Toxics Use Reduction Institute

Session C:
Higher Hazard Substances

Liz Harriman
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University of Massachusetts Lowell

TUR Planner Continuing Education Conference
April 3, 2014

Session C Agenda

- Higher Hazard Substance (HHS) Overview *– Liz Harriman, TURI*
- Solvent Substitution: Alternatives to Methylene Chloride (dichloromethane) *– Amy Cannon, Beyond Benign*
- Mass VOC regulation update *– Azin Kavian, MassDEP*
- *Participant priorities?*

Massachusetts TURA

- Sustain and promote the competitive position of Massachusetts industry
- Promote reduction in the use of toxic and hazardous substances
- Require businesses to analyze their use of chemicals, to look for opportunities to reduce toxics use and waste.
  - TUR Options Assessment – Alternatives Assessment
- Publicly report their toxic chemical use

TURA Chemical Categorization

TURA List of Toxic and Hazardous Substances

SAB More Hazardous Chemicals

TURA Higher Hazard Substances (HHS)*

PBTs, TCE, perc, cadmium & compounds, formaldehyde, chromium VI, methylene chloride

Remainder of list, uncategorized

SAB Less Hazardous Chemicals

TURA Lower Hazard Substances (LHS)**

Tert-butyl alcohol; sec-butyl alcohol; n-butyl alcohol; ferric chloride; ferrous chloride; ferric sulfate; ferrous sulfate; butyl acetate; and iso-butyl acetate

*TURA Higher Hazard Substances have 1000 lb reporting threshold
**Lower Hazard Substances have no per chemical fee

Higher & Lower Hazard Substances

- Higher Hazard Substances:
  - Lowers the TURA threshold to 1,000 lb/year
  - Designations to date: Cadmium; Cadmium Compounds; Trichloroethylene; Perchloroethylene, Formaldehyde, Hexavalent chromium compounds, and EPA PBTs
- Lower Hazard Substances:
  - Eliminates the per-chemical fee
  - designations to date: iso-butyl alcohol; sec-butyl alcohol; n-butyl alcohol; ferric chloride; ferrous chloride; ferric sulfate; ferrous sulfate; butyl acetate; and iso-butyl acetate

Categorization Objectives

- Focus: Focus companies efforts and TURA program support on HHS
- Guidance: List consists of a broad hazard spectrum; provide guidance to companies about which toxic substances are preferable, if they must be used.
- Coverage: Bring smaller users of the most hazardous substances into TURA reporting and planning

HHS/LHS Designation Process

TURA decision-making process: Decisions related to the list of Toxic or Hazardous Substances *

Initiation*

⇩

TURI gathers data

⇩

SAB votes on a recommendation

⇩

TURI prepares policy analysis

⇩

Advisory Committee provides input**

⇩

TURI makes revisions & conducts additional research as needed

⇩

Administrative Council votes

⇩

Draft regulations

⇩

Regulations

*Proposal may be initiated by

- SAB
- TURA Program agency
- MA stakeholders
- Advisory Committee
- Administrative Council
- Statutory Requirement

**all TURA program agencies and the Advisory Committee provide input throughout the process as well.

TURA Chemical Categorization

Chemical Lists

TURA List of Toxic and Hazardous Substances

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**Lower Hazard Substances have no per chemical fee

HHS Resources

Toxics Use Reduction Institute

Policy Analysis

Higher Hazard Substance Designation Recommendation:
Perchloroethylene, Tetrachloroethylene, or PCE (CAS 127-18-4)

The TURA Science Advisory Board (SAB) has recommended designating perchloroethylene (also known as tetrachloroethylene, perc, or PCE) as a higher hazard substance under TURA. With this designation, the reporting threshold for PCE use woul
in TURA-covered industry sectors with ten or mor
program under the lower reporting threshold would be
annual toxics use fees, and develop a toxics use redu
TURA program would prioritize PCE in allocating
receive targeted assistance in reducing or eliminating u

This policy analysis summarizes key scientific info
facilities that are likely to enter the program as a resu
opportunities and challenges that new filers are likely t
policy measure for the TURA program. Based on this
supports the SAB's recommendation that PCE be desig

1. **State of the Science**

PCE has serious adverse effects on human health, inclu
PCE most often enters the environment through fugitiv
degreasing operations and by spills or accidental releas
environmental contamination, presence in consumer pr
specific data points considered by the SAB in developi

Acute toxicity

- Short term exposure to PCE can cause symptom irritation, depression of central nervous system incoordination, and unconsciousness. Very high

