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Electronic Materials Evaluation - Corrosion Preventative Compound Studies

Air Force Corrosion Conference

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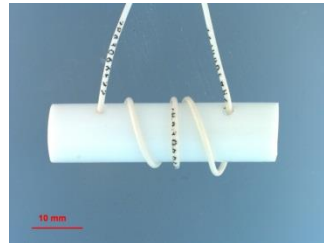


Impact of Corrosion Preventative Compounds (CPCs) on Wire Insulation and Connector Materials



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- **Purpose:** Evaluate and assess the impact of application of structural and electronic grade CPCs on wire insulation and electrical connectors. Determine long and short term effects on mechanical, electrical, and chemical properties.
- **Customer:** Uniformed Services, FAA, SAE
- **Approach:**
 - Cost effective approach for dealing with CPC coating of the EWIS system
 - Procedures for ensuring integrity of the electrical system
 - Characterize currently approved and common CPCs used on USAF aircraft.
 - Coordinate with depots and technical order authorities
 - Apply CPCs to wiring components under accelerated life test conditions
 - Document mechanical and electrical degradation and impact on critical properties such as flammability
- **Impact:**
 - Provide guidance to depots on addressing CPCs
 - Detailed matrix on CPC impact on various wiring materials and recommended process of dealing with CPCs on wiring. Leave in place, remove on inspection, or remove at next depot overhaul.
 - Provide consistent policy to all aircraft programs and maintenance organizations specifically corrosion control and maintenance manuals and TOs.





Background



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- Corrosion Preventative Compounds (CPCs) are commonly applied to aircraft structures and electrical components such as connectors and connector pins to prevent corrosion and degradation of surfaces
 - CPCs primarily for metallic surfaces
 - CPC compartment fogging and pressurized spraying can coat EWIS parts
 - Only limited immersion compatibility tests have been conducted on connectors long-term exposure impact not evaluated
- Inconsistencies exist in the corrosion and general wiring manuals (T.O. 01-1A-509-3 and T.O. 01-1A-505-1) with regard to application of CPC products to EWIS parts
 - Conflict between the wiring maintenance and avionics corrosion manuals on use of Corrosion Preventative Compounds (CPCs)
 - NAVAIR 01-1A-505-1 state no CPCs to be applied internally to connectors
 - Avionics corrosion manual NAVAIR 01-1A-509-3 encourages application of M81309 CPCs internally to connectors
- Develop a test plan to evaluate the adverse impact and potential effectiveness of applying electronic grade CPCs internally to connectors
- NAVAIR sponsored study in 2007 evaluated impact of three electrical grade CPC products (MIL-PRF-81309 Type III and MIL-L-81177) on EWIS parts
 - Documented degradation of electrical contact surfaces and certain wire insulation materials
 - Latest NAVAIR policy is to not spray the inside of a connector



Background



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- Aircraft are aging and the life of the electrical systems is being overextended, making them more susceptible to degradation.
- Maintainers have begun using electrical CPCs to remedy the problem on some platforms
- Corrosion Preventive Compounds (CPCs) are frequently applied to military aircraft frames. Wiring, switches, connectors, etc. are subject to being coated in varying amounts of these compounds
- Need to understand impact of conventional CPC's on wire insulation material and connectors of military aircraft
- Testing described here focuses on several properties of wire insulation materials including size, insulation resistance, dielectric withstand, and flammability



CPCs Selected for Evaluation



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CPC	Manufacturer
Super Corr A Electrical Grade	Lektro-Tech
So Sure 813 Electrical Grade	LHB Industries
ZC 026 CIC Electrical Grade	Zip-Chem Products
ACF 50 Electrical Grade	Daubert Chemical Co.
Ardrox AV-30 Structural Grade	Lear Chem. Research Group
Cor Ban 35 Structural Grade	Zip-Chem Products
Cee Bee A CPC Cleaner	McGean



