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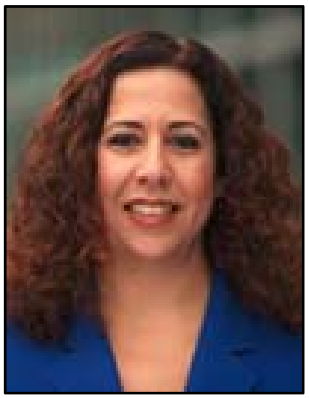
"**Cadmium and Chromate Elimination Efforts**: Implementation Plans and Strategic Roadmaps for Three DoD Depots"

March 24, 2016

Welcome and Introductions

Rula A. Deeb, Ph.D.
Webinar Coordinator



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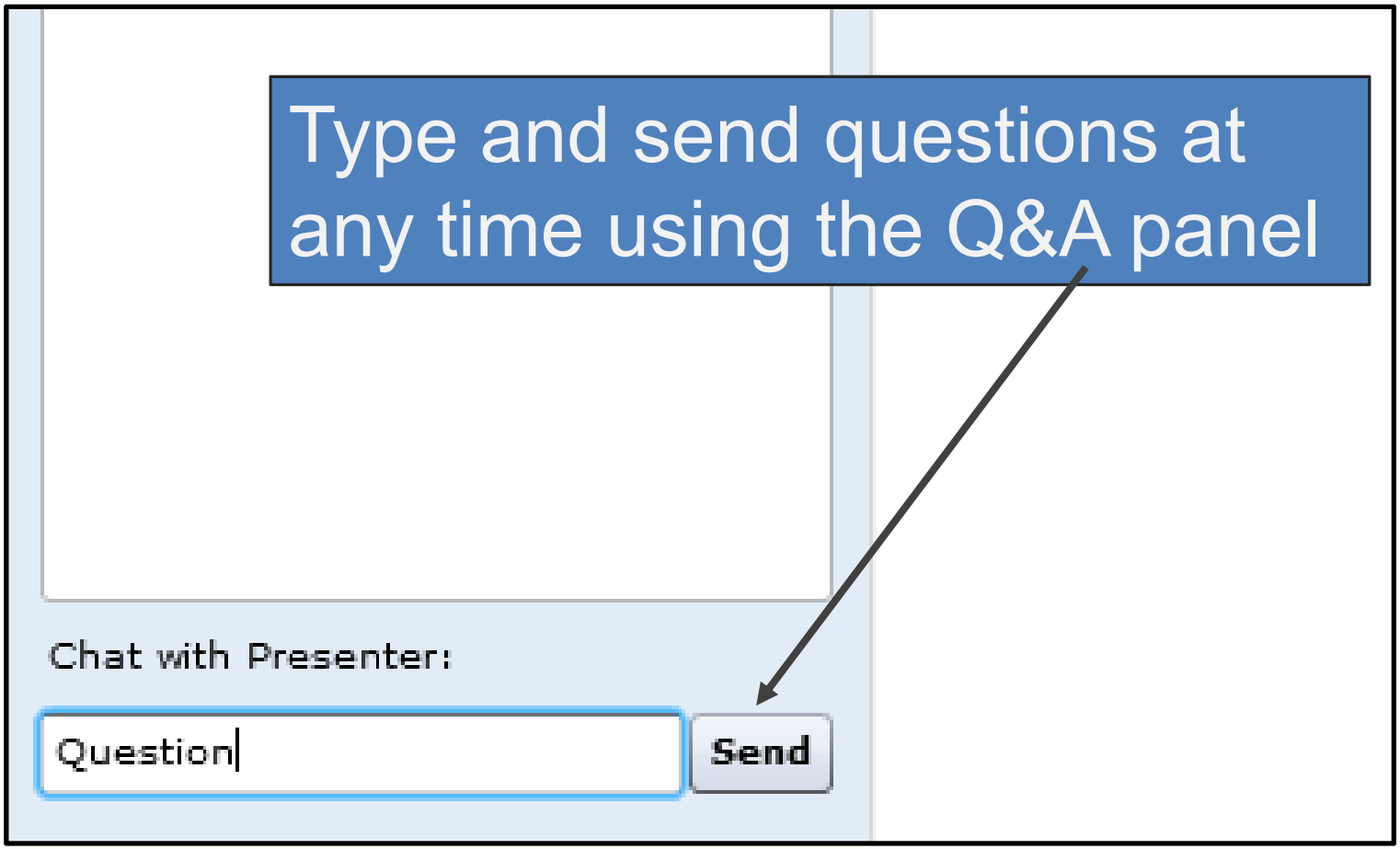
Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Rula Deeb, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (10 minutes)
  Dr. Robin Nissan, SERDP and ESTCP
- **Cadmium and Chromate Elimination Efforts: Implementation Plans and Strategic Roadmaps for Three DoD Depots**
  Mr. Scot Bryant, Noblis
  - Overview of 5-Year Strategy and Roadmap (25 minutes + Q&A)
  - Depot-Specific Implementation Plans (25 minutes + Q&A)

How to Ask Questions



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SERDP and ESTCP Overview

Robin Nissan, Ph.D.

Weapons Systems and Platforms Program Manager

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SERDP

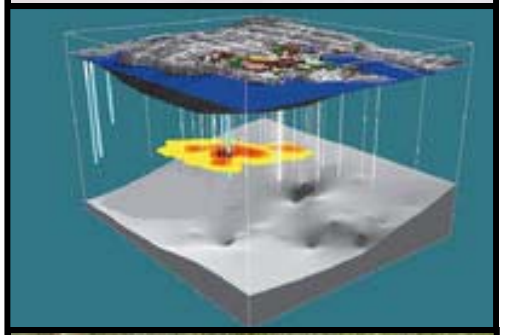
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Climate Change
5. Weapons Systems and Platforms

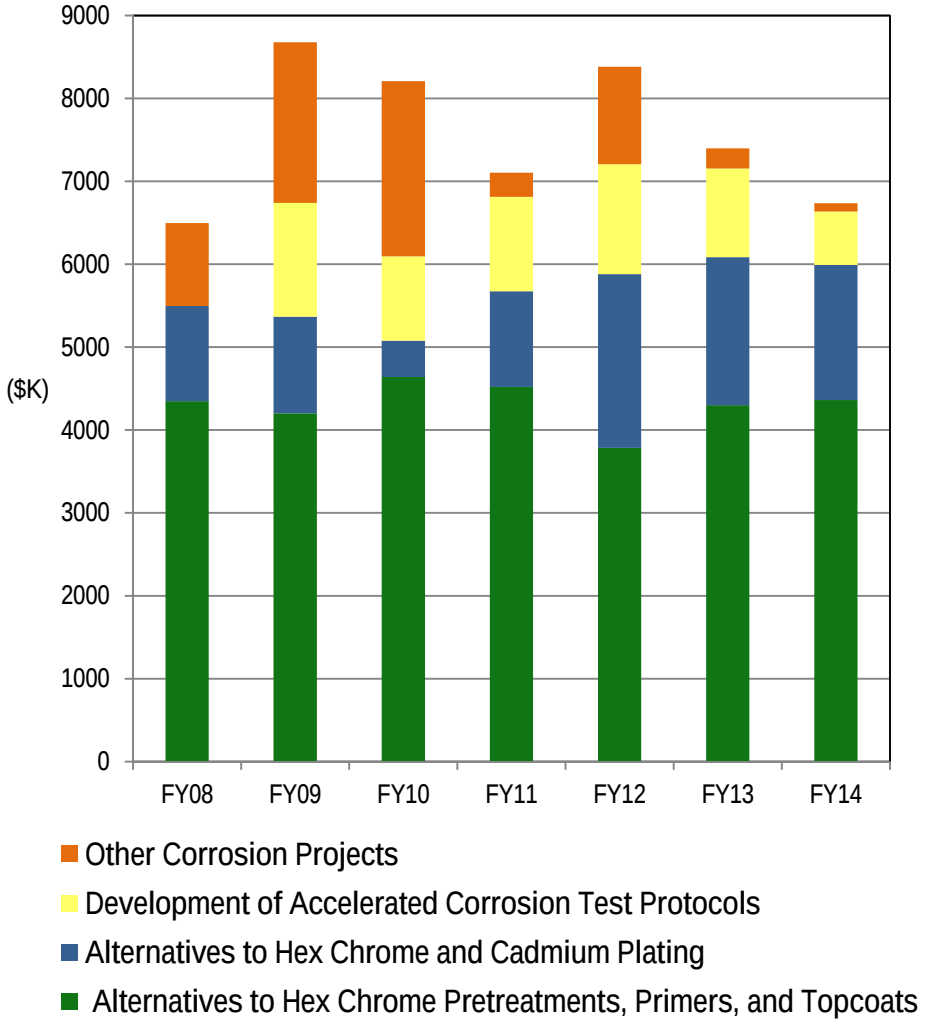




Weapons Systems and Platforms

- Major focus areas
  - Surface engineering and structural materials
  - Energetic materials and munitions
  - Noise and emissions
  - Waste reduction and treatment in DoD operations
  - Lead free electronics