Chronic toxicity

- The International Agency for Research on Canc (probably carcinogenic to humans).[3] The US Na as "Reasonably anticipated to be a human carci
- A recent Massachusetts-based research project through contaminated drinking water and found cancer rates.[5]
- Exposure to PCE may cause liver, kidney or cer suggest that long term exposure to organic solv

March 4, 2008

THE MASSACHUSETTS TOXICS USE REDUCTION INSTITUTE

Massachusetts Chemical Fact She

Perchloroethylene (PCE)

This fact sheet is part of a series of chemical fact sheets developed by TURI to help Massachusetts companies, community organizations and residents understand the chemical's use and health and environmental effects, as well as the availability of safer alternatives. Since Massachusetts companies report usage under the Toxics Use Reduction Act, readers will learn how the chemicals are being used and by which companies.

PCE FACTS	
Other Names	Tetrachloroethylene, Tetrach Ethylene tetrachloride, Carb
Chemical Formula	C2 Cl4
CAS Number	127-18-4
Vapor Pressure	18.47 mm Hg at 25 °C
Water Solubility	0.15 g in 100m g of water (a
Description	Clear, colorless, non flamma ether-like odor

Able to dissolve most organic materials, perchloroethylene (PCE) is the most widely used dry cleaning solvent in Massachusetts and nationally. Its other major uses are as a metal degreaser, a chemical intermediate and an ingredient in consumer products, such as automotive aerosol parts cleaners and degreasers. PCE is reported to be the chemical most widely found in groundwater contamination at Superfund sites.

Testing at TURI's laboratory over the years has revealed a number of suitable replacement cleaners and solvents for many of the uses of PCE throughout various industry sectors. This information can be found on the laboratory's website, ***www.cleanersolutions.org*** or by contacting the lab directly at 978-934-3133.

Health and Environmental Impacts

Human Health Effects

Human exposure to PCE can occur from occupational practices, environmental contamination or use of consumer products that contain PCE. PCE levels in the environment tend to be higher in urban and industrial areas. The most prevalent route of exposure to PCE is by inhalation and it is readily absorbed into blood through the lungs.

Another potential exposure route of concern is oral, via drinking water or contaminated food. General dermal exposure is not considered a major route of exposure but direct skin exposure to PCE in the liquid form can result in irritation and blistering. The primary organs targeted by PCE are the central nervous system (CNS) and the liver.

Some studies suggest that long term frequent over-exposure to organic solvents such as PCE may cause lasting and possibly permanent CNS effects. Fatigue, lack of muscle coordination, loss of concentration as well as short term memory loss, and personality changes exhibited as nervousness, anxiety or irritability are some of the potential permanent long-term effects of chronic and frequent exposure. In addition, PCE inhaled by pregnant women can cross the placenta causing exposure of the developing fetus. PCE has also been found in breast milk of mothers exposed to the chemical.

Acute Exposure

Concentrations of 200 ppm or more have been associated with

dizziness, confusion, headache, nausea, and irritatio and mucous tissue. Exposure to extremely high leve (>1,500 ppm) may lead to unconsciousness and, in death from respiratory depression. Nausea and von follow from inhalation of large amounts of PCE. The dangerous to life or health air concentration value (the National Institute for Occupational Safety and H as respirator selection criteria for PCE has been set a

Symptoms of exposure to skin can include redness, pain. Prolonged exposure can result in the removal protective oils from skin resulting in irritation, dryn dermatitis. Likewise, extended dermal contact can r and third-degree chemical burns. Contact of PCE va ppm with the eyes will result in irritation, redness, a

Chronic Exposure

Long term exposure to PCE may cause liver, kidney Furthermore, the exposure can aggravate pre-existi For example, persons with pre-existing skin disorde or impaired liver or kidney function may be more s the effects of the substance. PCE can affect your bra as a whole; in a similar way as the consumption of a Therefore the consumption of alcoholic beverages time period of exposure to PCE enhances the toxic effects from PCE and alcohol. The two would have an additive effect on the CNS.

Overexposure may result in cumulative liver and CNS damage or narcosis. Overall, PCE can affect the liver, kidneys, eyes, skin, respiratory system, and CNS.

