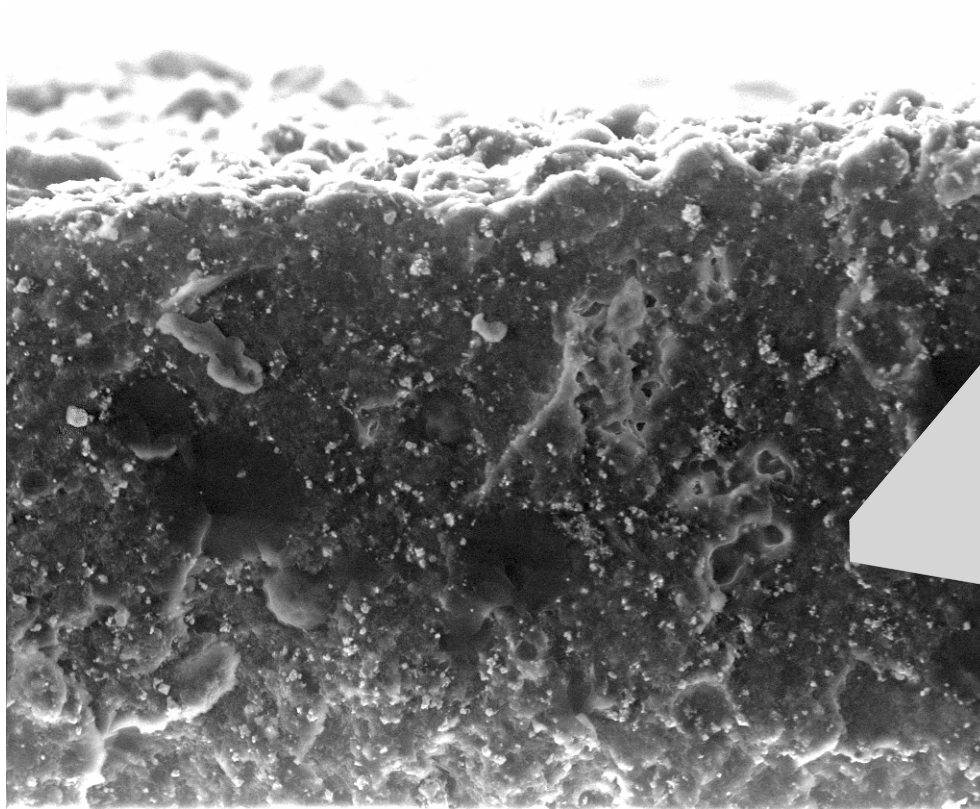
Diatomaceous silica



Talc



MIL-DTL-64159 Type II Topcoat Cross-Section. Water Reducible CARC with Polymeric Extenders