SERDP/ESTCP Investments Related to Corrosion

- DoD assets are subject to significant degradation due to corrosion, with specific impacts in following areas
  - Financial: $18-$22 billion annually
  - Readiness: Weapons systems routinely out of commission
  - Safety: Weapon systems mishaps documented
- Many materials used to impart corrosion resistance have environmental and/or worker safety concerns



Recent ESTCP Projects to Address Cd or Cr^{6+}

- FY2010
  - Electrocoat Process for Non-Chromate Primers in DoD Manufacturing (AFRL)
- FY-2011
  - Demonstration/Validation of Zinc-Nickel as Replacement for Cadmium/Cyanide Plating Process for Air Force Landing Gears (Hill AFB)
  - Chromium Elimination and Cannon Life Extension (Benet Labs)
  - Comprehensive Evaluation and Transition of Non-Chromated Paint Primers (NAVAIR Pax River)
- FY2012
  - Chrome Replacement for Gun Barrels (NAVSEA Dahlgren)
- FY2013
  - Environmentally Friendly Fastener Coating Demonstration (PPG)
  - Environmentally Friendly Zirconium Oxide Pretreatment (ARL)
  - Improved Magnesium Protection for DoD Aviation and Weapon Component Technology (ARL)
- FY2014
  - Cadmium-Free Alternatives for Brush Plating Repair Operations (WRALC)
- FY2015
  - Demonstration and Validation of Siloxane-Based Aircraft Topcoats that are Isocyanate-Free and Provide a Reduced Environmental Impact (NRL)

Strategic Goals and Next Steps Towards Achieving Measurable Results

- Several meetings were convened to address technical gaps and barriers to implementation of Cd and Cr^{6+} alternatives
- Subject matter experts from DoD, industry and academia provided current status
- A special study was initiated to compile maintenance and lifecycle issues at DoD depots
- ***Results of this special study will be presented during this webinar***

SERDP and ESTCP Webinar Series

DATE	Topics
April 7, 2016	Use of Climate Information for Decision Making and Impacts Research
April 21, 2016	Long Term Monitoring Issues at Chlorinated Solvent Sites
May 05, 2016	Battery Energy Storage
May 19, 2016	Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations – Part 1
June 02, 2016	Insensitive Munitions
June 16, 2016	Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations – Part 2
June 30, 2016	TBD
July 14, 2016	Remote Methods for Water Conservation
July 28, 2016	An Environmentally Acceptable Alternative for Fast Cook-off Testing, Demonstration, Validation and Implementation Efforts

SERDP and ESTCP Webinar Series

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

"**Cadmium and Chromate Elimination Efforts**: DoD-Level Strategic Roadmap and Implementation Plans for Three Depots"

Scot Bryant
Noblis

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Agenda

- Introduction
- Project objectives
- Background and problem definition
- Five year strategy and roadmap
- Implementation plans
- Conclusions

Project Objectives

- Develop a strategy and roadmap to achieve >90% reduction of Cr^{6+} and Cd usage at DoD depots in 5 years
- Develop a strategy and roadmap to achieve >90% reduction of Cr^{6+} and Cd emissions, waste streams, and exposure potentials at DoD depots in 5 years
- Generate 3 depot-specific implementation plans to translate the strategy into finite, depot-level actions

Background and Problem Definition
Why Replace Cr^{6+} and Cd?

- Hexavalent chromium (Cr^{6+})
  - Known carcinogen
  - Attacks the respiratory tract, liver, kidneys, skin, and eyes
  - Exposures occur during welding, coating processes, and surface finishing processes
- Cadmium (Cd)
  - Known carcinogen
  - Attacks the cardiovascular system, respiratory tract, reproductive system, neurological system, gastrointestinal system, and kidneys
  - Exposures occur during welding, coating processes, plating processes, and handling Cd coated fasteners and connectors

Background and Problem Definition
Regulatory Drivers

- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Resource Conservation and Recovery Act (RCRA)
- Toxic Release Inventory (TRI)
- 48 CFR Parts 223 and 252 Defense Federal Acquisition Regulation Supplement (DFARS), "Minimizing the Use of Materials Containing Hexavalent Chromium" (DFARS Case 2009–D004)
- DOD Instruction 5000.02
- Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)
- Restriction of Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)
- Memorandum from John Young, USD(ALT), to Secretaries of Military Departments, "Minimizing the Use of Hexavalent Chromium"

Background and Problem Definition
Processes

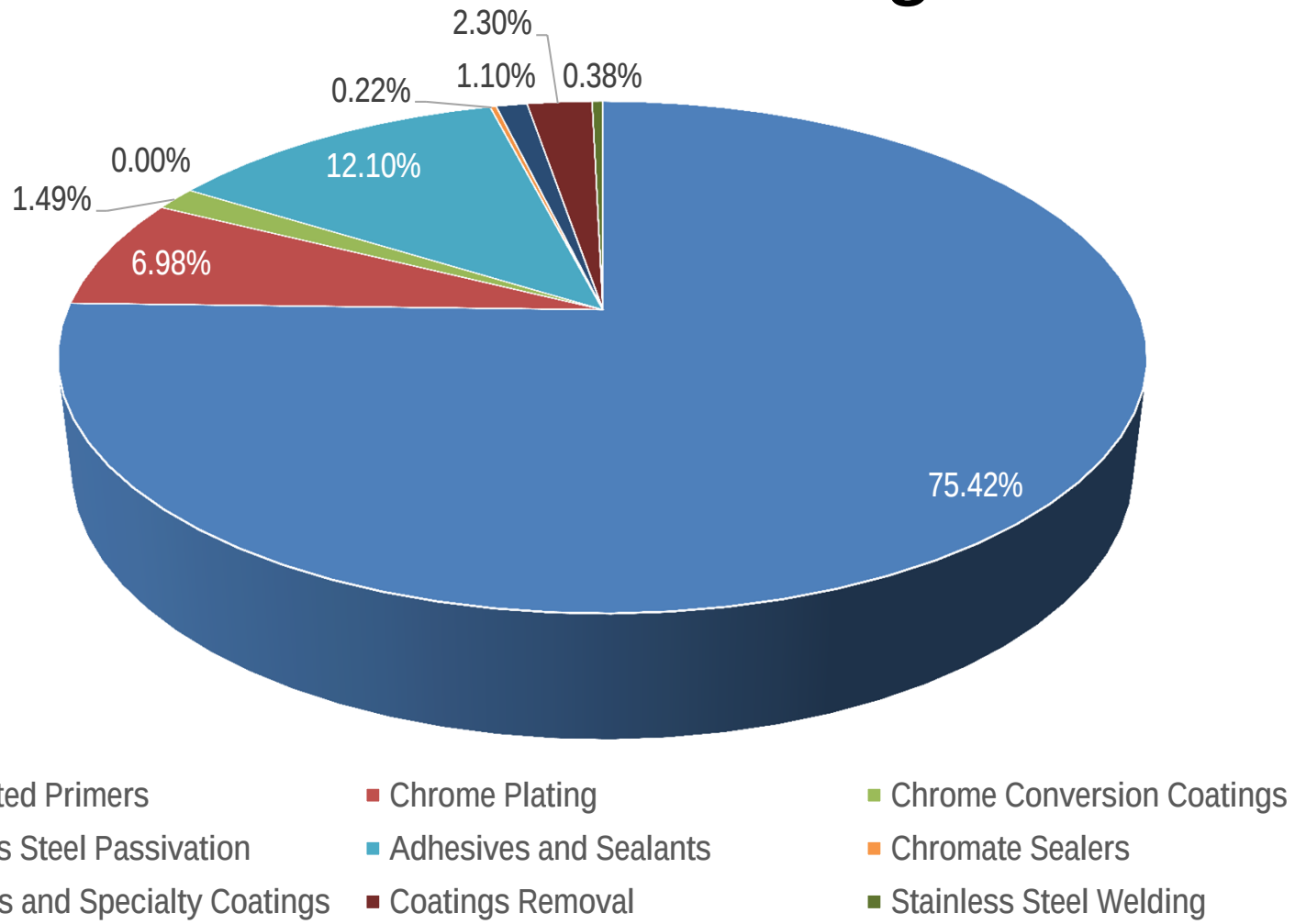
- Chromated primers
  - Aerospace primers
  - Wash primers
- Chrome plating
- Cadmium plating
- Chromate conversion coatings
  - Aluminum
  - Magnesium
- Stainless steel passivation
- Adhesives and sealants
- Cadmium brush plating
- Chromate sealers
  - Anodize
  - Phosphate coatings
  - Black oxide
  - Cadmium plating
- Topcoats and specialty coatings
- Coatings removal
- Stainless steel welding