Cancer Risk

Several agencies have investigated PCE's association with cancer. The US National Toxicology Program classifies PCE as "Reasonably anticipated to be human carcinogen". IARC lists PCE as Group 2A, "Probably carcinogenic to humans." EPA is currently reassessing PCE's carcinogenicity classification and ACGIH designates it as an

The Toxics Use Reduction Institute is a research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989.
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Massachusetts Safer Alternatives Fact Sheet

Alternatives to Perchloroethylene Used in Professional Garment Care

Perchloroethylene (perc) was designated as a Higher Hazard Substance by the Massachusetts Toxics Use Reduction program in 2008. This fact sheet was developed by the Toxics Use Reduction Institute (TURI) to help Massachusetts professional garment care shop owners and their communities identify safer alternatives to perc for their dry cleaning operations.

Perchloroethylene has been the standard dry cleaning solvent because of its effectiveness, ease of use, and relatively low cost. Unfortunately, improper use, storage and disposal of perc have resulted in widespread contamination of groundwater and soil at dry cleaning sites. In addition, exposure to perc is associated with a variety of adverse human health effects. Because of these impacts, perc is more strictly regulated today than in the past, and many cleaners are investigating alternatives for use in their operations.

Recent industry surveys estimate that from 50 to 70% of cleaners currently continue to use perc, while many US cleaners have switched to other solvents or cleaning methods. Even with these trends, Massachusetts dry cleaners reported using more than 450,000 pounds of perc and generating over 290,000 pounds of hazardous waste in 2010.

About the Alternatives

TURI conducted an assessment of seven common alternatives to perc to find technically viable and environmentally preferred methods for professional garment cleaning. The alternatives evaluated include:

- **Professional Wet Cleaning:** a water-based process that uses computer-controlled washers and dryers along with biodegradable detergents and specialized finishing equipment to process delicate garments that would otherwise be dry cleaned. While this alternative is not new, the technology has evolved in the past 5-10 years, resulting in significantly improved performance.

Learn more about wet cleaning technology at
http://www.turi.org/drycleaning

- **Liquid Carbon Dioxide**: combining liquid carbon dioxide with specially formulated cleaning agents in a traditional basket-style machine under high pressure (700 psi). The higher cost of this alternative has limited its adoption.
- **High Flash Hydrocarbons:** a class of low-odor petroleum-based combustible dry cleaning solvents with a flash point greater than 140°F. This technology is the most widely used alternative to perc dry cleaning.
- **Acetal**: a halogen-free combustible solvent that came onto the US market in 2010 under the trade name SolvonK4, and appears to be gaining market share. Little information is available on the human health and environmental effects associated with this alternative.
- **Propylene Glycol Ethers**: a class of combustible petroleum solvents that were introduced in the late 1990s and can typically be used with a hydrocarbon machine after making minor modifications.
- **Cyclic Volatile Methyl Siloxane**: an odorless, combustible liquid that can be used in multi-solvent machines. The most common brand of this solvent is GreenEarth®.
- **N-Propyl Bromide (nPB):** considered a "drop-in" replacement for perc in existing dry cleaning equipment. However, nPB has toxicity concerns that make it an unacceptable alternative.

Assessing the Alternatives

Criteria considered when assessing the alternatives include:

- Performance Impacts and Technical Feasibility
- Financial Considerations
- Environmental and Human Health Impacts
- Regulatory and Safety Implications

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Ph: (978) 934-3275 • Fax: (978) 934-3050 • Web: www.turi.org • Printed on 100% post-consumer recycled paper

Trichloroethylene (TCE)

- Hazards
  - Neurotoxin/CNS effects
    - Acute and chronic, can be irreversible
  - Skin irritant, defatting
  - Reasonably anticipated to be a carcinogen (liver, kidney, non-Hodgkin's lymphona)
  - Liver and kidney effects
  - Groundwater pollutant

- Uses
  - Vapor degreasing, cleaning, adhesive, sealant and coating formulations
- 2011 TURA Data
  - 17 filers
  - 303,000 lbs total use
    - Chemical distributors 169,000 lbs
    - shipped in products 50,000 lbs
  - 155,000 lbs byproduct
  - 42,700 lbs released

Perchloroethylene (perc, PCE)

- Hazards
  - Neurotoxin/CNS effects
    - Acute and chronic, can be irreversible
  - Skin irritant, defatting
  - Reasonably anticipated to be a carcinogen (bladder, esophageal, cervical, and non-Hodgkin’s lymphoma)
  - Liver and kidney effects
  - Groundwater pollutant

- Uses
  - Vapor degreasing, cleaning, garment dry cleaning, formulations
- 2011 TURA Data
  - 17 filers (9 dry cleaners)
  - 146,000 lbs total use
    - Chemical distributors 84,000 lbs
  - 55,000 lbs byproduct
  - 24,300 lbs released

Perchloroethylene

- MA TURA Higher Hazard Substance
- Focus on dry cleaning
  - Identify alternatives
  - Evaluate technical performance
  - Assess environmental, health and safety characteristics
  - Estimate costs
  - Present information for dry cleaners to assist them in making decisions.