Wire Sample Types



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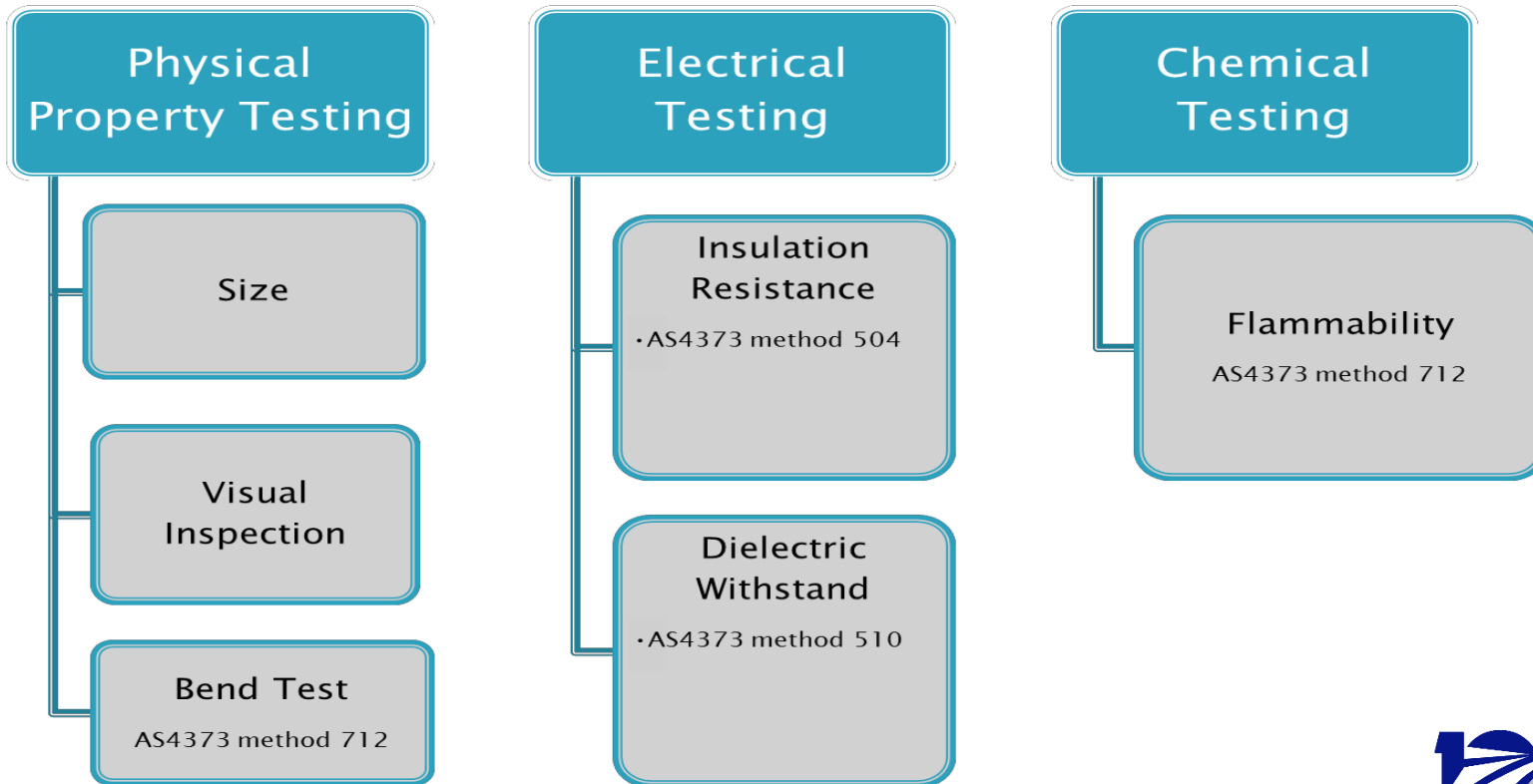
Wire		Insulator
M22759/11-20-9		Fluoropolymer-Insulated, Extracted ETFE
M22759/16-20-9		Fluoropolymer-Insulated, Cross-Link Modified ETFE, normal weight
M22759/43-20-9		Fluoropolymer-Insulated, Extracted ETFE, medium weight
M22759/87-20-9		Polytetrafluoroethylene/Polymide Insulated, normal weight
M5086/2-20-9		Polyvinyl Chloride Insulated PVC-Glass Nylon
M81044/12-20-9		Cross-linked Polyalkene Insulated, lightweight
M23053/1-101-0		Chlorinated Polyolefin, Cross-linked
M23053/5-105-9		Polyolefin Flexible, Cross-linked
AS81824/1-2		Class 1 Splice
M17/184-00001		Coax
M17/74-RG213		Coax
M22759/4-20-9		Fluoropolymer-Insulated, TFE-Glass-FEP, medium weight
M22759/34-20-9		Fluoropolymer-Insulated, Cross-linked modified ETFE, medium weight



Tests Performed



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Tests Performed



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Wrap wire around 10X diameter (or minimum diameter allowable for a specialty cable) mandrel . This would be a 0.5 inch diameter for a 20 gauge AS22759/87 wire. To maintain the stress consider using PTFE coated mandrels.