Background and Problem Definition
Chemical Usage

- Chemical usage over a 12-month period (usually calendar year 2014)
  - 76,074 pounds of Cr^{6+}
  - 684 pounds of Cd
    - Includes all of Air Force (16 June 2014 through 15 June 2015)
    - Army data includes only Letterkenny Army Depot (LEAD)
    - Navy data includes only Fleet Readiness Center Southeast (FRCSE)

Background and Problem Definition

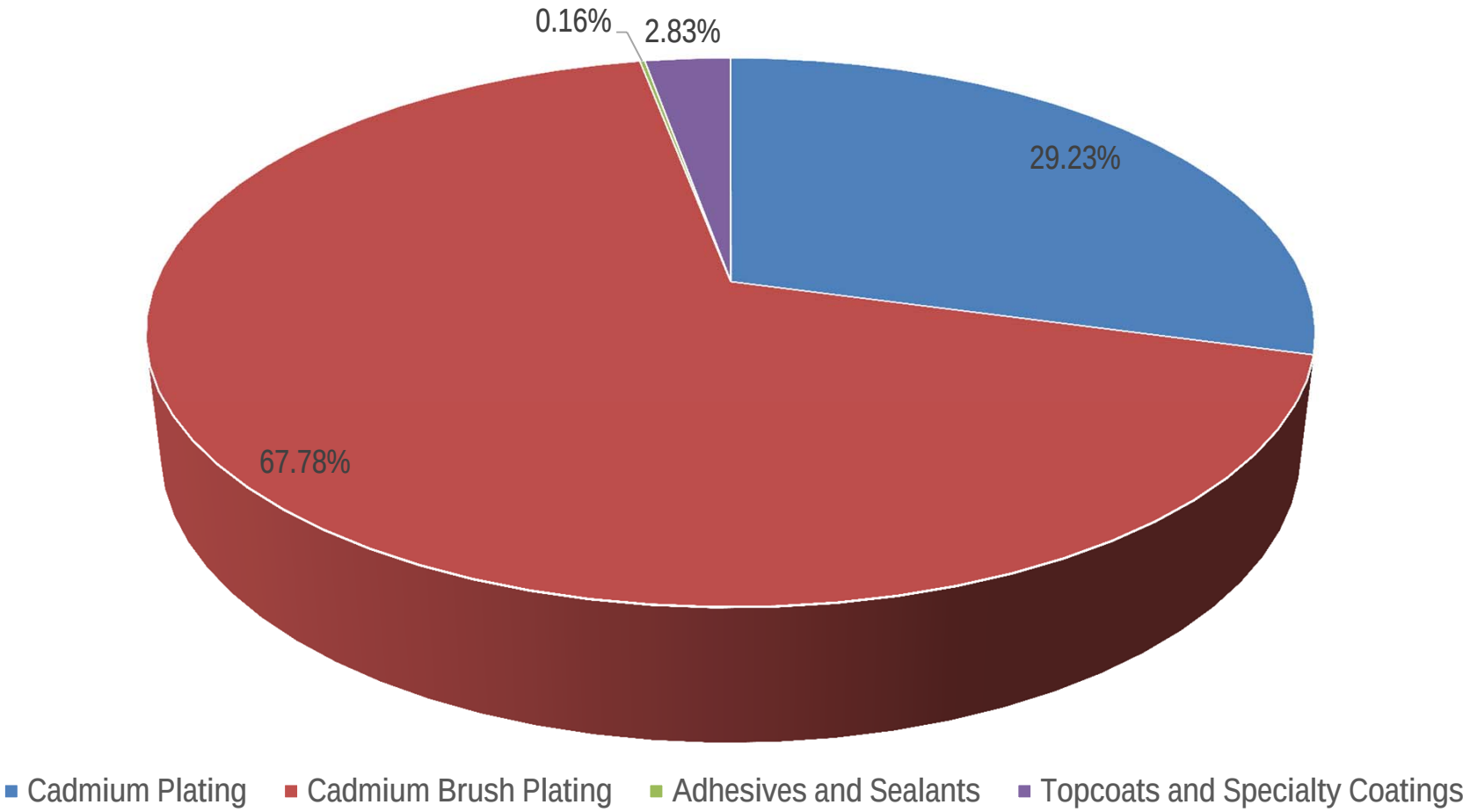
Cr^{6+} Process Usage



Background and Problem Definition
Cr^{6+} Process Usage (Cont'd)

- Calculated using actual species of Cr^{6+} in the chemicals
- Top usage of Cr^{6+} in the DoD
  - Chromated primers
  - Adhesives and sealants
  - Chrome plating
- Army and Navy data is incomplete and could change the percentages
- Stainless steel welding does not capture that conducted at the shipyards; largest exposure potential according to the Defense Occupational and Environmental Health Readiness System (DOEHRS)
- Does not account for infrastructure dedicated to the process

Background and Problem Definition
Cd Process Usage



Background and Problem Definition
Cd Process Usage (Cont'd)

- Calculated using actual species of Cd in the chemical
- Top usage of Cd in the DoD
  - Cd brush plating
  - Cd plating (tank)
- Army and Navy data is incomplete and could change the percentages
- Does not account for infrastructure dedicated to the process

Background and Problem Definition

Waste, Emissions, Exposures and Infrastructure

- Wastes
  - Coatings removal largest waste stream for Cr^{6+} and Cd
  - Solid and liquid hazardous wastes
- Emissions
  - Engineering controls keep emissions within limits
  - Stainless steel welding largest source of Cr^{6+} emissions
- Exposures
  - Engineering controls and PPE prevent exposures…does not remove the potential
  - Stainless steel welding largest source of exposure potential according to DOEHRS
- Infrastructure
  - For some processes, a better reference than usage
  - Reflects the burden or liability at the depot even when usage data is low

5-Year Strategy and Roadmap
Stakeholders

- Depots
- Life cycle management centers
- System "owners"
  - System program offices
  - Program executive offices
  - Program managers
  - Product managers
- Laboratories
- Original equipment manufacturers (OEM)
- Specification "owners"
- Corrosion authorities

5-Year Strategy and Roadmap

Goals

- Reduce the use of Cd and Cr^{6+} containing compounds in DoD depots by 90% in 5 years
- Reduce Cd and Cr^{6+} emissions, waste streams, and exposure potentials in DoD depots by 90% in 5 years
- Impacts
  - All DoD depots
  - Many processes (e.g., chromated primers, adhesives, and sealants) impact field maintenance as well – potentially hundreds of installations
  - Hundreds of processes
  - Hundreds of weapon systems (and variations) and platforms
  - Potentially thousands of drawings, technical orders, technical manuals, and depot maintenance work orders

5-Year Strategy and Roadmap
Objectives and Success Metrics

- Objectives based on processes observed and documented at the depots
- Intermediary accomplishments to achieve the high-level goals
- Success metrics established based on pounds of usage, emissions, waste stream, or exposure potential
- Baselines established from usage data or, when available, emissions and waste data

5-Year Strategy and Roadmap
Actions

- Finite activities or initiatives to address intermediary objectives
- At the strategy level, actions are not individual projects-more likely groups of projects
- Tied to impacted depots
- Prioritized

5-Year Strategy and Roadmap
Prioritization Methodology

- Qualitative analysis of several factors
  - Impact to readiness
  - Likelihood of implementation
  - Return on investment
  - Impact to reduction goals
- Actions/initiatives designated
  - **Tier 1:** critical, high impact, necessary to achieve goals
  - **Tier 2:** not as critical or far-reaching, lesser impact on goals
  - **Tier 3:** usually more localized requirement with impact to few missions, not necessary to meet goals