Alternatives Assessment

A. Define goal

B. ID Chemicals of High Concern

C. Identify Alternatives

D. Prioritize and Pre-Screen Alternatives

E. Alternatives Assessment
   - Technical/Performance Assessment
   - EH&S Assessment
   - Financial Assessment

F. Analyze information

G. Select alternative

IC2 (Interstate Chemicals Clearinghouse)
Safer Alternatives Assessment Model

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Summary Table: Comparison of Perc and Seven Garment Cleaning Al

Alternatives:

- n propyl bromide
- Siloxane (D5)
- Propylene glycol ethers
- Acetal (Solvon K4)
- High flashpoint hydrocarbons
- Liquid CO_2
- Wet Cleaning

Key Assessment Criteria		Perc (reference)	Wet Cleaning[1]	Carbon Dioxide	High Flashpoint Hydrocarbons	Acetal	Propylene Glycol Ethers	Siloxane	n Propyl Bromide
Common Trade Names / Manufacturers of Equipment or Solvents			Wascomat, Miele, Continental, HwaSung, AquaSolo	Cool Clean Technologies, Solvair®	DF2000™ Fluid, EcoSolv®, ShellSol D60, Caled Hydrodene	Solvon K4	Solvair®, Rynex 3®, Impress®, Gen-X®	Green Earth® D5 solvent	Drysolv®, Fabrisolv™ XL
Solvent Chemical Identification [CAS#]		Perchloroethylene [127-18-4]	Solvent: Water Detergents: See full report[1]	Carbon Dioxide [124-38-9]	Naphtha (petroleum) hydrotreated heavy [64742-48-9]; C10-C13 Isoalkanes [68551-17-7]	1-(butoxy methoxy) butane (butylal) [2568-90-3]	dipropylene glycol tert-butyl ether, [132739-31-2]; di-propylene glycol n-butyl ether, [29911-28-2]	Decamethylcyclo-penta siloxane (D5) [541-02-6]	N Propyl Bromide (nPB) [106-94-5]
Technical / Performance[2]	Cycle time (min)	45	20-40	35-45	60-75	60-65	>45	53-58	45
	Load capacity (lb)	50	20-75	60	35-90	40-90	43	55	50
	Materials system may have difficulty with	Leather, suedes, beads, delicates	Leather, suede and fur	Triacetates, specially dyed acetates	Vinyl appliqués	Appliqués or decorations glued to fabric	None identified	None identified	Leather, suedes, beads, delicates
	Spotting requirements	Moderate	Low	High	Moderate	Low	Low	High	Low
Financial	Equipment	$40,000 - $65,000	$36,000 - $61,000	$100,000 - >$150,000	$38,000 - $75,000	$50,000 - $100,000	$56,000	$30,500 - $55,000	$40,000 - $60,000 or retrofit costs
	Chemical cost per gallon	$17	$0.007/gal (water); $25-$31/gal (detergent)	$0.18/lb ($CO_2$); $40/gal (detergent)	$14-$17	$28-$34	$25-$30	$22-$28	$40-$64
	Electricity usage[3] (kWh/100 lb)	26.6	9.3	30.9	35.5	Similar to hydrocarbon	Unavailable	54.2	Unavailable
	Typical cost per pound cleaned[4]	$0.63-$1.94 avg. $1.02	$0.57-$1.32 avg. $1.10	$1.40	$0.73-$1.02 avg. $0.88	Unavailable	$1.14	$1.08-$2.33 avg. $1.71	Unavailable
Environmental	Persistence[5] (water, soil, sediment, air)	M (water), H (soil, sed, air)	L (water, soil, air), M (sed)	NA	L (water, soil, air), M (sed)	L (water, soil, air), M (sed)	L (water, soil, air), M (sed)	L (water), M (soil), H (sed, air)	L (water, soil), M (sed), H (air)
	Bioaccumulation[6]	Low	Low	NA	Moderate	Low	Low	Moderate	Low
	Aquatic Toxicity[7]	Moderate	Low to Moderate[8]	Low	High	Moderate[9]	Low	High	High
Human Health	Recommended Exposure limits[10]	25 ppm	NE	5000 ppm	100 ppm[11]	NE	NE	10 ppm[12]	10 ppm
	Central Nervous System Effects	Yes	No[13]	No[14]	Yes	No data available	Yes	Some evidence	Yes
	Carcinogenicity	IARC Probable human carcinogen	Not classified by IARC	Not classified by IARC	Not classified by IARC	Not classified by IARC	Not classified by IARC	Some evidence	Clear evidence in animal studies by NTP
	Reproductive / Developmental Toxicity	Yes	Negligible[15]	No data available	No data available	No data available	No[16]	Studies indicate concern	Yes

http://www.turi.org/TURI_Publications/TURI-Methods-Policy-Reports/Assessment_of_Alternatives_to_Perchloroethylene_for_the_Dry_Cleaning_Industry