For post-immersion testing, a 24 inch wiring sample will be adequate.

The immersion vessel will be a plastic or glass beaker. Ends of the wiring must be completely out of the immersion fluid. Each vessel should only contain one wire type since the CPC may leach material and contaminate another insulation type.

Immerse wire coil in fluid and elevate to test temperature. For this test, we agreed upon a test temperature of 30C. In the past, NAVAIR tested CPCs at 60C, but several of the CPCs have low flash points which require a much lower temperature to avoid combustion.

The samples will be immersed for 336 hours at 30C. After the immersion stage, the sample s will be allowed to dry and then run through the post-tests to observe any changes from the CPCs.



Flammability Video

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- **Wire M22759/11-20-9 not coated with CPCs**

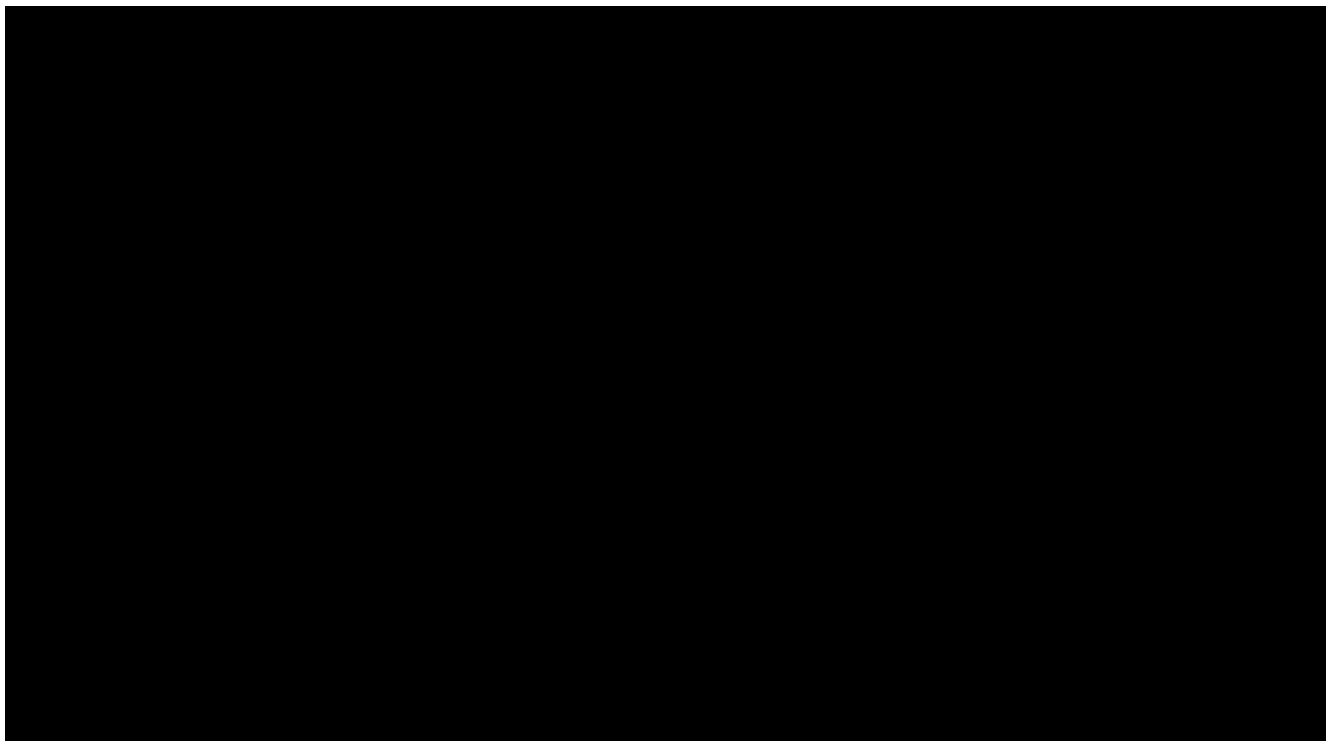




Flammability Video

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- **Wire M22759/11-20-9 coated with structural CPC**