5-Year Strategy and Roadmap
Strategy and Roadmap Example

Goal

Notional Timeline

Goal 1 – Reduce the use of Cd and Cr^{6+} containing compounds in DoD depots by 90% in 5 years.												
Objective	Success Metric	Baseline	Actions	Depot(s)	Priority	2016	2017	2018	2019	2020	2021
1.1 Reduce the use of chromated primers in DoD depots by 90% within 5 years.	Reduction in pounds of Cr^{6+} species (e.g., strontium chromate, barium chromate) as compared to the baseline established in this Strategy and Roadmap.	56,772 lb Cr^{6+}	1.1.1 Non-Chromate Primer on Aircraft OML	OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW	1						
			1.1.2 Non-Chromate Primer on Aircraft non-OML Surfaces	OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW	1						
			1.1.3 Non-Chromate Primer on Off-Aircraft Components and Commodities	OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW	1						
1.2 Eliminate the use of chromated wash primers in DoD depots within 5 years.	Reduction in pounds of Cr^{6+} species (e.g., chromic acid, barium chromate) as compared to the baseline established in this Strategy and Roadmap.	605 lb Cr^{6+}	1.2.1 HAP-Free, Non-Cr^{6+} Wash Primer	LEAD, ANAD, TYAD, RRAD, MCLB Barstow, MCLB Albany	1						
1.3 Reduce the use of hard chrome plating in DoD depots by 95% within 5 years.	Reduction in pounds of Cr^{6+} species (e.g., chromic acid) as compared to the baseline established in this Strategy and Roadmap.	5,314 lb Cr^{6+}	1.3.1 Alternative to Chrome Plating	OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW, CCAD, ANAD, RIA, NNSY, PSNS, PNS	1						
1.4 Eliminate Cd tank plating at DoD depots within 5 years.	Reduction in pounds of Cd species (e.g., cadmium sulfamate) as compared to the baseline established in this Strategy and Roadmap.	200 lb Cd	1.4.1 Alternative to Cadmium Plating	OO-ALC, FRCSE, FRCE, FRCSW, CCAD, RIA, TYAD	1						
1.5 Reduce the use of chromated conversion coatings on Al in DoD depots by 90% within 5 years.	Reduction in pounds of Cr^{6+} species (e.g., chromic acid) as compared to the baseline established in this Strategy and Roadmap.	1,134 lb Cr^{6+}	1.5.1 Non-Chrome Chemical Conversion Coatings for Aluminum	OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW, LEAD, CCAD, RRAD, ANAD, RIA, TYAD	1						
1.6 Reduce the use of chromated conversion coatings on Mg in DoD depots by 50% within 5 years.	Reduction in pounds of Cr^{6+} species (e.g., chromic acid) as compared to the baseline established in this Strategy and Roadmap.		1.6.1 Non-Chrome Chemical Conversion Coatings for Magnesium	OC-ALC, FRCSE, FRCE, FRCSW, CCAD	3						

Objective

Action

Priority

5-Year Strategy and Roadmap

Tier 1 Initiatives – Cr^{6+}

- Non-chromate primer on aircraft outer mold line (OML)
- Non-chromate primer on aircraft non-OML surfaces
- Non-chromate primer on off-aircraft components and commodities
- HAP-free, non-Cr^{6+} wash primer
- Alternative to chrome plating
- Non-chrome chemical conversion coating for aluminum
- Alternative coatings removal processes to reduce Cr^{6+}-containing waste streams
- Implementation of engineering controls for stainless steel welding operations

5-Year Strategy and Roadmap
Tier 1 Initiatives – Cd

- Alternative to cadmium plating
- Alternative to cadmium brush plating

5-Year Strategy and Roadmap
Tier 2 Initiatives

- Non-chrome stainless steel passivation
- Alternative to dichromate sealers in anodizing operations
- Non-chromated coatings removal alternatives
- Non-chrome consumables for stainless steel welding

5-Year Strategy and Roadmap
Tier 3 Initiatives

- Non-chrome chemical conversion coatings for Mg
- Non-chrome sealants for aerospace applications
- Non-chrome structural adhesives for defense applications
- Alternative to dichromate sealers for brush plating finishes
- Alternative to dichromate sealers for black oxide and phosphate finishes
- Specialty coatings
  - Non-chrome aluminized coating for aircraft engine applications
  - Non-chrome anodized dyes
  - Non-chrome conductive EMI Coating
  - Non-cadmium silk screen ink
  - Non-cadmium safety paint
- Non chrome desmutting/deoxidizing alternatives
- Robotic painting to reduce worker exposure and increase maintenance efficiency
- Reducing emissions and exposure from chromated adhesives and sealants
- Reduction of emissions, waste, and exposures associated with cadmium brush plating

5-Year Strategy and Roadmap
Program Synergies

- SERDP and ESTCP
- Toxic Metals Reduction (TMR) Program
- Naval Sustainability Development to Integration (NESDI) Program
- Various Air Force Research Laboratory (AFRL) efforts
- Various Army Research Laboratory (ARL) efforts
- Various Naval Research Laboratory (NRL) efforts
- Small Business Innovative Research (SBIR) programs
- Defense Logistics Agency (DLA)
- Air Force Life Cycle Management Center (AFLCMC) efforts
- Naval Air Systems Command (NAVAIR) programs
- Depot-specific efforts

Q&A Session 1

Depot-Specific Implementation Plans

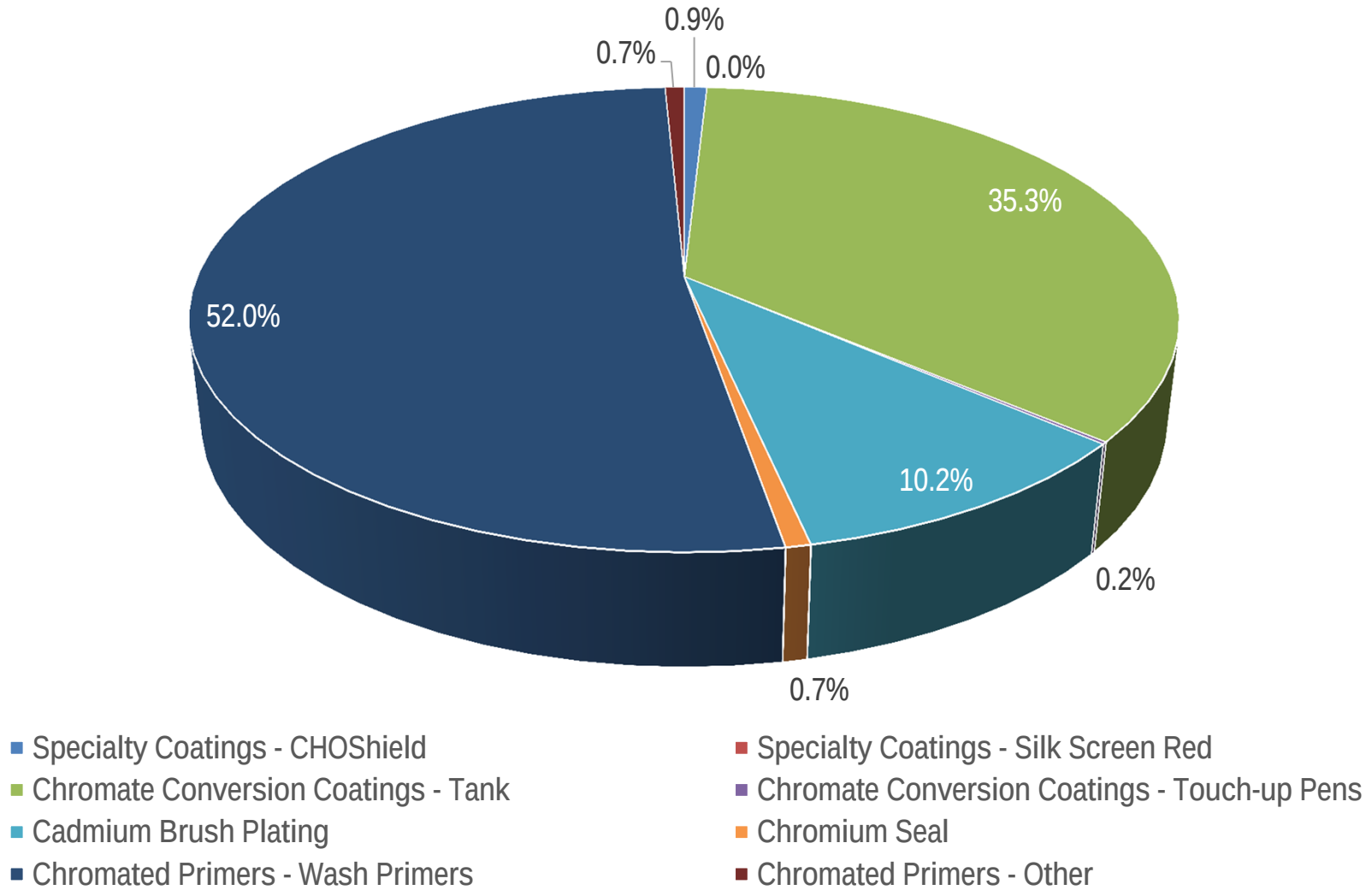
- Letterkenny Army Depot (LEAD)
  - 17-18 February 2015
- Fleet Readiness Center Southeast (FRCSE)
  - 25-26 March 2015
- Oklahoma City Air Logistics Complex (OC-ALC)
  - 5-6 May 2015

Letterkenny Army Depot (LEAD)