Professional Wet Cleaning

http://www.turi.org/Our_Work/Business/Small_Businesses/Dry_Cleaning

Cadmium and Compounds

- Hazards
  - Neurotoxin/CNS effects
    - Acute and chronic, can be irreversible
  - Known to be human carcinogens (lung)
  - Kidney, lung, bone effects

- Uses
  - Metal plating, alloys and clad metals, e-waste recycling, pigments
- 2011 TURA Data
  - 9 filers
  - 208,000 lbs total use
  - 11,300 lbs byproduct
  - 18 lbs released
  - 1 Trade Secret filer

Lead and Compounds

- Hazards
  - Neurotoxin/CNS effects
    - Acute and chronic, can be irreversible
  - Developmental and reproductive toxin
  - Reasonably anticipated to be human carcinogens (lung, stomach, urinary bladder)
  - Kidney, lung, bone effects

- Uses
  - Solder & surface finishes in electronics, e-waste recycling, batteries, plastic heat stabilizers, pigments, WtE utilities, alloys, concrete
- 2011 TURA Data
  - 128 filers (68 lead, 60 cmpds)
  - 3.73 million lbs total use
  - 2.94 million lbs byproduct
  - 341,000 lbs released

Hexavalent Chromium Compounds (Cr^{+6})

- Hazards
  - Contact dermatitis, skin, eye and respiratory irritant, sensitizer, asthmagen
  - Known to be human carcinogen (lung, sinonasal)
  - Skin, kidney, liver effects
  - Developmental toxin

- Uses
  - Pigments, plating, metal finishing, e-waste recycling, electric utilities, granules
- *2011 TURA Data (all Chromium Compounds, no HHS)*
  - *7 filers*
  - *235,000 lbs total use*
  - *20,000 lbs byproduct*
  - *158 lbs released*

Toxics Use Reduction Institute

Aerospace/Defense Supply Chain Research Results for Hex Chrome Free Materials

Greg Morose
Toxics Use Reduction Institute
University of Massachusetts Lowell

April 3, 2014

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Hex Chrome – Uses in Defense/Aerospace Applications

- Sealants
- Primers
- Conversion coatings

Conversion coatings inhibit corrosion on metal
parts, and are important in military, nautical and aerospace applications. Conversion coatings account for the most significant ongoing use of hexavalent chromium in Massachusetts.

Source: TURI Summary of Policy Analysis

Hex Chrome: Driver for Change

- Defense Federal Acquisition Regulation Supplement (DFARS) , May 2011

- No Department of Defense contract may include a specification or standard that results in a deliverable containing more than 0.1% hexavalent chromium or requires use or removal during subsequent phases of the deliverable, unless an exception or approval applies.

- Several exceptions include <u>conversion coatings</u>; hard chrome plating; chromic acid anodizing; most chromate metallic ceramics; and chromate washes,