Testing Results Summary



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WIRE TYPE/PLICE	M2275911-20-9 (Thermat)	M2275916-20-9 (Harboan)	M2275943-20-9 (RSCC)	M2275987-20-9 (Thermat)	M5086-2-20-9 (RSCC)	M8104412-20-9 (Nerans)	M230531-101-0 (Sambton)	M230533-105-9 (Sambton)	ASH18241-2 (TriStar)	M17184-0001 (RSCC)	M1774-RZ131 (Cokman)	M227594-20-9 (Specbad)	M2275934-20-9 (Jaki)
CPC/TEST													
Control													
Immersion	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Dielectric Withstand	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Pass	Pass
60° Angle Flammability	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	-	Pass	Pass	Pass	Pass
Super Cor A (Electrical Grade)													
Immersion	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Fail	Pass	Pass
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Pass
Dielectric Withstand	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	-	Fail	Pass	Pass	Pass
So Sure 813 Electrical Grade													
Immersion	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Fail
Dielectric Withstand	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	-	Pass	Pass	Pass	Pass
ZC 026 CIC Electrical Grade													
Immersion	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Pass	Pass	Pass
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Dielectric Withstand	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Pass	Pass	Fail	Pass	Fail	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	-	Fail	Pass	Pass	Pass
ACF 50 Electrical Grade													
Immersion	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Dielectric Withstand	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Fail	Fail	Pass	Fail	Fail	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	-	Pass	Pass	Pass	Pass
Ambrox AV-30 Structural Grade													
Immersion	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Fail
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Dielectric Withstand	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Fail	Fail	Fail	Pass	Fail	Fail	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	-	Fail	Pass	Fail	Fail
Cor-Ban 35 Structural Grade													
Immersion	Pass	Fail	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Insulation Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass
Dielectric Withstand	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Pass	Pass	Fail	Pass	Fail	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Fail	Fail	Fail	Pass	Fail	Fail	Fail	Fail	-	Fail	Pass	Pass	Fail
Cee-Bee A CPC Cleaner													
Immersion	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Pass
Insulation Resistance	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass
Dielectric Withstand	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Radiant Heat Panel	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	-	Fail	N/A	Pass	Pass
60° Angle Flammability	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	-	Pass	Pass	Pass	Pass





Test Results Summary



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In general, the M22759 insulated wire test samples had no major issues with exposure to the electrical CPCs or the cleaner.

The remaining samples had issues with CPC exposure regardless of whether it was electrical or structural.

Most of the samples had some issues with structural CPCs.

The splices had issues with both electrical and structural CPC and cleaner exposure.

There is a correlation between the amount of CPC on a wire and the flammability characteristics of that wire i.e., the more CPC on a wire, the greater the likelihood of failing flammability testing.

Immersion or spraying several coats of CPC on wire insulation, as tested here, similarly increases its flammability. It is all dependent on the amount of CPC present on the wire.



Future Work

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1. There are dozens of proprietary, electrical-grade CPCs that are qualified for use on military systems through performance based specifications. Some are known to perform far better than others and some are known to degrade electrical connections instead of protecting them. Conduct materials testing to identify the most appropriate CPCs for a given application and provide USAF community with a guide for optimum selection of a CPC based on CPC performance for a particular application and environment.
2. Electrical-grade CPCs are considered short term solutions that protect a surface from corrosion and significant oxide build-up for up to 30 days (documented in specifications). Assess the long term effectiveness of CPCs with respect to maintaining electrical path integrity on connectors and other wiring components. Identify key characteristics and develop and longer lasting electrical grade CPC.
3. Assess cleaning efficacy for legacy aircraft which already have CPC on avionic systems.



Recommendations

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- Protect the integrity of the aircraft wiring by masking and preventing CPC overspray coming in contact with the wiring.
- Programs should be made aware that certain CPC types may compromise wire flammability performance and consider a risk assessment to determine if any action should be taken.

Questions?