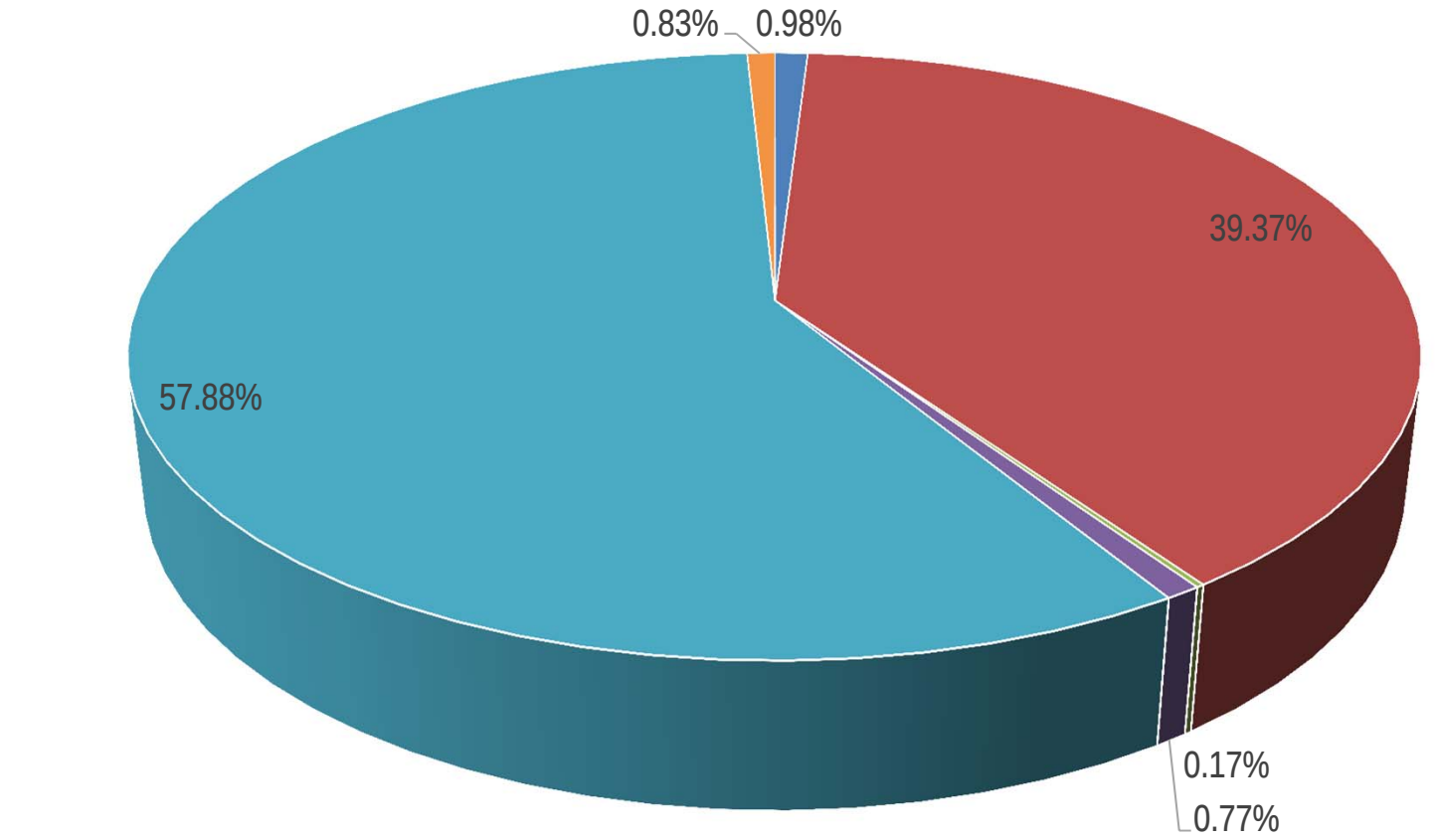
Processes

- Chromated primers
  - Wash primers
  - Epoxy primers
- Al chromate conversion coatings
  - Tanks
  - Touch-up Pens
- Cadmium brush plating
- Specialty coatings
  - CHOShield
  - Silk Screen red
- Chromate Seal
  - Phosphate Coatings
  - Cadmium Brush plating
- Stainless Steel welding
- Coatings Removal
  - Chemical
  - Physical

LEAD: All Processes by Species



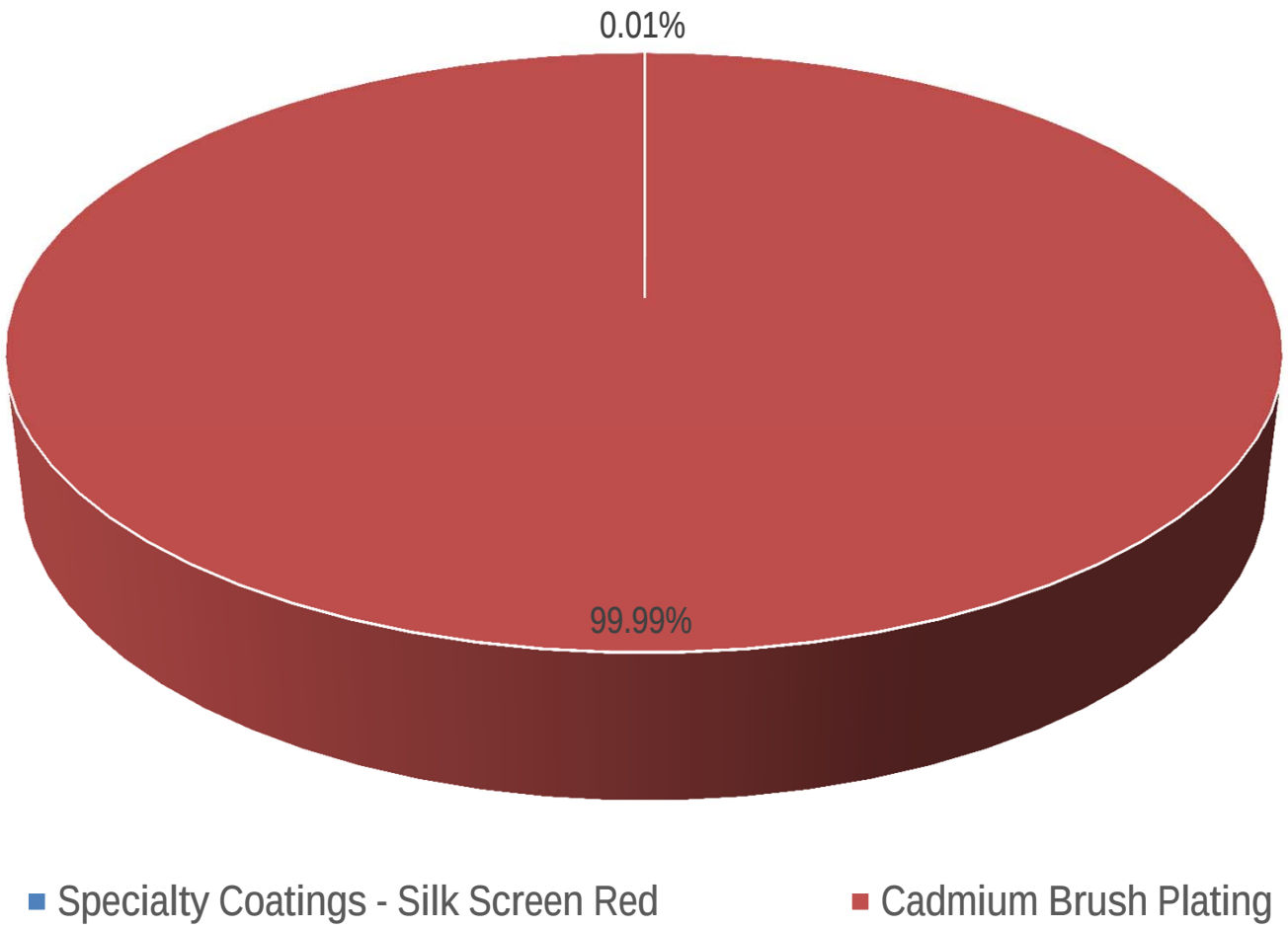
LEAD: Cr^{6+} Processes by Species



LEAD: Key Cr^{6+} Processes

- Chromated primers – Wash primers
- Chromated conversion coatings

LEAD: Cd Processes by Species



LEAD: Priority Initiatives

- Tier 1 initiatives
  - HAP-free, non-Cr(VI) wash primer
  - Non-chromate conversion coatings for Aluminum
  - Alternative to Cadmium brush plating
  - Reduction of Cr^{6+} and Cd Spent blast media
- Tier 2 initiatives
  - Non-chrome conductive EMI coating
  - Non-chrome sealer for phosphate coatings
- Tier 3 initiatives
  - Non-cadmium silk screen red