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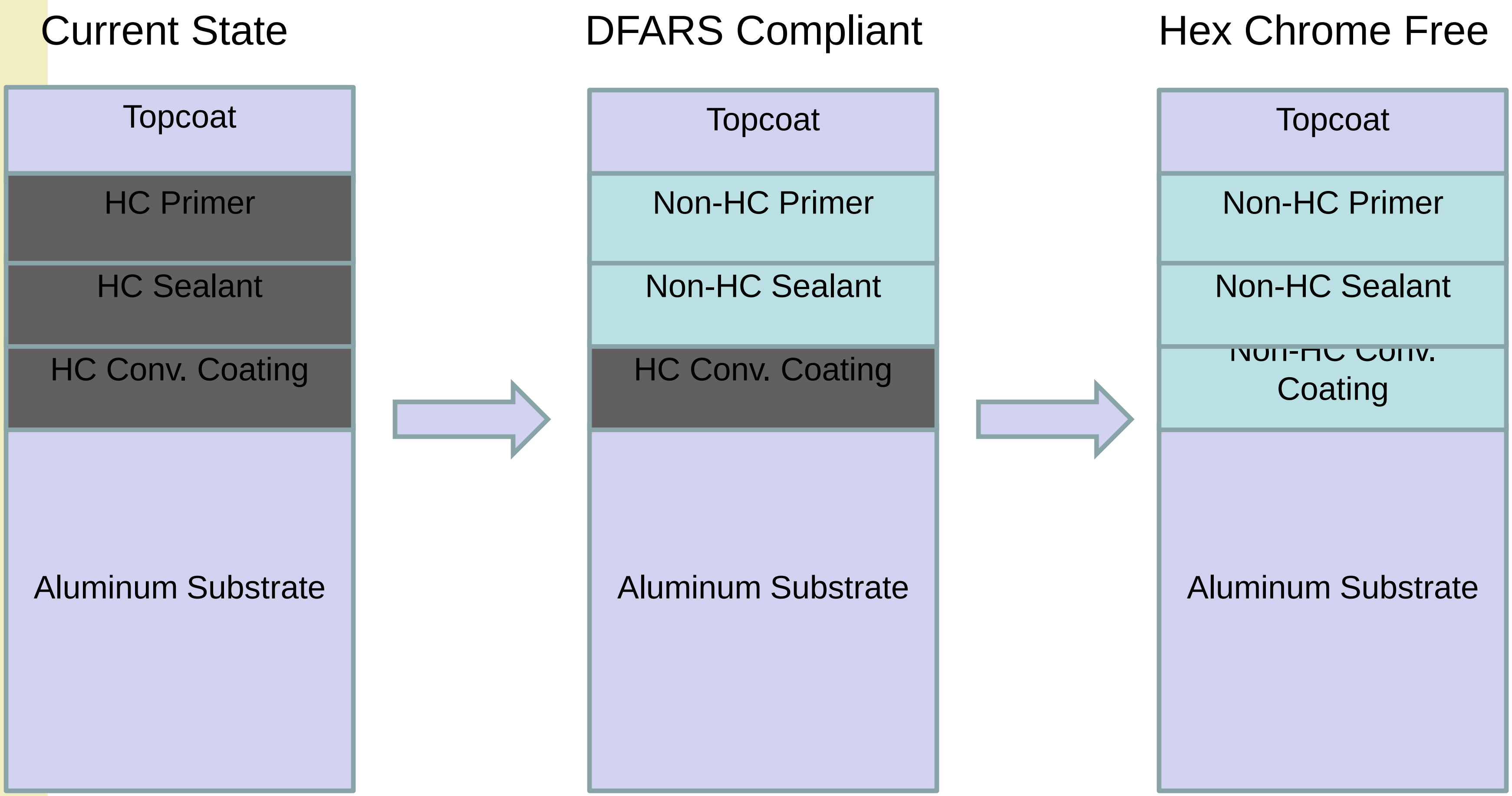
TUR of Hexavalent Chromium (HC)



Phase II Sealant Evaluation Team

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Government

Aviation & Missile Command Safety Office

NAVAIR
NAVAL AIR SYSTEMS COMMAND

NASA

U.S. AIR FORCE

OTA
OFFICE OF TECHNICAL ASSISTANCE & TECHNOLOGY

Industry

LOCKHEED MARTIN

BOMBARDIER
the evolution of mobility

NORTHROP GRUMMAN

Raytheon

Academia

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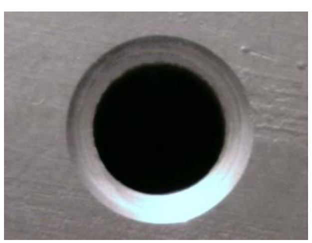
Sealant Research Overview

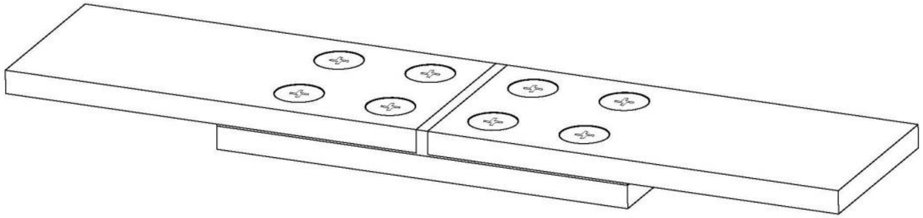
Research Phase	Timeframe	Purpose	Materials Evaluated
Phase I	2012	Screening level research of the key factors for sealant performance	4 sealants 2 conversion coatings 2 aluminum alloys 2 primers 2 fastener types With & without topcoat
Phase II	2013	• DFARs compliance for sealants • Sealant removal evaluation	6 sealants
Phase III ??	2014 ??	Totally hex chrome free stack-up: conversion coating, sealant, primer, & topcoat ?????	To be determined