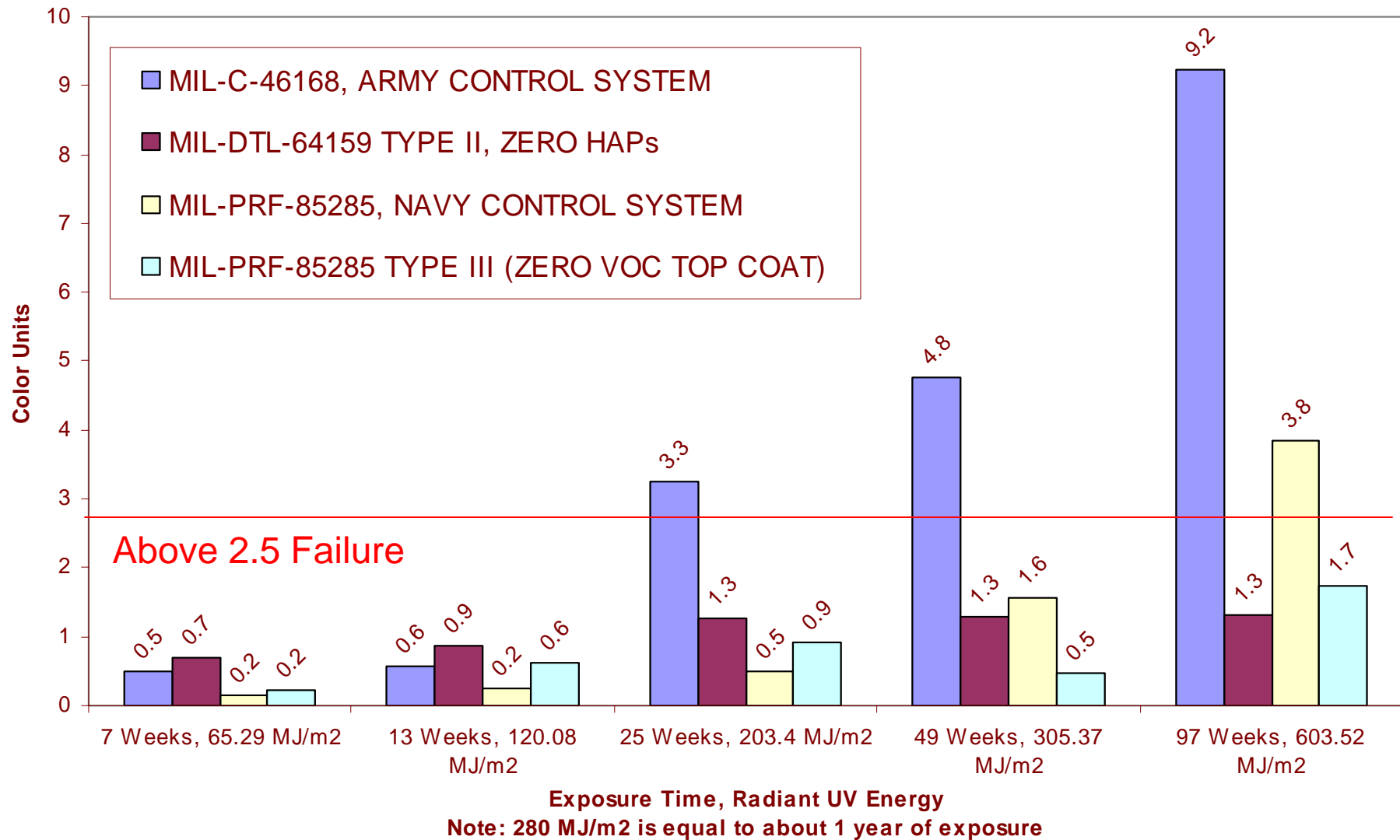


•Integrated within Film

13.kV 500x GSED 9.48mm 3.4T

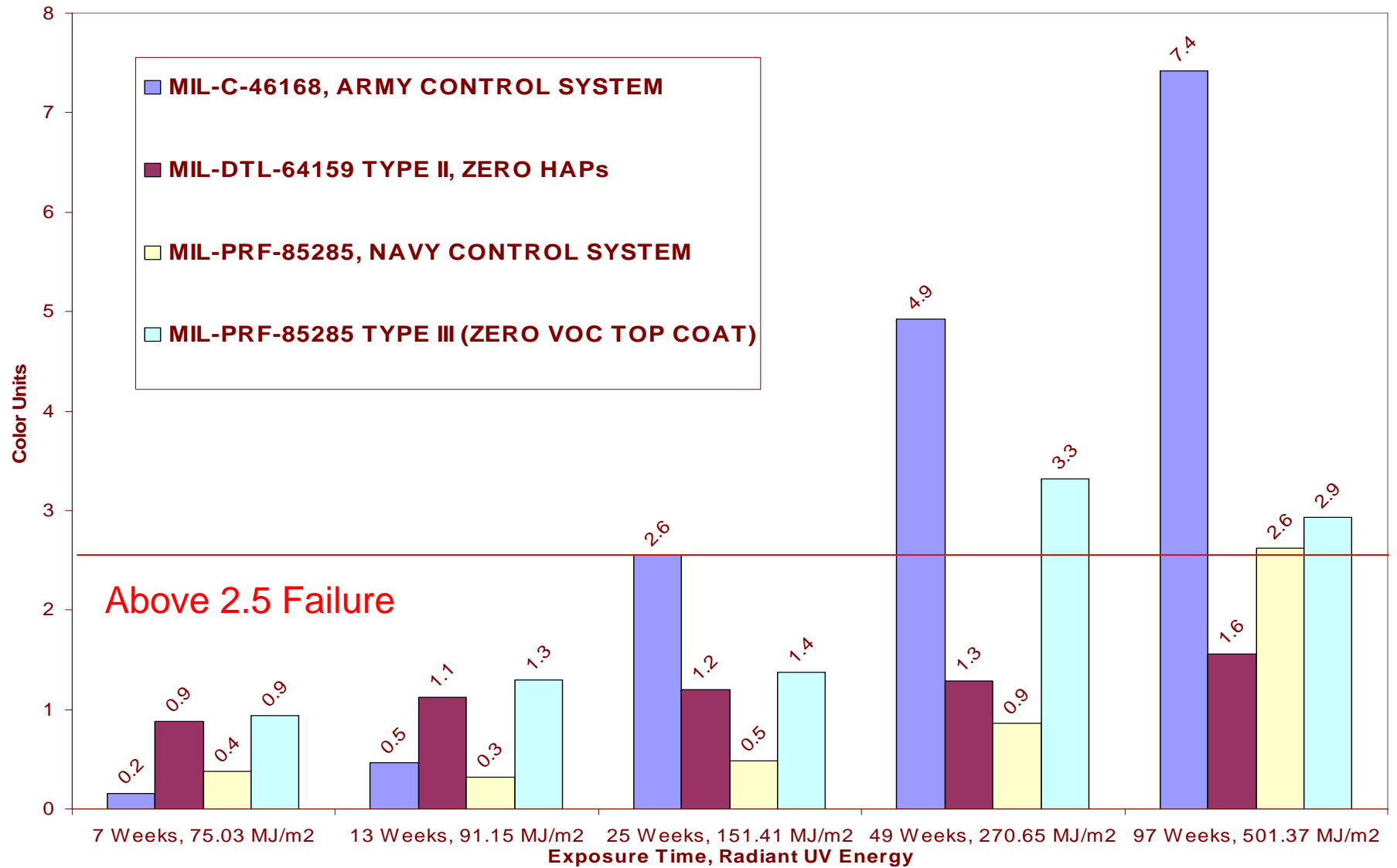


Arizona Exposure Data: Color Change





Florida Exposure Data: Color Change



Note: 280 MJ/m² is equal to about 1 year of exposure



Water Reducible Coating

- Reduction with water
- No Hazardous Air Pollutants
- 1.5 – 1.8 lbs/gal of VOCs
- Enhanced mar, weather resistance
- Superior Flexibility



Water Dispersible Coating Status

- **Multiple vendor participation**
- **Military Specification for Type I & II**
 - **MIL-DTL-64159**
- **Type I Silica Based Flattening Agents**
 - **Will eliminate at next revision***
- **Type II Polymeric Based Flattening Agents**
- **Material Available and Aerosol kits approved (Coordination with GSA)**



MIL-DTL-53039



- **No Hazardous Air Pollutants (All Type II formulas)**
- **1.0 to 3.5 lbs/gal VOCs**
 - Type I- 3.5 or less VOCs
 - Will eliminate with next revision*
 - Type II -1.5 or less VOCs
- **Formulation with polymer flattening agent being used to enhance mar resistance and weathering properties**



MIL-DTL-53039 Status

- **Multiple vendor participation**
- **Military Specification for Type I & II**
 - **Type I 3.5 VOC (some formulas HAP free)**
 - **Type II 1.5 or less VOC & HAP free**
- **Changes in Mil Spec requiring testing and validation**
 - **Super Tropical Bleach (STB) Completed***
 - **Accelerated indoor and outdoor exposure**
 - **Live agent testing (HD and GD)**



MIL-DTL-53039 TIMELINE for QPL

- **Imperative to test all material to ensure coatings meet specification**
- **STB evaluation completed**
- **Mid May 2006 for Type I**
- **End of June 2006 for Type II**
- **Provide updates as testing is completed**



Current Efforts

- **Evaluation and Approval for MILSPRAY Touch up kits**
- **Cartridge Spray systems (Spectrum Coatings for primary colors)**
- **Alternative Non-Hexavalent Chromium wash primer (on going)**
- **Partner with GSA to identify any non-CARC materials and certify all aerosol kits for CARC systems**