LEAD: Past and Current Efforts

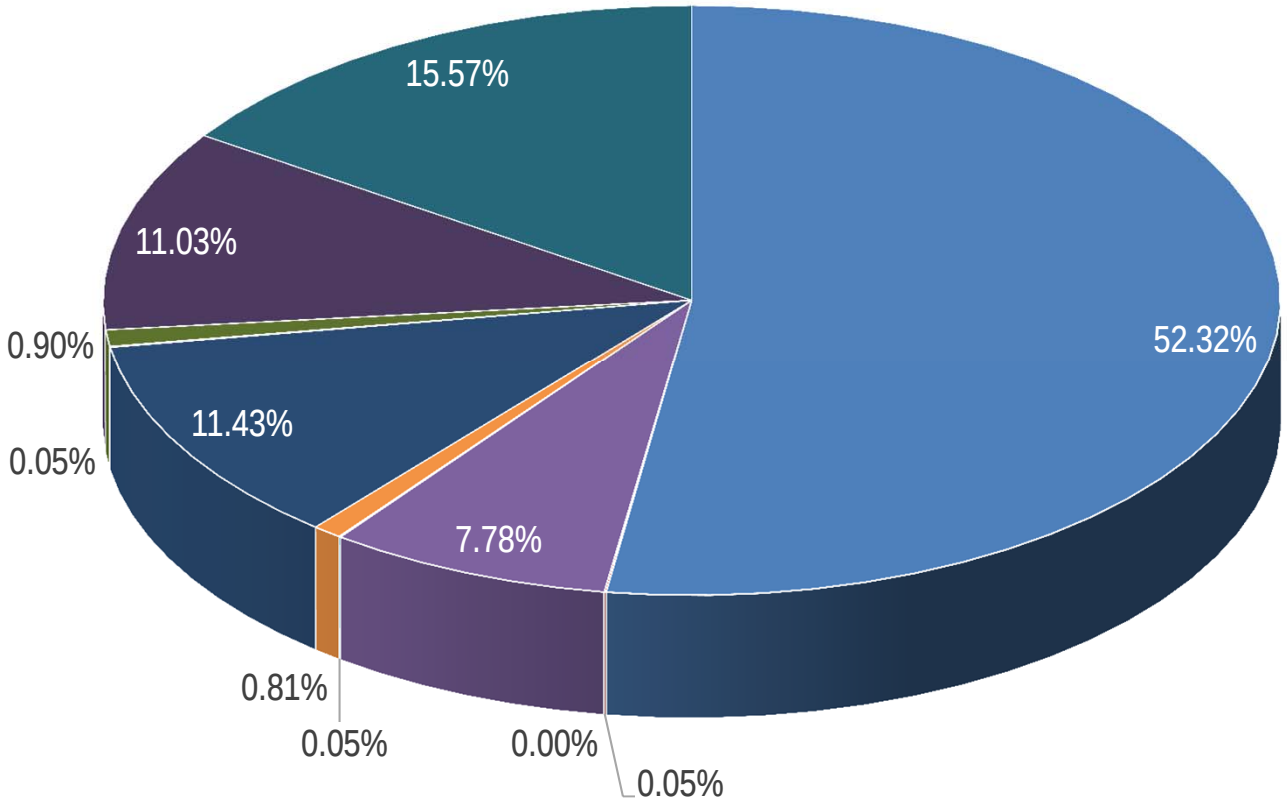
- Wash primers
  - Replacement Alternatives to the Chromate Wash Primer DOD-P-15328 (ARL)
  - Cr (VI)-Free, Low VOC Alternatives for Spray-in-Place, Mixed Metal Pretreatment (TMR 12-01)
  - Validation/Demonstration of a Zero-VOC/HAPS-NC Wash Primer for Department of Defense Weapons Platforms (WP-201621)
  - Non-Chromate, ZVOC Coatings for Steel Substrates on Army and Navy Aircraft and Ground Vehicles (WP-200906)
- Chromated conversion coatings
  - Cr(VI)-Free Conversion Coatings (TMR 14-02)

Fleet Readiness Center Southeast (FRCSE)

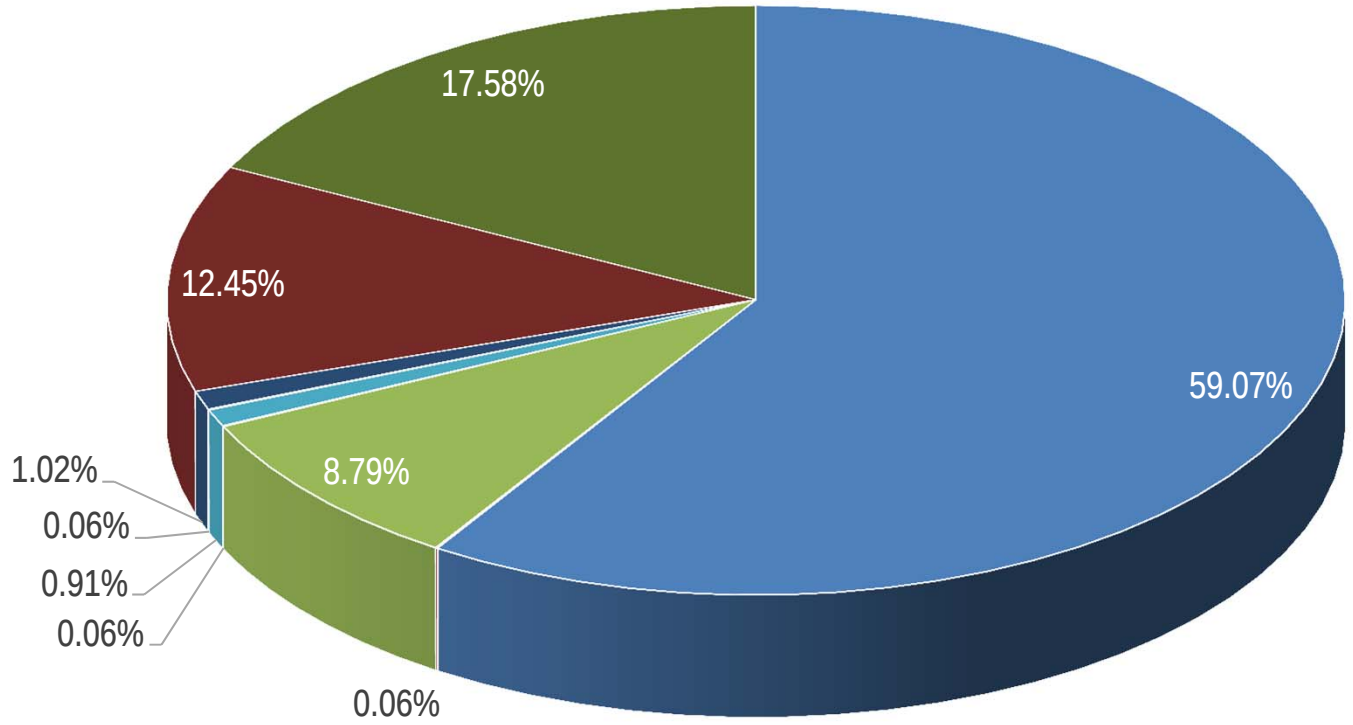
Processes

- Chromated primers
- Chrome plating
- Cadmium plating
- Chromate conversion coatings
  - Aluminum
    - Tanks
    - Spray-on
    - Touch-up pens
  - Magnesium
- Stainless steel passivation
- Adhesives and sealants
- Cadmium brush plating
- Chromate sealers
  - Anodize
  - Phosphate coatings
  - Cadmium brush plating
- Specialty coatings
  - SermeTel W
  - Black anodize dye
- Coatings removal
  - Chemical
  - Physical
- Stainless steel welding