Sealant Applications

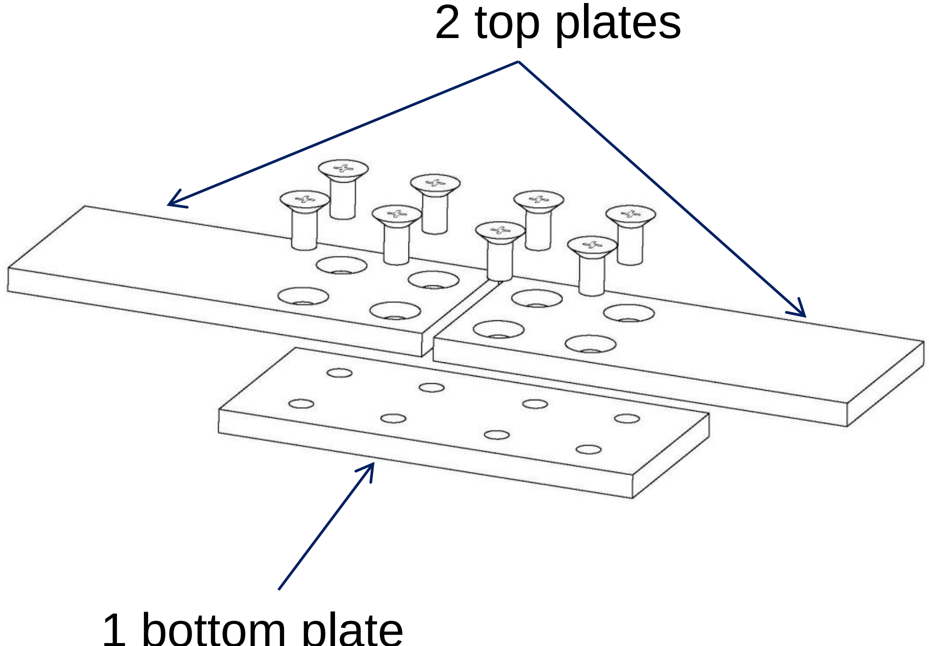
1. Sealant applied to the threads of a fastener (wet installation)
2. Sealant applied to the ends of a fastener
3. Sealant applied to butt joint (for example a ¼ inch gap between materials)
4. Sealant applied to faying surfaces (the surfaces of materials in contact with each other and joined together)



Test Vehicle Assembly Drawing



Three aluminum plates: 2” x 4.5” x 0.25” (alloy 7075 only)



8 stainless steel fasteners with 100 degree countersunk heads

Phase II Research Project Objectives

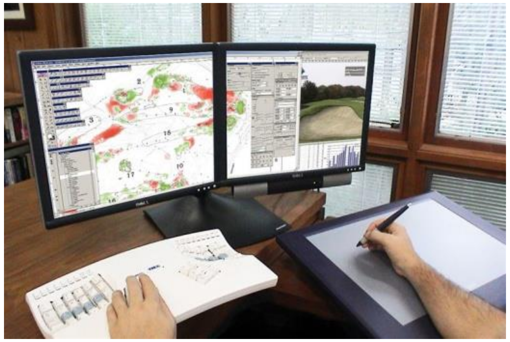
- Conduct technical performance testing to evaluate the corrosion resistance of six types of sealants for four different types of sealant applications.
- The research results should provide significant statistical data to justify the use of DFARS-compliant assembly including hex chrome free sealants.
- Continue the working relationship with research participants as a basis for continued collaborative research.

Phase II Sealant Selection

Vendor	Vendor PN	Specification	Purpose	Chemical Class	Corrosion Inhibitor
PPG Aerospace	PS-870	MIL-PRF-81733 Type II Class 1 Grade A	Baseline	Polysulfide	Hexavalent chromium
3M	AC-735	MIL-PRF-81733 Type II Class 1 Grade B and AMS 3265 Class B	Alternative Sealant	Polysulfide	Zinc phosphate
PPG Aerospace	PR-1775	AMS 3265 Class B	Alternative Sealant	Polysulfide	Phosphite salt
PPG Aerospace	PR-2870 (RW-6040-71)	MIL-PRF-81733 Type II Class 2 Grade B	Alternative Sealant	Polythioether	Phosphite salt
Flame Master	CS 5500N CI	Not yet qualified	Alternative Sealant	Polysulfide	Molybdates
PPG Aerospace	PR-1440	AMS-S-8802 Type 2 Class B	Negative Control	Polysulfide	None