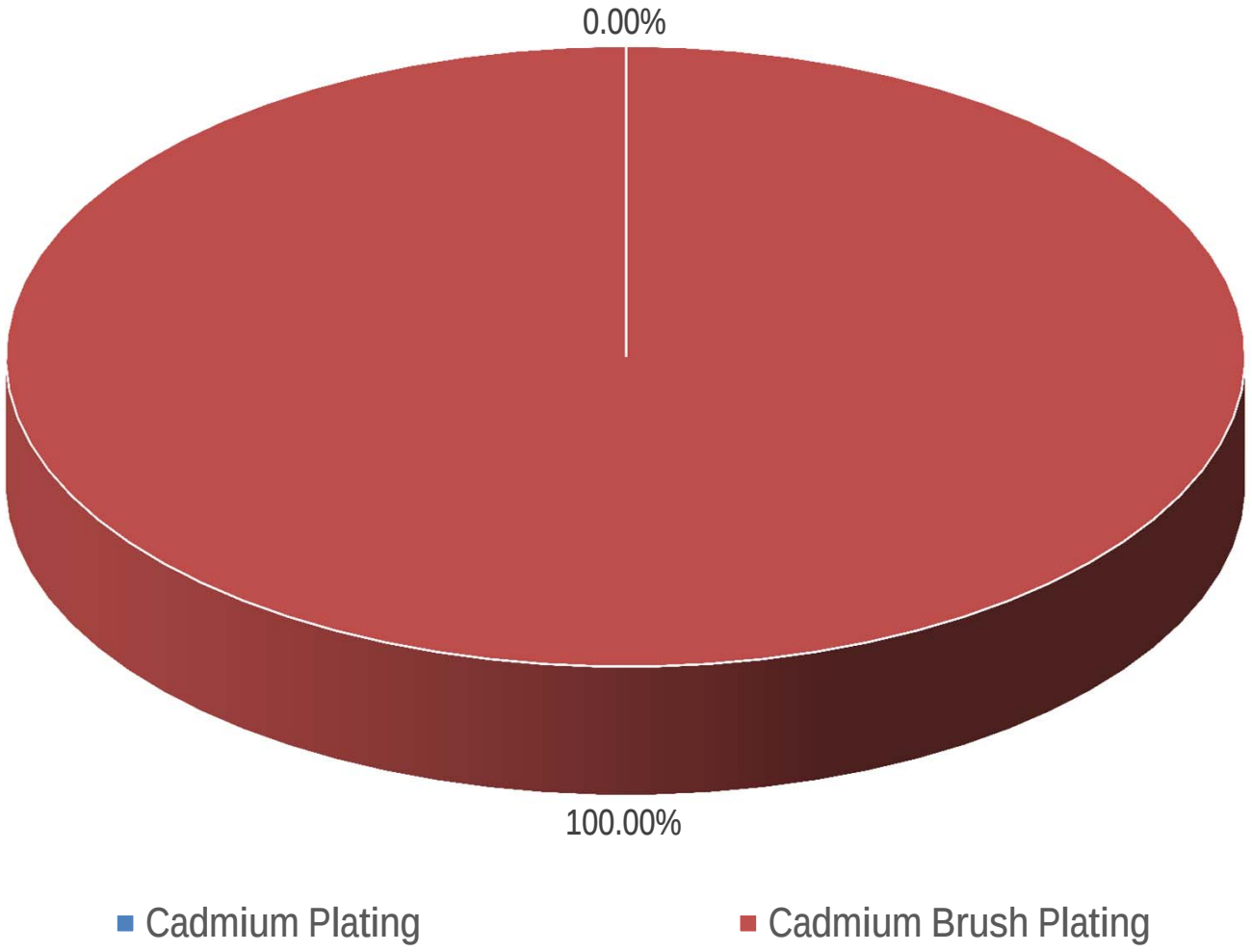
FRCSE: All Process by Species



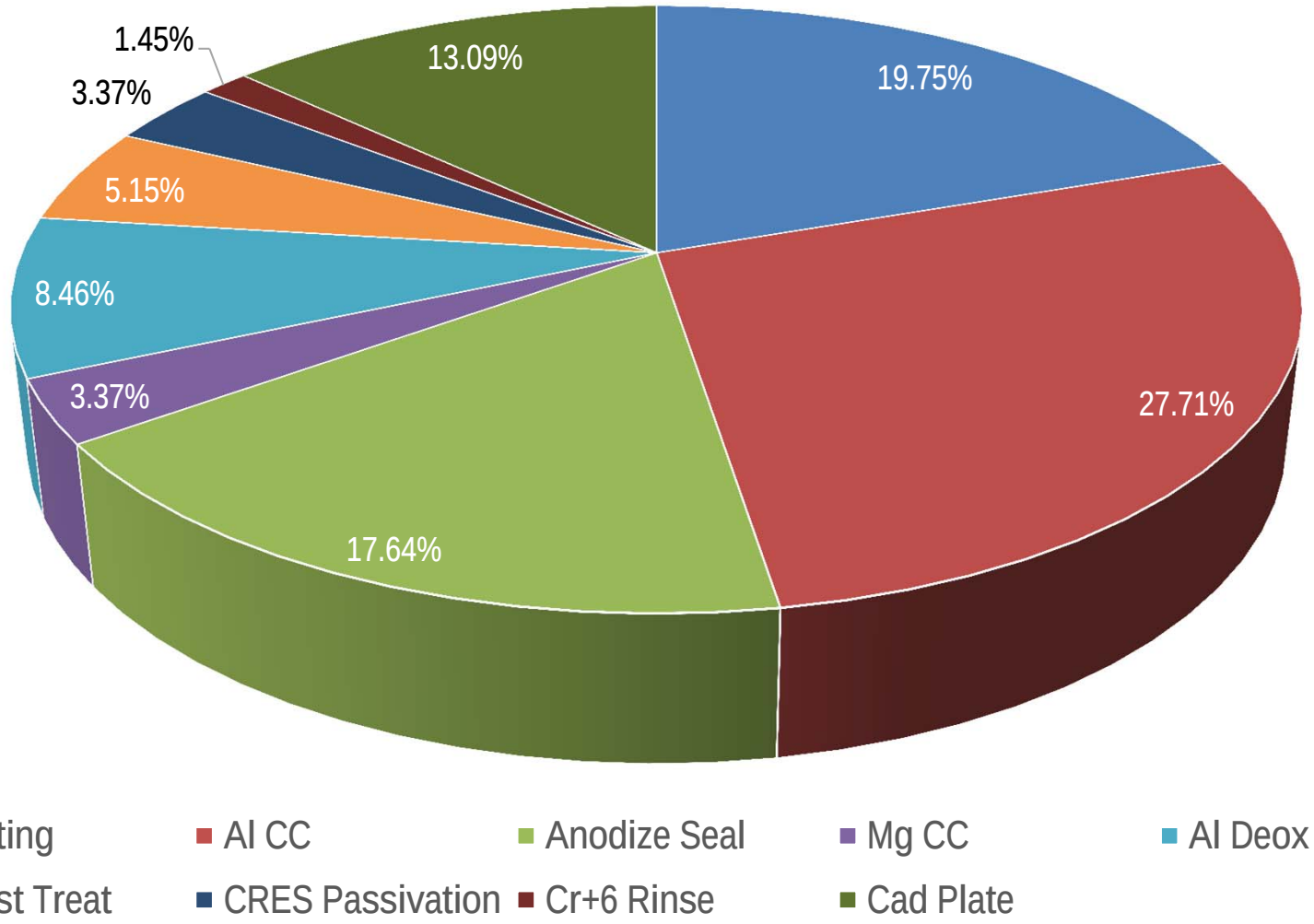
FRCSE: Cr^{6+} Processes by Species



FRCSE: Cd Process by Species



FRCSE: Cr^{6+} and Cd Infrastructure



FRCSE: Key Processes

- Cr^{6+}
  - Chromated primers
  - Chromated conversion coatings
  - Chrome plating
  - Chromated anodize seal
  - Stainless steel welding
- Cd
  - Cd brush plating
  - Cd plating (tank)

FRCSE: Priority Initiatives

- Tier 1 initiatives
  - Chrome-free primer on OML
  - Non-chrome primer on non-OML applications
  - Non-chromate conversion coatings for Aluminum
  - Alternative to hard chrome plating
  - Alternative to coatings removal processes to reduce Cr^{6+} containing waste streams
  - Alternative to cadmium brush plating
  - Alternative to cadmium plating
- Tier 2 initiatives
  - Non-chrome Al Oxidizer
  - Reduction of Cr^{6+} Emissions from stainless steel welding operations
  - Non-chrome stainless steel passivation
  - Non-chrome anodize sealer
- Tier 3 initiatives
  - Non-chrome anodize dye
  - Non/low chrome SermTel alternative