Phase II Research Process

Test plan development
All participants

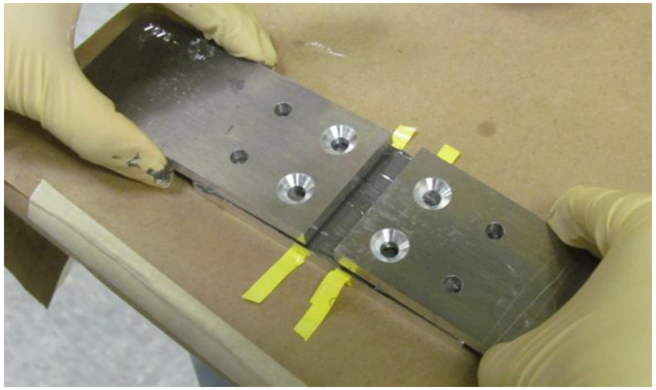


Test vehicle CAD design
Raytheon

Aluminum plate machining
NASA

Research Process

Conversion Coating
(MacDermid Iridite 14-2)
Northrop Grumman



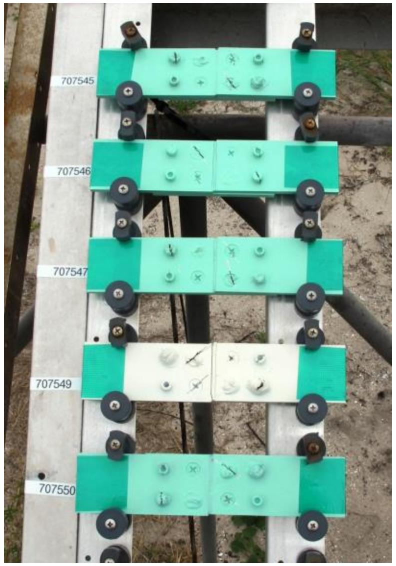
Test Vehicle Assembly*
Raytheon

Test Vehicle Preconditioning
U.S. Navy

*Fasteners for the test vehicle provided by **Bombardier.**

Research Process

Accelerated Corrosion Test
1,000 hours
SO_2 Salt Fog, ASTM G85 Annex 4
(24 Test Vehicles)
Lockheed Martin



Long-term Corrosion Test
1 year duration
(6 Test Vehicles)
NASA

Research Process

Sealant Removal
TURI, UMass Lowell

Corrosion Inspection & Analysis
Lockheed Martin

Statistical Analysis & Write Paper
TURI, UMass Lowell

Phase II Conclusions

For the faying surface/butt joint areas, several alternative sealants containing non-hex chrome corrosion inhibitors (AC-735, CS 5500N CI,
PR-1775, and PR-2870) provided equivalent corrosion prevention performance to the baseline sealant PS-870.

For the fastener holes and ring around the fastener areas, several alternative sealants containing non-hex chrome corrosion inhibitors (AC-735, PR-1775, and PR-2870) provided equivalent corrosion prevention performance to the baseline sealant PS-870.

For Further Information

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Toxics Use Reduction Institute

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Formaldehyde

- Hazards
  - Respiratory and skin irritant, asthmagen
  - Known to be human carcinogen (nasopharyngeal)
  - Reproductive toxin

- Uses
  - Resins, binders, adhesives, chemical intermediate, tissue preservative, electroless plating
- 2011 TURA Data (incl. paraformaldehyde, no HHS filers)
  - 8 filers
  - 2 million lbs total use
  - 138,000 lbs byproduct
  - 20,000 lbs released
  - + 1 Trade Secret filer 3,000 lb released, 2.2 million lbs to POTW

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UMASS LOWELL

Methylene Chloride (Dichloromethane, DCM)

- Hazards
  - Neurotoxin/CNS effects
    - Acute and chronic, can be irreversible
  - Skin irritant, defatting
  - Reasonably anticipated to be a carcinogen (liver, kidney, non-Hodgkin's lymphona)
  - Liver and kidney effects
  - Groundwater pollutant

- Uses
  - Vapor degreasing, cleaning, adhesive, sealant and coating formulations
- 2011 TURA Data (no HHS)
  - 17 filers
  - 303,000 lbs total use
    - Chemical distributors 169,000 lbs
    - shipped in products 50,000 lbs
  - 155,000 lbs byproduct
  - 42,700 lbs released

Thank-you

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