FRCSE: Past and Current Efforts

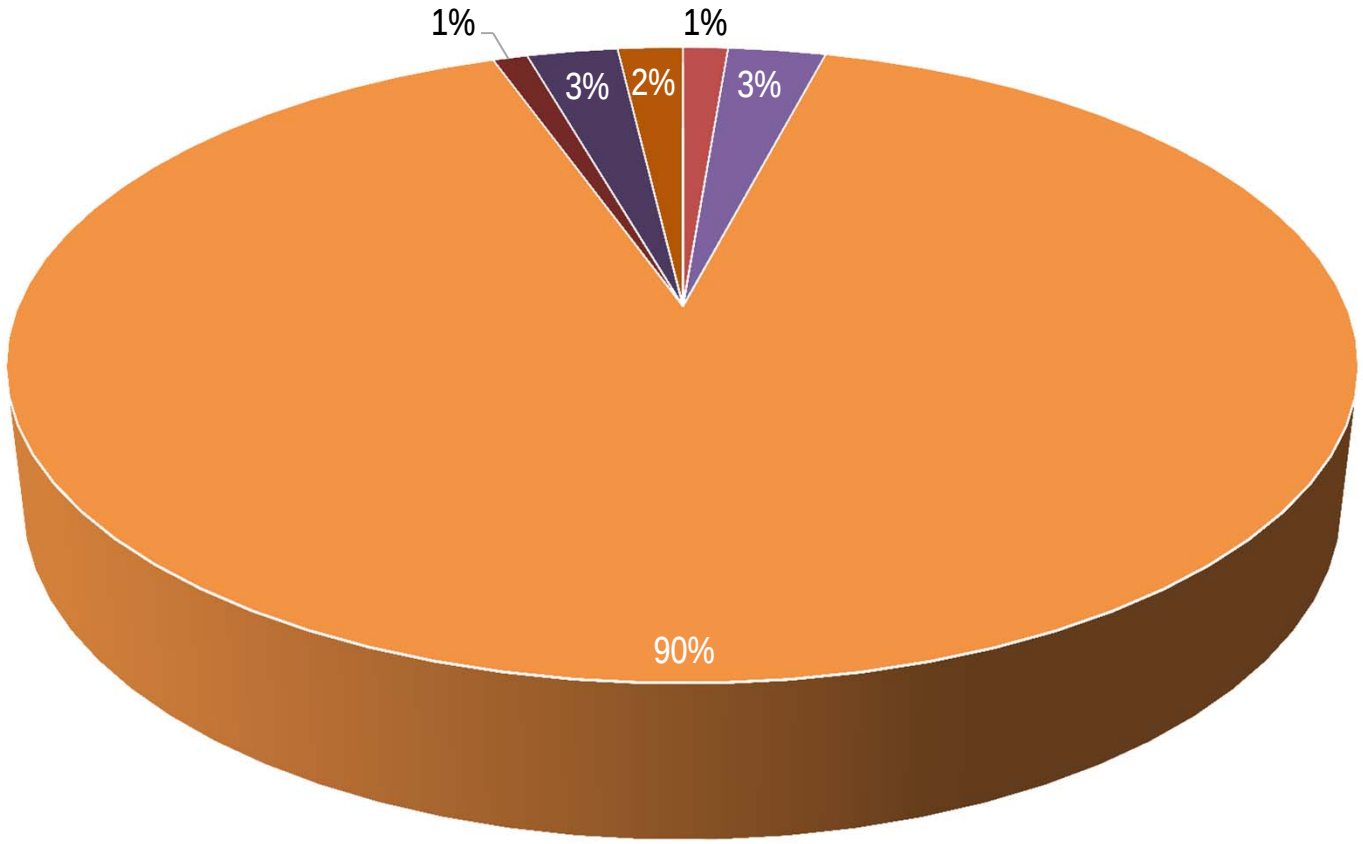
- Chromated primers
  - Non-Chrome Primers on OML of Gloss-Finish Aircraft
  - Non-Chrome Primers on OML of Tactical Aircraft
  - Comprehensive Evaluation and Transition of Non-Chromated Paint Primers (ESTCP WP-201132)
- Chrome plating
  - Electrodeposition of Nanocrystalline Co-P Coatings as a Hard Chrome Alternative (ESTCP WP-200936)
  - Nanocrystalline Cobalt Alloy Plating for Replacement of Hard Chrome and Thin Dense Chrome on Internal Surfaces (ESTCP WP-200411)
  - Industrial Implementation of Environmentally Friendly Nanometal Electroplating Process for Chromium and Cadmium Replacement Using Low Cost Pulse Current Power Supplies (ESTCP WP-200934)

Oklahoma City Air Logistics Complex (OC-ALC)

Processes

- Chromated primers
- Chrome plating
- Topcoats and specialty coatings
  - Ceral 34
  - TemperKote 1000 safety red
- Coatings removal and cleaners
  - Chemical
  - Physical
- Al chromate conversion coatings
- Adhesives and sealants
- Cadmium brush plating
- Chrome sealers
  - Anodize
  - Cadmium brush plating

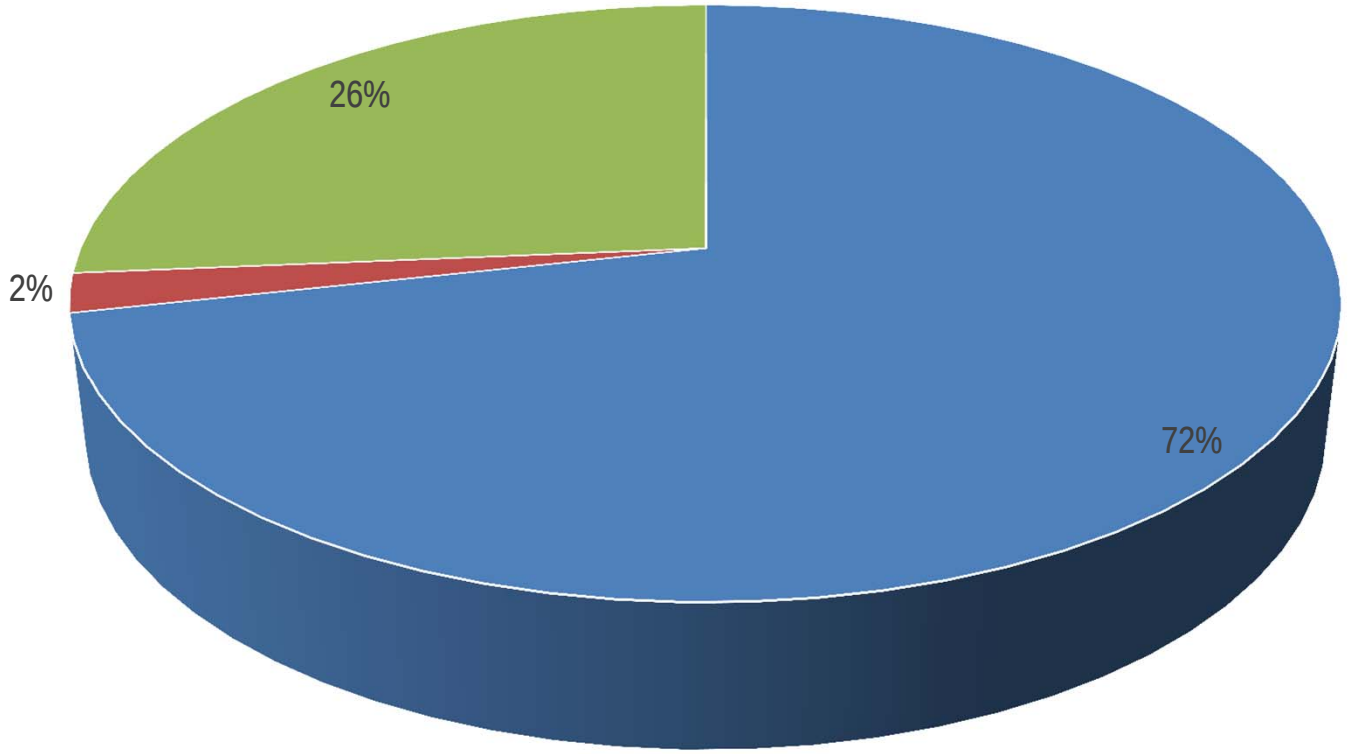
OC-ALC: Cr^{6+} Processes by Species



OC-ALC: Key Cr^{6+} Processes

- Chromated primers
- Chrome plating
- Chromated conversion coatings

OC-ALC: Cd Processes by Species



OC-ALC: Key Cd Processes

- Cd brush plating
- Specialty coating – safety red paint (TemperKote 1000)

OC-ALC: Priority Initiatives (Cont'd)

- Tier 1 initiatives
  - Non-chrome primer on aircraft Outer Mold Line (OML)
  - Non-chrome primer on non-OML Aircraft, components and commodities
  - Non-chrome primer on composite parts
  - Non-chrome electro-deposited E-Coat on KC-135 and E-3 parts
  - Alternative to cadmium brush plating
  - Non-cadmium containing safety red paint
  - Alternative coatings removal processes to reduce Cr^{6+}-containing waste streams
- Tier 2 Initiatives
  - Alternative to chrome plating
  - Alternative to dichromate sealers in anodizing operations
  - Non-chrome chemical conversion coatings for aluminum
  - Trivalent chrome Dipsol IZ-264 alternative on Zn-Ni plating
  - Non-chrome adhesives and sealants

OC-ALC: Past and Current Efforts

- Chromated primers
  - Prototype non-chromate coating system on E-3
  - Prototype non-chromate coating system on KC-135
  - Evaluate chemical stripping properties of the non-chrome Mg-rich coating system
  - Prototype non-chrome electro-deposited E-Coat on KC-135 and E-3 Parts
- Chromated conversion coatings
  - Non-chromate conversion coating on outer mold-line
  - Non-chromate conversion coating on flight controls
- Chromate sealers
  - Non-chrome sealer and primer for anodized parts
  - Trivalent chrome Dipsol IZ-264 for post treatment of zinc-nickel plating

Conclusions

- Dynamic strategy that will change as new data is received and new initiatives are launched
- In many cases, DoD and/or the depots have already initiated programs to address Tier 1 and 2 initiatives
- There is a need, however, for addition outreach and collaboration to ensure all stakeholders needs are addressed
- The Strategy compliments other DoD and Services programs such as the Toxic Metals Reduction (TMR) Program
- Need to capture additional data moving forward
  - Process data from additional depots (e.g., shipyard, rotary wing aircraft maintenance)
  - Hazardous materials data from all depots

Q&A Session 2

For additional information, please visit www.serdp-estcp.org

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